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Investigation of DNA/BSA binding of three Ru(II) complexes by various spectroscopic methods, molecular docking and their antimicrobial activity

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ABSTRACT

An intercalative ligand, ppip (ppip = {2-(4-(piperidin-1-yl)phenyl)-1*H*-imidazo[4,5-*f*][1,10]phenanthroline}), and its mononuclear Ru(II) polypyridyl complexes, [Ru(phen)₂(ppip)]²⁺ (**1**) (phen=1,10-phenanthroline), [Ru(bpy)₂(ppip)]²⁺ (**2**) (bpy=2,2'-bipyridine) and [Ru(dmb)₂(ppip)]²⁺ (**3**) (dmb=4,4'-dimethyl-2,2'-bipyridine), have been synthesized and characterized by elemental analysis and spectroscopic techniques such as UV-vis, IR, ¹H, as well as ¹³C NMR and ESI-MS. The interaction of these complexes with DNA/BSA (bovine serum albumin) was investigated using absorption, emission spectroscopy, viscosity measurements and molecular docking studies. The docking study infers that the binding strength (*K_b*) of these complexes was in agreement with results from absorption and emission techniques. These studies reveal that these three Ru(II) polypyridyl complexes bind to DNA/BSA. The binding ability of these complexes in the presence of different ions and solvents were also reported. All complexes were effectively cleaving pBR322 DNA in different forms and follows order which is similar to absorption and emission studies. These complexes were effective exhibiting the antimicrobial activity against different microbes *Bacillus subtilis*, *Escherichia coli* and *Staphylococcus aureus*.

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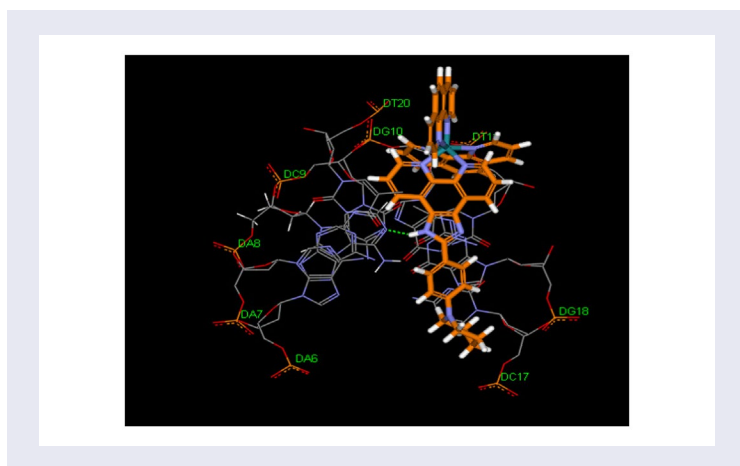
KEYWORDS

Ru(II) complexes; DNA/BSA binding; photocleavage studies; docking studies

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1. Introduction

Since DNA is the material of inheritance and controls the structure and function of cells, the binding of metal complexes with DNA has been extensively studied [1, 2]. Metal chelates which bind to DNA-strand as reactive models for protein–nucleic acid interaction provide routes toward rational drug design to develop sensitive probes for DNA structure [3] and to get information about drug design tools of molecular biology [4, 5]. Polypyridyl metal complexes can bind to DNA in a non-covalent interaction mode, such as groove-binding for ancillary ligands, electrostatic binding for cations [6], intercalative mode of binding for planar ligands and partial intercalative binding for incompletely planar ligands [7, 8]. Platinum metallodrugs are most effective DNA-binders used for the treatment of cancer, and three such agents (cisplatin, carboplatin and oxaliplatin) are in widespread use. However, they have limited potential efficacy due to side-effects, drug resistance phenomena, etc. Therefore, development of new alternative strategies for treatment of cancer is immediately required by finding new materials, based on different metals and ligands with the aim of enhancing specificity, reducing toxicity and thereby enhancing the therapeutic efficacy through non-covalent binding with DNA. Ruthenium-based compounds are known for their significance as drug nominees, though they have very little in common with the existing platinum-based drugs. Antitumor potential of these compounds was established over two decades ago, but interest to explore their cytotoxic profile was very low, possibly because they do not mimic cisplatin in their mode of action [9]. Various types of ruthenium(II) complexes are actively studied as metallodrugs; they are believed to have low toxicity and good selectivity for tumors. Recently some ruthenium compounds NAMI-A ([ImH][*trans*-Ru(III)Cl₄(Im)(DMSO)] and KP1019 ([Hind][*trans*-Ru(III)Cl₄(Ind)₂]) successfully completed phase-I clinical trials [10, 11].

Interactions between the ruthenium complexes and most abundant protein bovine serum albumin have great interest because of its structural homology with human serum albumin [12, 13]. It is well known that a drug in blood is bound to plasma proteins. Therefore, the absorption, distribution, metabolism, excretion properties, stability and toxicity of chemical substances can be significantly affected due to the binding of serum albumins, in the interim

maybe inducing the conformational changes of serum albumin. Studies on the binding of compounds with protein will also allow us to interpret the metabolism and transporting process of them.

There are several metal-based drugs in literature, especially ruthenium-based drugs to be used [14a–d]. Three major important properties of ruthenium complexes make it suitable for medicinal application: (i) the range of accessible oxidation states, (ii) the rate of ligand-exchange and (iii) the ability of ruthenium to mimic iron in binding to certain biological molecules. Ruthenium-based complexes show very good antimicrobial activity [14e–g]. The antimicrobial activity of organic chloroquine has been enhanced by binding to ruthenium. Organic chloroquine alone is 2 to 5-fold less effective than ruthenium(II)–chloroquine complex. Currently, ruthenium complexes are used as antiviral and antileukemic drugs, and also for the treatment of Crohn's disease [14b]. Based on this study we are inspired by the interest in the therapeutic application of ruthenium complexes.

Herein, we report the synthesis and characterization of three new ruthenium(II) polypyridyl complexes (**1–3**) with ppip = {2-(4-(piperidin-1-yl)phenyl)-1*H*-imidazo[4,5-*f*][1,10]phenanthroline} as an intercalating ligand by changing ancillary ligands. Our research group published several articles on interaction of ruthenium(II) polypyridyl complexes with CT DNA by inducing structural changes on intercalating as well as ancillary ligands [15–19]. The aim of the present investigation is to study in detail the interaction of Ru(II) polypyridyl complexes with DNA/BSA protein. The DNA/BSA-protein binding ability is studied by various spectroscopic methods like UV–vis, fluorescence spectroscopy and viscosity measurements. Effects of different ions and solvents on luminescence with these complexes are also noticed in the presence of DNA. All the complexes exhibited cleavage of plasmid pBR322 DNA effectively and showed antimicrobial activity.

2. Experimental

2.1. Materials

$\text{RuCl}_3 \cdot 3\text{H}_2\text{O}$, 1,10-phenanthroline, 2,2'-bipyridine, 4,4'-dimethyl-2,2'-bipyridine, 4-(piperidin-1-yl)benzaldehyde and BSA were purchased from Sigma Aldrich. pBR322 DNA was purchased from Bangalore Genie. All other chemicals and solvents were obtained from local existing sources. All solvents were purified before use as per standard procedures [20]. The spectroscopic titration was carried out in the buffer (5 mM Tris–HCl, 50 mM NaCl, pH 7.2) at room temperature. Solutions of DNA in Tris–HCl buffer (pH 7.2) gave a ratio of UV absorbance at 260 and 280 nm is 1.8–1.9, indicating that the DNA was sufficiently free from protein [21]. BSA titrations were performed in Tris–HCl buffer (pH 7.2).

2.2. Physical measurements

Elico-spectrophotometer (Model: BL 198) was used for the UV–vis absorption studies to determine the binding constants. Cary Eclipse instrument serial number (MY12400004) spectrofluorometer was used to record the fluorescence spectral data to determine the binding constant values. Ostwald Viscometer was used for viscosity measurements. KBr disks on a Perkin-Elmer FTIR-1605 spectrometer used to record IR spectroscopic data. The 400 MHz

Standard NMR using DMSO- d_6 as the solvent and TMS as an internal standard, Bruker Z Gradient single axis fitted high-resolution NMR Probe were used to measure the ^1H and ^{13}C NMR spectral data. Perkin-Elmer 240 elemental analyzer was used for varioMICRO CHNS analysis (C, H and N).

2.3. Synthesis and characterization of ligand and complexes

The starting materials 1,10-phenanthroline-5,6-dione(phen-dione) [22] *cis*-[Ru(phen) $_2$ Cl $_2$] \cdot 2H $_2$ O, *cis*-[Ru(bpy) $_2$ Cl $_2$] \cdot 2H $_2$ O and *cis*-[Ru(dmb) $_2$ Cl $_2$] \cdot 2H $_2$ O [23] were synthesized according to the reported literature methods. Chemical structures of Ru(II) complexes were given in Figure 1.

2.4. Synthesis of ligand

ppip (2-(4-(piperidin-1-yl)phenyl)-1*H*-imidazo[4,5-*f*][1,10]phenanthroline) was prepared by the addition of phen-dione (0.525 g, 2.5 mM), 4-(piperidin-1-yl)benzaldehyde (0.662 g, 3.5 mM), ammonium acetate (3.88 g, 50 mM) and glacial acetic acid (15 mL) which were refluxed together for 4 h as per Steck and Day [24], then cooled to room temperature and diluted with water. Dropwise addition of ammonia gave a yellow precipitate which was collected, washed with water, the crude product was recrystallized with C $_5$ H $_5$ N.H $_2$ O and dried. Yield: 86.9%. Analytical data: Elemental analysis for C $_{24}$ H $_{21}$ N $_5$: Calcd (%): C: 75.97; H: 5.58; N: 18.46; Found: C: 75.67; H: 5.539; N: 18.39; ESI-MS (CH $_3$ OH): m/z = 379.18 and obtained 380.2. ESI mass of ligand 380 (Figure S10 in Supporting Information). ^1H NMR (DMSO- d_6 , 400 MHz), δ (ppm): 8.92 (d, 2H), 8.11 (d, 2H), 7.81 (t, 2H), 7.11 (d, 2H), 6.99 (d, 2H), 3.28 (t, 4H), 1.57 (s, 6H); ^{13}C [^1H] NMR (100 MHz, DMSO- d_6), δ (ppm): 154.57 (C $_e$, 2C), 151.94 (C $_g$, 1C), 151.40 (C $_k$, 1C), 147.34 (C $_a$, 2C), 131.55 (C $_c$, 2C), 129.46 (C $_d$, 2C), 127.31 (C $_f$, 2C), 125.42 (C $_r$, 2C), 123.05 (C $_b$, 2C), 119.26 (C $_h$, 1C), 114.73 (C $_j$, 2C), 48.48 (C $_i$, 2C), 24.79 (C $_n$, 1C), 23.89 (C $_m$, 2C). IR (KBr, cm $^{-1}$): 1124 (C–N), 2929 (C–H).

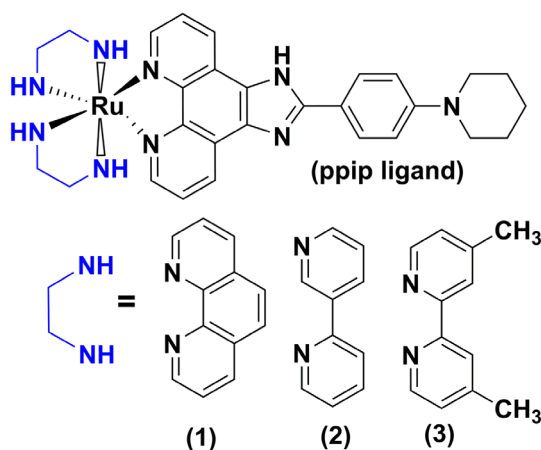


Figure 1. Chemical structure of ppip ligand and ruthenium(II) complexes 1–3.

2.5. Synthesis of 1–3

2.5.1. $[Ru(phen)_2(ppip)](ClO_4)_2 \cdot 2H_2O$ (1)

A mixture of *cis*- $[Ru(phen)_2Cl_2] \cdot 2H_2O$ (0.284 g, 0.5 mM), ppip (0.189 g, 0.5 mM) and ethanol (15 mL) was refluxed for 8 h under N_2 atmosphere. When the light-purple solution was obtained, it was cooled to room temperature and an equal volume of saturated aqueous solution of $NaClO_4$ was added under vigorous stirring. The brick-red solid was collected and washed with small amounts of water, ethanol and diethyl ether, then dried under vacuum. Yield: 66.86%. Anal. data for $RuC_{48}H_{41}Cl_2N_9O_{10}$: calcd C, 53.44; H, 3.84; N, 11.72; found: C, 53.35; H, 3.72; N, 11.79. ESI-mass of **1**: 841 (Figure S11 in Supporting Information). 1H -NMR (DMSO- d_6 , 400 MHz), δ (ppm): 9.03 (d, 6H), 8.78 (d, 6H), 8.38 (d, 2H), 8.12 (d, 2H), 7.97 (t, 6H), 7.78 (d, 2H), 7.14 (d, 2H), 3.33 (t, 4H), 1.61 (s, 6H). $^{13}C[^1H]$ NMR (100 MHz, DMSO- d_6), δ (ppm): 153.41 (C_g , 1C), 152.63 (C_a, C_1 , 6C), 149.89 (C_k , 1C), 147.24 (C_5 , 4C), 136.75 (C_3, C_r , 6C), 130.43 (C_4, C_e , 6C), 130.27 (C_r , 2C), 128.03 (C_6, C_d , 6C), 127.68 (C_r , 2C), 126.32 (C_2, C_b , 6C), 118.13 (C_h , 1C), 114.58 (C_j , 2C), 48.31 (C_l , 2C), 24.94 (C_n , 1C), 23.91 (C_m , 2C). IR (KBr, cm^{-1}): 624 (Ru–N), 1111 (C–N), 2924 (C–H) and 3404 (N–H).

2.5.2. $[Ru(bpy)_2(ppip)](ClO_4)_2 \cdot 2H_2O$ (2)

A mixture of *cis*- $[Ru(bpy)_2Cl_2] \cdot 2H_2O$ (0.260 g, 0.5 mM), ppip (0.189 g, 0.5 mM) and ethanol (15 mL) was refluxed for 8 h under N_2 atmosphere. When the light-purple solution was obtained, it was cooled to room temperature and an equal volume of saturated aqueous solution of $NaClO_4$ was added under vigorous stirring. The brick-red solid was collected and washed with small amounts of water, ethanol and diethylether, then dried under vacuum. Yield: 61.18%. Anal. data for $RuC_{44}H_{41}Cl_2N_9O_{10}$: calcd C, 51.42; H, 4.02; N, 12.26; found: C, 51.11; H, 4.01; N, 12.15. ESI-mass of **2**: 793 (Figure S12 in Supporting Information). 1H -NMR (DMSO- d_6 , 400 MHz), δ (ppm): 9.08 (d, 8H), 8.86 (t, 4H), 8.22 (d, 2H), 8.10 (t, 2H), 7.91 (d, 2H), 7.85 (d, 2H), 7.60 (d, 2H), 7.34 (d, 2H), 7.15 (d, 2H), 3.32 (t, 4H), 1.63 (s, 6H). $^{13}C[^1H]$ NMR (100 MHz, DMSO- d_6), δ (ppm): 156.76 (C_5 , 4C), 154.56 (C_g , 1C), 151.37 (C_a, C_1 , 6C), 149.38 (C_k , 1C), 144.57 (C_3 , 4C), 137.91 (C_r , 2C), 131.57 (C_e , 2C), 130.35 (C_d , 2C), 127.74 (C_l , 2C), 126.04 (C_4, C_r , 6C), 125.39 (C_b , 2C), 124.42 (C_2 , 4C), 118.19 (C_h , 1C), 114.63 (C_j , 2C), 48.34 (C_l , 2C), 24.95 (C_n , 1C), 23.81 (C_m , 2C). IR (KBr, cm^{-1}): 630 (Ru–N), 1085 (C–N), 2935 (C–H), 3412 (N–H).

2.5.3. $[Ru(dmb)_2(ppip)](ClO_4)_2 \cdot 2H_2O$ (3)

A mixture of *cis*- $[Ru(dmb)_2Cl_2] \cdot 2H_2O$ (0.288 g, 0.5 mM) ppip (0.189 g, 0.5 mM) and ethanol (15 mL) was refluxed for 8 h under N_2 atmosphere. When the light-purple solution was obtained, it was cooled to room temperature and an equal volume of saturated aqueous solution of $NaClO_4$ was added under vigorous stirring. The brick-red solid was collected and washed with small amounts of water, ethanol and diethyl ether, then dried under vacuum. Yield: 63.31%. Anal. data for $RuC_{48}H_{49}Cl_2N_9O_{10}$: calcd C, 53.19; H, 4.56; N, 11.63; found: C, 53.13; H, 4.21; N, 11.57. ESI-mass of **3**: 848.1 (Figure S13 in Supporting Information). 1H -NMR (DMSO- d_6 , 400 MHz), δ (ppm): 9.04 (d, 4H), 8.70 (d, 4H), 8.11 (d, 2H), 8.03 (d, 2H), 7.90 (d, 2H), 7.67 (d, 4H), 7.42 (t, 2H), 7.16 (d, 2H), 3.33 (t, 4H), 2.56 (s, 12H), 1.62 (s, 6H). $^{13}C[^1H]$ NMR (100 MHz, DMSO- d_6), δ (ppm): 156.29 (C_6 , 4C), 154.59 (C_g , 1C), 153.47 (C_k , 1C), 152.37 (C_a , 2C), 150.53 (C_1 , 4C), 149.51 (C_3 , 4C), 149.38 (C_e , 2C), 135.38 (C_r , 2C), 131.56 (C_l , 2C), 129.99 (C_d , 2C), 128.49 (C_5 , 4C), 127.78 (C_2 , 4C), 126.13 (C_r , 2C), 124.98 (C_b , 2C), 118.13 (C_h , 1C), 114.64 (C_j , 2C), 48.34 (C_l , 2C), 24.95 (C_n , 1C), 23.91 (C_m , 2C), 20.73 (C_4 , 4C). IR (KBr, cm^{-1}): 624 (Ru–N), 1080 (C–N), 2926 (C–H), 3419 (N–H).

2.6. DNA binding studies

All the solutions were prepared using doubly distilled water for DNA-binding interaction studies. The experiments involving the interaction of Ru(II) complex with CT-DNA were performed in Tris buffer (5 mM Tris-HCl, 50 mM NaCl, pH 7.1). Stock solution of CT-DNA was stored at 4 °C in the dark and used within 3 days after preparation. Stock solutions of Ru(II) complexes were prepared in DMSO. The absorption experiment of **1–3** in the buffer was performed by treating fixed concentration of complex (10 μM) to which increments (0–120 μM) of the DNA stock solution (0.617×10^{-4} M) were added. Before recording the absorption spectra of the mixture of complex-DNA, solutions were allowed to incubate for ~5 min. UV-vis spectra were recorded, after each addition of DNA solution and the intrinsic binding constant (K_b) calculated by using Equation (1) [25],

$$[\text{DNA}]/(\varepsilon_a - \varepsilon_f) = [\text{DNA}]/(\varepsilon_b - \varepsilon_f) + 1/K_b(\varepsilon_b - \varepsilon_f) \quad (1)$$

where [DNA] is the concentration of DNA, ε_a , ε_b and ε_f correspond to the apparent absorption coefficient $A_{\text{obsd}}/[\text{complex}]$, the extinction coefficient for the complex in the fully bound form and the extinction coefficient for the free complex, respectively. The graph plotted between $[\text{DNA}]/(\varepsilon_a - \varepsilon_f)$ and [DNA] gives the intrinsic binding constant (K_b). It is obtained from the ratio of slope to the intercept. Emission intensity measurements of the Ru(II) complexes were carried out by increasing concentration of DNA to the fixed concentration of complex. The spectra were recorded in the range 520–750 nm. The binding constant was calculated using Equation (2) [26],

$$C_b = C_t[(F - F_0)/(F_{\text{max}} - F_0)] \quad (2)$$

where C_t is the total complex concentration, F is the observed fluorescence emission intensity at a given DNA concentration, F_0 is the intensity in the absence of DNA, and F_{max} is the intensity of maximum complex bound to DNA. Binding constant was calculated from the Scatchard equation by a graph in between r/C_f versus r , where r is the $C_b/[\text{DNA}]$ and C_f is the concentration of free complex. Light switch experiment was performed on these complexes by the addition of equal concentrations of Co^{2+} and Na_2EDTA solutions at constant concentration of complex. Sensor studies of various cations and anions were performed by recording the changes in the emission spectra by adding different cations (Ni^{2+} , Fe^{2+} , Mn^{2+} , Cu^{2+} , Zn^{2+} , Mg^{2+} , Ba^{2+} , Cd^{2+} , Hg^{2+}) and anions (F^- , Br^- , Cl^- , H_2PO_4^- , CH_3COO^-) at predetermined concentration of complex and DNA. The stock solution of all tetrabutylammonium salts was prepared using double distilled water (0.01 M). Using different solvents, the emission spectra were recorded at predestined concentration of complex and DNA.

The UV-vis titration experiments were also carried out by the addition of complex to different pH buffer solutions taken in a cuvette at room temperature. The different pH-solutions were prepared according to the literature [27] and confirmed by pH-meter using glass electrode. The spectra were recorded after the solution was completely mixed. The fluorescence titration studies were done in a similar procedure with excitation wavelength fixed at ~427 nm and the spectra were recorded by changing the pH-solutions. Ostwald viscometer was used for the viscosity studies; the viscometer was immersed in thermostated water bath

to maintain constant temperature (30 ± 0.1 °C) by taking BPE buffer (6 mM Na_2HPO_4 , 2 mM NaH_2PO_4 , 1 mM Na_2EDTA , pH 7.0). The CT-DNA samples of approximately 200 base pairs in average length were prepared by sonication to minimize the complexes arising from DNA flexibility [28]. Using a digital stopwatch the flow time was recorded and each sample was repeated thrice; an average flow time was calculated. The calculated data were presented as $(\eta/\eta_0)^{1/3}$ versus concentration of $[\text{Ru(II)}]/[\text{DNA}]$ [29], where η is viscosity of DNA in the presence of the complex and η_0 is the viscosity of DNA alone.

2.7. Protein binding

All the BSA-binding studies were performed at room temperature. BSA solutions were prepared in 5 mM Tris–HCl buffer to keep pH value constant (pH 7.2) stored at -20 °C in the refrigerator and used within 4 days. UV–vis studies of BSA with Ru(II) complexes were performed by keeping the constant concentration of complex and successive additions of stock solutions of BSA (6×10^{-5} M), for each addition of BSA, spectra were recorded and calculated the binding constant [30]. The binding constant of complexes was determined using Equation (3),

$$[\text{BSA}]/(\varepsilon_a - \varepsilon_f) = [\text{BSA}]/(\varepsilon_b - \varepsilon_f) + 1/K_b(\varepsilon_b - \varepsilon_f) \quad (3)$$

where $[\text{BSA}]$ is the concentration of BSA, ε_a , ε_b and ε_f correspond to the apparent absorption coefficient $A_{\text{obsd}}/[\text{complex}]$, the extinction coefficient for the complex in the fully bound form and the extinction coefficient for the free complex, respectively. The graph plotted between $[\text{BSA}]/(\varepsilon_a - \varepsilon_f)$ and $[\text{BSA}]$ gives the intrinsic binding constant (K_b). The binding constant was obtained from the ratio of slope to the intercept.

In the fluorescence studies, the spectra of ruthenium(II) complexes were recorded in the presence and absence of BSA. The emission of BSA was performed by taking fixed concentration of the complex with increasing amounts of the BSA. The fluorescence spectra were recorded at an excitation wavelength of 420 nm and emission bands of **1–3** were observed between 600–640 nm; after each addition of BSA, the results were analyzed and calculated binding constants using Equation (2), where C_t is the total complex concentration, F is the observed fluorescence emission intensity at a given BSA concentration, F_0 is the intensity in the absence of BSA, and F_{max} is the complex is maximum bound to BSA. From the Scatchard equation, a graph was drawn in between the r/C_f versus r , and the binding constant was calculated, where r is the $C_b/[\text{BSA}]$ and C_f is the concentration of free complex.

2.8. Photocleavage experiments

Photocleavage experiment was performed using super coiled pBR322 DNA (0.5 $\mu\text{g}/\mu\text{L}$). Ru(II) complexes (10–40 μM) were treated with pBR322 DNA in buffer B (Tris–HCl, 18 mM NaCl buffer pH 7.2) and the resultant solutions were irradiated at room temperature with UV lamp (365 nm, 10 W). The samples were analyzed by electrophoresis for 1 h at 60 V on a 1% agarose gel in Tris–acetic acid–EDTA buffer, pH 7.2. The gel was stained with 1 $\mu\text{g}/\text{mL}$ ethidium bromide and photographed under UV-light.

2.9. Antimicrobial studies

Antimicrobial studies were performed by using standard disk diffusion method [31]. All the complexes were tested for their antimicrobial activity against *Bacillus subtilis* (*B. subtilis*), *Escherichia coli* (*E. coli*) and *Staphylococcus aureus* (*S. aureus*). Two different concentrations, 0.5 mg/mL (500 μ M) and 1 mg/mL (1,000 μ M), in DMSO were used for testing spore germination of each fungus. Filter paper disks of 5 mm size were prepared using Whatmann filter paper No.1 (sterilized in an autoclave) and saturated with 10 μ L of complexes, placed in the Petri dishes containing LB (Luria Bertini) agar media inoculated with *B. subtilis*, *E. coli* and *S. aureus* separately. The Petri dishes were incubated at 30 ± 0.2 °C and the zones of inhibition were recorded after 24 h. The plates were then observed and the diameters of the inhibition zones (in mm) were measured and tabulated. These results were compared with standard antibacterial drug Ampicillin at the same concentration.

2.10. Molecular docking studies

Molecular docking was performed by CDOCK module in Discovery studio program, to study the binding affinity of the Ru(II) complexes with DNA. CDOCKER is a grid-based molecular docking method that employs CHARMM force field [32]. The PDB 2L8I DNA sequence (5'-D(GCTGCAAACGTCG)-3') was used for docking studies and minimized by CHARMM force field. The structures of the Ru(II) complexes taken for binding analysis are drawn using Chemskech and saved in mol2 format. The saved complexes are later imported and minimized in Discovery Studio. The 3-D structure is generated using catalyst algorithm in Discovery Studio. All the complexes were docked into the DNA using CDOCKER. For each of the docking case, the lowest energy confirmation was selected. CDOCK Score is used to estimate the binding energies of top-ranked conformations. Free binding energy of the ligand from a given pose is estimated by CDOCK Score function.

3. Results and discussion

3.1. Synthesis and characterization

Synthesized three Ru(II) polypyridyl complexes and the intercalating ligand structures are shown in Figure 1; these structures were confirmed by different spectral studies.

In the IR spectra, the ligand (PPIP) vibrations attributed to $\nu(\text{N-H})$ at 3149 cm^{-1} and $\nu(\text{C-N})$ at 1124 cm^{-1} are shifted to $\nu(\text{N-H})$ at $\sim 3410\text{ cm}^{-1}$ and $\nu(\text{C-N})$ at $\sim 1085\text{ cm}^{-1}$ after complex formation. A metal-ligand charge-transfer characteristic band observed at 624 cm^{-1} for **1**, 630 cm^{-1} for **2** and 624 cm^{-1} for **3** is assigned to $\nu(\text{Ru-N})$ [33] which did not appear in free ppip. It indicates that, all six Ru-N bonds have same bond lengths showing perfect octahedral structure.

In the ^1H NMR Spectra, the atoms H_i and $\text{H}_{m,n}$ of ppip gives peak at 3.28 and 1.57 ppm, respectively; after the formation of the complex, these protons were shifted upfield around ~ 3.41 and 1.62 ppm, respectively. In each complex, as protons are very labile and fast proton exchange between two imidazole N's, therefore no peak was observed for the N-H group of imidazole ring [34, 35].

In the ^{13}C [^1H] NMR spectra, the ^{13}C data of all the complexes have given the characteristic peaks at 48.31 (C_p), 24.94 (C_n) and 23.91 (C_m) ppm of cyclohexane, confirming the formation of the complex.

In the UV–vis spectra, all the complexes exhibit metal-to-ligand charge-transfer band in the range of 420–440 nm. It confirms the formation of the complex, since **1–3** showed MLCT bands at ~420, 432 and 437 nm, respectively.

3.2. Interaction with DNA

3.2.1. UV–vis spectral studies

The interaction of DNA with Ru(II) complexes was investigated by UV–vis absorption spectroscopy. The UV–vis spectra of Ru(II) complexes were significantly affected by the addition of DNA. The absorption bands of **1–3** are around 430 nm and the absorbance intensity decreased (hypochromicity) upon addition of 10 μM CT-DNA. The absorption bands of **1–3** were found at 420, 432 and 437 nm with hypochromism of about 20.91, 19.79 and 14.39%, upon addition of DNA, respectively. These spectral changes were a result of these complexes bound to DNA through intercalation [36, 37]. The “hypochromic effect” was due to the dissociation of ligand aggregates or due to its external contact (surface binding) with the duplex by engaging in hydrogen bonding interactions between the coordinated NH and OH groups with the functional groups positioned on the edge of DNA bases [38]. The intrinsic binding constants as calculated by Equation (1) are 2.8×10^5 , 2.5×10^5 and $2.2 \times 10^5 \text{ M}^{-1}$ for **1**, **2** and **3**, respectively (Table 1). These values are in good agreement with previously reported similar ruthenium(II) polypyridyl complexes $[\text{Ru}(\text{phen})_2(\text{MAFIP})]^{2+}$ ($5.15 \times 10^5 \text{ M}^{-1}$) and $[\text{Ru}(\text{bpy})_2(\text{MAFIP})]^{2+}$ ($3.31 \times 10^5 \text{ M}^{-1}$) [15]. The binding strength of the complexes follows the order **1** > **2** > **3**. Due to more planarity available on ppip ligand and no steric hindrance in ancillary ligands, **1** shows high K_b value and **3** shows less strength due to steric hindrance of ancillary ligands. Absorption spectrum of **2** is given in Figure 2 and for **1** and **3** are given in Supporting Information (Figure S1).

3.2.2. Fluorescence studies

Luminescence spectroscopy is one of the most sensitive and useful way to analyze drug interactions with biomolecules such as DNA. The emission spectrum was recorded keeping the complex concentration constant with increasing DNA concentration. The fluorescence intensity increases with the interaction of Ru(II) complexes with CT-DNA. It was due to the hydrophobic environment inside the DNA helix reduces the accessibility of solvent H_2O molecules with complexes and complex mobility was restricted at the binding site, leading to the decreasing relaxation and increasing fluorescence intensity. The excited bands appeared at 601, 602 and 617 nm for **1**, **2** and **3**, respectively. The binding constant was calculated using modified Scatchard equation [26] and plot between r/C_f versus r , where r is the $C_\text{p}/[\text{DNA}]$ and

Table 1. Absorption, emission, and quenching binding constants of ruthenium(II) complexes with CT-DNA.

Complex	K_b for absorption (M^{-1})	K_b for emission (M^{-1})
$[\text{Ru}(\text{phen})_2(\text{ppip})]^{2+}$	$1.8(\pm 0.015) \times 10^6$	$9.0(\pm 0.024) \times 10^6$
$[\text{Ru}(\text{bpy})_2(\text{ppip})]^{2+}$	$1.1(\pm 0.012) \times 10^6$	$5.2(\pm 0.032) \times 10^6$
$[\text{Ru}(\text{dmb})_2(\text{ppip})]^{2+}$	$0.9(\pm 0.019) \times 10^6$	$4.5(\pm 0.029) \times 10^6$

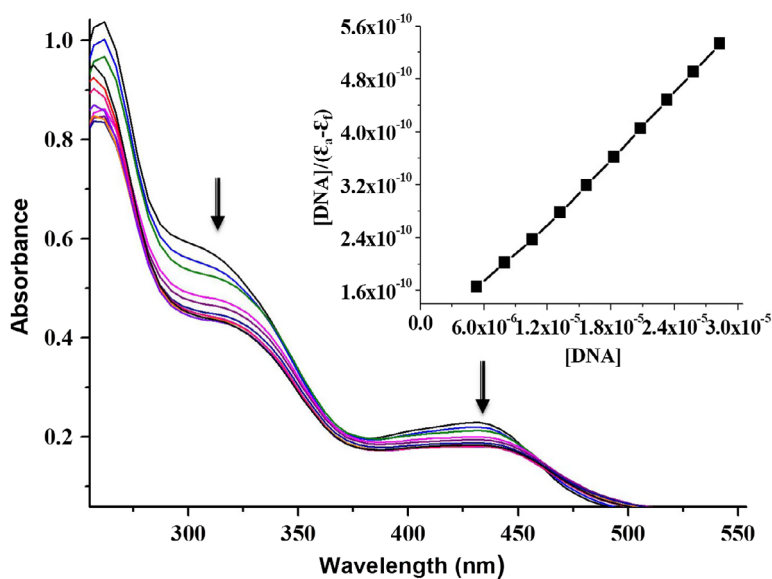


Figure 2. Absorption spectra of **2** (for **1** and **3** are given in Supporting Information) in the absence (top) and presence (lower) of CT-DNA in Tris-HCl buffer. The stock solution complex concentration (0.001 M) is added 10 μM to Tris-HCl buffer having cuvette, and DNA stock concentration (0.617×10^{-4} M) is added 0–120 μM . Arrow shows changes upon increase of DNA concentration. Inserted plot, $[\text{DNA}]/(\epsilon_a - \epsilon_f)$ vs. $[\text{DNA}]$ for the titration of DNA with Ru(II) complex which gives intrinsic binding constant (K_b).

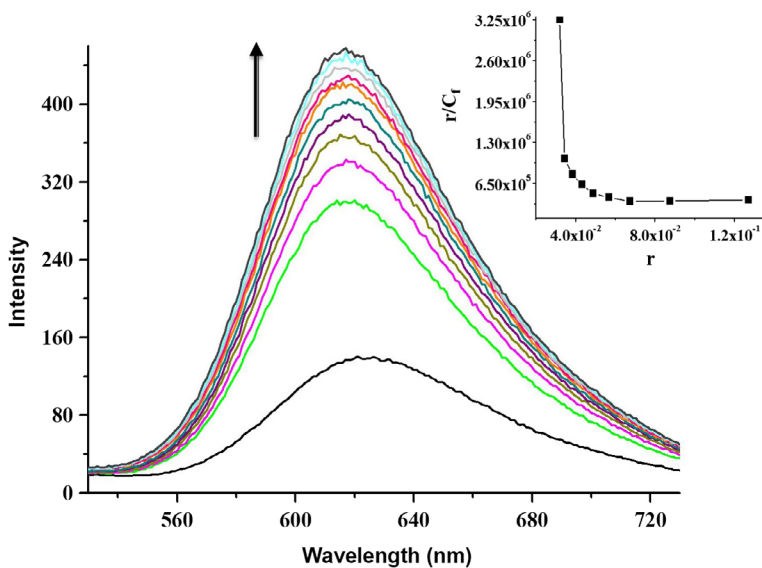


Figure 3. Emission spectra of **1** (for **2** and **3** are given in Supporting Information) in Tris-HCl buffer upon addition of CT-DNA. The arrow shows the intensity change upon increase in DNA concentration. Inset: Scatchard plot of above complex, which gives binding constant (K_b).

C_f is the concentration of the free metal complex. The binding constant (K_b) values are 2.0×10^5 , 1.8×10^5 and $1.0 \times 10^5 \text{ M}^{-1}$ for **1**, **2** and **3**, respectively (Table 1). The difference in the binding constant is due to change in ancillary ligand. These values are comparable with calculated binding constants using absorption technique. The order of complexes is **1** > **2** > **3**. Complex **3** has lower value due to steric hindrance. Emission spectrum of **1** is given in Figure 3 and **2** and **3** are given in Supporting Information (Figure S2). As previously reported [29], fluorescence quenching experiments were performed at ambient temperature and constant ionic strength with KCl as a neutral electrolyte and $K_4[Fe(CN)_6]$ as the quenching agent. This further supports the binding of complex with DNA. In the absence of DNA, complexes were efficiently quenched by quencher while in the presence of DNA, quenching was less because the highly negatively charged $[Fe(CN)_6]^{4-}$ species would be repelled by the negative charge of the phosphate backbone of DNA, which would obstruct the quenching emission of the bound complexes. All complexes showed linear Stern–Volmer plots (Table 1). The Stern–Volmer quenching constant K_{sv} can be determined by using Equation (4),

$$I_0/I = 1 + K_{sv}[Q] \quad (4)$$

where I_0 is the fluorescence intensity in the absence of a quencher, I is the fluorescence intensity in the presence of a quencher, Q is the concentration of the quencher and K_{sv} is a linear Stern–Volmer quenching constant; figures are given in Supporting Information (Figure S3).

Another application of emission study is that by adding DNA to the complex its emission intensity increased (light switch on), because complex was bound to DNA and form DNA-complex. While adding cobalt(II) ion into the resultant solution, the emission of complex

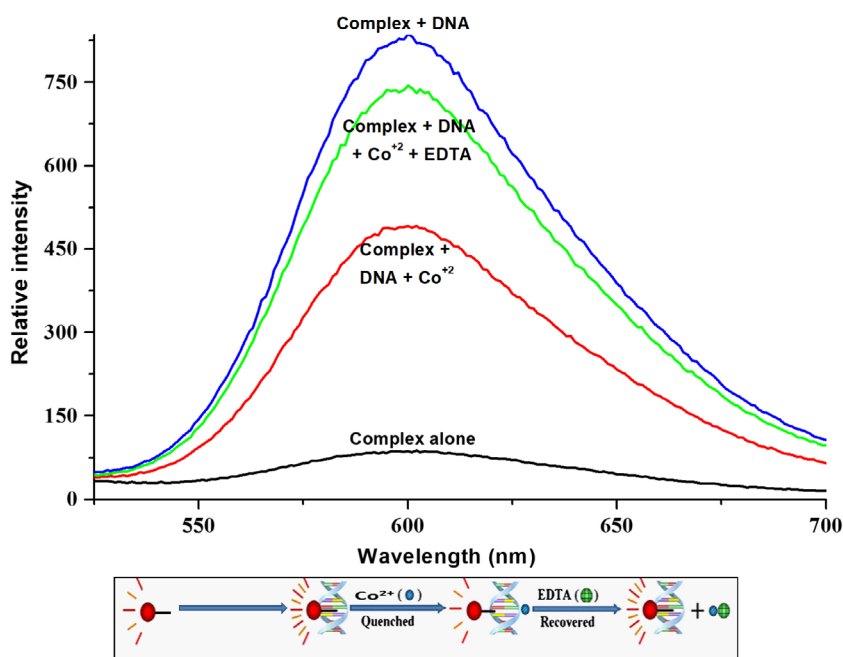


Figure 4. (A) DNA-light switch on and off experiment showing the luminescence changes upon addition of Co^{2+} , EDTA and DNA to **1** and (B) graphical expression of light switch off and on experiment.

was quenched, thus turning the light switch off [39]. The addition of Co^{2+} to complex-bound DNA resulted in loss of luminescence due to the formation of heterometallic complex with imidazole nitrogens of ligand. On the addition of EDTA into the buffer system containing heterometallic solution, the emission intensity of the complex was recovered again (light switch on) (Figure 4). It indicated that heterometallic complex became free again due to EDTA- Co^{2+} complex formation. Similar observations were found for all complexes.

3.2.3. Sensor effect

Fluorescence studies were conducted in order to estimate the capability of the receptors to operate as a fluorescent cation and anion sensors. In these studies, by keeping complex and DNA concentration constant, changing different cations (Ni^{2+} , Fe^{2+} , Mn^{2+} , Cu^{2+} , Zn^{2+} , Mg^{2+} , Ba^{2+} , Cd^{2+} , Hg^{2+} , Pb^{2+}) and anions (F^- , Br^- , Cl^- , H_2PO_4^- , CH_3COO^-) the spectra were recorded. We observed that emission band of different cations at 600 nm as shown in Figure 5(A). All cations showed sensing property with DNA. Some cations showing increasing intensity and others decreasing; it is due to the effective magnetic moment and binding ability with DNA or complex. For the cations Ba^{2+} , Pb^{2+} , Cd^{2+} , Hg^{2+} and Mg^{2+} intensity is increasing while for Ni^{2+} , Fe^{2+} , Mn^{2+} , Cu^{2+} and Zn^{2+} intensity is quenched; among all these cations, Hg^{2+} shows high sensitivity due to its inherent advantage of high sensitivity and selectivity as well as providing real-time chemical analysis and Ni^{2+} has more quenching property. Among anions, intensity of H_2PO_4^- , F^- increased whereas that of Br^- , CH_3COO^- decreased but for Cl^- , it neither increased nor decreased. This was probably due to the high electronegativity, binding capacity of the anions with DNA or complex (Figure 5(B)) [40].

3.2.4. Solvent effect

Solvents have an effect on solubility, stability and reaction rates. To know the solvent effects on this, we used different solvents at fixed concentration of complex and DNA, the emission spectra were recorded. The non-aqueous solvents such as CHCl_3 , CH_2Cl_2 , ethanol, methanol and MeCN were monitored at 500–750 nm; we got the emission band at ~600 nm. It depends on two factors: (i) the polarity of the non-aqueous solvents and (ii) the steric factor of the complex-solvent. As polarity of the solvent increases, its intensity increases, as steric factor

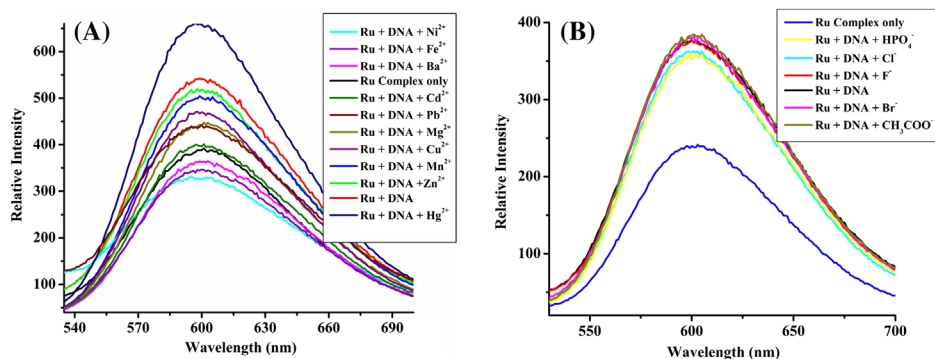


Figure 5. Comparison of emission intensity of **1** and DNA in the presence of (A) various cations (0.01 M) and (B) anions (0.01 M) at room temperature in Tris–HCl buffer.

increases its intensity decreases. Similar phenomenon was observed in other complexes under analogous condition (Figure S4 for **1**) [41, 42].

3.2.5. pH Effect

UV-vis spectroscopy can create considerable impact on the pH of the sample solution. UV-vis spectrophotometric pH titrations were carried out with pH range from 3 to 11. The spectral change indicates that the complex undergoes protonation/deprotonation of imidazole proton at different pH range (Figure S5). We observed pH values in two intervals from 3 to 5 and 7 to 11. As increasing pH from 3 to 5 and 7 to 11, the absorption intensities decreased. These changes were observed due to the dissociation of one proton on the imidazolium group. In deprotonation step, as increasing pH from 5 to 7 from the neutral imidazole. The absorption intensities were increased [43]. The emission spectral changes in aqueous solution at different pH are shown in Figure S6. We can see that the complex emission spectra are sensitive to pH of this solution. As increasing pH from 3 to 5, the emission intensity gradually decreases with protonation of imidazole group and the intensities almost remained constant for pH from 5 to 7. As the pH increased from 7 to 11, a small change in emission intensity was observed at 605 nm, indicating the deprotonation process. These are in accordance with the UV-vis spectral values.

3.2.6. Viscosity measurements

In the absence of crystallographic data, viscosity studies were performed to measure DNA-length changes, which are sensitive and most vital assessments of the DNA-binding mode. In classic intercalation mode, elongation of the DNA-helix takes place. The distances between the adjacent base pairs increased to host the Ru(II) complex, which leads to enhancement of the viscosity (length) of the DNA. A partial or non-classical intercalation mode would bend (or kink) the DNA strands reducing the effective length of the DNA molecule as well as the DNA viscosity. In addition, groove and electrostatic bindings have shown little effect on DNA viscosity [44]. Upon consecutive additions of the Ru(II) complexes **1–3**, viscosity of the solution increased as shown in Figure 6. If the DNA binders are planar and their dimensions were similar to the base pairs of the DNA, the classic intercalation occurs typically. From this observation, we found that our complexes are bound in between the base pairs of DNA, so the viscosity of the complexes increases in the order **1** > **2** > **3**. These results confirm that these Ru(II) complexes intercalate in between base pairs of DNA.

3.2.7. BSA protein-binding studies with UV-vis and fluorescence spectral methods

The absorption studies were performed to understand the mode of interaction of **1–3** with BSA and the changes in absorption intensity were recorded by changing concentration of BSA protein, as in CT-DNA binding studies [45]. By keeping constant concentration of complex, increasing BSA concentration the absorption intensity of **1–3** recorded. Hypochromism at ~450 nm was observed (Figure 7(3)), indicating that the complexes were bound to BSA. A comparable spectral pattern was observed for **1–3** and the binding constant (K_b) was calculated at 450, 465 and 470 nm, respectively (Table 2), following the order **1** > **2** > **3**. The emission properties of BSA occur from intrinsic characteristics of the proteins it is mainly due to the presence of tryptophan and tyrosine residues. Changes in the emission spectra take place primarily from the tryptophan residue because of protein conformational changes, sub unit association, substrate binding, or denaturation [46–49]. Fluorescence titration

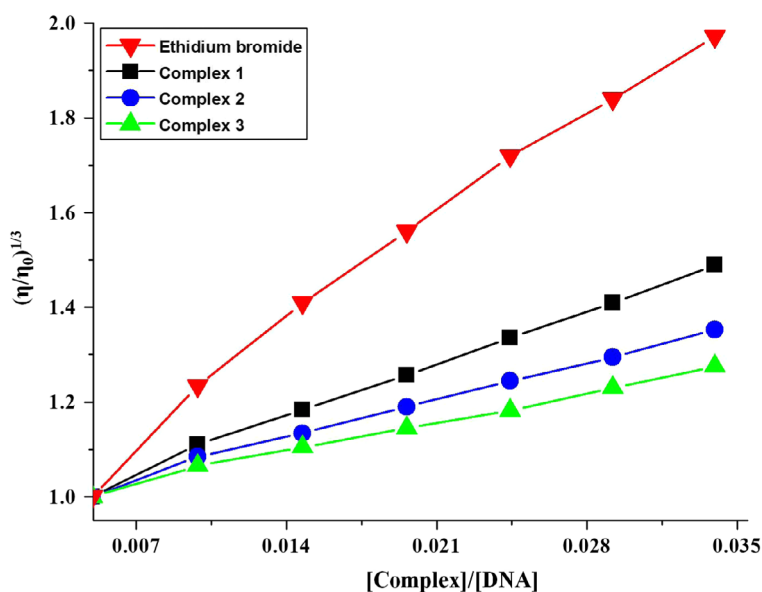


Figure 6. Viscosity studies of 1–3 in BPE buffer with increasing amounts of complexes and ethidium bromide (EtBr) on the relative viscosity of calf thymus DNA at room temperature.

Table 2. Absorption and emission binding constants of ruthenium(II) complexes with BSA protein.

Complex	K_b for absorption (M^{-1})	K_b for emission (M^{-1})	K_{sv} (M^{-1})
$[Ru(phen)_2(ppip)]^{2+}$	$2.8(\pm 0.014) \times 10^5$	$2.0(\pm 0.032) \times 10^5$	10,325
$[Ru(bpy)_2(ppip)]^{2+}$	$2.5(\pm 0.011) \times 10^5$	$1.8(\pm 0.026) \times 10^5$	10,161
$[Ru(dmb)_2(ppip)]^{2+}$	$2.2(\pm 0.016) \times 10^5$	$1.0(\pm 0.023) \times 10^5$	6108

studies were performed at room temperature by keeping constant concentration of 1–3 (2 μM) and variable concentration of BSA (10–100 μM), and the spectrum was recorded in the wavelength range 500–700 nm. The fluorescence intensity of BSA at 590–625 nm showed a small hypsochromism of 2, 4 and 9 nm for 1–3, respectively (Table 2), fluorescence spectrum of 2 is given in Figure 7(2). It is due to the presence of hydrophobic environment in protein. It suggests that, some interaction takes place between the complexes and the BSA protein. The binding constants are calculated from emission studies also follow the order 1 > 2 > 3.

3.2.8. Photo-activated cleavage studies

The photo-excited states of metal complexes are known either indirectly or directly damage DNA. Therefore, we studied the effect of photoexcitation reaction of 1–3 with plasmid DNA. The ability of 1–3 to cleave plasmid DNA upon irradiation was resolved by using gel-electrophoresis with supercoiled pBR322 DNA. Agarose gel-electrophoresis is an effective method used to identify, separate and purify nucleic acid fragments (RNA and DNA). The various forms of pBR322 DNA can be separated as supercoiled (form I), nicked circular (form II) and linear (form III) having same molecular weight drifts at different rates through agarose

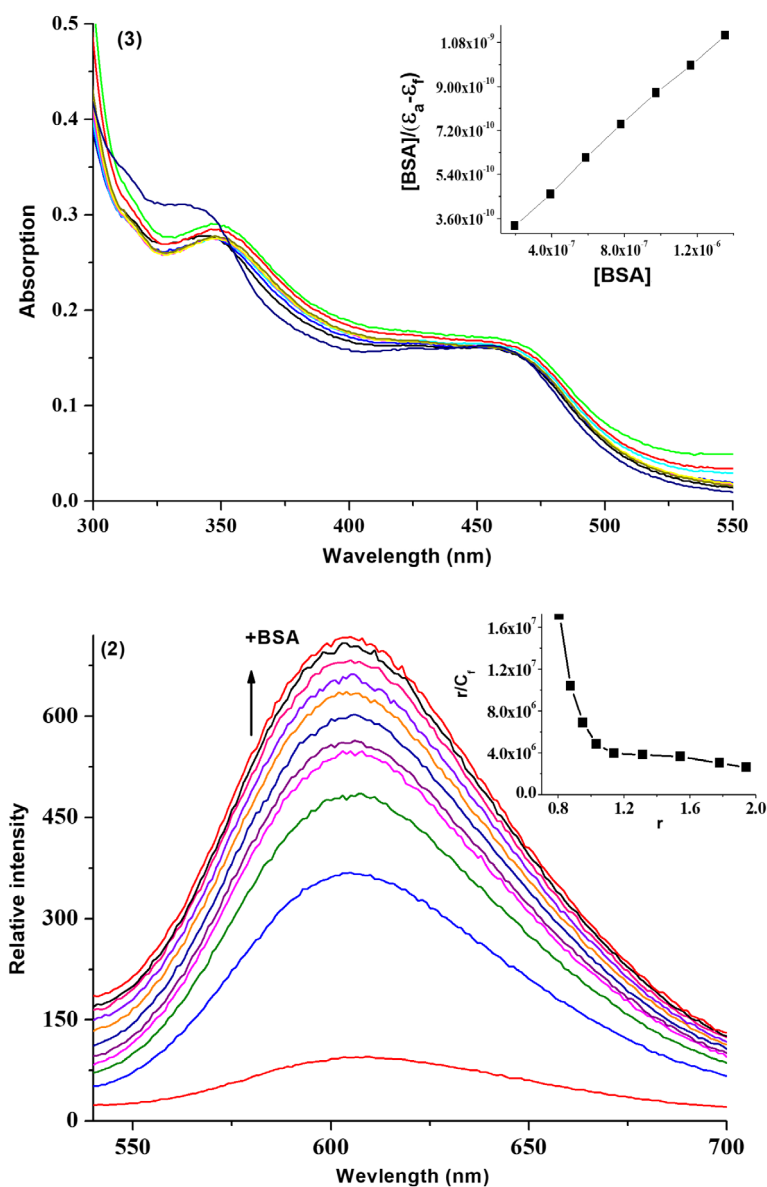


Figure 7. Absorption and emission spectra of **3** and **2** in Tris-HCl buffer. Spectra of **1** and **2** (for absorption) and **1** and **3** (for emission) are given in Supporting Information (S7) upon addition of BSA. Arrow shows changes upon increase of BSA concentration. Inset plot: $[BSA]/(\epsilon_b - \epsilon_f)$ vs. $[BSA]$ for the titration of BSA with Ru(II) complex, which gives intrinsic binding constant (K_b).

gels. DNA cleavage is controlled by relaxation of the supercoiled circular form of pBR322 DNA into linear and nicked circular forms. When circular plasmid DNA is affected by electrophoresis, the fastest drift will be observed for form I. If one strand is cleaved, the supercoiled form will relax to produce a slower moving form II. If both strands are cleaved, form III will be generated and migrate in between forms I and II [50]. Concentrations of Ru(II) complexes

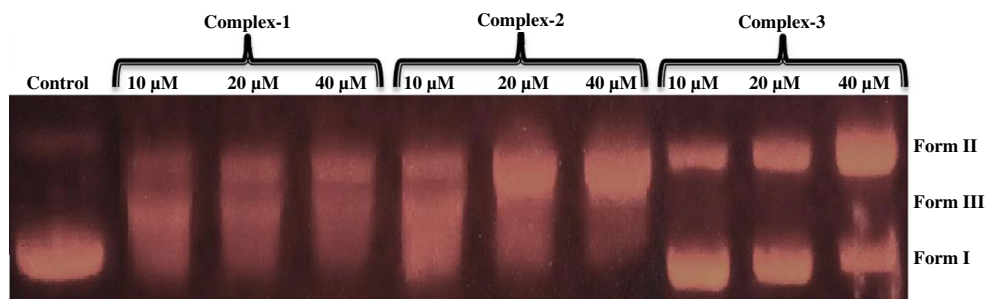


Figure 8. Agarose gel electrophoresis of pBR322 DNA in the presence of different concentrations (10, 20 and 40 μM) of **1**, **2** and **3** after irradiation at 365 nm for 30 min.

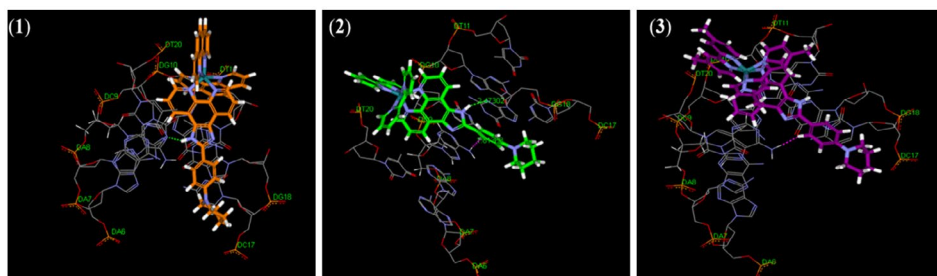
(10, 20 and 40 μM) were altered and monitored by agarose gel-electrophoresis. No DNA-cleavage observed for control in which complex was absent or incubation of the plasmid with the Ru(II) complex in the dark. By increasing the concentration of **1–3**, the amount of form **I** of pBR322 DNA diminishes gradually, whereas that of form **II** (circular form) increases. These results indicate that **1–3** can effectively cleave pBR322 DNA into various forms on irradiation at 365 nm. The different cleaving efficiency is consistent with the DNA-binding affinity of the three Ru(II) complexes as shown in Figure 8.

3.2.9. Antimicrobial studies

One of the major advances in medical science is development of antimicrobials. Predominantly, the fact that ruthenium complexes show antimicrobial activity due to the following important factors: the deliberation of the element, the nature and chelating effect of ligands which are bound to central ruthenium metal, since the N,N'-donor ligands show higher activity against complexes with monodentate nitrogen-donor ligands. Antimicrobial activity is also depends on the total charge of the complex and nuclearity of the metal center; mononuclear centers are usually less active than dinuclear ones [36]. In these studies, Ampicillin was used as a positive control and DMSO as a negative control. As per the results from Table 3, all selected Ru(II) complexes have shown considerable antimicrobial activity against *E. Coli*, *S. Aureus* and *B. subtilis* at 1 and 0.5 mg/mL concentrations. Complex **1** has shown a little better activity values than others, *i.e.* inhibition zone of 18, 14 mm against *B. subtilis* at concentrations of 1 and 0.5 mg/mL. Similarly, **1** also showed a little better activity of 13, 12 mm of inhibition zone against *E. coli* and *S. aureus* at concentrations of 1 and 0.5 mg/mL, respectively. The remaining complexes **2** and **3** also showed good activity against these selected bacteria like **1** (Figure S7). When the activity was compared with positive control Ampicillin and negligible activity DMSO, these complexes show considerable activity. Complexes **1–3** show higher activity compared to previously reported ruthenium(II) complexes $[\text{Ru}(\text{phen})_2(\text{debip})]^{2+}$, $[\text{Ru}(\text{bpy})_2(\text{debip})]^{2+}$ and $[\text{Ru}(\text{dmb})_2(\text{debip})]^{2+}$ (Table 3) toward *E. coli*, *S. aureus* and *B. subtilis* bacteria. As the chelate effect and nature of the ligands factors are present in our complexes, we believe that **1** is little more active due to its more planarity of its ancillary 1,10-phenanthroline ligand. It is evident from our results that all three metal complexes possess good antibacterial activity.

Table 3. Antimicrobial activity of complexes **1–3** with their zones of inhibition (in mm).

Complex	<i>E. Coli</i>		<i>S. aureus</i>		<i>B. subtilis</i>	
	1000 μ M	500 μ M	1000 μ M	500 μ M	1000 μ M	500 μ M
[Ru(phen) ₂ (ppip)] ²⁺	13	12	13	12	18	14
[Ru(bpy) ₂ (ppip)] ²⁺	12	11	12	11	18	14
[Ru(dmb) ₂ (ppip)] ²⁺	12	11	12	11	17	14
	<i>E. Coli</i> (0.2 mL)			<i>S. aureus</i> (0.2 mL)		
⁵² [Ru(phen) ₂ (debip)] ²⁺	7.8		8.5			
⁵² [Ru(bpy) ₂ (debip)] ²⁺	7.2		7.6			
⁵² [Ru(dmb) ₂ (debip)] ²⁺	6.8		7.1			
Ampicillin	28	26	20	19	34	32
DMSO	–	–	–	–	–	–

**Figure 9.** Docking binding mode of **1–3** with DNA.**Table 4.** The table gives information about No. of H-bonding and van der Waals forces with Cdocker energy.

Complex	Cdocker energy (kcal/mol)	Interacting residues	Interacting atoms	Donor	Acceptor	H-bond distance (Å)
[Ru(phen) ₂ (ppip)] ²⁺	272.404	DC9, DG10 DT20, DT11 DA8, DG18	C9:H81 - A:DA8:N1 C9:H85 - A:DA8:H62	H81 H85	N1 H62 N3	2.42 1.83 2.47
[Ru(bpy) ₂ (ppip)] ²⁺	228.495	DT11, DA8 DC9, DG10 DT20, DT11	C10:H77 - B:DG18:N3 C10:H81 - A:DA8:H62	H77 H81	H62	1.81
[Ru(dmb) ₂ (ppip)] ²⁺	227.506	DC9, DG10 DT20, DT11 DA8, DG18	A:DA8:H62 - C11:H78	H62	H78	1.82

3.2.10. Molecular docking studies

Molecular modeling techniques can be utilized to speed up the drug discovery process for obtaining new drug molecules. Molecular docking studies of the three complexes were performed to carry the information about interaction of metal complex with DNA. This is a computational process to analyze the non-covalent binding present in the complexes. In this method, we used the DNA sequence (5'-D(GCTGCAAACGTCG)-3') to study the interaction of the complexes. From these we analyzed, **1** and **2** had two hydrogen bonds but **3** exhibited one hydrogen bond (Figure 9) as **3** has steric hindrance due to the presence of methyl groups in ancillary ligand. The CDOCK Score results of **1–3** are tabulated in Table 4. Complex **1** shows

highest value of 272.404 kcal.mol⁻¹ than **2** and **3**, which indicates stronger binding affinity. The various CDOCK score values for **1–3** have similar intercalation due to change in ancillary ligands. These results are good agreement with our experimental results [51].

4. Conclusion

Three new Ru(II) complexes were synthesized and characterized by adding a piperidine moiety to act as an efficient DNA- and BSA-binder, established by absorption and emission studies. The binding constants were comparable with previously reported complexes. In viscosity measurements, we found that the mode of binding was intercalative. Sensor studies with different ions explained that the binding capacity depends on the number of binding sites and activity of ions. Solvent studies revealed that polar solvents will enhance the binding ability of the complexes. pH studies explain the on/off behavior with the imidazole proton and neutral pH indicates suitability for binding studies. BSA studies recognized the binding capacity of complexes similar to DNA binding. In photocleavage experiments, three ruthenium complexes **1**, **2** and **3** can cleave pBR322 DNA upon irradiation, suggesting that the singlet oxygen is responsible for the cleavage of pBR322 DNA. Antimicrobial activity studies indicated that **1** was more active compared to other complexes against all tested micro-organisms. The molecular docking study explains that the hydrogen bonding and van der Waal interactions play an important role in DNA binding. From all these studies, we conclude that **1** has higher binding capacity than **2** and **3** because of availability of more planarity and no steric effect on ancillary ligand.

Supporting information

Additional information pertaining to ¹H, ¹³C-NMR, mass and IR spectra of the receptor before and after addition of ligand (Figures S10–S25) are given in the Supporting Information.

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Disclosure statement

No potential conflict of interest was reported by the authors.

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CHANGING CONTOURS OF CONCEPT OF WELFARE STATE IN INDIA – AN INSIGHT INTO NORDIC MODEL

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INTRODUCTION

Aristotle's observation that, "state comes into existence originating in the bare needs of life and continuing in existence for the sake of good life" reflects the spirit of welfare state.

A **welfare state** is a concept of government where the state plays a key role in the protection and promotion of the economic and social well-being of its citizens. It is based on the principles of equality of opportunity, equitable distribution of wealth, and public responsibility for those unable to avail themselves of the minimal provisions for a good life¹. As defined by Kent, "Welfare state is a state that provides for its citizens a wide range of social services." All modern states have metamorphosed from Police States to Welfare States. The genesis and development of the concept of the welfare state lay in the interaction of ideas, mainly, conservatism, liberalism and socialism.

"Power has only one duty – to secure the social welfare of the people" as stated by Benjamin Disraeli in his novel *Sybil: or The Two Nations* (1845), out folds the emerging change in public policy that the objective of the Government is not 'power' but 'welfare'. During the period of Great Depression, the welfare state was seen as a "middle way" between the extremes of Communism on the left and unregulated laissez-faire capitalism on the right. In the period following World War II, many countries in Europe moved from partial or selective provision of social services to relatively comprehensive "cradle-to-grave" coverage of the population..The welfare state provides education, housing, sustenance, healthcare, pensions, unemployment insurance, sick leave or time off due to injury, supplemental income in some cases, and equal wages through price and wage controls. It also provides for public transportation, childcare, social amenities such as public parks and libraries, as well as many other goods and services. Some of these items are paid for via government insurance programs while others are paid for by taxes.

There are two main interpretations of the idea of a welfare state:

1. A model in which the state assumes primary responsibility for the welfare of its citizens. This responsibility in theory ought to be comprehensive, because all aspects of welfare are considered and universally applied to citizens as a "right".
2. Welfare state can also mean the creation of a "social safety net" of minimum standards of varying forms of welfare.²

FORMS OF THE WELFARE STATE

There are two ways of organizing a welfare state:

1. According to the first model the state is primarily concerned with directing the resources to "the people most in need". This requires a tight bureaucratic control over the people concerned, with a maximum of interference in their lives to establish who are "in need" and minimize cheating. The unintended result is that there is a sharp divide between the receivers and the producers of social welfare, between "us" and "them", the producers tending to dismiss the whole idea of social welfare because they will not receive anything of it. This model is dominant in the US.³
2. According to the second model the state distributes welfare with as little bureaucratic interference as possible, to all people who fulfil easily established criteria (e.g. receiving medical treatment, having children etc). This requires high taxing, of which almost everything is channelled back to the taxpayers with minimum expenses for bureaucratic personnel. The intended – and also largely achieved – result is that there will be a broad support for the system since most people will receive at least something. This model was constructed by the Scandinavian ministers Karl Kristian Steincke and Gustav Möller in the 30s and is dominant in Scandinavia.⁴

Objectives:

1. To analyze the journey of the ideal of welfare state during pre and post New Economic Policy – 1991.
2. To study the characteristic features of Nordic Model of welfare state.
3. To assess the feasibility of implementation of Nordic Model of welfare state in India.
4. To identify the obstacles in the realisation of welfare state in India.

India as a welfare state

“*Sarve jana Sukhino bhavantu*” (Let the entire world be happy) a well noted ancient Sanskrit sloka reflects the ideal of welfare state in Indian tradition. Ancient Indian political philosophy and history has myriad glimpses of the ideals of welfare state. Renowned Indian political philosopher Kautilya, in his book Arthashastra said, “In the happiness of his population, rests the ruler’s own happiness, in their welfare lies his welfare, he shall not necessarily consider as good whatever pleases him but he shall consider as good whatever pleases his population”.⁵

The Preamble of the Indian constitution declared India as a “Sovereign, socialist, secular, democratic and republic” state. And it also promises to provide to people justice, liberty and equality alongside promoting the feeling of fraternity and national integration. The essence of the preamble itself reflects the avowed objective of the framers of the Indian constitution to usher the era of service state in the newly emerged independent nation. In this regard two specific provisions have been made, one in the form of Fundamental Rights and the other as Directive Principles of state policy.

India, not only is a welfare state, but also the largest democracy in the world. The sentence “we the people of India” in the preamble declared that sovereignty vest not in the parliament but in the people of the union of India. “Social Welfare” has been at the centre of our policy making from the time of independence itself. From the “First Five Year Plan” itself Programmes and schemes have been launched related to social welfare issues as like agriculture and rural development, employment and labour welfare, healthcare, education, etc. In spite of scarcity of economic means the government was focussed on the welfare policies and inclusive development.

The Fundamental Rights embodied in Part III of the Indian constitution act as a guarantee that all Indian citizens can and will enjoy civil liberties and basic rights. These civil liberties take precedence over any other law of the land. They are individual rights commonly included in the constitutions of liberal democracies. Fundamental Rights enshrined in the Indian constitution are: Right to Equality, Right to Liberty, Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Right and Right to Constitutional Remedies.

Directive Principles of state policy enshrined in Part IV of the Indian constitution can be considered as a pivot in achieving the objective of a welfare state. They are the instruments of instructions to the central and state governments to bring forth an egalitarian society and a welfare state. These principles aim at manifestation of social and economic democracy. Article 38 provides a mandate for the State to ‘secure a social order for the promotion of welfare of the people’. In a sense the directive principles of state policy epitomize the ideals, the aspirations, the sentiments, the precepts, and the goals of our entire freedom movement. In another sense, they represent a compromise between the ideals and reality. Though the

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Directive Principles are not enforceable by any court of law, these principles are fundamental in the governance of the country.

The spirit of **social justice** subsequently was infused into the constitution by the initiation of judiciary. This it did in a series of cases of which *Maneka Gandhi v. Union of India (1978)* was significant. This case is a landmark judgement which played most remarkable role towards the transformation of judicial view on Article 21, so as to imply more fundamental rights. In this case the courts decided that limitations have to be posted on the formation of laws that deprived individuals of life and liberty. The procedure prescribed by the law should also satisfy the test of reasonableness, justice and fairness.

In *Francis Coralie Mullin* case (1981) the court declared, “the right to life includes the right to live with human dignity and all that goes with it, namely, the bare necessities of life such as adequate nutrition, clothing and shelter and facilities for reading, writing and expressing oneself in diverse forms, freely moving about and mixing and commingling with fellow human beings. The magnitude and components of this right would depend upon the extent of economic development of the country, but it must, in any view of the matter, include the bare necessities of life and also the right to carry on such functions and activities as constitute the bare minimum expression of the human self.”⁶

Models of Welfare State:

Among numerous studies that have advanced distinct regime theory, the most influential contribution to date is Esping-Anderson’s (1990) “*Three Worlds of Welfare Capitalism*”. The distinct regime model identifies three subtypes of welfare state models which can be mentioned as below:

1. Social-Democratic Welfare State model: Denmark, England, Netherlands, Norway and Sweden.
2. Christian-Democratic (Corporatist) Welfare State Model: Austria, Belgium, France, Germany, Italy and Spain.
3. The Liberal Model: Australia, Canada, Japan, New Zealand, Switzerland and US.

In this scheme, the Liberal regime is associated with poor relief that maintains class distinctions based on income: the Corporatist regime is identified with contributory social insurance that sustains differentiation based on occupational status: and Social Democratic regime is linked to middle-class universalism and social equality. A rigorous study of three countries in the Esping-Anderson sample identified as liberal (U.S), social democratic (Netherlands) and corporatist (Germany) regimes.⁷

The Nordic Model of Welfare State (Social-Democratic model)

The Scandinavian welfare states have enjoyed an international reputation for combining generous welfare state entitlements with rapid economic growth, low unemployment and very high levels of labour force participation, particularly among women. They seemed to have achieved the elusive combination of social equality and economic efficiency.⁸

The Nordic Model refers to the economic and social policies common to the Nordic or Scandinavian countries like Denmark, Finland, Norway, Iceland and Sweden. This includes a combination of free market capitalism with a comprehensive welfare state and collective bargaining at the national level. The Nordic model began to earn attention after World War II.

Although there are significant differences among the Nordic countries, they all share some common traits. These include support for a ‘universalist’ welfare state aimed specifically at enhancing individual autonomy and promoting social mobility, a corporatist system involving a tripartite arrangement where representatives of labour and employers negotiate wages and labour market policy mediated by the government, and a commitment to widespread private ownership, free markets and free trade.⁹ In simple terms ‘universalist welfare state’ means everyone—rich and poor—gets free higher education, free medical services, free eldercare, etc. Universal totally beats the means-testing characteristic of their dreadful old welfare system that they discarded and that the United States still has. It is observed that welfare state entitlements have played little part in the current economic problems of the Scandinavian countries.

Each of the Nordic countries has its own economic and social models, sometimes with large differences from its neighbours. According to sociologist Lane Kenworthy, in the context of the Nordic model, “social democracy” refers to a set of policies for promoting economic security and opportunity within the framework of capitalism rather than a system to replace capitalism.¹⁰

The Nordic Model characterises the system as follows.

1. An elaborate social safety net in addition to public services such as free education and universal healthcare.
2. Strong property rights, contract enforcement, and overall ease of doing business.
3. Public pension plans.

4. Low barriers to free trade. This combined with collective risk sharing (social programs, labour market institutions) which has provided a form of protection against the risks associated with economic openness.
5. Little product market regulations. Nordic countries rank very high in product market freedom according to OECD rankings.
6. Low levels of corruption. In Transparency International's 2015 Corruption Perceptions Index, Denmark, Finland, Sweden, and Norway were ranked among the top 10 least corrupt of the 167 countries evaluated.¹¹
7. High percentage of workers belonging to a labour union. In 2013, labour union density was 85.5% in Iceland, 69% in Finland, 67.7% in Sweden, 66.8% in Denmark, and 52.1% in Norway. In comparison, labour union density was 13.6% in Mexico and 10.8% in the United States.¹² The lower union density in Norway is mainly explained by the absence of a Ghent system since 1938. In contrast, Denmark, Finland and Sweden all have union-run unemployment funds.
8. A partnership between employers, trade unions and the government, whereby these social partners negotiate the terms to regulating the workplace among themselves, rather than the terms being imposed by law. Sweden has decentralised wage co-ordination, while Finland is ranked the least flexible. The changing economic conditions have given rise to fear among workers as well as resistance by trade unions in regards to reforms.¹ At the same time, reforms and favourable economic development seem to have reduced unemployment, which has traditionally been higher. Denmark's Social Democrats managed to push through reforms in 1994 and 1996.
9. Sweden at 56.6% of GDP, Denmark at 51.7%, and Finland at 48.6% reflect very high public spending.¹³ One key reason for public spending is the large number of public employees. These employees work in various fields including education, healthcare, and for the government itself. They often have greater job security and make up around a third of the workforce (more than 38% in Denmark). Public spending in social transfers such as unemployment benefits and early-retirement programmes is high. In 2001, the wage-based unemployment benefits were around 90% of wage in Denmark and 80% in Sweden, compared to 75% in the Netherlands and 60% in Germany. The unemployed were also able to receive benefits several years before reductions, compared to quick benefit reduction in other countries.
10. Public expenditure for health and education is significantly higher in Denmark, Sweden, and Norway in comparison to the OECD average.¹⁴
11. Overall tax burdens (as a percentage of GDP) are among the world's highest; Sweden (51.1%), Denmark (46% in 2011), and Finland (43.3%). The Nordic countries have relatively flat tax rates, meaning that even those on medium and low incomes are taxed at relatively high levels.¹⁵

12. The United Nations *World Happiness Report 2013* shows that the happiest nations are concentrated in Northern Europe. The Nordics ranked highest on the metrics of real GDP per capita, healthy life expectancy, having someone to count on, perceived freedom to make life choices, generosity and freedom from corruption. The Nordic countries also place in the top 10 of the *World Happiness Report 2017*, with Norway and Denmark taking the top spots.¹⁶
13. The Nordic countries received the highest ranking for protecting workers rights on the International Trade Union Confederation's 2014 Global Rights Index, with Denmark being the only nation to receive a perfect score.¹⁷

Feasibility of Nordic Welfare State Model in India:

Globalisation, Liberalization and Privatisation introduced by New Economic Policy in 1991 has tilted India towards capitalist economy withholding its socialistic roots. This transfigured the idea of welfare state adopted since independence in the framework of mixed economy with an inclination towards socialistic ideology. New Economic Policy has now become the prism from which all the policies of the government, particularly the economic policies are focussed. The New Economic Policy has brought a paradigm shift from state-centred welfare state to citizen-centred welfare state, with state playing the role of a facilitator.

As per the date report of National Sample Survey Office (NSSO) on Health and Morbidity known as 'Social Consumption on Health' conducted during NSS 71st round (2014), 'percentage of persons having covered under any health insurance scheme is 14.1% in rural areas and 18.1 % in urban areas'. The country's public financing for health care is less than 1% of the world's total health expenditure, although it is home to over 16% of world's population. Families meet almost 70% of their health expenses out of their own pockets. These statistics on health insurance throw light on the fact that majority of the people still rely on individual security. This hinders the purchasing capacity of the people and promotes polarization of income.

The New Economic Policy of India equates to the dual policies of 'Perestroika' and 'Glasnost' introduced in erstwhile Soviet Union in 1985 by Mikhail S. Gorbachev, the General Secretary of Communist Party of the Soviet Union. According to Naomi Klein, former Soviet leader Mikhail Gorbachev sought to move the USSR in a similar direction to the Nordic system, combining free markets with a social safety net—but still retaining public ownership of key sectors—ingredients that he believed would transform the USSR into "a socialist beacon for all mankind."¹⁸

The recent fiscal reforms like Demonetization Policy (8th November, 2016) and tax reforms like Goods and Services Tax - GST (1st July, 2017) launched by the union government in the recent past opened the gates to discuss the pros and cons of

the feasibility of implementation of Nordic Model of welfare state in India. Impact of tax policy on income and wealth redistribution is profound in realizing the objective of welfare state. Redistribution through transfer has a major contribution to reducing inequality and polarization of income. The fiscal reforms in present-day circumstances imply as outcome to the so called 'tax uniformity', embedding income redistribution through budgetary mechanisms, an arrangement that greatly depends on the alternative chosen by the authorities for the distribution of tax burden among various categories of contributors.^{18(a)}

Calls have been made among policy makers in India, with special mention to Nobel prize winning welfare economist Amartya Sen, to implement reforms along the Nordic lines in India. On the question of the idea of justice, Amartya Sen said, "we should organize society so that people are given the opportunity to realize their own life projects". But, the need of the hour is a 'welfare state coupled with responsibility'. State directed welfare will never achieve its avowed objective, unless and until the citizens go hand in hand with the government and acknowledge their responsibilities to make it a success.

Nordic Welfare State Model requires a strong runway of concrete tax structure and effective fiscal policy to give buoyancy to welfare state to takeoff. In this direction, the introduction of Goods and Services Tax on 7th July, 2017 by the Indian government replaced a slew of indirect taxes with a unified tax and is therefore set to dramatically reshape the country's 2 trillion dollar economy. GST is expected to bring a better taxation system, increase in country's GDP, same price for goods across the country, reduced tax on manufacturers ect.

Besides streamlining the slabs on GST, it is required to stabilise the direct tax system to garner funds for the provision of more welfare facilities to the people. Scandinavian countries are known for having high taxes on income. According to OECD, Denmark (26.4%). Norway (19.7%) and Sweden (22.1%) all raise a high amount of tax revenue as percent of GDP from individual income taxes and payroll taxes. According to Income Tax data published for the first time in India in 16 years state that a total of 28.7 million individuals filed income tax returns, of which 16.2 million did not pay any tax, leaving only about 12.5 million tax-paying individuals, which is just about 1% of the 1.23 billion population of India in the year 2013. Low levels of tax collections could be challenge in realizing the objectives of a welfare state.¹⁹

Conclusion:

Indian proponents of Nordic model advocate establishing a state along the social democracy lines. But the truth is that Scandinavia isn't really all that socialist. Scandinavian countries have certain socialist characteristics such as high taxes and extensive welfare systems. However, these countries have relatively capitalistic

markets. Scandinavian businesses are mostly free from regulation, nationalization and protectionism. Sweden, Denmark and Finland rank higher than US in business freedom, monetary freedom, investment freedom, fiscal freedom, property freedom and freedom from corruption. Norway ranks higher than the US in trade freedom, property freedom and freedom from corruption.

Journey towards Nordic model could be too long owing to Indian socio-economic conditions like huge population, vast diversities among people, stagnant economy, corruption, lack of transparency among political leaders and bureaucracy, ineffective tax structure and lack of commitment among the people for collective benefits. But the journey always has a destination to reach, though not Nordic model of welfare state, the destination could be a state in which people have effective social security and improved quality of life.

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“50 DAYS OF DEMONETIZATION – REINFORCED PEOPLE’S COOPERATION IN THE IMPLEMENTATION OF PUBLIC POLICY: A CASE STUDY OF KODAD”.

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Abstract: Public policy can be generally defined as a system of laws, regulatory measures, courses of action, and funding priorities concerning a given topic promulgated by a governmental entity or its representatives. Public policy is a course of government action or inaction in response to public problems. Public Policy and its implications carry a lot of significance in this model digital world, thanks to the availability of myriad information in the hands of the people through internet and social media. In this concept this study tries to elucidate the contemporary political scenario and people’s socio-psychological behavior towards policy decisions. The present study carries worth because it throws light on the recent and startling policy of the Indian Government to demonetize the higher denomination currency for the diverse future gains extending to the extremes of financial benefits to the control of terrorism. Few principal theoretical perspectives, relating to self-interest, national-interest and the belief in democratic principles, respectively, have been proposed in the study as causal explanations. The findings converge to the conclusion that national-interest is one of the avowed motives for people’s cooperation towards public policy. When national-interests are at stake, people tend to shun their self-interest for the state.

Key Words: Funding priorities, myriad, causal explanations.

1. INTRODUCTION:

Public policy can be generally defined as a system of laws, regulatory measures, courses of action, and funding priorities concerning a given topic promulgated by a governmental entity or its representatives. In any society, governmental entities enact laws, make policies, and allocate resources. This is true at all levels. Public policy is a course of government action or inaction in response to public problems. It is associated with formally approved policy goals and means, as well as the regulations and practices of agencies that implement programs¹. Robert Eyestone terms public policy as "the relationship of government unit to its environment"². Thomas R. Dye says that "public policy is whatever government chooses to do or not to do"³. Richard Rose says that "public policy is not a decision; it is a course or pattern of activity".

Public Policies are goal oriented. This means that Public policies are formulated and implemented in order to attain the objectives which the government has in view for the betterment of the public.

1.1 CHARACTERISTICS OF PUBLIC POLICY:

1. It is purposive and goal oriented.
2. Public policies are made up by public authorities.
3. Public policy consists of set of pattern of action taken over time.
4. Public policy is a product of demand.
5. Government directed course of actions.
6. It can be positive or negative.

Policy studies emerged as an important focus in political science in the 1970s. Dissatisfaction with the existing state of political science was inevitable⁴. Kirkpatrick pointed out that, "Dissatisfaction produced ferment, and ferment change"⁵. In 1969, David Easton (1969), president of the American Political Science Association, was frustrated with the trend in political science research to study narrow questions that lent themselves to the quantitative methods expected by the behavioral movement. Thus, he called for a post-behavioral revolution where political scientists would study the most important political problems of the day even when quantitative methodologies could not be employed. Easton writes, "Contemporary political thought lives parasitically on ideas a century old and, what is more discouraging, we see little prospect of the development of new political synthesis"⁶. Easton’s call served as a

catalyst for policy research that sought to explain and predict policy patterns as well as to evaluate the relative impact of various types of policy solutions.

Across the carpet of social sciences the focus is on to understand how to garner motivation from the people on issues of collective significance. Studies in Economics show that economic policies bear fruits only when the hierarchy of bureaucracy scrupulously strives in the implementation of the policy. Law research shows that crime and problems of community disorder are difficult to solve without the active involvement of community residents. The police and courts need the active cooperation of members of the community to control crime and urban disorder by reporting crimes and cooperating in policing neighborhoods. Studies in management show that work organizations benefit when their members actively work for company success. Political scientists recognize the importance of public involvement in building both viable communities and strong societies. And those in public policy have identified the value of cooperation in the process of policy making—for example, in stakeholder policy making groups. Decision making and cooperation go hand in hand. The Communication Theory as propounded by Karl. W. Deutsch looks at the task of government and politics in the sense of a process of steering and co-coordinating human efforts towards the attainment of a set of goals”⁷.

Those who hold political office want people to cooperate by participating in personally costly acts ranging from paying taxes to fighting in wars. Further, it is equally important for people to actively participate in society in ways that are not required, such as by voting, by maintaining their communities through working together to deal with community problems, and by otherwise helping the polity to thrive. For these reasons, understanding how to motivate cooperation is central to political scientists, leading to an interest in exploring why people do or do not have trust and confidence in the government. Governance involves the study of how to motivate desired political behaviors. As said by Emile Lahoud, “Democracy, good governance and modernity cannot be imported or imposed from outside a country”.

One aspect of governance involves studies of public policy, which are concerned with developing social policies that can effectively coordinate the actions of people within communities. Such efforts focus on creating a procedure for developing and implementing policies and policy decisions, be they decisions about New Economic Policy-1991 or Demonetization Policy-2016. The key to success in such efforts is to create policies that all of the people within a community are motivated to accept—that is, to be able to gain widespread rule adherence. And, as is true in the other arenas outlined, the value of cooperation in general is widely recognized. In particular, it is important that people not just do what is required. Many aspects of involvement in a community are voluntary, and it is especially important to motivate community residents to engage in voluntary acts such as quitting smoking in public places and participating in community problem solving over issues such as environmental use.

Public Policy and its implications carry a lot of significance in this model digital world, thanks to the availability of myriad information in the hands of the people through internet and social media. In this concept this study tries to elucidate the contemporary political scenario and people’s socio-psychological behavior towards policy decisions.

Understanding why people are motivated to cooperate with the government policy when the out-comes are obscure is a long-term focus of social psychological research. In particular, social psychologists are interested in identifying the motivations that are the antecedents of voluntary cooperation. Graham Wallas in his book “Human Nature in Politics (1908) laid emphasis on the socio-psychological foundations of political behavior”⁸. The goal of this Study is to examine the reasons for cooperation, exploring the motivations that shape the degree to which people cooperate the government policies, in particular, the Demonetization Policy of the Indian government announced on 8th November, 2016. The present study carries worth because it throws light on the recent and startling policy of the Indian Government to demonetize the higher denomination currency for the diverse future gains extending to the extremes of financial benefits to the control of terrorism.

1.2 DEMONETIZATION:

Demonetization is the act of stripping a currency unit of its status as legal tender. Demonetization is necessary whenever there is a change of national currency. The old unit of currency must be retired and replaced with a new currency unit. There are multiple reasons why nations demonetize their local units of currency. Some reasons include to combat inflation, to combat corruption, and to discourage a cash system. The process of demonetization involves either introducing new notes or coins of the same currency or completely replacing the old currency with new currency⁹.

Demonetization was adopted by many countries in the past to counter inflation and to fight corruption. The Coinage Act of 1873 demonetized silver in favor of adopting the gold standard as the legal tender of the United States. The Burmese kyat replaced the Indian rupee at par in 1952. During the government of Muhammadu Buhari in 1984, Nigeria introduced new currency and banned the old notes. In 1982, Ghana ditched their 50 Cedis note to tackle tax evasion and empty excess liquidity. In 2015, the Zimbabwean government demonetized the Zimbabwean dollar as a way to combat the country’s hyperinflation that was recorded at 231,000,000%. Another example of demonetization occurred when the nations of the European Monetary Union adopted the euro in 2002

1.3. DEMONETIZATION IN INDIA:

The demonetization of ₹500 and ₹1,000 banknotes was a policy enacted by the Government of India on 8 November 2016, ceasing the usage of all ₹500 (US\$7.40) and ₹1,000 (US\$15) banknotes of the Mahatma Gandhi Series as legal tender in India from 9 November 2016. However, the banknote denominations of ₹100, ₹50, ₹20, ₹10 and ₹5 of the Mahatma Gandhi Series and ₹2 and ₹1 remained legal tender and were unaffected by the policy. The government claimed that the demonetization was an effort to stop counterfeiting of the current banknotes allegedly used for funding terrorism, as well as a crack down on black money in the country. The move was also described as an effort to reduce corruption, the use of drugs, and smuggling. The recent Indian history shows that demonetization was done twice in the recent past. It was done twice In January 1946, banknotes of 1,000 and 10,000 rupees were withdrawn and new notes of 1,000, 5,000 and 10,000 rupees were introduced in 1954. The Janata Party coalition government had again demonetized banknotes of 1,000, 5,000 and 10,000 rupees on 16 January 1978 as a means of curbing counterfeit money and black money.

2. ORIGIN OF RESEARCH PROBLEM:

The present study intends to shed light on reasons for reinforced people's cooperation towards public policy in general, and the Demonetization Policy in particular. Public policy is the principled guide to action taken by the administrative executive branches of the state with regard to a class of issues, in a manner consistent with law and institutional customs. The foundation of public policy is composed of national constitutional laws and regulations. Further substrates include both judicial interpretations and regulations which are generally authorized by legislation. Public policy is considered strong when it solves problems efficiently and effectively, serves justice, supports governmental institutions and policies, and encourages active citizenship.

The latitudinal survey on 50 Days of Demonetization which was announced by the union government on 8th of November, 2016 was initially overwhelmingly welcomed by the citizens with the higher expectations of its intended outcomes like curbing corruption, black money. Counterfeit notes and terrorists financing. This unforeseen policy has forced the people of Kodad in particular and India in large to many hardships like sudden cash crunch, disruption to daily activities, standing in long queues for long hours for cash withdraw from banks and ATMs, loss of work for daily labors, and violation of human right of freedom to withdraw their hard earned savings at will.

Despite all these inconveniences the people of India exhibited unmeasured cooperation towards the government's policy. This study investigates which socio-economic and ideological factors make individuals support the normative principles of the welfare state. Few principal theoretical perspectives, relating to self-interest, national-interest and the belief in democratic principles, respectively, have been proposed in the study as causal explanations.

3. INTER-DISCIPLINARY RELAVANCE:

The present study carries interdisciplinary relevance at large. To one degree or another, solutions to social, political, intellectual, and economic problems do not lie in a single focus. The present study provides a background for approaching issues holistically through an understanding of the complexity and interconnectedness of public policy and economic implications. This study draws the fiber from Political Science, Economics and Sociology to weave a fabric to derive the reasons for reinforced people's cooperation towards public policy.

4. REVIEW OF LITERATURE:

A review of the previous studies on this topic is quite essential to understand what the other research scholars have already explored through their research studies, books and articles. Prominent among them are:

- Thomas R. Dye: Understanding Public Policy, Pearson Publications, 2012. In this book the author provides an accessible assessment of a wide range of theories and models from policy cycles, policy transfer, rational choice and socio-economic explanations to multi-level governance, advocacy coalitions and punctuated equilibrium and of their value to policy analysis.
- Kuldeep Mathur: Public Policy and Politics in India, Oxford University Press, Noida Uttar Pradesh, India: This author explains how institutions matter by a significant amount of research in India focuses predominantly on policy goals and consequences, and less on policy processes.
- S.P. Varma: Modern Political Theory, Vikas Publishing House, New Delhi. This author explains about the transition in political science from the study of institutions to political processes.

5. OBJECTIVES:

The objectives benchmarked for the Study Project are as below:

- To explore the reasons for the reinforced cooperation of the people towards the public policy, in specific, the Demonetization Policy of union government.
- To identify whether self-interest or national-interest motivates the people to support a public policy.

- To assess the opinion of myriad sections of people like farmers, businessmen, people's representatives, auto drivers and government employees on demonetization policy.
- To figure out the measures adopted by the people to tackle the cash crunch situation arose because of demonetization.
- To identify whether the people are financial literates or not.

6. RESEARCH METHODOLOGY:

In the completion of the study empirical and descriptive methods are adopted, specifically the methodology adopted is **Exploratory**, to inquire the magnitude or extent of the public policy, its impact and problems; **Descriptive**, to making careful observations and detailed documentation of demonetization policy and; **Explanatory**, in the sense, to analyze the observed phenomenon.

The conclusions derived in this study are based on primary data through questionnaires/ schedules and secondary data through books, magazines, news papers and internet. The selection of respondents was through random sampling. This survey aimed at eliciting information on the respondent's knowledge, experiences and view on the public policy. The research design adopted for the study is the preparation of questionnaires and schedules to collect the opinion from 250 respondents 50 each from 05 sections of people in Kodad constituency like, Farmers, Businessmen, Government employees, Auto drivers and People's Representatives.

7. SIGNIFICANCE OF THE STUDY:

Public Policy and its implications carry a lot of significance in this model digital world, thanks to the availability of myriad information in the hands of the people through internet and social media. In this concept this study tries to elucidate the contemporary political scenario and people's socio-psychological behavior towards policy decisions. The present study carries worth because it throws light on the recent and startling policy of the Indian Government to demonetize the higher denomination currency for the diverse future gains extending to the extremes of financial benefits to the control of terrorism.

8. LIMITATIONS OF THE STUDY:

This Study is limited to gathering the opinion of the people from 05 sections of the constituency of Kodad. This leaves a lot of research gaps which are to be addressed in the future study for more information on the topic.

9. STUDY AREA HISTORICAL BACKGROUND:

Kodad is a town in Suryapet district of the Indian state of Telangana. It is a municipality and the Mandal headquarters of Kodad Mandal in Kodad revenue division. It lies on the National Highway 65 between Hyderabad and Vijayawada. According to Census of India, 2011, population of Kodad town is 65,234 of which 32,010 are male and 33,224 are female. The literacy rate of the town is 96.7%. Sex ratio is 1060 females to 1000 males. Child sex ratio is 1100 girls to 1000 boys. Kodad Mandal has a population of 134,130, of which 66,604 are male and 67,526 are female. The literacy rate is 94.33%. Kodad Municipality is the civic administrative body of the town which was constituted in the year 2011. It is spread over an area of 31.90 km²(12.32 sq mi) with 30 wards. The present Municipal Commissioner is L.Balajinaik and the chairman is Vantipuli Anitha.

10. FINDINGS AND DISCUSSIONS:

50 days into India's demonetization initiative, long lines of people looking to exchange notes still spew out of banks, some sectors of the economy continue struggling with the lack of readily available cash, grassroots businesses are still being revolutionized with electronic payment capabilities, and masses of people continue transitioning towards new ways of paying for basic goods and services.

Though the decision of the government to demonetize higher denomination currency notes has halted the economy, on the other side it also has given some positive indications of a bright future. The economic parameters of post-demonetization can be condensed as below:

- There has been 14.4% increase in direct tax collection
- There has been a massive 26.2% increase in indirect tax collection.
- Central Excise collection has witnessed an increase in 43.3%.
- Rabi Crop sowing has witnessed an increase in 6.3% while the net agricultural growth has been 6.5%, flatly refuting the fear of an agro-economic slowdown that was being proposed in the media.

Aristotle while explaining the general rules of revolution in his book “The Politics” stated that “*A statesman must never neglect any small issue relating to the governance. If decisions are made in haste without considering its implication such actions are likely to lead to an uproar*”. It is for this reason; Aristotle stated that a need for overhauling the entire system actually comes when small changes are overlooked¹⁰. Surprisingly Aristotle proved wrong in India, where though there was haste in the government’s policy without taking into note its implications, the people did not agitate against the government, but instead gave its support for the success of the policy.

This Study Project intends to explore the reasons for the reinforced people’s support towards the public policy. As Arthur Bentley pointed out that, “Measurement conquers chaos” the attempt is made to quantify the data to arrive at a meaningful conclusion (Arthur Bentley, “The Process of Government, Evanston, Illinois, 1908).

- The observations derived out of the study indicates that out of the respondents selected for the study 60% respondents were in favor and 28% respondents against the demonetization policy. The data throws light on the fact that Businessmen and Government Employees have positive expectations on the demonetization policy. Farmers, auto driver and Peoples Representatives are midway in favor and against the policy, which bespeak that educated sections were in favor and uneducated were half hearted towards the demonetization policy (Table No. 1).
- The findings draws the conclusion that out of 60% respondents in favor of demonetization policy 66% of the farmers are ignorant about eradication of black money and ushering of cashless economy, instead they have a blind trust on the government. 90% of the businessmen and People’s Representatives feel that this policy may help to eradicate black money, but it may not help in bringing about a cashless economy. Government Employees and Auto drivers see that demonetization policy would eradicate black money and also would initiate cashless transactions (Table No. 2).
- This study reveals the means adopted by the people for financial transactions during the cash crunch. The survey point to the fact that 60% of the farmers and 70% of the businessmen recourse to borrowings to tackle their financial transactions. 80% of the Government Employees and 90% of the People’s Representatives could avail withdraw facility from banks. The survey gives a startling revelation that 90% of the Auto Drivers availed ATM facility. The above data throw light on the fact that farmers and businessmen still today do not mileage on bank facility, which needs to be addressed (Table No. 3).
- Reconstruction of the data depicts that majority of the respondents were of the view that neither the government nor the banks were prepared for the post-demonetization phase. (Table No. 4).
- The findings show that 90 % of the Government Employees, Auto Drivers and 80 % of the businessmen were not in favor of bringing an agitation or a revolt against the government’s policy. Only 50% of the farmers and 30 % of the People’s Representatives had recourse to agitations. The agitations by the People’s Representatives can be because of political identifications rather than of personal misgivings on the policy, as depicted in their response for other questions (Table No. 5).
- The findings narrate that, but for the farmers the disruption to day-to-day activities was manageable for all the remaining other respondents (Table No. 6).
- Evidence out of findings of the survey regarding the methods adopted by the people for financial transactions during post-demonetization, the observations reflect the fact that 80 % of businessmen, 50% of farmers, 40% of Government Employees and 10% of Auto Drivers kept their payments pending during post-demonetization. It also reveals haw-dropping information that 0 % of People’s Representatives and businessmen; 30% of Government Employees and Auto drivers and 10% of Farmers used mobile wallets (Table No. 7).
- The findings in Table No. 8 inform that majority of the people are unaware of different mobile wallets to foster cashless or digital economy.
- The findings in Table No: 9 regarding the opinion of the people weather to introduce digital economy or not, only 18% of the respondents are in favor, 14% are against and 17% have no idea. Out of the respondents in favor of digital economy majority are the Government Employees accounting to 70%. Only 10% of the businessmen are in favor of digital economy.
- The sequel of the survey in Table No. 10, to elicit the reasons for people’s reinforced cooperation to Public Policy, in specific, the Demonetization Policy declared by the Indian Government on 8th November, 2016, show that 80% of the Government Employees, 70% of the People’s Representatives, 60% of Auto Drivers and 50% of farmers and businessmen have a hope for the better future in supporting the government’s policy. This corresponds to the hypothesis that National-interest is one of the avowed motives for people’s cooperation towards public policy. When national-interests are at stake, people tend to shun their self-interest for the state.

11. CONCLUSION:

It is quite evident from the study that the issue of cooperation from the citizens to public policy is central to many of the problems faced by real-world. As a result, the fields of political science, law and management all seek to understand how to most effectively design institutions that can best secure cooperation from those within groups.

Their efforts to address these issues are mainly informed by the findings of social psychological and economic research. The present study draws the following conclusions.

- Demonetization Policy of the government is accepted not just because the people feel it is their responsibility as a citizen.
- It is accepted because people believed that it would help to build a better future, and thus gave importance to the collective and national interest.
- The present study also gives an insight that financial literacy is imperative before taking a shift from cash economy to digital economy.
- The findings herein will show that people are motivated by a broader range of goals than is easily explained via material self-interest—that is, by people's concerns about incentives and sanctions.
- The key to success in garnering people's cooperation is to create policies that all of the people within a community are motivated to accept—that is, to be able to gain widespread rule adherence.
- As is true in the other arenas outlined, the value of cooperation in general is widely recognized. In particular, it is important that people not just do what is required. Many aspects of involvement in a community are voluntary¹².

From 05 sections of the constituency of Kodad. This leaves a lot of research gaps which are to be addressed in the future study for more information on the topic. This study is confined to identify whether it is personal-interest or the national-interest that motivated the people to extend their cooperation in the execution of Demonetization Policy. This leaves an open ground to investigate on other socio-psychological motives that inspire the people to support a public policy.

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Table No. 1 to 10 showing the findings of the study.

Sl. No	Category	Table 1			Table 2			Table 3			Table 4				Table 5		Table 6		
		1	2	3	1	2	3	1	2	3	A		B		1	2	1	2	3
1	Farmers	25	25	0	0	10	15	20	0	30	30	20	30	20	25	25	20	25	5
2	Businessman	35	0	15	45	5	0	10	5	35	35	15	25	25	10	40	5	10	35
3	Government employees	35	5	10	25	25	0	40	0	10	15	35	15	35	5	45	10	10	30
4	Auto Drivers	30	15	5	15	15	5	5	45	0	30	20	35	15	5	45	20	10	20
5	Peoples Representatives	25	25	0	20	5	0	45	5	0	5	40	25	25	15	30	15	15	20

1. In favor

2. Against

3. No idea.

1. To eradicate black money
2. To bring cashless economy
3. Belief in government.

1. Bank

2. ATM

3. Borrowings

A. Government

B. Bank

1. Yes

2. No

1. Yes

2. No

1. Yes

2. No

3. Manageable

Sl. No	Category	Table 7			Table 8							Table 9			Table 10		
		1	2	3	1	2	3	4	5	6	7	1	2	3	1	2	3
1	Farmers	20	5	25	0	0	0	0	0	0	0	10	20	20	0	25	25
2	Businessman	10	0	40	10	5	15	20	0	0	5	5	0	45	5	25	20
3	Government employees	15	15	20	25	0	0	0	10	0	0	35	15	0	15	40	5
4	Auto Drivers	30	15	5	5	0	0	0	0	0	0	25	5	50	5	30	15
5	Peoples Representatives	50	0	0	5	0	0	0	5	0	5	15	30	0	5	35	10

1. Cash

2. Mobile Wallets
3. Kept payments pending?

1. Paytm

2. Free Charge
3. Chillr

4. Itzcash

5. Jiomoney

6. Freedm

7. Bheem

1. Yes

2. No
3. No idea

1. Responsibility as citizen

2. Hope for better future
3. Left with no other option

Quota System in Various Countries

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Abstract : This paper discusses affirmative action policies in various countries. The main purpose of the paper is enunciate that protected treatment for under privileged sections of the society is not specific to India alone. This paper also examines the different approaches to employment quotas for women and physically challenged persons and critically evaluates the reasons for divergence.

Introduction: In 1989, the International Convention on the Elimination of All Forms of Racial Discrimination stipulated in its Article 2.2 that affirmative action programs in order to rectify systematic discrimination may be required in countries that ratified the convention. It also states that such programs "shall in no case entail as a consequence the maintenance of unequal or separate rights for different racial groups after the objectives for which they were taken have been achieved.¹It also proclaims:

‘The principle of equality sometimes requires States parties to take affirmative action in order to diminish or eliminate conditions which cause or help to perpetuate discrimination prohibited by the Covenant.’

Hence, apart from India, many other countries also have the quota or reservation systems, or positive discrimination (in the UK and employment equity in SA and Canada) as a part of their inclusive policy, generally termed as ‘affirmative action’ as many of them have already realized that a comprehensive development is not possible without inclusion of all social groups. The following countries have inclusive policies in one or the other way:

1. Brazil
2. Bangladesh
3. Canada
4. China
5. Finland
6. Germany
7. Israel
8. South Africa
9. Malaysia
10. Japan
11. Macedonia
12. Nepal
13. New Zealand
14. Norway.
15. Pakistan
16. Romania
17. South Korea
18. Sri Lanka
19. Sweden
20. The United Kingdom
21. The United States

Though, unlike India, these countries do not have a cast system, but they adopted affirmative policies to include the minority groups or aborigines into the mainstream. However, quota for endogamic social groups - caste, tribe, and ethnicity exists to some extent, though under the guise of bumiputra, sons of soil or indigenous people in South Asian countries that were influenced by the Indian caste system in olden days.

Main content

Brazil, in 2001, announced its racial based affirmative action by providing quota for black students in public funded institutions of higher education which generally intakes the students on the basis of a Vestibular exam, a kind of entrance test. It was a surprising step as the Brazilian democracy has been generally tagged as a racial democracy. Under this system 49 out of 95 government run (state and federal) universities have adopted quota system while some universities have introduced a 'point' system which gives additional "points" to the applicants belonging to disadvantaged class. In 2012, National Congress approved a law (Quota Law) that made it mandatory for all federal higher education institutions to implement quotas on the basis of family income, race (being indigenous, black, or brown) and previous attended school (for students who came from government schools). It is assessed that around 45 thousand students are benefited by this system by the end of 2010.² Further, the University in Sao Paulo reserved its 50% of seats to the black students.

In Bangladesh, a relatively conservative country with negative bias towards women, approximately 10% quota has been reserved in parliament constitutionally for women initially for 10 years and later extended through presidential proclamations upto 2001. It has similar quota in local bodies also. This system relatively empowered the women in otherwise men-dominated country.³ Further, there is a 5% quota for Tribals.

Canada passed, in 1986, the Employment equity law that requires employers to adopt measures to increase the representation of four designated groups, namely Women, Aboriginals (Indians, Inuit (the Aboriginal people of the Arctic), Métis (people of mixed French-Aboriginal ancestry in western Canada), and Visible Minority (other than Aboriginal non-Caucasian in race or non-white in colour) and Disables.

Though, this law falls under the category of 'soft laws' that are usually regarded rather an initiation than mandatory, the Canadian government claims that the law has been a success as the categories of the people mentioned in this laws has been employed more than their share in the work force. For instance, Women surpassed their share in work force of 52.2% by 1.8% margin and Visible Minority group by 0.8%. They form 13% of work force but after implementing of this law their representation in working force raised to 13.8%. Similarly, the aboriginals and handicaps got 5.1% and 5.6% respectively against their workforce availability of 3.4% and 4.4%.⁴

In China has its own affirmative action policy called Youhui Zhengce, since 1949, under which the Minorities receive proportional representation in local government institutions. The minority regions need not to send taxes to the central government; all of it can be spent locally. The government offers interest-free loans to businesses-men belonging to minorities. Minority students receive bonus points in the National Higher Education Entrance Examination. There are some exclusively minority universities also and the minority students get additional assistance through bilingual programmes to learn *Mandarin Chinese*, the official Chinese language. The Chinese government officially allows minority couples to have more than one child inspite of One Child Policy that has been strictly imposed upon Han people. Some prominent government posts may be filled by minority-model citizens.⁵

Finland has certain quota -- in some, not all, universities such as Helsinki University -- for those who achieve a certain degree of skills in the Swedish language; for these students the education is partially arranged in Swedish. There is separate autonomous School of Social Sciences in Helsinki University for Swedish minority linguistic group. Apart from this, women may get preferential treatment in recruitment for certain public sector jobs if there is a gender imbalance in the sector.⁶

South Africa also has an affirmative action plan, similar to that of Canada, under the Black Economic Empowerment law generally called as BEE. This act, adopted in 2003, makes it mandatory for Employers with more than 50 workers, local government institutions, and state-organs to employee people belonging to disadvantage sections of the population, namely Women (without colour/race discrimination), handicapped (without colour/race/sex discrimination), and Blacks in accordance with their representation in population. The commercial Companies must have 70% blacks, 10% Coloured and 8% Indians, and 10% Whites in their Board of Directors. If they fail to comply, the Department of Labour can impose fines and may also prosecute such defaulters.⁷

However, there is an astonishing fact about BEE that it is not meant for any minority group but for the majority. The BEE commission defines its aims as 'to ensure broader and meaningful participation in the economy by black people to achieve sustainable development and prosperity'. Later, in 2007, another broad based programm named as 'Broad-Based Black Economic Empowerment' (B-BBEE) has been initiated to coup up with the shortfalls of the previous programme. The later include the, previously excluded, South African Chinese also under the term Black, though, through a court intervention.⁸

Similarly, Malaysia, after the racial riots of 1969, adopted a *New Economic Policy (NEP)* in 1971. This policy was also intended to protect the economically and socially backward Malay majority against the economically well developed Chinese minority. Officially, the policy has been aimed to provide assistance to all Malaysians in: *Finding employment, Securing participation in economic activities, Acquiring ownership in various economic sectors.*

This policy has been more concentrated on provision of economic hold to the *Bumiputras*, 'the Sons of the Soil' or in other words, indigenous people belonging to Malay race. The distinguishing feature of this imperative action was to set aside a 30% equity shares for *Bumiputra* investors in all Initial public offerings (IPOs) and to provide 7% discount on houses or property.

Apart from the wealth distribution, the NEP provided quota system for the *Bumiputras* in admission to government educational institutions, qualification for public scholarships, marking of universities exam papers, special *bumiputras*-only classes prior to university's end of term exams, for positions in government, and ownership of businesses. Though the quota system was canceled in 2002 but in its place an additional points-rewarding system has been introduced in entrance exams. Further, the policies framed under the influence of NEP include:

- Companies listed on the Kuala Lumpur Stock Exchange (*Bursa Saham Kuala Lumpur*) must have 30% *bumiputra* ownership of equity to satisfy listing requirements. Foreign companies that operate in Malaysia also must adhere to this requirement.
- For a limited period, certain percentage of any new housing scheme has to be sold to *bumiputra* owners with a minimum 7% discount
- A basket of government-run and profit-guaranteed mutual-funds are exclusively available only for *bumiputras*. The *Amanah Saham Nasional (ASN)* has return rates approximately 3 to 5 times that of local commercial banks.
- Many government-tendered projects require that companies submitting tenders be *bumiputra* owned.
- Certain Projects were earmarked exclusively for *bumiputra* contractors.
- Approved Permits (APs) for automobiles preferentially allow *bumiputra* to import vehicles. Automotive companies wishing to import cars need to have an AP that is possible if the company have at least 70% *bumiputra* ownership.

The above measures successfully increased the economic hold of indigenous Malay people in Malaysian economy and wealth-holding.⁹

Germany, introduced quotas in 2001 for Women and disabled persons in the public employment sector, but its implementation in private sector employment still faces serious opposition. Opinions still differ as to whether Articles 3(2) and 3(3) of the Constitution allow the affirmative action with regard to women and disabled person's employment or not as the amendments to the Basic Law in November 1994 did not clearly endorse this approach. Nevertheless, there are programs initiating that if men and women have equal qualifications, women have to be preferred for a job; Similarly, the disabled should be preferred to non-disabled people. This was applicable for all positions in state and university service as of 2007¹⁰

Israel has a unique quota system, in four university admissions that is based on structural disadvantages, especially neighborhood Socio-economic status and high school rigor. Further, individual hardships are also weighed. Apart from the above, Women, Arabs, Blacks and handicaps are entitled to Affirmative Action in the civil service employment and they are entitled for full University tuition scholarships by the state.

New Zealand provided Affirmative action under section 73 of the Human Rights Act 1993 and section 19(2) of the New Zealand Bill of Rights Act 1990. Under this programme individuals of Māori or other Polynesian descent are often offered improved access to university courses, and provided special scholarships.

In the UK, affirmative action is rendered illegal as it is based upon racial discrimination.¹¹ On the contrary the approach to equal treatment is described as being "color blind" or "positive action" that ensures the absence of prejudice to the criteria of merit. The focus here tends to be on providing equal opportunity and for this purpose measures such as targeted advertising campaigns to encourage ethnic minority candidates may be launched. However, it allows selection of a equally qualified candidate from an "under-represented" group, practically, ignoring another potential candidate belonging to the sufficiently-represented group.

However, there are certain exemptions to the above anti-discriminatory law. For instance, The Sex Discrimination (Election Candidates) Act 2002 allows the all-women shortlists to increase

women representation in various elected bodies. Similarly, the Good Friday Agreement, that is the outcome of the Northern Ireland Peace Process, make it mandatory to maintain 50:50 balance in Northern Ireland police force between Protestants and Catholics.

In the USA affirmative action was initiated in 1965. The Federal Government through the Executive Order 11246 affirms its commitment "to promote the full realization of equal employment opportunity through a positive, continuing program in each executive department and agency". Later, it was extended to women by Executive Order 11375. In original purpose of the U.S. affirmative action was to pressure institutions into compliance with the nondiscrimination mandate of the Civil Rights Act of 1964.

In Taiwan Ministry of Education and Council of Aboriginal Affairs announced in 2002 that Taiwanese Aboriginal students would have their high-school or undergraduate entrance exams boosted by 33% for demonstrating some knowledge of their tribal language and culture. The percentage of boost have been revised several times, and by 2013 it reached to 35%.¹²

In Norway, Sweden, and Finland certain special provisions are provided to Sami people such as certain areas were excluded for them in respect to the purchasing of property and Reindeer rearing.¹³

In Macedonia, the gender-reservation was provided to the 'under-represented sex' that practically means women, who at that time forms only 3% in Macedonian elected bodies. The Election law, passed on 25th June 2002, made it obligatory for all political parties to enlist at least 30% of the women candidates for the elections of national elective bodies where as in local bodies certain positions are earmarked for women.¹⁴

Conclusion : the above observations shows that in several countries of the world, apart from India, the quota system is in vogue. In some countries it is on ethnic, or religious base and in some countries it is gender base or dis-ability based.

¹ United Nations Committee on Human Rights, General Comment 18 on Non-discrimination, Par. 10

² Edward Telles and Marcelo Paixão, 'Affirmative Action in Brazil' *Lasaforum*, Spring 2013, vol. XLIV : issue 2

³ Prof. Najma Chowdhury, Proceedings of 'Regional Workshop on The Implementation of Quotas: Asian Experiences by International Institute for Democracy and Electoral Assistance (IDEA) on 25 September 2002 in Jakarta, Indonesia : 'The Implementation of Quotas: Bangladesh Experience — Dependence and Marginality in Politics'.

⁴ 23rd (2014-15) Annual Report to Parliament on Employment Equity in the Public Service of Canada by the President, Treasury Board of Canada, Catalogue No. BT1-28E-PDF; ISSN: 1926-2485

⁵ Singer, Rena. "China's Minorities Get Huge Affirmative-Action Benefits." *Knight-Ridder Newspapers at The Seattle Times*. Tuesday August 26, 1997. Retrieved on January 4, 2014.

⁶ <https://www.helsinki.fi/en/swedish-school-of-social-science/about-sockom>

⁷ WageIndicator 2017 - Mywage.co.za - Affirmative Action

⁸ <http://www.bee.co.za/content/Information.asp%7D>

⁹ Just Faaland, Mukhriz Mahathir and Khairy Jamaluddin (2003). *Malaysia's New Economic Policy: An overview*. Utusan Publications & Distributors Sdn Bhd

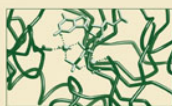
¹⁰ Stock, Anke J., Affirmative Action: A German Perspective on the Promotion of Women's Rights with Regard to Employment. *Journal of Law and Society*, Vol. 33, No. 1, pp. 59-73, March 2006

¹¹ The UK Labour law prohibits discrimination against a person because they have one of the "protected characteristics", which are, age, disability, gender reassignment, marriage and civil partnership, race, religion or belief, sex, and sexual orientation.

¹² Alain Kralsfield *et al*, *Intrnational Handbook on Diversity management at work*, 2nd ed. 2014, Edward Elgar Publishing, Glos, UK)

¹³ Wikipedia/taiwan

¹⁴ Daniela Dimitriveska, *Quotas, the case of Macedonia*, paper presented in a conference on The Implementation of Quotas: European Experiences, organised by IDEA, at Budapest, Hungary, on 22-23 Oct, 2004,



DNA binding, photocleavage, antimicrobial and cytotoxic properties of Ru(II) polypyridyl complexes containing BOPIP ligand, (BOPIP = {2-(4-(benzyloxy) phenyl)-1H-imidazo [4,5-f] [1,2]phenanthroline})

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DNA binding, photocleavage, antimicrobial and cytotoxic properties of Ru(II) polypyridyl complexes containing BOPIP ligand, (BOPIP = {2-(4-(benzyloxy)phenyl)-1H-imidazo [4,5-f] [1,2]phenanthroline})

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ABSTRACT

A novel ligand BOPIP (BOPIP = {2-(4-(benzyloxy)phenyl)-1H-imidazo[4,5-f][1,10]phenanthroline}) and its mononuclear Ru(II) polypyridyl complexes [Ru(phen)₂ BOPIP]²⁺ (**1**) (phen = 1,10-Phenanthroline), [Ru(bpy)₂ BOPIP]²⁺ (**2**) (bpy = 2,2'-bipyridyl), [Ru(dmb)₂ BOPIP]²⁺ (**3**) (dmb = 4, 4'-dimethyl 2, 2'-bipyridine), [Ru(Hdpa)₂ BOPIP]²⁺ (**4**) (Hdpa = 2,2'-dipyridylamine) have been synthesized successfully and characterized by elemental analysis, UV-vis, IR, ¹H, ¹³C-NMR, and ESI-MS Spectroscopy. The interaction of these complexes with CT-DNA was studied using absorption, emission techniques, viscosity measurements and molecular docking studies. The docking study also supports the binding ability of complexes obtained through the absorption and emission techniques. These studies reveal that the Four Ru(II) polypyridyl complexes bind to DNA predominantly by intercalation. The Antimicrobial activity and cytotoxicity of these complexes are also reported.

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Antimicrobial activity; DNA binding; MTT Assay; Molecular Docking; Photocleavage; Viscosity

1. Introduction

Cancer is mostly considered as a group of dreadful diseases, characterized by uncontrolled cell growth. Cancer, still proven to be one of the unruliest diseases to which humans are subjected, and as yet no practical and completely effective drugs or methods to control are available. Hence, identification of new effective, selective, and less cytotoxic anticancer agents is still one of the most pressing health issues.^[1–4] DNA, the carrier of genetic information, has been identified as the primary target for a variety of anticancer drugs because of their ability to interfere DNA transcription

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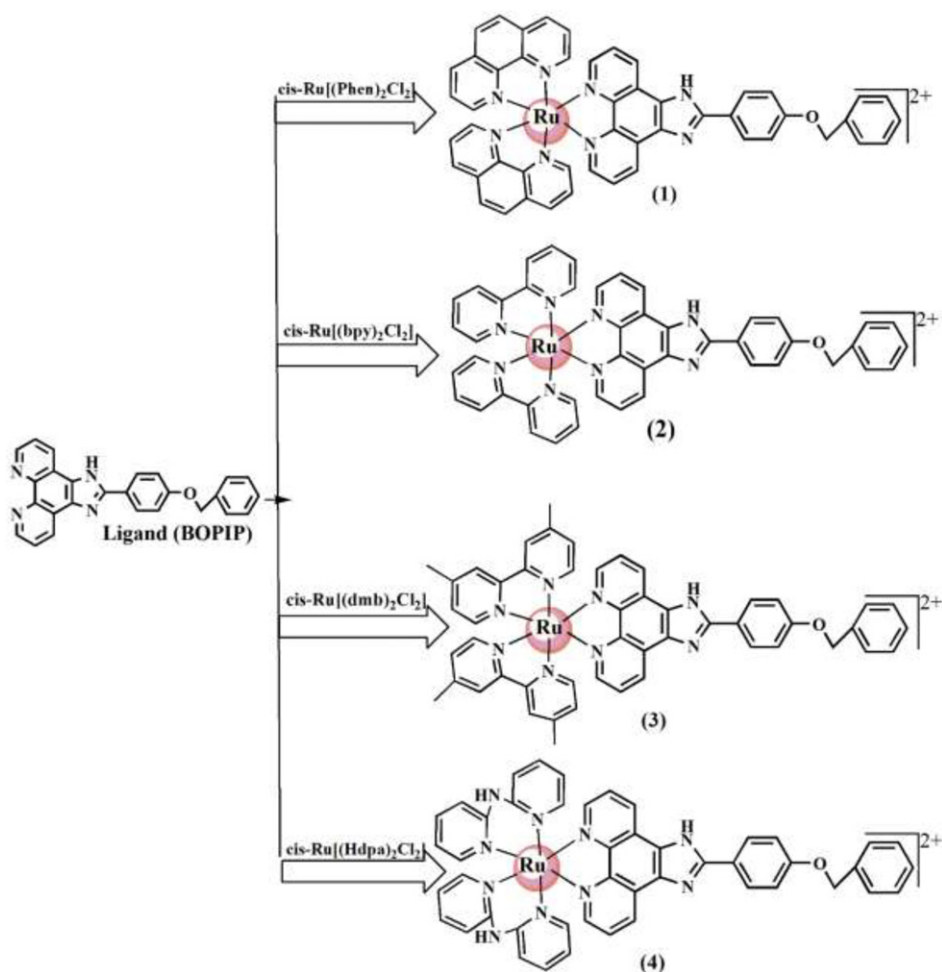
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and replication, which are major steps of cell growth and division.^[5] Thus, knowing and understanding drug-DNA interactions is important to comprehend the mode of action of any anticancer drug targeting DNA. DNA offers a number of sites for different covalent and noncovalent interactions with the drugs.

The field of anticancer metallodrugs is dominated by platinum-based compounds and the so-called “DNA paradigm”, which presumes that the mechanism of action of metallodrugs relies on direct DNA damage.^[6] The quest for alternative drugs to the well-known cisplatin and its derivatives, which are still used in more than 50% of the treatment regimes for patients suffering from cancer, is highly desirable.^[7,8] The development of more efficient anticancer drugs with improved selectivity and diminished toxic side effects is currently an area of intense research. With the objective of developing compounds with a new mode of action in comparison to the established anticancer drugs cisplatin, carboplatin, and oxaliplatin for treatment of a broader range of tumors and with fewer side effects, many metal complexes were investigated in recent years for their tumour inhibiting properties.^[9] New metal-based anticancer drugs may be able to widen the spectrum of treatable cancers, reduce toxic side effects, and overcome platinum resistance.

Ruthenium is the most attractive metal owing to its chemical and air stability, structural diversity, low toxicity and ability to mimic iron binding in biological system, which finally supported them as highly potent anticancer agents rather than platinum-based drugs.^[10-12] Due to unique photophysical properties, ruthenium complexes have been widely applied in DNA probing, cellular imaging, protein monitoring, and anticancer activity.^[13-20] Presently, ruthenium complex NKP-1339 (trans-[tetrachloridobis (1H-indazole) ruthenate(III)]) has successfully entered into the clinical trials.^[21,22]

Changes in the structure of main ligand could be used to attain diverse DNA binding ability of ruthenium(II) complexes. Therefore, extensive studies on different structured ligands are necessary to further elucidate the DNA binding ability and its mechanism of Ru(II) complexes and discover some new potential anticancer reagents. In this article, we report the synthesis, characterization, DNA binding, light switching, photocleavage, cytotoxicity, and antimicrobial activity studies of the ligand 2-(4-(benzyloxy) phenyl)-1H-imidazo[4,5-f][1, 10]phenanthroline (BOPIP) and four of its ruthenium(II) complexes. $[\text{Ru}(\text{phen})_2(\text{BOPIP})]^{2+}$ (**1**), $[\text{Ru}(\text{bpy})_2(\text{BOPIP})]^{2+}$ (**2**), $[\text{Ru}(\text{dmb})_2(\text{BOPIP})]^{2+}$ (**3**), $[\text{Ru}(\text{Hdpa})_2(\text{BOPIP})]^{2+}$ (**4**) (Scheme 1) The absorption & emission studies, viscosity measurements, and photocleavage studies show that the four complexes predominantly interact with DNA by an intercalative mode. The cytotoxicity of these compounds evaluated by 3-(4,5-dimethylthiazol-2-yl)2,5-diphenyltetrazolium bromide (MTT) assay.



Scheme 1. Schematic synthetic route for the preparation of complexes 1, 2, 3 and 4, Where 1 = $[\text{Ru}(\text{Phen})_2\text{BOPIP}]^{2+}$, 2 = $[\text{Ru}(\text{bpy})_2\text{BOPIP}]^{2+}$, 3 = $[\text{Ru}(\text{dmb})_2\text{BOPIP}]^{2+}$, 4 = $[\text{Ru}(\text{Hdpa})_2\text{BOPIP}]^{2+}$.

The cytotoxicity studies show that these compounds exhibit efficient activity against HeLa (human cervical cancer cell line) cell lines in a dose-dependent manner. The antimicrobial activity experiments show that these compounds exhibit decent antimicrobial activity.

2. Materials and methods

2.1. Materials

All reagents and solvents of analytical grade were commercial products and were used as received unless otherwise stated. 1,10-Phenanthroline-5,6-dione,^[23] $\text{cis-}[\text{Ru}(\text{phen})_2\text{Cl}_2] \cdot 2\text{H}_2\text{O}$, $\text{cis-}[\text{Ru}(\text{bpy})_2\text{Cl}_2] \cdot 2\text{H}_2\text{O}$, $\text{cis-}[\text{Ru}(\text{dmb})_2\text{Cl}_2] \cdot 2\text{H}_2\text{O}$,^[24] and $\text{cis-}[\text{Ru}(\text{Hdpa})_2\text{Cl}_2] \cdot 2\text{H}_2\text{O}$ ^[25] were synthesized according to literature

procedures. 4-(benzyloxy) benzaldehyde, $\text{RuCl}_3 \cdot 3\text{H}_2\text{O}$, and MTT were procured from Sigma-Aldrich. 1,10-Phenanthroline monohydrate, 2,2'-bipyridine (bpy), 4,4'-dimethyl-2,2'-bipyridine (dmb), and 2,2'-dipyridyl amine (Hdpa) were acquired from Merck. Calf thymus DNA (CT-DNA) was bought from Aldrich, Supercoiled pBR322 plasmid DNA (stored at -20°C) was obtained from Fermentas Life Sciences and was used as received. Agarose was purchased from Genei. Ultrapure Milli-Q water (18.2 mX) was used in all experiments and for preparing various buffers double-distilled water was used. The HeLa human cervical carcinoma cell line was obtained from NCCS, Pune, and was maintained in RPMI 1640 standard (Sigma Aldrich) supplemented with 10% (v/v) fetal bovine serum, 2 m.mol L-glutamine, 4.5 g L-1 glucose, 19 nonessential amino acids, and 19 antibiotics consisting of penicillin/streptomycin, gentamicin, amphotericin B, and nystatin (basal growth medium). Binding of the complexes with CT-DNA was studied in tris(hydroxymethyl)aminomethane (Tris)-HCl buffer (5 m.mol Tris-HCl, 50 m.mol NaCl, pH 7.2). A solution of CT-DNA in Tris-HCl buffer gave a ratio of UV absorbance at 260 and 280 nm of 1.8:1 to 1.9:1, indicating the DNA was sufficiently free of protein.^[26] The concentration of DNA per nucleotide was determined spectrophotometrically using a molar absorptivity of $6,600 \text{ M}^{-1} \text{ cm}^{-1}$ (260 nm).^[27] Concentrated stock solutions of CT-DNA were prepared in buffer and were determined by the UV absorbance at 260 nm after 1:100 dilutions. Stock solutions were stored at 4°C and used after not more than 4 days. Concentrated stock solutions of metal complexes were prepared by dissolving calculated amounts of metal complexes in DMSO and diluted suitably with the corresponding buffer to the concentrations required for all the experiments.

2.2. Physical measurements

The UV-Vis spectra was recorded on Shimadzu UV-2600 spectrophotometer. Cary Eclipse instrument serial number (MY12400004) Spectro fluorometer was used to record the luminescence spectral data for determining the binding constant values. IR spectra were recorded on a PerkinElmer 1605 Fourier transform IR spectrometer by means of KBr disks. ^1H and ^{13}C NMR spectra were recorded with a Bruker 400-MHz spectrometer with dimethyl- d_6 sulfoxide (DMSO- d_6) as the solvent and tetramethylsilane as the internal standard at room temperature. Elemental microanalysis (C, H, and N) was conducted by using PerkinElmer 240 elemental analyser. Electrospray ionization mass spectrometry (ESI-MS) mass spectra were recorded with a Quattro LC triple quadrupole mass spectrometer fortified with the MassLynx software program (Micromass, Manchester, UK).

2.3. Synthesis and characterization of ligand and complexes

The 1,10-phenanthroline-5,6-dione (Phendione),^[23] cis-[Ru(phen)₂Cl₂], cis-[Ru(bpy)₂Cl₂], cis-[Ru(dmb)₂Cl₂], and cis-[Ru(Hdpa)₂Cl₂]^[24,25] were synthesized according to reported literature methods. Schematic diagram of Ru(II) complexes were shown in Scheme 1.

2.4. Synthesis of ligand [BOPIP]

The ligand was synthesized according to the procedure in the literature.^[28] A mixture of phendione (0.53 g, 2.50 m.mol), 4-(benzyloxy) benzaldehyde (0.743 g, 3.50 m.mol), ammonium acetate (3.88 g, 50.0 m.mol) is liquified in glacial acetic acid (25 ml) and the ensuing solution was refluxed for 5h. A clear wine-red colour solution attained. The above solution was cooled to room temperature and transferred into distilled water, drop wise addition of Conc. NH₃ form a yellow precipitate, which was collected, washed with H₂O and dried. The crude product recrystallized with C₅H₅N.H₂O and dried (Yield: 81.04%). Anal. Data for C₂₆H₁₈N₄O: Calcd(%): C, 77.59; H, 4.51; N, 13.9; found(%): C, 77.64; H, 4.45; N, 13.76. ES-MS(m/z) Calc: 402; found: 403 [M + H]⁺. ¹H-NMR (DMSO-d₆, 400 MHz): δ 8.93(d,2H), 8.26(d, 2H), 7.88(m, 5H), 7.44(t, 2H),7.27(d, 2H), 7.1(d,2H), 5.22(s,2H). ¹³C[¹H] NMR (400 MHz, DMSO-d₆, ppm): δ153.8, 153.1, 140.4, 137, 128.2, 122.6, 115.4, 114.8, 69.8. IR (KBr, cm⁻¹): 3641 (v, N-H), 1118 (v, C-N), 1240 (v, C-O-C).

2.5. Synthesis of complexes

2.5.1. [Ru(phen)₂(BOPIP)](ClO₄)₂·2H₂O(1)

Cis-[Ru(Phen)₂Cl₂].2H₂O (0.284 g, 0.5 m.mol), BOPIP (0.201 g, 0.5 m.mol) dissolved in ethanol (25 ml) plus water (15ml) mixture and refluxed for 8h at 120 °C under N₂ atmosphere. When the light purple colour solution was obtained, it was cooled to room temperature and an equal volume of saturated aqueous NaClO₄ solution was added under vigorous stirring. The yellow precipitate was collected and washed with small amounts of water, ethanol and diethyl ether, then dried under vacuum (yield: 78%). Anal. data for RuC₅₀H₃₄N₈O: calcd (%): C, 69.51; H, 3.97; N, 12.97; found: C, 69.62; H, 3.88; N, 12.81. ES-MS(m/z) cal: 864; found: 866 [M + H]⁺². ¹H-NMR (DMSO-d₆, 400 MHz): δ 9.06(d,6H), 8.79(d, 6H), 8.21(d, 4H), 8.09(d, 2H),7.79(m, 6H), 7.2(d,2H), 5.25(s,2H). ¹³C[¹H] NMR (400 MHz, DMSO-d₆, ppm): δ 160.5, 153.2, 147.7, 137.2, 132.2, 130.9, 128.9, 128.2, 126.8, 122.5, 116.0, 115.7, 69.9. IR (KBr, cm⁻¹): 3475 (v, N-H), 1116 (v, C-N), 1143 (v, C-O-C), and 626 (v, Ru-N).

2.5.2. [Ru(bpy)₂(BOPIP)](ClO₄)₂·2H₂O(2)

This complex was synthesized by adopting the same procedure as described above for Complex 1. taking a mixture of cis-[Ru(bpy)₂Cl₂].2H₂O (0.260 g, 0.5 m.mol), BOPIP (0.201 g, 0.5 m.mol) (yield: 78%). Anal. data for RuC₄₆H₃₄N₈O: calcd(%): C, 67.72; H, 4.20; N, 13.73; found(%): C, 67.82; H, 4.23; N, 13.63. ES-MS(m/z) calc: 816; found: 817 [M + H]⁺. ¹H-NMR (DMSO-d₆, 400 MHz): δ 9.10(d,2H), 8.9(d, 4H), 8.84(d, 2H), 8.11(t, 4H),8.28(t, 4H), 7.86(d, 2H), 7.61(d,4H), 7.44(t, 2H), 7.34(m, 5H), 7.22(d,2H), 5.25(s,2H). ¹³C[¹H] NMR (400 MHz, DMSO-d₆, ppm): δ 160.6, 157.2, 153.2, 151.8, 138.4, 137.1, 128.9, 128.3, 124.9, 122.5, 116.0, 115.7, 69.9. IR (KBr, cm⁻¹): 3444 (v, N-H), 1078 (v, C-N), 1143 (v, C-O-C), and 626 (v, Ru-N).

2.5.3. [Ru(dmb)₂(BOPIP)](ClO₄)₂·2H₂O(3)

This complex was synthesized as described above by taking a mixture of cis-[Ru(dmb)₂Cl₂].2H₂O (0.288 g, 0.5 m.mol), BOPIP (0.201 g, 0.5 m.mol) (yield: 72.71%). Anal. data for RuC₅₀H₄₂NO₉: calc. C, 53.82; H, 4.04; Cl, 6.76; N, 12.02; O, 13.73; Ru, 9.64; found: C, 54.01; H, 4.32; Cl, 6.60; N, 11.94; O, 13.82; Ru, 9.50. ES-MS(m/z) calc: 1048; found: 1050 [M + H]⁺. ¹H-NMR (DMSO-d₆, 400 MHz): δ 8.75(d, 6H), 8.28(d, 2H), 8.07(s, 4H), 7.66(d, 4H), 7.44(t, 2H),7.17(m, 5H), 5.24(s,2H), 2.46(s, 12H). ¹³C[¹H] NMR (400 MHz, DMSO-d₆, ppm): δ 160.5, 156.7, 150.0, 137.1, 132.2, 128.9, 128.2, 127.2, 122.6, 115.7, 69.9, 51.0. IR (KBr, cm⁻¹): 3444 (v, N-H), 1133 (v, C-N), 1141 (v, C-O-C), and 624 (v, Ru-N).

2.5.4. [Ru(Hdpa)₂(BOPIP)](ClO₄)₂·2H₂O(4)

This complex was synthesized as described above by taking a mixture of cis-[Ru(Hdpa)₂Cl₂].2H₂O (0.19 g, 0.5 m.mol), BOPIP (0.201 g, 0.5 m.mol) (yield: 52.71%). Anal. data for RuC₄₇H₄₂Cl₂N₉O₉: calc. C, 53.82; H, 4.04; Cl, 6.76; N, 12.02; O, 13.73; Ru, 9.64; found: C, 54.01; H, 4.32; Cl, 6.60; N, 11.94; O, 13.82; Ru, 9.50. ES-MS(m/z) calc: 1048; found: 1050 [M + H]⁺. ¹H-NMR (DMSO-d₆, 400 MHz): δ 8.96(d, 4H), 8.25(d, 2H), 8.05(d, 2H), 7.74(t, 6H), 7.43(d, 2H), 6.97(m, 5H), 6.9(d, 6H), 5.24(s,2H), 4.2(s, 2H). ¹³C[¹H] NMR (100 MHz, DMSO-d₆, ppm): δ 160.5, 153.8, 153.1, 137.1, 128.9, 128.2, 122.6, 115.9, 69.9. IR (KBr, cm⁻¹): 3444 (v, N-H), 1133 (v, C-N), 1141 (v, C-O-C), and 624 (v, Ru-N).

2.6. DNA-binding and photocleavage experiments

2.6.1. UV-Visible absorption spectral studies

The DNA-binding studies were conducted at room temperature. Concentrated stock solutions of metal complexes were prepared by

dissolving calculated amounts of metal complexes in DMSO and diluted accordingly with the corresponding buffer to the concentrations required for all the experiments. The absorption titrations were performed in Tris-HCl buffer. The absorption titrations of the complex in buffer were performed using a fixed complex concentration (20 μ l), to which increments of the DNA stock solution was added. Ru-DNA solutions were incubated for 5 min before the absorption spectra were recorded. The intrinsic binding constants K_b of these complexes with regard to DNA were calculated by using the following equation.^[29]

$$[\text{DNA}]/(\varepsilon_a - \varepsilon_f) = [\text{DNA}]/(\varepsilon_b - \varepsilon_f) + 1/K_b(\varepsilon_b - \varepsilon_f) \quad (1)$$

where [DNA] is the concentration of DNA, ε_a , ε_b and ε_f correspond to the apparent absorption extinction coefficient ($A_{\text{obsd}}/[\text{complex}]$), the extinction coefficient for the complex in the fully bound form and the extinction coefficient for the free complex respectively. The graph was plotted between $[\text{DNA}]/(\varepsilon_a - \varepsilon_f)$ versus [DNA] gave the intrinsic binding constant K_b . The K_b value obtained from the ratio of slope to the intercept.

2.6.2. Florescence (Luminescence) spectral studies

The luminescence titrations were performed similarly to the absorption titrations using Tris-HCl buffer. To the fixed metal concentration (10 μ l), various concentrations (10–200 μ l) of DNA were added. The binding constant was calculated using Scatchard equation.^[30]

$$C_b = C_t [(F - F_0)/(F_{\text{max}} - F_0)] \quad (2)$$

where C_t is the total complex concentration, F is the observed fluorescence emission intensity at a given DNA concentration, F_0 is the intensity in the absence of DNA, and F_{max} is when the complex is maximum bound to DNA. From the Scatchard plot of r/C_f versus r , where r is the $C_b/[\text{DNA}]$ and C_f is the concentration of the free complex, the negative slope gives the intrinsic binding constant K_b of the complexes based on the relation

$$r/C_f = K_b(1 - nr) \quad (3)$$

Quenching studies with $[\text{Fe}(\text{CN})_6]^{4-}$ were extended under this luminescence experiment for further understanding the binding ability of these complexes with DNA. We also observed an interesting thing that these complexes are exhibiting the light switch on/off effect by taking the same concentrations of Co^{2+} and Na_2EDTA solutions in ideal concentrations of complex in fluorescence titrations.

2.6.3. Viscosity studies

Ostwald viscometer was used for the viscosity studies, Ostwald viscometer was immersed in thermo stated water bath maintained a constant temperature (30 ± 0.1 °C) by using BPE buffer (6 m.mol Na_2HPO_4 , 2 m.mol NaH_2PO_4 , 1 m.mol Na_2EDTA , pH = 7.0). The used CT-DNA samples approximately 200 base pairs in average length were prepared by sonication to minimize the complexes arising from DNA flexibility.^[31] Using the digital stopwatch, the flow time was recorded and each sample was repeated thrice. The recorded data were presented as $(\eta/\eta_0)^{1/3}$ versus concentration of $[\text{Ru}(\text{II})]/[\text{DNA}]$, where η is the viscosity of DNA in the presence of the complex, and η_0 is the viscosity of DNA alone. Viscosity values were calculated from the observed flow time of DNA-containing solutions (t) corrected for the flow time of the buffer alone (t_0).

2.6.4. Photocleavage experiment

For the gel electrophoresis experiments pH 8.0 buffer of 40 m.mol Tris base, 20 m.mol acetic acid, and 1 m.mol EDTA was used. A buffer of 10 m.mol Tris-HCl and 1 m.mol Na_2EDTA was used for dilution of pBR322 DNA. Supercoiled pBR322 DNA ($0.1 \mu\text{g}/\mu\text{L}$) was treated with ruthenium(II) complexes with concentrations of 20, 40, 80 μL , and the mixtures were irradiated at room temperature with a UV lamp (365 nm, 10 W) for 60 min. A loading buffer containing 25% bromophenol blue, 0.25% xylene cyanole, and 30% glycerol (2 μL) was added. The samples were then analysed by 0.8% agarose gel electrophoresis at 50 V for 2 h. The gel was stained with 2 μL (from 1 mg/100 μL) ethidium bromide and photographed under UV light.^[32] The gels were viewed with a gel documentation system and photographed using a CCD camera (Alpha Innotech).

[CAUTION: *Ethidium bromide is a mutagen and potential carcinogen. Gloves should be worn and care should be taken when handling. UV light is damaging to eyes and exposed skin. Protective eyewear and apron should be worn at all times.*]

The photocleavage experiments were also performed with singlet oxygen ($^1\text{O}_2$) inhibitor Histidine and Hydroxyl free radical ($\cdot\text{OH}$) inhibitor Mannitol to establish the reactive species responsible for the photoactivated cleavage of the plasmid.

2.7. Antimicrobial studies

Antimicrobial studies were performed using standard disk diffusion method.^[33] The antibacterial activity of the complexes was studied against *Escherichia coli* and *Staphylococcus aureus*. Each of the ruthenium(II) complex was dissolved in DMSO at different concentrations of 10, 20, and

40 µg. Paper disks of Whatman filter paper no. 1 were sterilized in an autoclave. The paper disks saturated with 10 µL of the ruthenium(II) complex were placed aseptically in Petri dishes containing LB agar medium inoculated separately with *E. coli* and *S. aureus*. The Petri dishes were incubated at 37 °C, and the inhibition zones were recorded after 24 h of incubation. The experiments were repeated twice and the average value was taken. The results were also compared with the results for the standard antibacterial drug Ampicillin.

2.8. Molecular docking studies

Accelry's Discovery Studio (version 2.1) was used to design lead molecules, estimate the docking interactions of a complex of drug and protein binding, and number of bonds formed by ligand with the target. The molecular docking of ruthenium complexes 1, 2, 3 and 4 was performed using LibDock.^[34] LibDock is a high-throughput algorithm for docking ligands into an active binding site on the receptor, which is also a site-features docking algorithm. Accelry's CHARMM force field was used throughout the simulation before running LibDock. The crystal structure of human DNA topoisomerase 1 (TOP1) receptor was downloaded from RCSB PDB (PDB ID-1T8I), after downloading the PDB format of the protein, all the water molecules of the protein were removed by using Discovery Studio and stabilizing the charges, filling the missing residues, and generating the side chains, according to the parameters available. The receptor should be in a biologically active and stable state. After the receptor is constructed, the active site within the receptor should be recognized. The receptor may have many active sites but the one of the interest should be selected. Ruthenium complexes were sketched using the tools ChemsSketch and used to dock into the target binding site. Ruthenium complex conformations aligned to receptor interaction sites and the best poses were reported at the end of docking simulations. The scoring functions have been used to estimate binding affinity to screen out active and inactive compounds during the process of virtual screening.^[35]

2.9. Cytotoxicity assay in vitro (MTT Assay)

Standard MTT assay was conducted as described in the literature.^[36] Cells were placed in 96-well microassay culture plates (8×10^3 per well) in 200 µL and were grown overnight at 37 °C in a 5% CO₂ incubator. Complexes 1–4, in the concentration range 1–100 µM, dissolved in DMSO (Sigma-Aldrich), were added to the wells. Control wells were prepared by addition of culture medium (200 µL). Wells containing culture medium

without cells were used as a negative control and cisplatin was used as a positive control. DMSO was used as the vehicle control. A stock solution of cisplatin (10 m.mol in DMSO) was freshly prepared for every experiment. After 48 h, 20 μL of MTT solution [5 mg/mL in phosphate-buffered saline (PBS)] was added to each well and the plates were wrapped in aluminium foil and incubated for 4 h at 37 °C. The purple formazan product was dissolved by addition of 100 μL of 100% DMSO to each well. The absorbance was monitored at 620 nm using a 96-well plate reader. The stock solutions of the metal complexes were prepared in DMSO, and in all experiments, the percentage of DMSO was maintained in the range of 0.1–2%. DMSO by itself was found to be nontoxic to the cells until a concentration of 2%. Data were collected for three replicates each to obtain the mean values. The IC_{50} values were determined by plotting the percentage viability versus concentration on a logarithmic graph and reading the concentration at which 50% of cells remained viable relative to the control.

3. Results and discussion

3.1. Electronic absorption titrations

Electronic absorption spectroscopy is the common means to study the interaction between metal complexes and DNA.^[37] For metallointercalators, DNA binding is associated with hypochromism and a redshift in the metal to ligand charge transfer (MLCT) and ligand bands.^[38] This is primarily due to the intercalation, involving strong stacking interactions between an aromatic chromophore and the base pairs of DNA. The extent of the hypochromism in a UV–visible band is consistent with the strength of the interaction.^[39] Thus, to provide evidence for the possibility of binding of each complex to CT-DNA, spectroscopic titrations of solutions of each of the complexes with several concentrations of CT-DNA were examined. A characteristic spectral curve of the complex at different DNA concentrations is shown in Figure 1. As the DNA concentration is increased, the MLCT bands of 1 at 453 nm, 2 at 462 nm, 3 at 467 nm, and 4 at 468 nm exhibit hypochromism of about 14.46, 13.74, 11.64, and 15.01%, respectively, and bathochromism of about 2–5 nm. To further elucidate the binding strength of the complexes with regard to DNA, the intrinsic binding constant K_b was determined in each case by monitoring the changes in their absorbance in the MLCT band with increasing concentration of CT-DNA. The K_b values of 1, 2, 3, and 4 are $7.1 \times 10^4 \text{ M}^{-1}$, $3.4 \times 10^4 \text{ M}^{-1}$, $2.5 \times 10^4 \text{ M}^{-1}$, and $8.3 \times 10^4 \text{ M}^{-1}$, respectively. The values are smaller than that of those DNA metallointercalators, such as $[\text{Ru}(\text{bpy})_2(\text{PPIP})]^{2+}$ $K_b = (4.3 (\pm 0.40) \times 10^4 \text{ M}^{-1})$, $[\text{Ru}(\text{phen})_2(\text{PPIP})]^{2+}$ $K_b = (1.13 (\pm 0.30) \times 10^5 \text{ M}^{-1})$ and

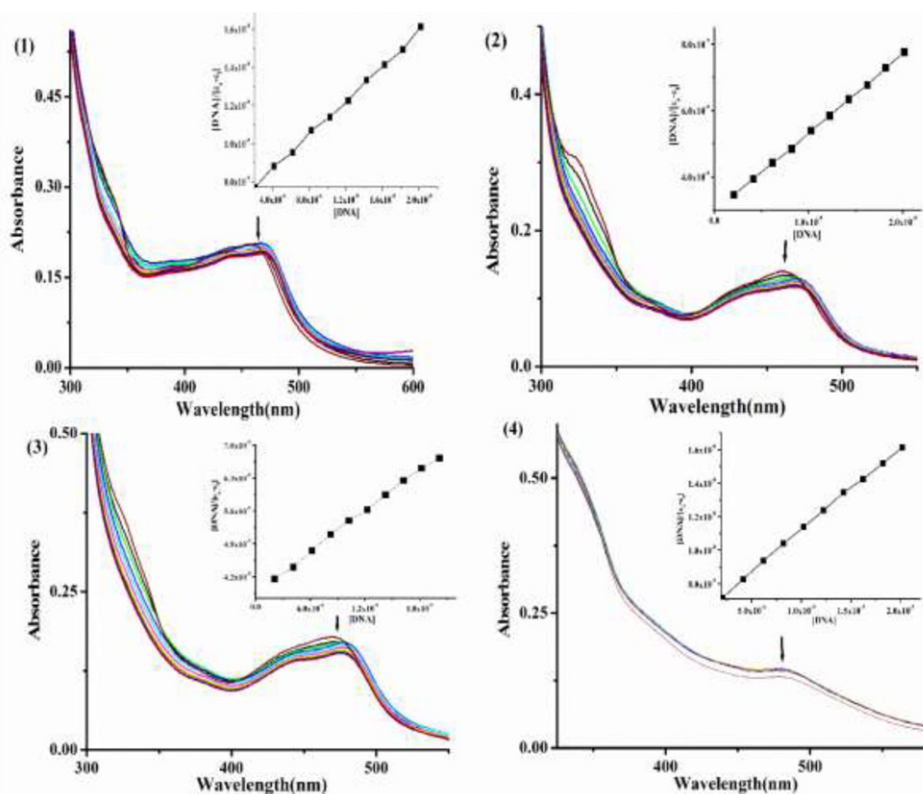


Figure 1. Absorption spectra of complexes 1–4 in absence and presence of CT-DNA in Tris-HCl buffer. Arrow shows hypochromism and bathochromism upon the increase of DNA concentration. Inset plot, $[DNA]/(\epsilon_a - \epsilon_f)$ versus $[DNA]$ for the titration of DNA with Ru(II) complexes, which gives intrinsic binding constant (K_b).

$[Ru(bpy)_2(dppz)]^{2+}$ ($dppz = \text{dipyrido-[3,2-a:2',3'-c]phenazine}$, $K_b > 10^6 M^{-1}$), but bigger than that of the parent complex $[Ru(phen)_3]^{2+}$ $K_b = (5.5 \times 10^3 M^{-1})$.^[38,40,41] Since the intercalator is common in all the four complexes, the different DNA binding properties of the four complexes are due to their diverse ancillary ligands. Going from bpy to phen, the planar area and hydrophobicity increases, which may lead to a greater binding affinity for DNA. The four additional methyl groups in complex 3 relative to complex 2 employ some steric hindrance, thus averting the complex from intercalating as effectively, and so instigating a decrease in the binding constant. The flexible nonplanar hdpa ligands approach more closely and coordinate to ruthenium(II) more strongly than the rigid phen ligands^[42] and the NH group in Hdpa may employ some added interactions such as hydrogen bonding with functional groups present on the edge of the DNA.^[43] This would contribute significantly to the greater binding constant in contrast to the other three complexes. The K_b values of all the complexes studied are in the order $4 > 1 > 2 > 3$.

3.2. Luminescence titrations

To further understand the exact nature of the complex binding to DNA, luminescence titration experiments were performed at a fixed metal complex concentration (5 μM) in Tris buffer (pH 7.2) at ambient temperature. The change of emission intensity is related to the extent to which the complex enters into the hydrophobic environment inside the DNA. Figure 2 shows the fluorescence excitation and emission spectra for the free and bound complexes 1–4 in the presence of different amounts of CT-DNA. Excitation wavelengths of 453, 462, 467, and 468 nm were used for fluorescence measurements of complexes 1, 2, 3, and 4, respectively and emission wavelength found to be 602, 610, 618, and 627 nm. When the CT-DNA was added to the solution of the complexes 1-4, the fluorescence intensity was found to increase. The fluorescence intensities of complexes 1, 2, 3, and 4 increased by 3.26, 3.18, 3.11, and 3.83 times, respectively, compared with the intensities in the absence of CT-DNA. The emission enhancement of the complexes 1-4 in the presence of CT-DNA is much smaller than that observed for complexes $[\text{Ru}(\text{phen})_2(\text{PPIP})]^{2+}$, $[\text{Ru}(\text{bpy})_2(\text{PPIP})]^{2+}$ and $[\text{Ru}(\text{dmb})_2(\text{PPIP})]^{2+}$.^[41] This implies that $[\text{Ru}(\text{phen})_2(\text{PPIP})]^{2+}$, $[\text{Ru}(\text{bpy})_2(\text{PPIP})]^{2+}$ and $[\text{Ru}(\text{dmb})_2(\text{PPIP})]^{2+}$ may interact with CT-DNA more strongly and when the complex intercalates between the DNA base pairs, the mobility of the complex is restricted at the binding site and the hydrophobic

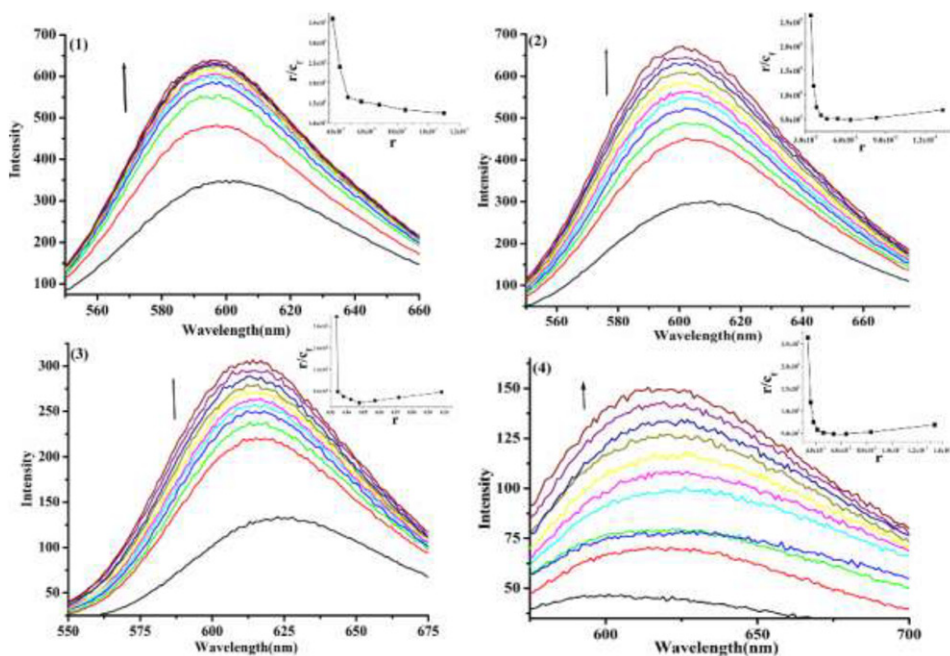


Figure 2. Emission spectra of complexes 1–4 in Tris-HCl buffer upon addition of CT-DNA. The arrow shows the intensity change upon the increase of DNA concentration. Inset: Scatchard plot of above complex, which gives binding constant (K_b).

environment inside the DNA helix reduces the accessibility of solvent water molecules to the complex, leading to a decrease of the vibrational modes of relaxation. The intrinsic binding constant from the fluorescence data was obtained from a modified Scatchard equation^[30] through a plot of r/C_f versus r , where r is the binding ratio $C_b/[DNA]$ and C_f is the free ligand concentration. Scatchard plots for the complexes were constructed from luminescence spectra, and the binding constants (K_b) were $7.29 \times 10^4 \text{ M}^{-1}$, $3.61 \times 10^4 \text{ M}^{-1}$, $2.57 \times 10^4 \text{ M}^{-1}$, and $9.8 \times 10^4 \text{ M}^{-1}$ for 1, 2, 3, and 4, respectively. The binding constants calculated are in comparable with the absorption spectra.

3.2.1. Quenching studies

Steady-state emission quenching experiments using $[\text{Fe}(\text{CN})_6]^{4-}$ as a quencher may provide further information about complexes binding to DNA, but cannot be used to determine the mode of binding. In quenching experiments, to maintain the ionic strength so that the quenching curves remain nonlinear, KCl was added along with $\text{K}_4[\text{Fe}(\text{CN})_6]$ such that the final and total concentration was constant at $4 \times 10^{-3} \text{ M}$.^[44] The Stern–Volmer quenching constant (K_{sv}) can be determined using the Stern–Volmer equation,^[45]

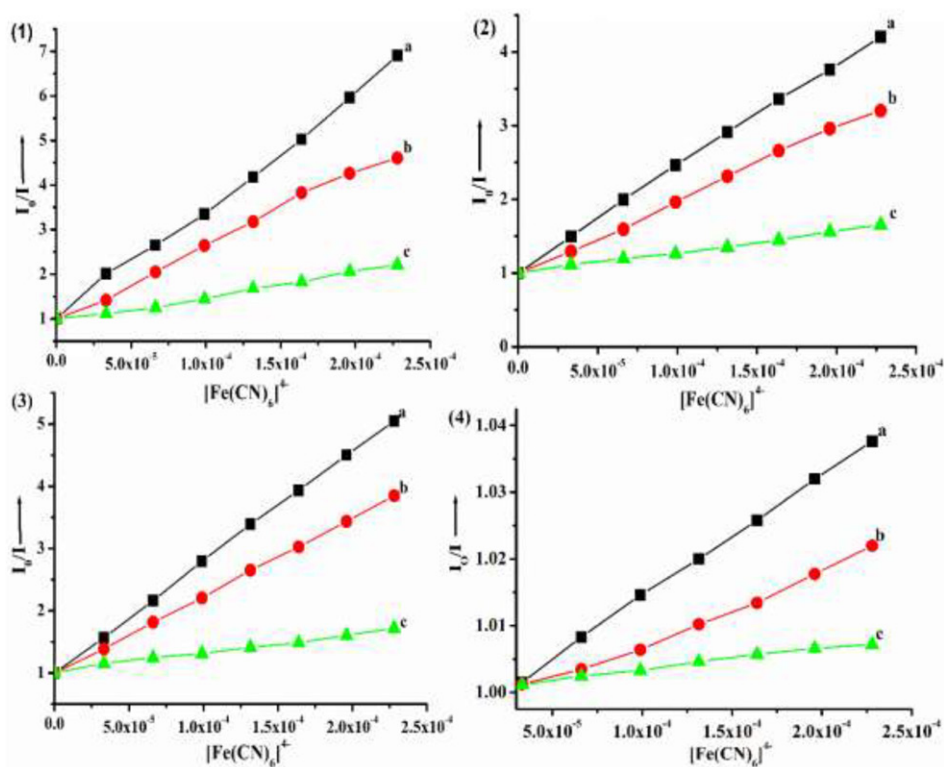


Figure 3. Quenching studies of complexes 1–4 in Tris-HCl with $[\text{Fe}(\text{CN})_6]^{4-}$ in the absence of DNA (a), presence of DNA 1:20 (b) and 1:100 (c).

Table 1. DNA binding and Ksv data for Ruthenium(II) complexes.

Complex	Absorption λ_{max} (nm) (MLCT)	Hypo chromism (%)	Absorbance binding constant (K_b)	Emission binding constant	Ksv values		
					Only Complex	Complex + DNA 1:50 1:100	
[Ru(Phen) ₂ BOPIP] ⁺² (1)	453	14.46	7.1×10^4	7.29×10^4	25279	16585	5542
[Ru(bpy) ₂ BOPIP] ⁺² (2)	462	13.74	3.4×10^4	3.61×10^4	17881	12063	3053
[Ru(dmb) ₂ BOPIP] ⁺² (3)	467	11.64	2.5×10^4	2.57×10^4	14026	9997	2804
[Ru(Hdpa) ₂ BOPIP] ⁺² (4)	468	15.01	8.3×10^4	9.8×10^4	28541	17441	5847

phen: 1,10-phenanthroline, bpy: 2,2'-bipyridine, dmb: 4,4'-dimethyl-2,2'-bipyridine, bpip: 2-(4-(benzyloxy)phenyl)-1H-imidazo [4,5-f][1,10]phenanthroline, hdpa: 2,2',-dipyridylamine, MLCT: metal-to-ligand charge transfer.

$$I_0/I = 1 + K_{SV}[Q]$$

where I_0 and I are the intensities of the fluorophore in the absence and presence of the quencher, respectively, $[Q]$ is the concentration of the quencher, and K_{sv} is the linear Stern–Volmer quenching constant. In general, positively charged free complex ions may be readily quenched by $[\text{Fe}(\text{CN})_6]^{4-}$, whereas the complex bound to DNA can be protected from the quencher as the negative charge of $[\text{Fe}(\text{CN})_6]^{4-}$ will be repelled by the negatively charged phosphate backbone of DNA, resulting in less quenching of the bound complex compared with the free complex. Figure 3. shows the Stern–Volmer plots for the free complexes in solution and the complexes in the presence of increasing amounts of DNA. The K_{sv} values for all four complexes are given in Table 1. From the quenching studies it is clear that the DNA binding affinity of complexes follows the order $4 > 1 > 2 > 3$, which is consistent with other results.^[38,40,46]

3.2.2. On–off–On light switching behaviour

As shown in Figure 4 the emission spectral profile of DNA bound complex **1** elucidates the switching of emission on and off when Co^{2+} and EDTA are added, respectively. The experiments were conducted using a method similar to that developed by our research group earlier.^[38,46] When the complex binds to DNA (switch on), the emission intensity is high, but when we add Co^{2+} (0.03 m.mol), the emission of DNA-bound complex **1** is quenched by Co^{2+} , thus turning the light switch off,^[47,48] owing to the formation of the Co^{2+} –complex **1** heterometallic complex. When EDTA (0.03 m.mol) was added to the buffer system containing Co^{2+} –complex **1**, the emission intensity recovered again (light switch on), based on the strong coordination of Co^{2+} to EDTA ($\text{EDTA} - \text{Co}^{2+}$) and the complex becomes free. A similar observation was made for other three complexes. The change in luminescence of the DNA-bound complex in the presence of Co^{2+} and EDTA reveals its use in the modulation of drug therapy.

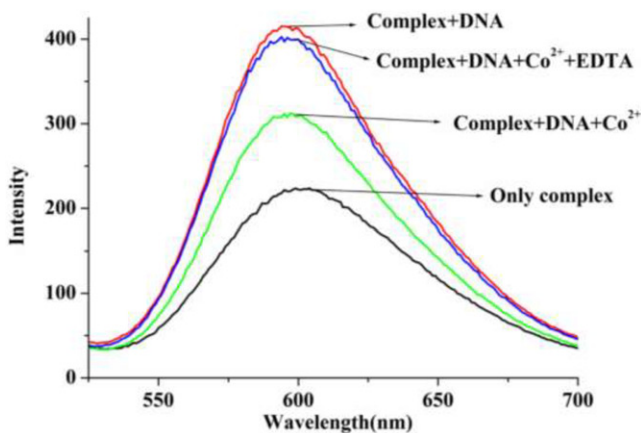


Figure 4. DNA light switch on and off experimentally showing the luminescence changes upon addition of Co^{2+} , EDTA and DNA to complex 1.

3.3. Viscosity studies

The DNA binding modes of complexes were further investigated by viscosity measurement. The viscosity measurements of DNA is regarded as the least uncertain and the critical test of a DNA binding model in solution in the absence of crystallographic data and provides strong evidence for intercalative DNA binding mode.^[31,49] A classical intercalation model results in lengthening the DNA helix as base pairs are detached to accommodate the binding ligand, leading to the increase of DNA viscosity. In contrast, a partial non-classical intercalation of ligand could bend (or kink) the DNA helix and reduce its effective length.^[50] For example, under suitable conditions, intercalation of dye like EtBr roots a significant increase in the overall DNA length. The effects of the complexes on the viscosity of rod-like DNA comparing with EtBr are shown in Figure 5. Though the intercalating ligand is same in all complexes, there is a small difference in the viscosity, this is due to the difference in the ancillary ligands. These further suggest that four Ru(II) complexes show an intercalative binding mode to CT-DNA, which parallel the absorption titration results. The increased degree of viscosity also supports the order of binding of the complexes to DNA as determined by other methods which follow the order $\text{EB} > 4 > 1 > 2 > 3$ (Figure 5).

3.4. Photocleavage of pBR322 DNA

The cleavage reactions on plasmid DNA induced by ruthenium(II) complexes were performed and monitored by agarose gel electrophoresis. When circular plasmid DNA is subjected to electrophoresis, comparatively fast migration is observed for the intact supercoiled form (form I). If scission

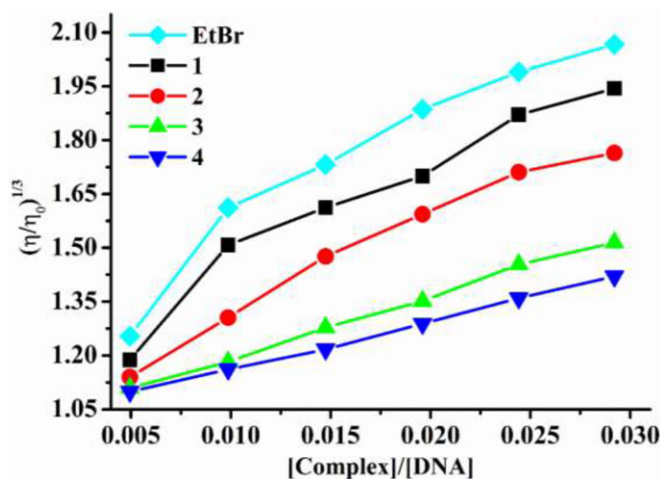


Figure 5. Viscosity studies of four complexes in BPE buffer with increasing amounts of complexes 1-4 and Ethidium bromide (EtBr) on the relative viscosity of calf thymus DNA at room temperature, 1 = $[\text{Ru}(\text{Hdpa})_2\text{BOPIP}]^{2+}$, 2 = $[\text{Ru}(\text{Phen})_2\text{BOPIP}]^{2+}$, 3 = $[\text{Ru}(\text{bpy})_2\text{BOPIP}]^{2+}$, 4 = $[\text{Ru}(\text{dmb})_2\text{BOPIP}]^{2+}$.

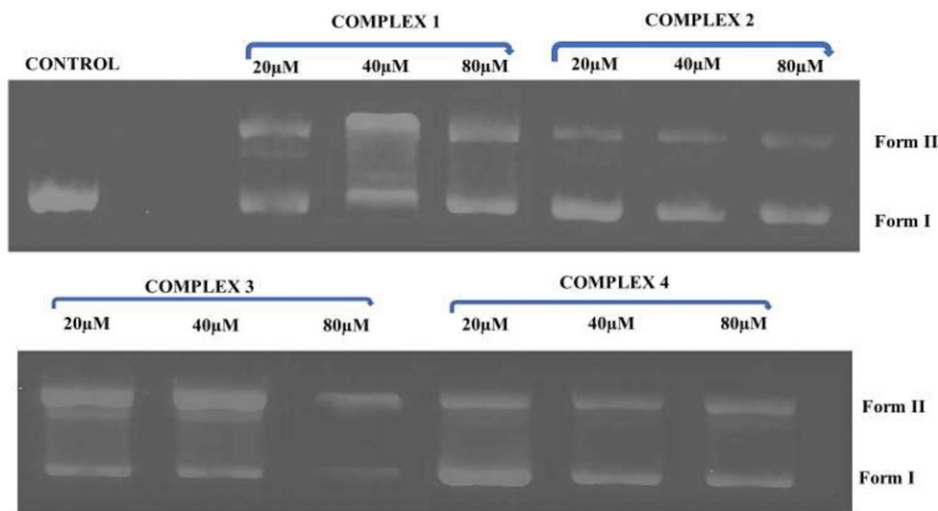


Figure 6. Photoactivated cleavage of pBR322 DNA in the absence (control) and presence of different concentrations (20, 40 and 80 μM) Of ruthenium complexes (1-4) after irradiation under UV light for 30 minutes.

occurs on one strand (nicking), the supercoiled form will relax to generate a slower-moving open circular form (form II). If both strands are cleaved, a linear form (form III) that migrates between form I and form II will be generated.^[32] Figure 6 shows gel electrophoresis separation of pBR322DNA after incubation with different concentrations of ruthenium(II) complexes and irradiation at 365 nm for 60 min. No DNA cleavage was observed for the control, in which the metal complex was absent. When the concentration of the ruthenium(II) complexes was increased, the amount of form I gradually

decreased, whereas the amount of form II increased. Under comparable experimental conditions, all complexes showed photocleavage activity. The pBR322 DNA photocleavage results for these complexes are consistent with the results obtained for other ruthenium(II) polypyridyl complexes.^[51,52] To establish the reactive species responsible for the photoactivated cleavage of the plasmid, we further investigated the influence of potentially inhibitive agents. Histidine, a naturally occurring amino acid, has been widely used as a scavenger of singlet molecular oxygen ($^1\text{O}_2$) especially during biological photooxidation processes.^[53] As reported $^1\text{O}_2$ reacts with histidine to form a transannular peroxide in its imidazole ring and thus loses its ability to react with other species. Histidine is also one of the most reactive biomolecules with regard to $^1\text{O}_2$ and exists in the muscle of animal tissues. In the presence of histidine (10 m.mol) (Figure 9), cleavage was absent (form II is not observed) or very much reduced compared what was observed for the complexes with DNA (absence of histidine). This indicates that $^1\text{O}_2$ plays an important role in the photocleavage mechanism. A photocleavage experiment was also conducted in the presence of mannitol, an OH radical inhibitor (Figure 7). In the presence of mannitol, form II is formed; hence, there is no change in the cleavage pattern, which indicates that the OH, radical is not responsible for cleavage and only $^1\text{O}_2$ is responsible for photocleavage of pBR322 in presence of the ruthenium(II) complexes.

3.5. Antimicrobial activity

Complexes 1–4 were screened in vitro for their microbial activity against *E. coli* and *S. aureus* at 1 mg mL⁻¹ concentration by the standard disk

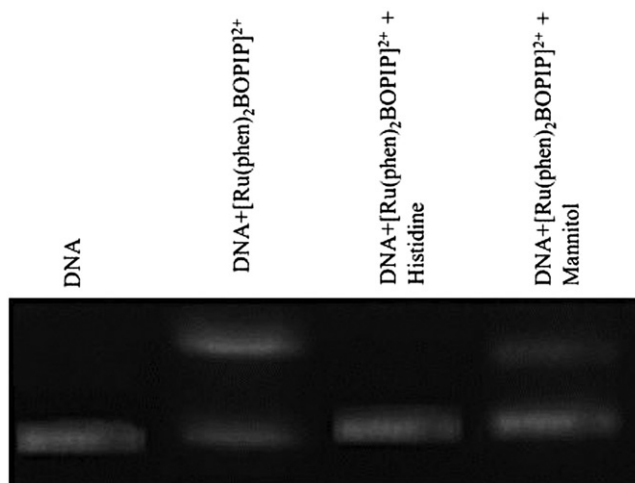


Figure 7. Photoactivated cleavage of pBR322 DNA in the presence of $[\text{Ru}(\text{Phen})_2\text{BOPIP}]^{2+}$ complex after irradiation at 365 nm for 30 min in the presence of histidine and mannitol.

Table 2. Antibacterial activity of ruthenium(II) complexes.

Compound	<i>Escherichia coli</i> (Gram negative)			<i>Staphylococcus aureus</i> (Gram positive)		
	10µg	20µg	40µg	10µg	20µg	40µg
BOPIP	3			4		
[Ru(Phen) ₂ BOPIP] ⁺² (1)	6.5	10.0	12	10	12	14.0
[Ru(bpy) ₂ BOPIP] ⁺² (2)	6.0	8.0	10	9	11	12.2
[Ru(dmb) ₂ BOPIP] ⁺² (3)	5.5	9.2	11.5	8	11.7	13.5
[Ru(Hdpa) ₂ BOPIP] ⁺² (4)	5.0	8.7	10.4	7	11.2	12.5
Ampicillin			18.0			21

Inhibition zone diameter in millimetres.

method. The results are expressed as inhibition zone diameter (in millimetres) versus the control (DMSO). The DMSO control showed negligible activity as compared with the metal complexes. The antimicrobial activity increased as the concentration of the compounds increased. The antibacterial activity data for the complexes at various concentrations (Table 2) indicate that the complexes exhibited appreciable activity against *E. coli* and *S. aureus*. The activity increased with the increase in the concentrations of the complexes. The complexes were more effective against *E. coli* than against *S. aureus* but were less effective than the standard drug ampicillin. As an increase in the lipophilic character of the complex favors its permeation through the lipid layer of the bacterial membrane, it shows more activity. These results are consistent with results from earlier studies.^[54,55]

3.6. Molecular docking studies

Molecular docking studies The LibDock module from Discovery Studio was used to perform the molecular docking of ruthenium complexes 1, 2, 3 and 4 with the active site pocket residues of human DNA TOP1. Human DNA TOP1 is an essential enzyme that relaxes DNA supercoiling during replication and transcription. The topoisomerase enzymes have been researched as targets for the generation of new cancer treatments because when they are inhibited in a cell, cell death results. Therefore, inhibitors of the topoisomerase enzymes have the ability to kill all cells undergoing DNA replication, reading of the DNA for protein production, or experiencing repair of DNA damage. Subsequently, cancer cells divide much more rapidly than normal cells, the cancer cells will be slaughtered by the topoisomerase inhibitors, however, some normal cells with topoisomerase activity will also be killed. DNA TOP1 is overexpressed in tumor cells and is an important target in cancer chemotherapy. All the ruthenium complexes were docked into the active site pocket of DNA TOP1, using LibDock. According to the results obtained from LibDock simulation, all ruthenium complexes were ranked by the LibDock scores. From the results, complex 4 exhibited the highest docking scores of 137.942 kcal/mol (Figure 8). The interactions and Dock scores of the

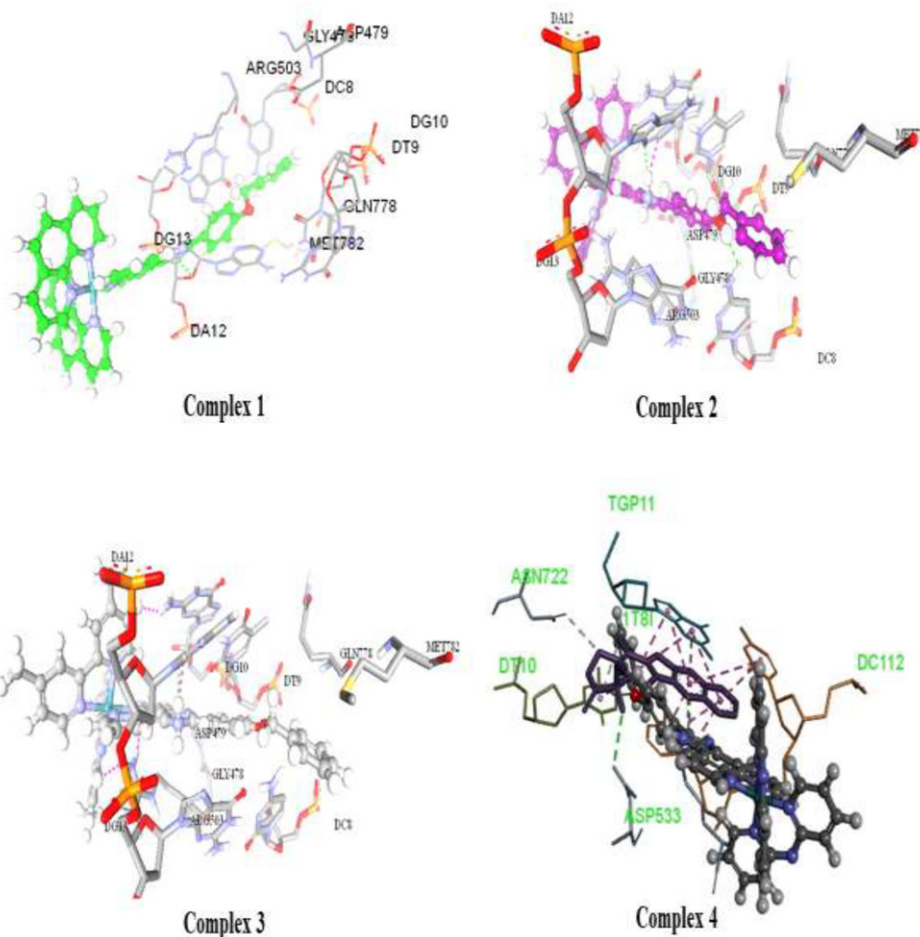


Figure 8. Molecular docking models illustrating the interaction between complexes with active site pocket residues of human DNA topoisomerase 1 (PDB ID: 1T81) target and showing intermolecular hydrogen bonds.

Table 3. The LibDock scores and docking interactions of the ruthenium complexes (1–4) with human DNA TOP 1.

Complex	Libdock Score (K.Cal/Mole)	Interacting Residues	Interacting atoms	H-Distance
1	121.159	DC8,DT9,DG10, Gly478, Asp479, Met782, Arg503, Gln778	5:H67 - F:DA12:O4' complex	2.2600
2	115.942	DC8, DT9, DG10, Gly478, Asp479, Met782, Arg503, Gln778	complex:H63 - F:DA12:N3 complex:H63 - F:DA12:C2	1.764 2.205
3	116.893	DC8, DT9, DG10, Gly478, Asp479, Met782, Arg503, Gln778	DC8:H42 - O49 complex complex:H68 - F:DA12:N3 complex:H62 - F:DA12:C1'	2.392 1.967 2.154
4	137.942	DT10, DC112, DA113, TGP11, Asn722, Asp533,	complex:H62 - F:DA12:C2' complex:C7 - A:ARG503:HH11 B:DT10:H3 - complex: O49	1.9070 2.0590 2.061

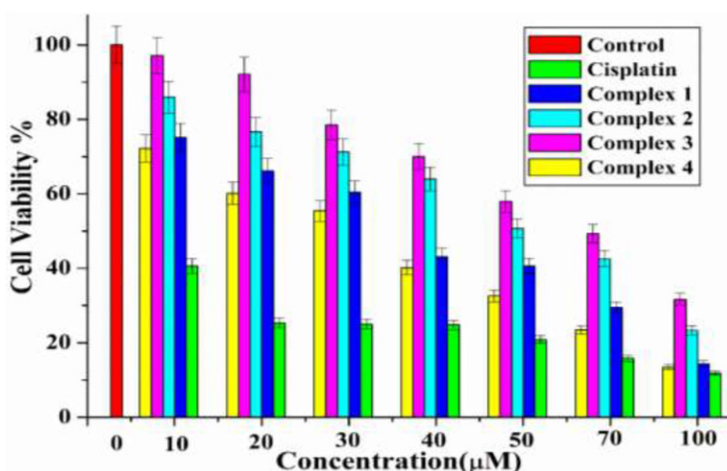


Figure 9. Cell viability of HeLa cell lines invitro treatment with complexes 1, 2, 3 and 4. Each data point is the mean standard error obtained from at least three independent experiment.

Table 4. The IC₅₀ values for complexes 1–4 against HeLa cell lines.

S.No.	Compound	IC ₅₀ (µM)
1	[Ru(Phen) ₂ BOPIP] ⁺² (1)	27.76
2	[Ru(bpy) ₂ BOPIP] ⁺² (2)	31.59
3	[Ru(dmb) ₂ BOPIP] ⁺² (3)	36.42
4	[Ru(Hdpa) ₂ BOPIP] ⁺² (4)	24.38
5	Cisplatin	4.81

ruthenium complexes with the active site pocket residues of human DNA TOP1 were tabulated in Table 3. The active site pocket residues of human DNA TOP1 were involved in hydrogen bonding formation with ruthenium complexes. A higher score indicates a stronger receptor–ligand-binding affinity.

3.7. In vitro cytotoxicity

The cytotoxicity activity of all four complexes and the corresponding ligand against the HeLa (human cervical cancer cell line) cell lines was evaluated by MTT assay. Cisplatin was used as a positive control and DMSO as negative control. The IC₅₀ values obtained for four complexes are shown in Table 4. The tumor cells in the presence of complexes 1–4 were incubated for 48 h. The IC₅₀ values for all the complexes ranged from 1 to 100 µM, suggesting that the ligand and the complexes exhibited antitumor activity against HeLa cell lines to different degrees. These compounds all exhibit relatively lower in vitro cytotoxicity against the selected HeLa cell line than cisplatin. Figure 9 showed that the cell viability decreased with increasing concentrations of complexes 1, 2, 3 and 4. Among all these, complex 4 exhibited higher in vitro cytotoxicity, with IC₅₀ values of 24.38. This is may be due to the presence of an amine group (–NH–) between two pyridine moieties in Hdpa.^[25]

The cytotoxicity activity of the complexes is consistent with their DNA binding abilities i.e. $4 > 1 > 2 > 3$. The obtained IC_{50} values are also comparable with the reported ruthenium (II) polypyridyl complexes.^[56]

Conclusion

Four Ru(II) complexes $[Ru(phen)_2 BOPIP]^{2+}$ (**1**), $[Ru(bpy)_2 BOPIP]^{2+}$ (**2**) $[Ru(dmb)_2 BOPIP]^{2+}$ (**3**), $[Ru(Hdpa)_2 BOPIP]^{2+}$ (**4**) were synthesized and characterized. The absorption spectral studies, Luminescence titrations, and viscosity measurements suggest that all the four complexes bind to CT-DNA through intercalation. The intrinsic binding constants calculated through absorption studies and fluorescence spectral studies are good in agreement and complex 4 exhibits slightly higher intrinsic binding constant among four complexes. Upon irradiation, under UV light all the four complexes can cleave pBR322 DNA and proved that singlet oxygen (1O_2) is responsible for the cleavage of pBR322 DNA. All the four complexes exhibit the Antimicrobial activity and showed cytotoxicity against A549 (human lung tumor cell line), Du145 (human prostate cancer cell line), and HeLa (human cervical cancer cell line) cell lines. These complexes exhibit relatively lower in vitro cytotoxicity against the selected cell lines than cisplatin. Molecular docking studies support the Hydrogen bonding and Vander Wall's interactions play a major role in binding to DNA.

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Comparative Studies on DNA Binding, Photocleavage, and Photophysical Properties of Ru(II) Complexes Containing TIP {TIP = 2-(Thiophen-2-yl)-1*H*-imidazo[4,5-*f*][1,10]-phenanthroline} Ligand¹

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Abstract—A thiophene contained imidazo phenanthroline ligand TIP {TIP = 2-(thiophen-2-yl)-1*H*-imidazo[4,5-*f*][1,10]phenanthroline} and its mononuclear Ru(II) polypyridyl complexes [Ru(phen)₂TIP]²⁺ (**1**) (phen = 1,10-phenanthroline) and [Ru(bpy)₂TIP]²⁺ (**2**) (bpy = 2,2'-bipyridyl), are synthesized and characterized by UV-Vis, IR, ¹H and ¹³C NMR, and ESI-MS spectra. Interaction of these complexes with CT-DNA is studied using UV-Vis and fluorescence spectra, viscosity measurements and molecular docking studies. The latter supports binding ability of complexes with stability constants deduced from UV-Vis and fluorescence spectra. The studies reveal that both Ru(II) polypyridyl complexes bind to DNA predominantly by intercalation, and the binding constant of complex **1** is greater than that of complex **2**. Complexes **1** and **2** cleave the pBR 322 DNA under UV light.

Keywords: DNA binding, viscosity, binding constant, pBR322, antimicrobial activity

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INTRODUCTION

Cisplatin or *cis*-diamminedichloro platinum(II) is the most commonly known metal-based anticancer drug most effective against lung, head, ovarian, neck, and esophageal cancers [1]. Although cisplatin and its derivatives are efficient against the vast majority of cancers, they also induce non-cancer cells toxicity [2, 3]. In the design of new anticancer drugs [4, 5], ruthenium complexes have been tested against a number of cancer cell lines [6], and are regarded as promising candidates for alternative drugs to cisplatin and its derivatives.

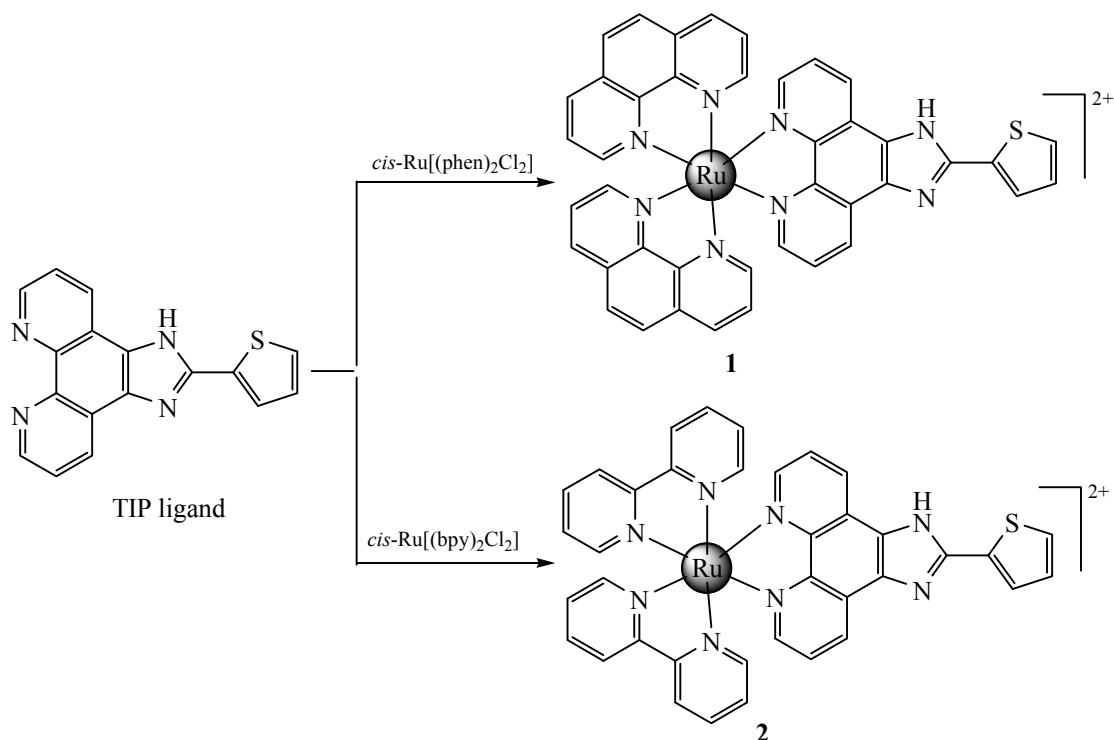
The ligand exchange kinetics of metal complexes in aqueous solutions influences upon their anticancer activity. It is quite similar for platinum and ruthenium

complexes [7]. Relatively low toxicity and ability to mimic iron in binding to biomolecules made ruthenium complexes an attractive alternative to platinum-based drugs [8]. Luminescence intensity and cytotoxicity of Ru complexes are strongly ligand-dependent. This fact initiates research in fine-tuning of these properties by changing the commonly used polypyridyl ligands [9]. In this context, we synthesized two different ruthenium complexes with a common auxiliary ligand {TIP = 2-(thiophen-2-yl)-1*H*-imidazo[4,5-*f*][1,10]phenanthroline} but different chelating ligands (phen = 1,10-phenanthroline, bpy = 2,2'-bipyridine) and studied inter-actions of the complexes with CT-DNA.

EXPERIMENTAL

RuCl₃·3H₂O, 2-thiophene carboxaldehyde, 1,10-phenanthroline, and 2,2'-bipyridine were purchased

¹ The text was submitted by the authors in English.

Scheme 1. Preparation of complexes **1** and **2** {[Ru(phen)₂TIP]⁺² (**1**) and [Ru(bpy)₂TIP]⁺² (**2**)}.

from Sigma Aldrich, the other chemicals and solvents were obtained from local existing sources. All solvents were purified by standard procedures. The spectroscopic titration was carried out in tris-buffer (5 mM tris-HCl, 50 mM NaCl, pH = 7.2) at room temperature. Solutions of DNA in tris-buffer gave a ratio of absorbance at 260 and 280 nm of 1.8–1.9, indicating that the DNA was sufficiently free of protein [10]. Concentration of CT-DNA was determined spectrophotometrically using the molar absorption $6600 \text{ M}^{-1} \text{ cm}^{-1}$ at 260 nm [11].

Luminescence spectral data were accumulated on a Cary Eclipse spectrofluorometer. UV-Vis spectra were recorded on an Elico-Spectrophotometer BL 198. NMR spectra were measured on an Avance-III 400 MHz spectrometer using DMSO-*d*₆ as a solvent. IR spectra were recorded on a Perkin-Elmer FT-IR-1605 spectrophotometer. An Ostwald Viscometer was used for viscosity measurements. Micro analysis was carried out on a Perkin-Elmer 240 elemental analyser.

1,10-Phenanthroline-5,6-dione (phendione) [12], *cis*-[Ru(phen)₂Cl₂], *cis*-[Ru(bpy)₂Cl₂] were synthesized according to the developed earlier methods [13]. Synthetic approach to Ru(II) polypyridyl complexes is presented in Scheme 1.

The TIP ligand was synthesized according to the developed earlier methods [14]. IR spectrum, ν , cm^{-1} : 3066.8 (N–H), 1076.2 (C–N), 709.8 (C–S). ¹H NMR spectrum, δ , ppm: 7.98 d (2H), 7.87 d (2H), 7.36 t (2H), 7.24 m (3H). ¹³C NMR spectrum, δ , ppm: 153.60, 143.4, 132.6, 127.5, 123.4, 119.6.

Synthesis of complexes [Ru(phen)₂(TIP)](ClO₄)₂·2H₂O (1**).** A mixture of *cis*-[Ru(phen)₂Cl₂]₂H₂O (0.284 g, 0.5 mM) with TIP (0.151 g, 0.5 mM) and ethanol (15 mL) was refluxed for 8 h at 120°C under the atmosphere of nitrogen. When the mixture gained light purple colour, it was cooled down to room temperature and a small amount of saturated aqueous NaClO₄ solution was added under vigorous stirring. The yellowish red solid was collected and washed with small amount of water, ethanol and diethyl ether, then dried under vacuum. Yield 64.6%. IR spectrum, ν , cm^{-1} : 3417.8 (N–H), 1148.2 (C–N), 719.45 (C–S), 628.87 (Ru–N). ¹H NMR spectrum, δ , ppm: 8.83 d (6H), 8.13 d (6H), 7.89 t (6H), 7.51 d (4H), 6.8 m (3H). ¹³C NMR spectrum, δ , ppm: 137.8, 128.4, 126.5, 124.7, 121.8, 119.3. Found, %: C 64.69; H 3.48; N 14.79. RuC₄₁H₂₆N₈S. Calculated, %: C 64.47; H 3.43; N 14.67.

[Ru(bpy)₂(TIP)](ClO₄)₂·2H₂O (2**).** The complex was synthesized according to the method described

above for the complex **1**. IR spectrum, ν , cm^{-1} : 3447.8 (N–H), 1108.2 (C–N), 714.45 (C–S), 627.43 (Ru–N). ^1H NMR spectrum, δ , ppm: 8.88 d (6H), 8.34 d (4H), 8.2 t (4H), 7.6 t (4H), 7.2 t (4H), 7.03 m (3H). ^{13}C NMR spectrum, δ , ppm: 157.4, 150.3, 138.4, 136.4, 127.7, 125.6, 121.8. Found, %: C 62.11; H 3.69; N 15.69. $\text{RuC}_{37}\text{H}_{26}\text{N}_8\text{S}$. Calculated, %: C 62.08; H 3.66; N 15.65.

DNA binding. DNA binding was studied at room temperature using tris buffer (5 mM Tris-HCl, 50 mM NaCl, pH = 7.1). Absorption studies of these complexes were recorded by keeping the complex concentration constant and varying DNA concentration. Before recording each spectrum the complex-DNA solution was stored for 5 min. For each reading, we observed the absorbance change at MLCT with increasing concentration of DNA, and calculated the intrinsic binding constant (K_b) [15].

In the emission titrations the complex concentration was kept constant and upon addition of incremental DNA, spectra were recorded in the range of 400–700 nm. The binding constant (K_b) was calculated using the equation:

$$C_b = C_t[(F - F_0)/(F_{\text{max}} - F_0)],$$

where C_t is the total complex concentration, F is the observed fluorescence emission intensity at a given DNA concentration, F_0 is the intensity in the absence of DNA, and F_{max} is the maximum complex bound to DNA. From the scatchard equation [16], a graph r/C_f vs. r was drawn and binding constant was calculated (r is the $C_b/[\text{DNA}]$ and C_f is the concentration of free complex.) The emission quenching experiment was carried out using $[\text{Fe}(\text{CN})_6]^{4-}$ as a quencher in the presence or absence of DNA. The emission study (light switch on/off effect) was carried out with the equal concentrations of Co^{2+} and Na_2EDTA solutions with constant concentration of a complex.

Viscosity. Viscosity studies were carried out using an Ostwald viscometer at constant temperature ($30 \pm 0.1^\circ\text{C}$) by immersing it in a thermo stated water bath using BPE buffer (6 mM Na_2HPO_4 , 2 mM NaH_2PO_4 , 1 mM Na_2EDTA , pH = 7.0). The CT-DNA samples, ca 200 base pairs of average length, were prepared by sonication to minimize the complexes arising from DNA flexibility [17]. The measurements were carried out in triplicates for all samples. The data were presented as a graph $(\eta/\eta_0)^{1/3}$ vs concentration of $[\text{Ru}(\text{II})]/[\text{DNA}]$, where η is viscosity of DNA in the presence of the complex, and η_0 is viscosity of DNA alone. Viscosity values were calculated from the

observed flow time of DNA-containing solutions (t) corrected for the flow time of the buffer alone (t_0) [18].

Photocleavage.² For gel electrophoresis experiments pH 8.0 buffer composed of 40 mM Tris base, 20 mM acetic acid and 1 mM EDTA was used. A buffer of 10 mM Tris-HCl and 1 mM Na_2EDTA was used for dilution of pBR322 DNA. Supercoiled pBR322 DNA ($0.1 \mu\text{g}/\mu\text{L}$) was treated with Ru(II) complexes **1**, **2** with concentrations of 20, 40, 80 μL . The mixtures were irradiated at room temperature with UV light (365 nm, 10 W) for 60 min. A loading buffer containing 25% bromophenol blue, 0.25% xylene cyanole and 30% glycerol (2 μL) was added. The samples were then analysed by 0.8% agarose gel electrophoresis at 50 V for 2 h. The gel was stained with 2 μL (of 1 mg/100 μL) ethidium bromide and photographed under UV light. The gels were viewed with a gel documentation system and photographed using a CCD camera (Alpha Innotech).

Molecular docking studies. Accelry's Discovery Studio (version 2.1) was used to design lead molecules, estimate docking interactions of a complex of drug and protein binding, and number of bonds formed by ligand with the target. The molecular docking of complexes **1**, **2** was performed using LibDock [19]. Accelry's CHARMM force field was used throughout the simulation before running LibDock. The crystal structure of human DNA topoisomerase **1** (TOP1) receptor was downloaded from RCSB PDB (PDB ID-1T8I), after downloading the PDB format of the protein, all water molecules of the protein were removed by using Discovery Studio and stabilizing the charges, filling the missing residues, and generating the side chains according to the parameters available. The receptor should be in a biologically active and stable state. After the receptor is constructed, the active site within the receptor should be recognized. The receptor may have many active sites but the one of interest should be selected. Ruthenium complexes were sketched using the tools Chemsketch and used to dock into the target binding site. Ruthenium complexes conformations aligned to receptor interaction sites and the best poses were reported at the end of docking simulations. The scoring functions have been used to estimate binding affinity

² CAUTION! Ethidium bromide is a mutagen and potential carcinogen. Gloves should be worn and care should be taken when handling. UV light is damaging to eyes and exposed skin. Protective eyewear and apron should be worn at all times.

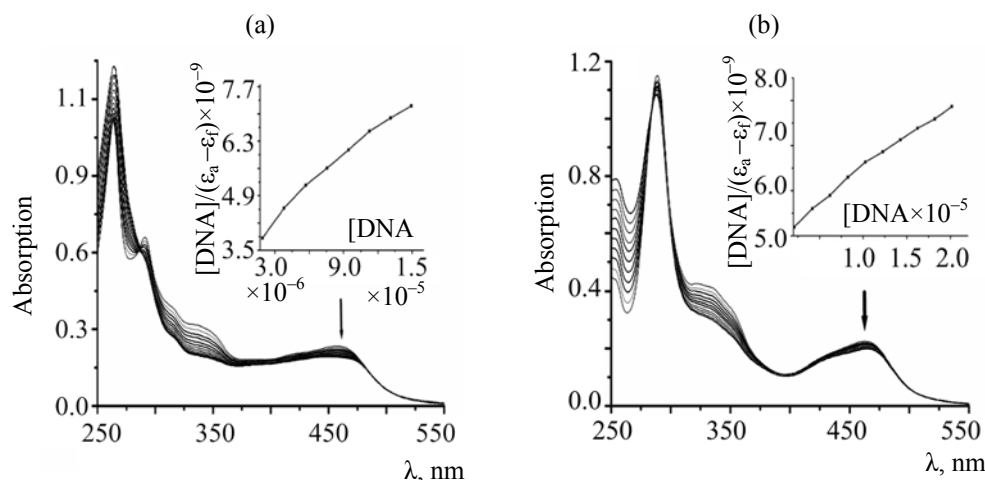


Fig. 1. Absorption spectra of complexes (a) **1** and (b) **2** in absence and presence of CT-DNA in Tris HCl buffer. Arrows show hypochromism and bathochromism upon increase of DNA concentration. Inserted plots, $[DNA]/(\epsilon_a - \epsilon_f)$ vs. $[DNA]$ for the titration of DNA with complexes.

to screen out active and inactive compounds during the process of virtual screening [20].

RESULTS AND DISCUSSION

In IR spectra the ligand band of (N–H) (3066.8 cm^{-1}) shifted to 3417.8 cm^{-1} upon complex formation. Weak bands at 628 cm^{-1} assigned to Ru–N of the complexes indicated all six Ru–N bonds that were of the same bond length, and indicated the perfect octahedral structure of the complexes. These were not observed for TIP ligand. ^1H NMR signals of TIP ligand shifted from 7.24–7.98 to 7.51–8.83 ppm in the spectra of complexes, confirming the complexes formation.

In UV-Vis spectra the Ru(II) complexes **1** and **2** demonstrated MLCT a band at ca 420 or 445 nm respectively, which was not recorded in the spectrum of TIP ligand.

DNA binding. *UV-Vis spectra.* UV-Vis spectra of Ru(II) complexes were significantly affected by addition of DNA (Fig.1). The bands below 400 nm pertained to π – π^* transitions attributed to DNA (below 300 nm) and ligands (300–400 nm), and above 400 nm belonged to Metal-to-Ligand Charge Transfer (MLCT). Intensity of UV-Vis absorption bands of complexes **1** and **2** at 460 nm lowered on addition of CT-DNA (Fig. 1). The intrinsic binding constants (K_b)

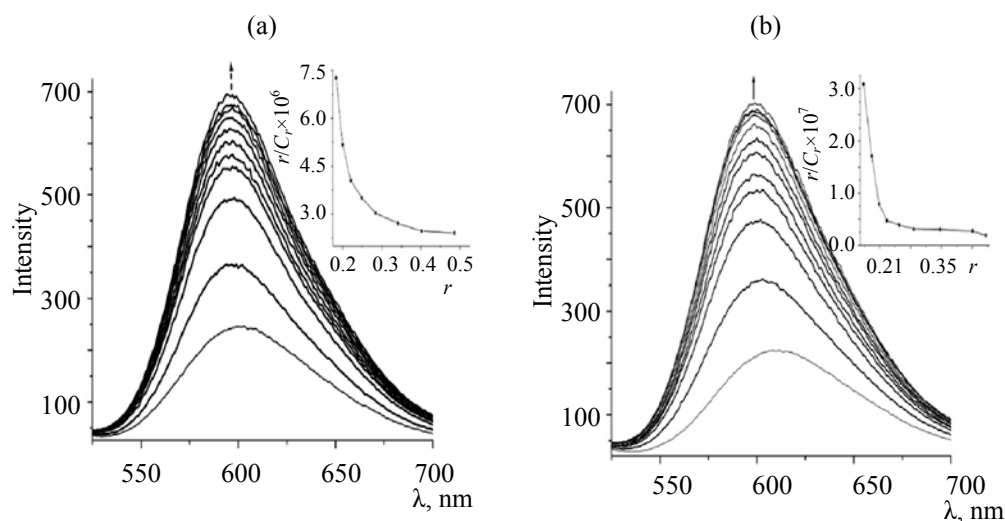


Fig. 2. Emission spectra of complexes (a) **1** and (b) **2** in Tris-HCl buffer upon addition of CT-DNA. The arrow shows the intensity change upon the increase of DNA concentration. Inset: Scatchard plot for the complexes.

Table 1. DNA binding and K_{sv} data for Ru(II) complexes **1** and **2**

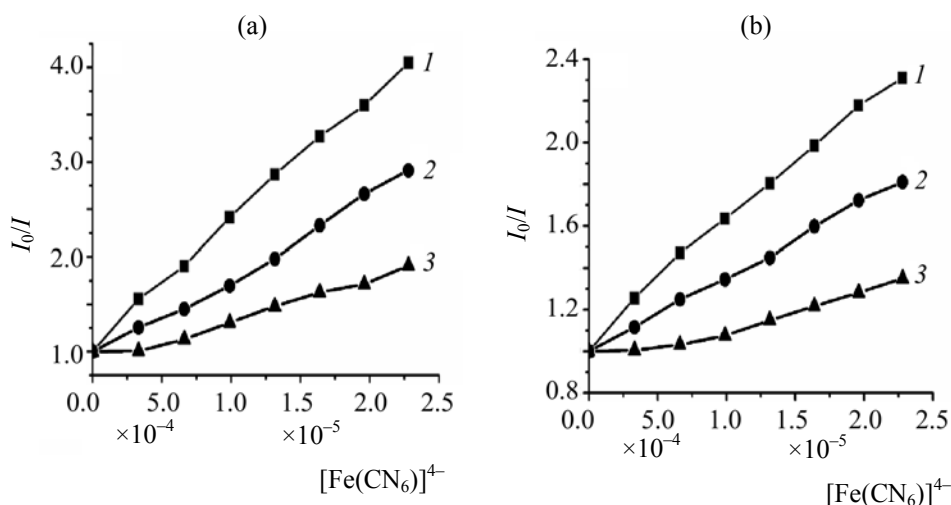
Complex	Absorption λ_{max} , nm (MLCT)	Hypo chromism, %	Absorbance binding constant (K_b), M^{-1}	Emission binding constant	K_{sv} values		
					complex	complex + DNA	
						1 : 50	1 : 100
[Ru(phen) ₂ TIP] ²⁺ (1)	460	10.46	3.36×10^4	3.81×10^4	21423	15641	4836
[Ru(bpy) ₂ TIP] ²⁺ (2)	468	9.74	2.61×10^4	2.94×10^4	16541	11584	3021

Table 2. LibDock scores and docking interactions of complexes **1** and **2** with human DNA TOP 1

Complex	LibDock score, kcal/mol	Interacting residues	Interacting atoms	H-Distance
1	104.147	DC8,DT9, DG10, Gly478, Asp479, Met782, Arg503, Gln778	DG13:N···HN13:Complex	2.125
2	99.159	DC8, DT9, DG10, Gly478, Asp479, Met782, Arg503, Gln778	Complex H54–D:DT9:O4'	2.319

of the complexes calculated at 460 nm were found to be in the order of 10^4 , but bigger than that of the parent complex [Ru(phen)₃]²⁺ ($K_b = 5.5 \times 10^3 M^{-1}$), suggesting that there was a strong stacking interaction between TIP ligand of the complexes and the base pairs of the DNA. Variance in the binding ability of the complexes **1** ($K_b = 3.36 \times 10^4 M^{-1}$) and **2** ($K_b = 2.61 \times 10^4 M^{-1}$) could be explained in terms of planarity and hydrophobicity. The TIP ligand was common for both complexes, but switch from the ancillary ligand 1,10-phenanthroline (phen) to 2,2'-bipyridyl (bpy) decreased the planarity and hydrophobicity, which led to a higher binding affinity of complex **1**.

Luminescence. In the absence of DNA, the complexes **1**, **2** emitted luminescence in Tris buffer. Upon addition of CT-DNA the emission intensities of complexes [Ru(phen)₂TIP]²⁺ (**1**), [Ru(bpy)₂TIP]²⁺ (**2**) increased (Fig. 2). The gradual increase in the luminescence of complexes was observed upon increasing concentration of DNA, which indicated that complexes could interact strongly with DNA and were protected by DNA efficiently due to hydrophobic environment inside the DNA helix, which reduced the accessibility of solvent water molecules to the duplex, and the complexes mobility was constrained at the binding site. This led to decrease in the vibrational

**Fig. 3.** Quenching of complexes (a) **1** and (b) **2** in Tris- HCl with [Fe(CN)₆]⁴⁻ in the absence of DNA (**1**), presence of DNA 1 : 20 (**2**), and 1 : 100 (**3**).

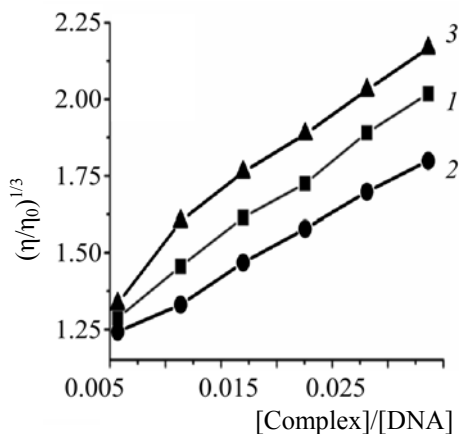


Fig. 4. Relative viscosity of DNA under the action of complexes (1) **1**, (2) **2**, and (3) EtBr.

modes of relaxation. Scatchard plots for complexes were constructed from luminescence spectra, and binding constants (K_b) were in the order of 10^4 (Table 1). The small divergences between the two sets of binding constants were due to different spectroscopy techniques and dissimilar calculations methods. However, the binding constants were comparable and followed the order $1 > 2$.

Quenching studies. In the emission quenching experiment, $[\text{Fe}(\text{CN})_6]^{4-}$ was used as a quencher in the presence or absence of DNA (Fig. 3). In the absence of DNA, Ru(II) complexes were efficiently quenched, resulting in the linear Stern-Volmer plot. But in the presence of an excess of DNA quenching was low, due to highly negatively charged $[\text{Fe}(\text{CN})_6]^{4-}$ species that

could be repelled by the negative charge of DNA phosphate backbone which could impede the quenching of bound complexes. The Stern-Volmer quenching constant K_{sv} was deduced from the corresponding equation [9] (Table 1).

Viscosity. Difference in the relative viscosity of DNA on addition of complexes **1**, **2** is presented in Fig. 4. As the concentration of complexes **1** and **2** increased the relative viscosity also increased, which suggested the intercalative binding mode of complexes to DNA according to the order of $1 > 2$. This was consistent with the analysis based on binding constants.

Photocleavage activity. Concentrations of Ru(II) complexes (20, 40, and 80 μM) were altered and monitored by agarose gel-electrophoresis. No DNA cleavage was observed for control in which complex was absent. The complexes **1** and **2** could effectively cleave pBR322 DNA upon irradiation by UV light for 30 min. The different cleaving efficiency was consistent with the DNA-binding affinity of the complexes.

Molecular docking studies. According to the data accumulated from LibDock simulation, the complexes were ranked by the LibDock Scores. Complex **1** exhibited the highest docking scores of 104.14 kcal/mol (Fig. 5). The interactions and Dock scores of the complexes with the active site pocket residues of human DNA TOP1 are tabulated in Table 2. The active site pocket residues of human DNA TOP1 were involved in hydrogen bonding formation with the complexes. A higher score indicated a stronger receptor-ligand-binding affinity.

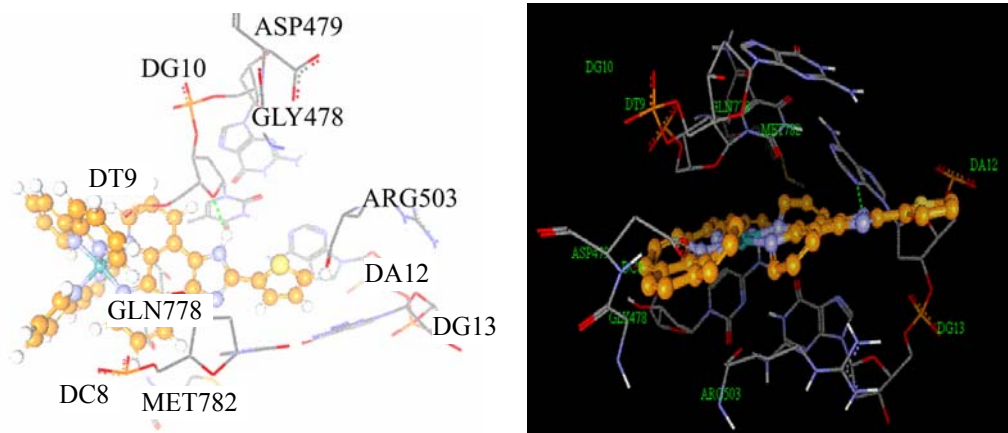


Fig. 5. Molecular docking models of the interaction between complex **1** and the active site pocket residues of human DNA topoisomerase **1** (PDB ID: 1T8I) target.

CONCLUSIONS

Two new Ru(II) polypyridyl complexes are synthesized and characterized by various spectral methods. Both complexes bind to DNA with marginally different binding constants. According to the study, the complexes can induce photo cleavage of DNA. According to viscosity measurements, the complexes can bind to DNA via intercalation. Complex **1** binds DNA more strongly and can be more efficient cytotoxic agent for cancer cells.

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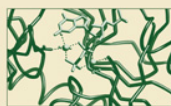
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CONFLICT OF INTEREST

No conflict of interest was declared by the authors.

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Synthesis, spectral studies, DNA binding, photocleavage, antimicrobial and anticancer activities of isoindol Ru(II) polypyridyl complexes

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Synthesis, spectral studies, DNA binding, photocleavage, antimicrobial and anticancer activities of isoindol Ru(II) polypyridyl complexes

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ABSTRACT

Three new Ru(II) polypyridyl complexes [Ru(phen)₂ClIP]²⁺ (**1**) {ClIP = 2-(5-Chloro-3a H-Isoindol-3-yl)-1H-Imidazo[4,5-f][1, 10]phenanthroline} (phen = 1, 10 phenanthroline), [Ru(bpy)₂ClIP]²⁺ (**2**) (bpy = 2, 2' bipyridine) and [Ru(dmb)₂ClIP]²⁺ (**3**) (dmb = 4, 4'-dimethyl 2, 2' bipyridine) were synthesized and characterized by different spectral methods. The DNA-binding behavior of these complexes was investigated by absorption, emission spectroscopic titration and viscosity measurements, indicating that these three complexes bind to CT-DNA in an intercalative mode, but binding affinities of these complexes were different. The DNA-binding constants K_b of complexes **1**, **2** and **3** were calculated in the order of 10^6 . All three complexes cleave pBR322 DNA in photoactivated cleavage studies and exhibit good antimicrobial activity. Anticancer activity of these Ru(II) complexes was evaluated in MCF7 cells. Cytotoxicity by MTT assay showed growth inhibition in a dose dependent manner. Cell cycle analysis by flow cytometry data showed an increase in Sub G1 population. Annexin V FITC/PI staining confirms that these complexes cause cell death by the induction of apoptosis.

ARTICLE HISTORY

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DNA binding; fluorescence; viscosity; photocleavage; antimicrobial and apoptosis

1. Introduction

Extensive studies in the last few decades have focused on the interaction between DNA and transition metal complexes. Metal complexes can bind to DNA via non-covalent interactions such as groove, electrostatic and intercalative binding. Furthermore, a large number of useful applications of the metal complexes require that the complexes can bind to DNA via an

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intercalation mode which could induce cellular degradation.^[1] Thus understanding the types of interactions of complexes with DNA is essential to design effective structure probe for DNA and provides insights for action mechanism of DNA targeted drugs. A number of Ru(II) complexes have been developed as potential cellular imaging and therapeutic agents.^[2–9] The advantages of using such Ru(II) polypyridyl complexes as cellular targeting agents lies in the fact that the structural nature of the polypyridyl units will dictate the overall function of the metal complex, which includes their solubility, lipophilicity, charge, and importantly their photophysical properties.

In the search for metal complexes active against tumors and less toxic than cisplatin, ruthenium compounds^[10–17] emerge as the most promising with biological features including mechanism of action, toxicity and bio distribution that are very different from those of classical platinum compounds.^[18–26]

In this report, three new ruthenium(II) polypyridyl complexes (Scheme 1) were synthesized and characterized by elemental analysis, ESI-MS, ¹H NMR and ¹³C NMR. The DNA-binding behaviors were studied by electronic absorption titration, photo activated cleavage and viscosity measurements, Antimicrobial and anticancer activities of these complexes were studied on the MCF7 (human breast adenocarcinoma) cell line.

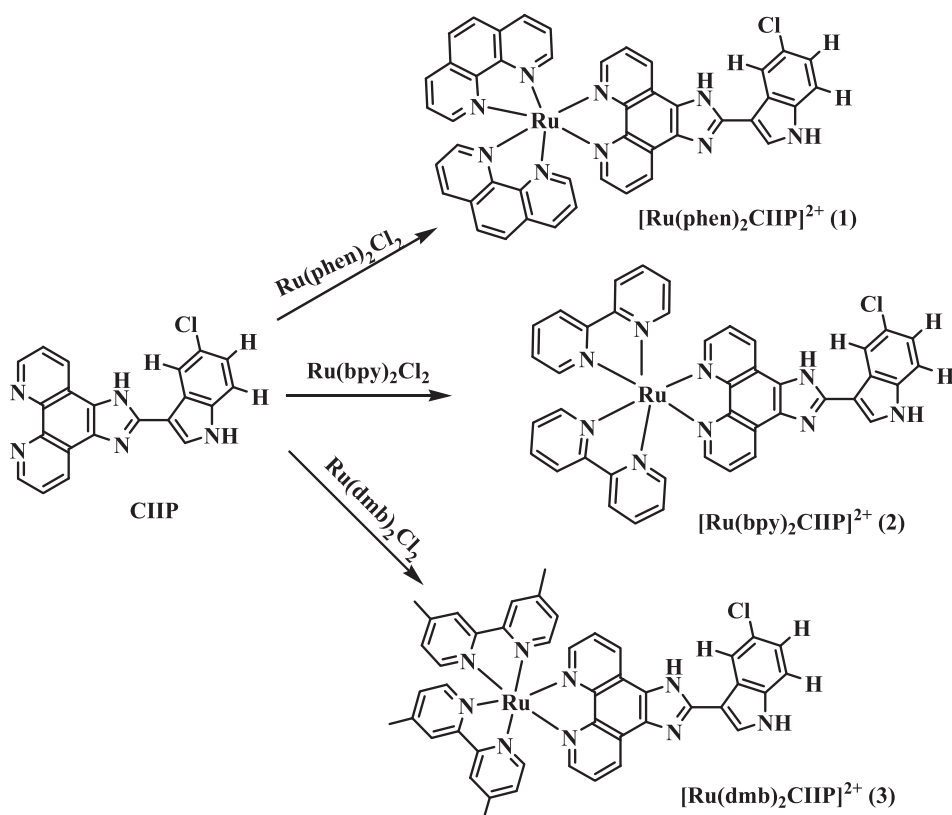
2. Materials and methods

2.1. Materials

5-Chloro indole-3 carboxaldehyde, RuCl₃·3H₂O, 1, 10-Phenanthroline, 2,2' bipyridine, and 4, 4' dimethyl 2, 2' bipyridine were purchased from Sigma Aldrich India. All the solvents were purified before use as per standard procedures.^[27] Calf Thymus DNA (CT-DNA) was purchased from Sigma Aldrich, pBR322 super coiled plasmid DNA was obtained from Fermentas life sciences (stored at –20 °C). The Spectroscopic titration was carried out in the buffer (5 mM Tris–HCl, 50 mM NaCl, pH 7.2) at room temperature. Solutions of DNA in Tris–HCl buffer (pH = 7.2), 50 mM NaCl gave a ratio of UV absorbance at 260 and 280 nm of 1.8–1.9, indicating that the DNA was sufficiently free of protein.^[28] Double distilled water was used for preparing various buffers. Ampicillin for antimicrobial studies was purchased from local pharmaceuticals.

2.2. Physical measurements

For DNA absorption studies, UV-visible spectra with an Elico BL 198 and fluorescence measurements with an Elico SL 174 spectrofluorimeter were



Scheme 1. Structures of three Ru(II) Polypyridyl complexes; [Ru(phen)₂CIIP]²⁺ (1), [Ru(bpy)₂CIIP]²⁺ (2) and [Ru(dmb)₂CIIP]²⁺ (3).

performed. FT-IR spectra were recorded with KBr disks on a Perkin-Elmer FT-IR-1605 spectrometer. A Bruker 400 MHz spectrometer was used for ¹H NMR and ¹³C NMR spectra with DMSO-*d*₆ as solvent at room temperature and tetramethylsilane (TMS) as the internal standard. Microanalyses (C, H and N) were carried out with a Perkin-Elmer 240 elemental analyzer.

2.3. Synthesis and characterization

Compounds 1, 10-phenanthroline-5, 6-dione,^[29] cis-[Ru(phen)₂Cl₂].2H₂O, cis-[Ru(bpy)₂Cl₂].2H₂O and cis-[Ru(dmb)₂Cl₂].2H₂O were synthesized according to methods given in literature.^[30] The synthetic scheme for the Ru(II) polypyridyl complexes are shown in Scheme 1.

2.3.1. Preparation of CIIP ligand

CIIP {2-(5-Chloro-3a *H*-isoindol-3-yl)-1*H*-imidazo[4,5-*f*][1, 10] phenanthroline}, was prepared by combining 1, 10-phenanthroline-5, 6-dione (1.06 g, 2.5 mM), 5-chloro indole-3 carboxaldehyde (1.2572 g, 3.5mM), ammonium

acetate (7.76 g, 60 mM) and glacial acetic acid (30 mL) and heating at reflux for 4 h as per Steck and Day,^[31] cooling to room temperature, and diluting with water. Dropwise addition of ammonia gave a yellow precipitate which was collected, washed with water, dried, and purified by recrystallization from pyridine-H₂O (9:1, v/v); Yield: 0.51 g (73%), Analytical data: Elemental Analysis for C₂₁H₁₂ClN₅: Calc. (%): C:68.20; H: 3.27; N: 18.94; Found: C:68.18; H: 3.20; N: 18.91; ESI-MS (m/z): 370 [M + H]⁺. ¹H NMR (DMSO-*d*₆, 400 MHz): δ: 9.04 (H-C=N), 7.30–8.71, (H-C=C) (aromatic protons), ¹³C[¹H]-NMR (DMSO-*d*₆, 100 MHz): 153 (-C=N), 138–122 (-C*=C) (aromatic carbons), 118 (-C*=C-Cl).

2.3.2. Synthesis of [Ru(phen)₂(CIIP)](ClO₄)₂·2H₂O (1)

This complex was synthesized by dissolving of Cis-[Ru(phen)₂Cl₂].2H₂O (0.143 g, 0.25 mM) and CIIP (0.093 g, 0.25 mM) in a mixture of ethanol (25 mL) and water (15 mL), and refluxing 70 °C for 8 h under N₂-atmosphere. At room temperature, the solution was titrated with saturated aqueous solution of NaClO₄ to give a brick red ppt. Then it was washed with CH₃CN-toluene (3:1) and vacuum dried. Yield: 0.39 g (67%). Elemental Analysis for C₄₅H₃₂Cl₃N₉O₁₀Ru, Calc. C: 50.69; H: 3.03; N: 11.82, Found: C: 50.49; H: 3.01; N: 11.76. ESI-MS (m/z): 415.56 for {[Ru(phen)₂(CIIP)]²⁺ - (ClO₄)₂·2H₂O}. ¹H-NMR (DMSO-*d*₆, 400 MHz): δ: 9.09 (H-C=N), 7.29–8.67, (H-C=C) (aromatic protons). ¹³C[¹H]-NMR (DMSO-*d*₆, 100 MHz): 153 (-C=N), 138–122 (-C*=C) (aromatic carbons), 118 (-C*=C-Cl).

2.3.3. Synthesis of [Ru(bpy)₂(CIIP)](ClO₄)₂·2H₂O (2)

Using the complex (1) procedure, this complex (2) was synthesized with cis-[Ru(bpy)₂Cl₂].2H₂O (0.13 g, 0.5 mM) in place of cis-[Ru(phen)₂Cl₂].2H₂O Yield:0.36 g (66%). Elemental Analysis for C₄₁H₃₂Cl₃N₉O₁₀Ru, Calc. C: 48.36; H: 3.17; N: 12.38. Found: C: 48.29; H: 3.11; N: 12.31). ESI-MS (m/z): 399.14 for {[Ru(bpy)₂(CIIP)]²⁺ (ClO₄)₂·2H₂O}. ¹H-NMR (DMSO-*d*₆, 400 MHz): δ: 9.17 (H-C=N), 7.31–9.02 (H-C=C) (aromatic protons), ¹³C[¹H]-NMR (DMSO-*d*₆, 100 MHz): 153 (-C=N), 138–122 (-C*=C) (aromatic carbons), 118 (-C*=C-Cl).

2.3.4. Synthesis of [Ru(dmb)₂(CIIP)](ClO₄)₂·2H₂O (3)

Using the complex (1) procedure, this complex (3) was synthesized with cis-[Ru(dmb)₂Cl₂].2H₂O (0.144 g, 0.5 mM) in place of cis-[Ru(phen)₂Cl₂].2H₂O. Yield: 0.41 g (67%). Elemental Analysis for C₄₅H₄₀Cl₃N₉O₁₀Ru, Calc. C: 50.31; H: 3.75; N: 11.73. Found: C: 50.28; H: 3.73; N: 11.70. ESI-MS (m/z): 419.6 for {[Ru(dmb)₂(CIIP)]²⁺(ClO₄)₂·2H₂O}. ¹H NMR (DMSO-*d*₆,

400 MHz): δ : 9.16 (H-C=N), 8.85-7.18 (H-C=C) (aromatic protons), 2.08 (-CH₃), ¹³C[¹H]-NMR (DMSO-*d*₆, 100 MHz): 153 (-C=N), 138-122 (-C*=C) (aromatic carbons), 118 (-C*=C-Cl), 24(-CH₃).

2.4. DNA binding studies

2.4.1. Absorption spectroscopic studies

The absorption spectroscopic titration using a fixed complex concentration (20 μ M) was performed in tris-(hydroxymethyl) amino methane hydrochloride and NaCl buffer, to this the DNA stock solution was gradually added up to the saturation point. Before the spectra were recorded the above mixture was allowed to equilibrate for 5 min. By monitoring the changes of absorption at the MLCT band with increasing concentration of DNA the intrinsic binding constant (K_b) was calculated by using the following equation.^[32]

$$[\text{DNA}]/(\varepsilon_a - \varepsilon_f) = [\text{DNA}]/(\varepsilon_b - \varepsilon_f) + 1/K_b(\varepsilon_b - \varepsilon_f) \quad (1)$$

where [DNA] is the concentration of DNA, ε_a , ε_f and ε_b correspond to the apparent absorption coefficient $A_{\text{obs}}/[\text{complex}]$, the extinction coefficient for the free complex and the extinction coefficient for the complex in the fully bound form, respectively. In plots of [DNA]/($\varepsilon_a - \varepsilon_f$) versus [DNA], K_b is given by the ratio of slope to the intercept. It is further extended with EtBr to confirm the binding mode of complexes to DNA. A study with EtBr was performed to examine the binding potential of our complexes with CT-DNA.

2.4.2. Emission spectroscopic studies

The emission spectroscopic spectrum was recorded in tris-(hydroxymethyl) amino methane hydrochloride and NaCl buffer a with fixed complex concentration. Before measurements, the excitation wavelength was fixed and the emission range was adjusted. The excitation intensities were monitored by varying the concentration of DNA with a fixed concentration of metal complex (20 μ M). The fraction of the ligand bound was calculated from the relation $C_b = C_t [(F - F_0)/F_{\text{max}} - F_0]$, where C_t is the total complex concentration, F is the observed fluorescence emission intensity at a given DNA concentration, F_0 is the intensity in the absence of DNA and F_{max} is when the complex is fully bound to DNA. The binding constant (K_b) was obtained from a modified Scatchard equation.^[33] From a Scatchard plot of r/C_f vs r , where r is the $C_b/[\text{DNA}]$ and C_f is the concentration of free complex and light switch 'on-off' studies were extended under this luminescence experiment.

2.5. Viscosity experiment

Viscosity experiments were carried out on Ostwald viscometer, placed in a thermostated water-bath maintained at $30 \pm 0.1^\circ\text{C}$. CT-DNA samples approximately 200 base pairs average length were prepared by sonication in order to minimize the complexes arising from DNA flexibility.^[34] Flow time was measured with a digital stop-watch, and each sample was measured at least three times, using an average flow time in the calculation. Data were presented as $(\eta/\eta_0)^{1/3}$ versus binding ratio of $[\text{Ru(II)}]/[\text{DNA}]$,^[35] where η is viscosity of DNA in the presence of the complex and η_0 is the viscosity of DNA alone. Viscosity values were calculated from the observed flow time of DNA containing solutions ($t > 100$ s) corrected for the flow time of the buffer alone (t_0).^[36]

2.6. Photo activated cleavage studies of Ru(II) complexes with pBR322 DNA

Super coiled pBR322 DNA was used for the gel electrophoresis experiments, super coiled DNA was treated with Ru(II) complexes in buffer B and the solutions were then irradiated at room temperature with a UV lamp (365 nm, 10 W). The samples were analyzed by electrophoresis for 1 h at 80 V on a 1.0% agarose gel in Tris-acetic acid-EDTA buffer, pH = 8.2. The gel was stained with $1 \mu\text{g mL}^{-1}$ ethidium bromide and photographed with GeNei gel documentation chamber.

2.7. Antimicrobial activity

Antimicrobial activity of the complexes were screened against viz. *Escherichia coli* (*E. coli*) and *Bacillus streptococcaceae* (B.S) with positive (Ampicillin) and negative (DMSO) controls respectively. The concentrations of each complex were 1 mg/mL and 0.5 mg/mL prepared in DMSO solution and tested against spore germination of each fungus. On culture plates 10 μL of each Ru(II) complex was taken on a disc of sterilized Whatman filter paper no.1 (5 mm size). The fungal culture plates were incubated at $25 \pm 0.2^\circ\text{C}$ for 24 h. The diameters of the inhibition zones (in mm) were measured and tabulated.

2.8. Cell culture

MCF-7 cells (human breast adenocarcinoma cell line) were grown in DMEM medium with 10% fetal bovine serum (FBS), 25 mg/mL streptomycin, 25 U/mL penicillin (all from Invitrogen Corporation, Grand Island, NY). The cells were incubated at 37°C in a humidified atmosphere containing 5% CO_2 .

2.8.1. Cytotoxicity by MTT assay

The cell proliferation was determined using the 3-(4, 5-dimethylthiazol-2-yl)-2, 5-diphenyltetrazolium bromide (MTT) assay (Sigma, USA) and performed as per standard protocol. MCF7 cells were seeded 5000/well in 96 well plates and after overnight incubation; they were treated with complexes 1, 2 and 3 from 200 μ M to 3 μ M for 48 h. After the stipulated time of incubation, MTT reagent was added (5 mg/mL) and incubated in the dark for 4 h at 37 °C and then media was removed and DMSO (200 μ L) was added to each well for dissolving the formazan crystals. The optical density was measured at 570 nm using a microtitre plate reader. Then IC₅₀ values of all three complexes were calculated. Each experiment was repeated three times.

2.8.2. Morphologic observation by phase contrast microscope

MCF7 cells were seeded and incubated overnight and then cells were treated with complexes 1, 2 and 3 to determine then respective IC₅₀ values after 48 h. Cell morphology was examined and photographed using a phase contrast microscope.

2.8.3. Cell cycle analysis

To determine the cell cycle dynamics, MCF7 cells were treated with complexes 1, 2 and 3 for 48 h. After the incubation period, cells were collected by centrifugation and washed with PBS then fixed in 70% ethanol for 60 min at 4 °C and then cells were centrifuged to discard the alcohol and washed with PBS twice. Cells were resuspended in 500 μ L of PBS containing 100 μ g/mL of RNase (Invitrogen, USA) and incubated for 30 minutes and then 20 μ g/mL of propidium iodide stain (Invitrogen, USA) was added and incubated further for 10 min in the dark at 37 °C before analysis. Cells with medium were used as a control. Cell cycle distribution of the cells was determined by analyzing 10,000 gated cells using a FACScan flow cytometer and Cell Quest software (FACS Calibur; Becton-Dickinson, San Jose, CA). All experiments were performed in triplicates.

2.8.4. Apoptotic analysis with annexin V FITC PI dual staining

MCF7 (1×10^6 cells) were seeded and incubated for overnight and then cells were treated with their respective IC₅₀ values for 48 h and cells without treatment were kept as controls. Camptothecin (Sigma, USA) was used as early apoptotic inducer. After incubation periods, cells were pelleted down washed with PBS and Annexin V FITC/PI kit was purchased from Sigma and experiment performed according to the kit protocol.

3. Result and discussion

3.1. Synthesis and characterization

The three synthesized complexes are shown in Scheme 1. From FTIR spectra, $\nu_{\text{N-H}}$, $\nu_{\text{C=C}}$, $\nu_{\text{C=N}}$ and $\nu_{\text{M-N}}$ of complexes were 3404, 1454, 1585 and 628 cm^{-1} , respectively. $\nu_{\text{M-N}}$ for all three complexes indicates that all six Ru→N bonds have the same bond order with an octahedral structure. ^1H NMR peaks of CIIP were slightly shifted towards to down field after complex formation, demonstrating complex formation.

3.2. DNA binding studies

3.2.1. Absorption spectroscopic studies

For metal complex and DNA interaction studies electronic absorption spectroscopy is the most useful tool.^[37] This interaction is associated with hypochromism and a red shift in the metal ligand charge transfer (MLCT) and ligand bands.^[38] This may be due to the intercalation of the aromatic chromophore between DNA base pairs. The degree of the hypochromism in a UV-visible band is constant with the strength of the interaction.^[39,40] Thus, to provide evidence for the possibility of binding of each complex to CT-DNA, spectroscopic titrations of solution of each of the complexes with various concentration of CT-DNA were performed. Figure 1 shows the representative spectral profile of the three complexes at different DNA concentrations. The intrinsic binding constants (K_b) of the complexes were in the order of 10^6 as shown in Table 1. The binding constant was stronger for $[\text{Ru}(\text{Phen})_2(\text{MIPC})]^{2+}$,^[41] because of the presence of electron withdrawing substituent ($-\text{Cl}$ in CIIP) on the intercalative ligand, which increases the DNA binding affinity. Complex 3 shows the less binding strength to double helical DNA than the remaining two complexes (1&2). This reduction is caused by the presence of methyl groups at the 4 and 4' positions of dmb (ancillary ligand), which causes steric hindrance and the complex moiety becomes electron rich, which causes a decrease in the binding affinity between the CT-DNA base pairs. The values are comparable to those of $[\text{Ru}(\text{phen})_2(7\text{-NO}_2\text{-dppz})]^{2+}$ ($3.56 \times 10^5\text{ M}^{-1}$) and $[\text{Ru}(\text{bpy})_2(7\text{-NO}_2\text{-dppz})]^{2+}$ ($2.92 \times 10^5\text{ M}^{-1}$)^[42] and $[\text{Ru}(\text{phen})_2(\text{dppca})]^{2+}$ ($3.4 \times 10^5\text{ M}^{-1}$) and $[\text{Ru}(\text{bpy})_2(\text{dppca})]^{2+}$ ($2.12 \times 10^5\text{ M}^{-1}$).^[43]

3.2.2. Luminescence studies

Luminescence titration experiments were performed to further understand the exact nature of the complex binding to DNA at a fixed metal complex concentration in Tris buffer ($\text{pH} = 7.2$). The change of emission intensity is related to the extent to which the complex enters into the hydrophobic

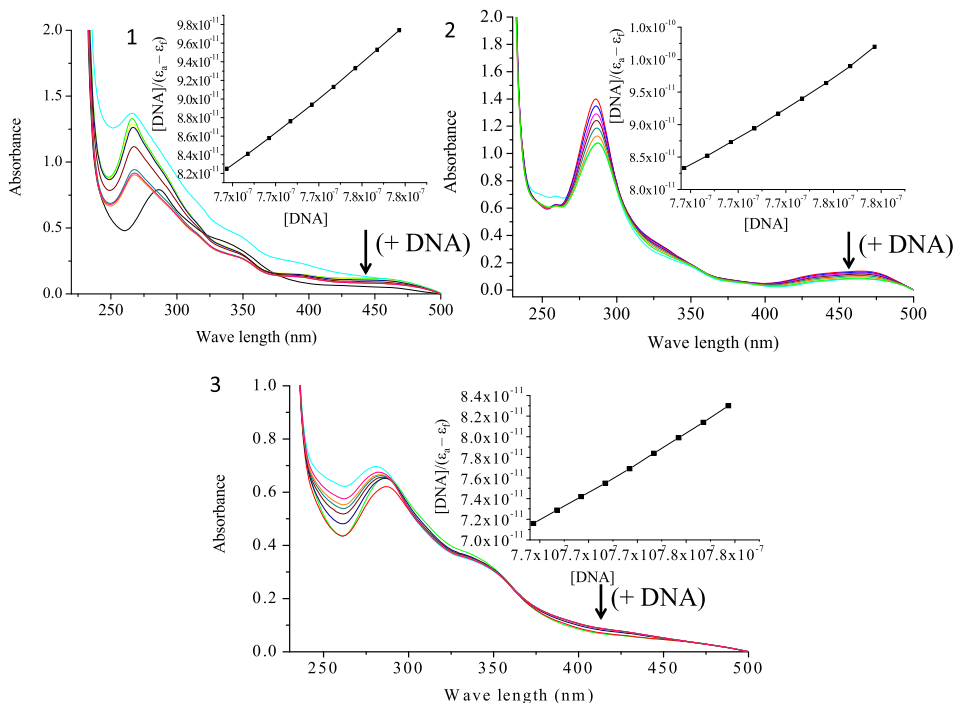


Figure 1. Absorption spectrum of three complexes $[Ru(phen)_2(CIIP)]^{2+}$ (1), $[Ru(bpy)_2(CIIP)]^{2+}$ (2) and $[Ru(dmb)_2(CIIP)]^{2+}$ (3) complexes, in Tris-HCl buffer upon addition of CT-DNA. Arrow shows hypsochromic shift upon increase of DNA concentration. Inset plot, $[DNA]/(\epsilon_b - \epsilon_f)$ versus $[DNA]$ for the titration of DNA with Ru(II) complex, which gives intrinsic binding constant (K_b).

Table 1. Absorption, and Emission binding constants of ruthenium (II) complexes with CT-DNA.

Complex	K_b for absorption studies (M^{-1})	K_b for emission studies (M^{-1})
$[Ru(phen)_2(CIIP)]^{2+}$ (1)	$1.90 (\pm 0.07) \times 10^6$	$2.32 (\pm 0.07) \times 10^6$
$[Ru(bpy)_2(CIIP)]^{2+}$ (2)	$1.77 (\pm 0.1) \times 10^6$	$2.15 (\pm 0.04) \times 10^6$
$[Ru(dmb)_2(CIIP)]^{2+}$ (3)	$1.26 (\pm 0.1) \times 10^6$	$2.10 (\pm 0.06) \times 10^6$

environment inside the DNA as shown in Figure 2. The relative intensities of the excitation increased as DNA was added to the solution of the complex. When the complex intercalates between the DNA base pairs, the mobility of the complex is restricted at the binding site and the hydrophobic environment inside the DNA helix reduces the accessibility of solvent water molecules to the complex, leading to a decrease of the vibrational modes of relaxation. From the fluorescence data, an intrinsic binding constant was calculated by using the Scatchard equation^[33] through a plot of r versus r/C_f , where r is the binding ratio $C_b/[DNA]$ and C_f is the free ligand concentration. Scatchard plots for the complexes were constructed from luminescence spectra, and the binding constants (K_b) were shown in Table 1 for 1–3, respectively. The binding constants calculated are consistent with the absorption spectra.

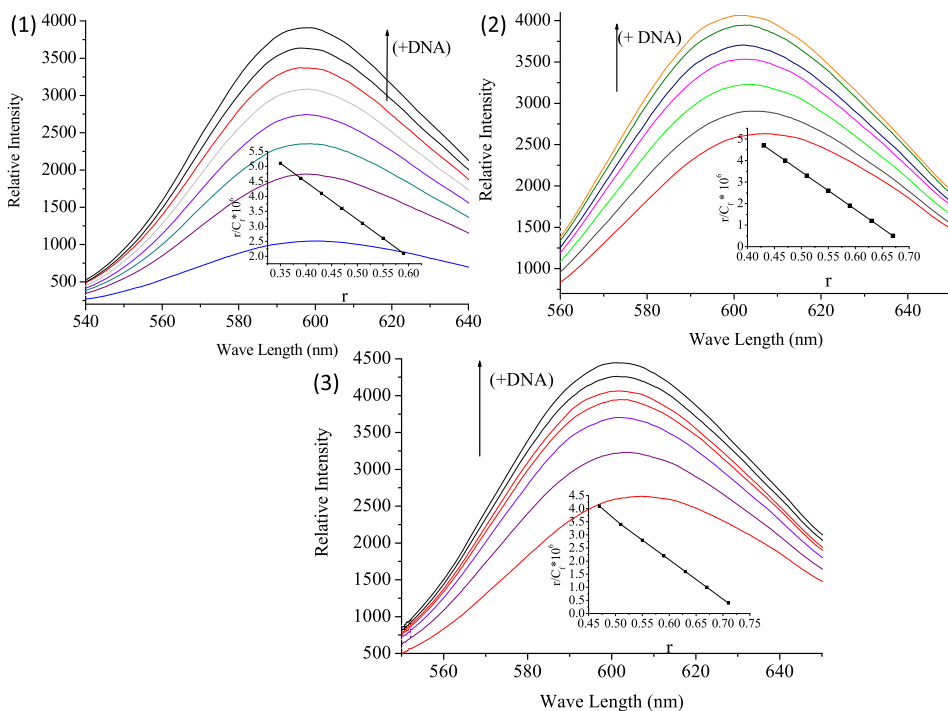


Figure 2. Luminescence spectrum of complexes $[\text{Ru}(\text{phen})_2\text{ClIP}]^{2+}$ (1), $[\text{Ru}(\text{bpy})_2\text{ClIP}]^{2+}$ (2) and $[\text{Ru}(\text{dmb})_2\text{ClIP}]^{2+}$ (3) in Tris–HCl buffer upon addition of CT-DNA. Arrow shows the intensity change upon the increase of DNA concentration. Inset: Scatchard plot of above complex, which gives binding constant (K_b).

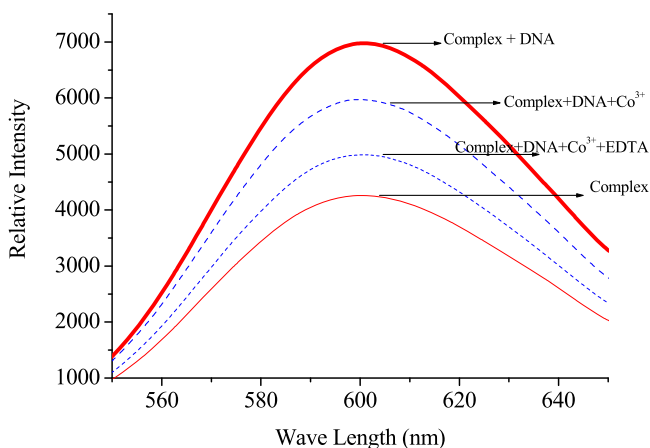


Figure 3. Luminescence modulation routes of $[\text{Ru}(\text{phen})_2\text{ClIP}]^{2+}$ in the absence and presence of DNA by Co^{2+} and EDTA respectively.

A Further investigation was performed on the photoluminescence of DNA - $[\text{Ru}(\text{phen})_2\text{ClIP}]^{2+}$ in the presence and absence of Co^{2+} . From Figure 3, it can be seen that when the complexes bound to DNA the emission intensity increased (switch on). By adding $\text{Co}(\text{II})$ ions to this resultant

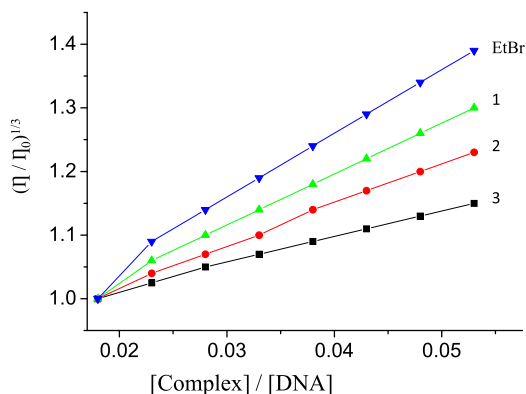


Figure 4. Effect of increasing amounts of EtBr, complexes $[\text{Ru}(\text{phen})_2\text{CIIP}]^{2+}$ (1), $[\text{Ru}(\text{bpy})_2\text{CIIP}]^{2+}$ (2) and $[\text{Ru}(\text{dmb})_2\text{CIIP}]^{2+}$ (3) on the relative viscosity of CT-DNA at $25(\pm 0.1)^\circ\text{C}$.

solution the emission intensity was quenched, turning the light switch off.^[44,45] The addition of Co^{2+} to DNA - $[\text{Ru}(\text{phen})_2\text{CIIP}]^{2+}$, results in the loss of intensity due to formation of a Co^{2+} - $[\text{Ru}(\text{phen})_2\text{CIIP}]^{2+}$ heterometallic complex. However, the emission can be recovered in the presence of EDTA, thus turning the light switch on. This is because Co^{2+} was removed by EDTA, and the Co^{2+} - $[\text{Ru}(\text{phen})_2\text{CIIP}]^{2+}$ heterometallic complex cannot be formed. The present results should be of value in further developing a luminescence DNA probe.

3.3. Viscosity measurements

The consistent method for the assignment of the mode of binding of complexes to DNA is viscosity measurements. It is well-known that a classical intercalation of a ligand into DNA is known to cause a significant increase in the viscosity of a DNA solution due to an increase in the separation of the base pairs at the intercalative site and, hence, an increase in the overall DNA molecular length.^[36] Figure 4 has shown that by increasing the amounts of complexes 1, 2 and 3, the relative viscosity of CT DNA solution increase steadily along with classical intercalator ethidium bromide. These results suggest that the three Ru(II) complexes intercalate between the DNA base pairs in the order of $1 > 2 > 3$, which is consistent with our interpretation based on binding constants.

3.4. Photo activated photo cleavage studies

The photo cleavage reactions of plasmid pBR322 DNA were induced by ruthenium (II) complexes and monitored by agarose gel electrophoresis. When electrophoresis is applied to circular plasmid DNA, the fastest migration of closed circular conformation (Form I) was observed. If one

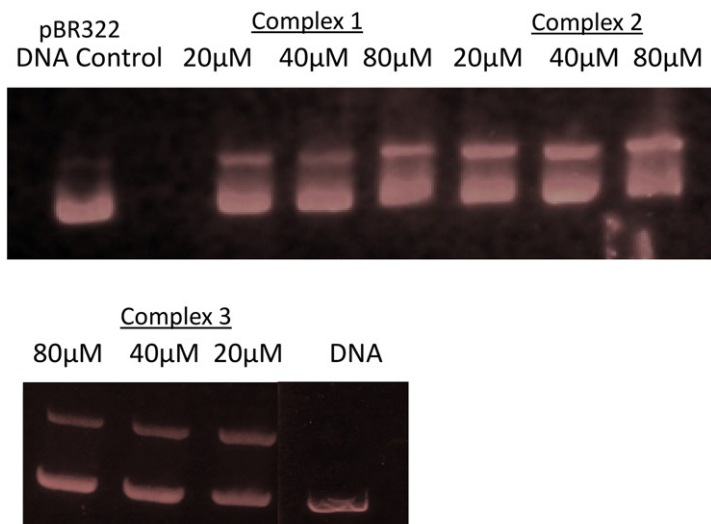


Figure 5. Photo activated cleavage studies of $[\text{Ru}(\text{phen})_2\text{ClIP}]^{2+}$ (1), $[\text{Ru}(\text{bpy})_2\text{ClIP}]^{2+}$ (2), $[\text{Ru}(\text{dmb})_2\text{ClIP}]^{2+}$ (3) with the concentration range of 20 to 80 μM against pBR322 DNA.

Table 2. Antimicrobial activity of complexes (1–3) with their minimum inhibition concentration (MIC) in mm.

Complex	Bacterial inhibition zone (mm)			
	Conc. (1000 μM)		Conc. (500 μM)	
	B.S	<i>E. coli</i>	B.S	<i>E. coli</i>
$[\text{Ru}(\text{phen})_2\text{ClIP}]^{2+}$ (1)	10.3	9.5	6.2	5.9
$[\text{Ru}(\text{bpy})_2\text{ClIP}]^{2+}$ (2)	9.3	8.9	5.9	5.7
$[\text{Ru}(\text{dmb})_2\text{ClIP}]^{2+}$ (3)	8.6	8.6	5.6	5.7
Ampicilin	14.7	13.2	8.8	8.7

strand is cleaved, the supercoil will relax to produce a slower moving nicked conformation (Form II). When both strands are cleaved, a linear conformation (Form III) is generated that migrates in between. As shown in Figure 5, no obvious cleavage was observed for the control in which metal complexes were absent (DNA alone), or incubation of the plasmid with the Ru(II) complexes in the dark. With increasing concentration of complexes, Form I decreases and Form II increases gradually. At the concentration range of 20–80 μM , the three complexes can completely cleave the plasmid DNA in the sequence of concentration changes.

3.5. Antimicrobial studies

These three complexes have shown significant antibacterial activities with *Escherichia coli* (*E. coli*) and *Bacillus streptococcus* (B.S). From Table 2, inhibition zone data indicate that three complexes showed considerable

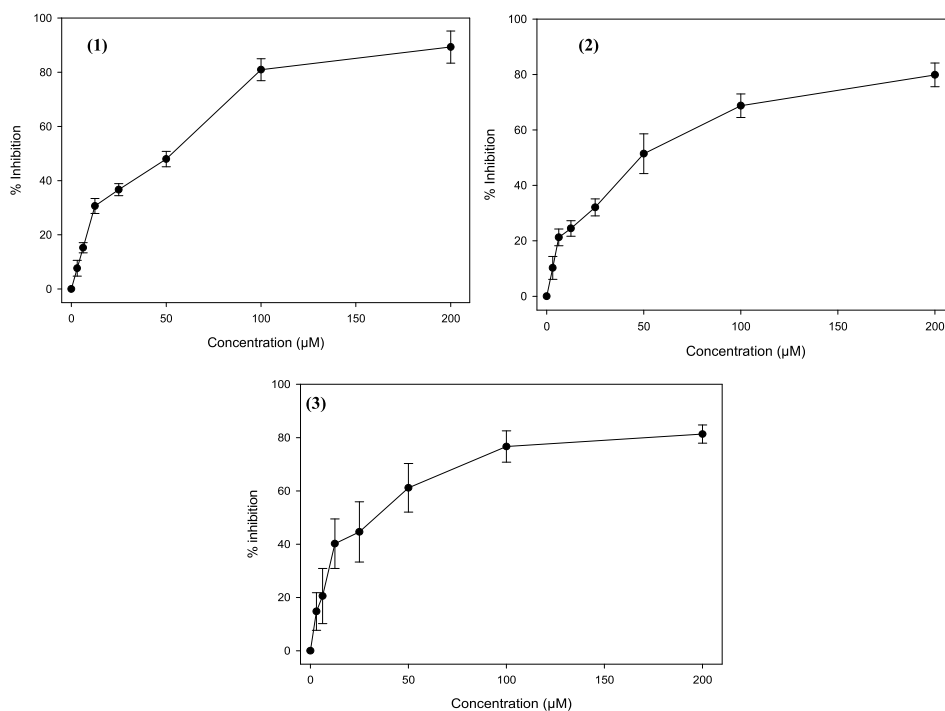


Figure 6. Cytotoxicity evaluation of complexes 1-3 on MCF 7 cell line by MTT assay. IC_{50} value was calculated. Data represented here are from three independent experiments.

activity against *E. coli* and *B.S* at 1 mg/mL and 0.5 mg/mL concentrations. The DMSO control showed a negligible activity and Ampicillin shows greater activity as compared with the three metal complexes. $[Ru(phen)_2CIIP]^{2+}$ showed slightly higher activity than other two complexes 2 and 3. The antimicrobial activity is increased as the concentration of the complexes increased.

3.6. MTT assay

All three complexes showed significant inhibition on MCF 7 cells in comparison to control. IC_{50} values were calculated using an MTT assay. The IC_{50} value for complex 1 was 52.7 µM whereas for complex 2 and 3 it was 48.7 and 33.5 µM as shown in Figure 6.

3.6.1. Morphological observations

The effect of three complexes on morphology of MCF 7 cells was observed by phase contrast microscope. After treatment of cells with complexes 1-3 for 48 h, it was observed that cell growth was inhibited in a significant manner when compared to control cells as shown in the Figure 7.

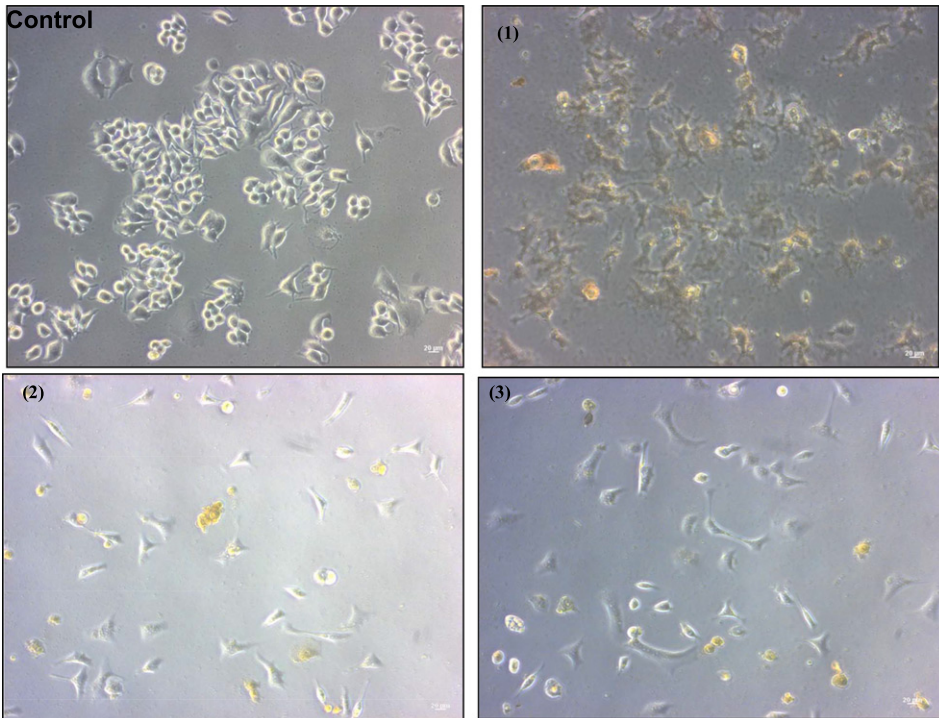


Figure 7. Morphological examination of MCF7 cells by Phase Contrast Microscope.

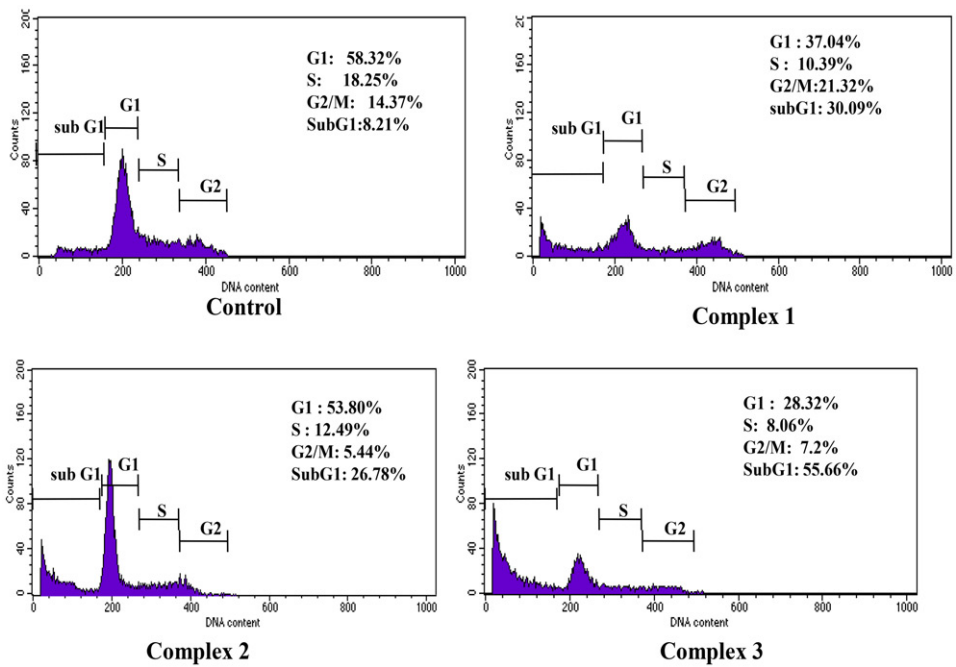


Figure 8. Cell cycle analysis by PI staining followed by Flow cytometry.

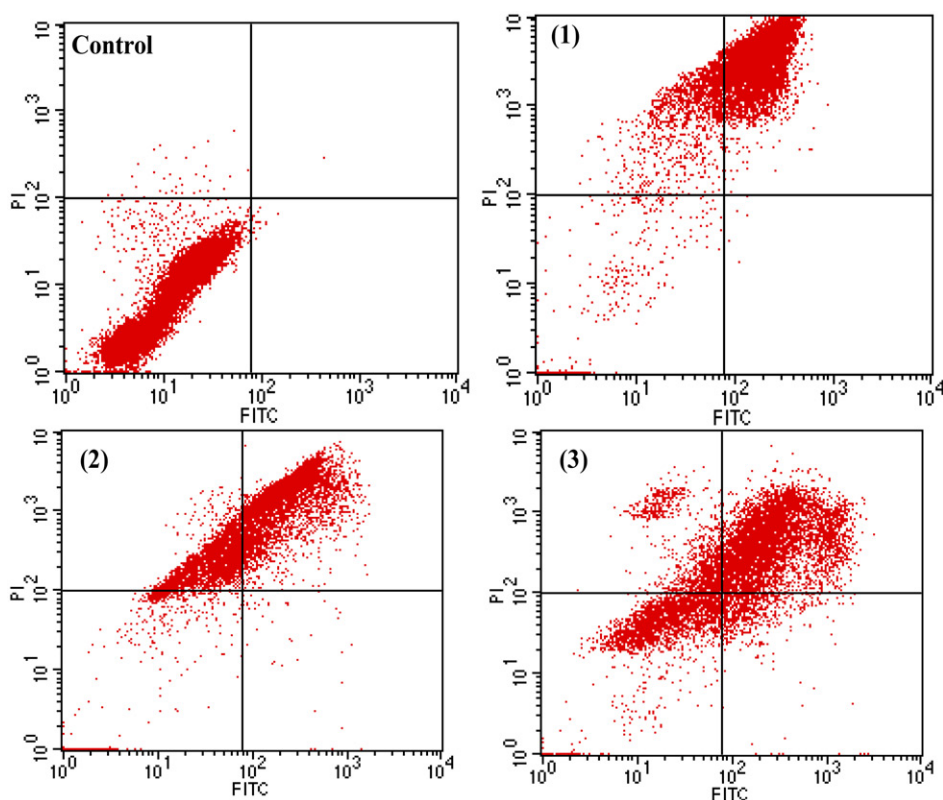


Figure 9. Determination of Apoptosis by Annexin V FITC/PI staining followed by Flow Cytometry.

3.6.2. Cell cycle dynamics

Cell cycle analysis following treatment with complexes **1–3** in MCF 7 cells showed significant increase in the subG1 population (hypodiploid DNA content and cell death) of cells as shown in **Figure 8**. These results suggested that all three complexes were effective in causing cell death.

3.6.3. Induce apoptosis

To investigate the possible mechanism causing cell death, cellular apoptosis was assessed by Annexin V/PI staining followed by flow cytometry. Results had shown that apoptotic percentages of MCF-7 cells were increased on treatment with complexes **1, 2** and **3** as shown in **Figure 9**. These results suggested that treatment with these complexes led to translocation of phosphatidylserine from inner to outer leaflet of the plasma membrane, which is an indicator of early apoptosis.

4. Conclusion

Three new ruthenium(II) polypyridyl complexes $[\text{Ru}(\text{phen})_2(\text{CIIP})]^{2+}$ (**1**), $[\text{Ru}(\text{bpy})_2(\text{CIIP})]^{2+}$ (**2**) and $[\text{Ru}(\text{dmb})_2(\text{CIIP})]^{2+}$ (**3**) were synthesized and

characterized. The absorption, emission and viscosity studies revealed that all the three Ru(II) complexes bind to DNA through an intercalative mode, and the binding affinity of three complexes are in the order $1 > 2 > 3$, due to the planarity and steric hindrance of the ancillary ligands. In a gel electrophoresis experiment, all three complexes can cleave effectively pBR322 DNA in different forms. Antimicrobial activity indicated that complex **1** was more active compared to other complexes against all tested microorganisms. All the synthesized ruthenium polypyridyl complexes showed cytotoxicity against MCF7 cell line and these complexes caused cell death by induction of apoptosis. These results may be useful in understanding the interactions of complexes with DNA and also useful in the development of new metal based anticancer agents.

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SCATTERED COMPUTING WITH REAL TIME AND DISTRIBUTED DEVICES

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ABSTRACT

In this paper the challenges in computer systems research posed by the emerging field of scattered computing. It first examines the relationship of this new field to its predecessors: distributed systems and mobile computing. It then identifies four new research thrusts: effective use of smart spaces, invisibility, localized scalability, and masking uneven conditioning. Next, it sketches a couple of hypothetical scattered computing scenarios, and uses them to identify key capabilities missing from today's systems. The article closes with a discussion. The goal of this article is to help us understand the challenges in computer systems research posed by scattered computing.

Keywords: scattered computing, Nano technology, peer, interfaces.

1 REAL TIME COMPUTING SYSTEM HISTORY

Scattered computing aims to revolutionize the current paradigm of human computer interaction. Computers have been used in various aspects of human life, but in most cases human beings have to adapt their behavior to each system. Scattered computing is a computing environment computing systems weave themselves in the fabric of everyday life and become invisible. Invisibility is the most important aspect of Scattered computing. The user is exposed to a few sets of services available to him/her and is oblivious to the complex system implementing those services. This takes the human-computer interaction into a whole different dimension, where the user is surrounded by a complete smart environment with devices/sensors communicating with each other and aggregating their functionalities to provide a set of consolidated services. The terms Scattered computing and Pervasive computing are used interchangeably, but they are conceptually different. Scattered computing uses the advances in Mobile computing and Pervasive computing to present a global computing environment. Mobile computing is about elevating computing services and making them available on mobile devices using the wireless infrastructure. The focus here is to reduce the size of the computing devices so that they can be carried anywhere or by providing access to computing capacity through high-speed networks. But Mobile computing has some limitations. The computing model does not change considerably as we move since the computing devices cannot acquire the context information and adjust accordingly. Pervasive computing, on the other hand, is about acquiring context from the environment and dynamically building computing models dependent on context. Pervasive computing is invisible to human

users and yet provides useful computing services. Scattered computing aims to provide Pervasive computing environments to a human user as s/he moves from one location to another. A Scattered computing environment can be built in two ways. The traditional approach is to achieve it by using Mobile computing and Pervasive computing together, in which the mobile devices remember the information about past environments they operated in and activate when we reenter into a known environment or proactively build up services as we walk into new environments. This allows context information to be stored on the Web and then shared across Pervasive computing environments via the Web to provide context-aware services. Scattered computing began in the Electronics and Imaging Laboratory of the Xerox Palo Alto Research Center (PARC)

Scattered computing is the third wave of computing technologies to emerge since computers first appeared:

- **First Wave** - Mainframe computing era: one computer shared by many people, via workstations.
- **Second Wave** - Personal computing era: one computer used by one person, requiring a conscious interaction. Users largely bound to desktop.
- **Third Wave** - Scattered (initially called scattered) computing era: one person, many computers. Millions of computers embedded in the environment, allowing technology to recede into the background.

1.1 SCOPE IN DISTRIBUTED SYSTEMS

The field of distributed systems arose at the intersection of personal computers and local area networks. The research that followed from the mid-1970s through the early 1990s created a conceptual framework and algorithmic base that

has proven to be of enduring value in all work involving two or more computers connected by a network. Whether mobile or static, wired or wireless, sparse or scattered. This body of knowledge spans many areas that are foundational to scattered like...

- **Remote communication**, including protocol layering, remote procedure call, the use of timeouts, and the use of end-to-end arguments in placement of functionality
- **High availability**, including optimistic and pessimistic replica control mirrored execution, and optimistic recovery
- **Security**, including encryption-based mutual authentication

1.2 MOBILE COMPUTING

Four key constraints of mobility forced the development of specialized techniques. The results achieved so far can be grouped into the following broad areas:

- **Mobile networking**, including Mobile IP ad hoc protocols and techniques for improving TCP performance in wireless networks.
- **Mobile information access**, including disconnected operation bandwidth-adaptive file access and selective control of data consistency.
- **Support for adaptive applications**, including transcoding by proxies and adaptive resource management.

2 SCATERED COMPUTING

Technology is moving from personal computers (PCs) to handheld, intelligent, and everyday devices with imbedded technology and connectivity

Scatered computing is a rapidly developing area of Information and communications Technology (ICT). The term refers to the increasing integration of ICT into people lives and environments, made possible by the growing variability of microprocessors with inbuilt communications facilities. Scatered computing has many potential applications, from health and home care to environmental monitoring and intelligent transport systems. This briefing provides an overview of scatered computing and discusses the growing debate over privacy, safety and environmental implications.

Scatered computing has been in development for almost 15 but still remains some way from becoming a fully operational reality. Some core technologies have already emerged, although the development of battery technologies and user interfaces pose particular challenges. It may be another 5-10 years before complete PCS become widely available. This depends on market forces, industry, public perceptions and the effects of any policy/regulatory frameworks. There have been calls for more widespread debate on the implications of scatered computing while it is still at an early stage of development

2.1 EFFECTIVE USE OF SMART SPACES

A space may be an enclosed area such as a meeting room or corridor, or a well-defined open area such as a courtyard or quadrangle. By embedding computing infrastructure in building infrastructure, a smart space brings together two worlds that have been disjoint until now .The fusion of these worlds enables sensing and control of one world by the other.

2.2 INVISIBILITY

The second thrust is *invisibility*. The ideal expressed by Weiser is complete disappearance of scatered computing technology from a user's consciousness. In practice, a reasonable approximation to this ideal is *minimal user distraction*. If a scatered computing environment continuously meets user expectations and rarely presents him with surprises, it allows him to interact almost at a subconscious level.

2.3 LOCALIZED SCALABILITY

The third research thrust is *localized scalability*. As smart spaces grow in sophistication, the intensity of interactions between a user's personal computing space and his/her surroundings increases. Scalability, in the broadest sense, is thus a critical problem in scatered computing. Previous work on scalability has typically ignored physical distance. A Web server or file server should handle as many clients as possible, regardless of whether they are located next door or across the country. The situation is very different in scatered computing. Here, the density of interactions has to fall off as one moves away; otherwise, both the user and his computing system will be overwhelmed by distant interactions that are of little relevance.

2.4 CONNECTIVITY

Scatered computing systems will rely on the interlinking of independent electronic devices into broader networks. This can be achieved via both wired (such as Broadband (ADSL) or Ethernet) and wireless networking technologies (such as Wi-Fi or Bluetooth), with the devices themselves being capable of assessing the most effective form of connectivity in any given scenario. The effective

development of scatered computing systems depends on their degree of interoperability, as well as on the convergence of standards for wired and wireless technologies.

2.5 DEVICES

PCS devices are likely to assume many different forms and sizes, from handheld units (similar to mobile phones) to near-invisible devices set into 'everyday' objects (like furniture and clothing). These will all be able to communicate with each other and act 'intelligently'. Such devices can be separated into three categories:

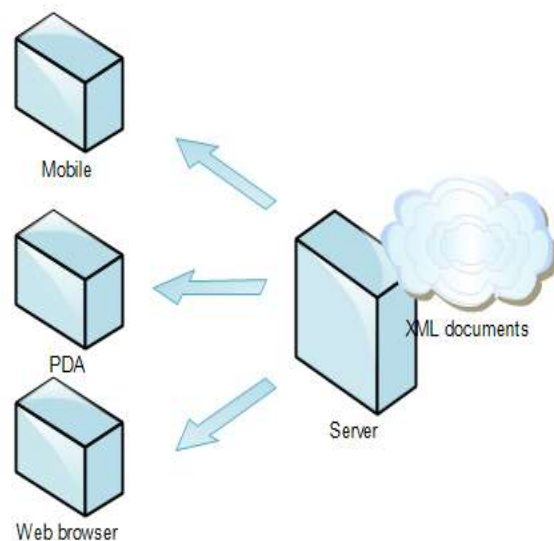
- **Sensors:** input devices that detect environmental changes, user behaviors, human commands etc.
- **Processors:** electronic systems that interpret and analyses input-data;
- **Actuators:** output devices that respond to processed information by altering the environment via electronic or mechanical means. For example, air temperature control is often done with actuators. However the term can also refer to devices which deliver information, rather than altering the environment physically. There are many visions for the future development of PCS devices. Several research groups are endeavoring to produce networks of devices that could be small as a grain of sand. The idea is that each one would function independently, with its own power supply, and could also communicate wirelessly with the others. These could be distributed throughout the environment to form dense, but almost invisible, pervasive computing networks, thus eliminating the need for overt devices.²

At the other extreme, augmented reality would involve overlaying the real world with digital information. This approach emphasizes the use of mobile technologies, geographical positioning systems and internet-linked databases to distribute information via personal digital companions. Such devices could come in many forms:

Children might have them integrated into school bags, whereas adults might use devices more closely resembling personal digital assistants (PDAs). Ultimately a spectrum of devices may become available. These will range from miniaturized (potentially embedded in surrounding objects) to a variety of mobile (including handheld and wearable) devices. While these could exist as standalone systems, it is likely that many will be interlinked to form more comprehensive systems

2.6 USER INTERFACES

User interfaces represent the point of contact between ICT and human users. For example with a personal computer, the mouse and keyboard are used to *input* information, while the monitor usually provides the *output*. With future user interfaces the input might be visual information – for example recognizing a person's face, or responding to gestures. Three very different forms of human-computer interaction are postulated: **active**, **passive** and **coercive**.



3 HUMAN-COMPUTER INTERACTIONS (HCIS)

Active: Users could have overt control over scattered computing technologies and devices in the environment. This could be achieved through language-based interfaces, allowing users to issue direct spoken or written commands

Passive: Scattered computing could disappear into the background. People would no longer know they were interacting with computers. The technology would sense and respond to human activity, behavior and demands intuitively and intelligently (for example, lighting altering in reaction to users' location, mood and activity).

Coercive: Scattered computing could control, overtly or covertly, lives and environments (for example if a device did not have an off-switch or a manual over-ride). Decisions made by developers (such as programming a system in accordance with health and safety regulations), development errors, unintended device interactions and malicious interference could all lead to loss of user control, and could possibly have negative implications for users.

4 ADVANTAGE

We increasingly rely on the electronic creation, storage, and transmittal of personal, financial, and other confidential information, and demand the highest security for all these transactions and require complete access to time-sensitive data, regardless of physical location. We expect devices -- personal digital assistants, mobile phones, office PCs and home entertainment systems -- to access that information and work together in one seamless, integrated system. Scattered computing gives us the tools to manage information quickly, efficiently, and effortlessly.

It aims to enable people to accomplish an increasing number of personal and professional transactions using a new class of intelligent and portable appliances or "smart devices" embedded with microprocessors that allow users to plug into intelligent networks and gain direct, simple, and secure access to both relevant information and services.. It gives people convenient access to relevant information stored on powerful networks, allowing them to easily take action anywhere, anytime.

Scattered computing simplifies life by combining open standards-based applications with everyday activities. It removes the complexity of new technologies, enables us to be more efficient in our work and leaves us more leisure time and thus scattered computing is fast becoming a part of everyday life.

5 APPLICATIONS

Scattered computing could have a range of applications, many of which may not yet have been identified. Applications in healthcare, homecare, transport and environmental monitoring are among the most frequently cited, as discussed below. Research is taking place in industry and academia, often collaboratively, handsome government activities are underway.

5.1 DOMICILIARY CARE

Improved methods for monitoring health and wellbeing could allow people to live longer in their own homes. Sensors embedded in items of clothing, for example, might allow constant monitoring of heart rates, body-mass index, blood pressure and other physiological variables. Further sensors embedded throughout the home could detect movement and fluctuations within the ambient environment (such as temperature change) to alert care-workers to any irregularities

5.2 ENVIRONMENTAL MONITORING

Scattered computing provides improved methods to monitor the environment. It will allow for continuous real-time data collection and analysis via remote, wireless devices. However, this poses significant challenges for PCS developers. Devices may be required to withstand harsh environmental conditions (such as heat, cold and humidity).

5.3 INTELLIGENT TRANSPORT SYSTEMS

Scattered computing technologies are being employed in the development of intelligent transport systems to try to alleviate these costs. Such systems seek to bring together information and telecommunications technologies in a environment. Computers are already incorporated into modern cars via integrated mobile phone systems, parking sensors and complex engine management systems. Intelligent transport systems take this process further by introducing 'intelligent' elements into vehicles. Vehicles could become capable of receiving and exchanging information 'on the move' via wireless technologies and be able to communicate with devices integrated into transport infrastructure, alerting drivers to traffic congestion, accident hotspots, and road closures. Alternative routes could be relayed to in-car computers, speeding up journey times and reducing road congestion.

5.4 HEALTH CARE

Scattered computing offers opportunities for future healthcare provision in the UK, both for treating and managing disease, and for patient administration. For instance, remote sensors and monitoring technology might allow the continuous capture and analysis of patients' physiological data. Medical staff could be immediately alerted to any detected irregularities. Data collection on this scale could also provide for more accurate pattern/trend analysis of long-term conditions such as heart disease, diabetes and epilepsy. Wearable sensors may offer greater patient mobility and freedom within hospitals and save both time and money by reducing the need for repeated and intrusive testing. Hospital administration could also be transformed. Patients might be tagged with wristbands containing digital photographs and medical notes. These wristbands would allow patients to be traced more effectively through hospital administration systems, reducing the risk of misidentification and treatment errors.

6 ISSUES

There are engineering problems to be solved before many of the envisaged applications of PCS can become a reality.

6.1 ENGINEERING ISSUES

The complexity of PCS systems means that their communications, software and hardware are likely to suffer from faults. These might be accidental, or the result of deliberate attempts to damage the system.³ If systems are interconnected it will be harder to establish who is responsible if something goes wrong.

6.2 PRIVACY, SECURITY AND SAFETY

Scattered computing systems may have implications for privacy, security and safety, as a result of their ability to:

- gather sensitive data

6.2.1 PRIVACY

PCS could be embedded in places considered private, such as the home. The advent of scattered computing may mean that data can be collected without a person's knowledge or consent. Some argue that this could violate existing data protection law⁴. Data mining involves processing large quantities of data to spot patterns and trends. In terms of consumer data, this can lead to more effective targeted marketing.

6.2.2 SAFETY AND SECURITY

Scattered computing also gives rise to debate over safety. Integrated transport systems could involve road vehicles having actuating devices that intervene in the driving process, possibly responding to hazards more quickly than humans. For example the new Mercedes S-Class features an active braking system that can detect rapidly slowing vehicles in front, activating the brakes without driver intervention. While this may help avoid accidents, there are also potential risks.

6.2.3 Technological measures

It is argued that privacy, safety and security can be better protected if appropriate procedures and protocols are integrated into PCS at the design level rather than implemented retrospectively. Three measures are frequently cited as vital in establishing robust security measures:

- The volume of transmitted data should be kept to a minimum;
- Data that require transmission should be encrypted and sent anonymously (without reference to the owner);
- Security should be treated as an ongoing and integral element of PCS. These principles are accepted by many centers of PCS research and development. However, consumer groups such as the NCC say that developers need to give more consideration to privacy issues. The NNC argues that in the case of RFID,⁶ privacy issues were considered only late in development and have still not been fully addressed.

7 EMERGING SCATERED (SCATERED) TECHNOLOGIES

7.1 Peer-to-Peer (P2P) networking

Napster popularized the application of P2P (peer-to-peer networking) products and now the same technology has begun to sing a business melody. The basic idea behind it being the sharing of files and programs and communicating directly with people over the Internet, without having to rely on a centralized server.

7.2 WIRELESS TECHNOLOGY

Wireless Internet connection helps access the Net through cellular phones, Personal Digital Assistants (PDAs) and Wireless laptops and this technology proposes enormous business opportunities. The

sales force can avail real-time access to inventory records; price lists, order and customer account status and can book a sale almost instantaneously. Constant communication with wireless gadgets (that cost many degrees lesser than a laptop) can ensure that there is a constant feedback loop thus ensuring a new way of reaching customers.

7.3 THE TAPESTRY OF DISTRIBUTED COMPUTING

Distributed computing is the processing power of thousands of PCs aggregated to create a super computer. A centralized server subsidizes a large computing task in to smaller bits. It then assigns those bits to thousands of desktop computers, each of which does a small task and returns the results to the server.

7.4 VOICE COMPUTING

Voice recognition software will soon allow users to switch on their computers by just talking to them. Even documents can be edited through voice commands. We'll finally be reaching out to the frontier where man will be able to talk to all his machines and command them to do as he wishes. In effect, we are talking about an e-web or the embedded web where the Internet's role as content provider and shopping assistant morphs into that of companion and advisor.

7.5 E-WEB

Embedded devices in cars, refrigerators, shop floors, hospital rooms extend the Internet's role beyond content providers and shopping assistants to companion and advisors. The Next-Gen web will be more interactive with a swarm of specialized devices like sensors, and other appliances, all with Internet access and the ability to communicate. Scattered computing illustrates a world that we are moving towards, quite rapidly. The promise of 'convenience' implies that islands of technologies will soon converge and simplify life even further. We will finally be witness to the long promised shift to convergence. Computing will no longer be a monopolizing activity that shackles us to our desktops.

8 CONCLUSION

Scattered computing refers to embedding computers and communication in our environment. Scattered computing provides an attractive vision for the future of computing. The idea behind the scattered computing is to make the computing power disappear in the environment, but will always be there whenever need or in other words it means availability and invisibility. Scattered computing will be a fertile source of challenging research problems in computer systems for many years to come. Solving these problems will require us to broaden our discourse on some topics, and revisit long-standing design assumptions in others. We will also have to address research challenges in areas outside computer systems. These areas include human-computer interaction (especially multimodal interactions and human-centric hardware designs), software agents (with specific relevance to high-level proactive behavior), and expert systems and artificial intelligence (particularly in the areas of decision making and planning). Capabilities from these areas will need to be integrated with the kinds of computer systems capabilities discussed in this article.

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HISTOPATHOLOGICAL STUDIES IN *CHANA PUNCTATUS* AND *MACROBRACHIUM ROSENBERGII* EXPOSED TO SONATA

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ABSTRACT

The present study is aimed to assess the histological damage caused to the fish *Chana punctatus* and prawn *Macrobrachium rosenbergii* were exposed to lethal concentration (15.39ppm & 12.09ppm) to Sonata (Fungicide). Light microscopic studies exhibited severe histopathological changes in the Gill, Liver and Brain. The histopathological changes in the gill of fish include: epithelial lifting, degenerated secondary lamella, curling of secondary filaments and degeneration of epithelial cells and gill of prawn include Detached cuticle, Degeneration of epithelium in secondary gill lamelle, Necrosis., Infiltrations of haemocytes, Edema reupture of epithelial

cells., Hypertrophy, Hyperpalsia., Disarrangement of secondary gill lamellae, Disruption of pillar cells and Enlargement of scondary gill lamellae. The histopathological changes in the Liver of fish include: blood cells among haptocytes, appearance of blood streaks among hepatocytes, formation of vacuoles and degegnated hepato pancreatic tissue and Liver of prawn include haemorrhage, vacuoles, necrosis and blood vesseles. The changes in the Brain of fish include: Degenerated dorsal olfactory area, degenerated Ventral olfactory area, blood streaks and degenerated septal area and brain of prawn include Pyknotic nuclei, Pyknotic nuclei with dense eosinophilic cytoplasamm, Vacuolated spaces, Prolifiration of gilala cells and Gliosis and nodule formation.

KEYWORDS: Sonata, Hypertrophy, Hyperpalsia, epithelial lifting, Pyknotic nuclei, Gliosis.

INTRODUCTION

In order to meet the growing population needs and demands, use of agrochemicals is inevitable for enhanced food production. Pesticides are highly effective substances used in control of pest and vectors of human disease. The increasing use of pesticides has caused

concerns about their effects on human health and the environment. In spite of potential applications in agriculture, horticulture and other allied fields, they also exert some disadvantages, they include toxicity to animals, plants and human beings. Persistence of some of these chemicals in the environment and their subsequent entry into aquatic systems causes a great havoc. Pesticides and fungicides exert their toxic action on arthropods, mussels, fishes, frogs, turtles, water birds and other wild life too. Excessive use leads to bioaccumulation in farm workers, fruits, vegetables, nuts and food crops, consumers, and it also causes biomagnification at various trophic levels of the food chain. Although Indian average consumption of pesticide is far lower than many other developed economies, the problem of pesticide residue is very high in India.^[1] Fungicides also threaten non target aquatic and terrestrial organisms through drift either by consumption or by ground water contamination. They enter water from agriculture and run off. The pollution of normal waters with synthetic chemicals has caused serious problems to the aquatic biota.^[2,3,4,5] Fish and prawn are useful bioindicators and integrators of contaminants. They accumulate in gills, liver, kidney, and fat and induces metabolic changes associated with these organs.

MATERIALS AND METHODS

Animal collection

The fish and prawn specimens samples of the two varieties namely *Channa punctatus* and *Macrobrachium rosenbergii* were collected from the freshwater lake located in waddepelly cheru, Warangal district. Fish measuring 14-15cms in length and weighing 250-300gms and prawn measuring 14-18cms in length and weighing 25-30gms specimens were brought to the laboratory immediately and analysed for various biological and nutritive value studies.

The fish and prawn were acclimatized to the laboratory conditions in large plastic tanks with unchlorinated ground water for two weeks at a room temperature of $28 \pm 2^\circ\text{C}$. During the period of acclimatization, the fish and prawn were fed with groundnut oil cake and rice bran. Feeding was stopped one day prior to the experimentation. All the precautions laid by committee on toxicity tests to aquatic organisms^[6] were followed. After Acclimatization, Fishes and prawns were divided into groups and treated with concentrations of 10 and 20 ppm biofungicide sonata at time points 48, 72 and 96 hrs. to decide the lethal toxicity (LC50). The LC50 values were calculated the using probits analysis based on finney's (1952) table.

Tissue collection

Gill, liver, and brain tissues were isolated from normal (not exposed to the toxicant) and experimental fish. Physiological saline solution (0.75% NaCl) was used to rinse and clean the tissue. They were fixed in aqueous Bouins solution for 48 hr, processed through graded series of alcohols, cleared in xylene and embedded in paraffin wax. Gills alone were processed by double embedding technique. Sections were cut of 4-6 μ (microns) thickness; stained with Hematoxylin-Eosin (dissolved in 70% alcohol)^[7] and were mounted in Canada balsam. Histopathological lesions were examined and photographed with the help of Intel Pentium QX3 computer attached microscope under 400X lens.

RESULTS

Gills

No histopathological changes were observed in the gill of the control fish and prawn. The structural details of the gill of control *C. Punctatus* and *M.rosenbergii* are shown in Fig. 1A&B. The most common changes in 15.39ppm & 12.09ppm concentrations of Sonata Fungicide were epithelial lifting, degenerated secondary lamella, curling of secondary filaments and degeneration of epithelial cells and in prawn include Detached cuticle, Degeneration of epithelium in secondary gill lamelle, Necrosis., Infiltrations of haemocytes, Edema reupture of cpithelial cells., Hypertrophy, Hyperpalsia., Disarrangement of secondary gill lamellae, Disruption of pillar cells and Enlargement of scondary gill lamellae. The histological changes noticed in the pesticide exposed and control fishes and prawns are shown in fig.1 A(A1) & FIG.1B(A1).

Liver

No histopathological changes were observed in the liver of the control fish and prawn. The structural details of the liver of control *C. Punctatus* and *M.rosenbergii* are shown in Fig. 2A&B. In the liver tissues of fish and prawn exposed to sonata concentrations of 15.39 ppm and 12.09 ppm, blood cells among haptocytes, appearance of blood streaks among hepatocytes, formation of vacuoles and degegnrated hepato pancreatic tissue and Liver of prawn include haemorrhage, vacuoles, necrosis and blood vesseles were seen (Figs. 2B-. The histological changes noticed in the pesticide exposed and control fishes and prawns are shown in Fig.2A(A1) & Fig.2B(A1).

Brain

No histopathological changes were observed in the brain of the control fish and prawn. The structural details of the brain of control *C. Punctatus* and *M.rosenbergii* are shown in Fig. 3A&B. The most common changes in 15.39ppm & 12.09ppm concentrations of Sonata Fungicide were Degenerated dorsal olfactory area, degenerated Ventral olfactory area, blood streaks and degenerated septal area and in prawn include Pyknotic nuclei, Pyknotic nuclei with dense eosinophilic cytoplasm, Vacuolated spaces, Proliferation of glial cells and Gliosis and nodule formation. The histological changes noticed in the pesticide exposed and control fishes and prawns are shown in fig.3 A(A1) & FIG.3B(A1).

Gill

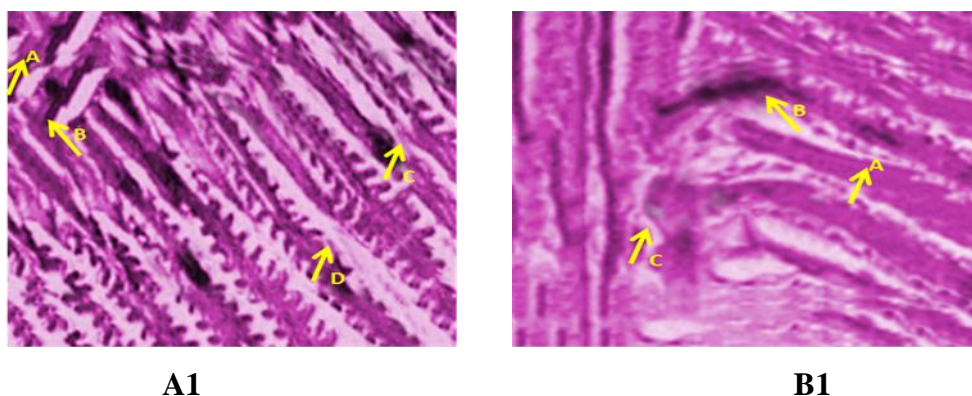


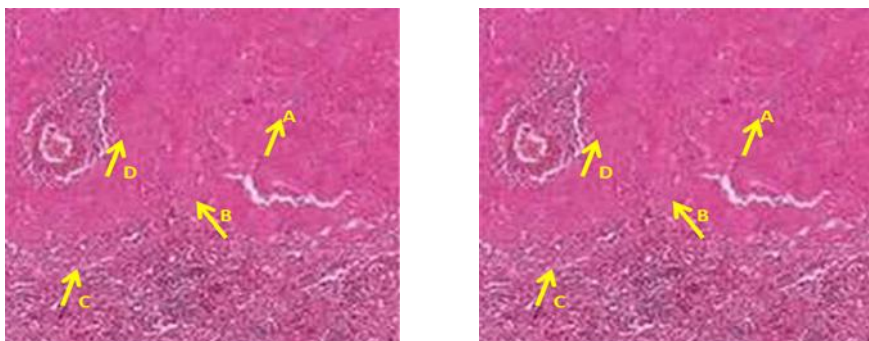
Fig 1A: Histopathology Studies of *Chana Punctatus* in Gill samples treated at 96 hrs (A&B); A1: Control: B1 Treated: In Control, A. Central Axis. B. Erythrocyte. C. Primary Gill Lamella. D. Secondary gill lamella: In Treated A. Epithelial Lifting. B. Curling of secondary gill filaments C. Degenerated secondary lamella.



Figure1B: Histopathology Studies of *Macrobrachium* in Gill samples treated at 96 hrs (A1 &B1); A1 - Control: B1- treated; In control: A. Pillar cells. B. Incites. C. Detached cuticle. D. Degeneration of epithelium in secondary gill lamelle. In treated: A. Necrosis.

B. Infiltrations of haemocytes. C. Disarrangement of secondary gill lamellae. D. Disruption of pillar cells.

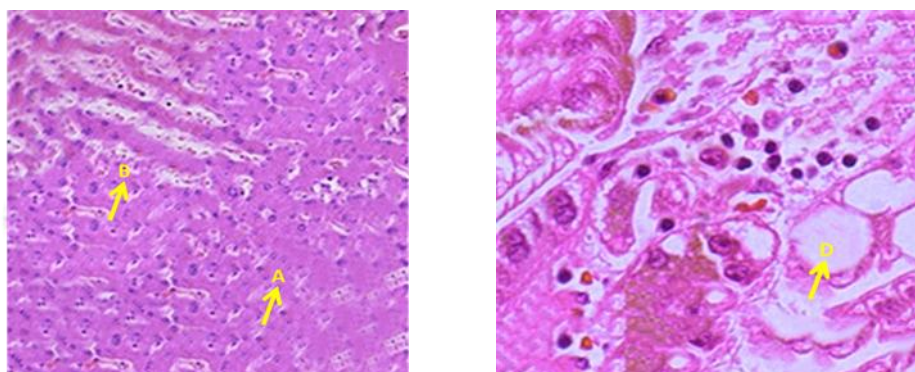
Liver



A1

B1

Figure 2 A: Histopathology Studies of *Channa Punctatus* in Liver samples treated at 96 hrs (A1 &B1). A1 Control: B1Treated. In Control, A.Hepatic cell. B. Nucleus. C. Lipid and glycogen granules: In Treated A. Degenerated hepato pancreatic tissue. B. Blood cells among hepatocytes C. Apperaence of blood streaks among hepatocytes. D. Formation of vacuoles.



A1

B1

Figure 2 B: Histopathology Studies of *Macrobrachium* in Liver samples treated at 96 hrs (A1 &B1); A1 -Control: B1- Treated: A. Hepatic cells. B. Hepatic pancreas. C. Haemorrhage. D. Vacuoles.

Brain

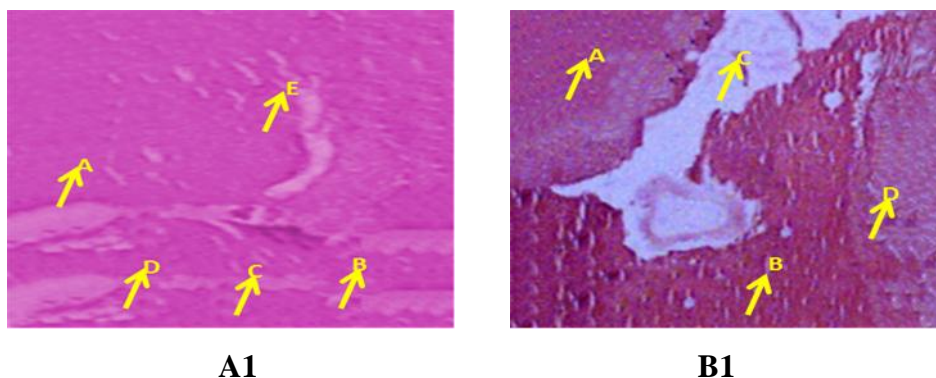


Figure 3 A: Histopathology Studies of *Channa Punctatus* in Brain samples treated at 96 hrs (A1 & B1); A1 Control: B1Treated: In Control, A Dorsal olfactory area. B. Ventral olfactory area. C. Septal area. D. Tractus olfactorius medialis. E Tractus olfactorius lateralis: In Treated A. Degenerated dorsal olfactory area B. Degenerated Ventral olfactory area C. Blood streaks. D. Degenerated septal area.

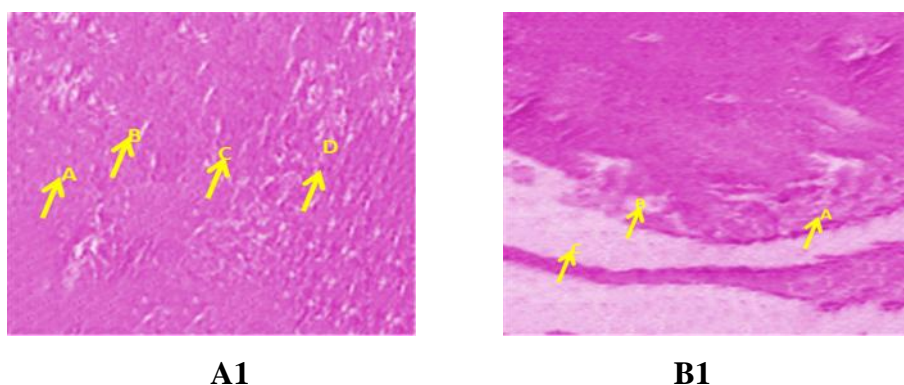


Figure 3 B: Histopathology Studies of *Macrobrachium.rosenbergii* in Brain samples treated at 96 hrs (A1 & B1); A1 Control: B1Treated: In Control, A Dorsal olfactory area. B. Ventral olfactory area. C. Septal area. D. Tractus olfactorius medialis. In Treated, A.Pyknotic nuclei. B. Pyknotic nuclei with dense eosinophilic cytoplasm. C. Vacuolated spaces and nodule formation.

DISCUSSION

The gills, which participate in many significant functions in fish, such as respiration, osmoregulation and excretion, remain in close contact with the external environment, and particularly sensitive to changes in the quality of the water, are considered the primary target of the contaminants.^[7,8,9] Alterations like epithelial lifting, hyperplasia and hypertrophy of the epithelial cells, besides partial fusion of some secondary lamellae are examples of defense mechanisms, since, in general, these result in the increase of the distance between the

external environment and the blood and thus serve as a barrier to the entrance of contaminants.^[10,7,11,12]

Liver, the first organ to encounter any foreign molecule through portal circulation is subjected to more damage.^[13] Liver is an important organ of detoxification which breaks down toxic substances and metabolites of administered substances. This breakdown is carried out by endoplasmic reticulum of hepatocytes. Due to these reasons the hepatic cells are damaged severely.^[13] reported that in fish *Tilapia mosambica* exposed to the toxicant resulted in vacuolation and necrosis in liver.^[14] reported that *Channa punctatus* under Malathion toxicity showed the degenerative changes in liver.^[15] reported that in teleost fish *Nemachilus denesoni* (Day) exposure to phosphamidon caused highly vacuolated and cloudy swelling and even the connective tissue was damaged in liver.^[16] reported significant alterations in the hepatic cell count and the nucleocytoplasmic index in the liver of zebra fish *Brachydanio rerio* (cyprinid) exposed to 0.9 mg/l concentration of Malathion.

Like gills and liver in sonata treated *Chana punctatus* fish, Pathological changes were observed in brain samples also. Changes include Degenerated dorsal olfactory area, degenerated Ventral olfactory area, blood streaks and degenerated septal area. Similar changes were observed by^[17] reporting swelling of the axon, atrophy, necrosis and pycnosis in the fish *Ctenopharyngodon idellus* under fenvalerate toxicity, and^[18] on *Cirrhinus mrigala* exposed to the sublethal and lethal concentrations of technical grade as well as 20% EC of Chlorpyrifos for 8 days and the severity of damage is more in lethal exposures than in sublethal exposures. Quinalphos technical grade caused more degenerative changes in brain than in 25% EC exposures (Plate VI.3, Fig. B, C, D and E).^[19] reported that hexachlorocyclohexane was neurotoxic and induced vacuolation of brain parenchyma and moderate swelling of pyramidal cells of the cerebrum and opined that vacuolation may have been due to glycolysis leading to microsomal and mitochondrial dysfunctions. Loss of Nissle substances and glial cell reaction, with evidence of glial nodule formation in places, were proof of the neurotoxic nature of the chemical.

In the present investigation, gill, liver and brain tissues shows changes in their structures were observed during acute and sublethal sonata exposure which may indicate the different rates of free radical generation and different antioxidant potentials of these tissues. The present study also demonstrated that sonata has a high oxidative-stress-inducing potential in *Chana*

punctatus and *Macrobrachium rosenbergii* and gill is the most sensitive organ in both acute as well as sub lethal concentration.

CONCLUSION

All the histopathological observation indicated that exposure to lethal concentrations of sonata caused destructive effect in the gill, liver and brain tissues of *C. Punctatus* and *M.rosenbergii*. Gil, liver and brain histopathological alterations, such as those observed in this study and findings from previous studies, could result in severe physiological problems, ultimately leading to the death of fish and prawn. As a conclusion, the findings of the present histological investigations demonstrated a direct correlation between pesticide exposure and histopathological disorders observed in several tissues.

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ANTIOXIDANT STUDIES ON SONATA (FUNGICIDE) INDUCED STRESS IN CHANA PUNCTATUS AND MACROBRACHIUM ROSENBERGII

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ABSTRACT

Acute toxicity tests (48hr, 72hr, 96 hr LC50 & Lethal concentration) of Sonata were conducted with two species (fish and prawn) viz. *Chana punctatus* and *Macrobrachium rosenbergii*. At the end of each trail, the animals were dissected and their organs viz. Liver, Gill and Brain were isolated for determination of antioxidant activity. Sonata was significantly more toxic in prawn than fish with 96hr LC 50 values of 12.094ppm and 15.399ppm respectively. Activity of SOD, Catalase, GSH and LPO increased with increasing sonata concentrations in the test mediums. The fish and prawn were kept in control

conditions (without sonata stress) showed maximum activity of catalase, SOD, GSH and LPO. Among fish and prawn organs Liver appeared as a target organ that accumulates significantly higher contents of sonata followed by that of gill and brain.

KEYWORDS: Acute toxicity tests *Chana punctatus* and *Macrobrachium rosenbergii*.

INTRODUCTION

Pesticides cover a wide range of compounds used in pest control; including insecticides, fungicides, herbicides, rodenticides and molluscicides.^[1,2] Pesticides and fungicides exert their toxic action on arthropods, mussels, fishes, frogs, turtles, water birds and other wild life too. Protection of wild life and water quality is possible when pesticide used selectively, and in combination with other pest control measures in a safe manner. The pollution of surface waters and contamination of aquatic life can be avoided. Excessive use leads to bioaccumulation in farm workers, fruits, vegetables, nuts and food crops, consumers, and it also causes biomagnification at various trophic levels of the food chain. Application of these compounds is most effective and accepted mean for protection of crops.^[3] They accumulate

in liver, kidney, salivary glands and fat. Fish are useful bioindicators and integrators of contaminants. Pesticides generally affect the biological active molecules like carbohydrates, proteins, lipids and enzymes. Depletion of oxygen content occurs in medium when pesticides, chemicals, sewage and other effluents contaminating organic matter are discharged into water bodies.

One of the important manifestations of toxic action of chemicals is overstimulation or depression of respiratory activity. Respiration also plays an important role in study in aquatic toxicology. Aquatic organisms like prawns, fish, bivalves, crabs respire through gills and it causes reduction in oxygen consumption and leads to physiological imbalance in the organism.^[4]

The extensive advantages of the utilization of pesticides are incompletely balanced by generous condition cost. An ecologically pervasive problem is widespread environmental contamination by pesticides, including the chemical compounds residues in aquatic life.^[5] The contamination of water sources by pesticides may affect non target aquatic organisms including fish.^[6,7,8]

Fish-toxin relationship has impressive significance in the investigation of fish populace and vitality designs in fish stocks of a particular area.^[9] The field of fishes and pesticide contamination plainly shows that impacts of individual pesticides on various physiological and biochemical parts of fishes have been broadly examined by an expansive number of specialists.^[10,11,12] Through the examinations involving the impact of individual pesticides on fishes have produced valuable information, the problem of pesticidal pollution becomes magnified when the runoff waters from cultivable land drain cause a wide spectrum of different pesticides accumulate into a particular fresh water body such as ponds, lakes or rivers.

Since the physiological changes that occur when organisms are exposed to sublethal levels of pressure could include rate of feeding as well as respiration and excretion, the net outcome could be a change in energy available for growth and reproduction. Since, pollutants uptake from water the most important route is gill the primary target and may be one of the first organs to exhibit symptoms of sublethal toxicity. Besides, there are biochemical parts like starches, for example, proteins and lipids that can likewise go about as vitality sources.^[13]

MATERIALS AND METHODS

Animal collection: The fish and prawn specimens samples of the two varieties namely *Channa punctatus* and *Macrobrachium rosenbergii* were collected from the freshwater lake located in waddepelly cheru, Warangal district. Specimens were brought to the laboratory immediately and analysed for various biological and nutritive value studies. Fish measuring 14-15cms in length and weighing 250-300gms and prawn measuring 14-18 cms in length and weighing 25-30gms specimens were brought to the laboratory immediately and analysed for various biological and nutritive value studies.

The fish were acclimatized to the laboratory conditions in large plastic tanks with unchlorinated ground water for two weeks at a room temperature of $28\pm 2^{\circ}\text{C}$. During the period of acclimatization, the fish were fed with groundnut oil cake and rice bran. Feeding was stopped one day prior to the experimentation. All the precautions laid by committee on toxicity tests to aquatic organisms,^[14] were followed.

Fungicide selected for the study: Procurement of technical grade SONATA fungicides technical grade 00.0% purity was supplied by Hyderabad chemical supplies limited Hyderabad.

Sonata acute toxicity assays: The lethal concentrations ensure death even before noticing the behavioural abnormalities.^[15] reported that sublethal exposures to longer periods may be dangerous to the organisms. Even when the animal is exposed to low concentrations continuously, many behavioural abnormalities and physiological alterations would be observed. In the present study 96 hr LC50 value was selected as sublethal concentration to study the behavioural alterations and physiological alterations (As per the recommendations of committee on toxicity studies.^[16,14]

Enzyme assays: The fish and prawn used in the acute (48-hr,72-hr,96-hr LC50) and lethal test trails were weighed and removed from the media. All the fish were dissected and organs viz. liver, brain and gills were removed. These organs were kept at -80°C for the further enzyme assays and biochemical analyses.

Preparation of extract: To remove RBCs the dissected organs of each fish and prawn were washed with phosphate buffer (pH 6.5), Organs were weighed and homogenate was prepared in phosphate buffer (0.2M, pH 6.5) with a ratio of 1: 4, respectively. These tissues

homogenates were then centrifuged at 10,000 rpm for 15 minutes at 4°C. The clear supernatant was preserved and used for further enzyme analysis.

1. Superoxide dismutase assay: The activity of superoxidedismutase was determined by measuring its ability to inhibit the O₂- dependent reaction or to inhibit the photo-reduction of nitro-blue tetrazolium (NBT) by superoxide.^[16]

2. Catalase assay: The crude enzyme was subjected to enzyme assay and the activities of catalase were measured by following the method of Beer and Sizer (1952).^[17] Catalase activity was concluded by measuring its ability to decrease the H₂O₂ concentration per minute at 240 nm.

3. Glutathione Reductase activity: The activity of Glutathione reductase was determined by measuring its ability to maintain adequate levels of reduced cellular GSH by Carlberg and Mannervik.^[17]

4. Lipid peroxidation activity: The activity of Lipid peroxidation was determined by measuring of MDA has been used as an indicator of lipid peroxidation by Utley *et al.*^[18]

Statistical analysis: The significance of sample mean between control and Sonata treated fish and prawn was tested using Student's "t" test.

RESULTS

The effect of sublethal concentration (15.399 ppm & 12.094 ppm) of sonata on metabolic enzyme activities in gill, liver and brain of *C. punctatus* and *Macrobrachium rosenbergii* is represented in Table 1 and 2. The antioxidant enzyme activities viz., SOD, CAT, GSH and LPO in fish *Chana punctatus* and in prawn *Macrobrachium rosenbergii* exposed to sublethal concentration of Sonata for 48hrs, 72hrs and 96hrs showed significant alterations when compared to control groups. A significant ($p < 0.05$) decrease in SOD activity was observed in gill, liver and brain of *Chana punctatus* and *Macrobrachium rosenbergii* throughout the study period when compared to the control group. The catalase activity in gill, liver and brain of sonata treated fish and prawn showed a significant ($p < 0.05$) decrease throughout the study period. The GSH activity in gill, liver and brain of sonata treated fish and prawn showed a significant ($p < 0.05$) decrease throughout the study period. The LPO activity in gill and brain showed a significant increase ($p < 0.05$) throughout the study period.

Table 1: SOD, Catalase, GSH, MDA activity in the Gill, liver and Brains of *C. punctatus* (n=5), exposed to the sublethal concentration of Sonata for 48,72,96hrs. The values given are mean \pm S.E.M. *= p<0.05.

	<i>Chana punctatus</i>									
	Incubation	Brain			Liver			Gill		
		Control	Experiment		Control	Experiment		Control	Experiment	
			10 PPM	20PPM		10 PPM	20PPM		10 PPM	20PPM
SOD (IU/Mg/protein)	48hrs	581 \pm 1.78	483 \pm 1.42	352 \pm 1.43	332 \pm 0.62	261 \pm 0.90	122 \pm 1.21	63 \pm 1.56	50 \pm 1.31	44 \pm 0.79
	72hrs	662 \pm 0.71	544 \pm 0.81	486 \pm 1.22	447 \pm 1.75	397 \pm 1.30	269 \pm 0.83	70 \pm 0.78	58 \pm 0.52	39 \pm 1.73
	96hrs	735 \pm 0.96	653 \pm 1.01	535 \pm 0.99	523 \pm 0.05	423 \pm 0.09	323 \pm 0.99	82 \pm 1.00	50 \pm 0.45	39 \pm 0.56
Catalase (μ mol/mg/protein)	48hrs	52 \pm 0.90	45 \pm 1.32	32 \pm 1.34	42 \pm 1.09	38 \pm 0.57	33 \pm 1.19	23 \pm 1.55	11 \pm 0.65	7 \pm 1.19
	72hrs	63 \pm 1.15	49 \pm 1.19	38 \pm 1.42	55 \pm 0.75	49 \pm 0.62	33 \pm 0.83	41 \pm 1.39	32 \pm 0.71	20 \pm 1.48
	96hrs	81 \pm 0.85	86 \pm 0.99	94 \pm 0.96	68 \pm 0.96	81 \pm 1.05	91 \pm 0.65	66 \pm 0.89	69 \pm 0.84	84 \pm 0.54
GSH (mU/mg/protein)	48hrs	702 \pm 0.95	582 \pm 1.39	422 \pm 1.10	441 \pm 1.23	389 \pm 0.79	312 \pm 1.14	115 \pm 1.29	87 \pm 0.87	62 \pm 1.45
	72hrs	783 \pm 0.82	676 \pm 1.42	579 \pm 1.23	512 \pm 1.35	443 \pm 0.90	333 \pm 1.36	154 \pm 1.48	139 \pm 1.21	129 \pm 1.69
	96hrs	815 \pm 0.58	915 \pm 1.56	996 \pm 0.98	598 \pm 0.98	625 \pm 1.91	721 \pm 0.58	172 \pm 0.68	175 \pm 0.95	197 \pm 0.87
MDA (nmol/mg/protein)	48hrs	6.68 \pm 0.94	7.36 \pm 1.16	8.29 \pm 1.22	4.66 \pm 0.84	5.88 \pm 1.61	5.99 \pm 0.88	0.54 \pm 0.89	0.83 \pm 1.10	1.7 \pm 0.78
	72hrs	8.03 \pm 0.99	9.25 \pm 1.05	12.1 \pm 1.28	6.11 \pm 1.09	7.63 \pm 1.52	8.72 \pm 0.92	1.39 \pm 0.92	1.91 \pm 1.33	2.9 \pm 1.13
	96hrs	12.58 \pm 0.58	13.49 \pm 0.96	18.7 \pm 1.45	11.78 \pm 1.58	9.58 \pm 1.68	11.05 \pm 1.02	1.76 \pm 0.68	2.54 \pm 0.84	5.1 \pm 0.85

Table 2: SOD, Catalase, GSH, MDA activity in the Gill, liver and Brains of *M.rosenbergii* (n=5), exposed to the sublethal concentration of Sonata for 48,72,96hrs. The values given are mean \pm S.E.M. *= p<0.05.

		<i>Macrobrachium rosenbergii</i>								
		Brain			Liver			Gill		
Incubation		Control	Experiment		Control	Experiment		Control	Experiment	
			10 PPM	20PPM		10 PPM	20PPM		10 PPM	20PPM
SOD (IU/Mg/protein)	48hrs	21.4 \pm 0.21	14.6 \pm 0.65	12.4 \pm 0.54	18 \pm 0.45	13 \pm 0.48	8 \pm 1.01	23.2 \pm 0.42	11.5 \pm 0.21	5.6 \pm 0.11
	72hrs	26 \pm 0.18	15 \pm 0.84	9.7 \pm 0.98	12 \pm 0.58	8 \pm 0.78	4 \pm 1.24	26.9 \pm 0.68	16.8 \pm 0.56	7.8 \pm 0.48
	96hrs	31 \pm 0.47	25 \pm 0.65	19.2 \pm 0.67	25 \pm 0.96	20 \pm 0.62	14 \pm 0.95	28.5 \pm 0.54	21.5 \pm 0.64	16.9 \pm 0.52
Catalase (μ mol/mg/protein)	48hrs	24.8 \pm 0.21	21.5 \pm 0.84	17.4 \pm 0.47	22.4 \pm 0.58	12.4 \pm 0.34	7.9 \pm 0.48	29.5 \pm 0.62	17.5 \pm 0.15	9.5 \pm 0.48
	72hrs	29.5 \pm 0.19	19.9 \pm 0.65	13.8 \pm 0.58	27.9 \pm 0.69	17.7 \pm 0.68	14.5 \pm 0.78	33.4 \pm 0.84	26.8 \pm 0.39	13.5 \pm 0.68
	96hrs	37.6 \pm 0.35	25.6 \pm 0.48	11.1 \pm 0.24	32.4 \pm 0.47	23.9 \pm 0.75	12.1 \pm 0.96	38.7 \pm 0.56	24.5 \pm 0.96	11.8 \pm 0.56
GSH (mU/mg/protein)	48hrs	1.65 \pm 0.15	1.47 \pm 0.58	1.34 \pm 0.47	1.54 \pm 0.64	1.37 \pm 0.58	1.24 \pm 0.47	3.25 \pm 0.13	2.68 \pm 0.68	1.85 \pm 0.74
	72hrs	1.99 \pm 0.28	1.89 \pm 0.91	1.57 \pm 0.82	1.97 \pm 0.38	1.89 \pm 0.91	1.57 \pm 0.82	6.89 \pm 0.35	2.65 \pm 0.89	4.47 \pm 0.89
	96hrs	2.32 \pm 0.48	1.92 \pm 0.99	1.38 \pm 0.96	2.35 \pm 0.79	1.92 \pm 0.99	1.28 \pm 0.96	9.9 \pm 0.59	9.6 \pm 0.97	7.5 \pm 0.95
MDA (nmol/mg/protein)	48hrs	0.89 \pm 0.18	1.14 \pm 0.28	1.28 \pm 0.24	0.46 \pm 0.34	0.89 \pm 0.87	1.01 \pm 0.98	0.86 \pm 0.21	1.02 \pm 0.35	1.24 \pm 0.85
	72hrs	1.25 \pm 0.34	1.59 \pm 0.67	1.86 \pm 0.54	0.98 \pm 0.56	1.48 \pm 0.95	1.68 \pm 1.05	1.12 \pm 0.56	1.35 \pm 0.47	1.58 \pm 0.99
	96hrs	2.65 \pm 0.84	2.84 \pm 0.59	2.99 \pm 0.68	1.23 \pm 0.24	1.96 \pm 0.65	2.05 \pm 1.24	1.24 \pm 0.69	1.48 \pm 0.69	1.96 \pm 1.02

DISCUSSION

The toxicity of many contaminants in aquatic organisms is mediated through oxidative damage when reactive oxygen species (ROS) are formed. Under normal conditions, ROS are removed from the cell by the action of antioxidant defence systems. If the production of ROS is in excess, the balance between the formation and removal of ROS will be destroyed and it will produce the oxidative stress.^[19] Lipid peroxidation (LPO) has been reported as a major contributor to the loss of the cell function under oxidative stress conditions and it is usually indicated by TBARS in fish.^[20] To minimise the potential toxic effects of ROS, fish have evolved an enzymatic antioxidant defence system composed of SOD, CAT, GPx, GR and other molecules to inhibit the formation of oxygen radicals.^[19] SOD is a primary oxygen radical scavenger of tissues converting the superoxide anion radical to H₂O and H₂O₂.^[21] CAT and GPx act cooperatively as scavengers of hydrogen peroxide (both enzymes) and other hydroperoxides (GPx).^[22] GR plays an important role in cellular antioxidant protection and adjustment processes of metabolic pathways.^[23]

In the present investigation tissue specific responses in the activities of antioxidant enzymes such as SOD, catalase, GSH and LPO were observed during acute and sublethal sonata exposure which may indicate the different rates of free radical generation and different antioxidant potentials of these tissues and also the varied concentration of Sonata in these tissues as reported by Monteiro^[24] The present study also demonstrated that sonata has a high oxidative-stress-inducing potential in *Chana punctatus* and *Macrobrachium rosenbergii* and gill is the most sensitive organ in both acute as well as sub lethal concentration.

CONCLUSION

The results of the present investigation indicate that acute and sublethal exposure of sonata induces significant changes in the enzymatic profiles in *C. Punctatus* and *Macrobrachium rosenbergii*. The presence of such level of sonata in the natural environment is dangerous to the ecosystem and will definitely affect the survival of fish. Gills, due to their large surface area and permeability, are the primary sites for absorption. The experimental data obtained with *C. Punctatus* and *Macrobrachium rosenbergii* can be considered as a useful reference for comparisons with biomarker responses of organisms living in polluted environments. These parameters can be used as biomarkers in assessing the pesticide toxicity in aquatic ecosystem.

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ACETYLCHOLINESTERASE GENE EXPRESSION STUDIES ON SONATA (FUNGICIDE) INDUCED STRESS IN *CHANNA PUNCTATUS* AND *MACROBRACHIUM ROSENBERGII*

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ABSTRACT

Acute toxicity tests (48hr, 72hr, 96hr LC50& Lethal concentration) of Sonata were conducted with two species (fish and prawn) viz. *Channa punctatus* and *Macrobrachium rosenbergii*. Acetylcholinesterase (AChE) is a key enzyme in the nervous system. It terminates nerve impulses by catalysing the hydrolysis of neurotransmitter acetylcholine. After serving as a neurotransmitter, acetylcholine is hydrolyzed by acetylcholinesterase (AChE). Inhibition of AChE is considered to be a specific biomarker for exposure to fungicides. In the present study, Acetylcholinesterase AChE genes were used in *Channa punctatus* and *Macrobrachium rosenbergii* brain were analyzed using real-time Polymerase chain reaction PCR to determine alterations in gene expression levels after Sonata fungicide treatment. The AChE gene was isolated from fish and prawn brain by RT-PCR methods using degenerate primers. RNA isolated from two samples of *Channa punctatus* and *Macrobrachium rosenbergii* and they were subjected to agarose gel electrophoresis.. cDNA (Complementary DNA) will be synthesized from RNA and complementary DNA will be subjected to RT-PCR. The amplified fragment of 800 nucleotides generated by PCR was cloned, and sequence analysis showed 80% nucleotide identity with AChE of the *Electrophorus electricus*. Specific primers of the fish and prawn AChE gene were then synthesized and used in the examination of AChE gene expression in brain tissue of fish and prawn exposed to sub lethal concentrations of sonata (36.05, 18.19 and 15.39ppm) and (18.40, 15.39 and 12.09ppm) for 48 hr, 72hr and 96 hr. RT-PCR was used to compare with the amplified GAPDH gene. Acetylcholinesterase gene expression got down regulated in *Channa punctatus* and up regulated in *Macrobrachium rosenbergii* after exposing of fungicides in comparison to the control group.

KEYWORDS: *Acetylcholinesterase, Fungicide, Sonata, Channa punctatus, Macrobrachium rosenbergii, Real-time PCR.*



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INTRODUCTION

Agriculture is the primary source of food for millions of people living in this world. More importantly, it is a major supplier of raw material and manpower for manufacturing and services sectors. Sustainable agronomic development is at the heart of implementing the economic development policies. In India, policy makers continue to consider agricultural development as the most important objective of planning and policy. Pesticides play an important role in keeping the plant healthy. They protect the plant from many outrageous diseases. However, both animals and human beings exposed to pesticides suffer from health problems. Currently, in the Asian continent, India is the largest producer of pesticides. With respect to using pesticides, it ranks twelfth in the world. Compared to many other countries, India's average consumption of pesticides is low. However, the problem of pesticide residue is high.¹ With increase of pest attacks, the use of chemical pesticides is also increased. When pesticides are used, the crop loss amounts to 20-30% of total crop. When the pesticides are not used, the loss amounts to 50-80% of the total crop. Pesticides have become popular because they are convenient to use, inexpensive and provide quick control of pests. The use of pesticides has increased significantly since 1950. Every year, about 2.5 million tons of industrial pesticides are produced and used across the world (USEPA, 2005). The pollution of water sources by pesticides can affect even the non-target aquatic organisms like the fish.²⁻³ In the investigation of fish populace and vitality designs in fish stocks of a particular area, the fish-toxin relationship plays an important role.⁴ A review of writing in the field of fishes and pesticide contamination plainly shows that impacts of individual pesticides on various physiological and biochemical parts of fishes have been broadly examined by an expansive number of specialists.⁵⁻⁷ When the literature in the field of fishes and pesticide contamination is examined, it is revealed that impacts of individual pesticides on various physiological and biochemical parts of fishes are thoroughly analyzed by a number of specialists. Because the physiological changes that happen when organisms are subjected to sublethal levels of pressure could comprise of rate of feeding, and respiration and excretion, which ultimately effects the final outcome could be a difference in energy available for growth and reproduction. Acetyl cholinesterase is an enzyme that through its hydrolytic activity degrades the neurotransmitter acetylcholine into its components choline and acetate. This enzyme is found in the neuromuscular junctions and cholinergic nervous system. It is mainly involved in the termination of synaptic transmission and has a high catalytic activity. In the present study, AchE gene expression was carried out on *Channa punctatus* and *Macrobrachium rosenbergii*.

MATERIALS AND METHODS

Animal collection

The fish and prawn samples of the two varieties namely *Channa punctatus* and *Macrobrachium rosenbergii* were

collected from the freshwater lake located in Waddepally, Warangal district. Fish measuring 14-15 cms in length and weighing 250-300 gms and prawn measuring 14-18 cms in length and weighing 25-30 gms specimens were brought to the laboratory immediately and analysed for various biological and nutritive value studies. The specimens of fish were acclimatized to the laboratory conditions in large plastic tanks with unchlorinated ground water for two weeks at a room temperature of 28±2°C. During the period of acclimatization, the fish were fed with groundnut oil cake and rice bran. Feeding was stopped one day prior to the experimentation. All the precautions laid by committee on toxicity tests to aquatic organisms⁸ were followed.

Fungicide selected for the study

Procurement of technical grade SONATA fungicides was supplied by Hyderabad chemical supplies limited, Hyderabad.

Experimental design

The fish and prawn used in the acute (48-hr, 72-hr, 96-hr LC50) and lethal test trails were weighed and removed from the media. Tissue processing after the desired time period, control and treated animals were sacrificed by cervical dislocation. All the fish and prawn were dissected and organs viz. liver, brain and gills were removed. Physiological saline solution (0.75% NaCl) was used to rinse and clean the tissue. These organs were kept at -80°C for the further enzyme assays and biochemical analyses and histopathological observations. In this study, Brain tissue is taken for gene expression studies.

Total RNA isolation

The total RNA was isolated by using Trizol method according to Chomczynski and Mackey K. (1995). RNA will be isolated from brain of *Channa punctatus* and *Macrobrachium rosenbergii* and were subjected to agarose gel electrophoresis. The pictures were taken using a gel doc (Bio-Rad).

Reverse transcription-polymerase chain reaction (RT-PCR)

Complementary DNA(c DNA) was synthesized from RNA by using one step takara kit method. Primers of AchE gene were designed in conserved region of fishes and other organisms from GENBANK using CODEHOP program. Primer

For the PCR reaction, 2 µl of cDNA from each synthesis was added to 10 µl of 'Syber PCR master mix' containing 5X PCR buffer, 10 mM dNTP, 25 mM MgCl₂ and 5 U of Taq DNA polymerase (Fermentas, USA). Twenty µM of each pair of the primers was added, and the final volume was adjusted to 14 µl with nuclease free water. The mixtures were denatured at 94°C for 3 min. Thirty five cycles of PCR were carried out with denaturation at 94 °C for 45 sec, annealing at 57°C for 30 sec, and extension at 72°C for 1 min, followed by a final extension period of 5 min. PCR products were analyzed by electrophoresis on 1% agarose gels stained with GelStar Nucleic Acid Gel Stain (Cambrex Bio Science Rockland, Inc.).

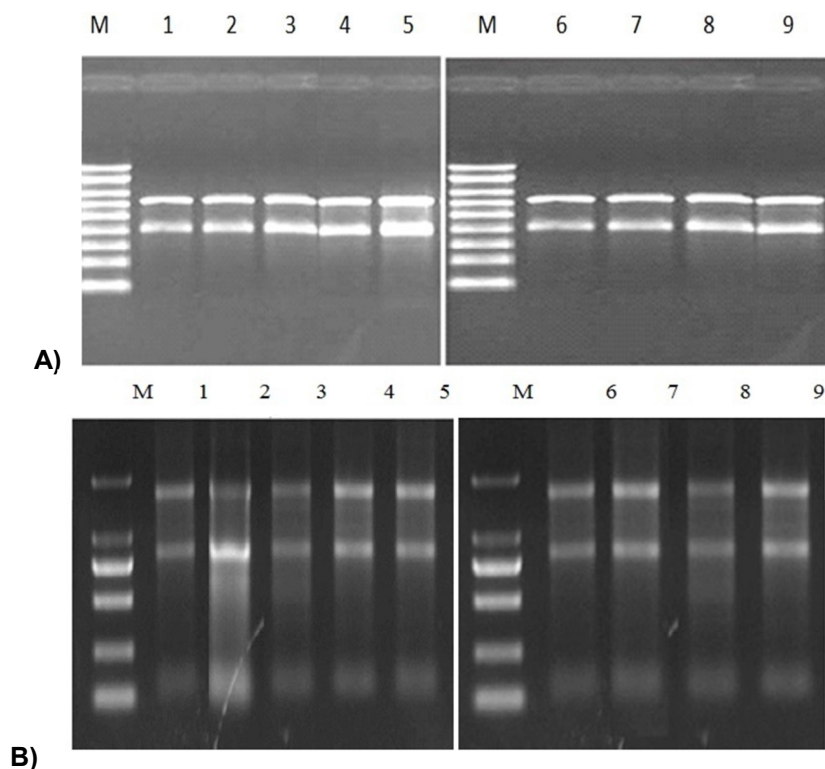


Figure 1

A) Agarose gel images of RNA isolation of brain Samples of *Channa punctatus*: M-Marker, 1-Control 48 hours, 2- dose I 48 hours, 3- dose II 48 hours, 4- Control 72 hours, 5- dose I 72 hours, 6- dose II 72 hours, 7- Control 96 hours, 8- dose I 96 hours, 9- dose II 96 hours.

B) *Macrobrachium rosenbergii*-M-Marker, 1-Control 48 hours, 2- dose I 48 hours, 3- dose II 48 hours, 4- Control 72 hours, 5- dose I 72 hours, 6- dose II 72 hours, 7- Control 96 hours, 8- dose I 96 hours, 9- dose II 96 hours.

RESULTS AND DISCUSSION

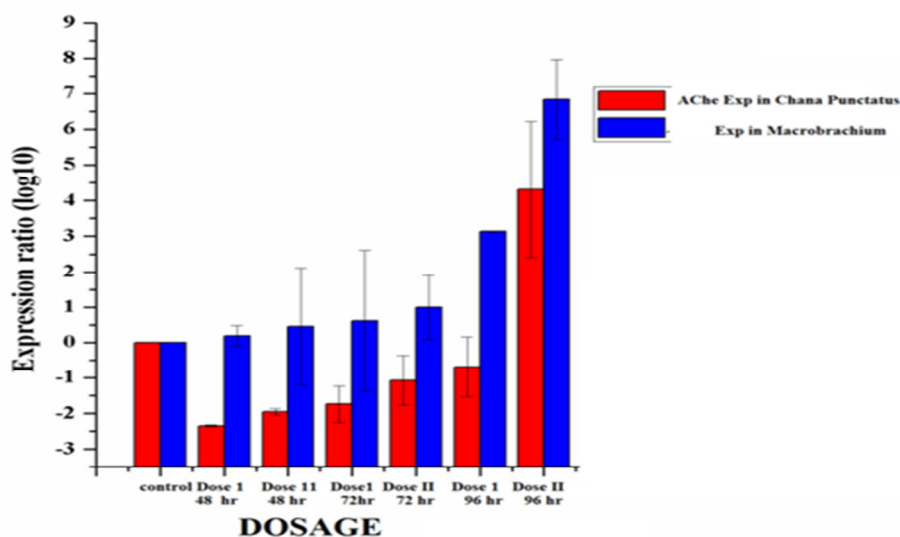


Figure 2

Comparative Graph of AchE gene Expression in *Channa punctatus* and *Macrobrachium rosenbergii* after treatment from 48 hr to 96 hr.

Comparative Graph reveals AchE gene expression in *Channa punctatus* and *Macrobrachium rosenbergii* after treatment from 48 hr to 96 hr. In 48 hr treatment expression fold of *Channa punctatus* is down regulated as compared to control but *Macrobrachium rosenbergii* has little high expression fold which represent gene up regulated as compared to control in Dose I and Dose II.

In 72 hr treatment, expression fold of *Channa punctatus* again down regulated as compared to control whereas *Macrobrachium rosenbergii* is up regulated in both set of dosage i.e., Dose I and Dose II. In 96 hr treatment, Dose I again shows down regulation for *Channa punctatus* and *Macrobrachium rosenbergii* again is found undergoing up regulation. In Dose II *Channa*

punctatus shows little up regulation with treatment whereas *Macrobrachium rosenbergii* shows very high expression which suggest good up regulation of gene with treatment. In this study, expression fold for *Macrobrachium rosenbergii* is up regulated with increase in time for both set of dosage but *Channa punctatus* up regulates in 96 hr treatment in dose II. as shown in figure 2. Acetylcholinesterase is an enzyme whose hydrolytic activity degrades the neurotransmitter acetylcholine into its components choline and acetate. This enzyme is found in the neuromuscular junctions and cholinergic nervous system. It is mainly involved in the termination of synaptic transmission and has a high catalytic activity. It hydrolyses 25000 acetylcholine molecules per second.⁹ The activity of this enzyme has been shown to reduce upon methylmercury exposure in Medekafish.¹⁰ In the present study Acetyl Cholinesterase AChE genes were used in *Channa punctatus* and *Macrobrachium rosenbergii* brain by using real-time PCR to determine alterations in gene expression levels after Sonata fungicide treatment. The outcome of RT-PCR analysis revealed that Acetyl Cholinesterase gene expression got down regulated in *Channa punctatus* and up regulated in *Macrobrachium rosenbergii* after getting exposed to fungicides induction. Acetyl Cholinesterase genes AChE gene expression is an important part of the cholinergic neuronal systems for the protection of CNS-central nervous system homeostasis.¹¹ Up-regulation may be ascribed to the feedback response of transcription to depressed cholinergic neurotransmission, leading to elevated levels of brain acetylcholine following sonata exposure. An autologous feedback response could regulate transcriptional elevation from the AChE gene through insecticide complexes acting on signalling intracellular pathways.¹² They are found in the brain of the mouse that diisopropyl fluorophosphate (DEF) (an OP insecticide) and pyridostigmine (a CB insecticide) increased levels of AChE mRNA over controls within 30 minutes; using sagittal hippocampal brain slices of mice. Even moderate changes in neuronal excitability may direct to overt modulations in brain gene expression.¹² Therefore, the up-regulation and down regulation of these two genes in

Channa punctatus and *Macrobrachium rosenbergii* are responsible for changing fatty acid biosynthesis after Sonata fungicide treatment. This alteration was first reported in relation to Sonata fungicide treatment toxicity in fishes and prawns. The levels of acetylcholine are continuously regulated by the hydrolytic enzyme acetylcholinesterase (AChE), which rapidly degrades acetylcholine in the periphery and the brain. AChE is expressed in cholinergic neurons and neuromuscular junctions as well as tissues that are not innervated by cholinergic neurons.¹³⁻¹⁴ In order to verify whether or not the AChE gene could be modulated when fish and prawn were exposed to the fungicides, the gene expression of AChE was investigated. The results showed that Sonata can alter the gene expression of AChE in fish and prawn of brain.

CONCLUSION

The early biological changes caused by xenobiotics may not be manifested as the pathological findings, but rather as inductions in the expression of the genes. In the case of the AChE gene, we observed such inductions in the fish and prawn following the exposure to sonata, indicating a potential biomarker for the early detection of fungicide contamination. Results from this study indicated that gene expression technique is quite sensitive, rapid and reliable than AChE enzyme activities and should be applied as a screening tool for detection of the fungicides contamination in fish and prawn.

AUTHORS CONTRIBUTION STATEMENT

S. Swetha carried out the experiment and wrote the manuscript with the support of Dr. E.Narayana who also supervised the experiment.

CONFLICT OF INTEREST

Conflict of interest declared none.

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DECLINING FEMALE LABOR FORCE PARTICIPATION IN THE EMERGING YOUNGEST NATION – A STUDY OF RURAL WOMEN IN THE STATE OF TELANGANA

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ABSTRACT

India, by 2020 is set to become the world's youngest nation with its population's average age at 29 years. The demographic dividend that our country gains cannot deliver positive results unless and until the human resources are harnessed effectively and efficiently. The present study endeavors to explore the reasons for declining female labor force participation in the rural areas of Telangana state. Random sampling technique was used to collect data from 200 respondents. The survey reveals the fact that education by itself do not facilitate women empowerment in rural areas. There is a dire necessity to focus on providing alternative employment sources to agriculture to the qualified women.

Keywords: *Harnessed, human resources, empowerment, facilitate, employment.*

INTRODUCTION

India is the biggest democracy in the world with a population of 1.2 billion. India is set to experience a dynamic transformation as the population burden of the past turns into a demographic dividend. In three years, India will become the world's youngest country. By the year 2020, India's average age will come to rest at 29 years. The findings of the 'State of the Urban Youth, India 2012: Employment, Livelihoods, Skills,' a report published by IRIS Knowledge Foundation in collaboration with UN-HABITAT trace that the population in the age-group of 15-34 increased from 353 million in 2001 to 430 million in 2011. Current predictions suggest a steady increase in the youth population to 464 million by 2021 and finally a decline to 458 million by 2026. By 2020, India is set to become the world's youngest country with 64 per cent of its population in the working age group. With the West, Japan and even China aging, this demographic potential offers India and its growing economy an unprecedented edge that economists believe could add a significant 2 per cent to the Gross Domestic Product (GDP) growth rate¹.

The demographic dividend that our country gains cannot produce positive results unless and until the human resources are harnessed effectively and efficiently. As stated by Aristotle "good citizens make a good state" it is a dire necessity to chisel the emerging young citizens and equip them with proper education, knowledge and skills to arrive at a good state. Demographic

dividend if goes hand in hand with poverty, illiteracy, gender bias, social and economic inequality, terrorism and social unrest will ultimately lead to peril.

ORIGIN OF RESEARCH PROBLEM

A survey conducted by Young Lives India - the Indian Chapter of Young Lives, a study of childhood poverty in 2016, funded by the University of Oxford, UK – in undivided Andhra Pradesh since 2002 revealed that ‘half of the women stay home or were married by age 22 and do not prefer to work’².

The logical link that education should lead to jobs is broken in India. In rural India, 67% of girls who are graduates do not work. In towns and cities, 68.3% of women who graduate don’t have paid jobs, says a 2015 report by the United Nations Development Programme (UNDP), Women’s Voices, Employment and Entrepreneurship in India³.

These data lend weight to other studies that show Indian women are at a significant and possibly widening disadvantage. Gap between men and women has widened on political empowerment, healthy life expectancy and basic literacy, resulting in India slipping 21 places to 108 in 2017 from 87 in 2016 on the Global Gender Gap Index of the World Economic Forum, FactChecker reported on November 3, 2017⁴.

The present study is to identify the reasons for the women confining themselves to homes though they are adequately qualified to take up employment. This study also identified the measures to be taken to bring women into the active workforce thereby providing them economic justice and economic development for the nation.

CONSTITUTIONAL PROVISIONS

The Indian constitution has provided many provisions to facilitate women’s right to economic justice and proper working conditions for women. The Directive Principles enshrined in Part IV of the constitution is an instrument of instructions to both union and state governments in ushering a classless and socialistic society.

- a) **Article 23(a)** - the state to secure for men and women equally the right to an adequate means of livelihood.
- b) **Article 39(b)** - the state to secure equal pay for equal work for both Indian men and women.
- c) **Article 39(e)** - the state is required to ensure that the health and strength of women workers are not abused and that they are not forced by economic necessity to enter avocations unsuited to their strength.
- d) **Article 42** – the state shall make provision for securing just and humane condition of work and maternity relief.

INTER-DISCIPLINARY RELEVANCE

The present study carries interdisciplinary relevance at large. To one degree or another, solutions to social, political, intellectual, and economic problems do not lie in a single focus. The

present study provides a background for approaching issues holistically through an understanding of the complexity and interconnectedness of gender bias as a stigma in economic development. This study draws the fiber from Political Science, Economics and Sociology to weave a fabric to derive the reasons for gender inequality and the reasons for the educated women not joining into the workforce.

SIGNIFICANCE OF THE STUDY

Women empowerment, gender equality and contribution of women to the economic development of the country carry a lot of significance when India is about to become the youngest nation in the world. The demographic advantage that the country is going to get shall be full-fledged only when there is inclusive development catering to the needs of all the sections of population.

But, unfortunately even after seven decades of independence, the governments and civil society were complacent towards women empowerment. Social and cultural norms too, at large stood as barriers for women to explore new opportunities. The recent statistics throw light on the fact that nearly 50 per cent of women in both Telangana and Andhra Pradesh states are confining to homes after the age of 22 in spite being educated. India has one of the lowest female participation rates in the world, ranking 120th among the 131 countries for which data are available. Even among countries with similar income levels, India is at the bottom, together with Yemen, Pakistan and Egypt. Worse still, the rate has been declining since 2005.

This is a matter of concern as women's paid employment is known to increase their ability to influence decision-making within the household, and empower them more broadly in society as a whole.

In this context this study tries to elucidate the reasons for low female labor participation in the state of Telangana and thereby attempts to derive at measures to address this lacuna.

LIMITATIONS OF THE STUDY

The present study is confined to understanding the reasons for low women labor participation in rural areas of Telangana state. This leaves a larger gaps like urban scenario, political participation of women, and cultural factors to be studied in future research.

REVIEW OF LITERATURE

It is imperative to have a thorough review of the previous studies on this topic to understand what the other research scholars have already explored through their research studies, books and articles. Prominent among them are:

1. Policy Research Working Paper titled "Precarious Drop - Reassessing Patterns of Female Labor Force Participation in India" written by Luis A. Andres, Basab Dasgupta, George Joseph, Vinoj Abraham and Maria Correia, Published by World Bank Group - South Asia Region Social Development Unit, April 2017. This research paper provides

- a description of nearly two decades of patterns and trends in female labor force participation in India from 1993–94 to 2011–12.
2. Research Paper on "Empowerment of Women Representatives in Panchayati Raj Institution in Gulbarga District in Karnataka" authored by Dr.K.N.Doddamani and published by Quest Journals Journal of Research in Agriculture and Animal Science Volume 2 ~ Issue 3 (2014) pp:09-14. This paper tries to explore women empowerment by providing political rights at grass root level.
 3. 'Half a Billion Rising: The Emergence of the Indian Women' book written by Anirudha Dutta and published by Rupa Publications Private Limited. This book analyzes the change drivers and the repercussions of present-day gender revolution. It also surveys how society at large and men in particular are reacting to the rise of women power.

OBJECTIVES

1. To estimate the extent of the recent decline in female labor force participation in the target area.
2. To assess the reasons for women not joining into work force.
3. To examines and assesses the contribution of various demographic and socioeconomic factors in explaining the female labor force participation decision and the recent drop.
4. To analyze weather education is the sole factor enough to help women to attain economic liberty by gaining employment.
5. To identify solutions to bring more women to embark on the journey for achieving economic liberty by attaining employment opportunities.

RESEARCH METHODOLOGY

In the completion of the study empirical and descriptive methods are adopted, specifically the methodology adopted is **Exploratory**, to inquire the extent of women participation as labor force in target area; **Descriptive**, to making careful observations and detailed documentation of reasons for women confining to homes and; **Explanatory**, in the sense, to analyze the observed phenomenon.

The conclusions derived in this study are based on primary data through questionnaires and secondary data through books, journals, magazines, news papers and internet. The selection of respondents was through random sampling. This survey aimed at eliciting information on the respondent's marital status, educational qualifications, skills acquired and their participation into labor force. The research design adopted for the study is the preparation of questionnaires to collect the opinion of 200 respondents from different sections of women in rural areas of Telangana, with special focus on women belonging to Scheduled Tribes. Survey was conducted in villages like Janakinagar, Sithal thanda Gudibanda, Chilukuru, Narayanapuram, Dondapadu, Balajinagar, Ramalaxmipuram of Suryapet district of Telangana state.

FINDINGS & DISCUSSIONS

Jawaharlal Nehru once remarked, “**I have long been convinced that a nation’s progress is intimately connected with the status of its women**”. In the wake of waves of economic liberalization, the condition of India – when thought of in terms of economic and human development- has improved dramatically.

Yet, while the status of women has arguably improved in both the public and private spheres, their ability to access opportunities in this newly liberalized economy remains precarious.

India’s Female Labor Force Participation (FLFP) rate has remained visibly low; the ILO (2013) ranks India’s FLFP rate as 121 out of 131 countries, one of the lowest in the world. In 2013, India had the lowest FLFP rate in South Asia, with the exception of Pakistan. Globally, only parts of the Arab world held a lower FLFP rates than India in the same year⁵.

Moreover, the FLFP rate dropped from 49.0 percent to 37.8 percent in rural areas between 2004-05 and 2009-10 (NSSO, 2011), despite an impressive annual GDP growth rate of around 8.6 percent, and an annual population growth rate of 1.74 percent. The same pattern continued into the most recent round of the National Sample Survey (NSSO) in 2011-12. Among the Asian economies, only China experienced a marginally higher drop in FLFP rate from 1990 to 2013. However, in comparison to India, China’s FLFP rate remained considerably higher at 64 percent. Pakistan, which had lower FLFP than India in 2013, experienced a sharp rise in women’s participation in the labor force during 1990-2013. Further, for the first time in recent history, estimates suggest that between 2004-05 and 2009-10, not only was there a decline in India’s FLFP rate, but also a shrinking of the total female labor force.

If the number of women who quit jobs in India between 2004-05 and 2011-12 (the last year for which census data is available), was a city, it would, at 19.6 million, be the third-most populated in the world, after Shanghai and Beijing.

Only 27% Indian women are currently in the labor force. Among G-20 countries, only Saudi Arabia is worse, IndiaSpend reported on April 9, 2016. Within South Asia in 2013, India had the lowest rate of female employment after Pakistan. In over two decades preceding 2013, female labor force participation in India fell from 34.8% to 27%, according to an April 2017 World Bank report⁶.

India’s female labor force participation rate, at 24%, was below the world average of 39% in 2016, according to World Bank data. India was ranked 172 among 185 nations for which data were available.

Not only were fewer women training themselves for the labor market, far more women were married by age 22 in 2016 than men, according to research by Young Lives India – the India chapter of Young Lives, a study of childhood poverty funded by the University of Oxford, UK – in undivided Andhra Pradesh since 2002.

These data lend weight to other studies that show Indian women are at a significant and possibly widening disadvantage. Gap between men and women has widened on political empowerment, healthy life expectancy and basic literacy, resulting in India slipping 21 places to

108 in 2017 from 87 in 2016 on the Global Gender Gap Index of the World Economic Forum, FactChecker reported on November 3, 2017.

“India remains the fastest growing economy in the world and it will get a big boost from its approach to GST which will - reduce the cost of doing business for firms, reduce logistics costs of moving goods across states, while ensuring no loss in equity,” said Junaid Ahmad, World Bank Country Director in India. “Low female labor force participation, however, remains a serious concern. Higher level of women participation in the economy can help propel India closer to double digit growth”⁷.

This paper attempts to conduct an empirical examination to better understand the socioeconomic milieu and demographic dynamics of this downslide in FLFP during the current decade. This study, through the data collected, endeavors to track insights into finding the reasons for the decline in FLFP and to explore the drivers to steer the women population into the productive activity there by ushering a gender equitable and socialist society.

1. Table 1 reflect that out of 200 respondents of the target area 76% belong to ST, 20% belong to SC and 04% belong to BC.

Community wise categorisation of respondents

Sl. No	Caste	Respondents
1	SC	40
2	ST	152
3	BC	8
4	OC	0

2. Table 2 highlights the educational qualifications of the respondents. Out of the respondents 15% are Post Graduates, 32% are Graduates, 33% completed Intermediate, 17% SSC and 3% are illiterates.

Educational Qualifications of Respondents

Sl. No	Qualification	Respondents
1	Illiterates	6
2	SSC	34
3	Intermediate	66
4	Graduation	64
5	Post Graduation	30

3. Table 3 details about the Employment Oriented Courses done by the respondents. This data reflects that 9% undertook Nursing training, 16% done TTC/B.Ed and 1% underwent Lab Technician training. This survey reveals that nearly 74% of the respondents are not seriously inclined to pursue any certified employment oriented course

for practical employment. Though majority of the respondents have regular academic qualifications, they are least equipped with employability skills.

Sl. No	Course	Respondents
1	Nursing	18
2	TTC/B. Ed	32
3	Lab Technician	2
4	Mushroom Culture	0
5	Librarian	0

4. Table 4 highlights about the Skill Enhancement Training undertaken by the respondents. This data reflects that 32% undertook Basic Computer Course, 29% tailoring, 10% Beautician, and 29% failed to undertake any kind of skill enhancement training.

Sl. No	Course	Respondents
1	Basic Computers	64
2	Tailoring	58
3	Beautician	20
4	Mobile Repair	0
5	Untrained	58

5. Table 5 explores the present daily grind of the respondents. The survey shows that 58% are either housewives or confined to homes, 16% are pursuing agriculture, 15% are engaged in private jobs, 1% are in Government Service, 2% are running business and 8% are continuing their caste-based occupation.

Sl. No	Present Occupation	Respondents
1	House Wife	116
2	Agriculture	32
3	Private Job	30
4	Government Job	2
5	Business	4
6	Traditional Occupation	8

6. Table 6 examines the participation of women in Self-help groups. The study projects that 19% are members of DWACRA group, 4% are members of Sthrinidhi and 78% are inactive in any of the self-help groups.

Membership in Self-help groups

Sl. No	SHG	Respondents
1	DWACRA	38
2	STHRINIDHI	8
3	OTHERS	0

OBSERVATIONS

1. The logical link that education should lead to jobs do not hold ground among women in India in rural areas. India's first chief statistician and country Head for the International Growth Centre's India Central Programme Mr. Pronab Sen observed that, "More girls are being educated than boys, but do not know where they are going,"⁸.

The survey sheds light on the fact that, though 97% of the respondents are educated (15% are Post Graduates, 32% are Graduates, 33% completed Intermediate, 17% passed SSC) only 18% of the women joined into work force.

2. Out of 97% of educated women, 58% are confining to homes without pursuing any active employment. Either they are married or are disinterested in pursuing any employment.
3. The survey reveals that the rural society is in favor of educating the girls, but stands far behind in giving equal opportunity with men to pursue employment and attain economic independence. The data extol that 71% of the women have undertaken Skill Enhancement Training (32% Basic Computer Course, 29% Tailoring, 10% Beautician). But, of these girls, only 18% have taken up employment which needs to be addressed.
4. 24% of the educated women are under employed and still pursuing traditional occupations like agriculture and caste based occupations (16% agriculture & 8% caste based occupations).
5. Fewer jobs in agriculture have not been replaced by alternative jobs considered suitable for women.
6. 78% of the women are not active participants of any self – help groups which are initiated to give a credit base to women at rural areas.
7. Cultural and societal prejudices still play a pivot role in deciding the status of women in the society. Social norms about appropriate behavior for women and the enforcement of these norms by parents, in-laws and husbands dictates their ability to seek employment. The 2011 Indian Human Development Survey finds that a sizeable number of women need to take permission from a family member to even go to the market or health centre, said Rohini Pande of Harvard Kennedy School⁹.

SUGGESTIONS

1. Women in rural areas, because of their social and cultural milieu, family obligations and for security reasons are unable to travel to cities for pursuing employment. Ergo, it is dire necessity to provide more employment opportunities for women in the rural areas.

2. Obvious solution to bring more women into workforce is skilling. It is important to skill young women to meet what industry demands. Department of Women Development & Child Welfare, Government of Telangana has in the recent past has launched number of projects for women like – Arogya Lakshmi, Balamrutham, Early Childhood Care and Education, Supplementary Nutrition Programme, Care and Nutrition Counselling Service and Child Protection¹⁰. Though the above projects are playing an instrumental role in taking care of health and hygiene of women, there is an immediate need to formulate policies that provide employment opportunities to women in the rural areas.
3. Telangana is one of the few states where a separate Department is functioning for development and welfare of women and children. Simultaneously the programmes like Deen Dayal Upadhyaya Grameen Kaushalya Yojana, TG SERP (Society for Elimination of Rural Poverty) ect, need to be enhanced to cover majority of women population in the state.
4. Rajiv Gandhi Scheme For Empowerment of Adolescent Girls (**RGSEAG**) **Sabla** is a centrally sponsored programme initiated in 2011. As a pilot project this programme is launched in 03 districts of Telangana i.e, Adilabadh, Mahaboobnagar and Hyderabad¹¹. Analyzing the pros and cons of this programme, there is a need to initiative such kind of programmes in all the districts of the state.
5. Woman-friendly workplaces need to be brought about. There's a dire necessity of infrastructure that would enable women's participation in the workplace.
6. Education on gender sensitization is of primary necessity. The societal norms that limit women to four walls need to be shattered.
7. Hostels for working women and crèches for their children.
8. The role of companies in nurturing gender diversity by providing equal number of jobs to women, and also to pay equal pay for equal work.
9. To bring a change in the attitude of women. They themselves seem inclined to choose trades that are traditionally considered women oriented: beauty and healthcare for instance. "Social norms and a lack of information often limit women's opportunities to so-called traditional jobs, closely linked to typical ideas of what women can and cannot do.

CONCLUSION

The present survey display a startling fact that nearly 58% of the women in the target area of study are confined to domestic boundaries, though 97% of them are educated and are qualified to take up positive employment. Many reasons like lack of alternative to agriculture to provide employment opportunities to women in rural areas, patriarchic social base, cultural prejudices, family burden, poor transport facilities to work place etc are playing an important role in confining the women to their homes. This gender bias needs to be addressed to bring about social and economic justice. If women participated in the economy on a par with men, India could increase GDP by up to 60%, or \$2.9 trillion, by 2025, according to a 2015 study by the McKinsey

Global Institute, a think tank. At present, women contribute a mere 17% to the country's GDP, well below the global average of 37%.

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GRAPHS

Table 1: Community wise categorisation of respondents.

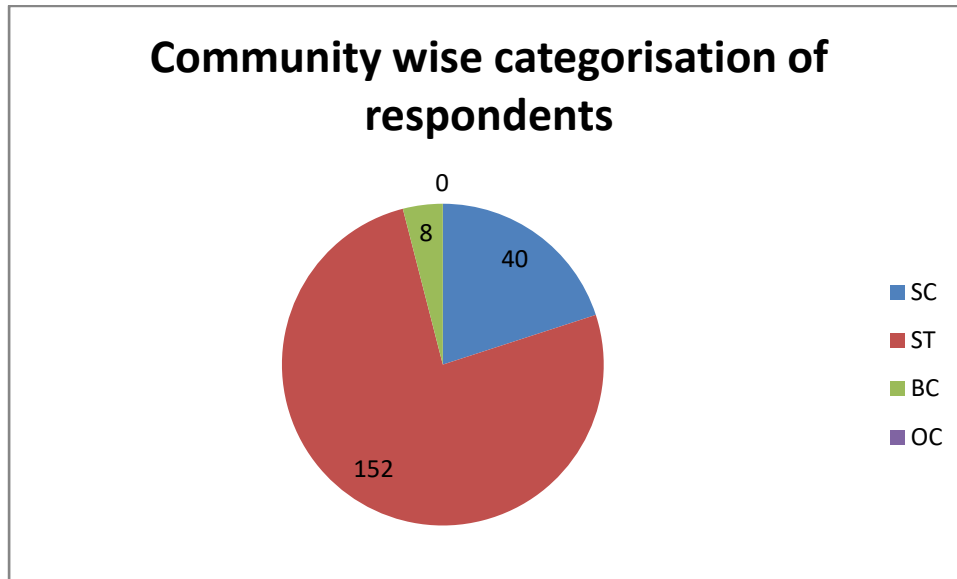


Table 2: Educational Qualifications of respondents.

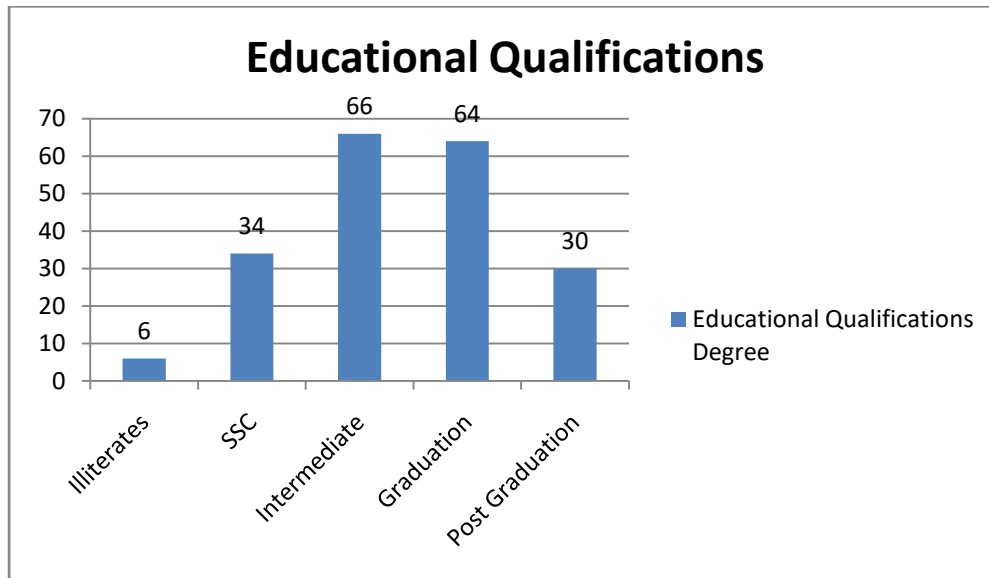


Table 3: Employment Oriented Courses undertaken by respondents,

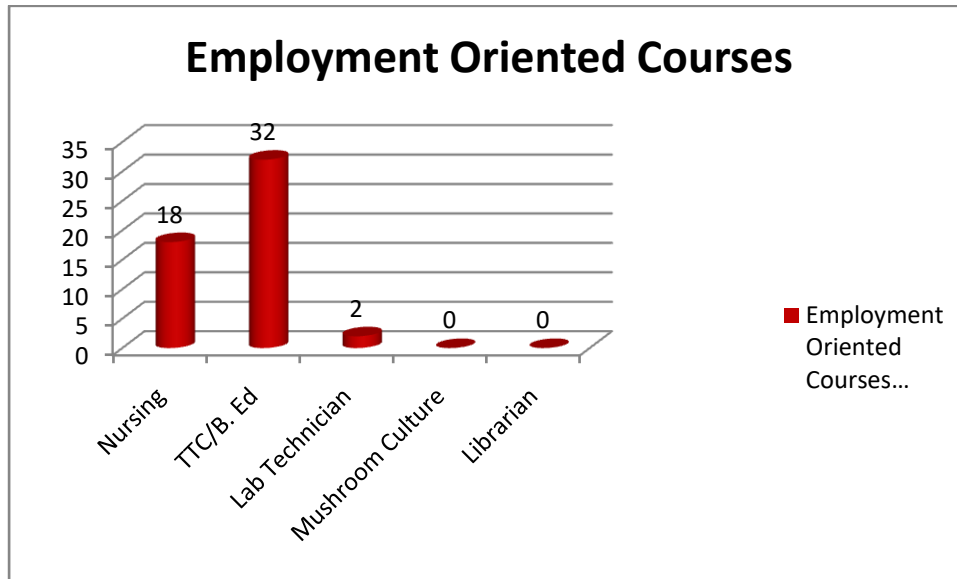


Table 4 – Skill Enhancement Training.

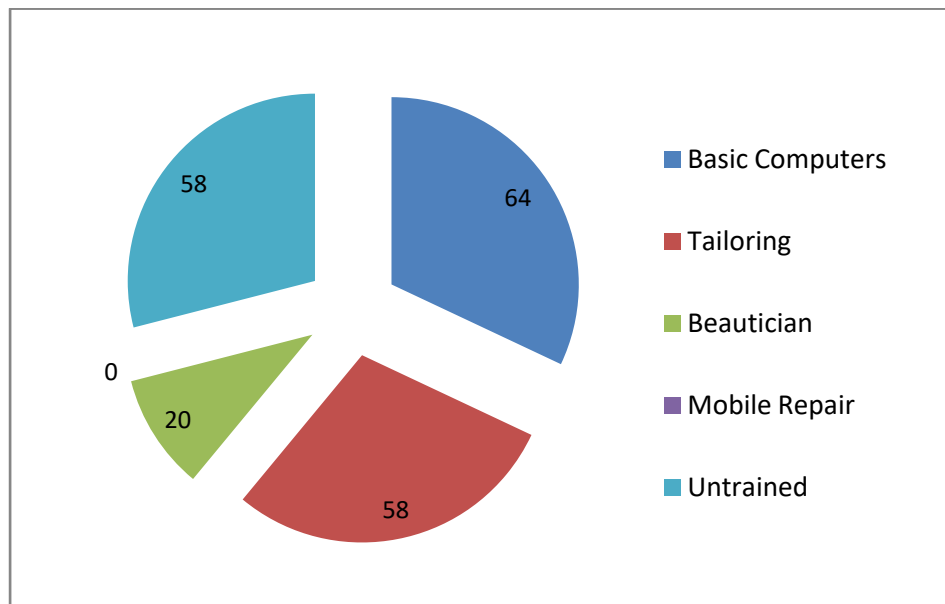


Table 5: Present Occupation of the respondents.

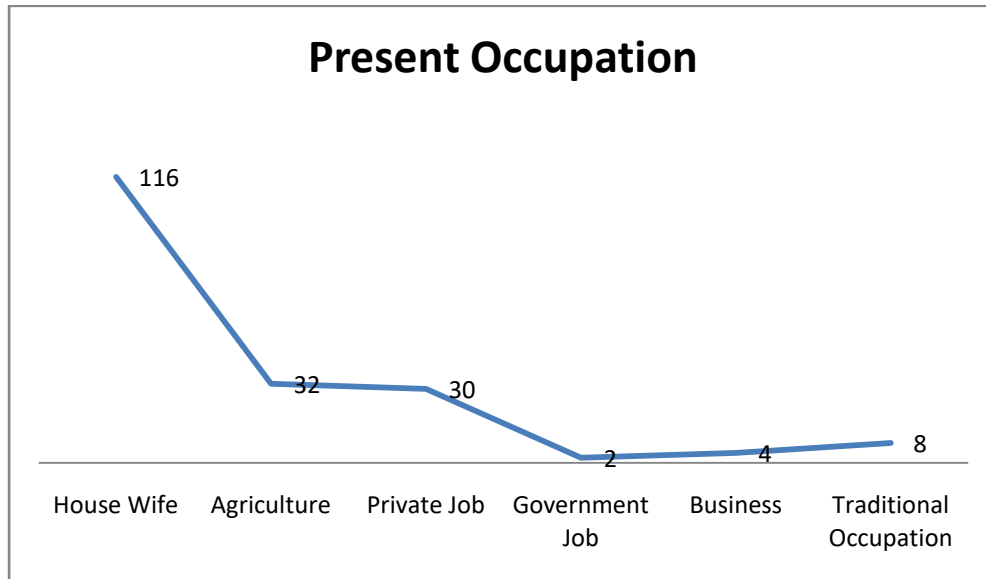
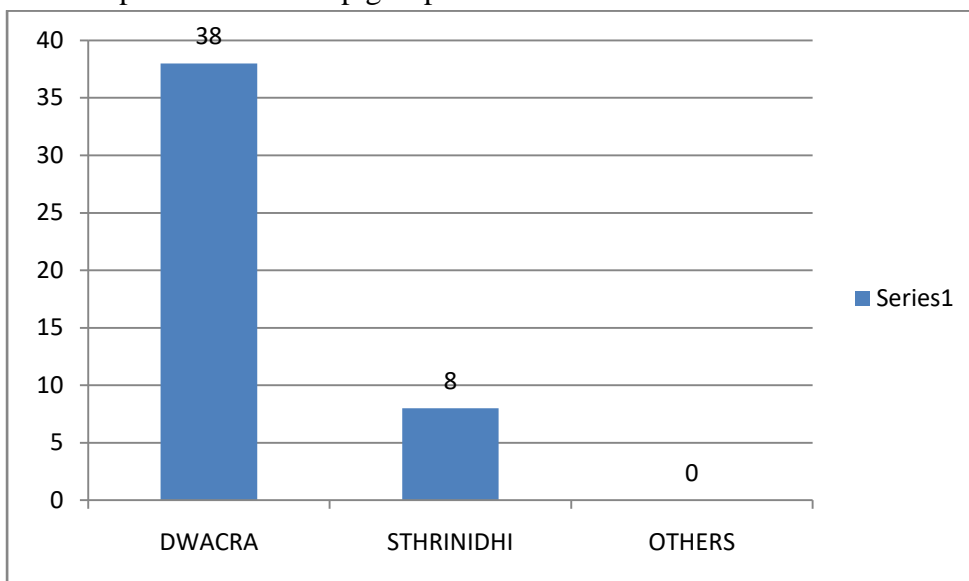


Table 6 – Participation in Self-help groups.



Hakimiat-e-Ilahia & Iqamat-e-Deen: The Core of Maududi's Political Ideology

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Abstract: This paper discusses the twin basic concepts of A.A. Maududi's vision of Islam and Politics. *Hakimiat-e-Ilahia* in plain English means Sovereignty of the God Almighty and *Iqamat-e-Deen* means establishment of Islam as a political force in, off course, Muslim majority states. This paper also examines Maududi's understanding of Islam. For him, Islam is not merely a religion but a way of life, that implies the political, social and legal aspects of human life. According to him, accepting Islam means 'giving oneself into complete subjugation to the Divine Commands.

Introduction: Abul Ala Maududi has been a well recognised name in the realms of Islamic theology as well as Political Science especially to those who have been concerned with Indian sub-continent, Middle East, or with just Political Islam. Many distinguished writers, such as Charles J. Adams, E.I.J. Rosenthal, Aziz Ahmed, Kalim Bahadur, S. V. Raza Nasr, have taken up his political thought but none focussed upon the core of his thought namely *Hakimiyat-e-Ilahia* and *Iqamat-e-Deen*, i.e. Divine Sovereignty and Establishment of the Religion respectively. Divine, for Maududi, is the Omnipotent and Omnipresent God Almighty to Whom he prefer to call *Allah*. In fact these two concepts are essentially one as the second is the process to realize the first. This concept is the natural corollary of his understanding of, what he called as, four basic terms of Quran, the Holy book of Islam.

Main content

Maududi's interpretation of what he called 'the four basic terms of the Qur'an' led him to form the core of his theo-political theory namely, *Hakimiat-e-Ilahia*, (Sovereignty of God) and *Iqamat-e-Deen*, (establishment of Islam) These are the two basic themes of all his theological and political, theoretical and practical discourses. Though interdependent and sometimes used interchangeably the earlier is the means to realise the later. The later is also not the ultimate aim, rather it is a means to achieve the final goal that is success in the life hereafter.

Hakimiat-e-Ilahia (Divine Sovereignty)

Hakimiat-e-Ilahia, is the central idea of Maududi's political thought. He calls it as the most fundamental and most revolutionary concept of the Quran.¹ According to Maududi, the Qur'an possesses its own concept of Universe that insists that Universe is the creation of Allah, all the humans, animals, heavens, earth, sun, moon, stars, in brief, each and every thing in the Universe is created by Him. Maududi quotes several verses from the Qur'an in this regard:²

"Your Guardian-Lord is Allah, Who created the heavens and the earth in six Days, then He established Himself on the Throne (of authority): He draweth the night as a veil O'er the day, each seeking the other in rapid succession: He created the sun, the moon, and the stars, (all) governed by laws under His Command. Is it not His to create and to govern? Blessed be Allah, the Cherisher and Sustainer of the Worlds!"³

"It is He Who created the heavens and the earth in true (proportions)."⁴

"Say: "Allah is the Creator of all things: He is the One, the Supreme and Irresistible"."⁵

"He rules (all) affairs from the heavens to the earth: in the end will (all affairs) go up to Him, on a Day, the space whereof will be (as) a thousand years of your reckoning."⁶

From the above Quranic verses, it is evident that Allah is the Master, Ruler, Manager, and Administrator of all His creation.⁷ He is Omnipresent, Omniscient, and Self-consistent. He never needs any other's help or assistance. No one has any share in His attributes or creation. If he wishes to destroy the Universe or any thing in it, or to punish any one, no one can refrain Him from doing so or rescue any body from His wrath. The Quran further says:⁸

¹ *Islamic Law*, p. 166

² See also *Qur'an*, 2:29, 4:1, 56:58-72., *Understanding the Qur'an*, Vol. I. p. 58; vol. II. p. 5., *Tafhim*, Vol. V. p. 257

³ *Quran*, 7:54., See also *Understanding the Qur'an*, vol. III. p. 32

⁴ *Ibid.*, 6:73., See also *Understanding the Qur'an*, vol. II. p. 243

⁵ *Ibid.*, 13:16., See also *Understanding the Qur'an*, vol. IV. p. 231

⁶ *Qur'an* 32:5., See also *Tafhim*, vol. IV. p. 38

⁷ See also *Qur'an*, 20:6, 30:26, 32:5., *Understanding the Qur'an*, vol. V. p. 181; *Tafhim*, vol. III. p. 750; vol. IV. p. 38

⁸ See also *Qur'an*, 2:107, 3:154, 6:57, 13:16, 16:17, 18:26, 25: 2, 28:70, 30:4,

Understanding the Qur'an, vol. I. pp. 100 & 293; vol. II. p. 237; vol. IV. pp. 231 & 319; vol. V. p. 101. *Tafhim*, vol. III. pp. 433, 659 & 731.

“Say: "Have ye seen (these) 'Partners' of yours whom ye call upon besides Allah? Show me what it is they have created in the (wide) earth. Or have they a share in the heavens?" Or have We given them a Book from which they (can derive) clear (evidence)? Nay, the wrong-doers promise each other nothing but delusions. It is Allah Who sustains the heavens and the earth, lest they cease (to function): and if they should fail, there is none -not one- can sustain them thereafter: verily He is Most Forbearing, Oft-Forgiving.”⁹

From the above Quranic verses it is clear that all the attributes and characteristics of Allah are exclusively concentrated in Him alone; no one else in the Universe possesses these attributes. He is Irresistible, Infallible, Self-subsisting, Acquainted with every thing, Preserver of Safety, and Protector, Eternal, Ever-awaken, Exalted in Might. All authority and power is in His hands; every thing is under His control; profit and loss is His blessings. Every one is answerable to Him but He is answerable to none. No one can deny or ignore His Command.¹⁰ To establish the sovereignty of God Maudūdi quotes the following Quranic verses:¹¹

“Knowest thou not that to Allah belongeth the dominion of the heavens and the earth? And besides Him ye have neither patron nor helper.”¹²

“He is the Irresistible, (watching) from above over His worshippers; and He is the Wise, Acquainted with all things.”¹³

“Allah is He, than Whom there is no other god; the Sovereign, the Holy One, the Source of Peace (and Perfection), the Guardian of Faith, the Preserver of Safety, the Exalted in Might, the Irresistible, the Supreme: Glory to Allah! (High is He) above the partners they attribute to Him.”¹⁴

Divine Sovereignty, for Maududi, is the logical consequence of the Quranic concept of the Universe. The Quran mentions in unequivocal words that the Ruler and Sovereign of the Universe is the Ruler and Sovereign of the humans too. He is the Omnipotent, Omnipresent, Omniscient, Irresistible, Supreme and Exalted; His powers are Universal, Comprehensive and Inalienable to Him; He does not have any counterpart in His powers, nor even wife or children:

“He to Whom belongs the dominion of the heavens and the earth: no son has He begotten, nor has He a partner in His dominion: it is He Who created all things, and ordered them in due proportions.”¹⁵

“They have no protector other than Him; nor does He share His Command with any person whatsoever.”¹⁶

The entire universe is one organic system that is being controlled by one authority.¹⁷ He created the Men and exclusively enjoys the authority to govern them and regulate their affairs; no one else is authorise to command or adjudicate them:

“Is it not His to create and to govern? Blessed be Allah, the Cherisher and Sustainer of the Worlds!”¹⁸

In the physical sphere of the Universe, Maudūdi writes, God’s Sovereignty has been established by coercion over each and every object including the mankind. Mankind, like other objects, is subject to His Will without any choice. It makes no difference whether men acknowledge His Supremacy or not. However, in volitional sphere mankind is physically, not morally, free for acceptance or rejection of His Sovereignty. Mankind is morally bound to acknowledge His Sovereignty by its own covenant with Him on the *yaom-e-alast* i.e. the day of Covenant. The Quran claims that Almighty drew the souls of all the human beings whom He intended to create until the Day of Judgement and made them testify. All have taken the oath of allegiance that they would obey and worship Him:

“When thy Lord drew forth from the Children of Adam from their loins, their descendants, and made them testify concerning themselves, (saying): ‘Am I not your Lord (Who cherishes and sustains you)?’ They said: ‘Yea! We do testify!’ (This), lest ye should say on the Day of Judgement: ‘Of this we were never mindful’.”¹⁹

Then, the God Almighty inculcated this Covenant in their sub-consciousness and very nature, like other pieces of knowledge. Hence, regarding any other entity as their sovereign amounts to the breach of the Covenant that is inherent in their instinct.²⁰ This is so inherent in the human nature that the non-believers and polytheists too did not deny the existence of the God, nor that the whole mechanism of universe is functioning in accordance with His commands:

“If thou ask them, Who created them, they will certainly say, Allah: how then are they deluded away (from the Truth)?”²¹

“Say: "Who is it that sustains you (in life) from the sky and from the earth? Or who is it that has power over hearing and sight? And who is it that brings out the living from the dead and the dead from the living? And who is it that rules and regulates all affairs?" They will soon say, ‘Allah’.”²²

⁹ *Qur’ān*, 35:40-41., See also *Tafhīm*, vol. IV. pp. 239-240

¹⁰ *Khilāfat*, pp 13-20

¹¹ See also *Qur’ān*, 2:204&255, 3:25 & 83, 5:1, 6:18, 7:128, 10:65 & 107, 13:9 & 41, 18:27, 23:88, 28:23, 36:83, 48:11, 59:23, 67:1, 72:23, 85:13-16, 95:8, *Understanding the Qur’ān*, vol. I. pp.161,196, 244 & 269; vol. II. p. 20; vol. IV. p.47, 71, 227 & 247; *Tafhīm*, vol. IV. p. 273; vol. V. p. 415; vol. VI. p.41& 120.

¹² *Qur’ān*, 2:107., See also *Understanding the Qur’ān*, vol. I. p. 100

¹³ *Ibid.*, 6:18., See also *Understanding the Qur’ān*, vol. II. p. 220

¹⁴ *Ibid.*, 59:23., See also *Tafhīm*, Vol. V. p. 416

¹⁵ *Ibid.*, 25:2., See also *Tafhīm*, vol. III. p. 433

¹⁶ *Ibid.*, 18:26., See also *Understanding the Qur’ān*, vol. V. p. 101

¹⁷ *Islamic Law*, p. 170

¹⁸ *Al Qur’ān*, 7:54., See also *Understanding the Qur’ān*, vol. III. p. 32

¹⁹ *Ibid.*, 7:172., See also *Understanding the Qur’ān*, vol. III. p. 97

²⁰ *Understanding the Quran*, Vol. III. pp. 97-100

²¹ *Al Qur’ān*, 43:87., See also *Tafhīm*, vol. IV. p. 553

²² *Ibid.*, 10:31., See also *Understanding the Qur’ān*, vol. IV. p. 31

The Quran claims, according to Maududi, are so-politically oriented that it would be difficult to limit them to the religious arena.

Allah has said: "Take not (for worship) two gods: for He is just One God: then fear Me (and Me alone)."²³

The Quran repeatedly uses the political terms like Kingship, Lord and Sovereign to explain the relationship of God with man and His other creations.²⁴

He is kind enough to send messengers and prophets to remind the Covenant and elucidate His attributes to the Mankind that they should recognise Him and acknowledge His Sovereignty intentionally, consciously and with their own will and wish, as the rejection would cause unending punishment in their eternal life.

According to Maududi, the real mission of all the prophets, right from the Adam to Prophet Muhammad, have been to call the Mankind towards acknowledging Hākimate Ilāhīa, Sovereignty of God Almighty over the entire life of man and to seek Iqāmate Deen, establishment of His deen on His earth.²⁵ The dispute between the prophets and the non-believers is that the prophets demanded absolute obedience to Allah and complete acknowledgement of His sovereignty in the religious, moral, social, cultural, economic, political and all other fields, but those in power refused to forego their authority and acknowledge that of Allah. As far as the concept of God over universe is concerned, in Maudūdī's opinion, it is accepted by most of the people to whom these prophets have been sent. For instance, the Pharaoh, Maudūdī writes, claimed godhood but he could not have meant that he was the Creator of the heavens and the earth. Nor any man in his good senses could claim that. The Pharaoh could not even mean that only he should be worshipped, for the Egyptians worshiped a host of deities along with the Pharaoh. His claim to godhood could only mean that he wanted to be obeyed as the King and the sovereign of the people of Egypt. And this position is similar with the claims of modern states for legal and political sovereignty.²⁶ These prophets have demanded their people to establish the Rule of the Allah over the earth. While explaining the 40th verse of Sura-e-Yousuf, Maudūdī writes:

"This verse determines that the power to adjudicate and right to rule (in other words, Sovereignty) is exclusively for Allah. Here, there is no such word or reason on which basis this Sovereignty could be confined in the sense of universal sovereignty. The Sovereignty of Allah is as much Political and legal, Moral and ideological, as it is universal. And there are explicit evidences in the Quran itself that reserved all such kinds of sovereignty exclusively to Allah alone. Hence, The Quran determines that Allah is not only *Rabb* and *Ilāh* of humans but He is *Malik*, the King of the humans too: 'Say: I seek refuge of (Allah) the Lord of Mankind, the King of Mankind'. It says that Allah is the King of the dominion and no one else share in His Kingship:

'Say: "O Allah! Lord of Power (and Rule), Thou givest Power to whom Thou pleasest, and Thou strippest off Power from whom Thou pleasest.' (3:26)

'Say: Praise be to Allah, Who begets no son, and has no partner in (His) dominion.' (17:111)

'Your Guardian-Lord is Allah, Who created the heavens and the earth in six Days, then He established Himself on the Throne (of authority): He draweth the night as a veil O'er the day, each seeking the other in rapid succession: He created the sun, the moon, and the stars, (all) governed by laws under His Command. Is it not His to create and to govern? Blessed be Allah, the Cherisher and Sustainer of the Worlds!' (7:54)"²⁷

Hence, acceptance of Islam, for Maududi, implies the acceptance of His sovereignty and rejection of this claim is rejection of Islam; the Quranic concepts of the Unity of God and the Divine Sovereignty are so vitally intertwined that the negation of one amounts to the negation of the other ipso facto. Hence, he equates acceptance of any other's supremacy in any aspect of life, including political with shirk, polytheism. For him, mere association in command involves association in worship. He quotes several verses from the Quran:

"Yet there are men who take (for worship) others besides Allah, as equal (with Allah): they love them as they should love Allah, but those of Faith are overflowing in their love for Allah. If only the unrighteous could see, behold, they would see the Punishment: that to Allah belongs all power, and Allah will strongly enforce the Punishment."²⁸

"Allah is He, than Whom there is no other god; the Sovereign, the Holy One, the Source of Peace (and Perfection), the Guardian of Faith, the Preserver of Safety, the Exalted in Might, the Irresistible, the Supreme: Glory to Allah! (High is He) above the partners they attribute to Him."²⁹

"These are the limits ordained by Allah; so do not transgress them if any do transgress the limits ordained by Allah, such persons wrong (themselves as well as others)."³⁰

According to Maududi, mankind is bound to follow His Laws and Commands. The believers in Him have no choice except to submit themselves to His Laws. They can neither amend these laws by themselves nor be content with laws made by others. Permitting others to legislate for them or following the laws made by others or according to their own whims will amount to shirk, polytheism:

According to Maududi, He(the God Almighty) has already caused legislation and communicated it to the Mankind through His Book, namely the Quran, and the practices of the Prophet Muhammad. These laws are ultimate and final, and un-amendable in any circumstances. However, the people of knowledge among the Muslims can deduce subsidiary laws from the Quran or the Practices of the Prophet. They can even infer a new law, if any novel situation arises, on the basis of the basic principles given in the Quran and Hadith.³¹

²³ *Ibid.*, 6:51., See also *Understanding the Qur'ān*, vol. II. p. 235

²⁴ *Islamic Law*, p 170

²⁵ *Ibid.*, p.175-176

²⁶ *Ibid.*, p. 166 & 172

²⁷ *Islami Riyasat*, pp 365-366.

²⁸ *Al Qur'ān* 2:165., See also *Understanding the Qur'ān*, vol. I. p. 133

²⁹ *Ibid.*, 59:23., See also *Tafhim*, vol. V. p. 515

³⁰ *Al Qur'ān*, 2:229., See also *Understanding the Qur'ān*, vol. I. p. 177

³¹ *Tafhimat*, vol. III. pp. 10-16

In brief, the Sovereignty lies exclusively with Almighty and no other person or the institution enjoys any share in it, not even the state. In fact, the basic attribute of the Islamic State is that it lacks sovereignty on its part; it is a mere vicegerent of Almighty on the earth to uphold His Commands. According to Maududi, the concept of political and legal sovereignty of Allah is the first among the basic principles of Islam and no Islamic constitution can be drafted unless the political and legal sovereignty of Allah is accredited in that. The Islamic constitution must embody that it is subservient to Allah, acknowledges Him as the Supreme Ruler and His Commands have binding effect upon it.³²

Maudūdi not only explains the necessity of Divine Sovereignty in Islam but he also proved that the Divine Sovereignty is the only possibility if sovereignty means absolute power and unlimited authority. He touches upon the most difficult question and the most disputed issue of political science that haunted several political philosophers and they pleaded to discard it altogether, including Bodin and Austin, that whether any sovereign on earth ever enjoyed or will enjoy the absoluteness as required by many of the political thinkers? In other words, Is it possible for any human sovereign to be, after all, a sovereign? In fact, it is impossible for any human being to have such independence, absoluteness, exclusiveness, eternity, inalienability and originality as required by Bodin,³³ Hobbes,³⁴ Austin,³⁵ and other political philosophers. According to Maudūdi such sovereignty is beyond the sphere of human competence. No emperor or autocratic ruler have, in reality, ever enjoyed or have been enjoying such absolute powers. His powers are limited by various internal and external factors that are beyond his control. In democratic systems also no one can determine where the sovereignty actually lies as everyone has been controlled by others and every one's authority is being checked by others. In fact, for Maududi, there is no one among the humans or other creatures who possesses such attributes of sovereignty. There is only one such being in the Universe and that is Allah, the God Almighty.³⁶ He writes:

“The root cause of all difficulties in respect to this question is a basic fallacy: the political philosophers have tried to place the cap of sovereignty on man being for whom it was never intended and whom it can never fit. Keeping in view the attributes of sovereign, no human being or human organisation can really claim title to it. And when sovereignty is forced upon human beings, it results in confusion on all hands.”³⁷

The second question, posed by Maududi, is ‘Who possesses the right to have sovereignty?’ He says that even if anyone has provided someone with such a status it would be inappropriate to follow his commands because no one has the authority to make him sovereign. One may try to justify it on the basis of popular choice but the people themselves have no such authority to handover such a power to anybody. Hence, authority of such sovereign will be void. According to Maududi, the paradox can be solved only, as done by the Quran, by having a supra-natural being, the God Almighty, as the legal sovereign.³⁸ He argues:

“The Quranic concept of sovereignty is simple. God is the Creator of the Universe. He is its real Sustainer and Ruler. It is His Will that prevails in the cosmos all around. As all Creation is His, His command should also be established and obeyed in man's society. He is the real sovereign and His Will should reign supreme as law.”³⁹

Thus, Maudūdi proves the Divine sovereignty not only on the authority of the Quran but by the very words of the western philosophers.

In brief, Islam, according to Maududi, by its virtue, claims *Hakimia-te-Ilahia*, Divine Sovereignty, over the earth and the entire life of man. He argues that Islam is not submission to and acceptance of Lordship and Omnipresence of the God Almighty in mere physical sphere of the life, but it requires a complete and exclusive submission to and acceptance of His exclusive Authority, Omnipotent Sovereignty, and Suzerainty in all spheres of volitional life also. It implies that Islam, in Maudūdi's view, demands *Hakimiat-e-Ilahia*, i.e., the exclusion of the right of Sovereignty in a State for the God Almighty alone and it requires *Iqāmat-e-Deen*, establishment of Islam as the political power.

Iqamat-e- Deen (Establishment of Islam)

Maududi, though, places great significance on the Concept of Divine Sovereignty but he is not content with a mere declaration that the constitution declares Allah as the Supreme Head of the Islamic State while as the entire system is functioning against His Will and Commands. *Hakimiat-e-Ilahia*, for him, is a mean to achieve *Iqamat-e-Deen*, the establishment of Islam as political authority. *Iqamat-e-Deen*, for him, does not mean mere establishment of a system of *Salat* and *Zakat*, or performing Hajj etc. In fact it is the establishment of the Will and Wish of Allah, as ordained in the Quran and *Sunnah*, in each and every field of human activity, right from private morals to foreign policy; it is enforcement of His Commands in social and political arena as it is enforced in religious sphere.

In brief, *Iqamat-e-Deen*, for Maududi, means establishment of Islam in its complete form and shape without any curtailment or compromise, through the political force. It also implies seeking political power and dominance to Islam that it becomes the dominant and decisive force on earth, as it does not descend to remain in a subservient position. Hence, Islam has no choice except to seek the reign of state for itself or for those who share its faith as it presents a complete system or way of life. If it has not sought, the others will do so and consequently, deprive it with ninety percent of its content. According to Maududi, such coercion is natural and unavoidable; it will be on the part of either Islam or any other religion. Islam possesses, for Maududi, preference in this regard since it is the embodied Will of the very Creator of this Universe.

Hence, according to Maududi, for Muslims, if they wish to lead their lives according to Islam, there is no choice except to submit their entire life to the Will of the God, conduct all their individual as well as congregational, private as well as public affairs, and resolve all their disputes according to His injunctions. Islam is a complete and comprehensive *deen*, way of life, it neither to resolve with any segregation between private and public life, nor to accept that Muslims will follow the commandments of God in their private affairs but follow the other's rules and regulations in their public life. Islam not only lays down principles

³² *Islami Riyasat*, p. 367

³³ Sukhbir Singh, *A History of Political Thought*, vol. I. pp. 405-406

³⁴ *Ibid*, vol. I. pp. 443-447

³⁵ *Ibid*, vol II. pp. 65-69

³⁶ *Islami Riyasat*, pp. 314-315

³⁷ *Islamic Law*, p. 166

³⁸ *Islami Riyasat*, p. 316

³⁹ *Islamic Law*, p. 166

of morality, and ethics but also regulates the social, economic and political fields. It prescribes criminal procedure, fiscal and economic regulations as it enunciates the methods of prayer and pilgrimage. According to Maududi, an individual's claim of Islam is doubtful if he will not follow His commandments in all aspects, including political, of his life as *deen* involves all of them. For instance, in 24th verse of *Sura-e-Baqrah*, Maudūdi quotes, the criminal law of Islam has been called as *Din-ul-lah*, i.e., the religion of Allah. It means that *deen* does not merely mean prayers, fasting, pilgrimage; criminal law is also a part and parcel of it and it is obvious that political power is necessary to realise it. A *deen* without government in its hands, for him, is like a blue print of a building, not the building itself. Hence, if anyone have been performing religious rites according to Islam but, on the other hand, adopting the criminal procedure made by someone else by his will he is trying to follow multiple of *deens* at once.⁴⁰

In Maudūdi's view, Islam did not descend to provide faithful subjects to the rulers. If the aim of Islam was mere submission to the existing system and rulers it would lead to inconsistency, as it means that Islam is presenting itself as the best *deen* and insisting upon its complete following but at the same time it is instructing its followers to submit themselves to the existing system and obey its commands as against to the commandments of Islam.

He argues that if it were be the nature of Islam the Arab pagans would prove themselves more secular and accommodating than the Britons. In fact, they were well aware that Islam presents a complete way of life and it demands, obviously, the authority and power to rule over them and regulate their entire lives according to the Will of the God and acceptance of Islam means submission of their free will to the Will of the God. It was the basic reason for their antipathy towards Islam. For Maududi, the real objective of Islam is to remove the lordship of man over man and to establish the Kingdom of God on Earth, that is expressed by his coined word '*Iqamat-e-Deen*'. It is, for Maududi, necessary, essential and inevitable to realise Islam. *Namāz, Rozah, Zakāt, Hajj* etc., are not the real objectives of Islam, but all are meant as preparation for a greater task namely *Jihād*, i.e., to stake one's life and everything else to achieve the *Iqamat-e-Deen*. *Iqamat-e-Deen* is necessary and unavoidable because, according to Maududi, the rotten political systems are the root of all the evils of the world. In fact, the bad character of government, largely, generates evils in the society. Power and wealth rests in its hands; laws are framed and enforced by it. Hence, it can either restrict or permit theses evils. According to Maududi, whatever evils there are in the present society, they are because the reins of government are in the hands of most wicked and mischievous elements of mankind. In order to effect reforms among the people and to bring them on the path of righteousness there is no remedy except to set right the mutilated shape of government. It will be impossible to stop drinking, gambling, adultery, and other such things by mere sermons, but it can be exterminated easily by an act of government. Whoever really wants, Maudūdi writes, to root out mischief and chaos from God's earth and is genuinely anxious to ameliorate the condition of God's creation, it is useless for him to work as a mere preacher. He should stand up to finish the government run on wrong principles, snatch power from wrong-doers and establish a government based on correct principles and following a proper system. After suggesting the remedy-measure, that is seeking power by the right-minded people, to eradicate the evils of the society, Maudūdi tackled with the root-cause of the government's badness. According to him, the rule of man over man is the basis of ignoble government. The reform he suggested is that there should not be lordship of man over man but that of God over man and this is what the Islam want to introduce. The striving for this is *Jihad* and the establishment of noble and God-fearing and God-guided government is *Iqamat-e-Deen*.

Conclusion:

The above observations show that establishment of the Divine-Rule on earth is the ultimate aim of Islam, as it is envisages by Maududi. He made the God Almighty as not only physical sovereign of the universe but the political and legal sovereign of the state also. For him Islam means complete subjugation to the Commandments of the God in personal as well as congregational life. Religion, for him, is not limited to the personal sphere but its scope includes the political realm also. However, Maududi never advocated terrorism or violent methods. He seeks the revolution through the propagation and peaceful means.

⁴⁰ *Fundamentals of Islam*, p. 255

Muslim Socio-religious Movements & Ideologies In Colonial India

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Abstract: The exclusive aim of this paper is to present the theo-political ideology that is presented by various theo-reformative movements among Muslims in the Indian sub-continent during colonial rule, hence, the history and organisational details of these movements have been consciously avoided. Hence, the stress has been on the ideologies and beliefs of several famous Muslim leaders and organisations of that period such as Mahmud ul Hasan and Reshmi Rimal Tehreek, Nanotawi and Deobandi Tehreek, Titu Mir and Tariqa-e-Muhammadiya, Haji Shariatullah and Faraedhi Tehreek, Qanunji and Tehreek-e-Ahl-e-Hadith, Syed Ahmed Khan and Aligarh Tehreek, Chiragh Ali and Rationalism, Titu Mir and Tariqa-e-Muhammadiya, Haji Shariatullah and Faraedhi Tehreek, Qanunji and Tehreek-e-Ahl-e-Hadith, Syed Ahmed Khan and Aligarh Tehreek, Chiragh Ali and Rationalism, Shibili Numani and Historical Glorification, Muhammad Ali Jauhar & Khilafat Movement, Iqbal and Pan-Islamism, Maulana Ilyas and Tablighi Jamat, Inayatullah Mashriqi & Khaksar Tehreek, Obaidullah Sindhi and Hijrat Movement, Jamiyat ul Ulama & Composite Nation Theory, Khudai Khidmatgar, Muslim League & Muslim Nationalism, Maulana Maududi & Jamat-e-Islami.

Introduction : For the Indian Muslims the post-Ghadar 1857 era was of a great uncertainty in the religious as well as political spheres. They have had already lost all their hopes for re-glorification due to failure in 1857.¹ This unsuccessful attempt ruined the Muslims in almost all aspects.² They had been facing severe economic crisis due to loosing of political power. Further, adoption of English replacing Persian as official language made the situation more aggrieved. There was no provision of teaching English under the traditional *madarsa* system; learning English for majority of Maulvis was tantamount to heresy. Therefore, majority of the Muslims themselves from the modern education system that, in due course resulted in lack of qualified Muslim candidates for public services. This phenomenon, in addition to the government's deliberate policy of alienation, resulted in less representation in public services, comparing to the other communities.³

Further, in 1924, Muslims faced another debacle by dissolution of Ottoman Caliphate that was the last symbol, though nominal, of their political unity and sovereignty as well as hope and inspiration.

Main Content

Mahmud ul Hasan and Reshmi Rimal Tehreek

The Muslim intelligentsia, at the above juncture, had no clear-cut solution to these surmounting problems. Some of the Muslim leaders were in British camp while some others were under the influence of Gandhi ji. Sir Syed Ahmed Khan and his followers had been vehemently advocating the British presence in India regarding it as a God's blessing. However, Maulana Abdul Aziz, Mawlana Mahmood al Hassan and Maulana Obaidullah Sindhi was still in favour of an armed struggle against the British.⁴ For many of such Mullas British India was a *dar al-harb*, land of War. They initiated the Indian Muslims to migrate to Afghanistan or any neighbourhood Muslim country.⁵ In 1870, Maulana Abdul Azeez revived the jihadi tradition of Shah Ismail Shaheed and Ahmed Shah Barelvi (1786-1831). He re-organised *Mujahideen* in the Northwestern province and started armed struggle against the British but failed due to un-matching power.⁶

Again, in the beginning of the twentieth century, Mawlana Mahmood al Hassan, then Nazim of the Darul uloom Deoband, strived hard to revive the above tradition of *Mujahideen*. He founded an underground movement, *Reshmi Rimal Tehreek*. He sketched to strike the English army through Durra e Khyber, banking upon the promises of Afghanistan, Iran, and Turkey. In 1918, he sent his most trustworthy fellow Obaidullah Sindhi to Afghanistan to negotiate with the rulers of Afghanistan and Iran as well as to reorganise the *Mujahideen*, who were overzealous to teach a lesson to the Briton. In the same year, he arrived at Hejaz to acquire the military favours from the Turkish government. The Turkish War Minister Anwar Pasha, promised to provide military assistance in this endeavour. Meanwhile, Obaidullah Sindhi established a government-in-exile with several associates of the '*Ghadar Movement*' at Kabul. But, the entire endeavour failed due to leaking of the secret to the British government as the British succeeded in arresting

¹See for the causes of the War, Sir Syed, *Asbaab-e Baghaawate Hind*, & Zakaria, Rafiqh. *Rise of Muslims in Indian Politics*, Bombay, 1970, pp.3-7., Hence, Zakaria.

²See for details on Muslims' persecution by the British, Peter Hardy, *The Muslims of British India*, Cambridge University Press, 1972, pp. 70-79. Hence, Hardy.

³For details see, Zakaria, pp.7-25.

⁴For details see, Hardy, p. 84.

⁵Qadhi Mohd. Aslam Saif, *Tahreek-e Ahl-e Hadith, Tareekh Ke Aainay mein*, Al-Kitab International, New Delhi,1996, p.252; See for detail discussion on *dar ul-harb*, *Ibid*, pp. 109-115.

⁶Aziz Ahmed, *Islamic Modernism in India & Pakistan*, London, 1967, p. 20. Hence, Aziz Ahmed.

Mahmud ul Hasan along with his followers at Mecca itself. They were sent to Malta for life imprisonment.⁷

Nanotawi and Deobandi Tehreek

The bulk of Ulama believe that the only way for Indian Muslims to be saved is to rejuvenate and revitalise their faith.⁸ They were more afraid of the Western ideology than her political domination. They were very much anxious about the existence of Islam and Muslims in India. Maulana Qasim Nanotawi (1832-1880) had strongly believed that popularising religious education among the Muslims was the need of the hour lest they would perish. He resorted only to the disseminating of theological knowledge because he thought that the government has already taken up the task of providing modern and scientific knowledge.⁹ Hence, he along with Maulana Haji Imdadullah Muhajir Makki and Maulana Rashid Ahmed Gangohi decided, in 1867, to establish a *Deeni Madarsa* at Deoband exclusively for Islamic education, unadulterated by Western influence. Hence, modern sciences and English could not found a place in its curriculum. Being products of the Waliullahi school¹⁰ they were more concerned about the conservation of the *Hanafi Maslak* and Deobandi tradition.

However, one may note that the objectives of the establishment of Deoband were not that simple.¹¹ All the three founders were not just academic luminaries of high excellence but active participants in the War of Independence at Shāmlī as well.¹² In fact, there was a profound underlying aim, namely re-gaining the theo-political glory of the past. For them, there was no difference between Shāmlī and Deoband, but of weapons. At Shāmlī armed struggle was tried, but here at Deoband intellectual and peaceful means were adopted.¹³

The presence of physical training of quasi-military nature, that led the people to remark sarcastically that it was rather a *madarsa-e harbīa* instead of a *madarsa-e Arabia*, envisages the minds of its founders.¹⁴ However, later it became a neglected aspect of the curriculum as the people at Deoband, with exception of a few, had forgotten the real aim of its founding father.

Titu Mir and Tariqa-e-Muhammadiya

Titu Mir (1782 - 1831), a reformist turned rebel, founded a movement, *Tariqa-e-Muhammadiya*, in Bengal. This was in fact a socio-religious reformist movement that soon acquired the character of an armed rebellion against British due to their continuous support to the oppressive landlords.

Titu preached against polytheism (*shirk*) and innovations (*bid'at*) at first, but soon found himself embroiled in a conflict with local zamindars and English indigo growers as he fought back against their repressive methods. He petitioned before British but in vain. Then he opted to take matters into his own hands, forming a *Mujahid* militia and training them in local weapons such as the *lathi*. British authorities took serious note of these activities and sent offensives against them. Titu bravely defeated at least three of such offensives but could not sustain for a long time before the well equipped British forces and martyred on 19th November 1831 after five days of fierce battle.¹⁵

Haji Shariatullah and Faraedhi Tehreek

Haji Shariatullah (1781-1840) after living in Mecca for twenty years founded the Faraedhi Tehreek in Bengal to lead Bengalian Muslims to the correct path of Islam. The term *Faraedhi* is derived from '*fardh*', i.e. obligatory duties enjoined by Allah. Haji Shariatullah, on the other hand, used the word in wider meanings to refer to all religious obligations mandated by the Qur'an and the Sunnah.

Bengali Muslims, while ignoring the real Islam, had been indulging in several un-Islamic customs, rituals, and ceremonies. Shariatullah emphasised the five pillars of Islam, urged on complete acceptance and strict adherence to pure Islam, and condemned all innovations like *Chhuttee*, *Puttee*, *Chilla*, *Shabgash*, *Fatiha*, *Milad*, *Urs*, *Taziah* as polytheism. He emphasised on '*Adl*, justice, equality, and the Islamic concept of *Ukhuwah*, brotherhood. He used the terms *ustaad* and *shagird*, instead of *peer* and *mureed*, to denote his relation with his disciples.

On the political side, Haji Shariatullah declared British regime as anti-Islam and Muslims. He pronounced that it is not true to perform Juma payer in absence of a legitimate Caliph.

This movement become famous in the districts of Dhaka, Tippera, Noakhali, Bakerganj, Faridpur, Mymensingh, Chittagong, and the adjacent province of Assam. In 1831, he was forced to leave his base, Ramnagar. Due to continuance tension with Hindu Zamindars and Indigo growers this movement converted this movement into a militant-reformist organisation. He, almost a century before to Gandhiji, ordered his followers to resist illegal cess and ban on cow slaughter. To take rid off him the Hindu lords, in 1837, accused him of attempting to set up a kingdom on the lines of Titu Meer. They also brought numerous lawsuits, with the help of

⁷Faruqi. Ziya ul Hasan, *Deoband School and the Demand for Pakistan*, 1967, pp. 59-62., Hence, Faruqi.

⁸Zakaria, p. 26.

⁹For details on introduction of modern education by the British see, Hardy, pp. 90-91 & De Bary. Wm. T., *Sources of Indian Tradition*, NY, 1958, pp. 35-37, Hence, De Bary.

¹⁰Most of the Muslim Movements of British India, many of whom were antagonistic to each other such as Ahnaf and Ahl-e-Hadith, surprisingly trace back their origin in Shah Waliullah's writings. His theo-political thought keeps the Islam alive in the Indian sub-continent. (Riyadh Ahmed, *Mawdoodi and Islamic state*, Lahore: P.P.H 1976, p. 15).

¹¹Mawlana Mahmud al-Hasan's remarks are crucial in this regard. He questioned, when he was suggested by the administration of *Dar al-'Uloom* to keep away from politics, "Did our revered teacher (Nanotawi) lay the foundations of this *madrasah* for mere educational purposes? It was founded in my presence and, as far as I know, one of its main objects was to compensate for the losses in 1857. Those interested only in education are free to do as they like but I stand for those objects which the founder of the *Dar al-'Uloom* had in view and for whose achievement he worked hard". (Faruqi, p. 59, n. 1)

¹²*Ibid*, p. 21.

¹³*Ibid*, p. 23.

¹⁴*Ibid*, pp. 30-37.

¹⁵'Titu Mir', *Wikipedia*, Electronic edn, 2008 cited to Rabiya Khatoun, *Titumirer Bansher Kella*, 1981.

European indigo planters against the Faraedhis. He was arrested by the police several times for allegedly causing agrarian disturbances in Faridpur.

On Shariathullah's demise his son Muhsinuddin Ahmad alias Dudu Miyan presides over the movement and brought an agrarian character to the movement.¹⁶

Qanunji and Tehreek-e-Ahl-e-Hadith

Muhammad Siddiq Hasan Khan al Qanunji (1832-1890) founded the *Ahl-e-Hadith* movement, in the late Nineteenth century on the ideas of Shah Waliullah (d. 1763), Syed Ahmad Shaheed (d. 1831) and Qadhi Ash-Shaukani (d. 1832). Its aim was to bring religious reform by denouncing *taqlid*, i.e. the following of any particular Imam amongst the four Imams of *Ahl-e-Sunnah*, as *bid'a*, i.e. sinful innovation. They were nicknamed as Indian Wahabis as ideologically they were akin with Muhammad b. Abdul Wahab of Najad.

Sadiq Hasan married the third Begum of Bhopal, Shah Jahan (reigned 1868-1901), that made his position strong enough to combat the traditional Indian '*ulama*, who were Hanafites. He compiled more than 200 books in three languages namely Persian, Arabic, and Urdu. He established a far-reaching network to sell his books and buy others for him. This challenges the common view that the nineteenth century India was just a periphery that did not participated in the intellectual developments and the trends of Islamic centres.¹⁷

Syed Ahmed Khan and Aligarh Tehreek

Sir Syed Ahmed Khan (1817 - 1898), who was also a product of the traditional education, on the other side, had radical views with regard to the nature and curriculum of education among Muslims. He had a strong belief that the key for salvation of Muslim community lies in their learning of English language, modern education and adopting western culture and civilisation. He insisted upon Muslims that they must abhor all those habits and beliefs that were in contrast to the western culture, civilisation, morality, or modern sciences. He pronounced that the real Islam would not be an impediment to the proposed modernisation as the *wahi*, revelation and natural laws are identical and connote the words and works of the Almighty respectively. The words of God i.e. Qur'an must be in harmony with the works of God i.e. Nature. Hence, the Qur'an cannot contradict the law of nature. Similarly, *wahi* and reason are identical. *Wahi* acts as an instinct in lesser forms of life while the reason as a revelation-instinct operates in scientific investigation.¹⁸ Hence, anything that descended through *wahi* cannot contradict to facts discovered by science and should be seen in that context.¹⁹ He considered *Jihad* as a defensive warfare and slavery as the product of historical Islam, not the real and revealed Islam.²⁰

His approach was purely materialistic and he was concerned with betterment of the mundane life of Muslims. For this sake, he was ready to interpret the Qur'an according to his modernistic and naturalistic point of view. In order to tune the Qur'anic verses with the western criteria he formulated his own fifteen principles of exegesis. He divided the Ayats of Qur'an into two kinds, basic and iconic. The former constitutes the basis of Islam, hence, cannot be altered while various interpretations in the later might be permissible as per the needs of the times that may be different from that of Prophetic period.²¹ He advocated that all Muslims have the right of an iconic or analytical interpretation of the Qur'an. The bases of interpretation, said Sir Syed, were to be *usul*, the basic principles and not *furū'*, the trivial principles derived therefrom. Similarly, those Ayats of the Qur'an that are referring to the specific historical situations cannot be a basis for interpretation.²² To rid with the unaccommodating *ahādith* he, like Goldziher and Schacht, challenged the authenticity of all the classical collections, including *Sahih Bukhāri* and *Sahih Muslim*.²³

Further, for the sake of developing cordial relations between Christianity and Islam he has written two books, *Tabaiin al-Kalām* and *Risala der Ta'am ahl al-Kitab*, in which he advocated that the Muslims should remove the social barriers with regard to the Christians.²⁴

While dealing all these, he was dare enough to criticise the British policy of discrimination against the Indians. He left the *Agra Durbar* unattended when he noticed that the chairs for Indian guests were arranged on a lower level to those of Europeans.²⁵

However, Sir Syed concentrated upon the popularisation of western education and social reforms among the Muslims. After a thorough analysis, he concluded that the root cause of all the backwardness and sufferings of the Muslims was their abhorrence to the English language, western education and sciences. He realised that if Muslims were not acquainted with the modern education

¹⁶“Faraezi Tehreek”, *Wikipedia*, Electronic edn., 2008.

¹⁷ *Ibid*, cited to Claudia Preckel, *The Begums of Bhopal*, Rolibooks, New Delhi.

¹⁸ Aziz Ahmed, pp. 42-43 & Ikram. *Indian Muslims & Partition of India*, ND, p.55., Hence, Ikram.

¹⁹ Sir Syed, on this assumption, strived to reconcile the Darwinian evolutionism with the Islamic tenets of Creation. For him, Adam connotes human nature. He considered the legend of Fall of Adam and all the Prophetic miracles, including the *M'eraj*, as metaphorical, legendary, or symbolic. Angels were either the properties of created things or divine moral support against overwhelming odds and Satan signifies dark passions of man. Similarly, Djinnns were either wilder men living in forests or projections of evil, diseases and other calamities. He viewed the soul as pragmatic reality and *wahy* and Gabriel as instinctive flash upon the mind of the prophet. (Aziz Ahmed, pp. 43-44 & 47-48)

²⁰ Sir Syed regarded the Prophet's expeditions as a defensive warfare-mechanism. *Ibid*, p. 50.

²¹ Sir Syed, on this basis, pronounced that the simple interest drawn from banks or government institutions is permissible. *Ibid*, pp. 45 & 52-54., However, astonishingly he supported *purdah* system among the Muslim women. (Zakaria, p. 244)

²² Aziz Ahmed, p. 42.

²³ *Ibid*, p. 49.

²⁴ Zakaria, pp. 237-238.

²⁵ S. M. Ikram, *Modern Muslim India and the Birth of Pakistan*, Delhi, 1991, p. 42., Hence, *Modern Muslim India*.

their condition will not be improved and they could not get an honourable position amongst the nations of the world. He, in 1864, founded the Scientific Society for introducing modern education among the Indian Muslims. He started with the establishment of a modern school at Ghazipur and encouraged the others to establish such institutions at the district level. However, he, unlike his predecessor Nanotawi, stressed upon English and modern sciences. He caused the translation of useful English books into Urdu. However, his great achievement in the field of education is the establishment of Anglo-Muhammadan Oriental College in 1874, at Aligarh on the model of Cambridge University with English as the medium of instruction. It aimed at the scientific education, broad mindedness, liberalisation of ideas, and a pragmatic approach to politics. This college in course of time developed into Aligarh Muslim University.²⁶

These endeavours produced a small but talented intelligentsia that contributed much in development of political consciousness among the Muslims and created dynamics in the fossilised society. It provided the leadership for Muslims to check the growing influence of the Congress. Moreover, the neo-elite, who had little sympathy towards Islam and its tenets, later played an active role in Pakistan movement as they believed in Muslim nationalism with respect to Indian subcontinent.

On the political front, Sir Syed was convinced that the British rule over India has been beneficial and a Divine blessing to the Indians, especially to the Indian Muslims. Hence, he remained loyal towards the British throughout his life and preached the same. He condemned the efforts to present the Mutiny of 1857 as a Muslim revolt and started a magazine, *The Loyal Muhammadans of India*, to correct the false impression of British officials.²⁷ His loyalism can be divided in three phases. From 1859 to 1870, he tried to persuade, on the one hand, the British authorities that until the Indian Muslims were free to perform their religious obligations there was no theological reason for them to revolt against the British,²⁸ and, on the other, the Muslim community that the British rule over India was in their interest. In the second phase, from 1870 to 1884, his objective was to check the advent of pan-Islamism, which he considered as a dangerous political adventurism. In the third phase, from 1887 to 1898, he led the Muslims towards political separatism. He on the basis of Urdu-Hindi controversy and the communal riots that followed, it is concluded that these two nations could not be united into a composite nation.²⁹ He succeeded in the first and third phase of his loyalism, but on the question of pan-Islamism he failed to attract the Muslim intelligentsia as well as masses.³⁰

In 1884, with regard to the self-government, he suggested a political pattern based on triangular, Hindu, Muslim, and British, participation. He was convinced that if anyone from Hindu or Muslim community rule the country, peace couldn't be maintained; therefore, the British rule is inevitable to retain the peaceful co-existence of all the communities in India. He was very critical of the Congress and always considered it as a Hindu organisation. He was afraid of any political alliance with the Hindus. In his view, it could lead only to the eventual domination and subjugation of the Muslim minority to the Hindu majority. Therefore, he opposed the Congress' stance to appease the minority, in the form of Khilāfat Movement. He reacted sharply when the Congress elected a Muslim, Badruddin Tayyabji, as its president. He condemned it as the beginning of erosion in Muslim community, which was numerically in minority, educationally backward, politically immature, and economically weak.³¹ He had certain reservations regarding the association with the Congress; firstly, he was afraid of the cultural dominance of the Hindus in the Congress that association with such an organisation would cause loss of identity for the Muslims and eventually they would absorb, like the Buddhists and Jains, into the Hindu community. Secondly, that the Congress' anti-British attitude would ruin the Muslim community again as it happened after the Mutiny of 1857. Hence, he pronounced that the Muslim's alliance with the Congress would cause 'a loss to this world as well as the next'.³² He founded two organisations one in 1888, and another in 1894 to counteract the Congress' influence on Indian Muslims.³³

In brief, Sir Syed's Naturalism rejected or reinterpreted all those elements in Islam that contradicted the modern science or western culture and civilisation; for this sake, he strived to rationalise the minutiae of dogma and liberalise the Islamic law. Thus, in this endeavour he disowned three-fourth of Islam. His Rationalist speculation, in which he was close to the Mu'tazilites, and loyalist Occidentalism can be summed up in the following six points:

1. A rationalistic approach to Islam;
2. A readjustment of Islamic traditions and customs in accordance with the changing times, i.e. according to western criterion;
3. An active interest in the history and literature of Islam;
4. A new approach that was based on *Deen* but in tune with the Western civilisation;
5. A better understanding of the Christians and their culture and civilisation; and
6. A loyalism towards the British combined with Muslim separatism.³⁴

Though, Sir Syed did not formally establish any organisation, his theo-socio-political endeavours has been generally referred as 'Aligarh Movement'.

²⁶ Aziz Ahmed, pp. 34-38. see for details, Ikram, pp. 31, 37-40.

²⁷ Ikram, p. 30., see also, Hardy, pp.84-85.

²⁸ Lord Mayo, by a letter, dt. 30th May 1871, suggested W.W. Hunter to analyse that whether the Indian Muslims have a religious duty to rebel against the Briton in the present situation? (Hardy, p. 85, see also, pp. 62-70)

²⁹ Zakaria, p. 82.

³⁰ Aziz Ahmed, p. 33.

³¹ *Ibid*, p. 34.

³² Zakaria, p. 84.

³³ For more details on these association see, *ibid*, pp. 66-70 & 82-85.

³⁴ *Ibid*, p. 240.

Chiragh Ali and Rationalism

Chiragh 'Ali (1844-1895), a radical disciple of Syed Ahmed Khan who called himself as Mu'tazili,³⁵ went a step ahead of his master. He considered the Prophet Mohammad, peace be upon him, only as a reformist, whose main concern was to improve the moral standards of Arabs and conditions of Women, bring monotheism in the place of polytheism. He, in unequivocal words, repudiated the authenticity of the *Ahadith* and rejected *Ijma'* as a source of law. He expressed reservations with regard to the authenticity of the traditional sources of law.³⁶ He also suggested that too much sanctity should not be attached to the Prophet, his words and practices.³⁷ He envisaged that there are several references to nature and principles of nature. He endeavoured to identify *mutlaq*, i.e. absolute and *muqayyad* i.e. conditional verses in Qur'ān and developed the notion that when the context and the ruling are comparable, an 'absolute' ayah should be interpreted in the light of a 'conditional' ayah. According to him, Islam does not provide any social system; however, Muslims in places where they were in majority have started to identify their social systems with the Qur'an. Islamic jurisprudence was essentially a reflection of such social experiences of ninth and tenth centuries. It may be still practicable in fossilised and static Muslim societies. But, in countries like India, Algeria and Turkey, which have been exposed to West, some of its sections become outdated and require re-writing; they, he insisted, should develop new laws. He disowned the legal disabilities against non-Muslims as having no real theological basis. He also considered jihād as a defensive mechanism irrelevant to the development of modernist Islam.³⁸ For him, all references of the Qur'ān with regard to the sword was false, meant only to malign Islam as the Qur'ān itself declared in unequivocal words that 'there is no compulsion in religion'.³⁹

He pleaded for religion-politics dichotomy as the Prophet, in his opinion, never mingled religion with state.⁴⁰ With regard to the real politics of the Colonial India, Chiragh Ali, like his master Sir Syed followed a loyalist. He generally opposed the Muslim participation in the Congress as well as their subscription to the view of pan-Islamism. However, he was sympathetic with certain aspects of nationalist movement, such as inter-communal harmony and peaceful coexistence with Hindus.⁴¹

Shibili Numani and Historical Glorification

Shibili Numani (1857-1914) strived to establish a synthesis between the extreme orthodoxy of traditional *ulama* and extremist modernism and naturalism of western educated intelligentsia. He favoured of English education and modernisation of certain social institutions, but to the extent that it did not harm the religious foundations of Islam. He discarded the superfluous and the ridiculous things crept into the Indian Muslim while adhered to essentials of *Deen*.

He was the driving force behind the establishment of *Nadwat al-Ulama* at Lucknow as a synthesis between the orthodoxy of Deoband and modernism of Aligarh. He admired many things in the Western civilisation and did not mind to borrow the ideas and institutions from Europe or for that matter from anywhere, but only if these were absolutely essential for the regeneration of Islam. However, he was to measure the Western ideas and values by the Islamic yardstick. Hence, he disagreed with Sir Syed in many of his theological interpretations. For instance, he, in quite contrast to Sir Syed, considered reason as the handmaid of religion.⁴²

With regard to the treatment of non-Muslim subjects, he suggested liberal measures. He discarded discriminatory practices against *dhimmi*s in erstwhile Islamic states as the personal attitude of the rulers, not essentially Islamic.⁴³

Shibili popularised the concept of Islamic historiography among Indian Muslims with a profound aim to revive the glories of Islam, at least in the hearts and minds of the new generation. He tried hard to establish a synthesis between traditional Islamic sciences with the modern Western one. He appreciated Orientalists' research towards cultural and religious resources of Islam to establish a historical as well as scientific perspective simultaneously to the Islamic studies.⁴⁴

Shibili has taken the refuge of history with two fold aims: one, to bring the Muslim community out of dismay and gloom that became its destiny since the unsuccessful War of 1857, by reminding their past glories. secondly, to convince the '*ulama* that in the earliest period of Islam, even in the reign of orthodox caliphs, several ideas and institutions have been borrowed from different sources alien to Islam, and he succeeded to a considerable extent in both his objectives.

Muhammad Ali Jauhar & Khilafat Movement

Muhammad Ali Jauhar (1879-1930) was a Pan-Islamist in action. His loyalty towards Islam was beyond the national considerations. At the onslaught of European powers over the Ottoman Empire he represented the anguish and anxiety of Indian Muslims regarding the fate of Caliphate, which had been regarded as the symbol of secular power and unity of Muslims worldwide. During the First World War, he, in his *Comrade*, begged the Allies to win over the Turks by compensating the losses inflicted upon them, in order to keep them away from the Germans. Despite these appeals, the Britain wrested many of Turkish territories from her, which shocked the Muslim opinion in the subcontinent. Yet, the Muslims still believed that they could pressurise the British and this could bring good to their Turkish brethren. Hence, they, under the leadership of Muhammad Ali, caused, in 1920, the *Khilāfat*

³⁵ *Ibid*, p. 242.

³⁶ Aziz Ahmed, pp. 57-61.

³⁷ Zakaria, p. 242.

³⁸ Aziz Ahmed, pp. 59-62.

³⁹ Zakaria, p. 242.

⁴⁰ *Ibid*, p. 242.

⁴¹ Aziz Ahmed, p. 65.

⁴² Zakaria, pp. 251-253.

⁴³ Aziz Ahmed, pp. 81-83.

⁴⁴ *Ibid*, p. 78.

movement.

Congress, at that moment, was keen to attract Muslim support. In fact, it had been since its inception, in 1885, striving to draw the Muslims towards it to cast off the Hindu colour and to present itself as a true representative body of all the Indians. The *Khilāfat* question provided an excellent opportunity to it. Hence, it decided to take the matter as its own. The entire nation under the dual leadership of Gandhi and Muhammad Ali stood united for the Turkish cause. However, this alliance could not last long as the Muslims turned hostile towards the congress again when it took-back the non-cooperation movement on the excuse of infiltration of violence into it, while Muslim masses, including Muhammad Ali, considered it as a lame excuse and moved further away from the Congress. The *Khilāfat* movement hung up until the Turks themselves abolished the Caliphate in 1924. Muhammad Ali died during his visit to London to attend the first Round Table Conference.⁴⁵

Obaidullah Sindhi and Hijrat Movement

Maulana Obaidullah Sindhi (d. 1944), a convert from Sikhism and a prominent disciple of Maulana Mahmud al-Hasan (1851-1920) was a real dynamic. He, besides taking part in the *Reshmi Rumal ki Tehreek*, initiated another movement called as *Hijrat* Movement. This movement regarded India as *dar al-harb* and encouraged Muslim-migration to any of the Muslim countries, preferably to Afghanistan. At Kabul, he succeeded in establishing a government-in-exile with several associates of the 'Ghadar Movement'.

On the political side, he followed the composite nation theory of Deoband Ulama as a bargaining strategy for achieving independence. He was first to develop the idea of linguistic nationalities in India. He envisaged free India as a confederation of linguistic and cultural nationalities.

Among the leading theories, socialism attracted him most. Astonishingly, he attributed this idea to the certain writings of Shah Waliullah. In his view, Islam was basically and inherently socialistic. He has seen the Communist revolution in the USSR as close to Islam. He envisaged that the Muslims should themselves evolve a mechanism based on *deen* to establish economic justice in the society. *Jihād*, for him, was the basis of organisation of Islamic social revolution. However, this should be achieved through non-violent method. He identified victory to Islamic social revolution on social scale as fulfilment of God's blessings on earth.

The difference, in his view, between the social revolution preached by Islam and communism was that the former believes in God while the later denies him. He connotes the Qur'ānic concept of *Jama'a* with Communist concept of revolutionary party.⁴⁶

Iqbal and Pan-Islamism

Allama Iqbāl (1875-1938), a one-in-all personality of the Muslim intelligentsia, was in fact an embodiment of the orthodox Orientalism and modern Occidentalism. He was convinced that a reconstruction of shariah had become essential due to the revolutionary changes in modern times. The traditional interpretations were good for the times in which they were made but in the context of the modern conditions, they become obsolete. He felt the need of a great *faqih* who could interpret Islam correctly in the light of new developments. According to some sources he put his hopes on Maududi.

Iqbāl suggested certain valuable reforms as an immediate concern, for instance, the proper protection of the rights of women and their education. He supported *pardah* and polygamy; condemned wasteful expenditure in Muslims marriages and other ceremonies. He pursued the Muhammadan Educational Conference to establish a Reforms Section under its auspices.

In the field of education, Iqbāl stressed upon the industrial education. In his view, there was no hope of progress without it.⁴⁷ However, he opposed neither traditional theological education nor modern education of general nature.

Iqbāl's contribution to the legal thought of Islam was his advocacy for widening of the span and weight of *Ijmā'* and *Ijtihād*. He envisaged that the power of *Ijtihād* should be taken from the individual representatives of different schools of jurisprudence and vested in a representative assembly of Muslims. The consensus reached in such a body was *Ijmā'* for him. He approved amendments in the Muslim law. In his view, it can be adjusted in accordance with the exigencies of the present society, as he thought it a non-sacred or this-worldly element of Islamic faith. For him, the freezing of Islamic Law by the so-called *masalik* or *mazahib* is an artificial phenomenon. This can be addressed by returning to the *Ijtihād*.⁴⁸

In his view, Islam is a moral ideal along with a specific type of state by which he means a society under a legal system and a moral ideal.⁴⁹ He was against religion-politics dichotomy since he was convinced that in Islam there is no such duality between spirit and matter, consequently, between Church and State. According to him, both were organic to each other. He rejected the idea to limit the religion in the private sphere of the individual life. He envisaged that the Prophet's experiences created a society or social order that in turn provided us basic outlines of a state with implied legal ideology. Hence, the spiritual objective of the Islam is so imbedded in its social order that one's rejection would gradually lead to the others negation. He was not content with accepting Islam in private life but rejecting the same in congregational matters and establishing separate national identities on the basis of region or race, colour or clan.

He was against the establishment of national states among Muslims and considered it as against the humanising and universalising spirit of Islam. On the contrary, he advocated al-Afghani's Pan-Islamism. In his narrative poem, *Jawed Nāma*, he presented his ideal Islamic state in the words of al-Afghani.

Nevertheless, he did not see any contradiction between pan-Islamism and demand for Pakistan as he considered the Indian case a distinct one. He rejected the idea of a composite nation of all Indians communities on the basis that establishment of a state on

⁴⁵De Bary, pp. 216-220.

⁴⁶Aziz Ahmed, pp. 195-201.

⁴⁷Zakaria, pp. 259-262.

⁴⁸Aziz Ahmed, pp.154-155.

⁴⁹*Ibid*, p. 160.

national considerations was unimaginable to a Muslim as it gives priority to other things over Islam. He, in unequivocal words, condemned Maulana Hussein Ahmed Madani for his statement that a composite nation could be constituted in India based on homeland.⁵⁰ He pointed out that in modern terminology homeland was a political concept that contradicted with Islam. In his view, the moral consciousness, emotional and psychological homogeneity that was required to constitute the essence of nation was not present in India.⁵¹ He suggested an autonomous province comprising of Muslims majority provinces of the subcontinent under an Indian federation to solve the communal problem. In his view, the diversity between Hindu and Muslim communities is a undeniable fact and it must be recognised, otherwise, it would harm both the communities.⁵² He writes:

“I would like to see the Punjab, North-West Frontier Province, Sind and Baluchistan amalgamated into a single State. Self government within British Empire, or without British the British Empire, the formation of a consolidated North-West Indian Muslim state appears to me to be the final destiny of the Muslims, at least of North-West India.”⁵³

Later this idea, in the hands of Jinnah, eventually led to the Pakistan Resolution for a sovereign Muslim State.

Maulana Ilyas and Tablighi Jamat

Maulana Muhammad Ilyas Kandhalvi (1885-1944) founded the Tablighi Jamat, in late 1920s, at Mewat as an apolitical and purely missionary movement. According to him, he inspired by a dream during the Hajj in 1926. The word ‘*Tabligh*’ means ‘to propagate’; so *Tablighi Jamat* stands for an organisation to propagate Islam.

However, its sphere of activity has been, right from its establishment, limited to the Muslim community only. Maulana Ilyas’ motto was ‘*Aye Musalmano! Musalman Bano*’, (‘O Muslims! Become real Muslims’). He had the opinion that the first priority should be given to develop true Islam among Muslims. He aims to revive the Muslim society by inculcating practice of basic obligations of Islam, especially the *Namaz*. He enunciated six-point formulae to be followed in order to become true Muslims. These are:

1. Firm belief in the Kalimah
2. Concentration and Devotion in prayer
3. ‘Ilm (knowledge) and Dhikr (to remind the God)
4. Respect towards Muslims
5. Ikhlas-e-Niyyat (good intent)
6. Dawat wa Tabligh (conveying of the message and propagation)

Tabligh was essentially a deobandi in its tenants but neither the Jamat nor the Darul uloom ever acknowledges this fact. Further, in many places even Ahle Hadees have associated with it. In fact, it was formed in turbulent period when there was a general feeling that the Muslims would perish their identity if they did not practically adhere to their religion.

After Maulana Ilyas’ demise (d. 1944), Maulana Muhammad Yusuf Kandhalvi (1917-65) became second *Amir*, followed by Maulana Inamul Hassan (1965-95). Now, in India, the Jamat is divided into two factions namely *Shurai* and Nizamuddeni has been headed by Maulana Sa’ad sahib while as the *Shurai* group was under the collective leadership of number of senior Maulanas of the jamat. *Fazail-e-Amal*, composed by Maulana Zakriya has been practically the basic literature of the Tabligh.⁵⁴

Inayatullah Mashriqi & Khaksar Tehreek

Inayatullah Mashriqi (1888-1963) was the founder of *Khaksar Tehreek*. He believed that there could not be any conflict among the basic teachings of various religions because if such a thing existed, it would mean that the Creator have been sent conflicting messages to the same creation. He examined the basic principles of different religions and concluded that all prophets’ teachings were closely related to the evolution of humankind as one and united specie, in contrast to animal species. He couldnot believe there was a contradiction and conflict in the Universe, and he couldn’t believe the battle between religions was true. If such a thing existed, then either religion was a lie, and the messenger was an impostor who misled and upset society, or he was misprojected by his followers. In his opinion, Religions were basically the Science of collective evolution of humankind and the purpose of prophets was to unite the humanity, not to divide them; the basic principles of all religions are one and the same.

In 1930, Mashriqi founded the Khaksar Tehreek after retiring from the British service. He was instrumental in steering the Muslims toward freedom. Mashriqi, his family, and a considerable number of Khaksars were frequently imprisoned. In 1938, he announced a fourteen point-charter in which the first is as follows:

“We *Khaksars* are determined to establish, by destroying all sectarian feelings and religious bigotry (but keeping religion intact), an egalitarian, non-partisan and tolerant order which would ensure a fair deal to all nations and their rightful growth, and which will be based on virtue, struggle, action and supreme justice.”⁵⁵

In this critical situation, the two centres of Muslim education and thought, viz. Deoband and Aligarh, ‘the two facets of the theological heritage of Waliullahi tradition’,⁵⁶ presented two different and extremely antagonistic approaches.

⁵⁰Iqbāl, Tasadduq Hussein Tāj, ed. *Madhāmīn-e-Iqbāl*. pp. 180-196.

⁵¹Aziz Ahmed, pp. 156-163.

⁵²De Bary, pp. 211-215.

⁵³*Ibid*, p. 215.

⁵⁴“Tablighi Jamat” *Wikipedia*, Electronic edn, 2008; Alex Alexiev, ‘Tablighi Jamāt: Jihad’s Stealthy Legions’, in *Middle East Quarterly*, Winter 2005, vol. XXII. No.1.

⁵⁵“Mashriqi”, *Wikipedia*, Electronic edn, 2008

⁵⁶Mawlana ‘Obaid Ullah Sindhi remarked that the *Dar al-‘Uloom*, Deoband and Muhammadan Anglo-Oriental College, Aligarh are two facets of Waliullahi tradition, Aziz Ahmed, p. 104.

Jamiyat ul Ulama & Composite Nation Theory

There was, on one hand, the Composite Nation Theory or United Indian Nationalism, presented by Indian National Congress and seconded by *Jamiyat-e-'Ulama-e-Hind*, founded in 1919, by the '*Ulama*' of Deoband, Nadwah and Firangi Mahal under the leadership of Maulana Hussein Ahmed Madani.⁵⁷ Maulana Rashid Ahmed Gangohi, Maulana Mahmood al-Hasan and Maulana 'Obaidullah Sindhi, were under the impression that an armed struggle was inappropriate at that time, also subscribed to that theory.⁵⁸ This theory advocates that the Hindus and Muslims of the Indian subcontinent together constitute a composite nation as they share the same homeland. Hence, they should live united under single government in a single sovereign state, by a federal arrangement, with their respective religious identities.⁵⁹ It considers the homeland as the very core of the nationalism. Hussein Ahmed pronounced:

"We, the inhabitants of India, in so far as we are Indians, have one thing in common and that is our Indianness which remains unchanged in spite of our religious and cultural differences. As the diversities in our appearances, individual qualities and personal traits and colour and stature do not affect our common humanness, similarly, our religious and cultural differences do not interfere with our common associations with our homeland. - - - - This is what I mean by the '*Muttahidah Qawmiyat*'.⁶⁰

Maulana Abul Kalam Azad (1888-1958), a Congress-man by conviction, provided a theological basis for this theory. He connoted the situation in India with that of Medina immediately after the *Hijrah*. According to him, in the Covenant, concluded between the Prophet and the people of Medina, Muslims as well as Jews and Pagans were described as a single community. He presented it as a precedent to constitute the composite nation of all the Indians irrespective of their religion.⁶¹

It was obvious that the Jamiyat had been advocating geographical considerations, instead of religious affiliation, as the basis for the constitution of a nation. Hence, it, on this basis, repudiated the very idea of Pakistan. Jamiyat's anxiety about the demand for Pakistan was three-folded;

- Firstly, it was suspicious about the British designs.⁶²
- Secondly, it was anxious about the safety and security of the Muslims left in India as minorities after the division.⁶³
- Thirdly, it was thinking with a missionary viewpoint that the division will surely cease, or at least impede, their objective of the propagation of Islam among the Hindus.⁶⁴

Maulana Hussein Ahmed Madani wrote in this regard:

"And Islam being a missionary religion, it is its duty, so far as possible, to absorb others in itself, not to reject them. This is why we should not hate our neighbouring peoples even if they hate us, if they call us unclean and impure."⁶⁵

"The great object of an over-all spread of Islam in the whole of India cannot be realised by appealing to passions of hatred and antagonism. It is the non-Muslims who are the field of action for the '*tabligh*' of Islam and form the raw material for this splendid activity. Today, by propagating hatred towards the Hindus, this field is being closed and this material wasted. It is contrary to the universal message of our great Prophet."⁶⁶

"Our object is to bridge the gulf of hatred, which is being created by the protagonists of the scheme of Pakistan. We are opposed to the idea of limiting the right of missionary activities of Islam within any particular area."⁶⁷

Objectives of the Jamiyat involved the preservation and promulgation of shariah in the Indian sub-continent. Though, shariah in this regard was limited to a mere application of the Islamic personal law into the private lives of Muslims. It was suspicious that the Western educated leadership of the League would not allow it to enforce even this abridged version of shariah and would impose their modernist alterations and naturalist interpretations in its proposed Muslim state. They felt more secure in India than in Pakistan. Although, some of the league-leaders have given the assurance that Pakistan would be an Islamic State, but Jinnah's statements ran

⁵⁷ It is noteworthy that a small section of the ulama-e Deoband was against the composite nation theory and collaboration with the Congress. Mawlana Ashraf 'Ali Thanawi (1863-1943) was the leader of this group. He along with Mawlana Shabbir Ahmed 'Uthmani and few other ulama-e-Deoband defected from the Jamiyat ul Ulama e Hind and established Jamiyat ul Ulama e Islam in 1946. They with the blessings of Mr. Jinnah counteracted the formers' activities. However, the bulk of the Deobandi ulama were against the demand for Pakistan. Faruqi, pp. 102-103, n. 4.

⁵⁸ Aziz Ahmed, p. 190.

⁵⁹ *Ibid*, p.104.

⁶⁰ *Ibid*, pp. 103-104.

⁶¹ *Ibid*, p. 189.

⁶² *Ibid*, pp.106-111.

⁶³ *Ibid*, pp. 111-114.

⁶⁴ *Ibid*, pp. 114-115.

⁶⁵ *Ibid*, p. 116.

⁶⁶ *Ibid*, p. 117.

⁶⁷ *Ibid*,

contrary to it.⁶⁸ He declared his secular policy unequivocally in some of his speeches:

“You may belong to any religion or caste or creed- that has nothing to do with the business of the State. - - You will find that in course of time Hindus would cease to be Hindus and Muslims would cease to be Muslims, not in the religious sense, because that is the personal faith of each individual, but in the political sense as citizens of the State.”⁶⁹

The ulama belonging to Jamaiyat were aware of the fact. Therefore, they were unwilling to support a sheer worldly scheme that, in their view, has no relevance to Islam, rather, harmful in terms of the future of Islam and Muslims in Hindu-India.

Khudai Khidmatgar

Another close ally of Congress among the Muslim organisations was *Khudai Khidmatgar* founded by Khan Abdul Ghaffar Khan, a Pakhtoon popularly known as Sarhadi Gandhi, in the Second decade of Twentieth century, with a strong belief in Gandhi ji's notion of non-violence. He regarded it as the true religion of the Prophet. He addressed his fellow men:

“I am going to give you such a weapon that the police and the army would not be able to stand against it. It is the weapon of the Prophet, but you are not aware of it. That weapon is patience and righteousness. No power on earth can stand against it.”

Over one-lakh members joined the organisation and became a legend for their peaceful opposition. However, they suffered a lot in the hands of the British army and police. On April 23, 1930, The British opened fire in Peshawar on the unarmed Khudai Khidmatgars gathered to protest against the arrest of their leader. This brutal incident killed 200-250 *Khudai Khidmatgars*.

Through political setup, strikes, and non-violent opposition, this organisation has achieved some success and become a dominative force in the NWFP. The political wing of the movement was led by Ghaffar Khan's brother Dr. Jabbar Khan. He was Chief Minister of the province for more than two decades, roughly from the late 1920s to 1947. After the independence Jinnah dismissed his government for his inclination towards India.

Ghaffar Khan was a staunch opponent of the partition. As the leader of Pakhtuns he was more comfortable in India than Pakistan. Hence, in 1946, he was attacked by the supporters of partition at Peshawar. He had been always labelled as anti-Pakistani and kept under house arrest by all successive Pakistani governments till his death in 1985.

Muslim League & Muslim Nationalism

Muslim League, founded in 1906,⁷⁰ comprising largely of Aligarh based English-educated Muslim elite,⁷¹ under the leadership of Muhammad Ali Jinnah, on the other hand, presented its ‘Two Nation theory’ which insisted that the Indian Muslims were a nation in itself, distinct from the Hindus and other communities by any definition of a nation and by all canons of International law. Jinnah argued that Indian Muslims have their own culture, civilisation, language, literature, art and history, therefore, they are a nation in their own and require a sovereign homeland for them, consisting of the Muslim majority areas of the subcontinent.

The League under the leadership of Muhammad Ali Jinnah launched a massive Pakistan Movement, in 1940, to pressurise the British to divide India into two sovereign states; one for Hindus and other for Muslims, before leaving the country. This demand reflected the sentiments of middle class Muslims who, being backward in all spheres, were frightened with their Hindu counterparts in an independent India. It was the outcome of the mixed feeling of fear and pride; fear of all sorts and the pride of being the erstwhile lords of the subcontinent.

Muslim League raised the cry of ‘Islam is in danger’ to attract the masses. Soon it became a popular goal, in the Muslim-dominated provinces, to be achieved at any cost.⁷² Jinnah was ready to sacrifice the twenty million Muslims living as minorities in different parts of India in the interests of the Muslim majority provinces.⁷³

It is in this theo-political context, at the advent of the fifth decade of the twentieth century, that Maudūdi presented his own theory of comprehensive Islam that at once rejected all the above. In his view, Islam descended to establish God Almighty's Will all over the earth, hence, acquiring just a piece of land for Muslims was out of context and un-Islamic. Muslims were distinct from Hindus but they were not a nation in western sense; they were rather *Ummah*, i.e. an ideological party; a party with a specific mission, namely propagation of Islam across the globe.

Maulana Maududi & Jamat-e-Islami

On 26th August, 1941 Maulana Maudūdi formally established the *Jamat-e-Islami* at Lahore to mobilise the Muslim Ummah towards a real essence of Islam. He adopted a Qur'ān-&-Sunnah-enlightened-rationalistic approach. In his opinion Muslims are not a nation but an *Ummah*, meaning of which is close to a ‘party’. He regarded nationalism as opposed to Islam. He opposed both Composite nationalism and separatism. He opposed identifying Islam with any other theory or ideology. state’ on the basis of Islam.⁷⁴

⁶⁸Faruqi, pp. 118-120.

⁶⁹*Ibid*, p. 121.

⁷⁰Zakaria, p. 110.

⁷¹It is noteworthy that entire western educated Muslim intelligentsia was not behind the demand for Pakistan. A secular minded group, having luminaries such as Muhammad ‘Ali Jauhar, Abul Kalam Azad, Zakir Hussain, Muhammad Mujib, ‘Abid Hussein in its fold, stood for the composite nationalism. (Aziz Ahmed, p. 194)

⁷²*Ibid*, pp. 94-95.

⁷³*Ibid*, p. 112.

⁷⁴*Ibid*, p. 52.

Maududi's ideology begins, revolves round, and runs with *Hakimiyat-e-Ilahia* (Divine Sovereignty) and *Iqamāt-e-Deen* (establishment of Islam). He envisages a Universal State that would be beyond the geographical and racial considerations. His justification for this state has been '*al-ardhu li-llah, al-mulku li-llah*, i.e. the land belongeth to God Almighty, hence, the right to rule belongeth to God Almighty alone. In fact, the need and justification for an Islamic state, for him, follows from the nature of universal order. It is a part of a broad integrated theology that is based upon the Sovereignty of the very Creator of the Universe. In Maudūdi's view, this Sovereignty has been enforced automatically in the physical and natural sphere of life. However, in volitional life, the human beings have physical liberty to acknowledge his sovereignty or refuse to do so, but morally they are bound to acknowledge as they have concluded an agreement with Him on the *Yaom-e Alast*.⁷⁵ However, he was inclined to a peaceful way through propagation and persuasion to establish the Islamic state. Hence, after establishment of Pakistan he migrated to it and took active participation in its *realpolitik* and influenced the formation of Pakistan-constitution.


Conclusion:

The above analysis shows how confused Muslims were there after the failure in the first War of Independence. There was no unified and dynamic leadership at this juncture. Various leaders have presented their own solutions and approaches on the basis of their own understanding of the problem. Maulana Mahmud ul Hasan adopted the path of armed struggle against the new regime but in vain. Maulana Nanotawi thought it would be wise to resort to *Dars wa Tadrees* in the unfavourable situation but not to forget the actual aim of revolution. Later, disciples of his school favoured composite nation theory while as Iqbal and Jinnah rejected this and presented a vertical division of India on the basis of religion. Meanwhile, intellectuals like Iqbal and Afghani, and Maulana Obaidullah Sindhi presented their own solutions in the form of Pan- Islamism and Islamic Socialism respectively. Various Ahl-e-Hadees movements and Maulana Ilyas's Tablighi Jamat found the solution in religious Puritanism and revivalism respectively. However, Maulana Maududi's approach was unique and all-embracing at once. He neither rejected any of the above approaches in toto nor adopted any of that in whole, with exception of rejection of Islamic Socialism. He presented Islam as a complete scheme or system of life that engulfs all the aspects of the life, spiritual as well material, individual as well congregational, social as well as political. He rejected the composite nation theory on the ground that the Muslims have a separate identity and a nation on their own, that is called by him as Muslim Ummah. Simultaneously, he rejected the demand for a Muslim Homeland on the ground that it would not be appropriate for a nation like Muslim Ummah to have homeland like other western nations. He also stressed upon Islamic Puritanism and reviving the Quran and Sunnah but did not go to the extent of Ahl-e-Hadith. However, his ideas could not gain popular support among Muslims as it lacks a short term achievable goal.

⁷⁵The Day of Covenant. Qur'ān claims that Almighty drew the souls of all the human beings whom He intended to create until the Day of Judgment and made them testify. All have taken the oath of allegiance that they would obey and worship Him.

FULL PAPER

Study of Anti-Apoptotic mechanism of Ruthenium (II) Polypyridyl Complexes via RT-PCR and DNA binding

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A set of novel mononuclear polypyridyl complexes of Ru (II) with N – N donor ligands 1, 10 phenanthroline (phen), 2, 2' bipyridine (bpy), 4, 4'-dimethyl 2, 2' bipyridine (dmb) and an intercalating ligand (bnpip = 2-(4-butoxy-3-nitrophenyl)-1*H*-imidazo [4,5-*f*] [1,10] phenanthroline) have been synthesized and characterized by various spectral methods. The RT - PCR assays suggest that ruthenium (II) complexes inhibit MCF-7, breast cancer cell line by inducing apoptosis via inhibition of cell cycle check points cyclin D, cyclin E and also upregulation of caspase 8 (protein involved in late Apoptosis). Further the binding potency of Ru (II) complexes were investigated using various spectroscopic techniques like UV-visible, fluorescence and viscosity studies. The complex binds to DNA in an intercalative mode as confirmed by viscosity data with differential binding strength. All complexes show cleavage of the pBR322 DNA through a singlet oxygen production. Theoretical evidence via docking of the complex with DNA reveals the significant residues of binding as guanine.

KEYWORDS

DNA binding, molecular docking, morphology, Photocleavage, RT-PCR

1 | INTRODUCTION

Although cancer growth existed throughout the previous couple of decades, it is as yet one of the real reasons for death around the world. Till today, the most dependable remedy for disease is to expel or to obstruct the expansion of dangerous tissues. The revelation of cisplatin inhibition of DNA replication and cell division has shown that metal complexes can expect a unique function in the treatment of malignant growth, opening permeability for anticancer research dependent on metallopharmaceuticals.^[1,2] Many metal complexes, for example, cisplatin, carboplatin and oxaliplatin were researched for their anti-tumor properties against a wide scope of

tumors.^[3] In the journey of anticancer drugs containing metals other than platinum, ruthenium compounds exhibiting most promising ones.^[4] Because of its ligand exchange kinetics of metal complexes in aqueous solution, which are similar for Pt (II) complexes.^[5] Ruthenium with its variable oxidation states, low poisonous quality, high selectivity for malignant growth cells due to its capacity to mimic iron to biomolecules.^[6,7] In fact, the cellular uptake of ruthenium (III) gives off an impression of being mediated by transferrin.^[8] Iron prerequisite is more prominent for quickly isolating cells (cancer cells), this outcome in up-regulation of the number of transferrin receptors on the cell surface. An expansion in the ruthenium fixation in malignancy cells when compared

with healthy cells has been confirmed in-vivo.^[9] In the meantime, as the medication is focused to disease cells, its harmfulness is decreased in light of the fact that less of it achieves the sound cells.

Ruthenium complexes are straight away analyzed for their utility as DNA structural tests, DNA foot printing, sequence specific cleavage operators and potential anticancer medication. The Interaction of small molecules with DNA has been concentrated widely, as it is material of legacy, controls the structure and capacities.^[10] Ruthenium (II) complexes of dipyrindophenazine (dppz) ligand were studied widely due perhaps to their potent DNA binding and high cytotoxicity.^[11–13] Ruthenium complexes containing imidazole and indazole are potent against various tumors.^[14,15] After broad preclinical tests, the compounds [indH][transRu(N-ind)₂Cl₄] (KP1019) and [imiH][trans-Ru(N-imi)(S-dmsO)Cl₄] (NAMI-An) entered the clinical preliminaries.^[4] The clinical studies revealed that NAMI-A causes skin blisters and results in intense pain,^[16] and with KP1019 the low solubility, makes it challenging to set dosage in clinical trials.^[17] Our research group reported few ruthenium (II) polypyridyl derivatives and their DNA binding investigations with several intercalating ligands.^[18–21] Yun-Jun Liu et al., also published ruthenium (II) polypyridyl complexes with different ligands, DNA binding behaviour and their anticancer properties.^[22–27] In the present article, we report the synthesis, characterization, binding capacities and mode of binding of three new ruthenium (II) complexes. In order to understand mode of action and the mechanism of apoptosis of the [Ru (phen)₂(bnpip)]²⁺, [Ru (bpy)₂(bnpip)]²⁺ and [Ru (dmb)₂(bnpip)]²⁺, we performed cell death assays, MTT assay and Annexin V staining and RT PCR to evaluate the up-regulation of pro-apoptotic genes and down regulation of anti-apoptotic genes.

2 | EXPERIMENTAL SECTION

2.1 | Materials

RuCl₃.xH₂O, 1,10-Phenanthroline, 2,2'-bipyridine, 4,4-dimethyl 2,2'-bipyridine, and 4-butoxy-3-nitrobenzaldehyde were purchased from Sigma Aldrich. The super coiled (CsCl purified) pBR322 DNA (Bangalore, Genie, India) was used as received. All other chemicals and solvents were acquired from neighbourhood sources. Every solvent was sanitized before use according to standard systems.^[28] The spectroscopic titration was done in the Tris-buffer (5 mM Tris-HCl, 50 mM NaCl, pH 7.2) at room temperature. DNA was dissolved in Tris-HCl buffer (pH = 7.2).

2.2 | Analytical measurements

The UV-visible absorption studies were carried out on Shimadzu UV-2600 spectrophotometer for the determination of K_b values. IR data is recorded as KBr disks on a Perkin-Elmer FT-IR-1605 spectrometer. For NMR, Bruker 400 MHz NMR spectrometer with high resolution probe Z was used for NMR studies, sample was dissolved in DMSO-*d*₆ and referencing is relative to TMS (¹H and ¹³C). Compound purity was confirmed by elemental analysis with Perkin-Elmer 240 elemental analyzer for Micro analysis (C, H and N). Luminescence measurements were carried out on Cary Eclipse spectrofluorometer using a 1 cm path length. Viscosity studies are carried out utilizing Ostwald viscometer.

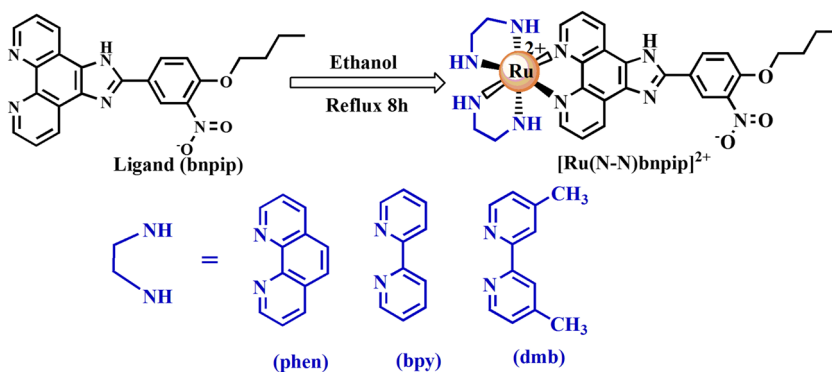
2.3 | Synthesis

The starting materials 1,10-phenanthroline-5,6-dione (phendione), cis-[Ru(N-N)₂Cl₂], Where N-N = phen, bpy and dmb were synthesized according to literature.^[29,30] Schematic drawing of ruthenium (II) complexes were shown in Scheme 1.

2.3.1 | Synthesis of ligand (bnpip)

The ligand was prepared according to the methodology in the literature.^[31] A mixture of phendione(0.53 g, 2.50 mM), 4-butoxy-3-nitrobenzaldehyde(0.6527 g, 3.50 mM), ammonium acetate (3.88 g, 50.0 mM) and glacial acetic acid (15 ml) was refluxed together for 4 hr. The above solution was cooled to room temperature and diluted with distilled water, drop wise addition of concentrated NH₃ to the solution leads to formation of yellow precipitate, which was gathered, washed with H₂O and dried. The crude product recrystallized with C₅H₅N.H₂O and dried (yield: 93.45%). Anal. data for C₂₃H₁₈N₅O₃: calc. C, 66.98; H, 4.40; N, 16.98; found: C, 66.51; H, 4.45; N, 16.62. ES⁺- MS Calc: 413.15; found: 414.30 [M + H]⁺(S10). ¹H NMR (DMSO-*d*₆, 400 MHz):δ 8.96(d, 2H), 8.74(d, 2H), 8.61(s, 1H), 8.34(d, 1H), 7.72(t, 2H), 7.41(d, 1H), 4.15(t, 2H), 1.72(q, 2H), 1.47(m, 2H), 0.95(t, 3H) (S4). ¹³C[¹H] NMR (100 MHz, DMSO-*d*₆, d, ppm): 152.17 (2C), 148.19 (1C), 147.57 (1C), 143.42 (2C), 139.07 (2C), 134.75 (1C), 131.72 (1C), 129.38 (1C), 126.31 (2C), 123.24 (1C), 122.99 (2C), 122.33 (2C), 115.46 (1C), 69.15 (1C), 30.38(1C), 18.50 (1C), 13.53 (1C)(S7). IR (KBr, cm⁻¹): 3093 (ν, N-H), 2956(ν, C-H), 1531 (ν, N-O), 1450 (ν, N-O), 1070 (ν, R-O-C)(S1).

SCHEME 1 Synthetic route the preparation and structures of ruthenium (II) complexes(1–3)



2.3.2 | Synthesis of complexes

[Ru(phen)₂(bnpip)](ClO₄)₂·2H₂O (1)

Cis-[Ru(phen)₂Cl₂].2H₂O (0.284 g, 0.5 mM), bnpip (0.206 g, 0.5 mM) and ethanol (15 ml) were refluxed at 120 °C under N₂ atmosphere for 8 hr. A light purple colour solution was obtained, it was cooled to room temperature and few drops of saturated aqueous NaClO₄ solution was added for neutralization with vigorous stirring. The Brick red solid was collected and rinsed with small amount of water, ethanol and diethyl ether, then dried under vacuum (yield: 94.91%). Anal. data for RuC₄₇H₃₈Cl₂N₉O₁₃: cal. C, 50.91; H, 3.45; N, 11.37; found: C, 50.12; H, 3.48; N, 11.15. ES⁺-MS cal: 875.19; found: 874.47(S11). ¹H NMR (DMSO-*d*₆, 400 MHz) δ 8.77 (d, 6H), 8.40(s, 1H), 8.16(d, 6H), 8.09(d, 1H), 8.03(d, 4H), 7.78(t, 6H), 7.62(d, 1H), 4.23(t, 2H), 1.70(q, 2H), 1.45(m, 2H), 0.92(t, 3H)(S5). ¹³C[¹H] NMR (100 MHz, DMSO-*d*₆, d, ppm): 152.80 (1C), 152.60 (1C), 150.45 (1C), 147.20 (6C), 145.47 (2C), 139.33 (4C), 136.80 (6C), 132.25 (1C), 131.47 (1C), 130.41 (4C), 128.60 (1C), 128.03 (4C), 126.25 (2C), 122.85 (2C), 121.59 (6C), 116.04 (1C), 69.38 (1C), 30.29 (1C), 18.47 (1C), 13.53 (1C) (S9). IR (KBr, cm⁻¹): 3414 (ν, N-H), 2956(ν, C-H), 1529 (ν, N-O), 1427 (ν, N-O), 1083 (ν, R-O-C), 628 (ν, Ru-N)(S2).

[Ru(bpy)₂(bnpip)](ClO₄)₂·2H₂O (2)

This was synthesized adopting the procedure as explained for complex 1 above by taking cis-[Ru(bpy)₂Cl₂].2H₂O (0.260 g, 0.5 mM) and bnpip (0.206 g, 0.5 mM) (yield: 81.34%). Anal. data for RuC₄₃H₃₈Cl₂N₉O₁₃: cal. C, 48.69; H, 3.61; N, 11.88; found: C, 48.18; H, 3.39; N, 11.63. ES⁺-MS cal: 827.19; found: 826.36(S12). ¹H NMR (DMSO-*d*₆, 400 MHz): δ 9.13(d, 2H), 8.81(d, 4H), 8.64(s, 1H), 8.43(d, 4H), 8.16(t, 4H), 8.08(d, 2H), 7.85(d, 1H), 7.73 (t, 2H), 7.68(d, 1H), 7.53(t, 4H), 4.26(t, 2H), 1.77(q, 2H), 1.51(m, 2H), 0.97(t, 3H)(S6). ¹³C[¹H] NMR (100 MHz, DMSO-*d*₆, d, ppm): 166.90 (4C), 156.47 (1C), 152.79 (1C), 151.15 (6C), 145.26 (2C), 139.15 (1C), 137.86 (4C), 134.98 (1C), 132.13 (2C), 131.47 (2C), 128.60 (6C), 127.83 (2C), 126.90 (1C), 125.44 (1C), 124.40 (4C), 115.93 (1C), 69.38

(1C), 30.37 (1C), 18.53 (1C), 13.82 (1C). IR (KBr, cm⁻¹): 3415 (ν, N-H), 2956(ν, C-H), 1531 (ν, N-O), 1463 (ν, N-O), 1085 (ν, R-O-C), 626 (ν, Ru-N)(S3).

[Ru(dmb)₂(bnpip)](ClO₄)₂·2H₂O (3)

This was synthesized adopting the procedure as explained for complex 1 above by taking cis-[Ru(dmb)₂Cl₂].2H₂O (0.288 g, 0.5 mM), bnpip (0.206 g, 0.5 mM) (yield: 81.34%). Anal. data for RuC₄₇H₄₆Cl₂N₉O₁₃: cal. C, 50.54; H, 4.15; N, 11.29; found: C, 50.01; H, 4.05; N, 11.13. ES⁺-MS cal: 883.25; found: 882.25 (S13). ¹H NMR (DMSO-*d*₆, 400 MHz): δ 8.98 (d, 2H), 8.91(d, 4H), 8.70(s, 4H), 8.52(q, 2H), 8.08(d, 2H), 7.90(d, 1H), 7.71(s, 1H), 7.66(d, 4H), 7.43(d, 1H), 4.26(t, 2H), 2.53(s, 12H), 1.76(q, 2H), 1.48(m, 2H), 0.95(t, 3H). ¹³C[¹H] NMR (100 MHz, DMSO-*d*₆, d, ppm): 156.25 (4C), 152.80 (1C), 152.38 (1C), 150.35 (4C), 149.43 (2C), 147.94 (4C), 139.34 (2C), 137.43 (1C), 133.95 (1C), 131.46 (2C), 129.95 (2C), 128.60 (8C), 124.97 (2C), 123.65 (1C), 122.86 (1C), 121.59 (2C), 116.03 (1C), 69.38 (1C), 30.32 (1C), 20.71 (4C), 18.49 (1C), 13.55 (1C). IR (KBr, cm⁻¹): 3414 (ν, N-H), 2956(ν, C-H), 1531 (ν, N-O), 1450 (ν, N-O), 1085 (ν, R-O-C), 628 (ν, Ru-N).

2.4 | Biological assays

The human breast cancer cells, MDA-MB-231 were cultured in Dulbecco's modified Eagle's medium (DMEM) supplemented with 10% fetal bovine serum, 100 µg/ml streptomycin and 100 U/ml penicillin. The cells were maintained at 37 °C and 5% CO₂. Stock solutions of complexes were prepared in DMSO and stored at 4 °C and subsequently, these stock solutions were further diluted to required concentration prior to treatment of cells.

2.4.1 | Cytotoxicity assay

The cytotoxicity exerted by the Ruthenium complexes was assessed using MTT assay.^[32] The assay is based on

the principle of only live cells which are actively metabolizing can reduce yellow MTT to blue formazan. Cells were seeded in 96-well culture plates (10^4 cells per well) and incubated overnight at 37°C in CO_2 incubator. Cisplatin and ruthenium complexes to be tested were then added to the wells to achieve final concentrations ranging from 2×10^{-7} to 2×10^{-4} M. Control wells were prepared by addition of culture medium (100 μL) and DMSO was used as solvent control. The plates were then incubated at 37°C in a 5% CO_2 incubator for 48 hr. After completion of the incubation, stock MTT dye solution (20 μL of 10 mg/ml MTT) was added to each well. After 3 hr of incubation, 120 μL DMSO was added to solubilise the formazan crystals. The optical density of each well was then measured on Biorad ELISA spectrophotometer at a wavelength of 570–590 nm. The IC_{50} values were determined by plotting the percentage viability vs concentration on a logarithmic graph and the concentration at which 50% of cells remained viable relative to the control was calculated. Each experiment was repeated at least three times to obtain mean values.

2.4.2 | Cellular uptake and morphology of cells

MCF-7 cells were seeded in 35 mm culture plates and incubated overnight at 37°C in a 5% CO_2 incubator. Different concentrations of ruthenium (II) complexes to be tested were added to each well while replacing with fresh medium. The plates were incubated at 37°C in a 5% CO_2 incubator for 24 hr and 48 hr, the cells were imaged in phase contrast microscope with 10X objective.

2.4.3 | Nuclear morphology and cell apoptosis assay

Cells undergoing apoptosis were assessed using PE-annexin-V apoptosis detection kit (Dead Cell Apoptosis Kit with Annexin V Alexa Fluor[®] 488 and PI kit) according to the manufacturer's instructions (Life Technologies Inc). Briefly, cells were plated in 6-well plates at a density of 1×10^5 cells/well and were treated for 48 hr with different concentrations of ruthenium complexes. Post treatment, cells were recovered, washed with binding buffer (BB) and centrifuged. Annexin-V FITC (10 μL) was added to the pellet and incubated in the dark for 15 min at room temperature. Subsequently, cells were washed and re-suspended in BB, and PI solution (20 $\mu\text{g}/\text{ml}$) was added and incubated in dark for 10 mins. The cells were then centrifuged and mounted in PBS with 90% glycerol containing 1 mg/ml anti-fade

(paraphenylenediamine) and 0.5 mg/ml, 4, 6-diamidino-2-phenylindole (DAPI). The cells were imaged using Olympus BX51 fluorescent microscope at 40X magnification.

2.4.4 | Real-time RT-PCR

An RT-PCR analysis was done to study the expression of specific genes related to apoptosis as described.^[33] Several studies have shown that cyclin D and cyclin E are regulated during apoptosis. Hence we studied their expression at mRNA level. We also monitored the expression of caspase 8 as it an apoptotic marker. The primers to amplify the specific genes were designed by using the Primer Express (TM) software (Applied Biosystems) or obtained from published literature or Primer Bank (<http://pga.mgh.harvard.edu/primerbank/>). The primers used include cyclin D; forward:5'-ATGTCGTGGCC TCTAAGATGA-3', reverse: 5'-CAGGTTCCACTTGAGCT TGTTC-3'. Cyclin E; forward:5'-TTTCAGGGTAT CAGTGGTG-3' reverse:5'-TGTGGGTCTGTATGTTGTG-3' and caspase 8;forward: 5'-AAGTTCCTGAGCCTGG ACTACAT-3', reverse:5'-ATTTGAGCCCTGCCTGGTG TCT-3'. All primer pairs were tested for specificity and amplification efficiency under the same conditions. (denaturation at 95°C for 30 s, amplification with 40 cycles of: $\{95^\circ\text{C}$ for 20 s, 60°C for 20 s, 72°C for 30 s}, and 72°C for 5 min). GAPDH was included in the gene set as internal control gene for normalization. After treatments, total RNA was prepared using Trizol method from MCF-7 cells either treated with ruthenium (II) complexes (1–3) or left untreated for 24 hr. cDNA was generated from total RNA using the Verso cDNA synthesis kit (thermo scientific make) cDNA synthesis kit. 1 micro gram cDNA was used in each RT-PCR reaction; subsequently, real-time quantitative PCR was carried out in an ABI PRISM 7900 (Applied Biosystems) sequence detection system with the cDNA as template using gene-specific primer sets and the dynamo kit containing SYBR green dye (Finnzymes). At the time of use, diluted cDNA was mixed with the appropriate amount of SYBR green PCR master mix (DyNAmo Color Flash SYBR Green qPCR kit) and added to each of the wells and PCR was carried out as described above. All measurements were made in duplicate. The expression of genes was analysed by Delta Delta CT ($\Delta\Delta\text{CT}$) method.

2.4.5 | Antimicrobial studies

Standard disk diffusion technique has been employed to test the Antimicrobial activity of the complexes against E.

coli, *Bacillus subtilis* and *S. aureus*. Two unique concentrations 1,000 μM , and 500 μM in DMSO were utilized for testing spore germination of every microbes. Filter paper disks of 5 mm size were prepared utilizing whatman filter paper no.1 (cleaned in an autoclave) immersed with 10 μL of complexes and was set in the petri dishes containing LB (Luria Bertini) agar media immunized with *E. coli*, *Bacillus subtilis* and *S. aureus* independently. The petri dishes were incubated at 25 ± 0.2 $^{\circ}\text{C}$ and the zone of inhibition were noted after 24 hr. The plates were then observed and the distances across of the inhibition zones (in mm) were estimated and compared with known standard antibacterial medication ampicillin at a similar concentration.

2.5 | DNA binding

The abilities of complexes **1–3** bind to DNA were examined according to known procedures. Stock solutions of complexes were prepared in DMSO and further dissolving in Tris buffer (5 mM Tris HCl, 50 mM NaCl, pH 7.1) to required concentrations for the usage in emission and absorption spectroscopy. Maintaining the complex concentration constant and varying the DNA concentration, spectra were recorded and calculated the binding constant by using UV–visible and fluorescence methods. An Ostwald viscometer is used with BPE buffer (6 mM Na_2HPO_4 , 2 mM NaH_2PO_4 , 1 mM Na_2EDTA , pH = 7.0) recorded and compared with proven ethidium bromide.

2.6 | Molecular dynamic simulations & molecular docking studies

The present examination centres around MD simulations and docking of ruthenium (II) complexes with DNA as discussed in our earlier protocols.^[34,35] The created 3D ruthenium (II) complexes were docked to ds DNA (PDB ID: 423D) utilizing Patch Dock server.^[36,37] Patch Dock results were obtained as a lot of scoring capacities dependent on the shape complementarity and the nuclear desolvation energy of the changed complex.

2.7 | Photocleavage experiments

Photocleavage experiments carried out using super coiled pBR322 DNA. Super coiled pBR322 DNA was treated with different concentrations (20–80 μM range) of ruthenium (II) complexes with in TAE buffer (Tris–HCl, 18 mM NaCl buffer pH = 7.2).

3 | RESULT AND DISCUSSION

3.1 | Synthesis and characterization

All the synthesized complexes were thoroughly characterized by their elemental (C, H, and N) analysis, mass, proton (^1H) NMR, ^{13}C -NMR, FT-IR spectroscopic measurements. From FT-IR spectra, the bnpip ligand vibrations of ν_{NH} at 3093 cm^{-1} , ν_{NO} at 1531, 1450 cm^{-1} are shifted to ν_{NH} at ≈ 3414 cm^{-1} , ν_{NO} at $\approx 1529, 1427$ cm^{-1} after complex development. Appearance of a new band at ≈ 628 cm^{-1} , an indication of formation metal – Nitrogen bond which has been assigned to ν_{RuN} .^[38] This indicates all six Ru-N bonds are equal bond length.

From ^1H NMR spectra, the ligand having aliphatic protons gives peak at δ 4.15 to 0.95 ppm, after complex formation these protons were shifted to around $\delta \sim 4.26$ to 0.92 ppm. In each of the edifices, the N–H protons on the imidazole ring were not seen; because the protons are extremely dynamic and quick proton transfer between two imidazole N's, along these lines no peak was seen for the N-H group of imidazole ring.^[39,40] From ^{13}C [^1H] Spectra of all the complexes show a characteristic peak at an aliphatic region, but compare to ligand the values were shifted, confirming the complex formation.

From absorption spectroscopy, all three complexes (**1–3**) were exhibiting metal to ligand charge transfer bond peak at $\approx 460, 455$ and 470 nm respectively. But ligand does not have this peak as shown in Figure 1. It confirms the complex formation.

3.2 | Biological studies

Over the past few decades, ruthenium (II) complexes have successfully been used in clinical research, yet the mechanisms followed by these compounds to eliminate cancer are to be explored. In the present study, the potential anti-proliferative effects of **1, 2** and **3** complexes on the viability of MCF-7 breast cancer cell lines were assessed by Annexin V staining, MTT reduction, fluorescent microscopy and RT-PCR analysis.

3.2.1 | MTT assay

All the three complexes were evaluate the concentration, where the cells were 50% viable by performing MTT assay. After treatment of MCF-7 cells for 48 hr with **1, 2** and **3** complexes in a range of concentrations (2.5–0.4 μM) as shown in Table 1, the percentage inhibition of growth of the cancer cells was determined. The cell viabilities (%) of concentrations were obtained by

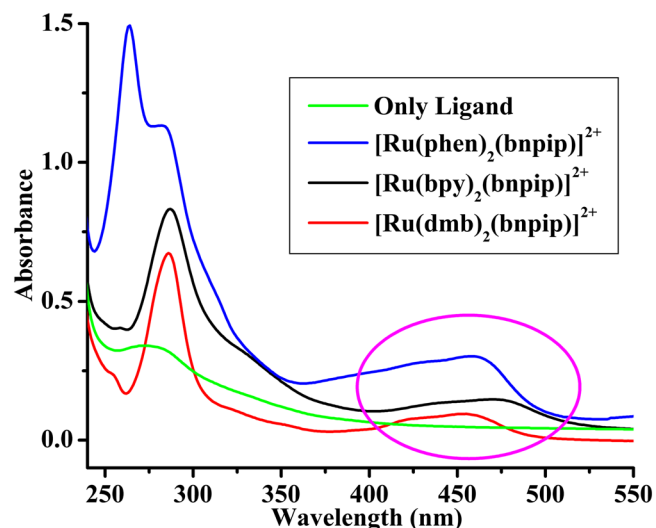


FIGURE 1 The absorption spectrum of only ligand (bnpip) and complexes $[\text{Ru}(\text{phen})_2(\text{bnpip})]^{2+}$, $[\text{Ru}(\text{bpy})_2(\text{bnpip})]^{2+}$ and $[\text{Ru}(\text{dmb})_2(\text{bnpip})]^{2+}$

plotting absorbance measured at different concentrations as shown in Figure 2.

3.2.2 | Cellular uptake and morphology of cells

MCF-7 cells exhibited morphological changes such as membrane blebbing, which are characteristics of apoptosis. These changes increased with time i.e. from 24 hr to 48 hr, more number of cells were dead and found floating in the medium. Figure 3 shows the nuclear fragmentation, cells in early and late apoptotic stages. Cells show shrinkage, vacuoles indicating various apoptotic stages.

3.2.3 | Nuclear morphology and cell apoptosis assay

Further, to confirm nuclear degradation and apoptosis, we used annexin V, PI and DAPI staining to treated and untreated cells. An early event of apoptosis is

TABLE 1 The IC₅₀ values for complexes 1–3 against MCF-7 cell lines

S.No.	Complex	IC ₅₀ (μM)
1.	Complex-1	0.41(\pm 0.014)
2.	Complex-2	2.3(\pm 0.021)
3.	Complex-3	1.5(\pm 0.019)
4.	Cisplatin	11.3(\pm 0.011)

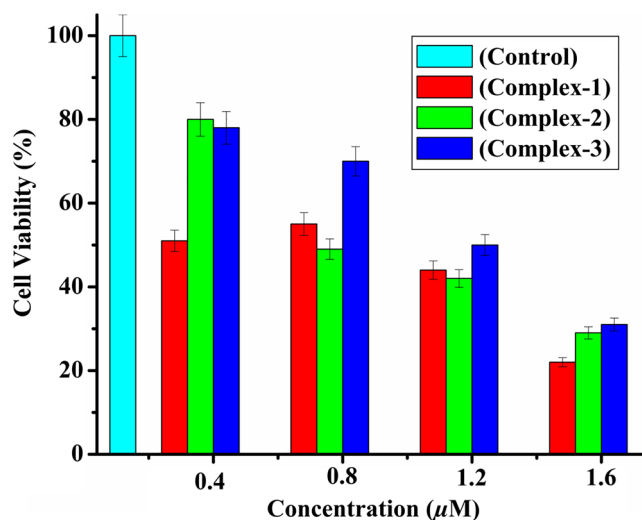


FIGURE 2 Cell viability of MCF-7 cell line in vitro treatment with complexes $[\text{Ru}(\text{phen})_2(\text{bnpip})]^{2+}$ (1), $[\text{Ru}(\text{bpy})_2(\text{bnpip})]^{2+}$ (2) and $[\text{Ru}(\text{dmb})_2(\text{bnpip})]^{2+}$ (3). Each data point is the mean \pm standard error obtained from at least three independent experiments

translocation of membrane phosphatidyl serine (PS) from the inner side of the plasma membrane to outer side. Annexin V conjugated to FITC binds to phosphatidyl serine which can be detected in fluorescent microscope. Propidium iodide is non permeable DNA binding dye which can enter only dead cells whose membranes are ruptured. DAPI is permeable DNA binding dye and therefore can enter live as well as dead cells. We used these stain to identify and confirm apoptosis after treatment. Control cells did not show annexin - V and PI staining but in MCF-7 cells treated with Ruthenium complexes, annexin V is found bound to the cells. Propidium Iodide staining was also observed in some of the treated cells confirming cell death (Figure 4).

The cytotoxic activity and DNA binding affinities are found to be associated with the size of ancillary ligand. The mechanism supporting the cytotoxic activity of the metal based drugs is poorly implied. However, several studies indicated that apoptosis of cells is an important mechanism of cytotoxic action of such compounds.^[41] Apoptosis is defined as highly complex and sophisticated programmed cell death, involving an energy-dependent cascade of molecular events leading to distinct morphological and biochemical changes.^[42] The vivid pathways (Extrinsic and intrinsic) require activation of different apoptotic and anti-apoptotic genes playing an important roles in induction of apoptosis.^[43,44] Caspase 8, an initiator caspase of extrinsic pathway has been found associated with breast cancer and it's expression has been found altered in several breast cancer cell lines.^[45] In

FIGURE 3 MCF-7 cells were exposed to IC50 concentration of complexes [Ru (phen)₂(bnpip)]²⁺ (1), [Ru (bpy)₂(bnpip)]²⁺ (2), [Ru (dmb)₂(bnpip)]²⁺ (3). Images were taken at 24 h and 48 hr time point using phase contrast microscope (Olympus) at 10X objective. Scale 10 μm

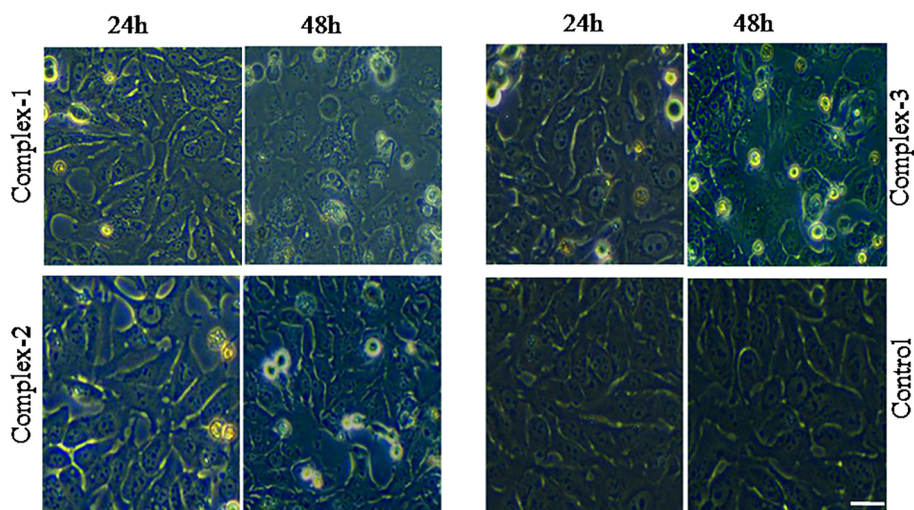
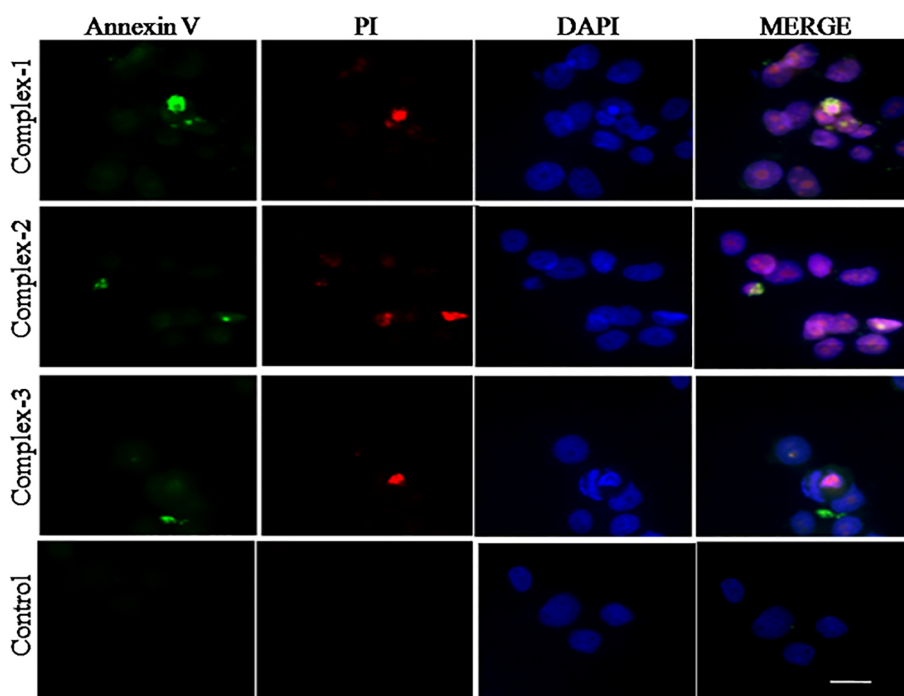


FIGURE 4 Apoptotic morphology was investigated by staining treated and untreated MCF-7 cells with Annexin V, Propidium Iodide and DAPI. Annexin V is observed in Green, propidium Iodide is shown in Red colour. DAPI stained nuclei are seen in blue colour respectively. Scale bar -20 μm



many tumours regulation of cyclin D1 was demonstrated to be required for tumour maintenance and its reduction in different types of human cancer cells (breast cancer, mantle cell lymphoma, squamous cell carcinoma, and colorectal cancer) was shown to enhance their sensitivity to radiation (i.e. chemotherapy).^[46] The abundance of the cyclin E transcript protein is found in carcinomas of the lung, gastrointestinal tract and breast in addition to lymphomas and leukemias.^[47] Cyclin E has been used as a prognostic marker as 18% to 22% of breast cancers patients have shown higher levels of expression. In our study, MCF - 7 cells treated with ruthenium compounds were exhibiting specific apoptotic features which were

confirmed by annexin V, propidium Iodide and DAPI staining.

3.2.4 | Real-time -PCR

Further, we studied gene expression by RT-PCR to understand the effect of ruthenium complexes on the regulation of caspase 8 (Figure 5), cyclin D (Figure 6) and cyclin E (Figure 7) during treatments. Caspase 8 was found upregulated by many fold compared to control cells. Cyclin D and cyclin E which are cell cycle check points and are found in abundance in cancer cells were

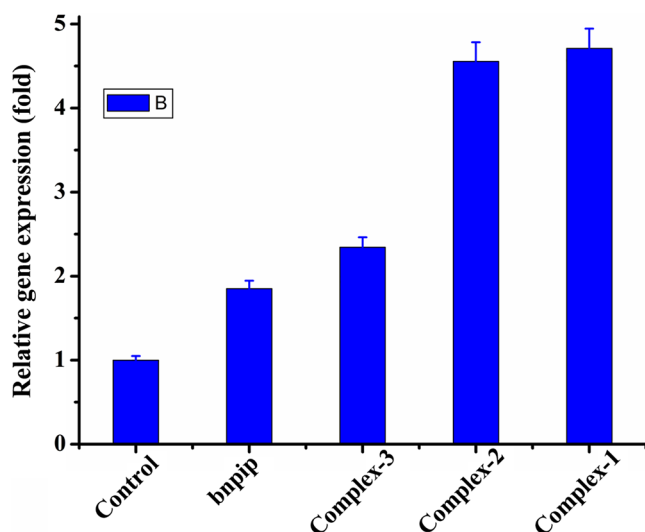


FIGURE 5 RT-PCR analysis showing changes in relative expression of Caspase 8 during treatment of MCF-7 cells with complexes. After treatments, total RNA was prepared, cDNA was synthesized and using gene specific primers RT-qPCR analysis was done. Fold increase in gene expression was calculated by $\Delta\Delta CT$ method. The lanes are as follows; Control, bnpip ligand, [Ru (phen)₂(bnpip)]²⁺ (1), [Ru (bpy)₂(bnpip)]²⁺ (2) and [Ru (dmb)₂(bnpip)]²⁺ (3)

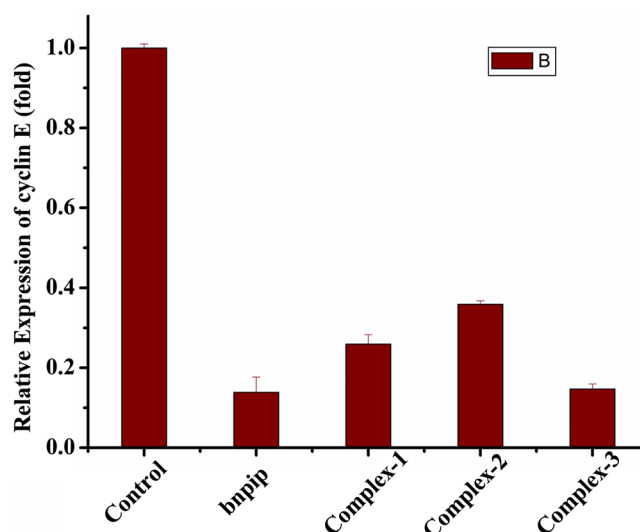


FIGURE 7 RT-PCR analysis showing changes in relative expression of Cyclin E during treatment of MCF-7 cells with complexes. After treatments, total RNA was prepared, cDNA was synthesized and using gene specific primers RT-qPCR analysis was done. Fold increase in gene expression was calculated by $\Delta\Delta CT$ method. The lanes are as follows; Control, bnpip ligand, [Ru (phen)₂(bnpip)]²⁺ (1), [Ru (bpy)₂(bnpip)]²⁺ (2) and [Ru (dmb)₂(bnpip)]²⁺ (3)

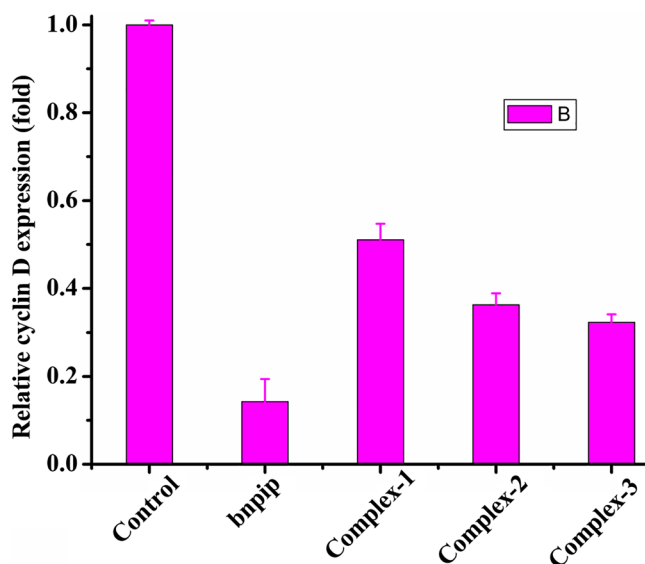


FIGURE 6 RT-PCR analysis showing changes in relative expression of Cyclin D during treatment of MCF-7 cells with complexes. After treatments, total RNA was prepared, cDNA was synthesized and using gene specific primers RT-qPCR analysis was done. Fold increase in gene expression was calculated by $\Delta\Delta CT$ method. The lanes are as follows; Control, bnpip ligand, [Ru (phen)₂(bnpip)]²⁺ (1), [Ru (bpy)₂(bnpip)]²⁺ (2) and [Ru (dmb)₂(bnpip)]²⁺ (3)

found down regulated after treatment with **1**, **2**, and **3** complexes.

3.2.5 | Antimicrobial studies

Antimicrobial action for the complexes **1–3** was tried utilizing paper disc method against the microscopic organisms *E. coli*, *S. aureus* and *Bacillus subtilis* at 1000 μM and 500 μM fixation in DMSO arrangement. DMSO demonstrated insignificant action as compared with ruthenium (II) complexes. [Ru (phen)₂(bnpip)]²⁺ showed marginally more active than [Ru (bpy)₂(bnpip)]²⁺ and [Ru (dmb)₂(bnpip)]²⁺. The outcomes were communicated as zone hindrance measurement (in mm) (Table 2). The antimicrobial activity is reliant on the concentration of the complex.^[48] These outcomes can be related to the activity of the drug ampicillin at a similar concentration.

3.3 | DNA binding studies

3.3.1 | Electronic absorption spectra

The Electronic spectra of the synthesized complexes show characteristic intense $\pi\text{-}\pi^*$ ligand and MLCT (metal-to-ligand charge transfer) transition in UV region and visible region respectively. For metallointercalators,

TABLE 2 The antimicrobial activity of the ligand (bnpip) and ruthenium (II) complexes (1–3) with different concentrations

Complex	<i>Escherichia coli</i> (<i>E.coli</i>)		<i>Staphylococcus aureus</i> (<i>S.A</i>)		<i>Bacillus subtilis</i> (<i>B.S</i>)	
	500 μL	1000 μL	500 μL	1000 μL	500 μL	1000 μL
Bnpip	6	7	7	8	6	7
Complex-1	9	12	8	10	10	12
Complex-2	8	10	9	10	8	12
Complex-3	8	10	8	10	10	11
Ampicillin	27	32	18	20	28	30

DNA binding is characterized by hypochromism and a red shift in the MLCT and ligand bands.^[49] The absorption spectra of complexes 1–3 in the absence and presence of CT-DNA at a fixed complex concentration, with increasing the DNA concentration were shown in Figure 8. As the DNA concentration increased, the MLCT band of $[\text{Ru}(\text{phen})_2(\text{bnpip})]^{2+}$ at 460 nm showed hypochromism of about 10% with a red shift of 6 nm, for $[\text{Ru}(\text{bpy})_2(\text{bnpip})]^{2+}$, MLCT band at 455 nm showed hypochromism of 14% with a red shift of 2 nm and $[\text{Ru}(\text{dmb})_2(\text{bnpip})]^{2+}$ MLCT band at 470 nm showed hypochromism of 11% with a red shift of 6 nm. Similar

hypochromic behaviour was reported for the complex $[\text{Ru}(\text{phen})_2\text{dppz}]^{2+}$, where dppz ligand plays major role for the intercalation binding with DNA.^[50]

In order to measure the binding strength of complexes 1, 2 and 3, the intrinsic binding constant K_b of ruthenium (II) complex to DNA was determined by measuring the absorbance at MLCT for the three complexes (shown in Figure 8) using Equation.^[1] The intrinsic binding constants K_b for complexes 1, 2 and 3 were $1.40(\pm 0.02)\times 10^6 \text{ M}^{-1}$, $1.00(\pm 0.02)\times 10^6 \text{ M}^{-1}$ and $0.80(\pm 0.01)\times 10^6 \text{ M}^{-1}$ respectively shown in table 3. The K_b values varies even the same intercalating ligand in all three

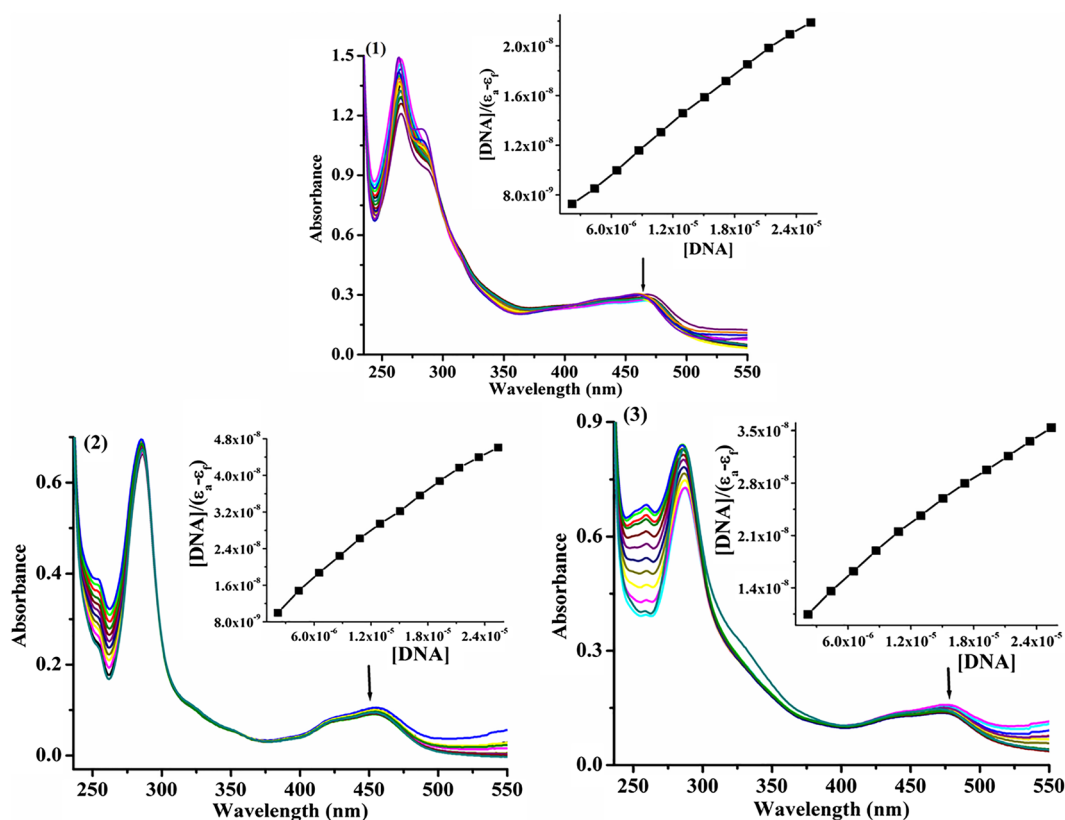
**FIGURE 8** Absorption spectra of complexes 1–3 in Tris-HCl buffer upon addition of CT-DNA. Arrow shows hypochromic and bathochromic shifts upon increase of DNA concentration. Inserted plot, $[\text{DNA}]/(\epsilon_b - \epsilon_f)$ versus $[\text{DNA}]$ for the titration of DNA with ruthenium (II) complex, which gives intrinsic binding constant (K_b)

TABLE 3 Absorption, Emission and quenching binding constants of ruthenium (II) complexes (1–3) with CT-DNA

S.No.	Complex	K_b for Absorption(M^{-1})	K_b for Emission(M^{-1})	K_{sv}
1.	Complex-1	$1.4(\pm 0.021) \times 10^6$	$6.0(\pm 0.021) \times 10^6$	3971
2.	Complex-2	$1.0(\pm 0.015) \times 10^6$	$5.3(\pm 0.015) \times 10^6$	3032
3.	Complex-3	$0.8(\pm 0.018) \times 10^6$	$4.4(\pm 0.018) \times 10^6$	2134

complexes is due to planarity and size of the anthracene ligand. The K_b values are comparable with the known DNA intercalators Δ -[Ru(phen)₂(dppz)]²⁺ ($3.2 \times 10^5 M^{-1}$), Λ -[Ru(phen)₂(dppz)]²⁺ ($1.7 \times 10^5 M^{-1}$),^[51] EB ($1.4 \times 10^6 M^{-1}$),^[52] suggesting more stacking interaction of the aromatic chromophore of the three complexes with the base pairs of the DNA. The complex **1** exhibits a slightly stronger DNA binding affinity than **2** and **3**, which is recognized to an intense electrostatic interaction between DNA and complex **1**. The binding constant of complexes from dmb, bpy, to phen the surface area and hydrophobicity increases, which leads to a strong DNA-binding affinity for complex **1**. Complex-3 ([Ru(dmb)₂(bnpip)]²⁺) exhibits less binding strength compared to complex-2 with DNA. It may be due to ancillary ligand having methyl groups at 4 and 4' positions that causes steric hindrance and donate electrons to ruthenium (II) and

enhances the electron density, thereby decreasing the binding constant from complex-2.

3.3.2 | Luminescence spectra

The binding of complexes **1**, **2** and **3** with DNA was further examined by luminescence titration measurements. All three complexes exhibit strong emission bands at 597 nm, 605 nm and 620 nm, respectively at room temperature, when excited between 460 nm, 455 nm and 470 nm. Changes in emission spectra of the ruthenium (II) complexes **1–3** with an increasing DNA concentrations are shown in Figure 9. As DNA concentration increases, the emission intensities of the complexes gradually increases until emission intensity becomes stable. The three complexes intensities in the presence of DNA

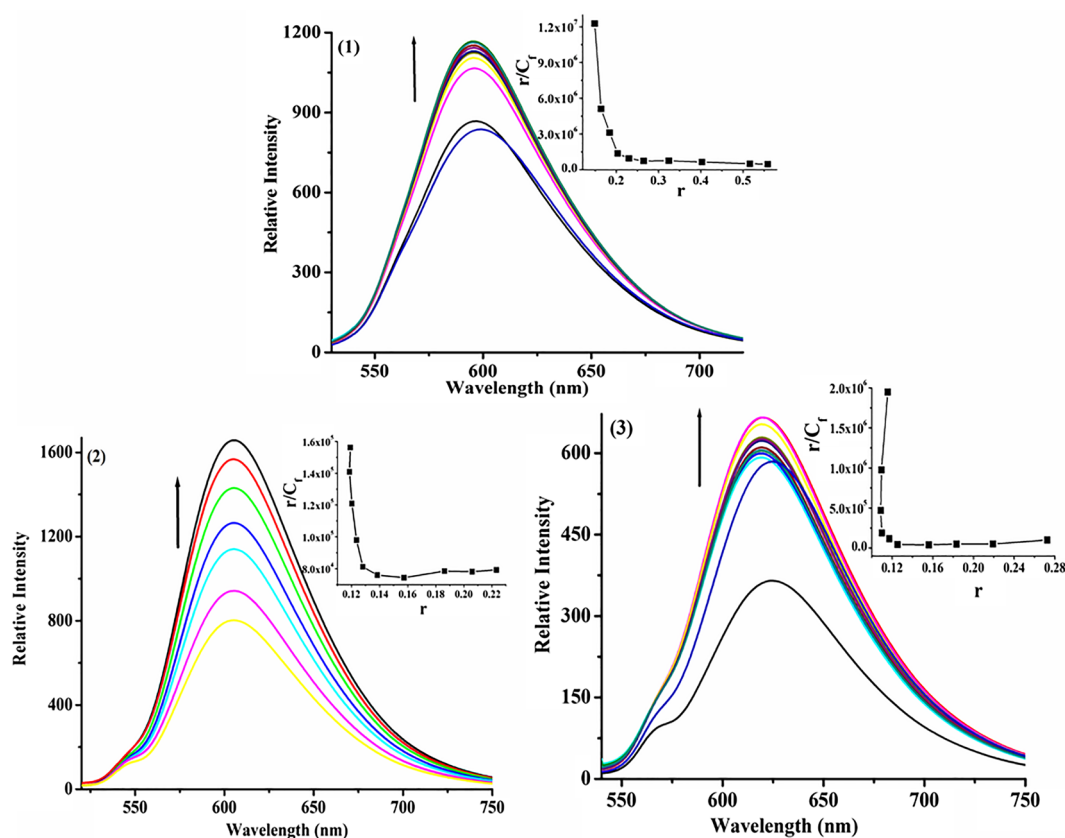


FIGURE 9 Emission spectra of complexes 1–3 in Tris-HCl buffer upon addition of CT-DNA. The arrow shows the intensity change upon the increase of DNA concentration. Inset: Scatchard plot of above complex, which gives binding constant (K_b)

were increased to 1.34, 1.00 and 1.62 times as compared to those of the DNA-free complexes, respectively. The intrinsic binding constant was obtained from the fluorescence data using a modified form of the Scatchard equation^[53] with a plot of r/C_f versus r , where r is the binding ratio $C_b/[DNA]$ and C_f is the free ligand concentration. Scatchard plots for complexes 1–3 have been obtained from luminescence spectra and binding constants (K_b) were 6.0×10^6 , 5.3×10^6 and $4.4 \times 10^6 \text{ M}^{-1}$. The K_b values of complexes 1–3 obtained from above two titration measurements (absorption and luminescence titration) are in agreement with each other.

In addition to comparing the DNA binding with ruthenium (II) complexes, the fluorescence quenching experiment was carried out. A negatively charged quencher $[Fe(CN)_6]^{4-}$ was used to be repelled by the negative phosphate backbone of the DNA, a extra deeply DNA-bound cationic ruthenium (II) complex have to be greater protected from quenching than freely bound complex. In the absence of DNA, complexes 1–3 had been successfully quenched by using $[Fe(CN)_6]^{4-}$, while in the presence of DNA quenching decreases. As DNA concentration increases the proportion of quenching is decreases. The Stern-Volmer plots for free complex and in presence of increasing amounts of DNA shown in Figure 10. The slope measures the binding affinity. The quenching constant (K_{sv}) of three complexes were tabulated in Table 3. Emission quenching data indicates that all complexes bind to DNA more effectively.

3.3.3 | Light switch on and off studies

In light-switch experiment, the emission intensity quenching and restoration were observed by the addition of Co^{2+} and EDTA solutions respectively. The $[Ru(bpy)_2(bn\text{pip})]^{2+}$ complex intercalates into the base pairs of DNA, hence the interaction between DNA and

$[Ru(bpy)_2(bn\text{pip})]^{2+}$ complex is strong. This may be observed by the enhancement in the emission intensity of the complex bound DNA (light switch on). When Co^{2+} is added to the DNA- $[Ru(bpy)_2(bn\text{pip})]^{2+}$ species it may binds to the nitrogen's of imidazole present in the intercalating ligand, forming a heterometallic complex (Co^{2+} - $[Ru(bpy)_2(bn\text{pip})]^{2+}$). It results the decrease in the emission intensity of complex bound DNA (light switch off).^[54] Further addition of polyanionic EDTA attracts the Co^{2+} ions forming a Co^{2+} -EDTA complex, thus restoring the DNA- $[Ru(bpy)_2(bn\text{pip})]^{2+}$ species, hence the emission intensity is recovered (light switch on) as shown in Figure 11. A similar examination was observed for other two complexes. The adjustment of luminescence intensity in the DNA-bound complex in the presence of Co^{2+} and EDTA explains its utilization in the modulation of drug therapy.

3.3.4 | Viscosity measurements

Three synthesized ruthenium (II) complexes mode of binding with CT DNA was further investigated by viscosity measurements. The binding mode is interpreted by the changes in the viscosity of the CT DNA upon addition of metal complex. The intercalation mode of binding causes the DNA base pairs to move away from each other in order to accommodate metal complexes hence the length of DNA increases.^[55,56] As DNA length increases, the flow time of viscosity also increases. The impact of the ruthenium (II) complexes on the viscosity of DNA is shown in Figure 12 it can be seen that, the viscosity of DNA increased marginally with increasing quantities of the complexes, demonstrating the binding mode of complexes may be through intercalation. The viscosity increasing order follows $EB > 1 > 2 > 3$ ($EB =$ Ethidium Bromide). This is in consistent with UV-vis and luminescence spectroscopy results.

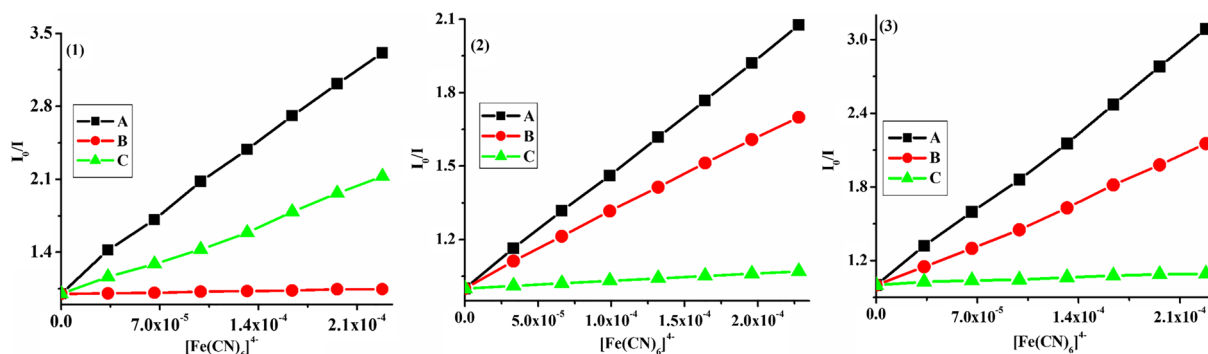


FIGURE 10 Emission quenching of complexes 1–3 with $[Fe(CN)_6]^{4-}$ in the absence of DNA (A), presence of DNA 1:20 (B) and 1:200 (C). ($[DNA] = 3.0 \times 10^{-5} \text{ M}$), $pH = 7.1$, at room temperature

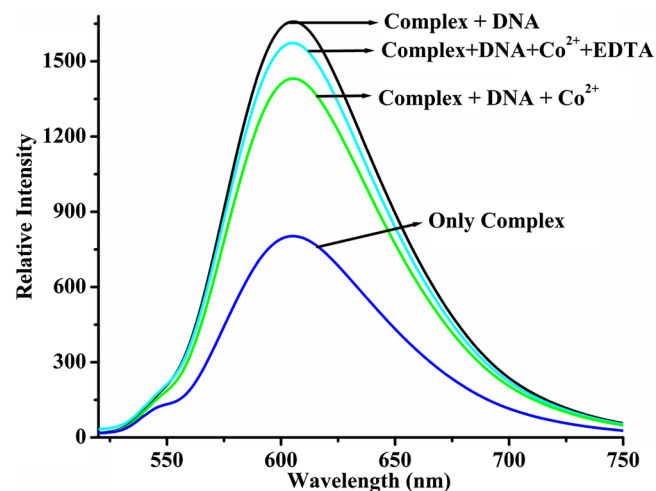


FIGURE 11 DNA light switch on and off experiment showing the luminescence changes upon addition of Co^{2+} , EDTA and DNA to complex 2

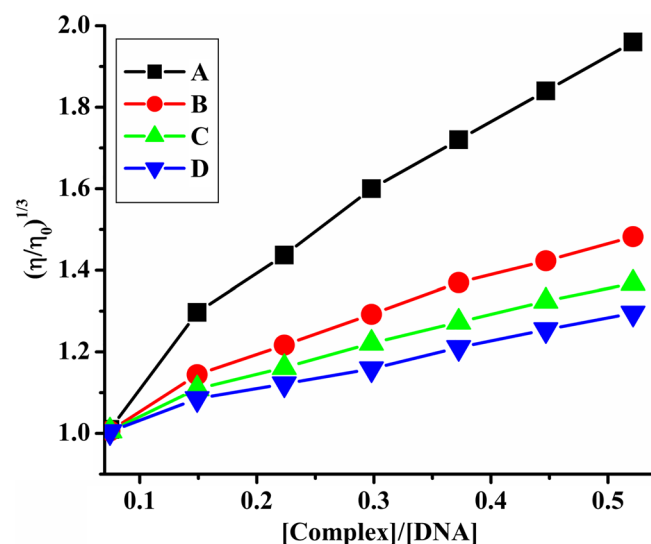


FIGURE 12 Effect of increasing amounts of Ethidium bromide (EtBr), $[\text{Ru}(\text{phen})_2(\text{bnpip})]^{2+}$ (1), $[\text{Ru}(\text{bpy})_2(\text{bnpip})]^{2+}$ (2) and $[\text{Ru}(\text{dmb})_2(\text{bnpip})]^{2+}$ (3) on the relative viscosity of calf thymus DNA at $30(\pm 0.1)^\circ\text{C}$. ($[\text{DNA}] = 3.0 \times 10^{-5} \text{ M}$), $\text{pH} = 7.0$, at room temperature

TABLE 4 Bond lengths of the 3D conformers of metal polypyridyl complexes(1–3), the bond lengths were calculated using HYPERCHEM 7.5 program

Complex	Ru-N ₁ ^a	Ru-N ₂ ^a	Ru-N ₃ ^a	Ru-N ₄ ^a	Ru-N ₅ ^b	Ru-N ₆ ^b	Total Energy	Ru-Int
Complex-1	1.94482	1.94481	1.95618	1.94867	1.94871	1.95	267.93	17.5963
Complex-2	1.99577	1.92494	1.99183	1.92133	1.92197	1.99041	303.6	17.5784
Complex-3	1.94699	1.94709	1.95079	1.94284	1.94284	1.94689	271.98	17.5724

^aN₁, N₂, N₃ and N₄ are polypyridyl (phen/bpy) nitrogen bonded to metal

^bN₅ and N₆, N of bnpip ligand bonded to metal

3.4 | Molecular docking studies

Table 4 shows the Ru – N and Ru – Intercalating ligand bond lengths (Figure 13), which has an effect on its DNA binding. The ligand is 15.5434 Å long and has a lengthening effect upon binding to metal. The intercalator ligand and metal complexes exhibit specificity in binding to guanine, the order of DNA binding is I > II > III, which can be understood with Atomic contact Energies (ACE) as given in Table 5. The intercalator has weak binding as compared to corresponding metal complex, which can be attributed to stronger interaction via hydrogen and vanderwaals forces of attraction in the metal complex. The strength of interaction of metal complex might be due to the rigidity of the intercalator, which is due perhaps owing to ancillary ligand. The nature of the ancillary ligand and length of intercalator has an influence on the DNA binding and is independent of the cytotoxicity.

3.5 | Photocleavage experiment

The cleaving efficacy of three ruthenium (II) complexes has been estimated by their capability to cleave supercoiled pBR322 DNA from different forms by gel electrophoresis experiment as shown in Figure 14. DNA alone is used as control (lane 1), it does not show any notable cleavage of pBR322 DNA. But in the presence of metal complexes pBR322 DNA was cleaved into two different forms. The complexes 1–3 at three different concentrations (10, 20 and 40 μM), were utilized for these cleaving, significant decline in the capabilities of the bands for the metal-bound DNA when compared with untreated control DNA was seen, which recommends the cleavage of DNA by metal complexes.^[57] The results show that the amount of cleavage improved with increasing concentration of complexes, show their potential chemical nuclease activity.

For the photo activated cleavage of the plasmid DNA, reactive species are responsible for cleavage of pBR322 DNA in different forms. The reactive species are O₂, H₂O₂ and OH⁻ (Type I) and ¹O₂ and ³O₂ (Type II). We

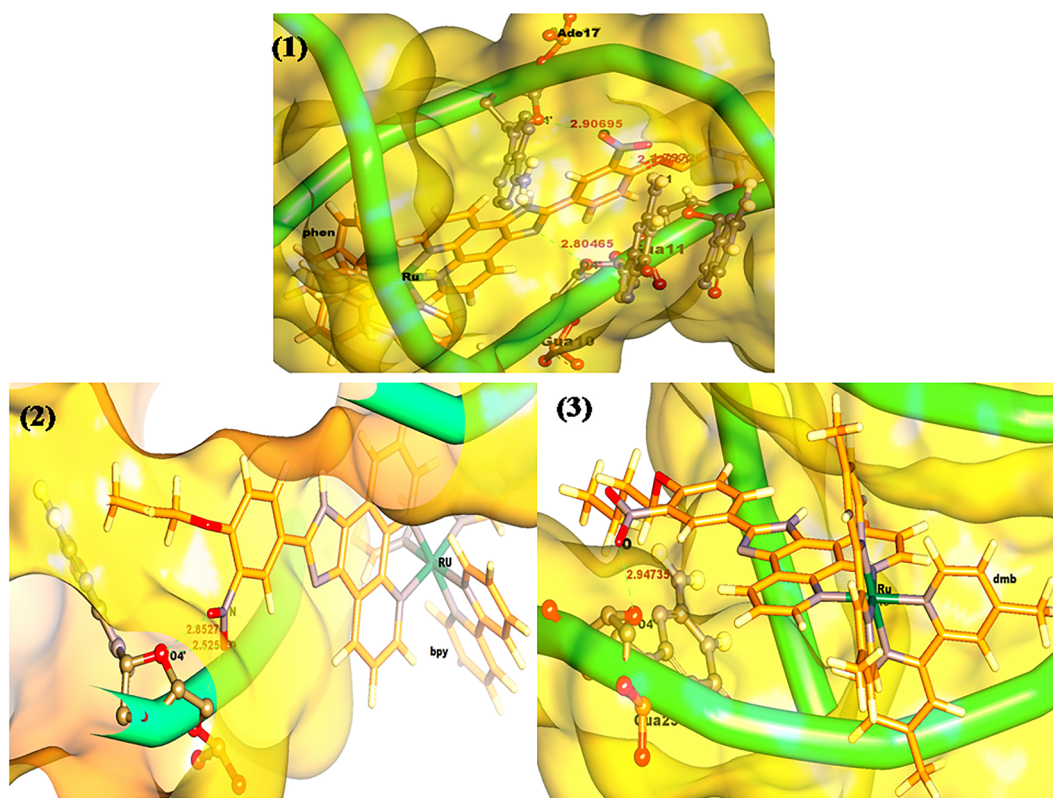


FIGURE 13 3D Model of the three ruthenium (II) polypyridyl complexes [Ru (phen)₂(bnpip)]²⁺ (1) [Ru (bpy)₂(bnpip)]²⁺ (2) and [Ru (dmb)₂(bnpip)]²⁺ (3) with bonding modes. Docked complex of DNA with Ruthenium complex showing the interactions. 1. [Ru (phen)₂(bnpip)]²⁺ + 2 – DNA complex, 2. [Ru (bpy)₂(bnpip)]²⁺ + 2 – DNA complex, 3. [Ru (dmb)₂(bnpip)]²⁺ + 2 – DNA complex binding interactions in the docked complex are represented as green dashed lines, DNA as ribbon model (green) with surface and in metal complex-carbon (Orange), metal ion (blue), Oxygen (Red), nitrogen (Purple) and hydrogen (grey)

investigated the DNA cleavage of synthesized complexes by gel electrophoresis in the presence of various radical scavengers such as Histidine (¹O₂), sodium azide (NaN₃)

(¹O₂), Mannitol (hydroxyl radical scavenger), Hydrogen peroxide (H₂O₂) (hydroxyl radical scavenger) and DMSO (hydroxyl radical scavenger).^[58,59] In the presence of

TABLE 5 Binding interactions involving the docked poses of DNA with metal complexes. Desolvation energy

S. No	Metal Complex	Patch Dock score	Binding interactions (donor group–acceptor group)	Bond length (Å°)	ACEa (kcal/mol)
1.	bnpip(L)	4462	N11 – BT20 O5'	3.1546	–395.3
			N16 – BG19 O4'	2.5180	
2.	Complex-1	5620	AG10 – N43	2.2376	–633.04
			AG10 – O50	1.7972	
			N41 – AG10 O4'	2.8046	
			O44 – BA17 O4'	2.9069	
			O45– BG11 O4'	2.9195	
3.	Complex-2	5808	N43 – AG10 O4'	2.8581	–471.21
			O44 – AG10 O4'	2.9299	
			O44– AG10 O5'	2.5253	
			O45– AG10 O4'	2.8527	
4.	Complex-3	5624	O44 – AG23 O4'	2.9473	–434.99
			N43 – BG23 O4'	3.1599	

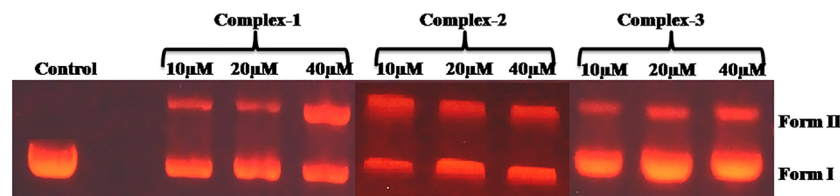


FIGURE 14 Agarose gel electrophoresis of pBR322 DNA in the presence of different concentrations (10, 20, and 40 μ L) of complexes (1–3) after irradiation at 365 nm for 30 min

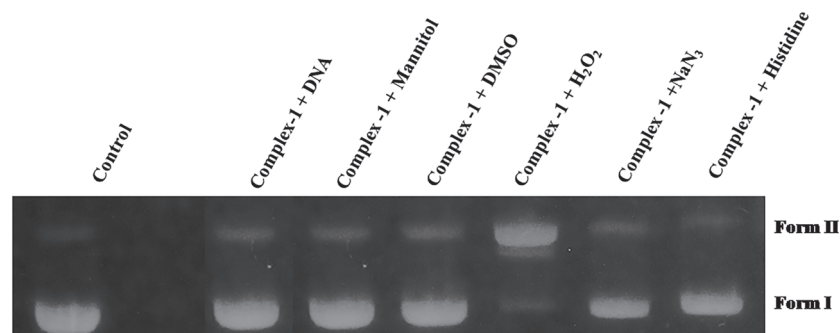


FIGURE 15 Photocleavage of pBR322 DNA experiments in the presence of Complex-1 ([Ru(phen)₂(bnpi)]²⁺) (20 μ M) and different reactive oxygen species inhibitors (Scavengers)

histidine (20 μ M) and NaN_3 (20 μ M), cleavage was not seen (form II is not seen) or very much diminished compared to what was seen for the complexes with DNA (absence of histidine and NaN_3). In presence of mannitol, H_2O_2 and DMSO form II is formed, similar to complexes with DNA. Mannitol, H_2O_2 and DMSO are an $\cdot\text{OH}$ radical inhibitors so there is no change in the cleavage pattern, which indicates that the $\cdot\text{OH}$ radical is not responsible for cleavage (Figure 15). These results indicate that $^1\text{O}_2$ plays significant role in the photocleavage mechanism.

4 | CONCLUSIONS

In summary, the *in vitro* cytotoxicity of ruthenium (II) polypyridyl complexes (1–3) with new intercalator ligand (bnpip) has been estimated. The ancillary ligand on the metal complex plays an important role in modulating the activity. We discovered ruthenium complexes containing the 1, 10 phenanthroline ligand to be powerful inhibitors of malignancy cells. We additionally demonstrate that inhibition of malignant growth cell after treatment with the ruthenium complexes includes both cell cycle arrest (cyclin D1 and cyclin E) and apoptosis induction (Caspase 8). Interestingly, all the complexes manage a similar arrangement of qualities which is suggestive of the way that these complexes may use a common mechanism of apoptosis induction. The selection of ligands is basic for cytotoxicity and in the arrangement analyzed, the best ligand is 1, 10 phenanthroline. The cytotoxicity of the intercalating ligand improves upon complexation with ruthenium. For this the experimental studies like DNA binding studies also supporting the same order. In photocleavage, $^1\text{O}_2$ is responsible for DNA cleavage.

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SUPPORTING INFORMATION

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Evaluation of DNA Binding Antimicrobial and Cell Viability Activity of Furan-Based Cobalt (III) Polypyridyl Complexes

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Abstract

This article describes the DNA binding properties of three new Cobalt (III) Polypyridyl complexes [Co(phen)₂CMIP]³⁺ (1), [Co(bpy)₂CMIP]³⁺ (2) and [Co(dmb)₂CMIP]³⁺ (3) where CMIP=2-(2-Chloro-8-methylquinolin-3-yl)w-1H-Imidazo[4,5-f][1,10]phenanthroline, phen = 1,10-phenanthroline, bpy = 2, 2' bipyridine and dmb = 4, 4 - dimethyl-2, 2' bipyridine. They have been synthesized and characterized by IR, ¹H & ¹³C NMR and Mass spectra. The DNA – binding constant (K_b) of the complexes was determined to be in the order of 10⁶ with an intercalative mode of binding. Photoactivated cleavage and antimicrobial studies of three complexes were shown better results, Cytotoxicity (MTT assay) showed growth inhibition in dose dependent manner. Among three complexes, complex 1 was more active than other two complexes.

Keywords

Co(III) polypyridyl complexes, Antimicrobial activity, Intercalation, Photoactivated cleavage, HeLa cells, MTT assay.

INTRODUCTION

The clinical drawbacks of cisplatin are apparent, including the limited applicability, the acquired resistance, and the serious side effects, such as neurotoxicity and nephrotoxicity^{1,2}. These limitations of cisplatin have motivated extensive investigations into alternative metal-based cancer drugs. Over the years, complexes of Ru, Ir, Cu, Ni, Zn, Co, etc., have been reported to possess much better anticancer property than *cis*-platin³⁻⁶. Cobalt is an essential trace element present in the human body. It is involved in important biological functions such as

fatty acid and amino acid metabolism, haematopoiesis, and in the form of vitamin B₁₂ it is indirectly involved in synthesis of DNA. Interestingly, one cobalt complex containing Schiff base ligand (Doxovir) has recently passed phase II clinical trial for anti-viral treatment⁷. Several *in vitro* studies suggest that cobalt complexes possess promising anti-cancer activity⁸.

Cobalt is widely distributed in the biological systems such as cells and body, and thus the interaction of DNA with cobalt compound has attracted much attention⁹. The binding properties of cobalt with calf

thymus DNA were studied by several methods, and the experimental results showed that the size and shape of the intercalated ligand had an important effect on the binding affinity of the compounds with DNA¹⁰. Hisaeda and co-workers discovered a new water-soluble dicobalt compound having two cobalt-carbon bonds and reported that this dicobalt compound showed higher ability for DNA cleavage in comparison with the corresponding monocobalt compound¹¹. The interaction of DNA with cobalt (II) tridentate compound, and the photocleavage studies showed that the cobalt (II) compound increased to nicking of DNA in the presence of plasmid DNA¹². Our previous works have shown that Ru (II) polypyridyl complexes containing *N*, *N*-chelating ligands were DNA intercalative and antiproliferative agents¹³⁻²⁰. This paper discussing about synthesis and various biological activities of newly synthesized furan derivatives of Co (III) polypyridyl complexes (**1-3**). Interactions of these compounds with CT-DNA were investigated by UV, visible spectroscopy, fluorescence spectroscopy and viscosity measurement.

MATERIALS AND METHODS

Materials

CoCl₂ · 6H₂O, 1, 10-Phenanthroline, 2, 2' bipyridine, 4, 4' dimethyl 2, 2' bipyridine and 2-Chloro-8-

methylquinoline-3-carboxaldehydewere purchased from sigma. All the solvents were purified before use, as per standard procedures²¹. CT (Calf Thymus) DNA was purchased from Aldrich, its solution gives a ratio of UV absorbance at 260 and 280 nm of 1.8–1.9, indicating that the DNA was sufficiently free of protein²², Supercoiled pBR 322 plasmid DNA (stored at -20 °C) was obtained from Fermentas life sciences, agarose (Genei) from Sigma. Double distilled water was used for preparing various buffers. Ampicillin for antimicrobial studies was purchased from local pharmaceuticals.

Physical measurements

UV–Visible spectra recorded with an Elico BL 198 spectrophotometer. Fluorescence measurements performed on an Elico SL 174 spectrofluorometer. IR spectra recorded on KBr disks on a Perkin–Elmer FT-IR-1605 spectrometer. ¹H NMR spectra recorded on a Bruker 400 MHz spectrometer with DMSO-d₆ as solvent at RT and tetramethyl silane (TMS) as the internal standard. Microanalysis (C, H, and N) carried out with a Perkin-Elmer 240 elemental analyzers.

Synthesis and characterization

Compounds 1, 10-phenanthroline-5, 6-dione²³, cis-[Co(phen)₂Cl₂] · 2H₂O, cis- Co(bpy)₂Cl₂ · 2H₂O and cis-[Co(dmb)₂Cl₂] · 2H₂O²⁴ were synthesized according to methods in the literature. Synthetic scheme of Co(III) complexes shown in Fig. 1.

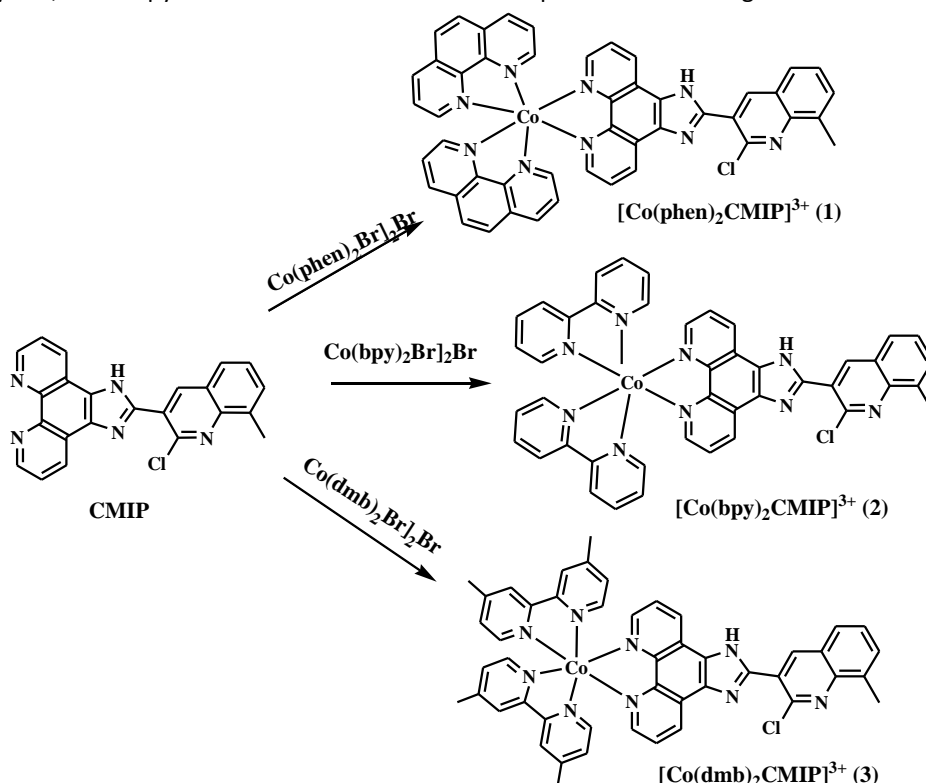


Fig. 1: Scheme; Synthetic scheme for four complexes, [Co(phen)₂CMIP]³⁺ (**1**), [Co(bpy)₂CMIP]³⁺ (**2**) and [Co(dmb)₂CMIP]³⁺ (**3**).

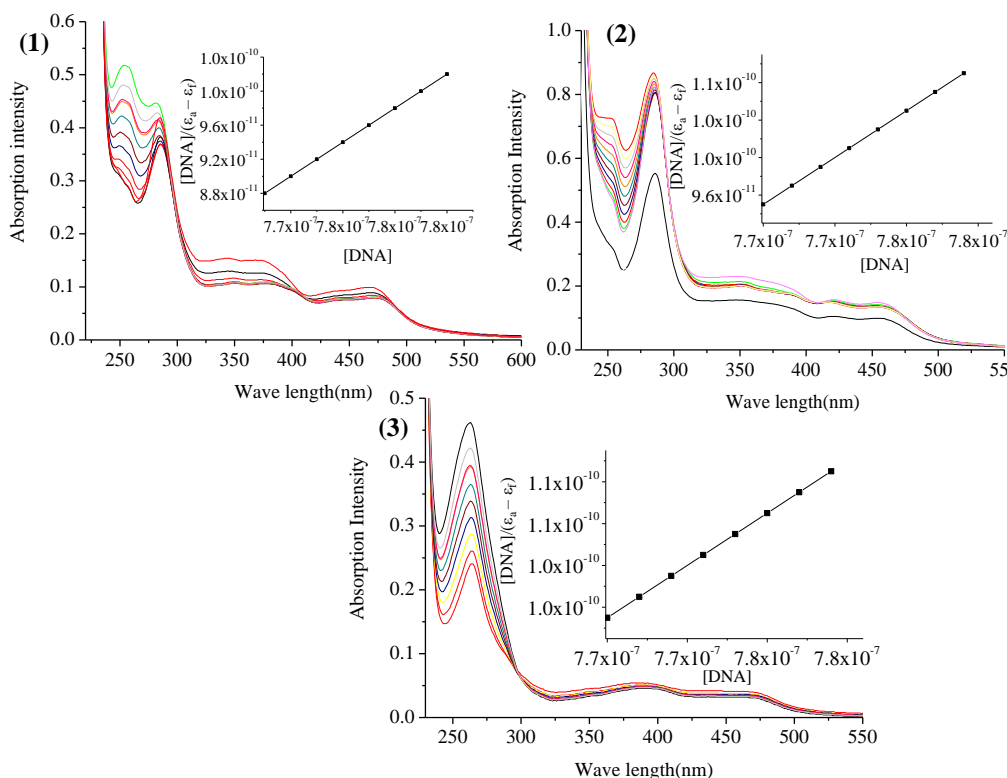


Fig. 2: Absorption spectra of four complexes 1, 2 and 3 in the absence (top red peak in each spectra) and in the presence of increasing concentration of CT-DNA. A plot of $[DNA]/(\epsilon_a - \epsilon_f)$ vs $[DNA]$ is shown in the inset. $[DNA] = 2.5 \times 10^{-4}$ M, $[Complex] = 10^{-3}$ M.

Preparation of CMIP ligand

CMIP=2-(2-Chloro-8-methylquinolin-3-yl)-1H-Imidazo[4,5-f][1,10]phenanthroline was prepared by the addition of 1, 10-phenanthroline-5, 6-dione (0.53 g, 2.50 mM), 2-Chloro-8-methylquinoline-3-carboxaldehyde (0.7196 g, 3.5 mM), Ammonium acetate (3.88g, 50 mM) and glacial acetic acid (10 mL) were refluxed together for 4 h as per Steck and Day²⁵, and then cooled to room temperature and diluted with water. Drop wise addition of ammonia gave a yellow precipitate which was collected, washed with water, dried, and purified by recrystallization from pyridine-H₂O (9:1, v/v); Yield: 0.51 g (73%), Analytical data: Elemental Analysis for C₂₁H₁₂ClN₅: Calc. (%): C: 68.20; H: 3.27; N: 18.94; Found: C: 68.18; H: 3.30; N: 18.97; ESI-MS (m/z): Calcd: 369, found: 370 $[M+H]^+$. ¹H NMR (DMSO-*d*₆, 400 MHz): δ : 8.9 (H-C=N), 7.2-8.2, m (H-C=C), 2.3 (CH₃), ¹³C[¹H]-NMR (DMSO-*d*₆, 100 MHz): 153 (-C=N), 122 (-C*=C), 148 (-C(Cl)=N), 136(C-C*(C)=C), 153 (N-C=C), 155 (N-C=C), 21 (1⁰ C).

Synthesis of [Co(phen)₂(CMIP)] (ClO₄)₃ · 2H₂O (1)

This complex was prepared by mixing Cis-[Co(phen)₂Br₂] Br · 2H₂O (0.143 g, 0.25 mM) and CMIP (0.5565, 1.5 mM) in 20.0 mL of ethanol and was refluxed for 6 hrs. After filtration it was then cooled to room temperature and added saturated

aq. solution of NaClO₄. The obtained light yellowish solid was cooled and washed with small amount of water and then dried under vacuum. Yield: 0.45 g (71%). Elemental Analysis for C₄₅H₃₂Cl₄N₉O₁₄Co, Calc. C: 48.11; H: 2.87; N: 11.22, Found: C: 48.13; H: 2.89; N: 11.25 %. ESI-MS (m/z): Calcd: 263, found: 264 for $\{[Co(phen)_2(CMIP)]^{3+} - (ClO_4)_3 \cdot 2H_2O\}$. ¹H NMR (DMSO-*d*₆, 400 MHz): δ : 9.1 (H-C=N), 6.3-8.2, m (H-C=C), 4.8 (H-C-N), 2.3 (CH₃), ¹³C[¹H]-NMR (DMSO-*d*₆, 100 MHz): 153 (-C=N), 122 (-C*=C), 118 (-C*=C-Cl), 127 (3⁰ C=), 123(=C-N), 138 (=C(H)-C=), 135 (=C(Cl)-C=), 21 (1⁰ C).

Synthesis of [Co(bpy)₂(CMIP)] (ClO₄)₃ · 2H₂O (2)

This complex was synthesized with similar procedure of the above complex (1), with cis-[Co(bpy)₂Br₂] Br · 2H₂O (0.578 g, 1 mM) in place of cis-[Co(phen)₂Br₂] Br · 2H₂O Yield: 0.44 g (72%). Elemental Analysis for C₄₁H₃₂Cl₄N₉O₁₄Co, Calc. C: 45.79; H: 3.00; N: 11.72. Found: C: 45.80; H: 3.03; N: 11.74 %. ESI-MS (m/z): Calcd: 246, found: 248 for $\{[Co(bpy)_2(CMIP)]^{3+} - (ClO_4)_3 \cdot 2H_2O\}$. ¹H NMR (DMSO-*d*₆, 400 MHz): δ : 9.1 (H-C=N), 6.3-8.5, m (H-C=C), 4.8 (H-C-N), 5.4 (H-C=C-Cl), 2.3 (CH₃), ¹³C[¹H]-NMR (DMSO-*d*₆, 100 MHz): 153 (-C=N), 122 (-C*=C), 118 (-C*=C-Cl), 127 (3⁰ C=), 123(=C-N), 138 (=C(H)-C=), 135 (=C(Cl)-C=), 21 (1⁰ C).

Synthesis of [Co(dmb)₂(CMIP)] (ClO₄)₃. 2H₂O (3)

This complex was synthesized with similar procedure of the above complex (1), with cis-[Co(dmb)₂Br₂] Br. 2H₂O (0.721 g, 1 mM) in place of cis-[Co(phen)₂Br₂] Br. 2H₂O. Yield: 0.39 g (69%). Elemental Analysis for C₄₅H₄₀Cl₄N₉O₁₄Co, Calc. C: 47.76; H: 3.56; N: 11.14. Found: C: 47.77; H: 3.58; N: 11.17 %.). ESI-MS (m/z): Calcd: 265, found: 266 for {[Co(dmb)₂(CMIP)]³⁺ - (ClO₄)₃. 2H₂O}. ¹H NMR (DMSO-d₆, 400 MHz): δ: 9.1 (H-C=N), 6.3-8.4, m (H-C=C), 4.8 (H-C-N), 5.4 (H-C=C-Cl), 2.3 (-CH₃), ¹³C[¹H]-NMR (DMSO-d₆, 100 MHz): 153 (-C=N), 122 (-C*=C), 118 (-C*=C-Cl), 127 (3^o C=), 123(=C-N), 138 (=C(H)-C=), 135 (=C(Cl)-C=), 36 (3^o C), 21 (1^o C), 24(-CH₃).

DNA binding and Photo activated Cleavage studies

The DNA-binding and photo activated cleavage experiments were performed at room temperature. Buffer A [5 mM tris(hydroxymethyl)aminomethane (Tris) hydrochloride, 50 mM NaCl, pH 7.0] was used for absorption titration, luminescence titration and viscosity measurements. Buffer B (50 mM Tris-HCl, 18 mM NaCl, pH 7.2) was used for DNA photocleavage experiments. Solutions of calf thymus DNA (CT DNA) in buffer A gave a ratio of UV-Vis absorbance of 1.8–1.9:1 at 260 and 280 nm, indicating that the DNA was sufficiently free of protein²⁶. The concentration of DNA was determined spectrophotometrically ($\epsilon_{260} = 6600 \text{ M}^{-1} \text{ cm}^{-1}$).

The absorption titrations in the buffer were performed using a fixed concentration (20 μM) complex to which increments of the DNA stock solution were added. The intrinsic binding constant K, based on the absorption titration, was measured by monitoring the changes in absorption at the MLCT band with increasing concentration of DNA using the following equation²⁷.

$$[\text{DNA}] / (\epsilon_a - \epsilon_f) = [\text{DNA}] / (\epsilon_b - \epsilon_f) + 1 / [K_b (\epsilon_b - \epsilon_f)]$$

where [DNA] is the concentration of DNA in base pairs, ϵ_a , ϵ_b and ϵ_f correspond to the apparent absorption coefficient $A_{\text{obsd}} / [\text{Co}]$, the extinction coefficient for the free Cobalt complex and the extinction coefficient for the ruthenium complex in the fully bound form, respectively. In plots of $[\text{DNA}] / (\epsilon_a - \epsilon_f)$ versus [DNA], K_b is given by the ratio of slope to the intercept.

In the emission studies fixed metal complex concentration (20 μM) was taken and to this DNA with varying concentrations was added. The excitation wavelength was fixed, and the emission range was adjusted before measurements. The fraction of the ligand bound was calculated from the relation $C_b = C_t [(F - F_0) / F_{\text{max}} - F_0]$, where C_t is the total complex concentration, F is the observed fluorescence emission intensity at a given DNA

concentration, F_0 is the intensity in the absence of DNA and F_{max} is when the complex is fully bound to DNA. Binding constant (K_b) was obtained from a modified Scatchard equation²⁸. From a Scatchard plot of r/C_f vs r, where r is the $C_b / [\text{DNA}]$ and C_f is the concentration of free complex.

Viscosity measurements were carried out on Ostwald Viscometer maintained at a constant temperature at 25.0 (± 0.1) °C in a thermostatic bath. DNA samples approximately 200 base pairs in average length were prepared by sonication to minimize the complexities arising from DNA flexibility²⁹. Flow time was measured with a digital stopwatch, and each sample was measured three times, and an average flow time was calculated. Relative viscosities for DNA in the presence and absence of complex were calculated from the relation $\eta = (t - t_0)/t_0$, where t is the observed flow time of the DNA-containing solution and t_0 is the flow time of buffer alone^{30,31}. Data were presented as $(\eta/\eta_0)^{1/3}$ versus binding ratio³² where η is the viscosity of DNA in the presence of complexes and η_0 is the viscosity of DNA alone.

For the gel electrophoresis experiment, supercoiled pBR 322DNA (0.1 μg) was treated with the Co (III) complex in buffer B, and the solution was then irradiated at room temperature with a UV lamp (365 nm, 10 W). The samples were analyzed by electrophoresis for 1.5 h at 80 V on a 0.8% agarose gel in TBE (89 mM Tris-borate acid, 2 mM EDTA, pH = 8.3). The gel was stained with 1 $\mu\text{g}/\text{ml}$ ethidium bromide and photographed on the Gel documentation system, UVDI - 312.

Antimicrobial Studies

The antibacterial activity of the complexes was studied against Escherichia coli and Staphylococcus aureus. Each of the Cobalt (III) complex was dissolved in DMSO at different concentrations of 500 μM and 1000 μM . Paper disks of Whatman filter paper no. 1 were sterilized in an autoclave. The paper disks saturated with 10 μL of the Cobalt (III) complex were placed aseptically in Petri dishes containing agar medium inoculated separately with E. coli and S. aureus. The Petri dishes were incubated at 37 °C and the inhibition zones were recorded after 24 h of incubation. The results were also compared with the results for the standard antibacterial drug ampicillin as a positive reference and DMSO as a negative reference at the same concentrations.

Cell viability studies by MTT assay

The cell viability was evaluated by MTT assay and performed as per standard protocol. HeLa cells, (human cervical carcinoma cell line) were seeded 5,000/well in 96 well plates and after overnight incubation; cells were treated with complexes 1, 2

and 3 in varying concentrations for 48h. After incubation, MTT reagent was added (5 mg/ml) and incubated further for 4h at 37°C in dark. After then, media was aspirated and to dissolve the crystals DMSO was added to each well. The optical density was measured at 570 nm. Untreated cells were taken as controls. Experiment was repeated with three independent times, each time with triplicates. Data represented here as mean \pm SEM.

RESULTS AND DISCUSSION

DNA Binding studies

It has been reported that DNA damaging agents can activate the intrinsic pathway of apoptosis involving the release of cytochrome c and other mitochondrial apoptogenic factors³³ and trigger autophagy simultaneously as a self-defence mechanism^{34,35}. DNA binding studies have been performed to determine whether Co(III)-induced apoptosis and autophagy are correlated with their abilities to cause DNA damage.

Absorption spectroscopic studies

The MLCT bands (\approx 450 nm) changes were monitored in the presence of increasing concentration of CT-DNA. The subsequent increase in the concentration of the DNA led to a hypochromic shift in the intensity

of the MLCT peak and it reached a saturation point for all three complexes as shown in the fig. 2. This decrease in intensity of the CT band was accompanied by considerable red shift in the spectral band. These observations clearly show that three complexes showed dual mode of DNA binding. It is possible that initially because of the $\pi - \pi$ stacking within the metal complexes, bind DNA electrostatically and at higher concentration of DNA the complexes get destacked and get intercalated between DNA bases. Such dual mode of DNA binding by a Co (III) complex has previously been reported³⁶. The DNA binding constant (K_b) values of 1, 2 and 3 complexes were in the order of 10^5 as shown in the table 1. The difference in K_b values was due to their different ancillary ligands. Complex 3 shows the less binding strength to double-helical DNA. Due to the presence of methyl groups on the 4 and 4' positions of the ancillary ligand, dmb causes steric hindrance when the complex intercalates into the DNA base pairs. Electron deficient rings interact more strongly with polyanion (DNA) than electron rich rings, so methyl group present on dmb ring may enhance the electron density on complex moiety and make electron rich, hence the binding constant for complex 3 is less than other two complexes.

Table 1: K_b values of three complexes

Complex	K_b for absorption studies (M^{-1})	K_b for Emission studies (M^{-1})
[Co(phen) ₂ CMIP] ³⁺ (1)	3.15 (\pm 0.01) X10 ⁵	3.11 (\pm 0.02) X 10 ⁵
[Co(bpy) ₂ CMIP] ³⁺ (2)	2.73 (\pm 0.01) X10 ⁵	2.75 (\pm 0.01) X 10 ⁵
[Co(dmb) ₂ CMIP] ³⁺ (3)	2.50 (\pm 0.02) X10 ⁵	2.32 (\pm 0.01) X 10 ⁵

Emission spectroscopic studies

Emission intensity (\approx 600 nm) of complexes from the MLCT excited states upon excitation at 460 nm is found to depend on DNA concentration. As shown in Fig. 3, upon the addition of DNA, the emission intensities increased from initial. The enhancement of emission intensity is indicative of binding of the complex to the hydrophobic pocket of DNA and is protected by DNA efficiently and the complexes mobility is restricted at the binding site, which leads to decrease in the vibrational modes of relaxation. The intrinsic binding constant from fluorescence data was obtained from a modified Scatchard equation³⁷ for all the complexes, and binding constants (K_b) were in the order of 10^5 as shown in table 1. K_b values for both absorption and luminescence studies are almost comparable with small differences in numerical³⁸.

Viscosity experiment

Viscosity experiments are sensitive to length changes to DNA and least ambiguous for binding mode in solution in the absence of crystallographic structural data³⁹. The effects of the complex and ethidium bromide (EB) on the viscosities of CT-DNA are shown in Fig. 4. EB, being as a classical DNA intercalator, can strongly raise the relative viscosity by lengthening the DNA double helix through intercalation. As revealed in Fig. 4, upon increasing the amounts of the three complexes, the relative viscosity of DNA increases similar to the behaviour of EB. This observation suggests that the principal mode of DNA binding by the complex involves base-pair intercalation, in which, relative increased of viscosity is in agreement order with the results obtained by electronic absorption, fluorescence spectroscopy.

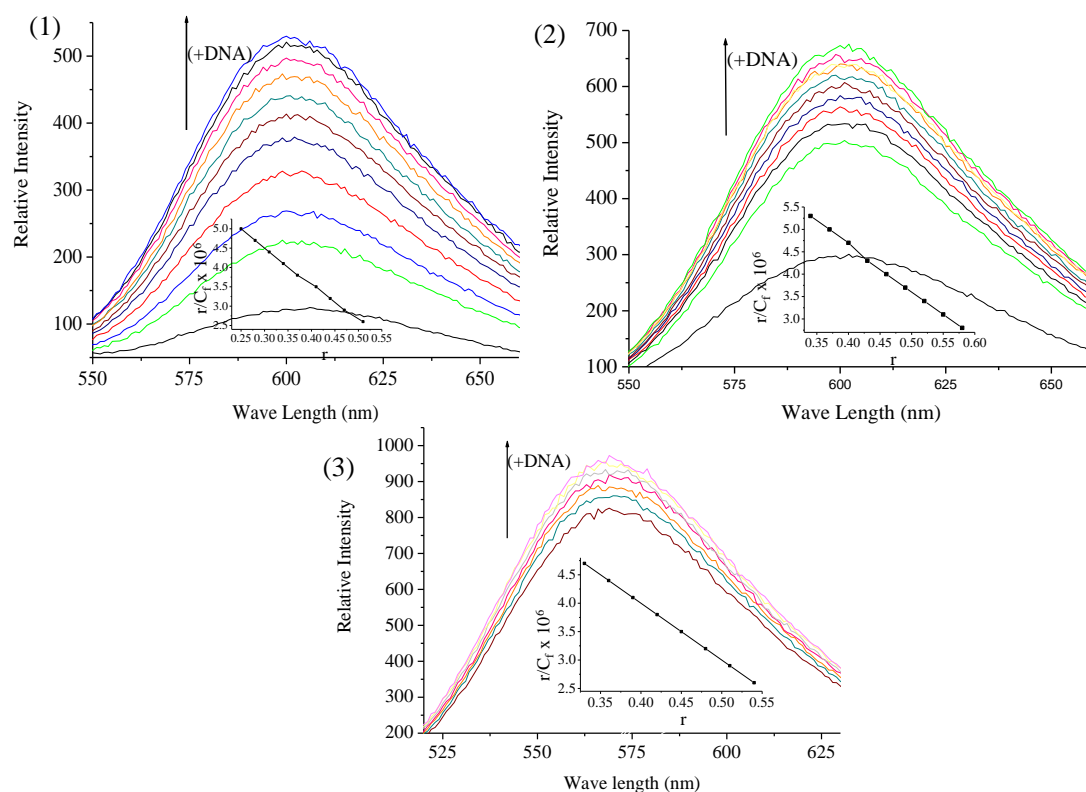


Fig. 3: Emission spectra of four complexes 1, 2 and 3 in the absence and in the presence of increasing concentration of CT-DNA. Inset: Scatchard plot of r/C_f above complexes, which gives binding constant (K_b). $[DNA] = 2.5 \times 10^{-4} M$, $[Complex] = 10^{-3} M$.

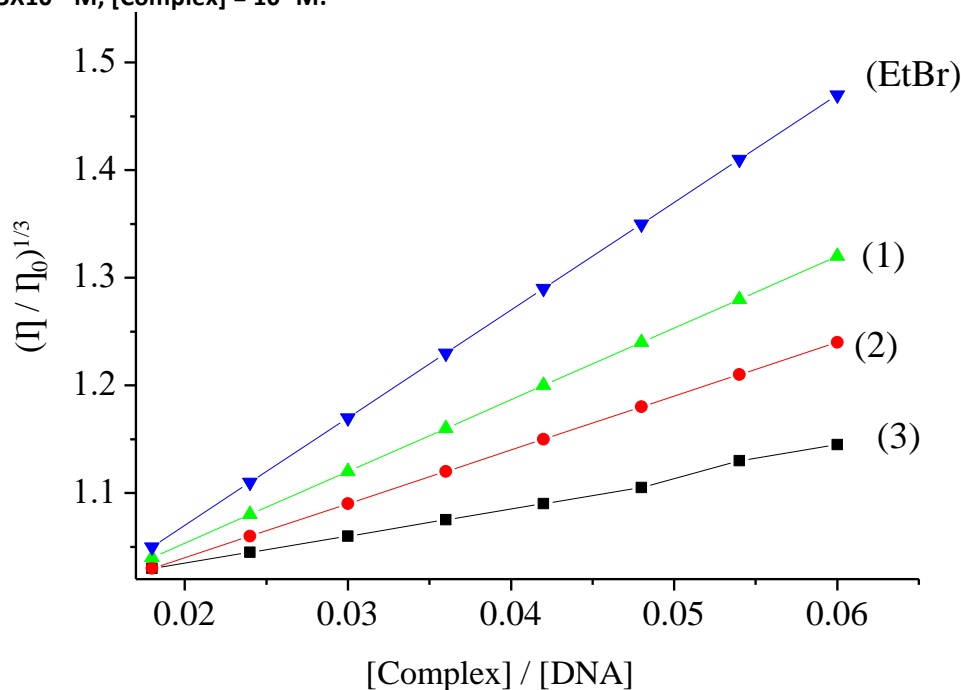


Fig. 4: Effect of increasing amounts of EtBr, complexes $[Co(phen)_2CMIP]^{3+}$ (1), $[Co(bpy)_2CMIP]^{3+}$ (2) and $[Co(dmb)_2CMIP]^{3+}$ (3) on the relative viscosity of CT-DNA at $25 (\pm 0.1)^\circ C$. $[DNA] = 2.5 \times 10^{-4} M$.

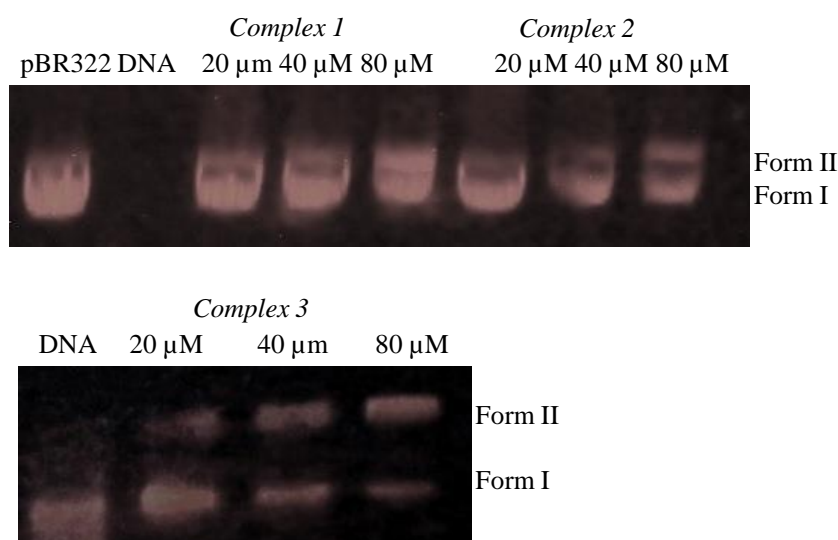


Fig. 5. Photo activated cleavage studies of $[\text{Co}(\text{phen})_2\text{CMIP}]^{3+}$ (1), $[\text{Co}(\text{bpy})_2\text{CMIP}]^{3+}$ (2) and $[\text{Co}(\text{dmb})_2\text{CMIP}]^{3+}$ (3) with the concentration range of 20 to 80 μM .

Photo activated cleavage of pBR 322DNA

Nuclear activity of 1-3 Cobalt (III) complexes were performed on pBR322 DNA and monitored by agarose gel electrophoresis. When plasmid DNA is subjected to electrophoresis, relatively fast migration is observed in the intact supercoiled form (form I). If scission occurs on one strand (nicking), the supercoiled form will relax to generate a slower-moving open circular form (form II). If both strands are cleaved, a linear form (form III) that migrates between form I and form II will be generated⁴⁰. Plasmid DNA incubated with four complexes with different concentrations (20 μM , 40 μM and 80 μM) pBR322DNA and irradiated at 365 nm for 60 min. We observed no DNA cleavage was in the control, in which the metal complex was absent (lane 1). When the concentration of 1-3 Cobalt (III) complexes was increased from 20 μM to 80 μM , the amount of form I gradually decreased, whereas the amount of form II increased as shown in fig. 5.

Antimicrobial activity

Three Cobalt (III) complexes were screened invitro for their antimicrobial activity against *E. coli* and *S. Aureus* with Ampicillin as positive control and DMSO as negative control. We observed variation in the inhibition zone (radius in mm) with two different concentrations (0.5 mg/ml and 1 mg/ml) 1-3 complexes. The antimicrobial activity increased as the concentration of the compounds increased. The antibacterial activity data for the complexes at various concentrations (Table 2) indicate that the complexes exhibited appreciable activity against *E. coli* and *S. aureus*. The complexes were more effective against *S. aureus* than against *E. Coli* but were less effective than the standard drug ampicillin. As an increase in the lipophilic character of the complex favours its permeation through the lipid layer of the bacterial membrane, it shows more activity [⁴¹].

Table 2: Antimicrobial studies of Complexes 1-3

Complex	Bacterial Inhibition zone (mm)			
	Conc. (1000 μM)		Conc. (500 μM)	
	B.S	E.Coli	B.S	E.Coli
DMSO	--	--	--	--
$[\text{Co}(\text{phen})_2\text{CMIP}]^{3+}$ (1)	12.0	10.2	6.9	6.6
$[\text{Co}(\text{bpy})_2\text{CMIP}]^{3+}$ (2)	10.1	9.7	6.0	5.5
$[\text{Co}(\text{dmb})_2\text{CMIP}]^{3+}$ (3)	9.5	9.5	5.7	4.9
Ampicilin	16.2	14.3	10.0	9.9

Cell viability studies by MTT assay

All three complexes were tested against HeLa cells to assess the viability by using MTT assay. These three compounds show significant cell death in dose dependent manner. Viability of the cells decreased

upon increasing the concentration of the compound as shown in fig. 6. The IC₅₀ for complex **1** is 14.1 μM for 48h whereas for complex **2** and complex **3** were 36.2 μM and 52 μM.

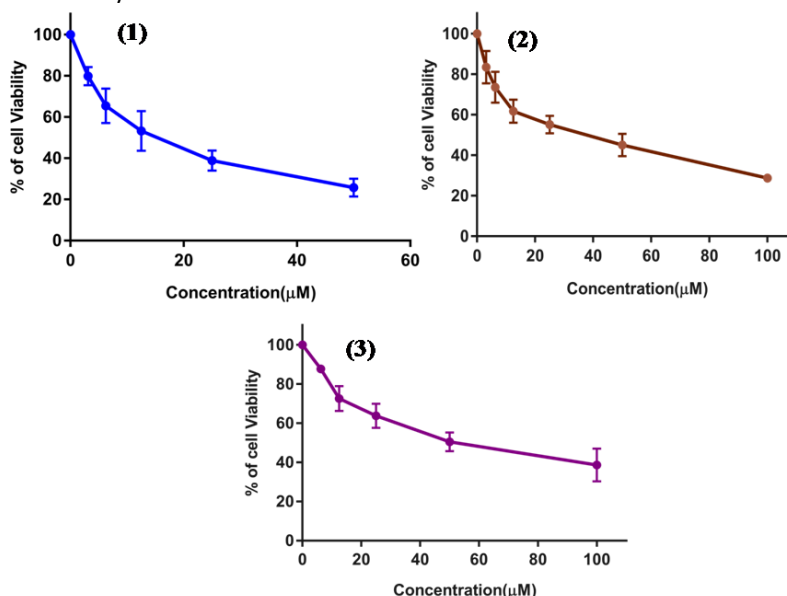


Fig. 6. HeLa cells were treated with complexes **1**, **2** and **3** with different concentrations for 48h and the untreated cells were used as a control and then cell viability was evaluated by the MTT assay.

CONCLUSION

Three new Cobalt (III) polypyridyl complexes [Co(phen)₂CMIP]³⁺ (**1**), [Co(bpy)₂CMIP]³⁺ (**2**) and [Co(dmb)₂CMIP]³⁺ (**3**) were synthesized and characterized. The DNA-binding behavior shows that the three Co (III) complexes were interacting with CT DNA through intercalative mode. Upon irradiation, these complexes can effectively cleave pBR322 DNA into three separate forms. The cytotoxicity assay indicates that complexes **1**, **2** and **3** can suppress the tumor cell proliferation in dose dependent manner. In DNA binding studies, complex **1** showed the greatest intrinsic binding constant due to π-π stacking with DNA base pairs may exert some additional interactions such as hydrogen bonding with functional groups present on the edge of the DNA.

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Abbreviations

CT-DNA: calf thymus DNA
 HEPES: [4-(2-hydroxyethyl)-1-piperazineethanesulfonic acid]

DMSO: Dimethyl sulfoxide

TMS: Tetramethylsilane

UV-Vis: Ultra Violet – Visible Spectroscopy

NMR: ¹H & ¹³C – Nuclear Magnetic Resonance Spectroscopy

IR: Infra-Red Spectroscopy

ESI-MS: Electrospray ionization mass spectrometry

MLCT: Metal-to-ligand charge transfer

MTT: 3-(4,5-Dimethylthiazol-2-yl)-2,5-

Diphenyltetrazolium Bromide

Tris: Tris(hydroxymethyl)aminomethane

CMIP: 2-(2-Chloro-8-methylquinolin-3-yl) w-1H-

Imidazo[4,5-f] [1,10] phenanthroline

Phen: 1, 10- Phenanthroline

Bpy: 2, 2' – bipyridine

Dmb: 4, 4' – Methyl, 2, 2' - bipyridine

Ppt: Precipitation

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A SURVEY ON DEEP LEARNING BASED RECOMMENDER SYSTEM ON APPLICATION DOMAIN CLASSIFICATION

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Abstract: Recommender system is major hardware for setting up an astounding correspondence among buyers and retailers in electronic business. Sensible and stunning correspondence to locate the fit thing is considered to have an epic outcomes to increase of offers accomplishment. Recommender framework set up in within 90s. In light of specific procedure, there are four of recommender structure model to be express system orchestrated separating, Contents Based, Knowledge Based and Demographic disengaging. Supportive separating is viewed as more pervasive than another tree frameworks. It offers clearly focal centers like good karma, eccentricity and accuracy. Regardless of the manner in which that it has two or three inclinations in recommendation result, with an extreme goal to improve the deficiency of the recommender structure, many including AI, AI with shallow layers was dominating in the 90's for example neural system, SVM. This paper gives a review of suggestion structures, which spotlights on critical learning approaches and the arrangement of occupations. The point by point portrayal of each suggestion framework is clarified, and the related datasets are promptly presented.

Keywords: *Recommender system, deep learning, neural network, Ecommerce.*

I. INTRODUCTION

The rule electronic business recommender structure was make and present in within 90s, The target foundation is the route by which web business clients could finding the reasonable thing suitably [1]. We can envision, the progression of Internet clients has broadened by and large. These parts were impact number of clients and number of things correspondingly developing essentially. By then online business affiliation must give a significant number of things to a monstrous number of clients at whatever point and any spots. Picking among a ton of thing is hard to be finished by clients. For instance, what thing needs to purchase, what news ought to be investigated, what film ought to be watched, what music to tune in, what hoisting ought to be looked, and so forth. Recommender structure is in like way especially steady for online business affiliation is to collect the measure of offers. In online business, there is enormous instrument how to give better data among buyer and maker that explicitly recommender structure. This instrument intends to make earth shattering correspondence for both. A wide degree of relationship, for example, Amazon.com, Netflix.com,

eBay.com, Half.com, CDNOW, J.C. Penney, and Procter and Gamble have suitably passed on suggestion advancements to develop web and stock game plans and improve client responsibility [2]. Web business has changed the course in different affiliations coordinate. To them, online business is never again a decision at any rate a target. Different affiliations are battling with the most basic issue: what is the best framework for structure up and coordinating in the automated economy? A few affiliations are moving their affiliations absolutely to the Web (e.g.egghead.com). Some are stirring up fortifications, by then turning them off as independent online business substances (for example barnesandnoble.com) [3]. The Internet has basically influenced the direct of business. Markets, adventures, and affiliations are being changed. The new economy requests the abuse of new models and rules. Data advancement (IT) straightforwardly drives affiliations and markets.

A recommender structure can envision whether an individual would buy a thing or not built up on the patient's inclinations. This structure can be executed dependent on a patient's profile or a thing's profile. This paper clarifies the thing based total separating based flourishing recommender

structure which gives beneficial data to patients subject to the thing's profile. These days there are different web journals and social discoursed open on the web where individuals can give assessments, surveys, online journals and trade points of view concerning things. Resulting to social event examinations for anything by patients, the recommender framework picks choices about patients who don't give any evaluations. Diverse e-business goals are working with the help of a recommender structure to broaden their compensation in the intense market [6]. Endless patients purchase their things through online electronic business goals. In the wake of purchasing things, they give their suppositions or any remarks about that thing in an individual web gathering. Thusly, making pay is the basic target everything being identical. Utilizing this recommender structure process, we can expand our business advantage in the market. While the propensities made by clients can be delineated as being generally shielded, decisions made in different segments may have progressively remarkable repercussions for the end quiet. Specifically, in the bit of human organizations, decisions can be hazardous as they are worried over the life and thriving of patients. The recommender framework ought not just help key specialist and divert threats or thwarted expectations, yet it ought to comparably screen patients and regulate treatment as huge, screen indispensable signs and present constantly by techniques for a concentrated server as for human organizations. These cutoff points address the reasonableness of Record structure.

II. RELATED WORK

In recommender systems, two fundamental segments anticipate squeezing businesses, to be unequivocal patients and things. Patients give their propensities about express things and these inclinations must be found of the collected information. The gathered information are tended to as an utility framework which gives the estimation of every patient-thing pair that tends to the level of inclinations of that patient for unequivocal things. Accordingly, the recommender motors are depicted into patient-based and thing based recommender motors. In a patient-based recommender structure, patients give their decisions and evaluations of things [11]. We can support that thing to the patient, which isn't surveyed by that patient with the assistance of a patient-based recommender motor, considering the likeness among the patients. In a thing based recommender structure, we utilize the similitude between things (not patients) to make wants from patients. Information

gathering for recommender structures is the rule work for want [12].

2.1. Times of Recommender System

(1) Information Collection Phase: This stage aggregates basic data about patients and readies a patient profile subject to the patient's attributes, practices or assets gotten to by the patient. Without structure up a well-depicted patient profile, a recommender motor can't work reasonably. A recommender framework heaps of information which are amassed in various ways, for example, unequivocal examination, certain data and mixture data. Express investigation takes data given by patients as exhibited by their vitality on a thing while grasped data takes tolerant inclinations in an aberrant way through watching decided lead [1].

(2) Learning Phase: This stage considers an assessment accumulated in the past stage as data and approach this investigation by utilizing a getting the hang of figuring to manhandle the patient's highlights as yield [1,2,13].

(3) Prediction/Recommender Phase: Preferable things are embraced for patients in this stage. By isolating examination gathered in data accumulation arrange, a craving can be made through the model, memory-based or watched exercises of patients by the structure [1,2].

The seasons of recommender structure are tended to in Figure 1.

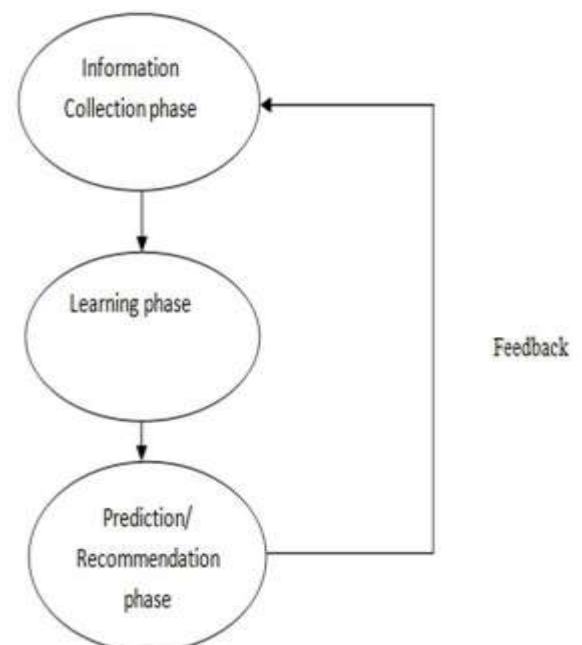


Figure 1. Phases of the recommender system.

2.2. Different Types of Filtering Based Recommender System

There are three types of filtering based recommender system available, which is shown in Figure 2.

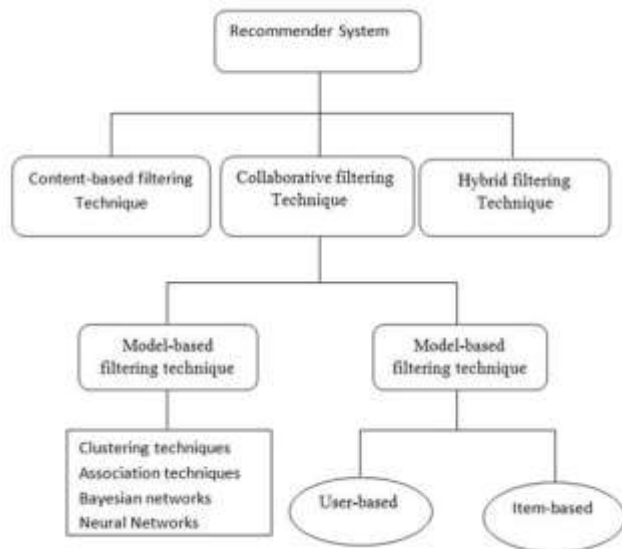


Figure 2. Hierarchy of Recommender System based on filtering.

(1) Content based Filtering Recommender System:

The content-based filtering technique focuses as for the appraisal of features and attributes of things to make conjectures. Content-based filtering is conventionally used in case of chronicle recommenders. In this system, a recommendation is made reliant on patient profiles, which deal with the different attributes of things close by patient's past acquiring history. Patients give their tendencies as evaluations which are sure, negative or objective in nature. In this framework, positive assessed things are endorsed to the patient.

(2) Collaborative based Filtering Recommender System: Collaborative filtering predicts obscure outcomes by making a patient-thing arrangement of decisions or inclinations for things by patients. Equivalent characteristics between patients' profiles are assessed by sorting out the patient-thing framework with patients' inclinations and interests. The region is made among social events of patients. The patient who has not evaluated to unequivocal things heretofore, that patient gets recommenders to those things by considering positive examinations given by patients in his neighborhood. The CF in the recommender structure can be utilized either for the gauge or recommender. Gauge is a rating respect $R_{i,j}$ of thing j for patient I . This communitarian sifting framework is commonly masterminded in two unique ways: memory based and model based synergistic disengaging. Figure 3 clarifies the entire

procedure of the system sifting methodology.

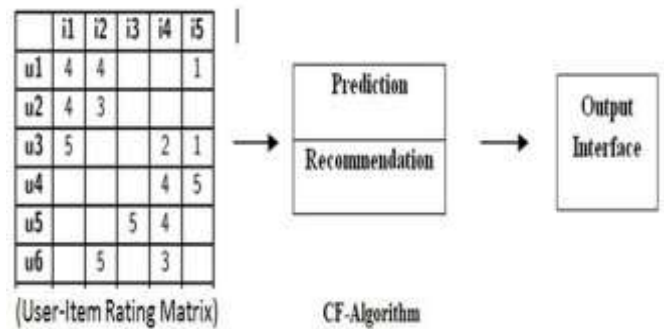


Figure 3. Collaborative Filtering Technique.

(3) Hybrid Filtering Recommender System: This methodology includes the more than two methodologies in order to fabricate the precision and execution of a recommender system. The cross breed filtering technique is performed by any of the going with ways: amassing a united recommender structure that combines both of the more than two procedures; applying some helpful isolating in a substance based philosophy, and utilizing some substance based isolating in the synergistic system. This strategy uses particular creamer methodologies, for instance, the course cross breed, weighted blend, mixed hybrid and changing cream as demonstrated by their exercises.

III. DEEP LEARNING FOR RECOMMENDER SYSTEM

Given the phenomenal achievement of the significant learning seemed various applications fields, it has starting late been proposed for updating the recommender structures quality. In this portion, we explore the particular significant learning structures used in the field of recommender system where we see that the coordination of significant learning is performed with the synergistic filtering model similarly as the substance based model where different plans can be taken an interest in a comparative structure.

The significant learning is a class of AI estimations. It relies upon the advances of the neural frameworks which are rebranded in the continuous years as significant learning. The significant learning shows his display in treating various application fields like talk affirmation, object area and trademark language taking care of exhibited by the trust offered by the most requesting undertaking on earth, for instance, Google, Facebook and Microsoft. The model of significant learning is addressed as a course of nonlinear layers

which structure a consultation of data. The significant learning is used for coordinated and unsupervised learning endeavors. In the composition, the nearness of significant learning is related to PC vision region including article and talk affirmation. The building of a neural framework is on a very basic level made from three layers: input layer, covered layer and yield layer. The refinement between the different sorts of frameworks is related to the kind of covered layer and the amount of covered layers choose the significance of the neural framework. The least troublesome phony neural framework is feedforward neural framework where the information moves from the data center points forward yield center points through the disguised center points a comparable path and without making circles or cycles in the framework. The advancement between layer is controlled with an activation work which can be immediate or nonlinear, for instance, tanh, sigmoid and Rectified Linear Unit (ReLU). The activation limits manage the looking at information sources loads w_{ij} . The designing of neural framework is depicted in Fig. 1. The red concealing presents the exercises associated on the clear feedforward neural framework to make an irregular neural framework where neurons in the covered layer are related drearily to neurons in the data layer.

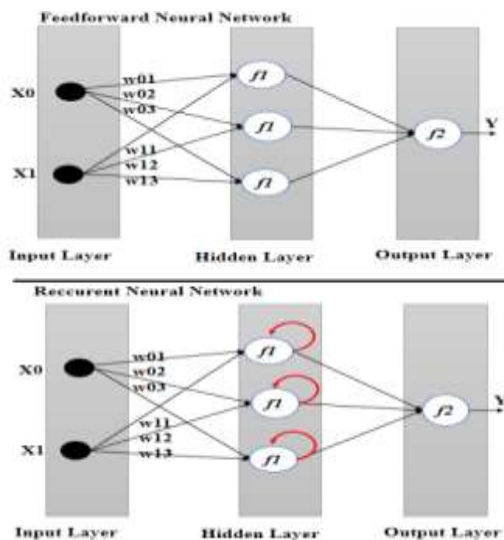


Fig. 1. Feed forward vs. recurrent neural network architecture

There are several categories of deep learning models. Among these models we cite the following which differ in term of complexity and application fields [21]-[24]:

- Multilayer Perceptron it is a variety of Feedforward Neural Network which is the most clear significant learning approach. MLP have diverse disguised layers which are interconnected in a feed-forward way. The mapping between

the data and the yield layers is driven by an abstract activation work.

- Unsupervised Learning Networks: This social affair covers three express structures which are Autoencoders, Deep Belief Networks (DBNs) and Generative Adversarial Networks (GANs).

The Autoencoder resembles MLP building with the unequivocality that the yield layer has undefined number of center points from the data layer to repeat the wellsprings of information yet in which the standard of dimensionality reduction is associated. The Deep Belief Network (DBNs) is produced using two deals with of layers Restricted Boltzmann Machines (RBMs) used for pre-planning stage and feed-forward framework used for finetuning stage.

The particularity of the Restricted Boltzmann Machines layer is the reliance between the two utilized layers where no intra-correspondence between them is permitted thus the assignment limited. The Generative Adversarial Network is made out of two neural systems. The principal system is utilized for applicants' age named as generator and the second for the competitors' assessment named as discriminator.

Convolutional Neural Network: It is a subclass of feedforward neural framework with the expressness of pooling errands and convolution layers. The convolution is a powerful thought that associates in structure continuously vivacious part space reliant on a sign. It is successfully associated in the PC vision and picture getting ready regions especially object affirmation and picture gathering.

- Recurrent Neural Network: It is a variety of feedforward neural frameworks. It is depicted by its ability to send information after some time steps. using of the inside memory of the framework and the circles errands which structure the genuine diverge from other feedforward neural framework It is comprehensively used in normal language getting ready, talk affirmation and computerized control applications. LSTM (Long Short-Term Memory) is a variety of Recurrent Neural Network model.

- Recursive Neural Network: Its plan empowers the recursive framework to get the hang of fluctuating progressions of parts of an image or words using a typical weight cross section and a matched tree structure. The complexity between a Recursive Neural Network and Recurrent Neural Network is

that the recursive one can be considered as a dynamic framework where there is no time factor to the information course of action and information sources are arranged continuously as shown by a tree structure. This structure is fit not solely to recognize challenges in an image, yet notwithstanding degage the association between all things in a scene. It is profitable as a scene or sentence parser.

IV. POSSIBLE RESEARCH DIRECTIONS

Deep learning-based recommendation methods can feasibly use multi-source heterogeneous data to moderate the data sparsity and cold start issues. In the past three years, the investigation on significant learning-based recommender systems has pulled in progressively more thought from the academic world and industry. This fragment discusses the possible research course of significant learning-based recommender structure.

A. CROSS-DOMAIN RECOMMENDER SYSTEM BASED ON DEEP LEARNING

A couple of existing works demonstrate the amplexity of significant learning in getting the hypotheses and differentiations transversely over different spaces and making better recommendations on cross-zone stages. At this moment, using significant learning frameworks, various sorts of data as a bound together commitment by introducing depictions, building significant level desire models for proposal by organizing various types of cross-arrange heterogeneous data. Cross zone recommendation can help target space proposition with the data picked up from source zones, gives a charming response for these issues. Single space proposal just spotlights on one zone while ignores the customer interests on various regions, which moreover strengthens data sparsity and cold start issues. Significant learning is fitting to move learning as it learns highlevel thoughts that unwind the assortment of different regions. A champion among the most extensively considered subjects in cross space recommendation is move acknowledging which expects to improve learning assignments in a solitary region by using data moved from various territories. Henceforth, it is a possible research course of significant learning based recommender system.

B. SCALABILITY OF DEEP LEARNING BASED RECOMMENDER SYSTEM

Versatility is fundamental to the handiness of proposal models in genuine systems as extending data volumes in the tremendous data. Significant learning has displayed to be

fruitful and promising in enormous data examination. We can change of the model multifaceted nature and flexibility with the exponential advancement of parameters. At present, the size of the framework is beginning to push toward progressively significant anyway less parameters. Another possible research course is high-dimensional data can be pressed to littler embedding to decrease the space and estimation time during model learning. The future research is to pack the overabundance parameters with the objective that the framework may have better exactness anyway have less parameters.

C. EXPLAINABILITY OF DEEP LEARNING BASED RECOMMENDER SYSTEM

Deep learning-based recommender systems use the significant learning model to clearly envision the customer tendencies by using multi-source heterogeneous data [106]. The eventual outcome of the model getting ready is to get the heaps between the neurons of significant neural framework. It is difficult to give a reasonable explanation direct to the recommendation results. Hence, making sensible proposals give off an impression of being unfathomable. One way is to make legitimate desires to customers, empowering them to understand the parts behind the framework's recommendations, demonstrate an appropriate proposition inspiration to disclose to the customer why the structure considers such a proposition to be reasonable. The other course is to focus on unveil ability to the master, testing burdens and establishments to see continuously about the model. Thusly, it can't avoid being it is moreover another possible research heading of significant learning-based recommender system, and consequent stage would to be to design better significant learningbased recommender models to give conversational or generative explanations.

D. ATTENTION MECHANISM BASED RECOMMENDER SYSTEM

Attentional framework has practically encouraged the non-interpretability stresses of significant learning models. Thought framework has provoked progressively unmistakable degrees of interpretability since the thought burdens not simply give encounters about the internal activities of the model and yet can give sensible results to customers. Attentional framework isn't only prepared for updating execution yet acknowledges increasingly critical explain limit. Applying the thought segment to recommender systems can help recommender structures to understand the most educational features of the thing, endorse the most operator thing, and

improve the interpretability of the model [107-113]. At the present time, thought part has been associated with significant learning models. For example, Attention part gives a better course of action and causes RNN than all the more promptly recall inputs. Thought based CNNs can perceive the most instructive bit of the issue from the information. Given that models are starting at now fit for finding the most illuminating parts of the wellsprings of information, we acknowledge that is another possible research heading.

E. DEEP COMPOSITE MODELS BASED RECOMMENDER SYSTEM

In current recommender systems, different portions should be outlined, including the effect of mixed affiliations, client thing correspondences, the dynamic progress of client inclinations, and so on. More fragments be shown can improve the presentation of recommender structures. Huge composite model joining assorted huge neural structures connects with a much increasingly essential asset for showing the heterogeneous qualities of the picking segments in recommender framework. There beginning at now have been a couple of examinations which organize grouped critical learning techniques together for improving shows. In any case, the endeavors are obliged veered from the potential developments, in light of the way that the model ought to be sorted out in a reasonable manner rather than discretionarily and uniquely fitted for accommodating necessities. Along these lines, the examination of huge composite models-based recommender structure is also one of things to come headings. Essentially, critical learning has wound up being prominent in recommender structures sort out both in the scholarly system and industry. By then, this zone of research is vivacious, there is much opportunity to improve in the as of late referenced research direction, in any case we in like way recognize that noteworthy learning will adjust recommender structures on a very basic level and get progressively open doors rethinking the client encounters for best customer devotion sooner rather over later.

V. CONCLUSION

The thrilling augmentation in the proportion of data being made by electronic and motorized devices requires the prerequisite for adroit techniques and applications that can properly and astutely store, method, get to and research information for most outrageous points of interest to

customers. Significant learning-based recommender systems(DLRS) are of such driving responses for these challenges, which are legitimate instruments to quickly help the strategy of information pursuing. Significant learning-based recommender structures can pick up capability with the lethargic depictions of customers and things from immense data, and a while later build up a recommendation model, finally make an amazing proposition list for the customer. The essential endeavors of the significant learning-based recommender systems are the best approach to deal with the immense multi-source heterogeneous data, manufacture progressively proper customer models according to customer tendencies necessities, and improve the introduction and customer satisfaction. Differentiated and customary recommender structures, significant learning-based recommender systems can use significant learning technique to normally get acquainted with the inert features of customer and thing by joining various sorts of multi-source heterogeneous data, model the gathering instances of customer lead, even more reasonably reflect the customer's different tendencies and improve the precision of proposition. It is believed that this overview will support tenderfoot and new experts to understand the improvement of DLRS. Moreover, ace examiners can use this overview as a benchmark to make DLRS and as a sort of point of view to the requirements of DLRS.

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Applications of Artificial Intelligence in Machine Learning: Review and Prospect

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ABSTRACT

Artificial intelligence(AI) is a combination of computer science, physiology, philosophy with mathematics and several other disciplines. AI and its applications is a very important aspect of computer and science revolution. As the world is fast globalizing, the hope for AI machines to take up human mental and physical capacity is rising, as it is believed will relieve menial works and duties that pose risk to life. In this paper, a brief review and future prospect of the vast applications of artificial intelligence in machine learning has been made.

KEYWORDS

Artificial Intelligence, Machine Learning, Supervised Learning, Unsupervised Learning, Reinforcement learning algorithms.

1. INTRODUCTION

The ultimate goal of AI is to develop human like intelligence in machines. However, such a dream can be accomplished through learning algorithms which try to mimic how the human brain learns. Machine learning, which is a field that has grown out of the field of Artificial Intelligence, is of utmost importance as it enables the machines to gain human like intelligence without explicit programming. However, AI programs do the more interesting things such as web search or photo tagging or email anti-spam. So, machine learning was developed as a new capability for computers and today it touches many segments of industry and basic science.

In the area of machine learning research, more emphasis is given to choosing or developing an algorithm and conducting experiments on the basis of algorithms. Such highly biased view reduces the impact on real world applications.

In this paper the various applications under the appropriate category of machine learning has been highlighted. This paper makes an effort to bring all the major areas of applications under one umbrella and present a more general and realistic view of the real world applications.

Apart from this, two application suggestions have been presented forward. The field of machine learning is so vast and ever growing that it provides to be useful in automating every facet of life.

2. MACHINE LEARNING

Machine learning is an application of artificial intelligence that provides systems the ability to automatically learn and improve from experience without being explicitly programmed. Machine learning focuses on the development of computer programs that can access data and use it to learn for themselves.

According to Arthur Samuel, machine learning is defined as the field of study that gives computers the ability to learn without being explicitly programmed. Arthur Samuel was famous for his checkers playing program. Initially when he developed the checkers playing program, Arthur was better than the program. But over time, the checkers playing program learnt what the good and bad board positions were, by playing many games against itself.

A more formal definition was given by Tom Mitchell as, "A computer program is said to learn from Experience(E) with respect to some Task(T) and some performance measure(P), if it's performance on Tas measured by P improves with experience (E), then the program is called a machine learning program."

In the checkers playing example, the experience E, was the experience of having the program playing games against itself. The task T was the task of playing checkers and the performance measure P was the probability that it won the next game of checkers against some new opponent. In all fields of engineering, there are larger and larger datasets that are being understood using learning algorithms.

3. Types of Machine Learning Methods

3.1 Supervised Machine Learning Algorithms

They can apply what has been learnt in the past, to new data using labeled examples to predict future events. Starting from the analysis of a known training data set, the learning algorithm produces an inferred function to make predictions about the output values. The system is able to provide targets for any new input after sufficient training. The learning algorithm can also compare its output with the correct, intended output and find errors in order to modify the model accordingly.

3.2 Unsupervised Machine Learning Algorithms

They are used when the information used to train is neither classified nor labeled. Unsupervised learning studies how systems can infer a function to describe a hidden structure from unlabelled data. The system doesn't figure out the right output, but it explores the data and can draw inferences from the data sets to describe hidden structure from unlabelled data.

3.3 Semi Supervised Machine Learning Algorithms

They fall somewhere in between supervised and unsupervised learning since they use both labeled and unlabelled data for training – typically a small amount of labeled data and a large amount of unlabelled data. The systems that use this method are able to considerably improve learning accuracy. Usually, semi supervised is chosen when the acquired labeled data requires skilled and relevant resources in order to train it/ learn from it. Otherwise, acquiring unlabelled data generally doesn't require additional resources.

3.4 Reinforcement Machine Learning Algorithms

This is a learning method that interacts with its environment by producing actions and discovers errors or rewards. This method allows machines and software agents to automatically determine the ideal behavior within a specific context in order to maximize its performance. Simple reward feedback is required for the agent to learn which action is best; this is known as the reinforcement signal.

4. INTEGRATION OF ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

Machine learning enables analysis of massive quantities of data. While it generally delivers faster, more accurate results in order to identify profitable opportunities or dangerous risks, it may also require additional time and resources to train it properly. Combining Machine Learning with Artificial Intelligence and Cognitive Technologies can make it even more efficient in processing large volumes of information.

5. APPLICATIONS

5.1 Unsupervised Learning

In Machine Learning, the problem of unsupervised learning is that of trying to find hidden structure in unlabelled data. Since the examples given to the learner are unlabelled, there is no error or reward signal to evaluate a potential solution.

5.1.1 Analysis of gene expression data: Cancer diagnosis

Cancer can be defined as a class of diseases that is characterized without control of self growth. There are about 900 different types of cancer claiming the lives of innumerable people across the world. Thus, identifying the type of cancer is a crucial step in its treatment. It is done through classification of patient samples.

The classification process and results may be improved by analyzing the gene expression of the patient which may provide additional information to the doctors. The merger of medical science and technology has already led to a lot of life saving breakthroughs in the field of medicine[1].

5.1.2 Social Network Analysis

Unsupervised Machine Learning Algorithms can automatically identify the friends within a user circle in Facebook or Google or it can identify the maximum number of mails sent to a particular person and categorize into collective groups. It also identifies which are groups of people that all know each other[7].

5.1.3 Market Segmentation

Many companies have huge databases of customer information. So, unsupervised machine learning algorithms can look at this customer data set and automatically discover market segments and automatically group customers into different market segments so that the company can automatically and more efficiently sell or market the different market segments together. Again, this is unsupervised learning because it is known in advance what the market segments are, or which customer belongs to which segment[7].

5.1.4 Cocktail Party Problems

Consider a cocktail party with two people, where both are talking at the same time. Two microphones are placed in the room at two different distances from the speakers; each microphone records a different combination of these two speaker voices. These two microphone recorders are given to an unsupervised learning algorithm called the Cocktail Party Algorithm. The cocktail party Algorithm separates out these two audio sources that were being added or being summed together[9].

5.1.5 Medical Records

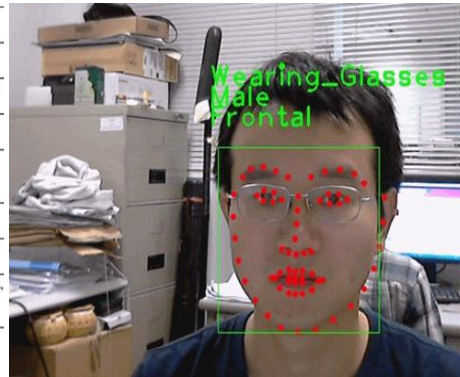
With the advent of automation, electronic medical records have become prevalent. So if medical records are turned into medical knowledge, diseases could be understood in a better way.

5.2 Supervised Learning

5.2.1 Pattern Recognition

It is the process of recognizing patterns by using machine learning algorithm. Pattern Recognition can be defined as the classification of data based on knowledge already gained or on statistical information extracted from patterns and/or their representation. One of the important aspects of pattern recognition is its application potential. In typical pattern recognition application, the raw data is processed and converted into a form that is amenable for a machine to use. Pattern recognition involves classification and clustering of patterns.

Problem Domain	Application	Input Pattern	Pattern Class
Bioinformatics	Sequence Analysis	DNA/Protein sequence	Known type of genes/patterns
Data mining	Searching for meaningful patterns	Points in multi dimension space	Compact and well separated clusters
Document classification	Internet search	Text document	Semantic categories
Document image analysis	Reading machine for the blind	Document image	Alphanumeric characters / words
Industrial automation	Printed circuit board inspection	Intensity or range image	Defective / non defective nature of product
Multimedia database retrieval	Internet search	Video clip	Video genres e.g. action, dialogue etc
Biometric recognition	Personal identification	Face, iris & finger print	Authorized user for access control
Remote sensing	Forecasting crop yield	Multispectral image	Land use categories, growth pattern of crops
Speech recognition	Telephone directory enquiry with operator	Speech waveform	Spoken words



(a)Pattern Recognition

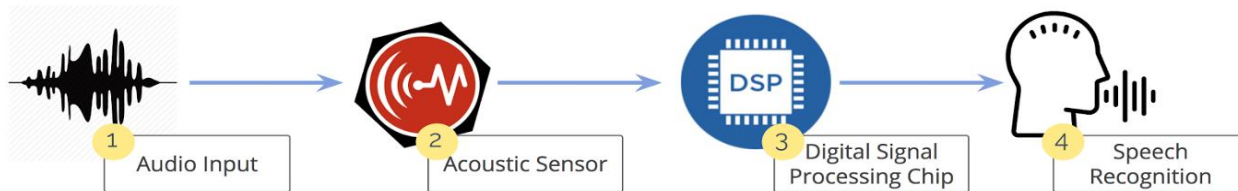
(b) Facial Recognition

5.2.2 Facial Recognition

Facial recognition is one of the common uses of machine learning. There are many situations for using facial recognition. As an example, high quality cameras in mobile devices have made facial recognition a viable option for authentication as well as identification. Apple’s iPhone X is one of its examples. Facial recognition application works in the software identifies 80 nodal points on a human face. Nodal points are end points used to measure variables of a person’s face, such as the length or width of the nose, the depth of the eye sockets and the shape of cheek bones [5].

5.2.3 Voice Recognition

Voice recognition or Speech recognition converts voice/speech into text. It is also known as Automatic Speech Recognition (ASR). Some examples are Google Assistant, Siri, Cortana and Alexa. Voice Recognition is one of the categories in Deep Learning.



The system analyses the human specific voice and uses it to fine-tune the recognition of that person’s speech, resulting in increased accuracy. Simple voice commands convert to decode and may be used to initiate phone calls, select radio stations or play music from a compatible smart phone, mp3 player or music loaded flash drive. Voice recognition software measures the unique biological factors, which form the users voice, from the sounds that a user makes while speaking[4].

5.2.4 Financial Services

Machine learning has a lot of potential in the finance and banking sectors. For example, Taaffeite Capital Management trades in a fully systematic and automated fashion using proprietary machine learning systems. In the finance world, stock trading is one of the most important activities. Stock market prediction is an act of trying to determine the future value of a stock other financial instrument traded on a financial exchange.

A Machine learning approach is trained from the available stocks data and gains intelligence. It then uses the acquired knowledge for an accurate prediction [2][3].

5.2.5 Health Care

The increasingly growing number of applications of machine learning in healthcare allows us to glimpse at a future where data, analysis, and innovation work hand in hand to help countless patients. One of the chief ML applications in healthcare is the identification and diagnosis of diseases and ailments which are otherwise considered hard to diagnose. Machine learning and deep learning are both responsible for the breakthrough technology called Computer Vision. Another sought after application of machine learning in healthcare is in the field of radiology.

5.2.6 Spam Filtering

It is mainly used to filter unsolicited bulk Email (UBE), junk mail, or unsolicited commercial email (UCE) from the emails. The spam filter saves the user from having to wade through tons of spam email, that's also a learning algorithm. The spam filter can also be learned by watching which emails you do or do not flag as spam. So in an email client if spam button is clicked to report some email as spam, but not other emails and based on which emails are marked as spam, the email program learns better how to filter spam email[6].

5.2.7 Information retrieval

Information retrieval(IR)is finding material of an unstructured nature that satisfies an information need from within large collections. The user provides an outline of their requirements- perhaps a list of keywords relating to the topic in question, or even an example document. The system searches the database for documents that are related to the user's query, and presents those that are more relevant. The IR process can be divided into four distinct phases: indexing, querying, comparison and feedback [8].

6. CONCLUSION

Humans have always sought to build a comfortable life, the proof of this lies in the fact that we have always depended on machines to get our work done more easily, in a faster more efficient manner. In the past machines have been used to reduce the manual labour required to the get a job done, but at present, with the advent of machine learning humans seek to build machines which are not only strong but also intelligent and hence machine learning has emerged to become an area of study that is ever in the bloom.

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SENTIMENT ANALYSIS BASED INTELLIGENT PRODUCT RECOMMENDER SYSTEM

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Abstract:- Evaluation appraisal is one of the dreary model examine centers in the field of substance mining. Mining feeling from customary language is a scraping undertaking. Supposition assessment gives tremendous data to basic ace in different spaces. Explicit tendency ID philosophy are open in any case may not render most clear outcomes in all point of view. In this paper, tendency of clients concerning the affiliations given by E-shopping regions is considered. The inclination or appraisal of the individuals is initiated by reviews, assessments and emojis. The things which have positive assessment

from the past clients are proposed for the present clients. For this stochastic learning estimation which investigates various information sources identified with the affiliations is utilized. The end is allotted negative, positive and impartial. Appraisal happens dependent on procedure. The proposed structure will discover counterfeit systems about a thing with the assistance of MAC address near survey posting plans. Client will login to the structure by giving the username and riddle key and will see different things and can give learn about the thing. To discover the survey is a phony or valid, the MAC region of the structure which is astounding is checked by the proposed framework. Thusly phony audits are not seen.

Keywords:-Text Mining, Sentiment Analysis, Ratings, Reviews, Emoticons, Recommend, Fake reviews

I. INTRODUCTION

As we watch out for all grip, it's Associate in Nursing time of information sway, during which we will all in all consistently get tremendous extents of learning. Along these lines, it's in pounding may need of selecting the satisfying and intriguing information rapidly. in order to choose this huge issue, proposition structure ascends at the fundamental minute. Among the present suggestion tallies, the thing based satisfying segregating proposal recipe is that the most in general utilized one. Its standard depends upon the client's evaluation of things. the truth is to watch out the closeness among clients, and supporter things to the objective client regarding the records of the for all intents and purposes indistinguishable clients. In any case, the proportion of customers and thing continues stretching out at a high rate, that will fabricate the cost to sweep out the bearing rundown for each client. The intensity of one typical pc won't fulfill the need and besides the super pc can regard a foolish extent of. in order to choose the issue, we tend to expected to utilize Map slice back way to deal with oversee total the heading structure. In addition, we will by and large pass on the work to some pc packs and additionally the PC record of the present pc bundle just relies on the past one or the beginning data. thusly the pipeline improvement are gotten the chance to help the power more. The assessment demonstrates that the structure will blend the intensity of some standard workstation to strategy tremendous scale data

in an extraordinarily short time span [1]. The undertaking survey information acknowledge a basic action inside the suggestion of study masters. during this paper, we will when all is said in done expect to work out survey pro's evaluating by maltreatment the certified rating records furthermore the legitimate choice outcomes on the past comes, and by recommends that of explicit guidelines, we will all in all structure a rating system for comes and pros. For the data exiguity burden of the rating framework and in addition the "cool beginning" downside of most recent talented suggestion, we will when all is said in done recognize that those undertakings/experts with comparative centers have close to segment vectors and propose an audit skilled steady proposition condition fortified subject relationship. Promptly, we will all in all get themes of tasks/specialists kept up idle Dirichlet task (LDA) model, and assembling the subject relationship course of action of activities/stars. By at that point, through the subject relationship between undertakings/specialists, we find a neighbor game-plan that offers the best closeness with objective assignment/ace, and orchestrate the social gathering into the pleasing separating suggestion condition kept up framework goals. At long last, by learning the rating system to begin include vectors of the comes and experts, {we can|we are capable to} envision the assessments that an objective task will offer contender study pros, and in this way make several bucks the audit capable

suggestion. Appraisals on veritable instructive gathering demonstrate that the engineered procedure may predict the audit talented rating a great deal of appropriately, and improve the direction effect of survey experts [2]. Recommender frameworks apply information revelation procedures to the matter of making changed recommendations for data, thing or associations all through a live correspondence. These frameworks, especially the k-closest neighbor pleasing confining predominantly based ones, space unit picking up in all cases ground on the net. The titanic progression inside the proportion of possible information and besides the gathering of occasion producers to web areas beginning late addresses some key difficulties for recommender structures. These are: making top quality recommendation, acting a few proposition for reliably for two or three clients and things and accomplishing high thought inside the substance of data sad quality. In obsolete strong segregating structures the proportion of work will reach out with the degree of people inside the structure. New recommender structure improvements area unit required that may rapidly make top quality recommendations, notwithstanding for unpleasantly gigantic scale issues. To deal with these issues we have evaluated thing based satisfying separating structures. Thing based procedure starting study the client thing structure to spot association between very surprising things, therefore utilize these relationship with in a contorted way process suggestions for clients [3]. Exponential improvement of information made by on-line social affiliations requests viable and versatile recommender structures to direct obliging outcomes. outdated frameworks become unfit because of they expel affiliation information; existing social proposition structures consider social partnership structure, at any rate social talk data has not been completely thought of [6]. it's major and hard to breaker social talk factors that zone unit got from clients' inspiration of social practices into social proposal. During this paper, we will when all is said in done research the social proposition burden on the clarification of mental science and humanism thinks about that show 2 indispensable segments: unequivocal affinity and social impact. We watch out for at an opportune time blessing the certified criticalness of those 2 factors in on-line lead measure. By then we will with everything considered propose a wonderful probabilistic structure objectives system to go along with them out of contraption house. We will when all is said in done constantly offer an adaptable recipe which may steadily system the gigantic scale data. We will when all is said in done direct assessments on each Face book vogue bifacial and Twitter vogue simplex social association educational records. The cautious outcomes and appraisal on these 2 epic educational records exhibit that our system in a general sense beats the present approaches [4]. Generally, we have seen a flourishing of zone - based obliging systems. A semantic depiction of area information

is required to oblige the need of zone seeing, analyzing, course and tending to. During this paper, we will manage in uncertainty expect to audit the recorded foundation of heading of social affair (POI) by obliterating the flooding heterogeneous client made substance (UGC) from absolutely remarkable pleasing systems. We will obviously get some information about the substance depictions, photographs, client appearance models, and setting for a domain semantics comparability progress. We will all around battle that the scene recorded foundation expect a colossal improvement in client appearance lead. Supported this contention, a bound together dish proposal condition is orchestrated by joining scene valid foundation as a regularize. Notwithstanding etymologizing client inclination fortified client setting appearance data, we will control in uncertainty put dumbfounding load on a zone phonetics comparability. At long last, we will when all is said in done direct a concentrated presentation assessment of region phonetics similarity and strategy recommendation over a confirmed world dataset amassed from Foursquare and Instagram. Starter results show that the UGC data will well outline the setting phonetics that aching to help the intrigue execution.

II. RELATED WORK

Existing structure Sentiment evaluation is energized on 3 totally abrupt levels: audit level, sentence-level, and verbalization level. Survey level assessment and sentence-level assessment consider to design the assumption of a whole assessment to in any event one of the predefined thought polarities, identically as positive, negative and regularly reasonable. notwithstanding the way wherein that state level assessment consider to evacuate the inclination most remote scopes of each part that a client passes on his/her point of view to the positive piece of a specific product. Zhanget al. propose a freely guided and lexiconbased evaluation plan way to deal with oversee control see thought most removed inspiration driving a survey that contains each issue words and emojis. similarly, that they use end for proposition. Lee et al. propose a recommender structure abuse the acceptability of experts to watch out every novel and applicable recommendations[8]. By separating the client assessments, they will propose basic managers to an objective client kept up the client masses. the present work fundamentally bases on referencing clients into joined assessment (for example positive or negative), and that they don't go more in mining client's supposition. The present procedures on an astoundingly principal level effect thing class data or name information to survey the social impact. These structures square measure all bound on the oversaw data, that isn't constantly reachable on unequivocal areas. Everything considered, USer blueprints will give us bits of information in mining social chose

thought and client propensities. we will when all is said in done propose an estimation based rating measure structure inside the structure of framework considering. In our work, we will when all is said in done utilize social clients' supposition to interpret examinations. Regardless, we will everything considered oust thing choices from client examines. By at that point, we find the supposition words, that square measure balanced portray the thing decisions. In addition, we will oversee in uncertainty use feeling word references to figure estimation of a specific client on Associate in Nursing thing/thing. The focal responsibilities of our point of view square measure as looks for after: we will when all is said in done propose a client nostalgic mensuration approach, that is predicated on the mined thought words and supposition degree words from client considers. We will when all is said in done utilize estimation for rating infer. Client slant proportionality bases on the client intrigue propensities. Client end impact reflects at any rate the supposition spreads among the unequivocal clients. Thing name closeness shows the potential giganticness of things. We will all around weave the 3 sections: client end vague quality, social examining influence, Associate in Nursing thing name closeness into a probabilistic cross district understanding structure to hold a right proposal. The exploratory outcomes and talked display that client's social estimation that we tend to mined could be a key consider up rating check shows up. In our paper, we watch out for not just mine social client's appraisal, at any rate conjointly audit social energetic impact and thing's name. At last, we will with everything considered bring every one of them into the recommender structure. the motivation driving our point of view is to watch out sensible signs from audits and anticipate social clients' evaluations. we will in general cementing client doubt comparability, lay individual idea impact, and thing name closeness into a bound together structure considering bundling work to accomplish the rating figure task.

III. PROPOSED METHOD

We propose an end based rating need strategy inside the course of action of cross area enlisting. In our work, we will when all is said in done utilize social clients' tendency to translate evaluations. Regardless, we will when all is said in done oust thing choices from client reviews. By at that point, we find the supposition words, that square measure balanced delineate the thing choices. Similarly, we will administer in uncertainty use end word references to discover supposition of a specific client on Associate in Nursing thing/thing. The basic responsibilities of our strategy square measure as scans for after:

a) We propose a client nostalgic mensuration approach, that is predicated on the mined end words and tendency degree

words from client investigates. b. We use supposition for rating need. Client supposition closeness pivots the client intrigue inclinations. Client supposition impact reflects at any rate the end spreads among the conspicuous clients. Thing name indistinct quality exhibits the potential criticalness of things. c. We join the 3 segments: client end comparability, social sharp impact, Associate in Nursing thing name resemblance into a probabilistic framework understanding structure to hold a right suggestion. The exploratory outcomes and talks show that client's social supposition that we tend to mined could be a key consider up rating need shows up. d. The extra strategy proposed as intersection point framework is utilized for perceiving social end sway among client and accomplices. the extra fragment like poor, odious, phenomenal is other than else inside which it's essentially to foresee the pivotal thing.

IV. ALGORITHM

As explained before the structure watches out for two issues. Regardless, building recommendation system for Algerian customers subject to evaluations appraisal. Second, dealing with the four vernaculars, of Algerian customers, including: Arabic, Algerian tongue, French and English. Fig. 1 amasses the different events of proposed strategy.

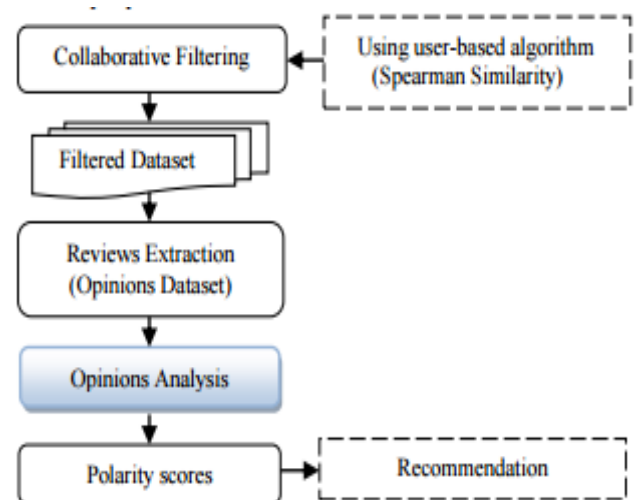


Fig: The proposed process for recommendation system based on opinions analysis.

1. Run of the mill disconnecting Breese et al. [21] pulled back communitarian isolating counts into two classes: memory-based figurings [22-26] and model-based

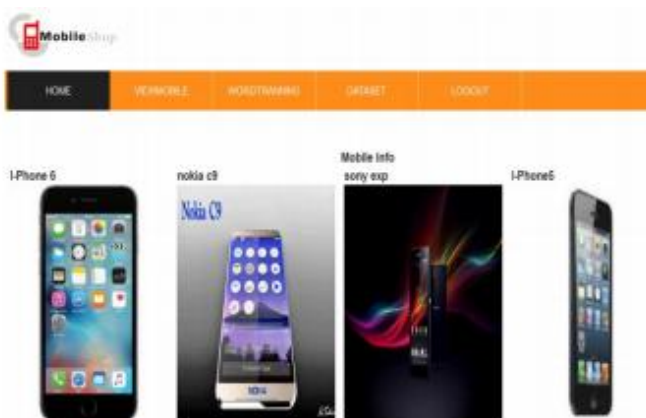
estimations [27-39]. Memory-based checks register a measure by joining examinations of picked customers or things that are picked a choice to be genuine. Model-based figurings use each and every open rating to end up being progressively acquainted with a model, which would then have the choice to be used to envision the rating of some sporadic thing by some theoretical customer. Memory-based CF incorporates can be in like manner limited into userbased CF figurings and thing based CF estimations. In this work, we used the customer based CF figurings [23, 25], where a ton of k nearest neighbors of the target customer is seen first by learning the affiliations or similarities between the customers' evaluations. We likely found that spearman closeness was the best similarity measure for the proposed structure. Spearman similitude contains finding a relationship coefficient, not between the qualities taken by the two segments, regardless between the spots of these properties. It is portrayed by:

$$r_s = \frac{\sum_{i=1}^n ((rang(x_i) - \overline{rang(x)})(rang(y_i) - \overline{rang(y)}))}{\sqrt{\sum_{i=1}^n ((rang(x_i) - \overline{rang(x)})^2 \sum_{i=1}^n (rang(y_i) - \overline{rang(y)})^2)}$$

Where, (xi) and (yi) are the declaration's conditions in the model. The for all intents and purposes indistinguishable attributes between the customers expel up from - 1 to 1. We picked the value 0 as a point of restriction to see the closest neighbors of a customer. The amazing isolating with spearman closeness picks the things picked by in each practical sense foggy customer's profiles. These last post concentrates identified with their tendency things

V. EXPERIMENTAL RESULTS

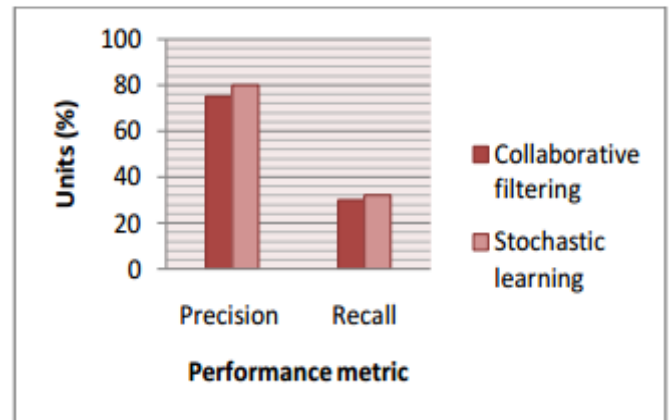
A site for booking phones is made using C#.NET framework as front end plan and SQL SERVER as back end.



$$\text{Precision} = \frac{\text{Number of Relevant Products extracted}}{\text{Total Number of Products extracted}}$$

$$\text{Recall} = \frac{\text{Number of Relevant products extracted}}{\text{Total Number of Products in}}$$

Database To look at the proposal structure, various types of suggestion incorporates are used. Some things in online business were taken reliant on appraisals. By then normal on exactness and standard on survey is made due with every evaluation. Result shows that proposed framework gave the better result in examination of structure.



V.CONCLUSIONS

In this proposed work, a novel execution of a thing suggestion structure dependent on mix recommendation check is appeared. The fundamental unprecedented condition of this method is the visual relationship of the information dependent on the disguised structure, and a basic reducing in the size of the intrigue space per result yield. Likewise the client can without a colossal measure of a stretch deals the things any place at whatever point. Evaluations, audits and emojis are examined and appointed positive and negative examinations. The things can be looked with the assistance of concentrate based segregating. Macintosh based disengaging technique can be utilized to keep up an essential decent ways from phony plans. This strategy was studied against determined client information amassed through an online webpage page, by utilizing a subset of the things loved by every client as commitment to the framework. The present outcomes are amazingly superior to unusual technique. In the long run, it is felt that with an otherworldly dataset and various updates this system may accomplish better outcomes. Mix Recommendation is one of the standard modules of the framework which demolitions the disadvantages of the standard Collaborative and Content Based Recommendations. Thusly encouraging outcomes are gotten utilizing this model.

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SUSTAINABLE DEVELOPMENT: WELLBEING ECONOMICS APPROACH

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ABSTRACT

India is an example of co-existence of 'the embarrassingly rich and the desperately poor'. Each sector, industry, community or group is in pursuit of its survival, identity and growth. Pursuit of self-interest is supposed to inherently ensure progress of society, according to received theories and imposed practices, but apparently failed to do so.

This paper takes a multi-pronged approach and inquires into the inter- and intra- sectoral interactions on wellbeing and measures to make it non-exclusive and equitable. The current real-time instances chiefly from the banking sector are a part of the study to prove the serious repercussions caused by ignoring the complexity of interactions and integrations and treating each factor or variable independently with de-unified knowledge. Consultative participatory institution is presented as an institution that enables interactions of every other variable and factor each reinforcing the other thus avoiding extremities in decision-making and producing unified knowledge in the process. Development and growth with a wellbeing perspective, endogeneity of ethics and non-exclusivity with consultative participatory standpoint is the sine qua non. A criterion for measuring the inclusivity in terms of consultative participation is taken as an indicator of measuring unity of knowledge.

Keywords: Wellbeing, Consultative Participatory Institution, Unified knowledge, Endogeneity of ethics.

1 Introduction

Today a vast majority of Indians are facing issues such as poverty, malnutrition, lack of basic amenities of water & sanitation, unemployability, price-rise, absence of sound health care system, affordable housing, good education, erosion of ethics, environmental degradation and credit crunch. The vertical growth of a small percentage and the horizontal increase in debasement of a large percentage necessitates us to revisit the epistemic reference, if any, for this lop-sided unsustainable 'growth'.

GDP was originally conceived as a metric to monitor cyclical fluctuations of the market, hence not designed or expected to gauge societal well-being. Budgets and plans are laid-out in terms of sectoral growth targets and not in terms of rates of poverty-reduction, employment-generation, health, education, environment and ethics and living standards of the people. Such plans are sectoral growth plans and not broad-based nation-building plans. The crucial issues affecting the masses is attempted to be resolved as an outcome of pursuing growth-centric policies. The Economic Advisory Committee and mainstream economics justify and are convinced that the surplus revenue generated out of more growth could be and would be directed towards the lower strata of the society. However, revenue generation that does not involve all the sectors and communities cannot in turn allow percolation of wealth downward. The received or accepted thought-process that considers 8% growth rate as a goal-post for Indians and a bench-mark to read India's progress needs to be revisited.

This paper discusses the political economy of wellbeing premising on unity of knowledge. The epistemic concept of unity of knowledge entails dynamic interactions, thus, participation of societal, political, economical, environmental, ethical, technological and diversely unified institutional and non-institutional variables in a consultative participatory institutional milieu. This is a perspective for sustainable world systems.

Thus, the outcome of a consultative participatory institution would be knowledge guided by unified world view generated out of pervasive complementarities, participatory development, causatory inter- and intra- sectoral linkages and evolutionary learning between the variables conducted through mutual discourses, participants of which are conscious of the episteme of unity of knowledge. Thus we render the episteme of unity of knowledge and unified world view into integrated wellbeing. The aim is to ensure broad-based development as opposed to pocketed development through wide consultative participation. Thus, a new approach of sustainability by a change in the structure of development into a wellbeing perspective is discussed.

2 Objective:

This paper presents an alternative thought process in order to premise on an episteme that can generate unified knowledge. Unified knowledge is knowledge that arises organically out of discursions of complex and dynamic inter- and intra- sectoral interactions recognized as natural to the world systems. Consequently, wellbeing of universe is a natural outcome, caused through endogeneity of all factors including ethics, environment, polity, society, economy and technology.

3 Background:

Economy is being built up on the edifice of growth. Democracy is about inclusive growth as non-inclusive growth could undermine democracy. The economic growth so far has been far from inclusive. We have had Nobel laureates and leaders speak out against this socio-economic injustice but political needs and expediencies have been overriding economic compulsions and resolves. Socio-economic movements such as Occupy Wall Street and Jan Lok Pal Bill, brought to fore the failures of market and political system, viz., capitalist democracy. It was a joint failure of the political system of democracy and the economic system of mainstream neo-classicism.

What we need is consultative participatory discourses that shape fresh thought processes evolving policies that lead to equitable and sustainable growth. The political economy of inclusive growth decisively leads us to understand the failures of corporate governance, where the political processes colluded with the financial institutions to shape the markets in favour of the agenda of the colluders under the garb of liberalism and deregulation.

4 Scholarly opinion on current issues of the non-inclusive neo-classical economic regime:

Citing shortcomings of the present market system, in a lecture at Indian Statistical Institute, Kolkata, Nobel Laureate Joseph Stiglitz said that, market forces were not efficient in producing and distributing information and knowledge. He pointed out that gap of knowledge is wider than gap of resources between developed and developing countries. He advocated a balanced role between markets, government and civil society. He criticized the developing countries attitude of borrowing and adapting technologies from north. He rightly pointed out that much of technological or other invention in developed nations has been targeted towards saving labour. Whereas in developing countries labour is in abundance and unemployment is the burning problem. Labor saving inventions only aggravate the social issue. He stressed that real scarcity is that of natural resources hence inventions should be towards saving resources and environment. There is serious dearth of research centers in developing world to focus on scarcities. He pointed out the failures in development thinking. Intellectual Patent Rights often restricted the use of knowledge and contributed to creating monopolies. He said that democratic ideals create knowledge economy and said non-inclusive growth could destabilize democracy.

Nobel laureate and Harvard professor Amartya Sen has always been a critic of the Indian academic-political-industrial obsession with the Gross Domestic Product(GDP) or growth rate targets over the more substantial goals such as universal guarantees such as basic health care, education, food and empowerment

through livelihood entitlements. This approach is of serious concern to the agricultural sector as more than 50% of Indian population are involved in agriculture sector activities and majority of this sector are poor.

Prof Mehabubul Huq, a Pakistani economist who was the founder of Human Development Report recommended lesser military expenditure for the sub-continent and use of funds on education and poverty reduction. He said political will and commitment is vital for all strategies to take shape. In his book 'Poverty Curtain' he specified that that growth is thought to bring about employment. Unemployment is treated as step-child of planning and growth.

5 Neo-classical theory and goals pursuing non-inclusive growth:

The usual arguments put forth by the neoclassical proponents of free-trade, free-markets, capital flow liberalization and economic growth are the market-driven competitive forces for efficient allocation of resources. Yet the missing element in capitalist globalization argument vis-à-vis market competition is a recognition of the short and long run social and private costs that globalization brings about through its approach based on market-driven competition. Neoclassical economics views long term survival in terms of market competition and efficient allocation of resources. All policies, institutions and programs remain exogenous to this fundamental condition.

6 Unity of Knowledge:

An inclusive growth entails the set up of an inclusive world system or unified world view. Unified world system is by its very nature the idea of that of causal linkages, consultative participation, complementarities and evolutionary learning. The objective of this framework is wellbeing. Inclusive growth is hence a natural offshoot of this framework.

The episteme of unity of knowledge necessitates the representatives of various entities to acknowledge and pay heed to the circular causal complementarities amongst the variables of the analyzed system and their entities. The natural systems are essentially unified, characterized within, as diverse dynamic complementary interactions, integrations and evolutions, and the natural laws are as defined and upheld by the principle of unity of knowledge and unified world-systems.

The institution of Consultative participation treats the diverse system representations as sub-systems that do not compete; rather they complement with each other. Thus the entities and representatives of the variables are recursively interrelated under a reinforcing mechanism generated out of the characteristics of broad

participation, wide representation, resulting into transparency, judicious responsibility and accountability leading to socio-economic efficiency and equitable development.

The knowledge deduced and the simulated levels of common wellbeing of the participating entities and the corresponding variables in this regard would go through a circular causation knowledge-gaining process. The interactive and evolutionary form of learning in unity of knowledge in Consultative Participatory institutional model is all-inclusive and integrated.

7 Conclusions:

Intellect cannot cast away what is discernibly good and true. There has to be an intellectual exchange between received and alternative ideas. This paper has discussed new grounds on the theme of socio-economic reconstruction at global and national levels by presenting concept and application underlying the science, society and economy embedding. The theme of consultative participatory political economy as a new idea of political economy in this socio-economic sense has been discussed. Such a definition recognizes the traditional one on conflict and power in the ownership, distribution and production of resources. But it extends to the moral and ethical foundation of unity of knowledge and its epistemic influence on the construction of politico-economic issues under study. Such a path towards moral and ethical reconstruction of the socio-economic question was considered as the way towards new socio-politico-economic contracts as human and wellbeing centric. The concept of unity of knowledge and its discursively driven organic participation has been discussed for political and institutional consideration.

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The Hindu – OP-ED – ‘Seeding a farm policy without the dirt on climate change’

The Hindu – EDITORIAL – ‘Sen, the moral universalist’



INNOVATIONS IN BANKING SECTOR - E-BANKING PRODUCTS

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INTRODUCTON

The term Innovation means to make something new. Banks no longer restrict themselves to traditional banking activities, but they have explored newer avenues of increasing their business and capturing new markets. Today we have a fairly well developed banking system with different classes of banks. Some of them have engaged in the areas of consumer credit, credit cards, merchant banking, Internet and phone-banking, leasing, mutual funds etc.

Banking in India

- In India, “The General Bank of India “was the first bank started in 1786.
- The qualitative and quantitative changes in the banking sector took place when, “The Bank of Bengal” was started in 1806.
- The Reserve Bank of India started in 1935 became the central banking authority.
- The Banking Company Act was passed in 1955.
- 14 Major Banks were nationalized in the year 1969 and 7 more banks in 1980 were nationalized.
- IN 1990’s greater emphasis was being placed on Technology and Innovation
- Opening up of the economy and implementation of the recommendations made by Narasimham Committee influenced the Indian Banking sector to a greater extent.
- New concepts like personal banking, retail banking, total branch automation etc.were introduced.

Concept of E-Banking

Liberalization and de-regulation process which started in 1991-92 made drastic changes in the Indian Banking System. From a totally regulated environment, the banks in India gradually moved into a market driven competitive system. E-Banking or electronic banking is a major innovation in the field of banking. Information revolution led to the evolution of Internet which led to the e-commerce continued by the evolution of E-banking. In the present Era, we cannot think about the success of any service or industry including the banking industry without Information Technology. The Information Technology has increased contribution of banking industry in the economy. Financial transactions can now be processed quickly and easily in fraction of seconds. Banks are able to generate more and more business opportunities resulting in greater profitability. The Information Technology Revolution in banking sector has not only provided improved services to the customers but also reduced operational costs of the banks.

History of E-Banking

The history of E-Banking dates back to 1980’s.The term online banking became popular in the late 90’s and referred to the use of a terminal, keyboard and monitor to access the banking system using a phone line. The first online banking service was introduced in 1994 in the United States of America. This service was developed by Stanford Federal Credit Union which is a financial institution and provided the first online internet banking services to all of its members in 1994.Later on the idea was snapped by various other banks.

E- Banking in India

In India e-banking is of recent origin. The traditional model for banking has been through branch banking. Only in the early 1990s there has been start of non-branch banking services.

Opening up of the economy in 1991 marked the entry of foreign banks in India .These banks brought new technology with them. The concept of internet banking has been simultaneously evolving with the development of the World Wide Web. The online shopping promoted the use of credit cards through internet. Banking products became more and more competitive and the need for diverse products and services was felt.

The credit of launching internet banking in India goes to ICICI Bank. Citibank and HDFC Bank followed with internet banking services in 1999.The ICICI bank firstly introduced online banking in India in 1996 under the brand name “Infinity”. Currently 78 percent of its customers are registered for online banking. 1996 to 1998 marked the adoption phase while usage increased only in 1999 owing to online charges, increased PC penetration and technology friendly atmosphere.

Several initiatives have been taken by the Government of India as well as the Reserve Bank to facilitate the development of e-banking in India. The Government of India enacted the IT Act, 2000 with effect from October 17, 2000 which provided legal recognition to electronic transactions and other means of electronic commerce. The Reserve Bank monitors and reviews the legal and other requirements of e-banking on a continuous basis to ensure that e-banking would develop on sound lines and e-banking related challenges would not pose a threat to financial stability. A high level Committee under chairmanship of Dr. K.C. Chakrabarty and members from IIT, IIM, IDRBT, Banks and the Reserve Bank prepared the „IT Vision Document- 2011-17“, for the Reserve Bank and banks which provides an indicative road map for enhanced usage of IT in the banking sector.

Modern banking is virtual banking which means the customer cannot see the bank but with the help of technology all the banking activities can be conducted from anywhere in the world. The Reserve Bank of India constituted a working group on Internet banking. The group divided Internet banking products in India into three types based on levels of access granted. They are,

- 1) Information only System
- 2) Electronic Information Transfer System
- 3) Fully Electronic Transactional System

Components of E-Banking

- Internet
- Wire Application Protocol based mobile (WAP is a technology started for accessing information over a mobile wireless network)
- Automated telephone
- ATM network
- SMS and FAX messaging components
- Multipurpose Information Kiosks

Using the above components financial transactions can be conducted from anywhere and allow non-stop working time.

The three broad facilities that e-banking offers are

- **Convenience** - Complete your banking at your convenience in the comfort of your home.
- **No more Q's** - There is no queue at an online bank.
- **24x7 Service** - Bank online services are provided 24 hours a day, 7 days a week and 52 weeks a year.

E-banking simply refers to the use of electronic channels like phone, mobile, internet etc for delivery of their services to their valuable customers. The use of e-banking technology includes using ATM's, Smart cards, ATM, Telephone banking, Internet banking and Mobile banking.etc. for doing day to day banking services.

E-banking products and services in India

- Internet Banking
- ATM
- Mobile Banking
- RTGS
- NEFT
- Debit and Credit Cards
- Smart Cards
- POS

Internet Banking: It is a system of banking in which customers can view their account details, pay bills and can transfer money by means of the internet. This includes the delivery of new and traditional banking products and services through electronic delivery channels. This system allows conducting the banking transactions online. It is the use of electronic means to transfer funds directly from one account to another rather than by cheque or cash.

Automated Teller Machine: ATM's are widely used as electronic channels in banking. It is operated by a plastic card with special features. It is a computer controlled device through which the customer can make withdrawals, check the balance in account.etc.

Mobile Banking: This refers to the use of a smart phone or other cellular device to perform online banking tasks while away from home computer. The activities such as monitoring account balances, transferring funds between accounts, payment of bills, locating an ATM etc.

RTGS: It stands for Real Time Gross Settlement. It is a fund transfer mechanism where transfer of money takes place from one bank to another. It is primarily for large volume transactions. The time taken for effecting funds transfer from one account to another is normally two hours.

NEFT: It stands for National Electronic Fund Transfer. It facilitates transfer of funds to other bank accounts in over 36000 bank branches across the country. It is simple, secure, safe, faster way to transfer funds.

Debit Card: It is a plastic card which provides an alternative payment method to cash for purchases. Functionally it can be called an electronic check as the funds are withdrawn directly either from the bank account or from the remaining balance on the card. It is used instead of credit card to pay bills such as utilities, insurance, etc.

Credit Card: It is a part of a system of payments named after the small plastic card issued to users of the system. It is a card entitling its holder to buy goods and services based on the holder's promise to pay for the same. The issuer of the card grants credit to the user or customer from whom the user can borrow money for payment to a merchant or as a cash advance to the user.

Smart Card: It is a micro chip based card used for making purchases without need of any PIN. It is a powerful card which carries out functions of ATM card, Debit card and Credit card.

POS: Point of Sale is the time and place where a retail transaction completes. It is the point at which a customer makes a payment to the merchant in exchange for goods or after provision of service. POS terminals are the electronic devices deployed at merchant outlets to accept the debit and credit cards.

Benefits of E-banking

E-banking helps the customers as well as banks by overcoming the drawbacks of manual system as computers are capable of storing, analyzing, consolidating, searching and presenting the data as per the requirement of customers and banks with a lot of speed and accuracy. It increases the efficiency in the area of effective payment by enhancing the delivery of banking services in quick time. E-banking has helped banks to retain the current customers, increase customer satisfaction, acquire further share in the markets and reduce the costs of delivering service to the customers. Delivery of services has gained increasing popularity through electronic platform. It provides alternative way for delivery of services in a faster way to the customers. Various services are being offered by banks through electronic banking.

Advantages to the Banking institutions

- E-banking helps in reducing the cost of delivering the services to the customers.
- It provides banks with competitive advantage among their peers.
- It reduces the use of paper money that helps the central bank in printing less paper notes.
- Through websites, banks can earn revenue by promotional activities.
- Customers can avail e-banking facility from anytime, anyplace, therefore there is a need to invest more and more on relevant infrastructure.

Advantages to the customers

- E-banking delivers 24x7 services to customer.
- Easy access to account information in quick time.
- Payment can be made online for the purchase of goods and services.
- With e-banking, customers can check account balance, can get statement of their account, apply for loans, check the progress of their investments and collect other relevant information.

Challenges of E-banking

The latest developments in information technology have also brought many challenges in successful delivery of e-banking services to the customers. Speedy changes in technology, complex, high costs, security and data privacy issues, new rules and regulations, lack of trained manpower are some of the challenges faced by the commercial banks in India.

Customers need to have skill to deal with computers and browsers. The people who are not comfortable with computer and internet often find it difficult to make use of the e-banking facilities. In many instances, a simple pressing wrong key may create a big problem.

Security Risk

Increasing number of fraudulent bank websites will mislead the customers. For example a suspicious bank website www.sbionline.com will create confusion with the original bank website www.onlinesbi.com.

Fake e-mails are sent to the customers from fraudulent banks.

Personal Information verification e-mails are also sent to customers from fraudulent banks.

Fake calls and messages to the customers insisting them to disclose ATM numbers and their passwords.

Guides the customers to enter fraudulent links on the web site.

CONCLUSION

The banking sector in India has become stronger in terms of capital and number of customers. It has become globally competitive and diverse aiming at higher productivity and efficiency. Exposure to worldwide competition and deregulation in Indian financial sector has led to the emergence of better quality products and services. Reforms have changed the face of Indian banking and finance. The banking sector has improved in terms of technology, products and services, information systems etc. With new opportunities unfolding in banking sector India is sure to emerge as a global power in banking services in the days to come.

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EMERGING TRENDS IN BANKING - IMPACT OF INFORMATION TECHNOLOGY IN BANKING INDUSTRY

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Abstract:

This paper explains that most of the banks have begun to take an innovative approach towards banking with the objective of creating more values for customers and consequently the banks. E-Banking enables the people to carry out most of their banking transactions using a safe website which is operated by respective banks. Various Innovations in Banking and Financial Sectors are ECS, RTGS, NEFT, EFT, ATM, Retail Banking, Debit and Credit cards and many more. With the emergence of Privatization, Globalization and Liberalization in India, banks are focusing on Research and Development and applying various innovative ideas and technology. There is a close relationship between the development of banking sector and the new innovations in technology and Electronic data processing. The present article focuses on the benefits and challenges of changing Banking trends and to study the performance of existing technology based products and services being offered by Banks in India and their future prospects as well as the advancement of banking sector by information technology.

KEY WORDS: *Banking Innovation, Information Technology, Payment and Settlement System in Banks, E-Banking.*

1. INTRODUCTION:

Banking environment has become highly competitive today. To be able to survive and grow in the changing market environment, banks are going for the latest technologies, which is being perceived as an enabling resource that can help in developing more flexible structure that can respond quickly to the dynamics of a fast changing market scenario. It is also viewed as an instrument of cost reduction and effective communication with people and institutions associated with the banking business.

The Banking sector is undergoing the process of radical transformation due to excessive competition of foreign and private players and changes in tastes, preference and habits as well as expectations of customers for newer products. The traditional view of business which was the right product must be available in the right place at the right time is replaced now by a more dynamic and flexible concept that any product should be available at anytime and anywhere.

Since the nationalization of banks in 1969, the public sector banks or the nationalized banks have acquired a place of prominence and since then have been instrumental in ascertaining tremendous progress. The need to become highly customer focused has forced the slow moving public sector banks to adopt a fast track approach. The Indian Banking has finally worked up to the competitive dynamics of new Indian market and its relevant issues concerning the various challenges of Globalization. Banks that employ IT solutions are perceived to be futuristic and proactive players capable of meeting the multifarious requirements of large customer base. Indian Banking industry is going through a phase of metamorphosis and has witnessed changing strategies by different banks to adapt to the evolving competitive environment. This shift from traditional social banking to profit banking, implementation of prudential norms pertaining to Capital Adequacy norms, income recognition, asset classification, exposure norms etc. have given rise to increased competition and thrown greater challenges in banking sector. With these variations in the level of IT in Indian Banks, it is useful to take account of the trends in IT and also to see the comparative position with Indian Banks.

The relevance of the status of Indian Banks with the perception when they get into IT up gradation is the main objective which strongly supports the inclusive growth in the Banking sector. IT has helped the Banking industry to deal with the challenges the new economy poses. Technology has opened up new markets, new products, new services and efficient delivery channels for the banking industry. Few examples are such as Online Banking, Mobile Banking and Internet Banking. The progress of technology and development of worldwide have significantly reduced the cost of global fund transfer. The IT revolution has set the stage for unprecedented increase in financial activity across the globe. It is IT which enables the banks in meeting such high expectations of the customers who are more demanding and also tech-savvy compared to their counterparts of the yesteryears.

2. OBJECTIVE OF THE STUDY:

The main Objective of this research paper is to review the implementation of IT in Banking Industry. Technological innovations have enabled the industry to open up new delivery channels, seeking the help of IT to deal with the challenges that a new economy poses. The Objectives of the present study are:

- 1) To study the rapid advancement occurring in the banking sector.
- 2) To analyse the performance of existing technology based products offered by the banks in India and its future prospects.

3. METHODOLOGY:

The present review paper is based on the Secondary data. It analyses the available literature on Banking technology and various existing and upcoming innovative products offered by banks in India. The Secondary data pertaining to the study was obtained from the various journals, books, newspapers and websites of the concerned Banks.

4. REVIEW OF LITERATURE:

Banking sector plays a very important and crucial role in the development of Indian economy with the use of technology; there had been an increase in penetration, productivity and efficiency of banking practices. It has not only increased the cost effectiveness but also has helped in making small value transactions feasible. Bhosle and Sawant in research paper, "Technological Developments in Indian Banking sector" discussed the role and concept of banking sector in the development of Indian economy. The paper highlights that the technology allows taking place faster and offering unparalleled convenience through various delivery channels like MICR, CTS, RTGS, and NEFT etc. Many researchers have given their views on the innovation in the services.

- Avasthi and Sharma (2000) in their study have analyzed that advances in technology are set to change the face of banking business. Technology has transformed the delivery channels by banks in retail banking. The study has also explored the challenges that banking industry and its regulator faces.
- Arora (2003) in his study highlighted the significance of bank transformation. Technology has a definite role in facilitating transactions in the banking sector and the impact of technology implementation has resulted in the introduction of new products and services by various banks in India. Mangnale, Chavan and Randive, in their research paper "E-CRM in Indian Banking Sector, Golden Research Thoughts" analyzed in their study that technology, people and customer are the three elements on which depends the whole success of banking in the fast changing economic environment. This paper analyzes the concept of e-CRM in Indian banks from its various dimensions covering specifically the needs, process, present status and future prospects.
- KPMG, "Technology enabled transformation in Banking", The Economic Times Banking Technology, Conclave 2011, this article has concluded that banking will be transformed by new technology by 2015. customer friendly products, delivery channel, easy and accessible services and competitive pricing would be driving forces- and technology shall play a dominant role in all these. Models using mobile devices and efficient payment systems will make banking services widely available 24 x 7 The various technological platforms provided by the banks to its customers bring greater flexibility and operational convenience by providing computerized banking environment, speedier transactions, accurate statements, ATMs offering 24

hours banking, Mobile banking, Internet banking; anywhere and at anytime. Customer terminals are proved to be a milestone in the development and growth of banks.

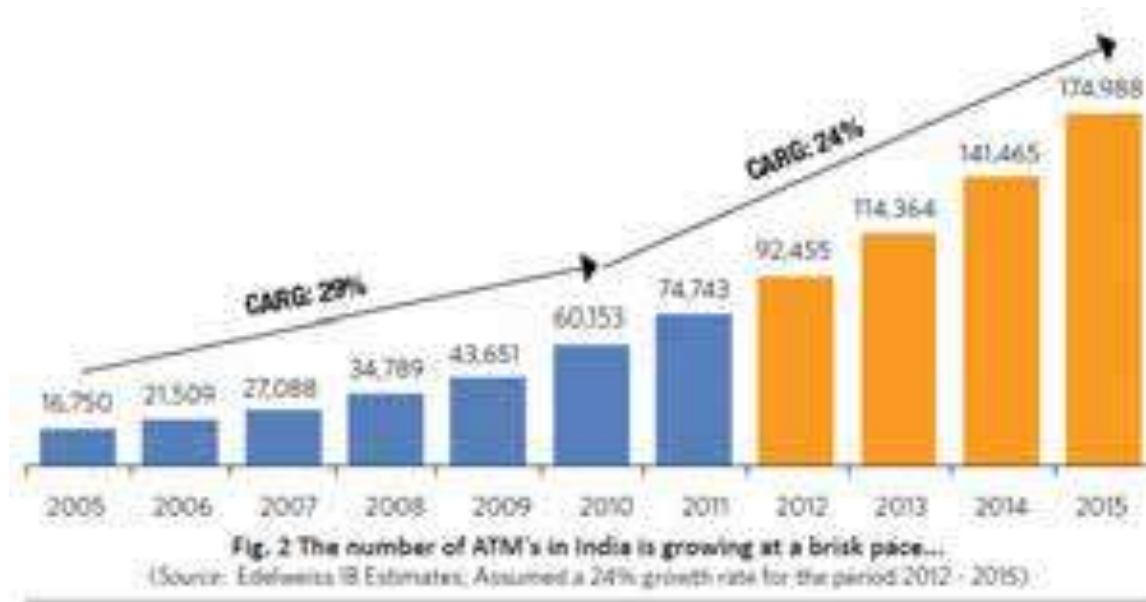
5. TECHNOLOGY AND INNOVATIONS IN BANKING:

Banking environment has become highly competitive today .Developments in the field inclusive of information technology strongly supports the growth and inclusiveness of the banking sector by facilitating inclusive economic growth. IT improves the front end operations with back end operations and helps in bringing down the transaction costs for the customers. Major events in the field of IT in banking sector in India are:

- Introduction of ATMs in 1987.
- Card based system in late 1980's and 90's.
- Electronic Clearing Services (ECS) in early 1995
- Electronic Funds Transfer (EFT) in early 2000.
- Introduction of RTGS in 2004.
- National Electronic Fund Transfer (NEFT) in 2005 by replacing EFT.
- CTS in the year 2008.
- The Payment and Settlement Systems Act passed in December 2007.

➤ AUTOMATED TELLER MACHINES:

ATMs were introduced to the Indian Banking industry during 1987 by HSBC Bank in Mumbai. With the advent of ATMs, banks are able to serve the customers outside the banking halls. Now the ATMs are equipped with modern technologies and facilitate various features for its customers who include Bill payments, ticket booking, Mobile recharges, Ubiquitous multifunction, ATMs biometric, Multilingual ATMs and ATM network switches. The number of ATMs in India is growing at a brisk pace. ATM segment witnessed a growth of 24% for the period from 2012-2015. According to available data the number of ATMs which were 92,455 in 2012 is increased to 1, 74, 988 in year 2015, which is a good sign for whole industry.



Source: Edelweiss IB Estimates

➤ CARD BASED SYSTEM:

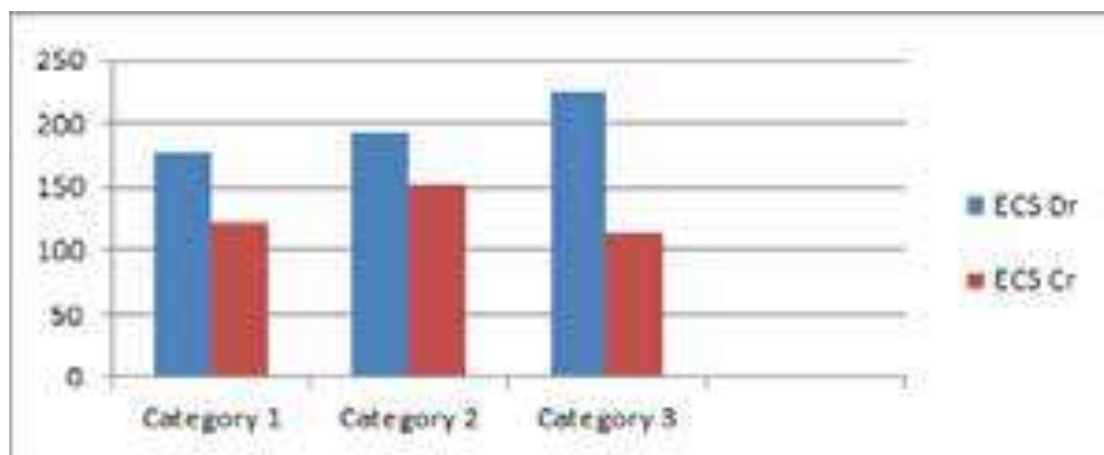
Among the Card based delivery mechanisms for various banking services, are Debit Cards and Credit Cards. The amount of Debit Card transactions increased rapidly which was Rs.469.1 million in year 2012-2013 and Rs.808.1 million in year 2014-2015, whereas the amount of Credit Card transactions was Rs.396.6 million in year 2012-2013 and Rs. 615.1 million in the year 2014-2015.

ITEMS	2012-2013	2013-2014	2014-2015
DEBIT CARDS	469.1	619.1	808.1
CREDIT CARDS	396.6	509.1	615.1

➤ ELECTRONIC CLEARING SERVICES (ECS):

ECS introduced by RBI in 1995, akin to Automated Clearing house system. ECS has two variants i.e. ECS Debit clearing services and Credit clearing services. ECS Debit operates on the principles of single credit multiple debits and is used by utility service providers for collection of electricity bills, telephone bills and other charges and also by banks for collection of principal and interest repayments. ECS Credit handles bulk and repetitive payment requirements of corporate and other institutions and is used for transactions like payment of salary, dividend, pension,

interest etc. ECS Debit amount is increased from Rs. 176.5 million to Rs. 226 million from 2012-2013 to 2014-2015 and ECS Credit amount is decreased from Rs. 122.2 million to Rs. 115.3 from 2012-2013 to 2014-2015.



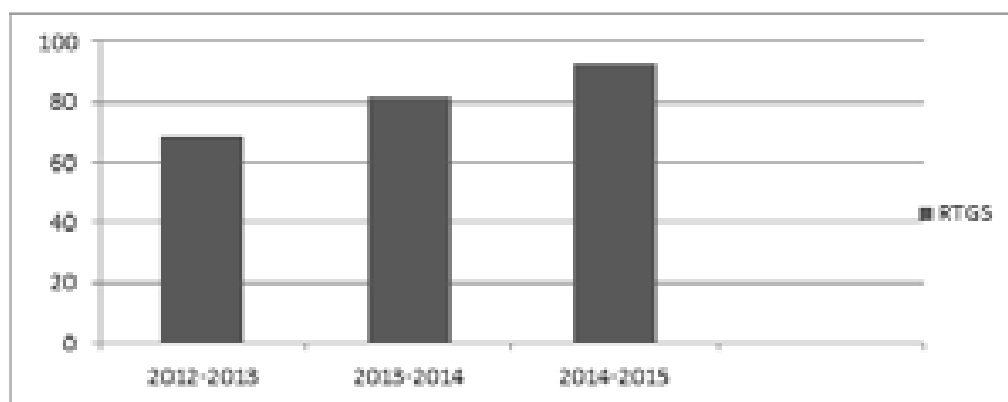
Source: rbi.org.in

➤ ELECTRONIC FUND TRANSFER:

The EFT system enables an account holder of a bank to electronically transfer funds to another account holder with any other bank..The most widely used EFT programs is Direct deposits, in which payroll is deposited straight into an employee bank account, although it transfer the funds through an electronic terminal including Credit card, ATM and Point of Sales (POS) transactions.

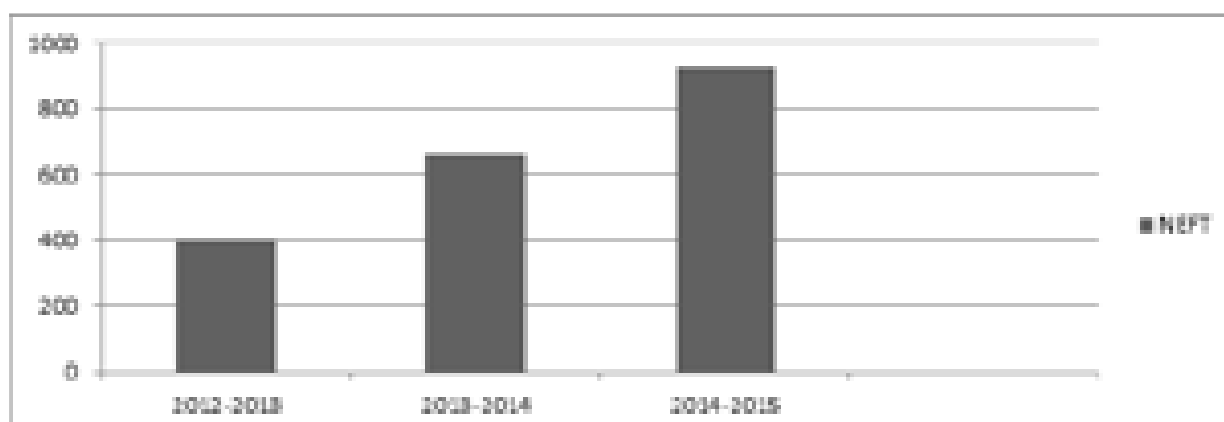
➤ REAL TIME GROSS SETTLEMENTS (RTGS):

The introduction of RTGS in 2004 was instrumental in the development of infrastructure for Systematically Important Payment System (SIPS) and it settles all interbank payments and customer transactions above 2 Lakhs. RTGS was launched by RBI, which enabled a real time settlement on a gross basis. To ensure that RTGS system is used only for large value transactions and retail transactions take an alternate channel of EFT. The reach and utilization of RTGS has witnessed a sustainable increase since its introduction. In the year 2012-2013 to 2014-2015 transactions related to customer remittances have raised from Rs.68.5 million to Rs.92.8 million. This shows the increasing popularity of RTGS in Indian banking industry.



➤ NATIONAL ELECTRONIC FUND TRANSFER (NEFT):

New and improved variant of EFT was implemented in November 2005 to facilitate one to one fund transfer requirement of individuals as well as corporate. It uses the Structured Financial Messaging Solution (SFMS) for EFT message creation and transmission from the branch to the banks gateway and to the NEFT centre, so it can transfer the funds with more security. With the SFMS facility, branches can participate in both RTGS and NEFT System. Using the NEFT infrastructure, a one –way remittance facility from India to Nepal has also been implemented by the RBI since 15th May, 2008. Overall EFT and NEFT based clearing increased from Rs.394.1 million to Rs.927.6 million in year 2012-2013 to 2014-2015.



6. INNOVATIVE PRODUCTS AND POLICIES OF BANKS:

- “My Saving Rewards”, the program allow customers to accumulate reward points on a host of savings account transactions such as bill pay, online shopping, EMI payment etc.
- 24x7 fully electronic branches are opened to undertake real time transactions by the customer.
- “E-Locker”, an online service for storing important documents for privilege banking customers.
- UID authentication for Aadhaar based payments and enabling corporate to pay taxes online.
- Cash Deposit Machines (CDMs) are installed for cash deposits by customers at these machines by using their ATM cum Debit card.
- E-trade SBI, a web based portal launched in March 2011 to access trade finance services with speed and efficiency.
- To facilitate the Electronic Benefit Transfer (EBT) scheme for routing MGNREGA where all scheduled commercial banks were instructed to open Aadhaar enabled bank accounts of all the beneficiaries.
- Expansion of branches in remote locations either through a bank branch or Business Correspondence (BC) or other modes so that every eligible person should have a bank account.
- Know Your Customer (KYC) norms simplified to facilitate financial inclusion and customer services.
- The RBI is replacing the existing RTGS with a new NGRTGS system which includes which includes few extra features like advanced liquidity management facility; Extensible Markup Language (XML) based messaging system etc.
- Recently launched scheme of government “Jan Dhan Yojana” with the motive that every family must have a bank account
- Today, the banks installed Solar ATMs, windmills to fulfill their own energy needs, paperless banking etc. SBI is the largest deployed of Solar ATMs.

7. CONCLUSION:

Today, Information Technology is used in two different avenues in banking- Communication and Business Process Re-engineering (BPR). It is reported that about 250 million internet users are there in India, which is among the top three in the world and this number is set to grow to 350 million by end of 2015. The E-banking, Mobile banking, Net banking and ATMs facility has gained the success among the customers. Today's generation is showing a keen interest in adopting all such technology enabled banking facility. Payment settlement systems like RTGS, NEFT, EFT, ECS, and CTS have proved to be successful among the customers using these facilities. Therefore, the IT revolution has set the stage for overcoming the challenges the new economy poses keeping in view the unprecedented increase in financial activity across the world.

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Economic Security through Micro Insurance - Problems and Prospects

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Abstract

Micro Insurance, commonly called as the insurance for the poor, is characterized by low value products and low premium. In India, it is a step to promote insurance coverage among economically vulnerable section of the society. IRDA'S Micro Insurance Regulation 2005, has strengthened the growth of regulated micro insurance in India and paved path for expanding the outreach to insurance to rural and underserved section of society. This paper throwing light on concept of micro insurance, its growth during post privatisation, significance of Micro Insurance in creating economic security. In this paper the problems and prospects of Micro Insurance in India were also highlighted.

Keywords: *Micro insurance, IRDA, Economic Security, Financial Inclusion etc*

INTRODUCTION:

Insurance occupies an important place in the complex modern world risk, which can be insured, has increased enormously in every walk of life. This has led to growth in the insurance business and evolution of various types of insurance covers. The insurance sector acts as a mobiliser of savings and a financial intermediary and is also a promoter of investment activities. It can play a significant role in the economic development of a country, while economic development itself can facilitate the growth of the insurance sector.

Insurance is a form of risk management which is used primarily to hedge against the risk of a contingent, uncertain loss. Insurance is defined as the equitable transfer of the risk of loss, from one entity to another, in exchange for payment. Insurance is essentially an arrangement where the losses experienced by a few are extended among many who are exposed to similar risks. It is a protection against financial loss or loss of life of a person that may occur due to an unexpected event. The insured receives a contract called an insurance policy which details the conditions and circumstances under which the insured will be compensated.

OBJECTIVES OF THE PAPER:

- To understand the concept of insurance and its growth in India, post privatisation of insurance sector,
- To analyse the role and significance of Micro Insurance in creating economic security
- To understand the problems and prospects of Micro Insurance in India.

SOURCES OF DATA:

The main sources of data used for the paper are Secondary one. IRDA Annual reports, KPMG report on Indian insurance sector and other related literature are used for the paper.

Insurance can be broadly classified into : (a) life insurance, and (b) general or non-life insurance.

- (a) Life insurance or life assurance is a contract between the policy owner and the insurer, where the insurer agrees to pay the designated beneficiary a sum of money upon the occurrence of the insured individual's death or other event, such as terminal or critical illness. In return, the policy owner agrees to pay a stipulated amount at regular intervals or in lump sums. Life-based contracts tend to fall into two major categories:
- **Protection policies:** These are designed to provide a benefit in case of a specified event, typically against lump sum payment. A common form of this policy is term insurance.
 - **Investment policies:** The main objective is to facilitate the growth of capital by single or regular premiums. The common forms in this category include whole life, universal life and variable life policies.
- (b) General insurance or non-life insurance policies, including automobile and homeowners' policies, provide payments depending on the loss from a particular financial event. General insurance typically comprises any insurance cover that is not deemed to be life insurance. Some categories of general insurance policies are: vehicle, home, health, property, accident, sickness and unemployment, casualty, liability, and credit. The terms of insurance generally depend on the company providing the cover.

Status of Life Insurance Sector in India - An Overview:

Since the opening of the sector in 2001, Indian life insurance industry has gone through two cycles-- the first one being characterised by a period of high growth with a CAGR of approx. 31 percent in new business premium between 2010-17 and a flat period showing a CAGR of around 2 percent in new business premium between 2010-19. During this period, there has been increase in penetration from 2.3 percent in FY01 to 3.4 percent in FY12, increased coverage of lives, substantive growth through multiple channels viz. agency, banc- assurance, broking, direct, corporate agency and increased competitiveness of the market due to growth of private players from four in FY01 to 24 private players in FY13.

Insurance Density and Penetration in India:

Two important indicators of the level of development of the insurance sector in any country are:

- (i) Level of insurance penetration which is measured as the percentage of insurance premium in gross domestic product (GDP); and
- (ii) Insurance density ratio (wherein insurance density is defined as the per capita expenditure on insurance premium and is directly correlated with per capita GDP).

Both insurance penetration and density have increased significantly over the years, especially with the opening up of the insurance industry to the private sector (as shown in Table 1). However, the increase has been marginal as far as the non-life insurance sector is concerned. While the density of life insurance in India grew from USD 15.7 in 2004 to USD 42.7 in 2018, the density in the non-life insurance industry for the same period grew from USD 4 to USD 10.50. Similarly, penetration in the life insurance sector increased from 2.53 per cent in 2015 to 3.17 per cent in 2018 and very marginally in the non-life insurance sector from 0.64 per cent in 2019 to 0.78 per cent in 2017. Thus, penetration in the non-life insurance sector has remained virtually constant over the years. India's insurance penetration is lower than the world average which in 2017 was 7.0 per cent,

while for India it was 5.2 per cent. Although, the penetration of Indian insurance is higher than that of some South Asian countries like Pakistan (0.7%), Bangladesh (0.9%) and Sri Lanka (1.4%), it lags behind other Asian countries like Japan (9.9%), South Korea (10.4%) and Singapore (6.8%).

However, in the life insurance sector, India's performance in terms of percentage of penetration at 4.6 per cent in 2018 is comparable with some developed countries and is above the world average of 4.0 per cent. In the non-life insurance sector, India with 0.6 per cent lags behind the world penetration average of 3.0 per cent in the year 2019.

Several factors are responsible for the low levels of insurance penetration in the country. These include low consumer preference, untapped rural markets and constrained distribution channels. In urban areas, life insurance penetration is approximately 65 per cent, and is considerably lesser in the low-income unbanked segment. In rural areas, life insurance penetration in the banked segment is estimated to be approximately 40 per cent, and at best is marginal in the unbanked segment. Before opening the sector to private insurers, it was felt that low levels of insurance penetration were due to ineffective market strategies adopted by Life Insurance Corporation (LIC) of India. Being a monopoly, the company had no strategic market plan. Advertising initiatives were limited to the print and electronic media, which mainly promoted LIC's products as being tax saving tools for salaried individuals. Although the level of penetration has increased after the entry of other players, it is still low compared to other countries. As per the surveys conducted on low levels of density and penetration, the problem has been exacerbated due to:

- agents' inability to clearly explain the features of the products;
- lengthy documents that are not user friendly; and
- the perception that agents are only concerned with their commissions.

Micro Insurance - Insurance for the Masses:

Micro insurance refers to insurance products which are designed to provide risk cover for low-income people. Generally, these products are focused towards providing adequate coverage to the customer segment with flexible payment schedules for the lower premiums. Although there are various benchmarks to distinguish micro insurance from insurance, product design (size of premium and risk cover) and access are key differentiators for micro insurance products. Simple products which are easily accessible through an efficient distribution process to keep the overall cost of products low are qualified under micro insurance.

Unlike in case of the urban regions, penetration of the insurance industry in rural regions has been relatively lower. Rural population has relatively lower access to information and lacks awareness of insurance products, mostly rendering them to be the 'un-insured' class of population. However, in order to make them aware of the insurance products and more importantly the need for insurance, it is necessary to educate them in person thus requiring a high touch service model to be followed. This requires identifying the 'centres of influence' to create awareness of insurance products, educating them on the need to be insured and finally converting them in a cost effective manner to tap this 'un-insured' and 'under-insured' market. Their potential opinion leaders in the rural markets can be Headmasters of local government schools, Sarpanch of the gram panchayats, Non-Governmental Organizations (NGOs) and Self Help Groups (SHGs) that work in certain rural districts or even be the banking agent or business correspondent.

The large untapped rural 'un-insured' population represents a significant growth opportunity and those who take the approach of identifying influencers might have a distinct advantage in the future. Certain facts and figures of potential points of presence in the rural regions:

- As per the 2018 census, there were 589 District Panchayats, 6,321 Intermediate Panchayats and 238,957 Village Panchayats across India
- As at 31 May 2019, there were 713 Multi-State Co-operative Societies in India
- As at 31 March 2019, there were 9,743 branches of Microfinance Institutions (MFIs) across India
- As at 31 March 2019, there were 10,78,407 government schools covering 644 districts across India
- As at date there are 48,125 voluntary organisations/state organisations registered under the NGO-partnership system with the Government of India.

The micro insurance business took its roots in India with a few schemes launched by non government organizations (NGOs), micro finance institutions (MFIs), trade unions, hospitals and cooperatives to create an insurance fund against a specific peril. These schemes were outside the ambit of the regulations and operated more on good faith of these institutions.

Life:

While many individual and group life Microinsurance products are offered by insurers in the form of term and endowment, credit life cover (protection against outstanding principal and interest of loan if the borrower dies) has been a starting point for many insurance companies in India, driven mostly by push-based sales by MFIs. However, credit life tends to offer little value to clients, with coverage limited to the duration of the loan.

a. Janashree Bima Yojana - A social security scheme of LIC (state owned largest life insurance company) launched in 2000, provides benefit to the weaker sections of society (covers 45 vocational and occupational groups such as workers in foodstuff, textiles, wood, paper, leather products, brick kiln workers, carpenters, fishermen, handicraft artisan, handloom amongst others). The premium for the scheme is INR 200 per member;

50 percent premium under the scheme is met out of the Social Security Fund. The balance premium is borne by the member and/ or Nodal Agency. The members get a cover of INR 30,000 (~USD 600) in the event of death, INR 75,000 (~USD 1500) in the event of death/total permanent disability and INR 37,500 (~USD 750) in the event of permanent partial disability. As on 31 March 2018, about 30 million people had been covered under this scheme.

b. BASIX - A leading MFI offers group life Microinsurance in collaboration with Aviva Life Insurance Company India Ltd. In FY2011, it had over 2 million customers paying an average annual premium of < INR 100 (~USD 2). However, post Andhra Pradesh crisis in 2017, when the state government brought in legislation to curb coercive loan recovery practices and banned MFIs from approaching the doorstep of their customers, the MFI business in the state has fallen, resulting in the coverage almost halving to a little under 1 million customers.

Health/Personal accident:

In India, health-care is funded mostly through out of pocket expenditure comprising ~60 percent of healthcare spending in 2018. Health is unarguably a product most demanded by low income groups. A number of schemes exist; donor-funded, subsidised, insurer and government schemes being the main formats.

a) Rashtriya Swasthya Bima Yojana (RSBY)

RSBY has been launched by Ministry of Labour and Employment, Government of India in 2008 to provide health insurance coverage for Below Poverty Line (BPL) families. Over 33 million BPL families (> 100 mn members) have been enrolled across 472 districts across the country; 12,531 hospitals empanelled to provide benefits under the programme.

Key features of the scheme:

- Hospitalisation coverage up to INR 30,000 (~USD 550) for most of the diseases that require hospitalisation; cashless benefit through smart card
- Fixed package rates for hospitals
- Pre-existing conditions are covered from day one and there is no age limit
- Coverage extends to five members of the family which includes the head of household, spouse and up to three dependents
- Beneficiaries need to pay only INR 30 (< USD 1) as registration fee while Central and State Government pays the premium to non-life insurers (maximum INR 750/~USD 14) selected by the State Government for each district on the basis of competitive bidding.

Challenges for the success of Micro

Insurance in the Rural India:

The challenges from the perspective of key stakeholders can be broadly classified into three categories viz. Un-insured target customer, Distribution intermediary and Insurance Company.

The Un-insured target customer: Given the lack of social security in India, in the event of disability, meager financial savings and reliance on borrowings from unorganised lenders are the only options available to a majority of the poor. While the developed countries provide social security network to their citizens, India's large population and low per capita income implies that provision for any sort of social security system is bound to be a significant drain on the country's limited resources.

Most customers in the target segment have low financial literacy and are unable to view insurance as a risk mitigation tool. Low awareness levels and lack of understanding of underlying benefits creates a barrier to purchase of intangible assets like insurance .

Further, the insurance companies have been focussing on reducing losses and improving profitability rather than increasing cost effective distribution reach to the lower strata. Poorly designed policies, lack of education, mis-selling through inadequately trained agents and rejections during claims settlement has led to lack of trust with this customer segment.

Distribution Intermediary: It is imperative to use an effective distribution channel mix to reach out to the target customer segment. Poor households live for the present rather than the future. Given their fatalistic attitude, the concept of insurance is linked to expenditure, rather than risk cover. Lack of adequate training to the distribution intermediary coupled with lack of motivation, makes it difficult to explain the products to largely uneducated customers. The feasibility of various products is also dependent on the availability of infrastructure, which is often lacking or low in quality. Limited incentive on a low premium product makes it difficult to cover operational costs of reaching out to the customers.

Further, delays in claim settlement and complicated formalities by the insurance companies also pose as a road block. It is important for the intermediaries to be able to build personal credibility with the client.

Insurance Company: Insurance companies are faced with challenges like high cost of customer acquisition given the high operating and administrative cost involved in reaching remote areas vs. value of premiums and unpredictable payment capacity of the segment. Moreover, given some of the operating models of the insurance companies the cost of customer service is also high. Regulatory compliance in terms of statutory requirements for customer acquisition, documentation also forces a cost build up for the companies. The companies do not have enough data on various sub-segments and associated risks for analysis and pricing. As a result, the claims ratio in the micro insurance segment is unpredictable.

CONCLUSION:

For India to reach its rightful place as a developed nation, it must financially empower its entire population. A key element of this empowerment is a base risk cover that covers elements of life, disability and health. This empowerment can only be achieved through the collaborative efforts of the government, regulators and private enterprises, who must be able to build commercially viable and scalable models for financial inclusion.

The key issues and challenges impeding growth of micro insurance in India from the perspective of the key stakeholders - the un-insured customer, the distribution intermediary and the insurance company, can be addressed by way of structural regulatory and policy changes coupled with extensive leverage of emerging technologies. Regulatory and structural changes should encourage further capital deployment and enable operational flexibility resulting in reduction in customer acquisition and policy management costs. The suggested measures will aid in increasing the micro insurance penetration in our country which can be achieved through focussed efforts and suitable partnerships across the industry and government bodies.

For micro insurance to succeed, demand has to be generated through building awareness, creating specific and simple products, and above all, by simplifying the processes of underwriting and claims management.

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Applications of Machine Learning Algorithms

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Abstract: — The goal of various machine learning algorithms is to devise learning algorithms that learn automatically without any human intervention or assistance. The emphasis of machine learning is on automatic methods. Supervised Learning, unsupervised learning and reinforcement learning are discussed in this paper. Machine learning is the core area of Artificial Intelligence. Although a subarea of AI, machine learning also intersects broadly with other fields, especially statistics, but also mathematics, physics, theoretical computer science and more. Machine learning algorithms and its purpose is to learn and perform specific tasks. Humans are always interested in making intelligent computers that will help them to do predictions and perform tasks without supervision. Machine learning comes into action and produces algorithms that learn from past experiences and make decisions to do better in the future

Keywords:- Classification, Clustering, Super vised Learning, UnSuper vised learning, Reinforcement learning.

I. INTRODUCTION

Machine learning is a subject that is based on computer algorithms, and its purpose is to learn and perform specific tasks. Humans are always interested in making intelligent computers that will help them to do predictions and perform tasks without supervision. Machine learning comes into action and produces algorithms that learn from past experiences and make decisions to do better in the future. Arthur Samuel, way back in 1959, said: “Machine Learning is the field of study that gives computers the ability to learn without being explicitly programmed”. Thus it is what precisely machine learning is. Here, past experiences are called data. We can say that machine learning is actually a field that gives computers the capability to learn without being programmed. For example, a telecom company is very much interested in knowing which customers are going to terminate their service. If they are aware or can predict those customers, they can offer them special deals to retain them. A machine learning program always learns from past data and improves with time. In simpler words, if a computer program improves on a certain task based on a past experience, then we can say that it has learned. Machine learning is a field that discovers structures of algorithms that enable learning from data. These algorithms build a model

that accepts inputs, and based on these inputs, they make predictions or results. We cannot provide all the preconditions in the program; the algorithm is designed in such a way that it learns itself. Sometimes the words, machine learning and Artificial Intelligence (AI), are used interchangeably. However, machine learning and AI are two distinctive areas of computing. Machine learning is solely focused on writing software that can learn from past experiences. Applications of machine learning include sentiment analysis, email spam detection, targeted advertisements (Google AdSense), recommendation engines used by e-commerce sites, and pattern mining for market basket analysis. Some real-life examples of machine learning are covered in the next section. Speech conversion from one language to another This Skype feature helps break the language barrier during voice/video calling. It translates a conversation into another language in real time, allowing both sides of speakers to effectively share their views in their native languages.

Suspicious activity detection from CCTVs

This is a wonderful example of how an application of machine learning can make society a safer place. The idea have a machine learning algorithm capture and analyse CCTV footage all the time and learn from it the normal activities of people, such as walking, running, and so on. If any suspicious activity occurs, say robbery, it alerts the authorities in real time about the incident.

Medical diagnostics for detecting diseases

Doctors and hospitals are now increasingly being assisted in detecting diseases such as skin cancer faster and more accurately. A system designed by IBM picked cancerous lesions (damage) in some images with 95 percent accuracy, whereas a doctor's accuracy is usually between 75—84 percent using manual methods. So, the computing approach can help doctors make more informed decisions by increasing the efficiency of recognizing melanoma and spotting cases where it is difficult for a doctor to identify it. Machine learning can be divided into three categories:

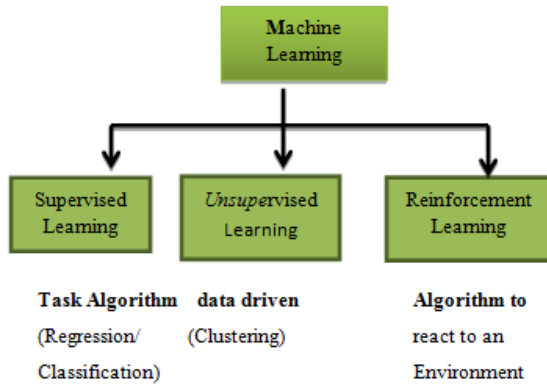


Figure 1.1 types of Machine learning

SUPERVISED LEARNING:-

Supervised learning is a type of machine learning where we have input and output Variables and we use an algorithm to learn the mapping from the input variable to the output variable. $Y = f(X)$ The goal here is to understand the mapping very well, and that enables us to transform the input into the output. When our program receives the input data, it runs the mapping function to generate output data. Why is this called supervised learning? Actually, the algorithm that is used to learn from the training dataset is similar to a teacher supervising the process. For each run, the algorithm makes predictions on the training dataset and the teacher is doing the correction. Once we get an acceptable level of correct predictions, the learning will stop and the algorithm will move on to the production environment. In supervised learning, there are dependent and independent variables. We need to understand the effect of each variable used in the mapping and see the effect on the output variable. We can further group supervised learning into classification and regression problems: Classification: A classification problem is when we need to predict a category. For example, we have a patient's history record in a hospital and we want to predict how many people have high chances of a heart attack. Here, the output variable will be yes or no. Regression: A regression problem is when we need to predict a number or value. For example, when predicting a stock value, it always results in a real number. There are further divisions of classification and regression problems that include time series predictions or recommendations and so on. Some famous examples of supervised learning algorithms are as follows: Random forest (classification or regression problems) Linear regression (regression problems) Support Vector Machines (SVM) (classification problems) Now we will learn supervised learning from a real-life example. Let's say we are in a garden and we have a bag full of different types of fruits. Now we need to remove all the fruits from the bag and put the same types of fruits together. That's an easy task because we're already aware of the physical

characteristics of each fruit. For example, we know which one is a mango and which is an apple. So, it's very easy to arrange them in groups. Here, our previous memory is working like training data. We've already learned the fruit names from the training data; here, the fruit names are actually output or decision variables.

Table 1.1 fruit characteristics:

Sno	Colour	Size	Shape	Fruit Name
1	Green	Small	Round	Grape
2	Green	Big	Half Moon	Banana
3	Red	Small	Heart	Cherry
4	Red	Big	Round	Apple

Table 1.1: Characteristics of fruits Let's say we take out a new fruit from the bag and now we need to place it into the correct group. We will check the color, size, and shape of the new fruit and take a decision based on the results to put it into the correct group. For example, if the fruit size is big, the color is red, and the shape is round with slight curves, then we can easily say it's an apple and place it in an apple group. This is called supervised learning because we've already learned something from training data and then we apply that knowledge to the new data (test data). The technique used for this type of problem is called classification. Why? It is a classification problem because we are predicting a category; here, the category is fruit name.

Unsupervised learning

Unsupervised learning is a type of machine learning in which we have only input variables and no output variables. We need to find some relationship or structure in these input variables. Here, the data is unlabelled; that is, there is no specific meaning for any column. It is called unsupervised learning because there is no training and no supervision. The algorithm will learn based on the grouping or structure in the data, for example, an algorithm to identify that a picture contains an animal, tree, or chair. The algorithm doesn't have any prior knowledge or training data. It just converts it into pixels and groups them based on the data provided. In unsupervised learning, we group the parts of data based on similarities within each other. The data in unsupervised learning is unlabelled, meaning there are no column names. This is not important because we don't have any specific knowledge/training of the data. Unsupervised learning problems can be further grouped as clustering and association problems: **Clustering:** A clustering problem is for discovering a pattern or understanding the way of grouping from the given data. An example is a grouping of customers by region, or a grouping based on age.

Association: Association is a rule-based learning problem where you discover a pattern that describes a major/big portion of the given data. For example, in an online book shop, the recommendation engine suggests that people who buy book A also buy certain other books. Some popular examples of unsupervised learning algorithms are:

Apriori algorithm (association problems) K-means (clustering problems) Now take up the same fruit grouping example again from the earlier section. Suppose we have a bag full of fruits and our task is to arrange the fruits grouped in one place. In this instance, we have no prior knowledge of the fruits; that is, we have never seen these fruits before and it's the first time we will be seeing these fruits. Now, how do we perform this task? What are the steps we will do to complete this task? The first step is to take a fruit from the bag and see its physical characteristics, say the color of this particular fruit. Then arrange the fruits based on color.

Table 1.2 Grouping Based on Color

Colour	Fruit name
Red Group	Cherries and Apples
Green Group	Grapes and bananas

Table 1.2: Grouping based on color Now we will group them based on size and color. See the result in Table 1.3:

Table 1.3 Grouping based on Size and Color

Size and Colour	Fruit name
Big and Red	Apple
Small and Red	Cherry
Big and Green	Banana
Small and Green	Grapes

Table 1.3: Grouping based on size and color It's done now! We've successfully grouped them. This is called unsupervised learning and the approach is called clustering. Note that in unsupervised learning, we don't have any training data or past example to learn from. In the preceding example, we didn't have any prior knowledge of the fruits.

Reinforcement learning

We use Machine Learning to constantly improve the performance of machines or programs over time. The simplified way of implementing a process that improves machine performance with time is using Reinforcement Learning (RL). Reinforcement Learning is an approach through which intelligent programs, known as agents, work in a known or unknown environment to constantly adapt and learn based on giving points. The feedback might be

positive, also known as rewards, or negative, also called punishments. Considering the agents and the environment interaction, we then determine which action to take. In a nutshell, Reinforcement Learning is based on rewards and punishments. Some important points about Reinforcement Learning: It differs from normal Machine Learning, as we do not look at training datasets.

- Interaction happens not with data but with environments, through which we depict real-world scenario.
- As Reinforcement Learning is based on environments, many parameters come in to play. It takes lots of information to learn and act accordingly.
- Environments in Reinforcement Learning are real-world scenarios that might be 2D or 3D simulated worlds or game based scenarios.
- Reinforcement Learning is broader in a sense because the environments can be large in scale and there might be a lot of factors associated with them.
- The objective of Reinforcement Learning is to reach a goal.
- Rewards in Reinforcement Learning are obtained from the environment.

The idea that we learn by interacting with our environment is probably the first to occur to us when we think about the nature of learning. When an infant plays, waves its arms, or looks about, it has no explicit teacher, but it does have a direct sensorimotor connection to its environment. Exercising this connection produces a wealth of information about cause and effect, about the consequences of actions, and about what to do in order to achieve goals. Throughout our lives, such interactions are undoubtedly a major source of knowledge about our environment and ourselves. Whether we are learning to drive a car or to hold a conversation, we are acutely aware of how our environment responds to what we do, and we seek to influence what happens through our behavior. Learning from interaction is a foundational idea underlying nearly all theories of learning and intelligence.

The Reinforcement learning is a type of machine learning that enables the use of artificial intelligence in complex applications from video games to robotics, self-driving cars, and more.

Reinforcement learning is learning what to do—how to map situations to actions—so as to maximize a numerical reward signal. The learner is not told which actions to take, but instead must discover which actions yield the most reward by trying them. In the most interesting and challenging cases, actions may affect not only the immediate reward but also the next situation and, through that,

all subsequent rewards. These two characteristics—**trial-and-error** search and delayed reward are the two most important distinguishing features of reinforcement learning.

Reinforcement learning (RL) formalizes the problem of learning an optimal behavior policy from the experience directly collected from an unknown environment. Such general model already provides powerful tools that can be used to learn from data in a very diverse range of applications (e.g., see successful Correct behavior, reinforcement learning is trying to maximize a reward signal instead of trying to find hidden structure.

- It Differs from normal machine Learning as we done the training data sets
- Interface between the environment through the real world scenarios
- As reinforcement learning is based on many parameter come to play and to learn about and act accordingly
- The reinforcement learning to use the to reach the goal
- Reward in reinforcement learning obtained the environments

To demonstrate some key ideas, we start with a simplified learning algorithm that is suitable for a deterministic model, namely:

$$s_{t+1} = f(s_t, a_t)$$

$$r_t = r(s_t, a_t)$$

We consider the discounted return criterion:

$$V \pi (s) = \sum_t \gamma^t r(s_t, a_t), \text{ given } s_0 = s, a_t = \pi(s_t)$$

$$V^*(s) = \max_{\pi} V \pi (s)$$

Recall our definition of the Q-function (or state-action value function), specialized to the present deterministic setting:

$$Q(s, a) = r(s, a) + \gamma V^*(f(s, a))$$

The optimality equation is then

$$V^*(s) = \max_a Q(s, a)$$

applications of RL to computer games, energy management, logistics, and autonomous robotics). Nonetheless, practical limitations of current algorithms encouraged research in developing efficient ways to integrate expert prior knowledge into the learning process. Although this improves the performance of RL algorithms, it dramatically reduces their autonomy, since it requires a constant supervision by a domain expert. A solution to this problem is provided by transfer learning, which is directly motivated by the observation that one of the key features that allows humans to accomplish complicated tasks is their ability of building general knowledge from past experience and transfer it in learning new tasks. Thus, we believe that bringing the capability of transfer of learning to existing machine learning algorithms will enable

them to solve series of tasks in complex and unknown environments.

Reinforcement learning is different from supervised learning, the kind of learning studied in most current research in the field of machine learning. Supervised learning is learning from a training set of labeled examples provided by a knowledgeable external supervisor. Each example is a description of a situation together with a specification—the label—of the correct action the system should take to that situation, which is often to identify a category to which the situation belongs.

Reinforcement learning is also different from what machine learning researchers call unsupervised learning, which is typically about finding structure hidden in collections of unlabeled data. The terms supervised learning and unsupervised learning would seem to exhaustively classify machine learning paradigms, but they do not. Although one might be tempted to think of reinforcement learning as a kind of unsupervised learning because it does not rely on examples of or, in terms of Q only:

$$Q(s, a) = r(s, a) + \gamma \max_{a'} Q(f(s, a), a')$$

Our learning algorithm runs as follows:

• Initialize: Set $Q^*(s, a) = Q_0(s, a)$,

for all s, a. • At each stage $n = 0, 1, \dots$

– Observe s_n, a_n, r_n, s_{n+1} .

– Update $Q^*(s_n, a_n): Q^*(s_n, a_n) := r_n + \gamma \max_{a'} Q^*(s_{n+1}, a')$

THE DIFFERENCE BETWEEN MACHINE LEARNING

The similarities of the above algorithms are:

- A machine learning algorithm learns from past experiences and produces an output based on the experiences.
- The algorithms have strong relations to mathematical optimization.
- The algorithms are related to statistical computation.

Supervised learning	Unsupervised Learning	Reinforcement learning
The output is based on the training data set. classification is used here	The output is based on the clustering of data.	The output is based on the agent's interaction with the environment . It used deterministic or nondeterministic way of learning.

Priori is necessary	Priori is not necessary.	Priori is required.
It will always produce same output for a specific input.	It will produce different outputs on each run for a specific input.	The output changes if the environment does not remain same for a specific input.

CONCLUSION

Machine Learning Research spans almost four decades. Much of the research has been to define various types of learning, establish the relationships among them, and elaborate the algorithms that characterize them [9]. But, much less effort has been devoted to bring machine learning to bear on real world applications. But recently researchers have found broader applications of machine learning to real world problems. Some of these are:

- Bioinformatics
- Brain-machine interfaces
- Classifying DNA sequences
- Computational finance
- Computer vision, including object recognition

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Human Resource in Digital Era: A Paradigm towards Progress

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Abstract

This topic is a general overview of the digital transformation and its implications on management, digital transformation is no longer a niche subject as it jumps into the boardrooms of leaders in the tech sector and industries, regions and geographies. The Digital India program is a flagship program of the Government of India, with a vision to transform India into a digitally empowered society and knowledge economy. The current digital age is but a stepping-stone in the development of a world enabled by the exponential use of technology in the workplace. The digital age is advancing at such a rapid pace that it is fundamentally changing the way organizations operate, whether in the private or public sector, and they need to develop new ways of thinking about service delivery. Which affect the operating model has been made. We therefore discuss the impact on the functions of human resources (HR) and all other management areas in an organization and their role in identifying new approaches to managing people and the entire organization.

Digitization is of critical importance for data processing, storage, and transmission, as it "allows all types of information to be carried across all formats with the same efficiency as well as interlaying". Digitalization is often seen as an essential factor in the 4th Industrial Revolution and being such a factor, it is powerful enough to have implications on current and future management practices. The need to connect with others and the critical thinking of social intelligence, soft skills, empathy, passion, open mind, creativity, innovation and human resource management.

Keywords- Digitalization, Human resources management practices, future challenges, digital transformation, digitalization management effects.

Introduction

Companies that embed digital transformation into their strategic framework are leveraging digital technologies to change their business models, their operations, and their interactions with stakeholders. In all industries, HR (HR) is one of the areas most affected by digitization - whether through big data analytics, social networks or mobile solutions. Digitization offers many new challenges, HR departments, which offers an exceptional opportunity to be strategic in their organizations and to strengthen their roles in the re-design of e, addressed the needs of HR professionals in the field is necessary for digitization, which are targeted to the needs of HR activities clearly defined strategic and operative In addition to the inclusion of the corporate culture and the development of digitalization. Digital natives and the older generation are no different from what they are looking for in owners. Employer attraction, safety, leadership and workplace position are very important for both groups.

The world has undergone cultural, social and economic changes based on the growing dominance of digital technology. In sum, these changes have led to the present era being classified as a "digital age". In line with these changes, digital technologies play a significant role in the lives of employees and in human resource management (HRM), which seem to be affecting in many ways. This special issue focuses on the impact of these changes on HRM, changes in the workforce, the use of technology in delivering HRM activities in general, and more specifically to HRM.

Why Digitization?

It is known for the big data it contains. To manually calculate this data, it takes several days and workers in this field can verify it. Much of the information in the manual system is generalized and mediated and because of this; The company is suffering from a lack of accurate data. We cannot afford to close our eyes to the most common technology. All we can do is get up and come up with the technology to work for you. We are so accustomed to completing everything manually that the software works on our behalf. This is why technology is invented, to completely eliminate the work that we manually do and in return help us accomplish more than we could ever accomplish on our own. Technology is here to stay and the best we can do is get on board and learn from it now before it grows too much and we are not able to catch up with it. Fear of failure and making mistakes, especially in business can keep you enslaved for the longest time. Establishing a new easier way to manage this data is a sign of relief for many individuals and companies. This can only happen through digitalization of the Human Resource Department. Digitalization of this sector will help the HR workers to ascertain specific details that help them improve in their decision making over the management of people. This in return will feed the company with accurate information that will help in achieving the set objectives.

Where to Start in Digitalization of the HR Department?

There is always a starting point for everything in this good earth. You only need two things - determination and expertise. With so much knowledge freely shared on technology platforms, we cannot say that we are short-changed. Before we start today, it's too late.

Today, there are a large number of well-learned followers who know the world of technology behind their hands. Such technology specialists are within or without our companies, but not far from our reach. There are people you bring on board to start and share ideas with them to help them begin their long journey to freedom. Before that, make sure that your HR department has a team of people who are flexible, enthusiastic and ready to learn and of course, literate. Such people will take seriously what is placed in their hands. Simply selling the idea to experts and then cracking the idea to them, defining it in terms of technology, developing tools to use and so on. At this point, we want to clarify that it is easier than what was done. Do not assume that what is suggested will automatically work, 90% of it fails. Do not try to take whatever has been suggested and take it down the throat of HR personnel, it will not work. Take time with this group of experts and allow them to try it out with your HR group. This is the only way you will be able to tell what works and what does not. It is also important to talk to other companies that have successfully digitized their HR department ahead of you. It equips you with smart ideas to handle matters in a more creative way. Realizing your weaknesses as a business is not a weakness; Rather, it is a strength because learning to do the right thing will make you better. Okay, it can cost the business some money and maybe move downstream but in the long run, the learned truth has benefited from it. There are simple easy steps that you can take to help you strategize by adopting how you will digitalize your HR field and all areas of your business.

What Does Digitalization Require?

Digital HR will require the creation and flow of mobile applications, design thinking, behavioral economics, and the use of fixed analytics. We have to realize that this is not just about building apps and all, but also developing platforms that have a wide range of apps built with analytical and cloud technology.

Creating such platforms allows you to use hundreds of applications on it, such as recruitment, collaboration, goal setting, employee attendance, employee welfare and many more. Designing such a platform allows you to integrate all data in one place, which is used to make recommendations throughout the day to users.

Digitalization challenges

- **Digital workforce:** How can organizations drive new management practices (what we call "digital DNA"), a culture of innovation and sharing, and a set of talent practices that facilitate a new network-based institution?
- **Digital workplace:** how organizations can create a working environment that enables productivity; Uses modern communication tools (such as the workplace by Facebook, Microsoft Teams, and many others); And promotes engagement, well-being and a sense of purpose?
- **Digital HR:** How can organizations change the HR function itself to operate in a digital way, use digital tools and apps to deliver solutions, and continuously experiment and innovate?

This shift is occurring rapidly, as HR leaders are being inspired to take on a larger role to help the organization "go digital", not just "do it digital." In the last five years, HR discipline has grown rapidly. Three years ago, we wrote about HR's "race to the cloud", as companies raced to replace legacy talent systems with legacy HR platforms. Two years ago, we characterized HR as a "need for makeover" as a function, as companies focused on reorganizing HR professionals, integrating the organization, and implementing analytics. This year, as digital management practices and agile organization design become central to business thinking, HR is changing again, focusing on people, work, and platforms. We refer to the resulting set of HR practices as "digital HR". Today, the focus of HR has shifted towards building the organization of the future. Companies are hiring young, digitally savvy workers who are comfortable working on their own and sharing information in a transparent way. They want an integrated, digital experience at work - which is built around teams, productivity and empowerment - and HR hopes to deliver it.

New equipment and expanded transport facility Digital HR

To empower employees to have more control over their career management, IBM developed a proprietary career management system, which helps people find new jobs and recommend new assignments by looking at their peers' patterns. Within HR, IBM leveraged the company's AI investments in Watson to use CIP (Cognitive Human Interface Personality), a cognitive assistant that can handle a wide range of HR-related questions. CHIP is an intelligent platform (available via computer, text message and soon voice) that identifies the 200 most frequently asked employee questions (such as "Tell me about the benefits of my leave" or " Find me an expert in digital marketing ") and become smarter all the time. The system has already reduced call center time and is proving popular with employees. IBM, a global company with more than 400,000 people, is leading the transition to digital HR, using a variety of experiments to drive a new digital HR solution. Following an employee hackathon, the company strengthened its performance management process by building a checkpoint, a new feedback process that dramatically increased engagement, alignment, and goal management.

For continuous learning, IBM discontinued its traditional global learning management system and replaced it with a new digital learning platform. The new system enables employees to publish any content they feel is important, curates and recommends training based on role and experience and integrates external learning from the Internet.

Development strategies

- **Redefine your mission:** HR today should define its role as a team that helps management and employees change rapidly and adapt to a digital way of thinking. Familiarize yourself with network organization structures, organizational network analysis and digital leadership models.
- **Upgrading core technology:** Replace legacy systems with integrated cloud platforms for sound digital infrastructure. Upgrade older tools for learning, hiring and performance management, and bring in systems that are easy to use for employees.
- **Develop a multiyear HR technology strategy:** In today's fast-changing HR technology world, it is important to create a multiyear strategy that includes cloud enterprise resource planning (ERP) platforms, apps, analytics and AI, case management, and a range of tools. It includes other solutions.
- **Build a digital HR team:** Dedicate teams to explore new vendor solutions and build others, and consider AI solutions to improve service delivery, recruitment and learning. Companies such as RBC and Deutsche Telekom now have digital design teams in HR, who work with IT to design, prototype and roll out digital apps.
- **Organize HR into a network of expertise with strong business partners:** Rethink your HR organization model to focus efforts on the new world of employee experience, analytics, culture, and learning. Make sure these teams communicate well: High-performing HR teams share leading practice and know what other teams are doing.
- **Make innovation a core strategy within HR:** Push yourself to reinforce and innovate in each people's practice. Many organizations are now using new performance management practices that are built around design sessions and hackathons. Investigate new innovations in recruitment, including using data to find high-performing people in the company.
- **Rotate younger people in the HR profession:** Rotate people in and out of HR regularly from business, use innovation teams to reverse-mentor senior leaders, and bring people with analytics skills into the profession by recruiting new MBAs.
- **Benchmark:** Visit other companies to see what they are doing. HR teams can bring in outside speakers, join research membership programs, and continuously seek out new ideas to promote innovation. Today's leading practices come from innovative ideas developed around an organization's culture and business needs, not from a book.

Conclusion:

Digital technologies can improve manufacturing operations. By automating processes, identifying weaknesses and bottlenecks in the production chain and in the supply chain, testing new ideas before implementing them, your business can save time and money. A digital factory design is a far more flexible workplace. Instead of the traditional, linear approach, where machinery is built based on designers' drawings and development cycles are silenced, digitization makes it possible to plan and develop in tandem. In this way, potential weaknesses can be identified and fixed as you go, rather than as an obstacle. Encouraged by new technologies such as 3D modeling systems and data connectivity, factories can be configured and reconfigured faster than ever for less money. Digitization gives you the opportunity to introduce rigorous quality management and control both for your own products and for your suppliers. Along with providing mental peace, you will also easily meet compliance demands. Customers will be happier, while employees will enjoy their work more. If you have a technologically advanced operation, you will also become more attractive to new employees.

Suggestions:

From the information mentioned, it is easy to tell what digitalization can accomplish but it's not all easy without hitches. Cooperation from all sectors is key in order to enjoy the end-product you want to see. The integration of the Human Resource Department being the hub of every business will fuel it to run smoothly and relationships will be highly improved; not forgetting the data will be precise and accurate.

The Human Resource Digitalization transformation is big and cannot be done in a rush. It has to begin with a change of mind-set within the HR department and every other sector in the business. The business rises from the art of teamwork, and digitalization is one of the key areas that require this kind of teamwork that brings achievements. Everyone in the business has to embrace the forward move right from the beginning to make it smooth sailing. They have to come to the level where they prioritize connectivity, real time operations and automation.

This should be viewed as a revolutionary opportunity all over the company, not just as a one sector responsibility. This is only a small section of digitizing the entire company. This being a very sensitive sector that determines the relationship between the HR and the employees, it must be handled with care. With the right approach that does not threaten the employees; the new technology will be embraced and worked towards with the right attitude.

There is still a long way to go until the HR sector is settled in the technology world and we can toast to that. A journey of a thousand miles starts with one step, its better you start yours today! You have the opportunity to showcase your company's success just like the above example of a successfully digitized company. Remember once you digitize the first sector in your business, all the rest will be easily integrated and brought on board to enjoy a fully digitized company that enjoys life the 21st Century way.

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ONLINE MARKETING: CHALLENGES AND ADVANTAGES

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Abstract:

Online marketing, which is also called internet marketing, involves use of interactive, virtual spaces for the sake of promoting and selling goods and services. In fact, new synchronous, internet-based communication technologies had contributed to the restructuring of major economic sectors including marketing. Being cost-effective, flexible, and fast and enjoying an on unprecedented global reach, internet marketing has brought about different businesses incredible gains. However, this effective, new method also involves its special disadvantages, e.g. lack of personal contact, security and privacy, etc which should be taken account for. The present study, then, concentrates upon the impacts of internet-fostered interactive spaces on marketing practice. The paper starts with defining online marketing and reviewing historical background to utilization of online marketing; different kinds of internet marketing, then, will be shed light upon. The marketing Advantages stem from introduction of this new, virtual space is the next focal point of concentration. The study continues with challenges, such as problems of security, privacy, etc, emerged in the field of marketing from implementation of virtual space produces. Contemplating the solutions to tackle the challenges ahead, we provide the conclusions.

Keywords: *Online marketing, offline marketing, Internet, Challenges, Advantages.*

Introduction:

Now it is a well-known fact that what we call 'marketing' has undergone substantial changes over the recent years (Petkus, 2010), and the key role in this transformation has been played by internet. Internet "refers to the physical network that links computers across the globe. It consists of the infrastructure of network servers and wide area communication links between them that are used to hold and transport the vast amount of information on the internet"(Chaffey, 2000: 12). Several studies have addressed the way in which introduction of internet have reshaped the structure and performance of different sectors, e.g. hospitality, travel and tourism (Xiang et. al 2008; Beldona 2005; Gretzel, et al. 2006; Kah, et al. 2006; Pan and Fesenmaier 2006; MacKay et al 2005; Weber and Roehl 1999), health and medicine (Rupoert, 2001; Datta, et al., 2008; Gadish, 2007), marketing education (Hollenbeck, et al. 2011; Eastman and Swift, 2001; Kynama and Keesling, 2000, etc. Introduction of internet has changed the rules and marketing practioners have no way but to adhere to it (scott, 2009:8). In fact marketing is just one of numerous fields have been substantially revolutionized by internet-based technological innovations. Halloway maintains that "Information and communication technology, as it is now known, has come to play a key role in all elements of the marketing mix, and the new term recognizes the importance of communication in the interface between a business and its customers" (2004). The most prominent point regarding the advent of Internet to the center stage of commerce and marketing is that Internet is not considered merely a new channel of promotion, a new type among other traditional, pre-Internet types of marketing goods and services. Quite contrary, it has brought about a turning point, a complete shift to a new business model, which results in an inevitable reconceptualization of the very nature of marketing (Deighton 1997; Wind and Rangaswamy 2001). This new understanding is inevitable since new communication technologies have fostered a new dynamic environment in which marketer oriented, top-to-down, unilateral approach gives its place to a customer-oriented, bottom-to-up, reciprocal process.

What is online marketing:

Kotler et al., 2010: 493) Online marketing consists of measures and activities to promote products and services and build relationships with customers over the Internet. Burrett (2008) understands online marketing as —carefully targeting users and getting them to interact with you while they're engaged with the most personal, intimate medium ever invented|| (44). The most comprehensive definition has been articulated by Chaffey (2007), he defines online marketing as —Applying Digital technologies which form online channels (Web, e-mail, databases, plus mobile/wireless & digital TV) to contribute to marketing activities aimed at achieving profitable acquisition and retention of customers (within a multi-channel buying process and customer lifecycle) through improving our customer knowledge (of their profiles, behaviour, value and loyalty drivers), then delivering integrated targeted communications and online services that match their individual needs". As this relationship concept definitions show online marketing revolve around interaction and building relationship with customers, a point which discriminates it from traditional, offline marketing.

Historic Background:

Internet has its origins in cold war and technological rivalry between USSR and US. In fact "while the World Wide Web was created in 1991, its origin dates back to 1957 when the Soviet Union launched the Sputnik I satellite" (Dickey and Lewis, 2011: 2). US reacted with establishment a department of Defence Advanced Research Project Agency (DARPA) which launched in 1960s ARPANET, an experimental project of computer networks from which what we now know as internet developed. Since then internet contributed to science incredibly and "by the late 1980s the internet was being used by many government and educational institutions" (Ferguson, 2008: 69). So internet was considered an inclusive communicative tool of scientific and research centres for several years and its academic function was its dominant prior to discovering its commercial capabilities which led to its commercialization. As Oksana (2007) puts it: "until the mid-nineties, the research and academic communities accounted for most of the internet population but the commercialization of internet soon gained enormous momentum and the business community quickly became aware of the potential it has to offer"(47). With increasing the number of internet users during the 1990s, entrepreneurs started to appreciate commercial prospects of this new medium. Although there is no complete consensus on when did internet marketing exactly start, but the majority of commentators refer to 1994. So it is widely held that "significant commercial use of the Internet began with the first _banner ads_ on web pages in 1994, and the appearance of Internet-based _malls_ (the electronic equivalent of a storefront) such as Amazon.com in 1995". Statistics make it clear that this young marketplace, online marketing, has had an astonishing rate of growth. So amazing is the growth rate of this new paradigm of marketing that it is hard to believe how young it is. In fact "in 1994, spending for internet marketing totalled nearly nothing, but increased to over \$300 million in 1995. After a decade later, marketing spending and internet marketing business has exploded to nearly \$500 billion (according to Forrester Research). Today, it's hard to believe in having an organization which doesn't have some kind of online presence." (Shirvastav and Alam, 2014: 25) This brief historic background is concluded by pointing to the fact that step by step online marketing has become a much more sophisticated practice. So early methods of internet marketing such as online advertising and email marketing has been followed by more younger, developed methods such as search engine optimization or social media marketing.

Different methods of online marketing: Online marketing which is also called internet marketing and e-marketing includes several methods and techniques which are introduced briefly as follows:

Online Advertising: The most known technique of online marketing is online advertising. In this method virtual space is used to put marketing messages on websites to attract internet users. Just similar to methods offline marketing and other types of online marketing, the major objective of online advertising is to increase sales and build brand awareness. Online advertising involves using of internet for displaying promotional

messages on the computer screens (Duguay, 2012) and refers to "deliberate messages placed on third-party websites ... search engines and directories available through Internet access" (Ha, 2008: 31). Online advertising similar to TV ads uses the element of interruption. But it uses it in a much more creative. Contrary to TV advertisement, online advertisement do not force the recipient to pay attention to the promotional peace, but it tries to persuade or attract s/he to do so, because instead of coming in intervals it is placed along or among other non-marketing contents. The now empowered internet recipient still has the power to ignore the advertisement and it is totally up to her/him to click or not. Online advertising, sometimes called display advertising, uses different methods to display a marketing message online. Needless to say that with the progress of technology, new ways of practicing the art of online advertisement is developed. In addition to images, pictures, logos etc, other different methods now used in this field including interstitial banners, pop-ups and pop-unders, map adverts, floating advert, banner advert (Stokes, 2009: 30).

Email-marketing: E-mail marketing, using e-mail for sending promotional messages to internet users, has been considered one of the more effective methods of online marketing. Several researchers have shed light upon privileges of conducting online marketing this way (Wreden, 1999; Jackson & DeCormier, 1999; Raad et al., 2010; Nial, 2000). In this regard Peppers and Rodgers (2000) among its benefits point to "high response rates" and "low costs" of email marketing and believe that this advantages "are rapidly turning email marketing into an invaluable tool"(4). Despite these benefits email marketing suffers from deficiencies. One these problems are that online customers can easily ignore the received advertisements and even some email clients would decide to put them in the spam folder. So some measures should be taken to overcome the possibility of ignoring promotional emails on the part of customers. One of the solutions is to not solely rely on email marketing. Marketers should employ different channels and methods of marketing to increase the chance of success. Another measure to transcend problems of email-marketing is permission email marketing. "Permission marketing" has been coined by Godin (1999). In this method recipients are asked for their permission to receive marketing messages from the commercial marketers. So unless the recipients have not expressed their consent, they will not send commercial emails.

Search Engine Optimization (SEP): Nowadays it is hardly possible to imagine a business which has not its own website. But having a well-designed website does not necessary result in an ideal amount of visits. In order for this goal to be accomplished another type of online marketing, called SEM should be adopted. In fact, one of major methods of conducting online marketing is search engine optimization, which is also called search engine marketing. Davis (2006) defines it in this way: "SEO - short for Search Engine Optimization - is the art, craft, and science of driving web traffic to web sites... web traffic is food, drink, and oxygen – in short, life itself – to any web-based business" (2). Parikh and Deshmukh (2013) also offer this definition: " Search engine optimization can be described as a cluster of strategies and techniques used to increase the amount of visitors to a website by obtaining high-ranking placement in the search results page of a search engine (SERP)" (1). The importance of search engine optimization lies in the fact that customers most of the time use engines as a major gate to get around in the internet. So some marketing techniques have been developed to enhance the rank of intended business websites in the search engine results. The purpose of SEO strategies is to place a given website among highly listed entries returned by search engines which in its turn produces more traffic. So, "Web site owners, webmasters and online marketers want search engines to send traffic to their site. Therefore, they need to make sure that their sites are relevant and important in both the eyes of the search engines and the users." (Stokes, 2009:70)

Affiliate marketing: Affiliate marketing is a major component of package of online marketing methods and refers to the process of gaining a commission by promoting products or services of another company. Also in this method two or more website owners can build relationship to increase mutual financial benefits. With respect to its definition, "affiliate marketing is simply defined as : A web-based marketing practice , often using automated systems or specialized software in which a business rewards their affiliate for each visitor, customer, or sale which is brought about as a result of affiliate's marketing efforts. In most cases, the reward

is monetary in the form of a monthly check. Most well-designed affiliate programs are easy to implement, require little or no setup, are free, and can instantly generate a new source of revenue for you" (Brown, 2009:17). Affiliate marketing has been used in a number of businesses for promoting products and services offline. But online environment has extended the prospect of deploying this method dramatically. The reason is that referral or affiliates are very easy to track online. This system of marketing is widely used to promote websites and affiliates are compensated for their effort to attract every single "visitor, subscriber, or customer". These affiliates sometimes are considered to be "an extended sales force" at the service of a website. Because affiliates are rewarded based on their performance, affiliate marketing is also called "performance marketing" (Stokes, 2009:46).

Social Media Marketing: Social media has changed every aspect of our life dramatically. In fact it has become "the method of statement in the 21st century, enabling us to express our belief, ideas and manner in an absolute new way". Beyond changing our way of conducting social life, social media provides world of marketing with unprecedented opportunities and "also have a huge impact on corporation, where they have realized that without a correct plan and social media strategy they have no chance to stand out in the rapidly changing digital freedom" (Saravanakumar and SuganthaLakshmi, 2012: 44). Social Media marketing, thus, has become increasingly a priority without taking which into consideration marketing cannot realize its objectives. Social media especially is promising for small businesses because it increases their competitive edge. This new rewarding type of marketing, social media marketing, can be easily defined as "a term used to describe the process of boosting website traffic, or brand awareness, through the use of social media networking sites...most social media marketing programs usually revolve around creating unique content that attracts attention and encourages the viewer to share it with their friends and contacts on social networks. Your business message spreads from one user to another and impacts with the user in a stronger way because it appears to originate from a trusted source, as opposed to the brand, business or company itself" (2014: 2). As is apparent from the above citation the key element of social media marketing is involving user of social networks. If users / readers come across a right and relevant content the likelihood of sharing it with other people in their social networks increases. So if a marketing body succeeds in making social media users share its promotional content with people in their network it that means that it has gained support from a trusted source and possibly will be regarded highly by the recipient. Clearly a promotional content shared by a close friend has much more impact than content directed from the part marketing party. The impact of contents shared by social network members is high due to the fact they are originally kind of a "word of mouth" circulating on the online environment. With respect to pillars of social media it should be noted that the "social media comes in many forms ... [such as] blogs, micro blogs (Twitter), social networks (Facebook, LinkedIn), media-sharing sites (YouTube, Flickr), social bookmarking and voting sites (Digg, Reddit), review sites (Yelp), forums, and virtual worlds (Second Life)" (Zarella, 2010: 3).

Viral Marketing: Another method of conducting online marketing which overlaps remarkably with social media marketing, due to centrality of "word of mouth" to it, is called Viral Marketing. Viral marketing, in fact, is "a form of word of mouth marketing which aims to result in a message spreading exponentially. It takes its name from a virus, because of the similarities that marketers aim to emulate: It is easily passed on. The number of people who have been infected grows exponentially" (Stokes, 2009: 150) Viral marketing is a new concept which has been developed with the advent of Internet. Viral marketing spreads through social networks and it is a virtual version of word of mouth. It is a very cheap mode of marketing and if you use it there is no need to spend massive amounts of money on traditional expensive marketing campaigns. Viral marketing works through encouraging people to share, pass along, and forward a marketing message; it is based on a high rate of pass-along from a user to another user. It is clear that harnessing such a powerful instrument, word of mouth, and having others share your products and sell it, guarantees the success, even compared with launching a classical marketing campaign. Among other means of promotion and building brand awareness such as images, jokes, e-carts etc, viral marketing campaigns employ creative digital videos as well. Digital videos are most useful according to Kirby (2006) due to following reasons:

1. They are small enough to be passed from peer to peer via email after downloaded from multiple distribution websites, encouraging greater user-driven spread.
2. They trackable after downloaded, as they are passed from user to user via email, so they are provide brands with greater campaign accountability.
3. There is a less risk of user interference with the agent.
4. Video is familiar, ad-like/film-like format to users, with the added advantage of interactivity (digital video files can include hotspots that enable users to link through the file to a web page).

Advantages of Online Marketing:

Empowering effect: One of advantages of online marketing is related with its enabling effect especially on small businesses since "internet can extent market reach and operational efficiency of small and medium interprises (SMEs)"(Dholekia and Kshetri, 2004: 311). In fact internet creates a kind of democratized environment in which marketing has been restructured in such a way that even small businesses are given a good chance to promote and brand their products on a much more larger scale (Jobber, 2001; Tapp, 2008). It should be, therefore, stressed that "internet has created unprecedented opportunities for small businesses to engage in national and international marketing campaigns which could have been unaffordable due to the huge amount of resources required" (Poon and Jevons, 1997: 29). Email marketing, bogging, launching web-sites, etc are among easily affordable inter-fostered channels than can provide small business with the ability to survive and compete.

Elimination of geographic barriers: One of the key advantages of online marketing is that it removes all geographical limitation from the practice of buying and selling. So internet allows an unlimited global reach (Allen and Fjermestad, 2001; Teo and Tan, 2002; Sigala, 2008) at on outstandingly lower cost. Due to massive cost of traditional media, global reach was once the exclusionary realm of huge multinational corporation, but the advent of cost-effective internet technologies has enabled smaller businesses to enjoy this kind of reach. Overcoming the geographic barriers, marketers are now able to present products and services to different groups of costumers across the universe with the simple condition that they have access to internet (Mohammed, 2010: 2).

24 hours / seven days availability: Internet now can provide customers with timely information due to its availability 24 hours a day, 7 days a week (Lane, 1996). So, due to the establishment of online shops, customers are now able to acquire information and shop online any time of day or night they wish and prefer. So there remain no time limitations in this regard because online businesses have no special closing and opening times. People may visit physical markets after searching internet or the other way round they can surf internet for competitive prices after visiting physical stores. (Sharma, 2011: 203). Besides that there is no doubt that online purchase is more convenient since there is no need to go out of home, visiting different stores and take the burden of comparing different products and prices. The buyers can do their shopping much more effectively from the comfort of their homes. Needless to say a lot of time and energy is saved this way.

Cost-effectivity: It goes without saying that, compared with traditional advertising media channels, which are very resource of gaining a commission by promoting products or services of another company. Also in this method two or more website owners can build relationship to increase mutual financial benefits. With respect to its definition, "affiliate marketing is simply defined as : A web-based marketing practice , often using automated systems or specialized software in which a business rewards their affiliate for each visitor, customer, or sale which is brought about as a result of affiliate's marketing efforts. In most cases, the reward is monetary in the form of a monthly check. Most well-designed affiliate programs are easy to implement, require little or no setup, are free, and can instantly generate a new source of revenue for you"(Brown, 2009:17). Affiliate marketing has been used in a number of businesses for promoting products and services offline. But online environment has extends the prospect of deploying this method dramatically. The reason

is that referral or affiliates are very easy to track online. This system of marketing is widely used to promote websites and affiliates are compensated for their effort to attract every single "visitor, subscriber, or customer". These affiliates sometimes are considered to be "an extended sales force" at the service of a website. Because affiliates are rewarded based on their performance, affiliate marketing is also called "performance marketing" (Stokes, 2009:46).

Trackability: Another aspect of the online marketing is its possibility of tracking. In fact "the track-ability of Internet Marketing is one of its greatest assets" (2014). Internet enables measurement of everything taking place on it. So, the number of clicks that a particular promotional piece receives and amount of website traffic is easily measured. In this way the marketer is enabled to track the visitors to her/his website and understand their behaviour. Internet also allows the companies to find out whether their campaigns are working or not, what kind of customers are interested in their products, from where? The ability to track online customers increases dramatically due to the fact that "internet constitutes the most accountable media ever. Web site log software and real-time profiling track the number of users who view each page, location of previously visited pages, date of view, time of view, duration of viewing, links followed, and so on" (Granitz and Greene, 2003: 19).

Personalization: Personalization which comes with customization is another important aspect peculiar to marketing online through internet. So online marketing is a personalized marketing which is also called marketing to the Segment of One or "one-to-one marketing" (Peppers and Rogers, 1993). But what is personalization? Personalization refers to tailoring products and services to customers' preferences based on their online, registered purchase history. In fact "since electronic interaction with customers allows the gathering of detailed information on the needs of each individual customer, firms can automatically tailor products and services to those individual needs" (Karavdic and Gregory, 2005:80). This process results in offering customized products to customers. In this way customers are sent personalized messages which produce much greater impact compared with impersonalized, generic messages sent indiscriminately to mailbox of customers. Personalization results in formation of sustainable relationship with customers; as Riecken (2000) puts it "personalization is about building customer loyalty by building a meaningful one-to-one relationship; by understanding the needs of each individual and helping satisfy a goal that efficiently and knowledgeably addresses each individual's need in a given context"(26). Based on metrics internet helps marketer to gather, customer, for instance, can be greeted with targeted offers whenever they visit website. So with the aid of gathered data of customers preferences, the sites can be customized for the target audience which brings about an increasing interaction and builds up a "sense of intimacy" between marketer and audience. This is especially important due to the fact that traditional modes of marketing such as Mass media, TV, and newspapers cannot be shaped by their users' needs, demands, inclinations, and preferences. So personalization and customization is obviously considered a major advantage or opportunity of online marketing via internet (Bhui and Ibrahim, 2013: 223)

Challenges of Online Marketing:

Problem of integrity: Integrated marketing has been a central theme of the profession (Clown and Baak, 2013; Kitchen and Burgman, 2010; Blech and Blech, 2013). On the other hand one of major problems with marketing campaigns is that they employ several offline and online promotions channels such as press, brochure, catalogue, TV, cell phone, e-mail, internet, social media etc, while lack a comprehensive, harmonizing marketing framework. Each item is used in isolation and accomplished as a different task not as a component of an integrated campaign aimed at realization of specified and particular objectives. This deficiency can be compensated for by taking a holistic approach which synchronizes different traditional and internet age modes of marketing communication as moments of an integrated structure. With respect to virtual, online component of an integrated marketing what is "also worth noting (or reminding) is that like offline marketing, all aspects of online marketing are inextricably linked- and in many cases interdependent. Therefore none of the element marketing should stand in isolation. The website will never be visited if there

are no links to it; viral marketing requires email or social media websites to communicate the message and search engines are useless without websites to link to it. So it is that in any internet marketing strategy all components must dovetail together (Charlesworth, 2009:341).

Lack of face-to-face contact: Lack of personal contact is another deficiency of online marketing which has been addressed in online marketing research and literature (Goldsmith and Goldsmith, 2002; Phau and Poon, 2000). Internet transactions involve no embodied, personal interaction and that is why some customers consider electronic modes of providing customer service impersonal and enjoy the experience of shopping in a bricks and mortar, physical store. They prefer to talk to store personnel in a face to face manner, touch the related product with their hands, and socialize with other customers. Virtual marketplace cannot provide for this function of offline shopping and lacks personal interaction. To be more specific "for the types of products that rely heavily on building personal relationship between buyers and sellers such as the selling of life insurance, and the type of products that requires physical examination, Internet marketing maybe less appropriate" (Kiang and Chi, 2001:159). Face to face contacts is not important just in the case of special types of products; here culture is also a relevant variable. For example Rotchanakitumnuai & Speece (2003) can be referred who have highlighted the lack of personal contact in online transactions. Among other things, they refer to Asian cultures in which personal relationships are of a prominent value and that this, together with the transaction context, is often plays a crucial role in ensuring the success of financial deals.

Security and Privacy: Information privacy is among major topics to be taken into consideration in today's evolving electronic world. It is clear enough that nowadays customers' data can easily be shared with other companies without asking for their permission. Moreover their more crucial personal data such as usernames and passwords are not immune from hackers (Lantos, 2011: 74). Another related problem is spas and pop-up adds which considered by majority of online customers an instance of intrusion of privacy (Drozdenco & Drake, 2002: 317). These security and privacy issues are among challenges in the way of online marketing. Effective internet marketing, therefore, depends on resolving the related problems in this regard. James W. Peltier et al. (2010) point to the role can be played by marketing curriculum and suggest "that students should be exposed to this topic in varied courses and in varying degrees of coverage" (225). The major dimension with respect to privacy is the choice or consent. This dimension has its roots in this belief that consumers whose data have been collected by the respective company should have control over the ways in which their information is used. Especially they also should be granted the right to have control "over how their personal information is used beyond the purpose for which it was collected" (ibid, 228).

Lack of trust: Closely related with the problem of security and privacy is the issue of lack of trust on the part of customers which has been recognized a great challenge on the way of online marketing growth. And it is the reason why "online trust is growing in importance as a topic of study and its influence on internet marketing strategies is increasing"(Urban et al, 2009: 179). Bart et al (2005) define trust in virtual environment as follows: "online trust includes consumer perceptions of how the site would deliver on expectations, how believable the site's information is, and how much confidence the site commands" (134). Today despite the rapid growth of online transactions several people still mistrust electronic methods of paying and still have doubt whether the purchased items will be delivered or not. On the other hand prevalence of online fraud has made customers hold negative or doubtful attitudes towards online transactions. So much more clearly remains to be done to build up the trust and convince the customers that interactions which take place in the virtual world are as real and honest as those happen in the real, offline world. No doubt, it is an ongoing, long process and needs more time to realize. It should be stressed that unless this trust has not been built, internet marketing cannot be taken advantage from to its fullest potential. So it is imperative for those in charge of online marketing revolutionize marketing. Marketers and IT managers are challenged with the task of changing the online climate in order to gain retain online consumers. This has generated tremendous interest in learning about online trust and in developing new site designs to respond to the increased power of customers" (Urban, 2008: 39).

Conclusion: Internet has revolutionized every aspect of life including economy and marketing. Introducing major techniques and methods of online marketing, this study has shed light upon opportunities and challenges of Internet. The major advantages internet has are its Empowering effect, Elimination of geographic barriers, 24 hours / seven days availability, Cost-affectivity, Trackability, and Personalization. However, implementation of Internet in the field of marketing involves special disadvantages such as Problem of integrity, Lack of face-to-face contact, Security and Privacy, Lack of trust. Unless these dual characteristic of Internet have not been taken into consideration, it cannot be deployed to its full advantage. An online marketing framework informed by insights from such a consideration would guarantee its financial objectives.

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Emerging Trends in Finance, Human Resource & Marketing

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Abstract

Trends are general directions of a market or an asset price. Trends are of two types - Uptrend and downtrend. Up trends and downtrends occur in all markets, stocks. Finance, Human Resource, Marketing, supply chain, & logistics are parts of an organization. To run an organization, these are essential. Organizations are nothing but, Social Systems are comprised of a collection of people, organized into structured grouping & managed to meet collective goals. This article discusses the emerging trends in finance, human resource (HR), and marketing.

Introduction

Finance is a broad term that describes activities associated with banking, debt, credit, capital markets, money, and investments. Finance represents money management and the process of acquiring needed funds. In simple words, Finance is providing funds for a person or enterprise. A business concern has to keep a systematic record of its business transactions. In India, the introduction of GST was a major economic policy change and caused major disruption in the way business activities are conducted in the country. Due to the digital India drive of the Indian government, the entire GST filing process is online. People who did not have knowledge of online technology have had to take help. This and more has been causing changes in the finance segment of business management and 2020 will see the following trends emerge.

Trends in Finance

The growth of technology will hit the market in 2020. The growth of financial businesses is expected to be concerned on their ability to mold the sharing economy and customer intelligence, and deal with advances in technologies such as block chain , robotics , Artificial Intelligence etc .

Block Chain Technology: Block chain will increase the Financial efficiency by reducing manual manipulation. Blockchain will create one version of the ledger allowing intercompany transparency and settlement at the same instant. This will allow Finance to focus more towards value creation activities. Block chain technology is a form of Distributed Ledger Technology (DLT), has the potential to transform well-established financial institutions and bring lower costs, & faster execution of transactions.

Robotic Process Automation: Use of robots helps in reducing costs and increasing operational efficiency. Robot Process Automation should help banks improve efficiency and avoid wasting time, especially if repetitive and easily reproducible activities are at stake.

Data Analytics: Data is has become very important in every industry sector. Financial Analysts use data to spot trends and extrapolate into the future, helping their employers and clients make the best investing decisions. Data analysts perform a similar role, the primary distinction being that these professionals analyze data that may or may not relate to investing decisions. Better Analysis leads to better decisions, which leads to an increase in profit for financial institutions. Companies analyse trends in data through intelligence tools.

Artificial Intelligence: AI has the potential to super-charge financial services and transforms the way services are delivered to customers. It could allow more informed and tailored products and services, internal process efficiencies, enhanced cyber security, and reduced risk. AI in finance is taking the industry by storm. In the next decade, AI will help financial service sources, decrease risk, and generate more revenue, in trading, investing, banking, lending.

Human Resource

Human Resources are the set of people who make up the workforce of an organization. Similar terms include people, work force, labour, personnel. HRM is the strategic approach to the

effective management of people in a organization such that they help their business gain a competitive advantage.

Trends in HR

- **Providing Flexible workspaces**

Allowing people to tailor and customize their work environments to best suit their working preferences helps to improve employee productivity. In 2020, we will see that the modern office has evolved beyond a physical place to become a function that could be carried out from anywhere. This will challenge employers to reconsider adjustments to their company policies around flexible work options, from offering work-from-home days to being open to hiring remote workers.

- **Providing Holistic Health Benefits**

Work related stress will impact the overall engagement and well being of employees. Holistic benefits plans and programs will be constructed to address all aspects of health and wellness care, from mind and body components and extending to include financial wellness and personal coaching. Companies that take on this responsibility for their people will see the benefits upon employee recruitment, retention, and productivity.

- **Digital Human Resources**

The department's responsibility is to roll out new digital initiatives to the entire workplace, implement new mobile applications (Slack, Workplace, Microsoft Teams, Gamelearn, etc.), software and tools that help change the way the company works. On this point, even chatbox services that use artificial intelligence for recruitment have found a niche in the most innovative companies.

- **Use of Data Analytics**

In the next decade, HR Teams will Focus of using of Data Analytics in a more focused manner to increase productivity , innovation , and revenue at the workplace . This will facilitate the creation of employee-centric environments, in turn driving up the role and importance of data driven strategies. For example, through access to the organization's

large database of employee information, specialized HR personnel will be able to understand employee behavioral patterns with regards to retention, recruitment, development and engagement, satisfaction, performance, and productivity, among others.

- **Chatbots**

Chatbot is software that conducts a conversation via auditory or textual methods. It uses natural language processing and can initiate a human-like communication. Candidates can get their all FAQs answered through this tool. Implementation of chatbot in the HR industry ensures 24*7 availability and 'on-demand' availability.

- **Continuous Transformation through Re-skilling**

Although a Re-skilling worker is important, it is not enough. Companies today are moving toward continuous transformation, not just one-time change initiatives. More than people development, they are redesigning their jobs and structures for more agility and scalability. Moreover, any time a company makes a strategic change that requires people to do things differently, they need to closely examine how those changes impact company culture and amend as necessary. This is critical because culture drives strategy execution. If this doesn't happen, re-skilled people who go back to their old jobs and culture will create a recipe for failure. Transformation must occur at every level of the organization. Middle managers—and even entry-level employees—are being given more control in how to structure their own work, as well as the work of their teams and colleagues.

Trends in Marketing

Marketing is the activity, set of institutions, and processes for creating, communicating, delivering, and exchanging offerings that have value for customers, clients, partners, and society.

- **Virtual and Augmented Reality:** In 2019, both augmented reality (AR) and virtual reality (VR) have become popular and are emerging as top trends in marketing. In 2020, AR is expected to surpass VR in popularity, despite VR's early lead. Already, many major companies are making use of AR. **IKEA**, for example, has an app that allows users to visualize what a piece of furniture would look like in their home before making a purchase

- **Content Marketing:** For years, “content is king” has been the axiom of digital marketing. As we are in 2020, it continues to be true. High-quality content allows you to show your expertise and communicate with your customers from a place of authority. Your content is also, what search engines provide to searchers online, so continuing to produce high-quality content is necessary.
- **Programmatic Advertising:** Programmatic Advertising means using AI to automate ad buying so you can target audiences that are more specific. Real-time bidding, for example, is a type of programmatic ad buying. This automation is much more efficient and fast, which means higher conversions and lower customer acquisition costs.
- **Social Media:** Social messaging apps can be very useful in sending messages to customers directly, as they allow personalization and add value to the user experience. In addition, people expect businesses to have a presence on messaging apps because it’s a direct and easy way to interact with them.
- **Omni channel Marketing:** Omni channel Marketing is the process of marketing across multiple platforms (such as social media, apps, email and blog) so you can connect with prospects on more touch points. When you do Omni channel marketing right, you can offer an enhanced user experience and cohesive brand message that drives people to action. To stay ahead, brands must present a seamless, consistent voice and message across all available mediums, including physical storefronts, social media channels, online, in catalogs and anywhere else you can imagine. All channels should be linked in one all-encompassing strategy for the best results.
- **Voice Search Marketing:** E-commerce is the way of the future, and with search interaction having increased, leading companies will find voice a profitable technology to drive sales and revenue. This has already been evidenced in the huge investment Amazon has put into Alexa and Google into Google Home and its Google Assistant. Businesses will see voice user interface as an innovative tool that enables faster, more efficient customer engagement as voice commands surround every sphere of life, driving purchases, & payments.

Conclusion

A PWC report predicts 77 percent of Financial Institutions will adopt some form of Blockchain technology in 2020. In addition, a recent study revealed that banking industry will derive \$1 billion of business value from the use of Blockchain based Crypto currencies in 2020. AI and Machine Learning technologies have become new trends in the HR industry. HR Industry is expecting AI & cognitive technologies to mature further in the next decade. Technologies such as AI driven Marketing will certainly be big trends in the upcoming years. The focus of marketing is on the people, not on the technology. The Marketing trends that will dominate in the next 12 months will include, content visualization, programmatic Advertising, social media and Omni channel Marketing. In the next decade, Artificial Intelligence and robots will be playing very important role in Human Resource, Finance, and Marketing sectors.

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MARKETING STRATEGIES OF INDIAN BANKS – A STUDY

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Abstract

Marketing becomes increasingly necessary in today's competitive environment. It becomes mandatory for the banks to think seriously about how they can compete effectively with other financial institutions. This has led them to pay due importance to marketing strategies. Marketing strategies perform two different functions i.e. attract the deposits on one hand and attract the borrowers and users of services. In banking sector marketing elements are especially important, they help to create powerful images and a sense of credibility, confidence and assurance. Therefore it is essential to evaluate all the elements of marketing strategy that are used in banking service sector. The present study throws light on the steps involved in designing marketing strategies and methods of delivering and deriving the customer satisfaction.

INTRODUCTION:

According to Oxford English Dictionary, a Bank is, –An establishment for custody of money received from or on behalf of, its customers. Its essential duty is the payment of the orders given on it by the customers, its profit mainly from the investment of money left unused by them.

Banking Regulation Act, 1949 (Sec. 5(c)), has defined the banking company as follows, Banking Company means any company which transacts business of banking in India. According to Section 5B, –Banking means the accepting of deposit of money from the public for the purpose of lending or investment, which are repayable on demand or otherwise and are withdraw able by cheque, draft, order or otherwise.

Different economists, banking professionals and authorities explained their viewpoints regarding banks or commercial banks. It has been rightly said by A.K. Basu that

a general definition of a bank or banking is by no means easy, as the concepts of banking differ from age to age, and country to country.

MARKETING:

According to Philip Kotler, Marketing is (i) both a social process and managerial process, (ii) by using such a process (i.e. marketing) individuals as well as groups of individuals (eg. an association or society or club) obtain what they need and what they want, and (iii) they obtain these (i.e. their needs and wants) through creating, offering and exchanging with others 'products' of value. Here, the term 'products' is used to include both the tangible (physical) products like manufactured goods as well as intangible products like banking services (bank products).

BANK MARKETING

Bank marketing is the aggregate of functions, directed at providing services to satisfy customers financial (and other related) needs and wants, more effectively and efficiently than the competitors keeping in view the organizational objectives of the bank.

This aggregate of functions is the sum total of all individual activities consisting of an integrated effort to discover, create, arouse and satisfy customer needs. This means, without exception, that each individual working in the bank is a marketing person who contributes to the total satisfaction to customers and the bank should ultimately develop customer orientation among all the personnel of the bank. Different banks offer different benefits by offering various schemes which can take care of the wants of the customers.

Marketing helps in achieving the organizational objectives of the bank. Indian banks have dual organizational objective – commercial objective to make profit and social objective which is a developmental role, particularly in the rural area.

Marketing concept is essentially about the following few things which contribute towards the success of any bank:

1. The bank cannot exist without the customers.
2. The purpose of the bank is to create, win, and keep a customer.
3. The customer is and should be the central focus of everything the banks does.

4. It is also a way of organizing the bank. The starting point for organizational design should be the customer and the bank should ensure that the services are performed and delivered in the most effective way. Service facilities also should be designed for customer's convenience.
5. Ultimate aim of a bank is to deliver total satisfaction to the customer.
6. Customer satisfaction is affected by the performance of all the personal of the bank.

All the techniques and strategies of marketing are used so that ultimately they induce the people to do business with a particular bank. Marketing is an organizational philosophy. This philosophy demands the satisfaction of customers needs as the pre-requisite for the existence and survival of the bank. The first and most important step in applying the marketing concept is to have a whole hearted commitment to customer orientation by all the employees.

Marketing is an attitude of mind. This means that the central focus of all the activities of a bank is customer. Marketing is not a separate function for banks. The marketing function in Indian Bank is required to be integrated with operation.

Marketing is much more than just advertising and promotion; it is a basic part of total business operation. What is required for the bank is the market orientation and customer consciousness among all the personal of the bank. For developing marketing philosophy and marketing culture, a bank may require a marketing coordinator or integrator at the head office reporting directly to the Chief Executive for effective coordination of different functions, such as marketed research, training, public relations, advertising, and business development, to ensure customer satisfaction.

The Executive Director is the most suitable person to do this coordination work effectively in the Indian public sector banks, though ultimately the Chief Executive is responsible for the total marketing function. Hence, the total marketing function involves the following:

- a) **Market research** i.e. identification of customer's financial needs and wants and forecasting and researching future financial market needs and competitors activities.

- b) **Product Development** i.e. appropriate products to meet consumer's financial needs.
- c) **Pricing of the service** i.e., promotional activities and distribution system in accordance with the guidelines and rules of the Reserve Bank of India and at the same time looking for opportunities to satisfy the customers better.
- d) **Developing market** i.e., marketing culture – among all the customer-consciousness Personnel of the bank through training.

Thus, it is important to recognize the fundamentally different functions that bank marketing has to perform. Since the banks have to attract deposits and attract users of funds and other services, marketing problems are more complex in banks than in other commercial concerns.

Everybody practices marketing in day to day life, in one or the other. Every one offers himself/herself for a service and exchanges it for value. We face interview for job, there we are offering our services in exchange of money. Prospective bride shows all his virtues, earnings to get a favourable life partner. In a way, all of us are practising marketing in our day to day life in one way or the other, though we are different from marketing professionals. If we take the definitions mentioned above, than the crux of all definitions is that all the activities targeted towards achieving the customer satisfaction better than the competitors is marketing. In other words achieving the customers delight is the task of marketing. In banking sector marketing is playing very important role. Competitive pressure is pushing the banks to adopt new marketing initiatives. Marketing is going to play very important role in this changing scenario. Employees have to realise the importance of marketing. The old methods of banking where walk-in customers were the source of business is not applicable in present scenario. The customer's expectations are changing. Now customers want the banks to visit them instead of them visiting the bank. Competition has set the reversal of roles. Customers are also expecting better services. Bank has to identify the financial needs of the customers and offer services, which can satisfy those needs. Marketing is about understanding, creating and retaining customers. All strategies are formulated to ensure that customers ultimately deal with us. Marketing is an important tool, which helps us in achieving organizational objective of the bank.

Marketing concept specifically speaks about the following few points which contribute to the bank's success:

- Bank cannot exist without customers.
- Banks have/has to understand, create and retain customers.
- Bank should ensure that services are performed and delivered in a way that satisfies customers in a way that satisfies customers.
- Product and Services should be designed in such a way that they conform with the convenience and requirements of customers as much as possible.
- Ultimate aim of the bank is to deliver upto the total satisfaction of the customers and fulfil his/her expectations.

Research Design:

Need for the study:

To study the Marketing Strategies used by the Banking Business to Market their Service oriented Products for attracting the customers.

Objectives of the Study:

To understand the various marketing Strategies using by banks for marketing their products (Services) to its stakeholders.

Data Collection:

The data is collected from secondary sources in the form of historical information from various relevant sites, journals, articles, company reports and databases.

MARKETING CONCEPTS – ITS APPLICATION TO BANKING

When we apply marketing to the banking industry, the bank marketing strategy can be said to include the following:

- i. A very clear definition of target customers.
- ii. The Development of marketing mix to satisfy customers at a profit for the bank.
- iii. Planning for each of the source markets and each of the user markets (A bank needs to be doubly market – oriented – it has to attract funds as well as users of funds and services).
- iv. Organization and Administration.

MARKETING OF BANK PRODUCTS – STEP INVOLVED

Five broad steps are involved in the marketing of bank products which are briefed below:

Step- 1: Identification of Target Market (Market segment) / Customer Identification:

Every bank needs to analyse its environment and decide what its market consist of. It has to identify the environmental variables acting upon it. Every bank should study as to who exactly are their customers and what exactly are their pshychographic and demographic profiles of the potential customers in the given target market. All these considerations are to be taken care of while identifying the target market. Then the market is classified according to the different psychographic and demographic parameters, such as age, sex, trade, profession, lifestyle, geographical location, income group etc. the bank has to decide what kind of marketing strategy it wants to adopt in the different market segments. It can be niche player in one particular market, it may have an aggressive marketing strategy in the second market, it may have the strategy of a follower in the third market, so on and so forth.

The different types of marketing strategy are based on the type of target market, its potential, the competitors and the external environment. In a remote place where a bank is already present then it can go for niche marketing strategy by exercising its influence over the niche market. In a market where other players are present then it has to adopt a different marketing strategy. Ideally there should be no customer segment untouched so that we give no scope for others to enter into competition. It may be noted that banks function in an environment that is subject to various regulations. So, all the marketing strategies of free market are not applicable to banks.

Step-2: Sales forecasting/Focus (Decide what to sell and when to sell): After identification of target market the bank has to decide the potential of the market based on its products. It should decide as to whether it should offer standard (one product fits for all) products, or customised products as per the needs of individual clients or groups thereof, or a mix of both. Standard product can be offered for mass and customised products for high value clients.

Step-3: Communicating with customer (Communication Mix): The brand/image building exercise is very important for the banks. The brand plays very important role in influencing the buying behaviour of the customers. What media vehicle to be used for communicating with the customers. Whether to go for advertising or publicity. If going for advertising then which media vehicle to use- TV, Print-Newspaper or Magazine, Radio, Outdoor, etc.

Step-4: How to sell? Which delivery channel to be used for selling the service? Bank Branch selling, Tele-selling, personalised selling. In services sector personalised selling is treated as the most effective form of selling but the costliest form of selling. Branch walk-in is also treated as the second most effective means of selling the products. This form of selling is mostly effective in cross selling of products to the existing clients. Depending upon the products, the objective of the organisation and the target customer's different form of selling methods can be adopted. e.g. if the product is to be targeted at high value clients like portfolio management service then personalised selling is most effective way but in case of student loan tele-calling can be more effective. In similar manner different approaches can be used.

Step-5 – Customer feedback and service recovery (After sales service): Last, but not the least is a comprehensive system for customer feedback and after-sales service. A satisfied customer can bring many prospective customers through his 'word of mouth'. So, constant monitoring and follow up of all clients, existing and prospective, should be ensured always. Pointing out the utmost significance of customer feedback, marketing expert Theodore Levitt has observed, "One of the surest sign of a bad or declining relationship is the absence of complaints from the customer. Nobody is ever satisfied, especially not over the extended period of time." Thus, banks should carefully take care of customer feedback, especially the complaints because those customers who are complaining wishes to remain with you and they want to get their problems resolved and once their complaint is resolved they are bound to remain with the bank but most of the dissatisfied customers doesn't complaint and they gradually change their service provider. Therefore, it is must to understand the customer complaint behaviour process and why a customer complaints? Banks should analyse that what proportion of their customer are unhappy and what are leading to these

problems. Banks should have feedback mechanism and proactive approaches like using of marketing intelligence, market research tools like ghost shopping, online feedbacks of service, toll free number for feedback. Such proactive steps and feedbacks not only help in service recovery but also helps in building brand image and also helps in development of new products and understanding the market in much better way.

Apart from the 4Ps traditionally used (viz. Price, Product, Place, and Promotion) for marketing of physical (tangible) products, in bank marketing (or, services marketing 3Ps are additionally relevant, thus making a 7Ps model (also called the extended marketing mix) plays vital role in marketing of bank marketing. The 3Ps additionally relevant in bank marketing (services marketing, in general) are: People, Process, and Physical Evidence.

STRATEGIES FOR MARKETING OF BANK PRODUCTS:

In view of the foregoing discussions, it is meaningful to suggest some pragmatic strategies for effective marketing of bank products in the ongoing reforms era characterized by fierce competition and fast adoption of ICT advances by banks. While all banks are embracing ICT in a big way, its most efficient use is to be ensured to get a competitive edge in the market.

1. Alternate Delivery Channels: With technological innovations alternate delivery channels have become means to market bank's product and services. ADC like ATMs, Kiosks, Internet, Phone calls are used to market bank's products. ATMs are not being used just as cash dispensers but are used to educate the customers (both home bank and other bank's customers) in respect of different services offerings by of the bank. The person who are interested in the bank's product can neither call on the numbers displayed or contact number information can also be captured at the ATMs. Similarly, Kiosks are used to disseminate information and offer different services to the banks.

2. E-Commerce: Internet is one of the strongest means to promote bank's products and services in the new technological area. Banks have started marketing their bank's services not only on the homepage of the bank's website but have also started using the blog's, twitters and social networking sites for marketing of the bank's products and services.

Even different chat rooms have also been used for marketing of bank's services. Few banks keep a close watch over the internet to manage the information related to them over the internet. Internet banking not only helps the banks in better targeting the customers but also helps the banks in decreasing their transaction costs. It also helps the banks to cross sell the products. Today when the customers do not have time to visit the brick and mortar branches, banks should use the internet as an effective means not only to disseminate information to the customer but also sell different products and services.

3. Mobile Banking: Mobile banking is a new area. Banks have started providing mobile banking services to the customers. Mobile banking services can also be utilised to market different bank products to the customers like sending selective SMS based on careful weeding by use of analytical data analysis using Customer Relationship tools and warehouse data. Such effective tools can be used to target the customers in a much better way.

4. Virtual Banking: Use of ICT has helped banks to such an extent that in future banks can market their services in form of 24 hour banking using virtual banking concept where there is no involvement of any human and the customer is able to avail banking services round the clock. Such, steps can be effective in marketing of banks services in future.

5. Continuous Innovation: The key to marketing of banks services in this competitive scenario is constant and continuation innovations not only of products but also the processes and service delivery. Every bank has to evolve its products and services on continuous basis based on the changing competitor's products and offerings and the changing customer's taste and preferences. In order to enable the bank to offer services in a effective manner every processes of service delivery needs to be looked into. There is always scope of improving on the process and devise a better way to do the current work. ICT advances have made it possible to expedite the service delivery process. The place and time of delivery of the service is the key to marketing. Today's customer is highly demanding and the banking sector where competition is increasing day by day, it is need of the hour for the banks to be alert and take every cue as input and evolve accordingly.

6. Managing Relationship and Building Loyalty: Relationship Marketing – builds relationship from customers commences from them and extends not just up to the business level but at every level. CRM (Customer Relationship Management) tools are very effective in managing customer relationships.

Suggestions & Recommendations:

Most of the banks are starting to adopt technology very fast. However the technology that the bank has set up can be used only to market their products to their existing customers. Hence, banks are failing to use the existing technology effectively.

Before banks start to market their products a proper analysis of the market is required. Once this is done they will be in a better position to determine benefits and the effectiveness of their marketing strategy.

A proper targeting of the market must be done for their various Bundles of services. Banks should use various tools of promotion to create awareness of their product to all the potential users as well as other targeted customers of the product.

An appropriate tool of marketing must be used by the bank to ensure the development of their Brand name. Hence proper selection of the channel of market their products must be done.

When the banks are marketing and attempting to promote their zero balance accounts, they must ensure that copies of the application forms are sent to all the respective branches, to ensure easy accessibility for their potential customers.

Conclusion:

The marketing done by banks has its own set of advantages and drawbacks. Hence it is vital for banks to conduct a proper analysis of the market and its marketing strategies before it consider marketing its brand and bundle of service (Product).

In the present day the segmentation and targeting done by banks are not effective. Hence appropriate steps must be taken to effectively segment and target the market. i.e., the selection of the segment should ensure the generation of users in a short or very short time period.

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YONO APP SERVICES AWARENESS AND USAGE BY CUSTOMERS

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ABSTRACT

Digital banking is the move to online banking where banking services are delivered over the internet. The advantages for banks and customers are providing more convenient and faster banking services. It involves high levels of process automation and web-based services. YONO (You Only Need One) is an integrated digital banking platform offered by State Bank of India (SBI) to enable users to access a variety of financial and other services such as flight, train, bus and taxi bookings, online shopping, or medical bill payments. For any product or service customer awareness and usage is the key for success and sustain in the market. The YONO app services are very innovative and integrated in nature. The present study is made to know the level of awareness and usage of the customer friendly app made available by State Bank of India. By using primary and secondary data sources this work is taken up to study the customer awareness and usage of features of YONO in Karimnagar District of Telangana, India. It is found that majority customers are aware of various services but usage is not up to the mark. To increase the awareness and usage of various services offered by YONO app of SBI a few suggestions are made on the basis of observations and responses given by the customers.

Key Words: Digitalisation, Banking Apps, Services, Customer Awareness,

The paper focuses on digital banking services app YONO provided by SBI Bank and analyze the awareness and usage of YONO App by customers in Karimnagar. This paper helps in understanding customer's attitude towards such modern services provided by banks. The YONO is an application that has been developed for a well-established bank operating primarily in India. In the world of this competitive environment and technological development, the bank has been totally computerized in the last few years, and to increase its customer base has started planning, for a concept called building digital banking platform. With this concept the bank wants to move very nearer to the customers and increase its basic operational strategies. Through this YONO App the bank wants to introduce the core concept of IT based Enabled Services (ITES).

- The digital banking services are executed only upon the customer, and these digital banking services would fully integrate with the core banking solution.
- Digital banking is the move to online banking where banking services are delivered over the internet.
- The advantages for banks and customers are providing more convenient and faster banking services.
- It involves high levels of process automation and web-based services and may include APIs enabling cross-institutional service composition to deliver banking products and provide transactions. It provides the ability for users to access financial data through desktop, mobile and ATM hat is already in usage.
- Digital banking is the move to online banking where banking services are delivered over the internet.
- The advantages for banks and customers are providing more convenient and faster banking services.
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MEANING OF DIGITALIZATION:

Digitalization is the process of converting information into a digital (i.e., computer-readable) format, in which the information is organized into bits. The result is the representation of an object, image, sound, document or signal (usually an analog signal) by generating a series of numbers that describe a discrete set of its points or samples. The result is called digital representation or more specifically, a digital image, for the object, and digital form, for the signal. In modern practice, the digitized data is in the form of binary numbers, which facilitate computer processing and other operations, but, strictly speaking, digitizing simply means the conversion of analog source material into a numerical format; the decimal or any other number system that can be used instead

DIGITAL BANKING:

Digital banking is the move to online banking where banking services are delivered over the internet. The advantages for banks and customers are providing more convenient and faster banking services. It involves high levels of process automation and web-based services and may include APIs enabling cross-institutional service composition to deliver banking products and provide transactions. It provides the ability for users to access financial data through desktop, mobile and ATM services.

TECHNOLOGY:

SBI Bank operates in a highly automated environment in terms of information technology and communication systems. All the bank's branches have online connectivity, which enables the bank to offer speedy funds transfer facilities to its customers. Multi-branch access is also provided to retail customers through the branch network and Automated Teller Machines (ATMs). The Bank has made substantial efforts and investments in acquiring the best technology available internationally, to build the infrastructure for a world class bank. The Bank's business is supported by scalable and robust systems which ensure that our clients always get the finest services they offer.

SBI Bank offers a bunch of products and services to meet the every need of the people. The company cares for both, individuals as well as corporate and small and medium enterprises. For individuals, the company has a range accounts, investment, and pension scheme, different types of loans and cards that assist the customers. The customers can choose the suitable one

from a range of products which will suit their life-stage and needs. For organizations the company has a host of customized solutions that range from funded services, Non-funded services, Value addition services, Mutual fund etc. These affordable plans apart from providing long term value to the employees help in enhancing goodwill of the company. The products of the company are categorized into various sections which are as follows:

- Accounts and deposits.
- Loans.
- Investments and Insurance.
- Forex and payment services.
- Cards.
- Customer center.

YONO App:

YONO (You Only Need One) is an integrated digital banking platform offered by State Bank of India (SBI) to enable users to access a variety of financial and other services such as flight, train, bus and taxi bookings, online shopping, or medical bill payments. YONO is offered as a Smartphone app for both Android and IOS. YONO (You Only Need One) is a major digital initiative of the Bank and would be available as an omni channel application. Apart from the digital banking products and services, the application will provide Online Marketplace which will be a single touch point for SBI Customers to access wide range of “Beyond Banking” products from multiple B2C e-Commerce merchant partners. This will include online purchase of retail, travel, daily, fashion and lifestyle needs as well as availing various online services. Online Marketplace will also provide personalized offers to the users. It will be a B2C platform where the number of merchants will be ramped up over a period of time.

YONO APP AND ITS BEST-IN-CLASS FEATURES:

- **Instant account opening** - Open a digital savings account in less than 5 minutes without leaving your home and get personalized platinum debit card, Concession on Bank service charges & Paperless
- **India’s largest shopping marketplace** - Exclusive discounts and offers for SBI customers across a large number of e-commerce merchants
- **Banking simplified** - Easy to understand interface, Simple and intuitive navigation
- **Quick pay** - Intelligent funds transfer with UPI enabled payments

- **One view** - Link and view all State Bank group relationships (Bank and all JVs) in one app
- **Smart spending** - Intelligent spending analysis using smart auto-tagging and categorization of the transactions
- **Your friend in need** - Pre-approved personal loans on the go up to Rs. 1 lakh without any documentation in 2 minutes

METHODOLOGY:

Both Primary and Secondary data is used in this work. The primary data collected through administered questionnaire and the secondary data collected from books, journals and websites. In this article, an structured questionnaire was designed which was filled by the customers of SBI Bank to know their awareness and opinions regarding the YONO services. The collected primary data organized and presented in the form of tables. Here, the tools of analysis used were percentages. SPSS software was used to analyze data. A random sample of sixty SBI-YONO customers is considered to receive the responses for the questionnaire. Primary data collected from Karimnagar town, Telangana state for the purpose of this study.

TABLE-01
DEMOGRAPHY OF RESPONDENTS

	Particular	Frequency	%
AGE	18-25	12	20
	26-35	23	38
	36-45	18	30
	Above -45	7	12
	Total	60	100
	INCOME	<10000	17
10000 – 20000		18	30
20000 - 30000		10	17
Above 30000		15	25
Total		60	100
EDUCATIONAL QUALIFICATION	SSC	10	17
	Inter	12	20
	Degree	28	46
	Above Degree	10	17
	Total	60	100
MARITAL STATUS	Married	22	37
	Un-Married	38	63
	Total	60	100
OCCUPA TION	Profession	23	38
	Business	37	62
	Total	60	100

Source: Questionnaire

The above table speaks about the demography of YONO responded customers. A sample of sixty is presented in five demographic categories and their percentages are made available. Business men in the middle age group are using YONO app frequently for their daily transactions. Customers with high qualification and low income group are accustomed to use the app and benefit out of the services offered.

TABLE-02
AWARE OF MPIN TO LOGIN

Valid	Frequency	Percent	Valid Percent	Cumulative Percent
Not Aware	5	8.3	8.3	8.3
Poor Awareness	1	1.7	1.7	10.0
Moderately Aware	8	13.3	13.3	23.3
Highly Aware	19	31.7	31.7	55.0
Completely Aware	27	45.0	45.0	100.0
Total	60	100.0	100.0	

Source: Questionnaire

Table 02 presents the frequency, percent and cumulative percent of YONO customer's awareness on Mobile Banking Personal Identification Number.

From the above data it is clear that customers are completely aware of MPIN to log in YONO App. About 77 percent of customers are aware of their log in personal identification number. It can be said that majority of the SBI Customers are aware of MPIN to login YONO app.

TABLE-03
AWARE OF USER ID TO LOGIN

Valid	Frequency	Percent	Valid Percent	Cumulative Percent
Not Aware	1	1.7	1.7	1.7
Poor Awareness	5	8.3	8.3	10.0
Moderately Aware	9	15.0	15.0	25.0
Highly Aware	13	21.7	21.7	46.7
Completely Aware	32	53.3	53.3	100.0
Total	60	100.0	100.0	

Source: Questionnaire

Table 03 presents the frequency, percent and cumulative percent of YONO customer's awareness on YONO app user log in.

The above table clearly shows that most of the women customers are completely aware of YONO user log in. 53.3 percent opted completely aware followed by highly aware (21.7 percent) of their use log in. Majority of the customers are equipped with latest technology of SBI and are aware of user login to YONO.

TABLE-04
I CAN VIEW ACCOUNT BALANCE

Valid	Frequency	Percent	Valid Percent	Cumulative Percent
Not Aware	3	5.0	5.0	5.0
Poor Awareness	3	5.0	5.0	10.0
Moderately Aware	8	13.3	13.3	23.3
Highly Aware	26	43.3	43.3	66.7
Completely Aware	20	33.3	33.3	100.0
Total	60	100.0	100.0	

Source: Questionnaire

Table 04 presents the frequency, percent and cumulative percent of YONO customer's awareness on account balance view using YONO app.

The data presented above exhibits that account balance viewing is aware and useful to 46 customers with approximately 77 percent of the respondents. Majority of the customers are viewing their account balance using this popular YONO app.

TABLE-05
PERFORMING TRANSACTION FROM YONO

Valid	Frequency	Percent	Valid Percent	Cumulative Percent
Not Aware	2	3.3	3.3	3.3
Poor Awareness	5	8.3	8.3	11.7
Moderately Aware	16	26.7	26.7	38.3
Highly Aware	20	33.3	33.3	71.7
Completely Aware	17	28.3	28.3	100.0
Total	60	100.0	100.0	

Source: Questionnaire

Table 05 presents the frequency, percent and cumulative percent of YONO customer's readiness and ease of using the app to transact regularly.

The above table depicts that most of the customers are highly aware of performing transactions using YONO App and its ease. About i.e., 33.3 percent of the respondents are highly aware of performing various transactions followed by completely aware (28.3 percent). About sixty percent customers only performing transactions using the app frequently.

CONCLUSION:

It is observed that most of the unmarried respondents aged between 26 - 35 years, possessing Degree Qualification, doing business and earning between Rs.10, 000 - Rs 20,000 are there in Karimnagar using smart phones and are customers of SBI.

1. Most of the women customers are equipped with latest technology of SBI and are aware to login to YONO for using their account.
2. Most of the customers are viewing their account balance using this App.

3. Most of the women customers are performing transactions from SBI bank to another bank.
4. Most of the women customers are creating new dream and saves money using YONO App.

SUGGESTIONS:

1. Effective awareness campaigns should be undertaken by the banks to make their customers more aware of digital banking service-YONO
2. The bank should make an effort to provide a platform from where the customers can access different accounts at single time without extra charge.
3. The bank should take steps to create a trust in mind of customers towards security of their accounts.
4. The SBI bank should introduce more services which can be accessed through Net Banking like advice on investment, TDS, etc.

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Impact of COVID – 19 Pandemic on Indian Economy

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Abstract:

Pandemics is seen for the first time by the present generation. But it has been seen right from the inception of mankind in some or the other name and form in the history. Pandemics jeopardized millions of people and planted in their minds a staggered number of negative effects that adversely affected the psychological well-being of people in the community. It also disorganized the students' educational process. The letter "P," has a pleasant meaning and imprint till the outbreak of "Pandemic COVID – 19." It jostled the world and distorted the image of people from Peace, Paradox to Perplexity, and created paranoid in minds and hearts. The COVID-19 pandemic gradually started spreading every nook and corner within no time. There is a continuous study on the prevention and detection of this new virus, which exploited human life to a large extent. As the COVID-19 situation is evolving rapidly, the whole world is faced with global challenges and simultaneously concentrated to ensure preventive measures. Public health concern increased day by day with the augment in the number of COVID – 19 cases in India. To reduce the number of victims, major countries in the world has enforced lockdown, encouraging people to implement social distancing, so as to reduce interactions between people which could eventually reduce the possibilities of new infection; however, it has affected the overall physical, mental, social and spiritual health of the people. The present paper throws a study on how the Pandemics havocked human life – socially, economically and psychologically.

Keywords: Pandemic, COVID-19, human life – social, economic, psychological and mental health, social distancing

Introduction:

Coronavirus disease 2019 (COVID-19) outbreak has substantially affected almost all parts of the world. Pandemics are contagions that ensue from time to time throughout human history, causing Millions and billions of people to die and negatively affecting human social, economic and psychological state. Pandemics have cataclysmic effects on not only the psychology of people experiencing the pandemic during the process, but even the psychology of future people. The COVID-19 pandemic was confirmed to have started spreading in India since March 2020. Since then the new infections grew exponentially and now the rate is highest in Asia along with wider community-level transmission. There was a steep rise in infection in April. In the week ending of April 2020, the new cases in India grew slowly and the number increased but did not decrease till

September 2020. People across the world are being advised to stay home, to practice “social distancing,” and to make hygiene a priority by using sanitizers or soaps to wash hands for every two hours.

Types of Pandemics over a period of time:

Name	Time Period	Type/Pre-human host	Estimated Death Toll
Antonine Plague	165-180	Believed to be either smallpox or measles	5 million
Japanese smallpox epidemic	735-737	Variola major virus	1 million
Plague of Justinian	541-542	Yersinia pestis bacteria/rats, fleas	30 to 50 million
Black Death	1347-1351	Yersinia pestis bacteria/rats, fleas	200 million
New World Smallpox Outbreak	1520-onwards	Variola major virus	56 million
Great Plague of London	1665	Yersinia pestis bacteria/rats, fleas	100,000
Italian Plague	1629-1631	Yersinia pestis bacteria/rats, fleas	1 million

Pandemics such as HIV / AIDS, influenza, Severe Acute Respiratory Syndrome (SARS), Middle East Respiratory Syndrome (MERS), and Spanish Flu, which have appeared in the past and threatened the health of people, have also led to negative consequences in people's psychology. Currently, people are still besieged with a pandemic. COVID- 19, which was first seen in Wuhan, China and then spread rapidly all over the world, shakes the whole world profoundly.

COVID-19 Pandemic effects:

The COVID-19 pandemic affects people psychologically. It is still continuing tremendously day by day. Increase of death rates comes to a pause of life and its control is unknown to the minds of Physicians, Psychologists and Scientists. Its emergence disturbed the whole nation and alarmed everyone beyond anyone's imagination. Like a haunted ghost the traumatic experiences that followed as shadows have caused many psychological problems on humans. Scientific research on COVID-19 is of great importance in order to prevent the destructiveness seen in Social, Political, Psychological, Educational and Economic dimensions. It is estimated that its effect will create more chaos in the short and long term.

COVID-19 Effects on Social and Economic development:

COVID – 19 affected every sector and field undoubtedly in an unparalleled manner. Peaceful sleep of an average human being is robbed due to the mayhem created by COVID – 19. Their innocent lives are shattered. People lost jobs, no salaries have been paid. Business collapsed. For daily laborers no other means to support families. Due to non-transportation, public had to cross borders under the scalding Sun on foot hundreds of miles. While migrating from one place to another people were deprived of minimum necessities. Though the government has introduced many schemes, sparsely reached people. If the comparisons are noticed with the 2008 global financial crisis characterized by a massive demand slump, COVID-19 has caused a severe supply-side recession. The pandemic has disrupted both global and local supply chains as the workforce has been restricted to virtual remote working at best. Tight restrictions on the movement of people and goods with transport and logistics severely curtailed, at the same time as demand for many goods and services has mushroomed. Over the span of few months, COVID-19 has triggered an economic contraction, leaving major world population without a job.

COVID-19 Pandemic Period - Psychological Wellbeing:

Pandemics have devastating effects on not only the psychology of people experiencing the Pandemic during the process, but also the future of the people and threatened the health of people, and led to negative consequences in people's psychology. The psychological reaction of each person in the face of intense stress and fear caused by pandemics is different. But one thing that is apparent is that pandemics cause psychological effects such as depression, anxiety, fear of death, losing loved ones, post-traumatic stress disorder, psychotic symptoms and mourning in general. However, some people learnt how to control the negative emotions of pandemics and continue their lives normally. But some people cannot cope up with these feelings and need professional support. Youngsters are not at risk and have the immunity to fight. Especially older people have to undergo a great distressful time as they do not have the ability to easily overcome the physiological symptoms caused by the virus and also no one to lend an ear to hear to their saga. Even some celebrities of top notch have undergone severe shock and despair and taken extreme step in their life.

COVID-19 on Education Reflections:

COVID-19 pandemic disrupted the students' educational process in a paramount way. Billions of students and Millions of educators are badly affected by school closures and other restrictions. The smooth sail of going to school regularly halted all of a sudden saddened their lives. Social distancing and other limitations due to COVID-19 caused negative psychological disorders such as anxiety, and fear affecting the well-being of students and parents. Most governments around the world have temporarily closed educational institutions in an attempt to contain the spread of the COVID-19 pandemic. These nationwide closures are impacting over 60% of the world's student population. Several other countries have implemented localized closures impacting millions of additional learners (UNESCO, 2020). Millions of students have not been able to continue

learning in schools, universities, vocational training institutions and adult learning programmes. Although precautions were taken, the students' learning process was negatively affected. Students who have been stripped of their freedom due to COVID-19 are deeply concerned about when face to face education will happen. Postponement of all entrance and competitive exams caused another anxiety to students. To overcome this problem, with the threshold of technology the country's education administrators want students to be accessible through distance or online education, which requires an excellent infrastructure, which is not feasible in developing countries.

Negative Effects of Online Classes:

Every student has to be equipped with the resources either with an android phone or a laptop to be accessible to online or distance education. But unfortunately access to the internet is not the same everywhere. Likewise, not every student has their own Mobile / Laptop / PC. Moreover, some regions of the world do not even have electricity. Even if the infrastructure problems are resolved in some way, the constant exposure of students to distance or online education is tedious to them. For this reason, the motivation of the students for learning decreases and the learning goals are not achieved. Not only students but also teachers and their families are affected by the negative effects of the COVID-19 pandemic on education. Families may not have enough support for their children to learn at home. This may be due to low socio-economic level of families, as well as low educational level of family members and low infrastructure. Likewise, teachers have an important role in the success of the educational process. But most teachers lacked pedagogical competence about how to manage the teacher distance or online education process. They didn't know how to develop online educational tools to keep the students stick to classes with interest. Therefore, the negative effects of the outbreak seem to be more difficult for the students to compensate.

Conclusion:

COVID-19 is the newly emerged pandemic across the globe at the end of 2019 but still shivering the world even after completion of one year. History signifies that there were different pandemic diseases across the globe at different times that brings a fundamental consequence in psychological and socio-economic situations. It's a continuous combat against virus and widened human relations. Evidences indicated that many countries in the world invest their time, money, energy and strategy to tackle COVID-19 with heavy hesitation for future market instability, hunger and other silent killer diseases as their current plan do not glance to them. The COVID-19 pandemic affects people psychologically because the spread of it still continues, death rates increased day by day, life comes to a halt and its control is unpredictable. The effect will cause many problems in the short and long term. The lockdown curfews, self-isolation, social distancing and quarantine have affected the overall physical, mental, spiritual and social wellbeing of the people. With the beginning of lockdown, the government decided to shutdown all cinema halls, gyms, health clubs and museums, as well as banned the gathering of people for

cultural, social or religious activities, including temples, monasteries, churches and mosques. In the case of death, the pandemic has disordered the normal mourning processes of families. The economic recessions have put significant financial pressure on many families, which might increase unhealthy conflict, family breakdown, abuse, depression and domestic violence. The psychological impacts of the COVID-19 lockdown might be a challenge for an indefinite time, hence it is necessary to emphasize and address coping strategies, mental health interventions and awareness using the available resources. To deal with the current pandemic and future health emergencies, the government should be equipped with adequate health logistics, technologies and skilled manpower, and needs to develop its capacity in health financing to foresee future opportunities and challenges. By strengthening the health care workforce, conducting mandatory health education and training in schools, wisely utilizing existing health manpower, investing and expanding the scope of health research and establishing well-equipped laboratories, every country is in need of and look forward hearing a positive nod from the governments.

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Institutional Credit for Agricultural Development: A Case Study

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Abstract

Credit is a device for facilitating temporary transfer of purchasing power from one individual or institution to another. It provides the basis for increased production efficiency through specialization of this function. Rural credit is a sine qua non for growth and development of agricultural activities in India. In this context, this paper examines how the establishment and strengthening of institutional credit respond to the needs of rural people in Andhra Pradesh. The complete enumeration of different issues is obtained from a simple random sampling process (cross section) of 100 households spread across the two villages in the district of Prakasam has been used for this purpose. Analysis of credit sources in sample villages showed that the traditional sources of credit are dominant compared to the institutional sources due to easy accessibility, viability and approachability. It was observed that the mode of operation by informal and partially by formal lending institutions in the sample villages made an endeavour in rural credit leading the rural masses to a larger base of agricultural production and productivity of crops through better prices for farmers.

Keywords: *Institutional Credit, Agriculture, Kandukur, Prakasam district, India*

1 Introduction

Agriculture is a way of life, a tradition, which, for centuries, has shaped the thought, the outlook, the culture and the economic life of the people of India. Agriculture, therefore, is and will continue to be central to all strategies for planned socio-economic development of the country. Rapid growth of agriculture is essential not only to achieve self-reliance at national level but also for household food security and to bring about equity in distribution of income and wealth resulting in rapid reduction in poverty levels (New Agricultural Policy, 2002).

Agriculture in India forms its economic base and has been treated as primary sector of the economy. Though the share of agriculture in both GDP and employment has declined over time, the pace of decline in its share in employment has been much slower than that in GDP. The share of agriculture, including the allied sectors in GDP declined from 39 per cent in 1983 to 22 per cent in 2003-04 and 18.8 in 2004-05 compared with a much lower rate of decline in its share in total employment from 63 per cent in 1983 to 57 per cent during the 2004-2005. The growth rate of agricultural production declined from 3.72% in eighties to 2.35% in the nineties indicating towards the need of sustainability in agriculture. The agriculture and allied sector witnessed a growth of 9.1% in 2003-04, which fell steeply to 1.1% in the following fiscal year 2004-05. The overall Gross GDP is estimated to grow at 8.4 per cent, with the agriculture and allied

sector projected to bounce back with 3.9 per cent growth during 2005-06. Indian agriculture is still beset with problems like inadequate capital formation, low productivity, high cost of production, uneven growth, etc. It is, however, revealed that the agriculture is becoming thoroughly neglected sector and no deliberate attempt was made by the government to uplift the cultivators from their deteriorating plight of impoverishment and indebtedness.

Need for institutional credit for agriculture in India

The general policy on agricultural credit has been one of progressive institutionalization aimed at providing timely and adequate credit to farmers for increasing agricultural production and productivity. Providing better access to institutional credit for the small and marginal farmers and other weaker sections to enable them to adopt modern technology and improved agricultural practices has been a major concern of the policy¹.

Credit plays an important role to accelerate the process of agricultural development in the developing countries like India. Credit in right quantity and of the right kind immensely contributes to agricultural development. The role of credit consists in laying the foundation stone of the farm revolution and maintaining the structure built upon it (Sharma, 1980). The advent of green revolution in Indian agriculture needed a variety of costly inputs like high yielding variety seeds, chemical fertilizers, pesticides and other agricultural inputs. These inputs could be made available in required quantities to farmers by provision of sufficient farm credit. Therefore, credit is required for the purpose of relief and rehabilitation because in agriculture, nearly 30% of farmers are poor; they are not in position to invest from own sources in any operations.

Need for institutional credit for agriculture at district and village levels

Institutional credit to agricultural farmers at district and village levels is the key constraint due to the decentralized system. It is required to ensure that concerns of farmers be mainstreamed into the area development approach to the grassroot levels. Conventional approaches to development have miserably failed to reflect the concerns and priorities of the farmers. Even though the provisions of Central Planning Commission are necessitated to bring farmers into the local governance, yet they are inadequate to address the concerns and priorities of them. What are often required were the tools and mechanisms that can integrate farmers in the process of planning and development. Mainstreaming credit process at the district and village levels process is an effective means of enabling integration of farmer's concerns and priority resulting in equitable development. Helping to build mechanisms that would guarantee the institutional credit in district plan and through allocations made in the district Budgets.

¹ The problems of credit are even more severe for small farmers (inclusive of marginal farmers) and other vulnerable sections (especially, the landless people) of the rural community, who often lack marketable collateral, credit-worthy projects and even political clout to access formal sources of credit. In spite of governmental stipulations in the form of priority sector credit and targets therein, the formal lenders are often not too keen to lend to the large number of borrowers belonging to the landless and small farming communities.

Objectives of the Study

The main objective of this study is to examine the institutional credit for agricultural credit in India and two villages of Prakasam district of Andhra Pradesh. The comparative study between the two villages of Prakasam district² was selected as one of case study areas to understand and review institutional credit at village level. The overall objective of the study is to help evolve a policy framework for village level planning of institutional credit to the farmers.

Methodology of the study

Data used in this analysis draw from both primary and secondary source material. The data on existing agricultural credit structure in the India are drawn from secondary sources consisting of Reserve Bank of India (RBI) publications, All India Rural Credit Surveys, All India Debt and Investment Survey, statistical statements relating to the Co-operative movement in India (RBI and NABARD) and from the previous studies.

Similarly a case study was supplemented with data collected by field survey from a carefully selected sample of 100 households spread over two villages, Venkatadripalem and Anantasagar in the Prakasam district of Andhra Pradesh. The sample households are selected following a random sampling process from each 50 households between September 2003 and January 2004. Data collected from these households are pertain to village characteristics, education and demographic features, occupational classification, agricultural production, asset holding status, income sources, and sources of credit both with formal and informal sources.

The present study is organised as follows. The first section provides introductory background of the study. Second section reviews the existing literature on credit needs and institutional credit for agriculture in India. In the third section status of institutional credit to the farmers are presented. Analysis of the results drawn from two case study villages is discussed in section four. The limitations of the study are detailed in section five. Lastly, in section six, the major conclusions of the study are summarized.

2 Literature review

Conceptual framework

As Dias Alejandro (1985) and Yotopoulos and Floro (1988) have rightly observed, credit-because of its very nature, is a "pure service" transaction between two time points rather than a spot transaction in "pure goods" like apples.

² Located in the Southern Part of India, Andhra Pradesh is the fifth largest state in the Indian Union both in terms of geographical area and population comprising of 23 districts 1,105 revenue mandals, 29,994 villages spreading over 2,76,814 sq.km. as per 2001 census provisional figures. The state came into existence with Hyderabad as the capital city in the year 1956. From being a predominately agriculture based economy, the state has made a rapid progress in the past one decade and is in the forefront of restructuring and reforming the economy, developing information technology and promoting good governance.

Credit is a device for facilitating temporary transfer of purchasing power from one individual or institution to another. It provides the basis for increased production efficiency through specialization of this function. Credit, in the financial sense, "is the confidence reposed in a person, who enables him to obtain from another, the temporary use of a thing of value, it may accord on the security of real estate in different forms depending on kind of security taken" (Joshi, 1985).

The review of literature related to institutional credit and agricultural credit in India is broadly focused on causes of borrowing, demand for credit, supply of credit, Inter-linkages of credit. A brief review of the studies relating to the evaluation of the institutional credit and agriculture in India is presented below:

Causes of borrowing

Previous studies related to causes for borrowing were classified into two types, viz., 'Basic' and 'Alterable'. The basic reasons includes the nature of the economy like weather, soil conditions and the size of land-holdings; the alterable reasons included that of low-prices, very high rate of interest, natural growth of population, litigations etc. The credit requirements and need to borrow was a reflection of the excess of expenditure over income. The main reason for these borrowings was due to poor financial background, illiteracy, smallholdings, lack of savings habit, etc among the cultivators. The Royal Commission on Agriculture in India (1928) describes the causes for the borrowing as due to that of "the longer the interval between successive receipts of the return for labour, the greater would be the need to borrow".

According to the Indian Central Banking Report (1931) attention has been drawn to such factors as poverty arising from the social condition, climate and irregular income, extravagance, the growth of population, the opportunities to borrow because of money-lenders influence and the revenue system of a fixed demand. The most important reasons for these big debts were of high interest rates and of ancestral debt. The debt burden assumed greater proportions, also because of the lack of distinction between short and long-term agricultural finance. The Reserve Bank of India (hereafter RBI) formed a committee in the year 1951, to conduct a compressive rural credit survey known as 'All India Rural Credit Survey Committee'. The Committee found that the moneylenders occupied the dominant positions in the rural credit system. The total borrowings of the cultivators for the country as a whole for the year 1951 - 52 were estimated at Rs. 750 cores (RBI, 1952).

The Government of India in the year 1979 formed Committee to Review Arrangements for Institutional Credit for Agriculture and Rural Development (CRAFICARD) under the Chairmanship of B. Sivaraman to find out the basic causes of rural poverty in the country. The Committee found credit as a burden instead of an instrument for the uplift of rural poor and suggested to provide tailor made loans to the needs of the specific areas and specific target groups.

In the year 1986, the RBI had set up the Agricultural Credit Review Committee under the chairmanship of A.M. Khusro. The Committee submitted its report in August 1989 (RBI, 1989). The major recommendations of the Committee were: to re-determine lending rates except for the re-defined priority sector borrowers subject to the ceiling of 15.5 per cent rate of interest; to amalgamate Regional Rural Banks into the sponsor commercial banks in view of their intrinsic weakness and built-in non-viability; to create a National Co-operative Bank to function to that of National Apex Bank for all Co-operatives and to provide

leadership in banking operative sector and operate as a balancing center at the national level; to provide concessional interest rates to small farmers having land below five hectares, and marginal farmers having land below two hectares, respectively³.

India initiated the process of economic reforms in 1991 in responses to the changes in the external and internal environment. Witnessing the series of reforms, the GOI set up a Committee in the same year under the Chairmanship of M. Narasimham to review the financial system of the economy (RBI, 1991). The Committee's main recommendations were; to eliminate concessional lending rates to the priority sectors and Government Sponsored Programmes; to set up rural banking subsidiaries by the Public Sector Commercial Banks; and to focus lending to the target group by RRB's. The main thrust of the Committee was to give more importance to the Commercial Banks and RRBs, to develop more credit facilities to the farmers. The recommendations of the Committee brought many changes in the functioning of financial system, particularly to the rural credit system.

Demand for credit

Sarma and Prasad (1989) estimated demand for farm credit for 1983-84 in selected districts of Andhra Pradesh. The forecasting of demand for farm credit was explained using a regression model and concluded that the technological variables have dominated the economic variable and mere productivity did not determine the demand for credit at the macro level. Srinivasan (1954) studied the problems farmers in terms of lack of awareness, lack of knowledge, information and the ability to contact existing sources of credit as the major hurdles in the success of credit institutions reaching them.

Godgil (1986, 1992, 1994) reviewed the major changes in farm credit policy, the role of the commercial banks in rural credit system, the contribution of agricultural credit in agricultural growth and equity, and the impact of above changes on the strength and viability of credit institutions since 1951. The major findings of the study were that the credit was no longer available for real productive uses but to ostensibly productive uses. The growth of credit was limited to farm families having accessed to formal credit sources and farmers with positive asset-debt ratio. The studies concluded that healthier lending rates would have a real impact on output and employment besides improving overall health of credit institutions.

Desai (1988) studied an overview of the institutional credit supply in the past and estimated the future credit requirements for agricultural production. Found that Co-operatives receding in supplying short-term credit with the advent of commercial banks. Shetty (1990) examined the behavior of Public and Private Sector investment in agriculture based on the National Account Statistics, published by the Central Statistical Organisation (CSO). Discussions on trends in agricultural investment, agricultural share in total domestic investment, behavior of fixed investment ratio and the factor responsible for decline in agricultural investment were made. The author found that "reduced public sector investment in agriculture, combined with an un-attractive growth horizon, adverse terms of trade, poor per capita income growth and

³ As per Government of India stipulations, a marginal farmer holds 0-1 ha of land and 1-2 ha by small farmers. The larger size of landholdings are held by medium and large farmers (Samar K. Dutta, 2003).

inadequate growth in savings, may have adversely affected both the incentive and the ability for farm households to invest in agriculture”.

Khan and Tewari (2002) examined that the gap between changing agricultural credit requirement and flow of institutional agricultural credit in nominal and real terms at all India level, the extent of inter-state disparities in the flow of institutional agricultural credit and the relationship of short-term agricultural credit flow with average cost of cultivation across States covers 17 agriculturally important states for the period from 1980-81 to 1999-2000. The results showed large gaps in agricultural credit are both in nominal and in real terms since mid-eighties. The rate of increase in credit gaps in post-liberalization period is comparatively low. The interstate disparities in per hectare flow of institutional credit gaps increased significantly during 1980-81 to 1990-91 and these disparities did not deteriorate till 1995-96, but increased slightly in 1996-97. Therefore, concerted efforts are needed for widening and deepening of institutional short-term credit to keep pace with the rising cost of cultivation in agriculture.

Supply of Credit

Subrata Ghatak (1975) attempted to study on the Rural Money Market System in the Indian economy. The author examined nature, composition and working of the organized and unorganized money markets, the factors affecting the demand side of agricultural credit, interest rates, and the working of the major organized agencies. It was found that the money markets are classified into organized and un-organized with later supplying 70 per cent of total rural credit. It appears that capital rather than family expenditure was the most significant explanatory variable affecting both borrowing and debt in most periods of the study. The study concluded that, there has considerable expansion of lending by the institutional agencies to farmers producing High Yielding Varieties (HYV).

Haque and Verma (1988) examined the nature and extent of inter-regional and inter-class variations in the supply of institutional credit to agriculture, and their policy implications. The authors found that the states of Bihar, Jammu & Kashmir, Madhya Pradesh, Orissa, Rajasthan, Uttar Pradesh, West Bengal and Karnataka had relatively lower amount of co-operative credit available per hectare than the national average. The amount of loan issued per borrower was the highest in Gujarat and the lowest in Bihar. Regarding policy implications the private agencies including the agricultural and professional moneylenders were found to dominate in the agricultural credit market in many regions where the liberation of farmers from the poverty and debt traps had a very remote possibility. Concluded that, the highly skewed distribution of institutional credit facilities in favor of the relatively progressive regions and better off section of the agricultural population was population was likely to generate strong back wash effects, there by restarting the overall pace of agricultural development.

An innovative study in crop planning was exercised by Patel (1988) by reorganizing Primary Co-operative Societies such as the Ramos Group Multipurpose Co-operative Society Limited (RGMC), the Gadha Group Co-operative Society Limited (GGC) and the Bayal Dhankharol Group Co-operative Society Limited (BDGC) that purvey agricultural credit to farmers in Modasa Taluka of Sabarkantha District of Gujarat. The study found that, after the adoption of the seed plot scheme, the farmers who were members of the 'RGMC' and the GGC societies could in all probability improve their economic conditions. However the

study finds that, the over-dues of Co-operative societies increased mainly because of the weak and unstable financial condition of the farmers. Hence increase in the income earning capacity of the farmers is a necessary. Shah (2002) evaluated the organizational, operational and financial viability of the co-operative credit societies affiliated to the district level institutions in Kolhapur District of Maharashtra. The study showed that, a reduction in the operational efficiency of the selected Primary Agricultural Co-operative Credit Societies during the post-economic reform period as against the pre-economic reform period. Desai and Nambodiri (1991) critically examined the performance of rural financial institutions such as Co-operative Financial Institutions, Co-operative Land Development Banks, Scheduled Commercial Banks, Regional Rural Banks and Rural electrification corporations for 1960-61 to 1980-81 periods. The study found that rural loans and deposits each as percentage of agricultural output and value added has continuously improved during the study period. There was positive association between banking infrastructure, rural deposits and different types of loans of agricultural credit societies pertaining to institutional rural finance system.

Inter-linkages of Credit

Giri and Dasgupta (1988) made an attempt to estimate the extent of inter-state and intra-state variations in the distribution of institutional credit. They found that there were large inter-state variations in the average loan per borrowing member. The rate of growth of loan per borrowing member was the highest in Punjab followed by Karnataka, Maharashtra, Orissa etc. Negative growth rate was observed in states like Assam, Bihar, Jammu & Kashmir and Tripura. It was concluded that there were large inter-state variations in the distribution of loans including lower per-borrowing member loan in the agriculturally less developed areas to higher per-borrowing member loan in agriculturally developed regions and in regions with strong co-operative movement. Further fixing of credit limit at variable proportion among the different size-groups of farmers would help to eliminate intra-state or inter farm difference in the distribution of agricultural credit.

Sarap (1991) examined the nature and functioning of interlinked agrarian credit markets operating in backward, poverty-ridden regions of India. The main objective of the study was to examine the functioning of formal credit agencies, including that of Co-operatives and Commercial Banks. The study concluded that interlinked credit transactions were found to be highest among the tenants and landless labourers following the small farmers. In another study Reddy (1992) also attempted to find out the incidence of different types of linkages prevalent in the developing village and backward village in two villages of Guntur district in Andhra Pradesh. The study revealed that incidences of interlinked transactions were less in the developed village compared to the backward village. Bardhan and Rudra (1978-84) highlighted that lenders exercised control using duration of loan and valuation of collateral as important instruments, apart from the conventional instruments of the size of the loan and the interest rate. But with respect to non-secured loans the lenders earned interest income with much of risk while resorting to other regulatory mechanisms of selection of borrowers through third parties, caste, kinship etc. Strong role of caste and personal relation had often resulted in discrimination towards Scheduled castes, Scheduled tribes and Migrant labourer Binswanger and Rosenzweig (1986).

In the above section relevant literature on different issues of institutional credit like need for borrowing, supply and viability of credit institutions, demand for agricultural finance, and inter-linkages of the land,

labour, credit activities were reviewed. During the time of Independence, most of the credit was provided by unorganized sector such as moneylenders, private agents, relatives, and friends contributing 97 per cent of the credit source. The organized sector contributed only 3 per cent of credit. The main reason was that of non-existence of organized institutions supplying credit. But after Independence, GOI established many credit institutions such as of Co-operative, Commercial Banks and RRB's to provide institutional credit. Presently institutional credit contributes 80 per cent of total credit and 40 per cent of total comes from the Co-operative Banks alone than that of any other bank. The activity of commercial banks has gradually decreased over the years and the RRBs are playing a pivotal role in providing credit for agricultural production and development. Agrawal, Puhazhendhi and Sai (1997) found that rural credit system appears that, from time to time the system has been sought to be strengthened by reinforcing rural credit structure with new institutions. When co-operatives failed to live up to expectations, commercial Banks were added and them to ensure equity in credit delivery RRBs were included and now came the proposal of private local area banks and linking with Self-Help Groups (SHG's). Increasing the outreach of credit and maintaining the viability standard of the institutions must be the priority for strengthening the existing credit delivery mechanism.

3 Current agricultural credit scenario in India

Agricultural credit is divided into two categories, i.e., institutional and non-institutional. The institutional sources comprise mainly the cooperative banks, scheduled commercial banks and regional rural banks. These banks provide the short, medium and long-term loans i.e., crops loans and land development loans. The non-institutional sources comprise agricultural moneylenders, landlords, merchants, traders, relatives, friends, and commission agents.

In the beginning, Commercial Banks (CBs) were not interested in financing agricultural operations and confined themselves largely to financing trade and exports. Consequently, co-operative credit structure could not achieve desired results till independence. The All India Rural Credit Review Committee (1969) therefore recommended multi agency approach to rural and especially agricultural credit. It therefore suggested enhancing the role of the CBs in providing agricultural credit. Further, under the Social Control Policy introduced in 1967 and subsequently the nationalization of 14 major CBs in 1969 (followed by another six banks in 1980), CBs have been given a special responsibility to set up their advances for agricultural and allied activities in the country. In 1975, another agency for providing institutional credit, i.e., the Regional Rural Banks (RRBs) emerged on the rural credit scene, on the recommendation of the Working Group of the Rural Banks, to fill the credit gap of small and marginal farmers and the weaker sections. In order to meet the growing demand for production and investment credit for agriculture and rural development activities the scheduled CBs and RRBs have expanded their geographical coverage, particularly in rural areas, in a big way during the last decades.

A considerable expansion in the institutional credit sources in rural areas includes 33000 branches of commercial banks, 14000 branches of RRBs and around 100,000 of cooperatives, making a total of 147000. The cooperatives include 92682 primary agricultural credit societies (PACS) for short-term credit and 2258 units for advancing term loans. There are also 30 state cooperative banks (SCBs) with 686 branches and 366 district central cooperative banks (DCCBs) with 10518 branches. However, 140

cooperative banks are sick. There are 196 RRBs with 14498 branches in 495 districts. Out of these, 187 RRBs have been provided with equity support. As for March 2003, their advances stood at Rs. 20700 crores (against deposits of Rs. 48900 crores) with gross non-performing assets (NPAs) of Rs. 3200 crores (14.4% of advances). The number of non-performing RRBs now stands at 20 only (Acharya 2004).

Indian Banking Sector together extended nearly Rs.550 billions of credit to agriculture sector and at present the overall performance of Banking sector is 15% as against the norm of 18% to NBC. The flow of institutional credit of agriculture and allied activities has increased from Rs.31,956 crore in the year 1997-98 to about Rs.64,000 crore in 2001-02. With regard to the demand and supply of rural credit, the total credit flow from all agencies viz. Commercial Banks, Regional Rural Banks, and Cooperatives Institutions, during the 9th Plan is expected to go up to Rs.2,33,700 crore. Moreover, during the 10th Plan the total credit flow has been projected at Rs.7,36,570 crore.

There has been substantial improvement in the flow of institutional credit in India for the past three decades. Despite expansion of institutional credit, the share of institutional agencies in total rural credit was only 61.2 percent in 1982 and around 66 percent in 1991. Still considerable part of the credit by rural families is availed from noninstitutional sources. As the institutional credit agencies are not able to internalize the peculiar credit needs of poor in their policies and programmes, rural poor continue to depend on informal sources. The lending terms of informal sources may be harsh but are convenient (Acharya 2004).

The growth of long-term institutional loans decelerated from 20.2 percent during the 1970s to 14.8 percent during the 1980s and further to 11.9 percent per annum during the nineties. The growth of long term advances by CBs came down from 29.9 percent per annum during the seventies to 18.6 percent during the eighties and further to 12.1 percent during the nineties. Agricultural credit as a proportion of agricultural GDP has gone up from 5.4 percent during the seventies to 8.3 percent during the eighties, 7.4 percent during the nineties and 8.7 percent during 2001-02. But the ratio of agricultural credit to total bank credit has been declining over the years. This ratio has declined from 20.5 percent during seventies and 20.1 percent during eighties to 14.4 percent during nineties and further to 10.5 percent during 2001-02.

Government of India has taken several policy initiatives for strengthening of rural credit delivery system to agricultural sector. Emphasis of these policies has been on progressive institutionalization for providing timely and adequate credit support to farmers with particular focus on small and marginal farmers and weaker sections of society to enable them to adopt modern technology and improved agricultural practices for increasing agricultural production and productivity. The policy essentially lays emphasis on augmenting credit flow at the ground level through credit planning, adoption of region specific strategies and rationalization of lending policies and procedures.

4 Case study: Analysis of credit sources in the sample villages

This section brings out the broad features of borrower households, the dynamics of socio-economic conditions and the sources of institutional credit from the two sample villages of the study. For examining empirically the role of institutional credit in agricultural development at the micro-level, two villages have

been selected, representing the district's agriculturally advanced mandals. The selection of respective sample villages, viz., Venkatadripalem and Anantasagar is located at Kandukur mandal of Prakasam district (profile presented in Appendix-I). Both villages share common geographical conditions but share uncommon propositions of demographic, occupation characteristics, agricultural land, cropping pattern, production and productivity.

General statistics of the study villages

Venkatadripalem (hereafter village-I) is located on western end, with a distance of 6 km. from Kandukur mandal (block) and 50 km from Ongole (sub-division) of Prakasam district. Anantasagar (hereafter village-II) is located between the west and south end with a distance of 10 km from Kandukur mandal and 55 km from sub-divisional town of Ongole. The two sample villages are connected with public transportation by road and rail network.

The summer season is from March to May, the monsoon is from June to November and the winter is from December to February in the vicinity of the two villages. The climate of two villages is hot and humid. The monthly average maximum and minimum temperatures observed at Kandukur observatory are 40.3⁰ C in the month of May and 19.1⁰ C in the month of December respectively⁴. The villages receive both south-west and north-east monsoons with 3/4 of the annual rainfall receiving from the north-east monsoon.

Soils in the proposed study area are mainly falling under three orders, viz. red, sandy and black. About 90 per cent of village-I is covered by red soil and 10 per cent by sandy and black soil. In village-II 80 per cent is covered by red soil and 20 per cent by sandy and black soil. However the soil was dry in both the villages because of humid weather conditions. The principal crops grown in village-I are *tobacco*, *genusu* (sweet potatoes), *sunflower*, *minimu* (black gram), *kandi* (yellow grams), *mirchi* and *onions* and in village-II, *tobacco*, *sunflower*, *kandi*, *minimu* and *mirchi*, respectively.

Demographic, literacy and education

The enumeration of 50 households from each of the two villages is studied in detail. According to the 2001 census the total population of village-I was 2140 persons constituting of 508 families with a sex ratio of 990. The village comprised of several caste groups dominated by peasant's class of *kamma* followed by *backward caste* (BCs), *scheduled caste* (SCs), *scheduled tribes* (ST), *trading community* and *artisans*. In village-II, the total population was 1650 consisting of 400 families. The village is mainly comprised of three castes groups following with *kamma's*, *scheduled caste*, and *backward caste*. The proportion of people according to caste groups are *kamma's* (50%), *schedule caste* (30%) and *backward caste* (20%) out of total population.

In Table-1, estimates of literacy and education of 50 households belonging to the two sample villages are shown. Overall the proportions of literates in village-I consists of about 60 per cent against 55 per cent in village-II.

⁴ As for the weather report from Mandal Revenue Office (MRO) Kandukur, the mean maximum temperature recorded was 39°C in the month of May 2003 and mean minimum of 23°C in January 2004.

Table - 1: Literacy and education of sample households

Village-I						
Particulars	Illiterates	Read & Write	Primary Education	Secondary Education	Graduates/above	Total
Marginal Farmers	21	1	1	6	9	38
Small Farmers	48	4	18	30	14	114
Large Farmers	18	~	3	9	8	38
Total	87	5	22	45	31	190
Village-II						
Marginal Farmers	74	17	17	12	10	130
Small Farmers	5	4	1	3	~	13
Large Farmers	52	14	5	16	14	101
Total	131	35	23	31	24	244

Source: Field survey

The total population of village-I, from the 50 households is 190. Out of the total 190 persons, 87 are illiterates, 5 are 'read and write' category, 22 have only primary education, 45 completed secondary education, and 31 hold graduation or higher education degrees. Contrary to village-I, village-II is has a total population of 224 person out of 50 households of whom 131 are said to be illiterate, 35 under 'read and write' category, 23 with primary education, 31 with secondary education and 24 graduation or higher education holders.

Occupational categorization

In considering the occupational categorization of the two villages, we categorised the households into four broad categories: owner-cultivators, agricultural labourers, casual labourers, and Government employees. On the whole households depending on the non-agriculture sources of living are very marginal. The majority of household's source of livelihood is agriculture with most of them working on their own lands. In village-I, out of 90 households, 508 families are large farmers, 150 small farmers, 80 marginal farmers and rest of them are landless agricultural labourers. The village-II has 400 households, out of which, 150 are large farmers, 50 are small farmers, 130 are marginal farmers and remaining of them are from landless agricultural labourers. The occupational categorization of sample households is explained in Table-2.

Table -2: Occupational categorization of sample households

Village-I						
Particulars	Owner-cultivators	Agricultural labourers	Casual labourers	Govt. employees	Other's	Total
Men	51	2	11	2	22	88
Women	54	4	~	1	21	80
Child	4	~	~	~	18	22
Total	109	6	11	3	61	190
Village-II						
Men	53	8	29	4	32	126
Women	46	9	1	~	35	91

Child	~	~	~	~	27	27
Total	99	17	30	4	94	244

Note: Others are old age people, housewives, students, and children.

Source: Field Survey

From the above table it is evident that out of 190 people from village-I, 109 people (comprising of Men (51), Women (54), and Children (4)) are working on their own fields, 6 of them as agricultural landless labourers, 11 as daily casual labourers working in town, 3 at Government service and remaining 61 as 'others' category (persons of old-age, housewives, students and children). The village-II has total population of 244 persons, out of which 99 are working on their own fields (Men (53), Women (46)), 17 as agricultural landless labourers, 30 as daily casual workers, 4 as Government employees and 94 of them in others' category.

Wages

The wage-rate pattern of daily agricultural labourers differs between two sample villages. In village-I wages are high during cropping season and low during non-cropping season. It was observed that there would be two to three cropping in a year of different combinations among the principal crops for cultivation in the village. The average wage-rate for men was about Rs. 60-70 and for women about Rs. 30-40 per day. The wage-rate during cropping season would rise to Rs. 100 to men and Rs. 60 to women per day. In case of village-II, there would be atleast two crops for cultivation in a year. Compare to village-I, the wage-rate in village-II was very high ranging from Rs.70-80 for men and Rs.40-50 for women per day. The number of man-days of employment for agricultural labourers on an average would be 140-160 days in a year.

Land use classification details

The land use/land cover classification details of the sample households of the two villages surveyed are given in Table-3. The land under cultivation by farmers in village-I is 1,600 acres and 2,000 acres in village-II.

Table -3: Land use classification details of sample households

Village-I				
Particulars	From 0 - 4 acres	From 5 - 8 acres	Above 9 acres	Total
Own land	9	30	9	48
Leased in	2	-	-	2
Leased out	-	-	-	-
Total	11	30	9	50
Village-II				
Own land	18	3	29	50
Leased in	~	~	~	~
Leased out	~	~	~	~
Total	18	3	29	50

Source: Field Survey.

The table demonstrates that in village-I, out of 50 households, 48 are own-cultivators with majority holding between 5-8 acres of land, and 2 cultivating leased land, of less than two acres. In village-II, out of 50 households, 18 households have less than 4 acres, 3 households having between 6-10 acres and 29 households with more than 9 acres of land for cultivation. Evidently, the majority of farmers are of own-cultivators of land from both the villages.

Irrigation and water sources

The sources of irrigation in the two villages are open wells and rainfall. In Table-4, open wells (especially with electrical motors) becoming the dominant source of irrigation to the villages, displacing canal irrigation and tanks, both of which have declined in terms of absolute area covered is shown. Rainfall is usually low and grossly provides any irrigation facilities to the villages. In village-I, open wells have been one of the single largest providers of water. Most of them are old wells dug about 25 years ago. No serious effort was made to improve the irrigation facilities by the farmers in the village. In village-II most of the wells are new constructed within three years span. The two villages open wells have been one of the single largest providers of irrigation to villages. The most serious problems of farmers related to irrigation are the growing difficulties of accessing sufficient groundwater, the high costs associated with reliance on wells, the tendency towards over-exploitation of groundwater preventing adequate recharge and causes existing wells to go dry.

Table - 4: Irrigation sources of households

Particulars	Village - I			Village - II		
	Open well	Other sources	Total	Open well	Other sources	Total
Marginal farmers	11	~	11	18	~	18
Small farmers	30	~	30	3	~	3
Large farmers	9	~	9	29	~	29
Total	50	~	50	50	~	50

Source: Field Survey.

Cultivated and uncultivated land

In Table-5 both the cultivated and uncultivated land details of households under survey are presented. The total land in village-I consists of 271 acres, and 270 acres belongs to cultivated land and remaining 1 acre of uncultivated land. In village-II, the total land is 463 acres out of which 408 acres is cultivated land and 55 acres of uncultivated land. The table shows that there exists a lot of difference between the villages in terms of cultivation pattern where in village-I, 50 households cultivate 270 acres and in village-II, 50 households cultivate the 408 acres of land.

Table -5: Cultivated and uncultivated land of the households

Farmers	No. of households	Total land (In acres)		
		Cultivated	Uncultivated	Total
Village-I				
Marginal	11	30	8	38
Small	30	122	28	150
Large	9	118	15	133
Total	50	270	51	321
Village-II				
Marginal	18	50	13	63

Small	3	18	5	23
Large	29	340	37	377
Total	50	408	55	463

Source: Field Survey.

Cropping pattern and yield per acre

The major crops in both the villages are *genusu* (sweet potatoes), *onions*, *sunflower*, *minumu* (black grams), *tobacco*, *kandi* (yellow grams), and *eucalyptus*. It was observed that crops such as sunflower and kandi are most preferred by the farmers. The total cultivated land is divided based upon the crop yielding per acre. Here we taken into consideration only the major crops like sunflower, tobacco, mirchi, *genusu* (sweet potato), *onions* and *minumu* (block grams) for survey. Table-6 details the crop-wise land cultivation in the sample villages.

Table-6: Crop-wise land cultivation of sample households (in acres)

Village - I								
Farmers	Sunflower	Tobacco	Mirchi	Genusu	Onions	Miumu	Others	Total
Marginal	-	-	8	12	5	-	5	30
Small	35	15	10	35	15	5	7	122
Large	30	28	15	20	11	4	10	118
Total	65	43	33	67	31	9	22	270
Village- II								
Farmers	Sunflower	Tobacco	Mirchi	-	<i>Kandi (yellow grams)</i>	<i>Minumu (block grams)</i>	Other s	Total
Marginal	15	2	8	-	10	5	10	50
Small	6	-	2	-	5	-	5	18
Large	110	90	35	-	5	20	40	340
Total	131	92	45	-	60	25	55	408

Source: Field Survey.

From the table, in village-I, *genusu* (67 acres)(sweet potatoes) sunflower (65 acres), tobacco (43 acres), mirchi (33 acres) and onions (31 acres) crops are cultivated by the villagers. Tobacco occupied third place and the cultivated land is decreasing gradually. The marginal farmers are mainly interested in *genusu* and onions, because, the duration of crop yield is very short which is generally for 2.5 months. The usage of fertilizers for the same crop is very less. In village-II, sunflower (131 acres), tobacco (92 acres), kandi (yellow grams) (60 acres) and mirchi (45 acres) crops are cultivated by the farmers.

Total production and productivity per acre

In the village-I, 248 acres of land was under cultivation by 50 households. The farmers are interested mainly in cultivating six crops i.e., *genusu*, onions, *minumu* (block grams), sunflower, tobacco and mirchi, with a production of 691 quintals. The average productivity per acre is nearly 2.8 quintals for a total production of 691 quintals. Table-7 shows significant differences in productivity of crops among farmers. The productivity

for sunflower was 2.3 quintal per acre by small farmers and 2.4 quintal by the large farmers. For tobacco it was 2.5 quintals per acre and 2.6 quintals per acres by small and large farmers. The productivity for major crop like genusu (sweet potato) crop was high with an average of 4.1 quintal per acre produced out of 67 acres of cultivating land.

Table -7: Crop (in acres), production and productivity (per acre) of village-I

Crops	Marginal farmers			Small farmers			Large farmers			Total		
	Land cultivating in acres	Land cultivating in acres	Productivity per acre (in quintal)	Land cultivating in acres	Total production (in quintal)	Productivity per acre (in quintal)	Land cultivating in acres	Total production (in quintal)	Productivity per acre (in quintal)	Land cultivating in acres	Land cultivating in acres	Productivity per acre (in quintal)
Sunflower	-	-	-	35	80	2.3	30	78	2.6	65	158	2.4
Tobacco	-	-	-	15	37	2.5	28	75	2.7	43	112	2.6
Mirchi	8	13	1.6	10	18	1.8	15	19	1.9	33	60	1.8
Genusu	12	48	4.0	35	140	4.0	20	86	4.3	67	274	4.1
Onions	5	12	2.4	15	38	2.5	11	28	2.5	31	78	2.5
Minumu	-	-	-	5	5	1.0	4	4	1.0	9	9	1.0
Total	25	83	3.3	115	318	2.8	107	300	2.8	248	691	2.8

Source: Field Survey.

In village-II the land under cultivation was 353 acres out of total 408 acres. The total production is estimated to be 1118 quintal with majority share coming from sunflower (448 quintals), tobacco (296 quintal) and kandi (yellow gram) (238 quintal). Table-8 presents the production and productivity pertaining to village-II.

Table-8: Crop (in acres), production and productivity (per acre) of village-II

Crops	Marginal farmers			Small farmers			Large farmers			Total		
	Land cultivating in acres	Land cultivating in acres	Productivity per acre (in quintal)	Land cultivating in acres	Total production (in quintal)	Productivity per acre (in quintal)	Land cultivating in acres	Total production (in quintal)	Productivity per acre (in quintal)	Land cultivating in acres	Land cultivating in acres	Productivity per acre (in quintal)
Sunflower	15	43	2.9	6	20	3.3	110	385	3.5	131	448	3.4
Tobacco	2	6	3.0	-	-	-	90	290	3.2	92	296	3.2
Mirchi	8	15	1.9	2	4	2.0	35	80	2.3	45	99	2.2
Kandi	10	38	3.8	5	20	4.0	45	180	4.0	60	238	4.0
Minumu	5	7	1.4	-	-	-	20	30	1.5	25	37	1.5
Total	40	109	2.7	13	44	3.4	300	965	3.2	353	1118	3.1

Source: Field Survey.

It was observed that marginal farmers have 109 quintals of total production out of 40 acres of cultivated land, small farmers with 44 quintals out of 13 acres and large farmers with 965 quintals out of 300 acres. The productivity per acre among all farmers is 0.1 quintal per acre.

Productivity difference between the sample villages

Table-9 presents productivity differences between the two villages for all crops. In village-I, productivity of sunflower is 2.4 quintals and in village-II 3.4 quintals with a difference of 1.0 quintals. Similarly overall difference in productivity in village-I for crops such as tobacco is 0.6 quintals, mirchi 0.4 quintals and minumi 1.0-quintals per acre. The total productivity of all crops in village-I is 2.8 quintals per acre and 3.1 quintals per acre in village-II.

Table-9: Productivity differences between sample villages (in quintals)

Crops	Village - I			Village - II			Productivity differences per acre
	Total cultivated land in acres	Total production	Productivity per acre	Total cultivated land in acres	Total production	Productivity per acre	
Sunflower	65	158	2.4	131	448	3.4	1.0
Tobacco	43	112	2.6	92	292	3.2	0.6
Mirchi	33	60	1.8	45	99	2.2	0.4
Genusu	67	274	4.1	-	-	-	-
Aonions	31	78	2.5	-	-	-	-
Minumu	9	9	1.0	25	37	1.5	1.0
Kandi	-	-	-	60	238	4.0	-
Total	248	691	2.8	353	1118	3.1	0.3

Source: Field Survey.

Sources of credit

The credit sources are broadly categorised as institutional credit and non-institutional credit. In village-I most of the villagers are depended on the non-institutional credit sources, i.e., agricultural moneylenders, professional moneylenders, merchants, traders, friends, relatives and others⁵. They all are locally accessible. In village-II, the farmers getting credit from the institutional sources. The credit-supplying bank is union bank, which is located at Kandukur town. The union bank provides loans to the farmers such as, crop loans, gold loans and land mortgage loans. Among the institutions, there exists a uniform rate of interest on direct long-term and short-term agricultural loans to all borrowers. In the case of loans borrowed under the IRDP scheme there is a 33% of subsidy for SC's and 25% subsidy for the BC's and for the rest, it is similar to other loans.

In Table-10 credit sources of sample households. In village-I, out of 50 households, 44 households got credit from informal agency, 3 households got credit from the formal agency and 3 households got credit from the both of formal and informal agencies are shown. In village-I, among these, 11 households are

⁵ Most of the informal lenders, however, were found to be belonging to a mixed category of borrowers-cum-lenders, whose affluent economic position in terms of better endowments of land and non-land assets and superior occupations further reinforced by their easy access to the formal sources of credit, constituted their lending potential.

Belonging to superior castes and occupational groups, who were pure lenders whose affluent economic position in terms of better endowments of land and non-land assets and superior occupations further reinforced by their easy access to the formal sources of credit, constituted their lending potential.

marginal farmers, 30 households are small farmers and 9 households are large farmers. In village-II, among the 50 sample households, all are getting credit from the formal agency. Out of 50 households, 18 households are marginal farmers, 3 households are small farmers and 24 households are large farmers. These all of them are got credit from the Union Bank.

In village-I, credit needs of the most farmers are met by informal sources⁶ at exploitative interest rates ranging from 36% to 60% per annum. The formal sources such as banks

Table-10: Households credit source

Particulars	Village - I				Village - II			
	Formal loans	Informal loans	Both loans	Total	Formal loans	Informal loans	Both loans	Total
Marginal farmers	1	10	~	11	18	~	~	18
Small farmers	1	27	2	30	3	~	~	3
Large farmers	1	7	1	9	29	~	~	29
Total	3	44	3	50	50	~	~	50

Source: Field Survey.

were non-encouraging to farmers as they are unable to offer banks any security for small loans. Banks in turn faced constraints due to the high transaction costs involved in processing small amounts to borrowers scattered in rural areas, as well as concerns related to loan recovery. Despite the mounting debt on their side, farmers prefer informal agencies for their credit needs. Contrast to village-I, in village-II, most of the farmers gets credit from the banks. The interest rate charged on the loans was around 10.8% during the study period, which was repayable by the farmers. The banks were also providing loans on subsidy to backward communities belonging to SCs and STs.

Credit needs

India today is not only self sufficient in agrarian production, but also has a substantial reserve. Agriculture and allied activities constitutes the single largest contributor to the Indian economy almost 33% of its GDP. Farmers required new techniques and technology for improving the crop production. It is only possible due to bringing of additional area under cultivation use of high yielding variety of seeds, extension of irrigation facilities better techniques evolved by scientists, water management and judicious use for fertilizers and pesticides. The increase of irrigation facilities as also will increase accuracy of monsoon and credit system plays a major role to increase the agricultural production.

The above-mentioned programmes only possible through the credit system at the rural level. It helps to develop better management of input to improve agricultural production. However, most of the rural areas lacked formal credit system. Though the sample villages consists many similarities in case of land, location,

⁶ See Besley, Timothy, (1995), "Nonmarket Institutions for Credit and Risk Sharing in Low-Income Countries", Journal of Economic Perspectives, Vol.9, No.3, pp. 115-127; Stiglitz, Joseph E., (1990), "Peer Monitoring and Credit Markets", World Bank Economic Review, 4;3, 351-66; Besley, Timothy, Stephen Coate, and Glenn Loury, (1993), "The Economics of Rotating savings and Credit Associations", American Economic Review, 83:4, 792-810;

soil, crop pattern, water availability etc the credit system varied from place to place. This is inevitable that the cultivation and the credit system are interdependent one on another.

In village-I most of the farmers get credit from the informal agencies with high interest rates, where it hampers production increase. And provides low wages to agriculture labourers consequently it leads to migrate agricultural labour to urban areas. Where as it said in this study it affecting the average wage rate per annum. More over skilled labour getting insufficient wages. They attracts towards urban areas as it was happened in case of first village-I, which is indicating the low production potential.

However, in case of village-II little natural variation can be found in contrast to the village-I. The chief difference is that this village people get formal credit system at low interests which encourages to grow the productive potential. It also stops the migration of skilled labour. Thus adequate wages prevailed in this village.

Agriculture is an unorganized sector where credit influences factors of production. Credit through formal institutions would help farmers to buy better inputs such as high yielding variety seeds (HYVs), fertilizers, pesticides, labour force, modern technology, etc. The availability of credit with lower interest rates would enable farmer to invest more money on land for improving the productivity of the land. In village-I the major source of credit to farmers are from informal sources. The money lenders who are the dominant group providing credit to farmers in these areas charge heavy interest rates on the credit. Cultivation and development of land would not take place if farmers lack availability of credit. However, in village-II farmers are provided credit from formal agencies such as bank loans for their cultivation and development of productive capacity of land.

For improving the irrigation system such as digging new wells and repairing the old wells, the institutions provide long-term loans to the farmers. It was apparent that village-II was able to improve water facilities through availability of loans from banks than village-I which had stagnated with their old water facilities.

5 Limitations of the study

Before we conclude this study, it is important to bring out its major limitations, so that the conclusions can be interpreted accordingly and future research efforts can be directed towards overcoming at least some of these limitations. The set of constraints are in terms of resource and time, which seem to have affected the rigour of the study in three ways. These limitations are listed below:

- a. The study could not collect detailed input-output data on agricultural operations of the borrower households to replicate the exercise done in the earlier study - namely, to examine whether or not interlinked credit transactions lead to overall efficiency in production.
- b. Many of the lender households being residents of villages/towns outside of the boundaries of the selected villages and also given the reluctance of most lender households to freely share information related to credit, the earlier study and more so the present study had to be content with mere

borrower-side information relating to credit (i.e., without confirmation of data from the lender side) and from only a handful of informal lenders, who had agreed to interact with the study team. In the absence of time and resource constraints, this limitation could have been overcome through repeated trials and efforts.

- c. Some of the formal credit organisations, local body representatives, NGOs operating in and around these villages could not be covered at all or not covered sufficiently.

6 Conclusion

India is one of the world's largest and the oldest agriculture societies, one which has remained predominantly rural despite of decades of modernization. Even today, every aspect of the country's economy and politics, as also the day to day lives of the majority of its one billion population are governed by what happens in the agricultural sector.

The agriculture sector in India is predominantly depended on monsoon, which is uncertain, and so frequent crops failures. The credit system plays a significant role in mitigating the monsoon uncertainty in agricultural sector. For the purpose of relief and rehabilitation and for costly inputs in agricultural sector, credit became a *sin-qua-none*. High yielding variety seeds, chemical fertilizers, pesticides and other agricultural labour inputs forced the farmers to approach the money lenders and other credit agencies.

In this study, two villages were selected. They were Venkatadripalem and Anantasagar. Both the villages had similar natural and geographical features, i.e. climate, rainfall and land soils. Most of the land consists in both villages is red soils. Their nature of work and their educational level is almost equal. In both villages majority of the farmers have their own lands. The water source of the villages is only wells. But, in village-I, farmers are using old wells which were constructed 25 years ago. In village-II, most of the farmers using new wells which constructed three/two years back.

Agricultural labour wage rate and working days to differ between these villages. In village-I, the wage rates are low and continuously changing, these changes are very less in village-II. They differ mostly in their credit sources. Thus village-I gets credit from informal agencies while village-II gets credit from formal agencies. The informal agencies are charging high interest rates, nearly 36% to 60% in village-I, while the formal credit agencies are charging nearly 11% as interest rate in village-II. Getting credit from the institutional agencies the farmers improved their land productivity with improved water facilities. These people expect future agricultural growth through the increase institutional credit.

The sample villages show that there is lot of difference between production and productivity per acre. The total productivity per acre in village-I is 2.8 quintals and village-II is 3.1 quintals. The productivity difference between the two villages is 0.3 quintal per acre.

For these two sample villages' rainfall was inadequate for their cultivation. The farmers generally cultivated one crop annually due to inadequacy of rainfall. Because of lack of rainfall the annual average wage rate was drastically reduced in village-I since four years. Whereas in village-II, they get institutional credit and improved their water resources by digging new wells. Consequently they had been cultivating two crops per year. Thus the average wage rate per annum had increased since the last four years.

Several concerns in relation to rural credit expressed are inadequacy, constraints on timely availability, high cost, neglect of small and marginal farmers, low credit-deposit ratios in several States and continued presence of informal markets. The commercial banks are more focused in improving efficiency and profitability but have tended to give comparatively less priority to rural credit. Regional Rural Banks (RRBs) and Co-operatives appear to face serious problems of governance as well as operational efficiency. It is argued that most part of the Co-operative Credit structure is multi-layered, under-capitalized, over-staffed and under-skilled, often with mounting non-performing assets while in a few cases resulting in erosion of public deposits as well. Many of the RRBs also appear to share most of these problems, though there are some vibrant and viable institutions in this category (Thorat 2005).

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Design, Synthesis and Molecular Docking Studies of Novel Indole-Isoxazole-Triazole Conjugates as Potent Antibacterial Agents

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Abstract— In search of better antibacterial agents, a series of novel 5-((aryl)methyl)-3-(1*H*-indol-2-yl)isoxazole (**IIIa–e**) and 5-((3-chlorophenoxy)methyl)-3-(1-((1-(aryl)-1*H*-1,2,3-triazol-4-yl)methyl)-1*H*-indol-2-yl)isoxazole (**VIa–e**) were synthesized in one-pot by using indole-2-carbaldehyde (**I**), Substituted (prop-2-yn-1-yloxy) benzene and different substituted 1-azidobenzene (**V**) and further evaluated for their *in vitro* antibacterial activity. 5-((3-chlorophenoxy)methyl)-3-(1-((1-(3-(trifluoromethyl)phenyl)-1*H*-1,2,3-triazol-4-yl)methyl)-1*H*-indol-2-yl)isoxazole (**VIc**) showed more potent activity against *B. subtilis* and *S. aureus*, whereas, the compound 5-((3-chlorophenoxy)methyl)-3-(1-((1-(3,5-dichlorophenyl)-1*H*-1,2,3-triazol-4-yl)methyl)-1*H*-indol-2-yl)isoxazole (**VIb**) showed potent activity against *S. aureus* when compared with standard streptomycin. Molecular docking studies were also carried out to complement the experimental results.

Keywords: one-pot, indole-2-carbaldehyde, isoxazole, triazole, antibacterial, molecular docking

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INTRODUCTION

In recent years, click chemistry has become a powerful tool for the synthesis of various biologically active molecules [1–3]. Copper-catalyzed [3+2] cycloaddition is the most popular example of click chemistry and is widely used for the synthesis of triazoles and isoxazoles. 1,2,3-triazoles are the important class of drug discovery heterocycles that can act as bioesters and linkers. 1,2,3-triazole-based compounds have a large number of biological activities such as antimicrobials [4, 5], antioxidant [6], anticancer [7–9], antidiabetic [10, 11], anti-HIV [12] and antimalarial activity [13]. There are several drugs on the market that have a group of 1,2,3-triazole, such as Cefatrizine and Tazobactam, and many more are available in the various phases of clinical trials, such as Carboxyamidotriazole (CAI) and tert-butyl dimethylsilyl spiroaminooxathiole-dioxide (TSAO) (Fig. 1) [14–17].

The isoxazole ring is a component of the structures of many drugs and is a known carrier of pharmacophoretic properties [18]. In this sense, new methods are currently being developed for the production and

functionalization of isoxazoles [19, 20]. Isoxazole is the basic component of several medications, such as zonisamide (anticonvulsant), leflunomide (disease-modifying antirheumatic drug, DMARD), and valdecoxib (COX-2 inhibitor) Fig. 2 [21]. On the other hand, indole derivatives are one of the most promising heterocyclic groups, which have active sites for the treatment of various diseases [22]. Many reports have been published on indole fragments and their derivatives, which may show anticancer [23] and antimicrobial activities [24].

Regarding the development of new protocols for azole synthesis and impressed by the broad spectrum of biological activity of triazole, isoxazole and indole discussed above, we have designed and synthesized isoxazole and isoxazole-triazole derivatives of the indole scaffold as outlined in Scheme 1, Scheme 2, installing triple bonds on the scaffold and clicking new groups while isoxazoles and 1,2,3-triazoles are formed with the Cu-catalyzed reaction. All synthesized compounds were evaluated for their *in vitro* and *in silico* antibacterial activities.

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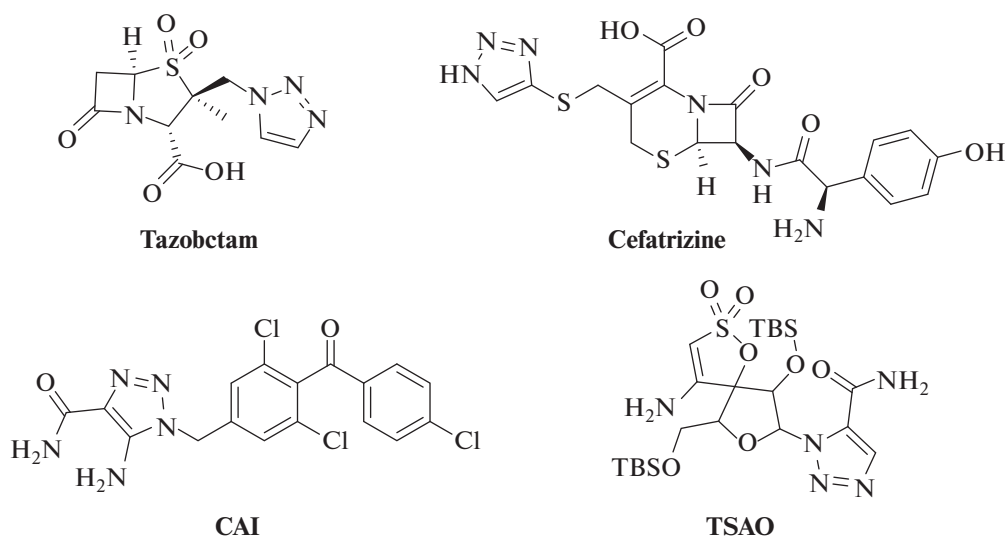


Fig. 1. Some of 1,2,3-triazole ring containing drugs in the market.

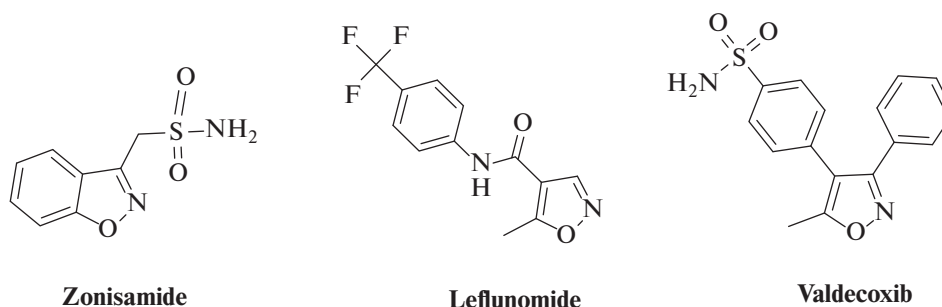


Fig. 2. Structures of isoxazole-congaing drugs.

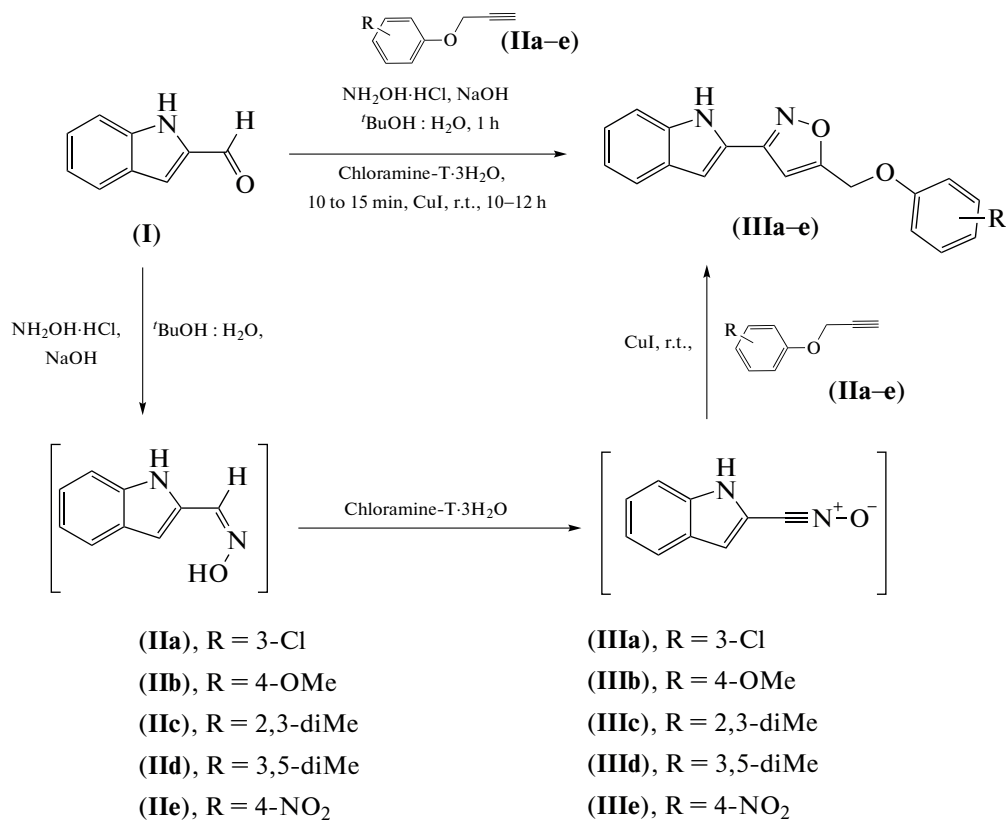
RESULTS AND DISCUSSION

The synthetic approach of targeted indole-isoxazole derivatives (**IIIa–e**) was presented in **Scheme 1**. The indole-2-carbaldehyde (**I**) was converted into the corresponding *in situ* indole-2-carbaldehyde oxime using hydroxyl ammonium chloride and NaOH in t-BuOH:H₂O solvent media at room temperature after 60 min which then consequently converted into corresponding nitrile oxides by the portion wise addition of chloramine-T trihydrate for 10 to 15 minutes. At the end, the 1,3-dipolar cycloaddition reaction between *in situ* formed nitrile oxide and different alkynes (**IIa–e**) in the presence of Cu(I) catalyst has provided the corresponding regioselective indole-isoxazole derivatives in good yields.

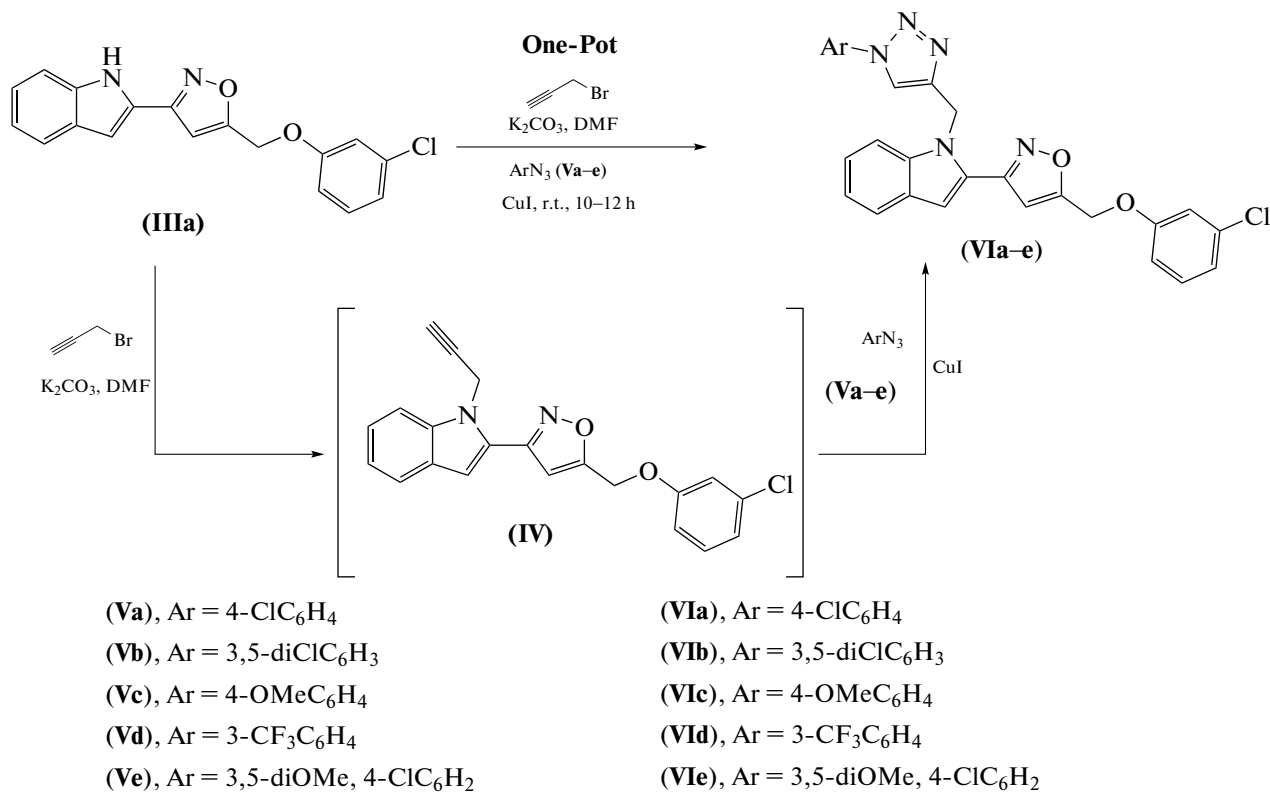
One-pot synthesis of isoxazole-indole-triazole hybrids (**VIa–e**) was performed according to the literature procedure [6]. The 1,3-dipolar cycloaddition of 5-((3-chlorophenoxy)methyl)-3-(1*H*-indol-2-yl)isoxazole (**IIIa**) with propargyl bromide and different aryl azides in the presence of CuI and K₂CO₃ in DMF at

room temperature yielded 5-((3-chlorophenoxy)methyl)-3-(1-((1-(aryl)-1*H*-1,2,3-triazol-4-yl)methyl)-1*H*-indol-2-yl)isoxazole (**Scheme 2**). The structures of the newly synthesized compounds (**IIIa–e**) and (**VIa–e**) were confirmed by analytical and spectral data (¹H-NMR, ¹³C-NMR, ESI-MS) and elemental (CHN) analysis.

All the spectral and analytical data of the synthesized compounds were in full agreement with the proposed structures and also discussed for a representative compound (**IIIa**). From the ¹H-NMR spectrum, the presence of the signals that appeared at δ 11.25 (s, 1H, -NH), δ 7.95–7.05 (s, 9H, Ar-H), δ 6.80 (s, 1H, Isoxazole-*H*) and δ 5.45 (s, 2H, OCH₂) confirmed the presence of required protons. From the ¹³C-NMR, the presence of carbon signals at 102.89, ppm (Isoxazole-*CH*), and 58.35 ppm (-OCH₂) confirmed the presence of characteristic carbon signals. The presence of [M + H] ion peak at *m/z* 325 in ESI-MS and the elemental analysis (CHN) data (C, 66.51; H, 4.09; N, 8.55) confirmed molecular formula (C₁₈H₁₃ClN₂O₂) of compound (**IIIa**).



Scheme 1. One-pot synthesis of Isoxazole-Indole hybrids (IIIa–e).



Scheme 2. One-pot synthesis of Isoxazole-Indole-Triazolehybrids (VIa–e).

Table 1. *In Vitro* antibacterial activity data of compounds (IIIa–e) and (VIa–e)

Compound	MIC, µg/mL ^a		
	<i>B. subtilis</i>	<i>S. aureus</i>	<i>E. coli</i>
(IIIa)	12.5 ± 0.44	25 ± 0.61	12.5 ± 0.53
(IIIb)	50 ± 0.89	25 ± 0.92	50 ± 0.44
(IIIc)	50 ± 0.78	50 ± 0.89	50 ± 0.28
(IIId)	25 ± 0.83	50 ± 0.48	50 ± 0.77
(IIIe)	25 ± 0.58	25 ± 0.63	50 ± 0.59
(VIa)	12.5 ± 0.41	6.25 ± 0.28	12.5 ± 0.72
(VIb)	6.25 ± 0.45	3.12 ± 0.66	6.25 ± 0.22
(VIc)	50 ± 0.29	50 ± 0.69	25 ± 0.45
(VIId)	3.12 ± 0.22	3.12 ± 0.14	6.25 ± 0.83
(VIE)	12.5 ± 0.29	25 ± 0.73	12.5 ± 0.42
Streptomycin	6.25 ± 0.19	6.25 ± 0.31	6.25 ± 0.20

^aMinimum inhibitory concentration (MIC) (µg/mL), ie, the lowest concentration of the test compound to inhibit the growth of bacteria completely.

Antibacterial Activity

All the newly synthesized compounds (IIIa–e) and (VIa–e) were further investigated for their *in vitro* antibacterial activity against various gram-positive microorganisms, i.e., *B. subtilis* and *S. aureus* and gram-negative microorganism *E. coli* using the broth dilution method [21] using streptomycin as standard drug for the comparison. The minimum inhibitory concentrations (MICs) for all the synthesized compounds were reported in µg/mL and the results are illustrated in Table 1. It is evident from Table 1, that the majority of the tested compounds exerted significant *in vitro* antibacterial activity against almost all the tested bacterial strains with MICs ranging from 3.12 to 12.5 µg/mL.

The antibacterial activity screening results (Table 1) revealed that, compound (VIId) has shown excellent inhibition against *B. subtilis* and *S. aureus*, with MIC value 3.12 µg mL⁻¹, and good inhibition against *E. coli* with MIC value 12.5 and 6.25 µg mL⁻¹, respectively. Similarly, compound (VIb) has shown excellent inhibition against *S. aureus* with MIC value 3.12 µg mL⁻¹ and good inhibition against *B. subtilis* and *E. coli* with MIC value 6.25 µg mL⁻¹, respectively. Compound (VIa) has shown good inhibition against *S. aureus*, with MIC value 6.25 µg mL⁻¹, and moderate against *B. subtilis* and *E. coli* with MIC value 12.5 µg mL⁻¹, respectively. Remaining compounds have shown moderate to weak inhibition against all the tested microorganisms, with MIC values ranging from 12.5 to 50 µg mL⁻¹. Structure–activity relationship of the compounds (IIIa–e) and (VIa–e) revealed that, all the potent analogues which contain indole-triazole-isoxazoles (VIa–e). However, the *in vitro* activity has been improved dramatically in the case of compound

containing both strong withdrawing groups fluoro and chloro phenyl on triazole ring.

In Silico Antibacterial Bioassay

All inhibitors were compared out of ten docking runs. The docking studies revealed that all the synthesized molecules exhibited good to excellent binding energies towards the receptor active pocket ranging from –8.06 to –10.16 kcal mol⁻¹ (Table 2).

All the compounds were energetically favored for *S. AUREUS MURB* active site, and are exhibiting bonds with amino acids of active pocket of the receptor and considered as the best docking poses. Among all the interactions of (IIIe) has three hydrogen bonding interaction with ARG A: 310, ASN A: 80 and SER A: 143 amino acids by two oxygen-atoms and remaining hydrophobic interactions through π – π stacking with aromatic rings to amino acids. Similarly, compound 3b has three hydrogen bonding interaction with ASN A: 80, PRO A: 141 and VAL A: 199 amino acids and remaining hydrophobic interaction through π – π stacking with aromatic ring to amino acid. The best docked orientations of synthesized ligands were shown in Fig. 3. The binding energies, inhibition constants and hydrogen bond interactions of all the compounds were tabulated in Table 2.

CONCLUSION

In conclusion, the synthesis of new isoxazole-indole (IIIa–e) and isoxazole-indole-triazole (VIa–e) hybrids based on 1,3-dipolar cycloaddition of *in situ* generated nitrile oxide with different alkynes and *in situ* generated alkyne and different aryl azides catalysed by Cu(I) has been reported. The newly synthesized hybrids (IIIa–e) and (VIa–e) were evaluated for *in vitro* antibacterial activity and results revealed that the compounds containing fluoro and chloro phenyl on triazole ring (VIId), (VIb) and (VIa) were found to be most active in the present antibacterial activity studies.

EXPERIMENTAL

All the reactants were purchased from the Aldrich chemical company. All the reagents and solvents were purchased from SD. Fine chemicals limited and used without further purification. Thin-layer chromatography (TLC: 60% ethyl acetate in hexane and 40% ethyl acetate in hexane) was performed using Merck silica gel 60F254 pre-coated plates (0.25 mm), and silica gel (particle size 60–120 mesh) was used for column chromatography. ¹H-NMR spectra were recorded on a Varian Gemini 400 MHz spectrometer. ¹³C-NMR spectra were recorded on a Bruker 100 MHz spectrometer. ¹H NMR spectra were reported relative to Me₄Si and residual DMSO. ¹³C NMR was reported relative to DMSO. Mass spectra were recorded on a

Table 2. Autodock binding energies, no. of hydrogen bonds and residues involved in hydrogen bonding interaction of ligands for *S. AUREUS MURB* (PDB ID: 1HSK)

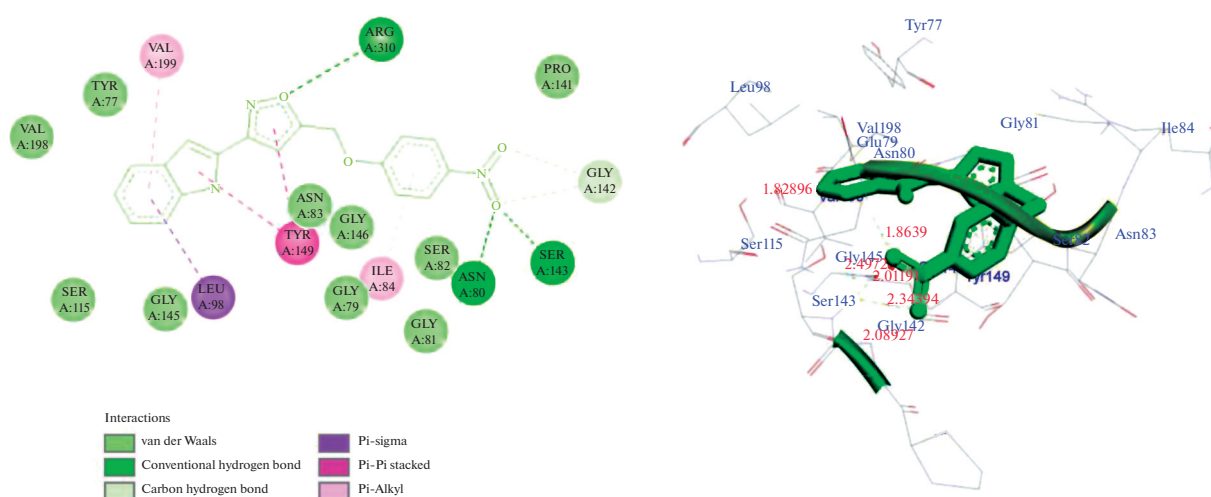
Compound	Binding Energy, kcal/mol	Inhibition Constant, nM	No. of hydrogen bonds	Residues involved in hydrogen bonding	Run
(IIIa)	-9.39	130.54	2	ARG A:310, TYR A:149	10
(IIIb)	-8.82	341.77	2	ASN A:80, PRO A:141	2
(IIIc)	-9.37	135.12	2	ASN A:80, PRO A:141	10
(IIId)	-9.66	83.60	1	SER A:81	7
(IIIe)	-10.16	35.87	3	ARG A:310, ASN A:80, SER A:143	7
(VIa)	-8.24	916.75	0	0	9
(VIb)	-8.06	1.23 μ M	1	ARG A:310,	7
(VIc)	-8.86	321.41	1	HIS A:271	2
(VI d)	-8.81	349.72	0	0	8
(VIe)	-8.36	747.26	1	ARG A:310,	10

Jeol JMC-300 spectrometer (ESI, 70 eV). Elemental analyses were performed on Carlo Erba 106 and PerkinElmer model 240 analyzers. Melting points were determined using a Cintex apparatus and are uncorrected.

General procedure for the synthesis of 5-((aryl)methyl)-3-(1H-indol-2-yl)isoxazole (IIIa–e). 1H-indole-2-carbaldehyde (**I**) (3.44 mmol) was added to a solution of hydroxylamine hydrochloride (5.17 mmol) in 10 mL of 1 : 1 *t*-BuOH : H₂O. To this was added NaOH (5.17 mmol), and after stirring for 1 hour at ambient temperature, TLC analysis indicated that the oxime formation was complete. Chloramine-T (5.17 mmol) was added in small portions over 15 min, followed by CuI (10 mol %). Substituted (prop-2-yn-1-yloxy) benzene (**II**) (5.17 mmol) was added, the pH was adjusted to 6 by the addition of a few drops of 1 M NaOH, and stirring was continued for a further 10–12 h. The reaction mixture was poured into cold

water (50 mL), and 5 mL of dilute NH₄OH was added to remove all copper salts. Isoxazole(**III**) was collected by filtration, redissolved, and passed through a short plug of silica gel (silica gel, 60% ethyl acetate in hexane).

5-((3-chlorophenoxy)methyl)-3-(1H-indol-2-yl)isoxazole (IIIa). Pale yellow solid (82%); mp 119–121°C; ¹H NMR (400 MHz, DMSO) δ : 11.25 (s, 1H, -NH), 7.95 (d, *J* = 8.0 Hz, 1H, Ar-H), 7.75–7.55 (m, 4H, Ar-H), 7.48 (d, *J* = 8.0 Hz, 1H, Ar-H), 7.33–7.20 (m, 2H, Ar-H), 7.18–7.05 (m, 1H, Ar-H), 6.80 (s, 1H, Isoxazole-H), 5.45 (s, 2H, OCH₂); ¹³C NMR (100 MHz, DMSO) δ : 144.04, 139.52, 138.06, 135.62, 134.00, 130.93, 130.69, 128.95, 128.66, 126.81, 124.09, 122.23, 120.81, 114.60, 110.41, 102.89, 58.35; ESI-MS *m/z*: 325 [M + H]. Anal. Cal for C₁₈H₁₃ClN₂O₂: C, 66.57; H, 4.03; N, 8.63; found C, 66.51; H, 4.09; N, 8.55.

**Fig. 3.** 2D & 3D interaction diagram for the ligand (**IIIe**) with *S. AUREUS MURB*.

3-(1*H*-indol-2-yl)-5-((4-methoxyphenoxy)methyl)-isoxazole (IIIb). Whitesolid (78%); mp 123–125°C; ¹H NMR (400 MHz, DMSO)δ: 11.25 (s, 1H, -NH), 7.80 (d, *J* = 8.0 Hz, 2H, Ar-H), 7.68 (d, *J* = 8.0 Hz, 1H, Ar-H), 7.46 (d, *J* = 8.0 Hz, 1H, Ar-H), 7.32–7.22 (m, 2H, Ar-H), 7.20 (d, *J* = 8.0 Hz, 2H, Ar-H), 7.11 (t, *J* = 4.0 Hz, 1H, Ar-H), 6.74 (s, 1H, Isoxazole-*H*), 5.46 (s, 2H, O-CH₂), 3.83 (s, 3H, O-CH₃); ESI-MS *m/z*: 321 [M + H]. Anal. Cal for C₁₉H₁₆N₂O₃; C, 71.24; H, 5.03; N, 8.74; found C, 71.29; H, 5.08; N, 8.66.

5-((2,3-dimethylphenoxy)methyl)-3-(1*H*-indol-2-yl)-isoxazole (IIIc). White solid (65%); mp 110–112°C; ¹H NMR (400 MHz, DMSO)δ: 11.24 (s, 1H, -NH), 7.72 (d, *J* = 8.0 Hz, 1H, Ar-H), 7.52–7.36 (m, 2H, Ar-H), 7.31–7.21 (m, 4H, Ar-H), 7.17–7.01 (m, 1H, Ar-H), 6.74 (s, 1H, Isoxazole-*H*), 5.44 (s, 2H, O-CH₂), 2.37 (s, 3H, Ar-CH₃), 1.97 (s, 3H, Ar-CH₃); ¹³C NMR (100 MHz, DMSO) δ: 143.50, 139.97, 138.99, 137.74, 133.69, 132.67, 128.20, 128.16, 127.69, 126.30, 125.46, 123.59, 121.72, 114.08, 109.89, 102.40, 58.98, 21.36, 15.40; ESI-MS *m/z*: 319 [M + H]. Anal. Cal for C₂₀H₁₈N₂O₂; C, 75.45; H, 5.70; N, 8.80; found C, 75.51; H, 5.61; N, 8.72.

5-((3,5-dimethylphenoxy)methyl)-3-(1*H*-indol-2-yl)-isoxazole (IIIId). White solid (76%); mp 115–117°C; ¹H NMR (400 MHz, DMSO)δ: 11.25 (s, 1H, -NH), 7.80–7.35 (m, 4H, Ar-H), 7.30–7.00 (m, 4H, Ar-H), 6.72 (s, 1H, Isoxazole-*H*), 5.44 (s, 2H, O-CH₂), 2.34 (s, 6H, 2Ar-CH₃); ¹³C NMR (100 MHz, DMSO) δ: 141.29, 139.41, 138.33, 131.97, 128.56, 126.72, 124.86, 123.99, 122.14, 119.64, 114.50, 110.32, 102.78, 58.40, 22.70; ESI-MS *m/z*: 319 [M + H]. Anal. Cal for C₂₀H₁₈N₂O₂; C, 75.45; H, 5.70; N, 8.80; found C, 75.52; H, 5.76; N, 8.73.

3-(1*H*-indol-2-yl)-5-((4-nitrophenoxy)methyl)-isoxazole (IIIe). Yellow solid (71%); mp 134–136°C; ¹H NMR (400 MHz, DMSO)δ: 11.26 (s, 1H, -NH), 8.23 (d, *J* = 8.0 Hz, 2H, Ar-H), 8.01 (d, *J* = 8.0 Hz, 2H, Ar-H), 7.72 (d, *J* = 8.0 Hz, 1H, Ar-H), 7.48 (d, *J* = 8.0 Hz, 1H, Ar-H), 7.30–7.25 (m, 1H, Ar-H), 7.23 (s, 1H, Ar-H), 7.21–7.06 (m, 1H, Ar-H), 6.80 (s, 1H, Isoxazole-*H*), 5.48 (s, 2H, O-CH₂); ESI-MS *m/z*: 336 [M + H]. Anal. Cal for C₁₈H₁₃N₃O₄; C, 64.48; H, 3.91; N, 12.53; found C, 64.43; H, 3.86; N, 12.58.

Synthesis of 5-((3-chlorophenoxy)methyl)-3-(1-(prop-2-yn-1-yl)-1*H*-indol-2-yl)isoxazole (IV). A mixture of 5-((3-chlorophenoxy)methyl)-3-(1*H*-indol-2-yl)isoxazole (IIIa) (1.54 mmol) and K₂CO₃ (4.62 mmol) in *N,N*-dimethylformamide (DMF) (15 mL) was treated with propargyl bromide (2.00 mmol) at room temperature for 6h. After completion of the reaction by Thin layer chromatography (TLC), the reaction mixture was poured carefully into ice-cold water (50 mL). The resulted solid was filtered off, washed with excess water and dried under vacuum for 2 h. Pale yellow solid (82%); mp 113–115°C; ¹H NMR (400 MHz, DMSO)δ: 7.95–7.84 (m, 1H, Ar-H), 7.75–

7.52 (m, 4H, Ar-H), 7.48 (d, *J* = 8.0 Hz, 1H, Ar-H), 7.31–7.23 (m, 2H, Ar-H), 7.18–7.06 (m, 1H, Ar-H), 6.78 (s, 1H, Isoxazole-*H*), 5.45 (s, 2H, O-CH₂), 4.26 (d, *J* = 8.0 Hz, 2H, N-CH₂), 3.30 (t, *J* = 4.0 Hz, 1H, -CH); ESI-MS *m/z*: 363 [M + H]. Anal. Cal for C₂₁H₁₅ClN₂O₂; C, 69.52; H, 4.17; N, 7.72; found C, 69.66; H, 4.12; N, 7.68.

General procedure for the synthesis of 5-((3-chlorophenoxy)methyl)-3-(1-((1-(aryl)-1*H*-1,2,3-triazol-4-yl)methyl)-1*H*-indol-2-yl)isoxazole (VIa-e). To a mixture of 5-((3-chlorophenoxy)methyl)-3-(1*H*-indol-2-yl)isoxazole (IIIa) (1.54 mmol), propargyl bromide (2.00 mmol), substituted 1-azidobenzene (V) (2.20 mmol), and K₂CO₃ (6.00 mmol) in DMF (20 mL), 10 mol% of CuI was added and stirred at room temperature for 10–12 h. After the completion of the reaction (monitored by TLC), the reaction mixture was filtered through a celite pad and diluted with ice-cold water (20 mL) and the product was extracted with ethyl acetate (2 × 20 mL). The combined organic layer was dried over anhydrous sodium sulfate, evaporated under vacuum and the crude product obtained was purified by column chromatography (silica gel, 40% ethyl acetate in hexane) to afford (VI).

5-((3-chlorophenoxy)methyl)-3-(1-((1-(4-chlorophenyl)-1*H*-1,2,3-triazol-4-yl)methyl)-1*H*-indol-2-yl)isoxazole (VIa). Pale yellow solid (78); mp 148–150°C; ¹H NMR (400 MHz, DMSO)δ: 8.25 (s, 1H, triazole-*H*), 7.80–7.76 (m, 3H, Ar-H), 7.73–7.68 (m, 3H, Ar-H), 7.48–7.34 (m, 4H, Ar-H), 7.26–7.20 (m, 2H, Ar-H), 7.16–7.10 (m, 1H, Ar-H), 6.79 (s, 1H, Isoxazole-*H*), 5.55 (s, 2H, O-CH₂), 5.26 (s, 2H, N-CH₂); ¹³C NMR (100 MHz, DMSO) δ: 146.73, 145.18, 145.00, 144.95, 140.91, 131.52, 131.40, 127.54, 127.33, 124.87, 124.42, 123.08, 122.89, 122.08, 121.98, 113.48, 113.25, 102.42, 58.61, 30.89; ESI-MS *m/z*: 516 [M + H]. Anal. Cal for C₂₇H₁₉Cl₂N₅O₂; C, 62.80; H, 3.71; N, 13.56; found C, 62.73; H, 3.68; N, 13.49.

5-((3-chlorophenoxy)methyl)-3-(1-((1-(3,5-dichlorophenyl)-1*H*-1,2,3-triazol-4-yl)methyl)-1*H*-indol-2-yl)isoxazole (VIb). Yellow solid (69%); mp 161–163°C; ¹H NMR (400 MHz, DMSO)δ: 8.24 (s, 1H, triazole-*H*), 7.85–7.65 (m, 2H, Ar-H), 7.60–7.48 (m, 2H, Ar-H), 7.46–7.29 (m, 5H, Ar-H), 7.23–7.00 (m, 3H, Ar-H), 6.74 (s, 1H, Isoxazole-*H*), 5.53 (s, 2H, O-CH₂), 5.25 (s, 2H, N-CH₂); ¹³C NMR (100 MHz, DMSO) δ: 149.31, 149.21, 148.89, 146.39, 140.01, 139.20, 132.80, 132.44, 131.04, 127.71, 127.58, 121.44, 121.26, 102.88, 58.63, 30.70; ESI-MS *m/z*: 550 [M + H]. Anal. Cal for C₂₇H₁₈Cl₃N₅O₂; C, 58.87; H, 3.29; N, 12.71; found C, 58.81; H, 3.23; N, 12.66.

5-((3-chlorophenoxy)methyl)-3-(1-((1-(4-methoxyphenyl)-1*H*-1,2,3-triazol-4-yl)methyl)-1*H*-indol-2-yl)isoxazole (VIc). White solid (0.66g, 76%); mp 125–127°C; ¹H NMR (400 MHz, DMSO)δ: 8.27 (s, 1H, triazole-*H*), 7.90–7.60 (m, 6H, Ar-H), 7.45–7.30 (m, 2H, Ar-H), 7.20–7.01 (m, 5H, Ar-H), 6.75 (s, 1H,

Isoxazole-*H*), 5.54 (s, 2H, O-CH₂), 5.24 (s, 2H, N-CH₂), 3.83 (s, 3H, O-CH₃); ESI-MS m/z: 512 [M + H]. Anal. Cal for C₂₈H₂₂ClN₅O₃; C, 65.69; H, 4.33; N, 13.68; found C, 65.63; H, 4.28; N, 13.63.

5-((3-chlorophenoxy)methyl)-3-(1-((1-(3-(trifluoromethyl)phenyl)-1H-1,2,3-triazol-4-yl)methyl)-1H-indol-2-yl)isoxazole (VIId). Yellow solid (71); mp 162–164°C; ¹H NMR (400 MHz, DMSO)δ: 8.77 (s, 1H, triazole-*H*), 8.40–8.07 (m, 4H, Ar-*H*), 7.96–7.60 (m, 6H, Ar-*H*), 7.50–7.30 (m, 2H, Ar-*H*), 7.20–7.10 (m, 1H, Ar-*H*), 6.80 (s, 1H, Isoxazole-*H*), 5.59 (s, 2H, O-CH₂), 5.25 (s, 2H, N-CH₂); ¹³C NMR (100 MHz, DMSO) δ: 149.64, 142.05, 139.60, 139.54, 137.98, 137.82(d), 134.89, 134.82 (d), 134.67, 134.58, 132.96, 131.35, 131.27, 128.44, 126.92, 117.56, 117.25, 102.92, 58.73, 30.53; ESI-MS m/z: 550 [M + H]. Anal. Cal for C₂₈H₁₉ClF₃N₅O₂; C, 61.15; H, 3.48; N, 12.74; found C, 61.19; H, 3.42; N, 12.67.

3-(1-((1-(4-chloro-3,5-dimethoxyphenyl)-1H-1,2,3-triazol-4-yl)methyl)-1H-indol-2-yl)-5-((3-chlorophenoxy)methyl)isoxazole (VIe). Yellow solid (63%); mp 173–175°C; ¹H NMR (400 MHz, DMSO)δ: 8.20 (s, 1H, triazole-*H*), 7.95–7.80 (m, 2H, Ar-*H*), 7.75–7.70 (m, 1H, Ar-*H*), 7.49–7.39 (m, 2H, Ar-*H*), 7.35–7.20 (m, 4H, Ar-*H*), 7.09 (s, 2H, Ar-*H*), 6.80 (s, 1H, Isoxazole-*H*), 5.56 (s, 2H, O-CH₂), 5.26 (s, 2H, N-CH₂), 3.84 (s, 3H, O-CH₃), 3.80 (s, 3H, O-CH₃); ESI-MS m/z: 576 [M + H]. Anal. Cal for C₂₉H₂₃Cl₂N₅O₄; C, 60.43; H, 4.02; N, 12.15; found C, 60.51; H, 4.08; N, 12.10.

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SUPPLEMENTARY MATERIALS

Supplementary materials are available for this article at...

COMPLIANCE WITH ETHICAL STANDARDS

This article does not contain any studies involving human participants performed by any of the authors and does not contain any studies involving animals performed by any of the author.

CONFLICT OF INTERESTS

The authors report no conflicts of interest.

SUPPLEMENTARY INFORMATION

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Influence of Co(III) Polypyridyl Complexes on Luminescence Behavior, DNA Binding, Photocleavage, Antimicrobial Activity and Molecular Docking Studies

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Abstract

A new ligand FIPB = 5-(1*H*-imidazo[4,5-*f*][1,10]phenanthrolin-2-yl)furan-2-yl-2-boronic acid, having three cobalt(III) polypyridyl complexes [Co(phen)₂(FIPB)]³⁺ (**1**) {FIPB = 5-(1*H*-imidazo[4,5-*f*][1,10]phenanthrolin-2-yl)furan-2-yl-2-boronic acid}, (phen = 1,10-Phenanthroline), [Co(bpy)₂(FIPB)]³⁺ (**2**) (bpy = 2,2'-bipyridyl), [Co(dmb)₂(FIPB)]³⁺ (**3**) (dmb = 4, 4'-dimethyl 2, 2'-bipyridine) have been synthesized and characterized by elemental analysis, ES-MS, ¹H-NMR, ¹³C-NMR, UV-Vis and FTIR. Their DNA binding behavior has been explored by various spectroscopic titrations and viscosity measurements, which indicated that all the complexes bind to calf thymus DNA by means of intercalation with different binding strengths. The binding properties of these all three complexes towards calf-thymus DNA (CT-DNA) have been investigated by UV-visible, emission spectroscopy and viscosity measurements. The experimental results suggested that three Co(III) complexes can intercalate into DNA base pairs, but with different binding affinities. Photo induced DNA cleavage studies have been performed and results indicate that three complexes efficiently cleave the pBR322-DNA in different forms. The three synthesized compounds were tested for antimicrobial activity by using *Staphylococcus aureus* and *Bacillus subtilis* organisms, these results indicated that complex **1** was more activity compared to other two complexes against both tested microbial strains. The in vitro cytotoxicity of these complexes was evaluated by MTT assay, and complex **1** shows higher cytotoxicity than complex **2** and **3** on *HeLa* cells.

Keywords DNA binding · Co(III) complexes · Polypyridyl complexes · Gel electrophoresis

Introduction

Metal-based drugs play a significant role in the history of medicinal chemistry [1]. Several excellent reviews describing novel transition metal drugs have shown the advantages over traditional organic molecules, such as ready structural modification, rich photo-physical and electrochemical properties, etc., [2–6]. Till today, many transition metal complexes have been reported to have a number of excellent

biopharmaceutical activities, and many of them have been applied in clinical practice. Basically, metallic drug research covers many aspects, such as anti-cancer drugs, anti-diabetic drugs, anti-parasitic drugs, and anti-bacterial drugs [7]. The metal complexes are capable of binding or cleaving DNA and proteins [8–12], exhibiting catalytic activity towards metal polypyridyl complexes are the current interest. DNA plays a significant role in the life process, because it bears heritage information and instructs the biological synthesis of proteins and enzymes through the replication and transcription of genetic information in living cells. DNA is a particularly good target for metal complexes as it offers a wide variety of potential metal binding sites [13–16].

Cobalt(III) complexes have been widely investigated in coordination chemistry and biochemistry [17] owing to their therapeutic activities [18]. Copper and cobalt are bioessential metals in all living systems which show antifungal and antibacterial properties against several pathogenic fungi and

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bacteria depending on the reaction with the central DNA system [19]. The binding of fluorescent polycyclic molecules to DNA can be conveniently investigated by a variety of techniques, including absorption and fluorescence spectroscopic methods because their absorption and emission properties significantly change on complex formation [20]. Recently, several mixed ligand complexes of ruthenium(II) and cobalt(III) have also been reported [21, 24, 26–28]. In this article, we report synthesis, characterisation of three new Co(III) polypyridyl complexes(1–3), influence of these complexes with DNA binding by UV-Visible spectroscopy, Fluorescence spectroscopy and viscosity measurement. Molecular docking studies were also performed and these results are comparable with the experimental results. The photocleavage of pBR322 DNA using these complexes was also reported. Antimicrobial studies were performed with different microbes.

Experimental Section

Materials

All the solvents were purified before use, as per standard procedures [29]. The starting materials $\text{CoCl}_2 \cdot 6\text{H}_2\text{O}$, 1, 10-Phenanthroline, 2, 2' bipyridine, 4, 4' dimethyl 2, 2' bipyridine and 5-Formylfuran-2-yl-2-boronic acid were purchased from sigma. Double distilled water was used for preparing various buffers. CT (Calf Thymus) DNA was purchased from Aldrich, its solution gives a ratio of UV absorbance at 260 and 280 nm of 1.8–1.9, indicating that the DNA was sufficiently free of protein [30], Supercoiled pBR322 plasmid DNA (stored at $-20\text{ }^\circ\text{C}$) was obtained from Fermentas life sciences, agarose (Genei) from Sigma.

Analytical Measurements

Bruker 400 MHz NMR spectrometer with high resolution probe Z was used for NMR studies, sample was dissolved in $\text{DMSO}-d_6$ and TMS (^1H and ^{13}C) is used as reference. Elemental analysis carried out with Perkin-Elmer 240 elemental analyzer for Micro analysis (C, H and N). FTIR data is recorded as KBr disks on a Perkin-Elmer FT-IR-1605 spectrometer. UV-Visible spectra were recorded with Shimadzu spectrophotometer (Model-UV 2610) spectrophotometer. Luminescence measurements were carried out on Cary Eclipse spectrofluorometer.

Synthesis and Characterization

Compounds 1, 10-phenanthroline-5, 6-dione [31], $\text{cis}[\text{Co}(\text{phen})_2\text{Br}_2]\text{Br} \cdot 2\text{H}_2\text{O}$, $\text{cis}[\text{Co}(\text{bpy})_2\text{Br}_2]\text{Br} \cdot 2\text{H}_2\text{O}$ and $\text{cis}[\text{Co}(\text{dmb})_2\text{Br}_2]\text{Br} \cdot 2\text{H}_2\text{O}$ [32] were synthesized according

to methods available in the literature. Synthetic scheme of Co(III) complexes shown in Scheme 1.

Preparation of FIPB Ligand

FIPB = 5-(1*H*-imidazo[4,5-*f*][1,10]phenanthrolin-2-yl)furan-2-yl-2-boronic acid was prepared by condensation of 1,10-phenanthroline-5,6-dione (0.5 g 2.38 mmol) and 5-Formyl-2-thiopheneboronic acid (0.497 g 3.55 mmol), Ammonium acetate (3.88 g, 50 mM), dissolved in glacial acetic acid (10 mL) were refluxed together for 4 h as per Steck and Day [33], and then cooled to room temperature and diluted with water. Drop wise addition of ammonia gave a yellow precipitate which was collected, washed with water, dried, and purified by recrystallization from pyridine- H_2O (9:1, v/v); Yield: 0.51 g (73%). Anal. Data for $\text{C}_{17}\text{H}_{11}\text{BN}_4\text{O}_3$ Calc: C, 61.85; H, 3.36; N, 16.97. Found: C, 61.62; H, 3.21; N, 16.47. Es + -MS Cal: 330, Found: 330.1. ^1H NMR (400 MHz, ppm, $\text{DMSO}-d_6$, TMS) δ 8.91(d, 2H), 7.98(d, 2H), 7.80(t, 2H), 6.77(s, 2H), 1.80(s, 2H).

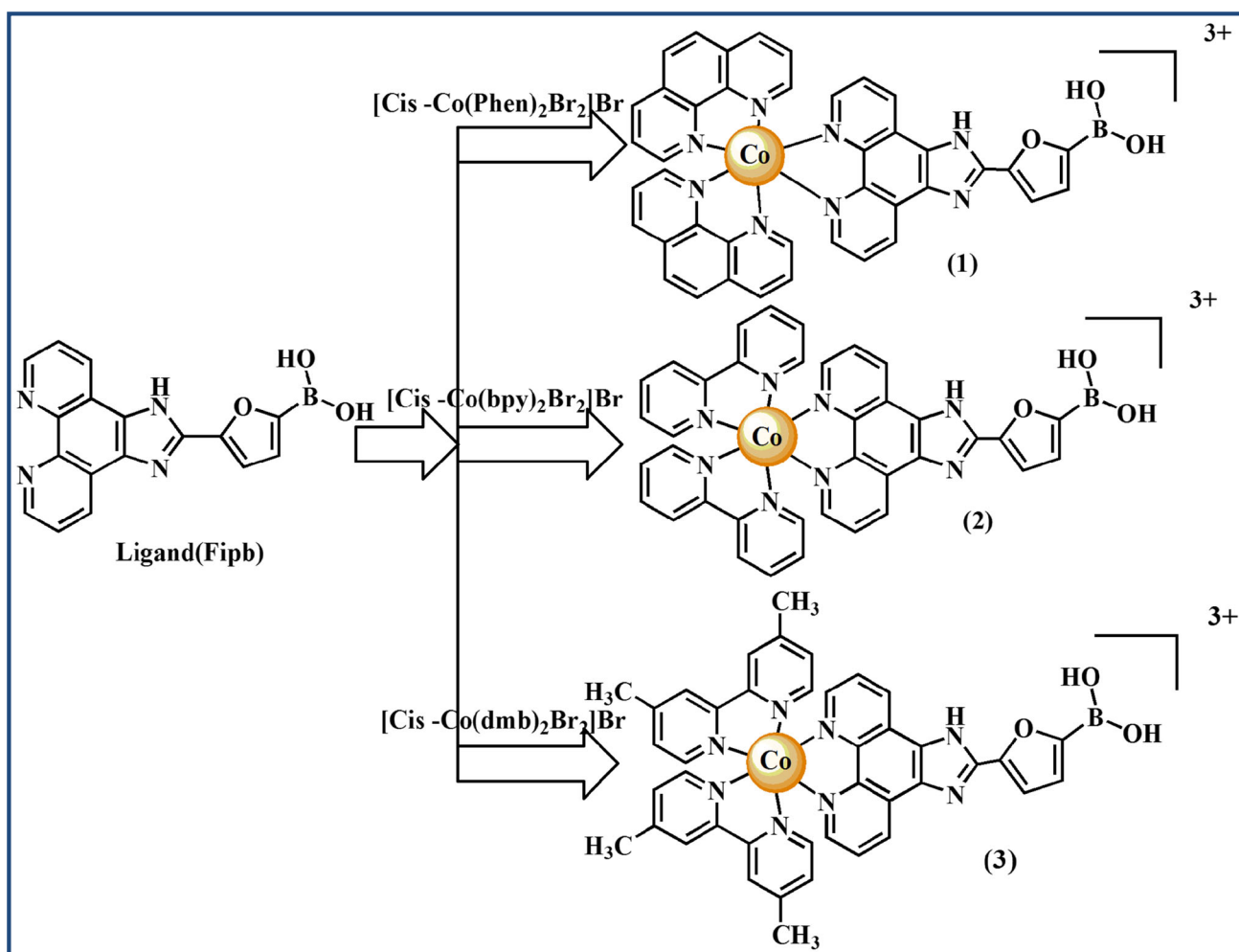
Synthesis of the $[\text{Co}(\text{L-L})_2\text{FIPB}]^{3+}$ Complexes

The metal complexes of the type $[\text{Co}(\text{L-L})_2\text{TIPB}]^{3+}$ where L = (Polypyridyl ligand) 1, 10-phenanthroline (phen), 2, 2-bipyridine (bpy) and 4, 4-dimethyl- 2, 2-bipyridine (dmb), were prepared by mixing the $[\text{Co}(\text{phen})_2\text{Br}_2]^{3+}$, $[\text{Co}(\text{bpy})_2\text{Br}_2]^{3+}$ and $[\text{Co}(\text{dmb})_2\text{Br}_2]^{3+}$ (0.25 mM) and FIPB (0.495, 1.5 mM) in 20.0 mL of ethanol and refluxed for 6 h under inert condition. Cooled the solution to room temperature and added saturated aq. solution of NaClO_4 . The obtained light yellowish solid was cooled and washed with small amount of water and then dried under vacuum. The metal complexes prepared, purified and characterized by mass, FTIR, ^1H & ^{13}C NMR.

$[\text{Co}(\text{phen})_2\text{FIPB}]^{3+}$ (1): Yield = 79%, Elemental Analysis for $\text{C}_{41}\text{H}_{26}\text{BN}_8\text{O}_3\text{Co}$, Calc. C: 65.71; H: 3.63; N: 14.95, Found: C: 65.52; H: 3.51; N: 14.74. Es + -MS Cal: 749, Found: 749.4. ^1H NMR (400 MHz, ppm, $\text{DMSO}-d_6$, TMS): δ 9.04(d, 4H), 8.92(d, 2H), 8.08(d, 4H), 8.02(d, 6H), 7.84(s, 4H), 7.27(t, 6H), 6.80(s, 2H), 1.91(s, 2H).

$[\text{Co}(\text{bpy})_2\text{FIPB}]^{3+}$ (2): Yield = 74%, Elemental Analysis for $\text{C}_{37}\text{H}_{26}\text{BN}_8\text{O}_3\text{Co}$, Calc. C: 63.36; H: 3.88; N: 15.98, Found: C: 63.20; H: 3.59; N: 15.63. Es + -MS Cal: 701, Found: 701.4. ^1H NMR (400 MHz, ppm, $\text{DMSO}-d_6$, TMS): δ 9.09(d, 2H), 8.62(d, 4H), 8.33(d, 4H), 7.82(d, 2H), 7.47(t, 4H), 7.25(t, 2H), 7.12(t, 4H), 6.99(s, 2H), 1.92(s, 2H).

$[\text{Co}(\text{dmb})_2\text{FIPB}]^{3+}$ (3): Yield = 72%, Elemental Analysis for $\text{C}_{41}\text{H}_{34}\text{BN}_8\text{O}_3\text{Co}$, Calc. C: 65.01; H: 4.66; N: 14.79, Found: C: 64.82; H: 4.41; N: 14.57. Es + -MS Cal: 757, Found: 757.5. ^1H NMR (400 MHz, ppm, $\text{DMSO}-d_6$, TMS): δ 8.99(d, 2H), 8.64(d, 4H), 8.42(s, 4H), 7.76(d, 2H), 7.63(t, 2H), 7.34(d, 4H), 7.17(s, 2H), 2.62(s, 12H), 1.92(s, 2H).



Scheme 1 Synthetic route and Structures of Co(III) Polypyridyl complexes; $[\text{Co}(\text{phen})_2\text{FIPB}]^{3+}$ (1), $[\text{Co}(\text{bpy})_2\text{FIPB}]^{3+}$ (2) and $[\text{Co}(\text{dmb})_2\text{FIPB}]^{3+}$ (3).

DNA Binding Studies

All experiments involving the interaction with DNA were conducted at room temperature. The absorption and luminescence titrations were performed in Tris-HCl buffer. Absorption titration experiments were performed by maintaining a constant metal complex concentration (40 μM) and varying the nucleotide concentration (0–100 μM) in the Tris-HCl buffer. After each addition of DNA to the metal complex, the resulting solution was allowed to equilibrate at 25 $^\circ\text{C}$ for 5 min, after which absorption spectra were recorded. The change in absorbance at MLCT band was recorded after each addition of DNA solution. The intrinsic binding constant K_b was determined according to the following equation [34].

$$[\text{DNA}]/(\varepsilon_a - \varepsilon_f) = [\text{DNA}]/(\varepsilon_b - \varepsilon_f) + 1/[K_b(\varepsilon_b - \varepsilon_f)]$$

where $[\text{DNA}]$ is the concentration of DNA in base pairs, ε_a , ε_b and ε_f correspond to the apparent absorption coefficient $A_{\text{obsd}}/[\text{complex}]$ the extinction coefficient for the free cobalt

complex and the extinction coefficient for the cobalt complex in the fully bound form respectively. In plots of $[\text{DNA}]/(\varepsilon_a - \varepsilon_f)$ versus $[\text{DNA}]$, K_b is given by the ratio of slope to the intercept

Emission titration experiments were performed by using a fixed metal complex concentration (20 μM) to which increments (0–120 μM) of the stock DNA solution were added. After the addition of DNA to the metal complex, the resulting solution was allowed to equilibrate for 5 min at room temperature before being excited in their intense metal to ligand charge transfer band between 420 and 430 nm, and the emission is measured at 370–500 nm. The fraction of the ligand bound was calculated from the relation $C_b = C_t[(F - F_0)/(F_{\text{max}} - F_0)]$. Where C_t is the total complex concentration, F is the observed fluorescence emission intensity at a given DNA concentration, F_0 is the intensity in the absence of DNA and F_{max} is when the complex is fully bound to DNA. Binding constant (K_b) was obtained from a modified Scatchard equation [35], binding data were cast into the Scatchard plot of r/C_f vs r , where r is the $C_b/[\text{DNA}]$ and C_f is the concentration of free complex. In order to decrease the inner filter effect, the

fluorescence intensities used in this study were all corrected for absorption of the exciting light and reabsorption of emitted light using the formula

$$F_{\text{cor}} = F_{\text{obs}} e^{(A_{\text{ex}}+A_{\text{em}})/2}$$

where F_{cor} and F_{obs} are the fluorescence intensities corrected and observed, A_{ex} and A_{em} are the absorption of the system at excitation and emission wavelength, respectively [36]. Steady-state quenching experiments were conducted by adding varying concentration of ferrocyanide to the solution of cobalt(III) complex in the presence and absence of DNA.

Viscosity experiments were carried out using BPE-buffer (6mMNa₂HPO₄, 2 mM NaH₂PO₄, 1 mM Na₂EDTA, pH = 7). Flow time was measured with a digital stopwatch and every sample was tested three times to get an average calculated time. The data were presented as $(\eta/\eta_0)^{1/3}$ vs the concentration of [Co(III)]/[DNA], where η and η_0 are the viscosities of DNA in the presence and absence of compound.

Molecular Docking Studies

Molecular mechanics (MM) has been used for conformational search and analysis [37, 38]. The conformational analysis of a pair of isomeric cobalt(III) hexamine cage complexes, where in the bond distances were predicted to an accuracy of order 0.01 Å using a well balanced MM force field for transition metal complexes [39–42].

Molecular modeling studies were carried out using Hyper Chem 7.5 software [43]. The 3D structures of complexes 1–3 were built using the drawing tools of the Hyper Chem model builder. Figure 6 shows 3D structures of complexes 1–3 as previous protocols [44, 45]. The 3D structure of the complex is subjected to a combination of optimization methods to search the potential energy matrix based on the contributions of a stretch (E_{BL}), bending (E_{BA}), dihedrals (E_{DA}), Vander Waals (E_{vdw}) and electrostatic (E_{EE}) interactions to the molecular energy (Eq. 2). A combination of optimization methods was used to search for the potential energy surface for energy minima.

$$E_{\text{Total}} = E_{\text{BL}} + E_{\text{BA}} + E_{\text{DA}} + E_{\text{vdw}} + E_{\text{SBI}} + E_{\text{EE}}$$

The conjugate gradient method was chosen for the molecular mechanics calculation to obtain energy minima with the AMBER force field. Geometric optimization is carried out by Polak–Ribiere algorithm [46]. Unit final convergence criteria of 1×10^{-5} K.cal/mol per Å are obtained to get an optimized 3D conformer of the metal complex.

Docking Studies

Patch dock server tool was used to perform docking calculations between the metal complexes (ligand) and B–DNA (Receptor) sequence. The input used for the docking is the B-DNA sequence 5'-D(AP CP CP GP AP CP GP TP CP GP GP T)-3' is obtained from Protein Data Bank (PDB id:423D) at a resolution of 1.6Å and the 3D conformer of the metal complexes built using Hyper Chem 7.5 are used. The receptor is prepared by deleting all the heteroatoms including water, Mg²⁺ ion and the polar hydrogen atoms were added.

The PDB files of both DNA and metal complexes were uploaded. The program parameters were set to RMSD of 4Å and all other parameters were at default settings. Patch dock results were obtained as a set of scoring functions based on the shape complementarity and the ACE, the atomic desolvation energy of the transformed complex is evaluated. The ACE desolvation score is based on the sum of the ACE scores of all ligand atom-receptor atom pairs in contact.

Gel Electrophoresis

Photocleavage experiments were studied by gelelectrophoresis with supercoiled pBR322 DNA. TAE-buffer (pH 8.0, 40 mM Tris-base, 20mMacetic acid, 1 mM EDTA) was used for Supercoiled pBR322 DNA (0.1 mg/mL) was treated with cobalt complexes (1–3), and the mixtures were irradiated at 365 nm for 1 h. The samples were then analyzed by 0.8% agarose gel electrophoresis at 50 V for 2 h. The gel was stained with 4 mL (from 1 mg/100 mL) ethidium bromide (EtBr) and photographed under UV light.

Antimicrobial Activity

The antimicrobial activity of the complexes was studied against *Staphylococcus aureus* and *Bacillus subtilis*. Each of the Cobalt(III) complex was dissolved in DMSO at a concentration of 1 mg/mL. Paper discs of Whatman filter paper no. 1 were sterilized in an autoclave. The paper disks were saturated with 10mL of the complex and were placed in the petri dishes containing LB (Luria Bertini) agar media inoculated with *Staphylococcus aureus* and *Bacillus subtilis* separately. The petri dishes were incubated at 37 °C and the zone inhibitions were recorded after 24 h. The results were also compared with standard antibacterial drug Ampicillin at the same concentration.

Cytotoxicity Assay

The cytotoxicity of compounds was evaluated on *HeLa* cells. Cells were exposed for 24 h to compounds using MTT assay.

Cell lines growing exponentially were added to 96well plates at a density of 4×10^4 per well after counting on hemocytometer. Stock solution (1000 μM) of compounds was prepared by dissolving it in DMSO and was further diluted with DMEM media to the required concentration. Concentrations of 2.5–100 μM were added to wells ensuring equal volumes across the plates in triplicates. Cell number/proliferation was measured after 24 h of incubation using standard MTT assay. The cells exhibited dose-dependent growth inhibitory effect against the tested cell lines and IC 50 values were calculated.

Results and Discussion

Synthesis and Characterization

We synthesized three complexes as their perchlorate salts. A detail description of synthesis and characterization is given in experimental section. The infrared spectra of **1–3** showed broad band ranges from 3415, 1658 and 1425 cm^{-1} represents N-H, C-N and C-C frequency respectively, the frequency of Co-N appeared at around 628 cm^{-1} . Which are on the lower frequency side relative to the frequency values obtained for the free ligand indicates the complexation. ^1H and ^{13}C [^1H] NMR of **1–3** resonated in the aromatic region between δ 6.80–9.09 and δ 115–155 which were attributed to the presence of aromatic protons and carbons respectively.

Absorption Titration

The interactions of complexes **1–3** with CT-DNA were investigated using absorption spectroscopy. The titrations were done with varying concentrations of DNA, at constant concentration of the compounds. The absorption spectra of complex-**1** in the absence and presence of CT-DNA at constant concentration is given in Fig. 1. These spectral characteristics suggested that they can interact with DNA that involves a stacking interaction between the aromatic chromophore and the base pairs of DNA. In order to compare the DNA binding affinities quantitatively, their intrinsic binding constant K_b was obtained by monitoring the changes in absorbance at 342, 338 and 340 nm for **1**, **2** and **3** respectively with increasing concentration of DNA. As DNA concentration is altered at 295 nm, the absorbance remains same. This is called an isobestic point as shown in Fig. 1. Binding constant values for **1–3** are 4.9×10^5 , 4.6×10^5 and $4.1 \times 10^5 \text{ M}^{-1}$. The difference in binding constants may be attributed to their ancillary ligand. This data indicates that the nature of ligands, Planarity and substituent's presents in the ancillary ligand has a significant effect on the strength of DNA binding [22, 23]. The K_b values are in the same order as those reported earlier for various analogous metal intercalators [24–27].

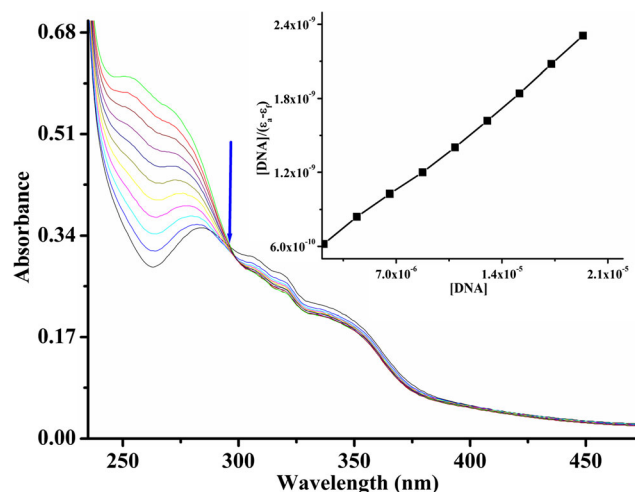


Fig. 1 Absorption spectrum of complex $[\text{Co}(\text{phen})_2\text{FIPB}]^{3+}$ (**1**) in Tris-HCl buffer upon addition of CT-DNA. Inset plot, $[\text{DNA}]/(\epsilon_b - \epsilon_f)$ versus $[\text{DNA}]$ for the titration of DNA with Co(III) complex, which gives intrinsic binding constant (K_b). $[\text{DNA}] = 2.5 \times 10^{-4} \text{ M}$, $[\text{Complex}] = 40 \mu\text{M}$

Emission Titration

It was found that the emission intensities of complexes **1–3** enhanced on addition of CT-DNA in Tris buffer at ambient temperature, the peaks were found at 422, 428 and 430 nm respectively. From this explains that compounds can strongly interact with DNA are shown in Fig. 2. The extent of enhancement decreases on moving from **1** to **3**, this indicates strong stacking interaction with DNA [25]. Binding data were cast into the scatchard plot of r/C_f vs r , where r is the binding ratio, $C_b/[\text{DNA}]$ and C_f is the free ligand concentration and the emission binding constant values are 4.4×10^5 , 4.1×10^5 and $3.9 \times 10^5 \text{ M}^{-1}$. The order of the binding constants is **1** > **2** > **3**,

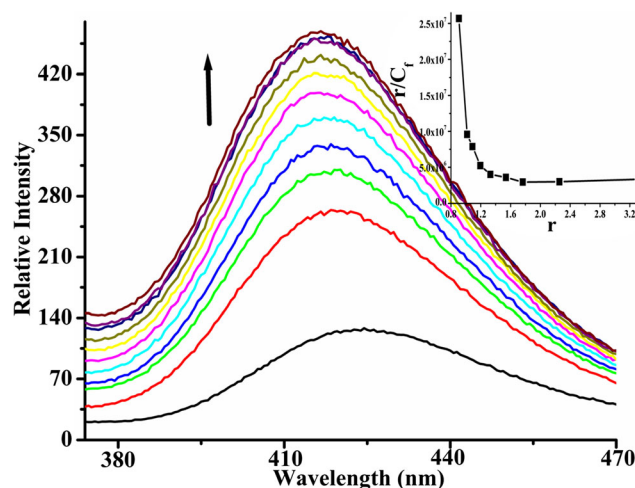


Fig. 2 Luminescence spectrum of complex $[\text{Co}(\text{phen})_2\text{FIPB}]^{3+}$ (**1**) in Tris-HCl buffer upon addition of CT-DNA. Arrow shows the intensity change upon the increase of DNA concentration. Inset: Scatchard plot of above complex, which gives binding constant (K_b). $[\text{DNA}] = 2.5 \times 10^{-4} \text{ M}$, $[\text{Complex}] = 20 \mu\text{M}$

indicates that **1** is showing stronger binding ability due to having more planarity in the intercalating ligand [22, 23]. The binding constants calculated are also in consistent with absorption data.

In order to support the above result, emission quenching experiments were performed using $[\text{Fe}(\text{CN})_6]^{4-}$ as quencher. The ferrocyanide quenching plots for **1–3** in the absence and presence of DNA are shown in Fig. 3. In the absence of DNA, compounds were efficiently quenched by $[\text{Fe}(\text{CN})_6]^{4-}$ resulting in linear Stern-Volmer plots. In the presence of DNA quenching was less, because of the highly negatively charged $[\text{Fe}(\text{CN})_6]^{4-}$ would be repelled by the negative charge of the DNA phosphate backbone which would hinder the quenching of the emission of the bound compounds [47].

$$I_0/I = 1 + K_{sv}[Q]$$

where I_0 and I are the fluorescence intensities in the absence and presence of quencher respectively, Q is the concentration

of the quencher. In the quenching plot of I_0/I vs $[Q]$, K_{sv} is given by the slope.

Viscosity Measurement

Generally, in absence of any crystallographic structural data, hydrodynamic measurements (such as viscosity, sedimentation, etc.) are the most sensitive techniques to determine DNA binding modes [48, 49]. To know the interactions between the complexes (**1–3**) and DNA, viscosity measurements were carried out. The relative viscosity of CT-DNA is well known to increase on interaction with intercalative binding substrates. This is because insertion of intercalator causes the base pairs of DNA to separate and thus cause lengthening of the DNA helix. In the presence of compound with DNA viscosity has been found to increase suggesting that they could bind to DNA through intercalation binding mode (Fig. 4). The intercalating strength is in similar order to the above absorption and emission spectroscopic

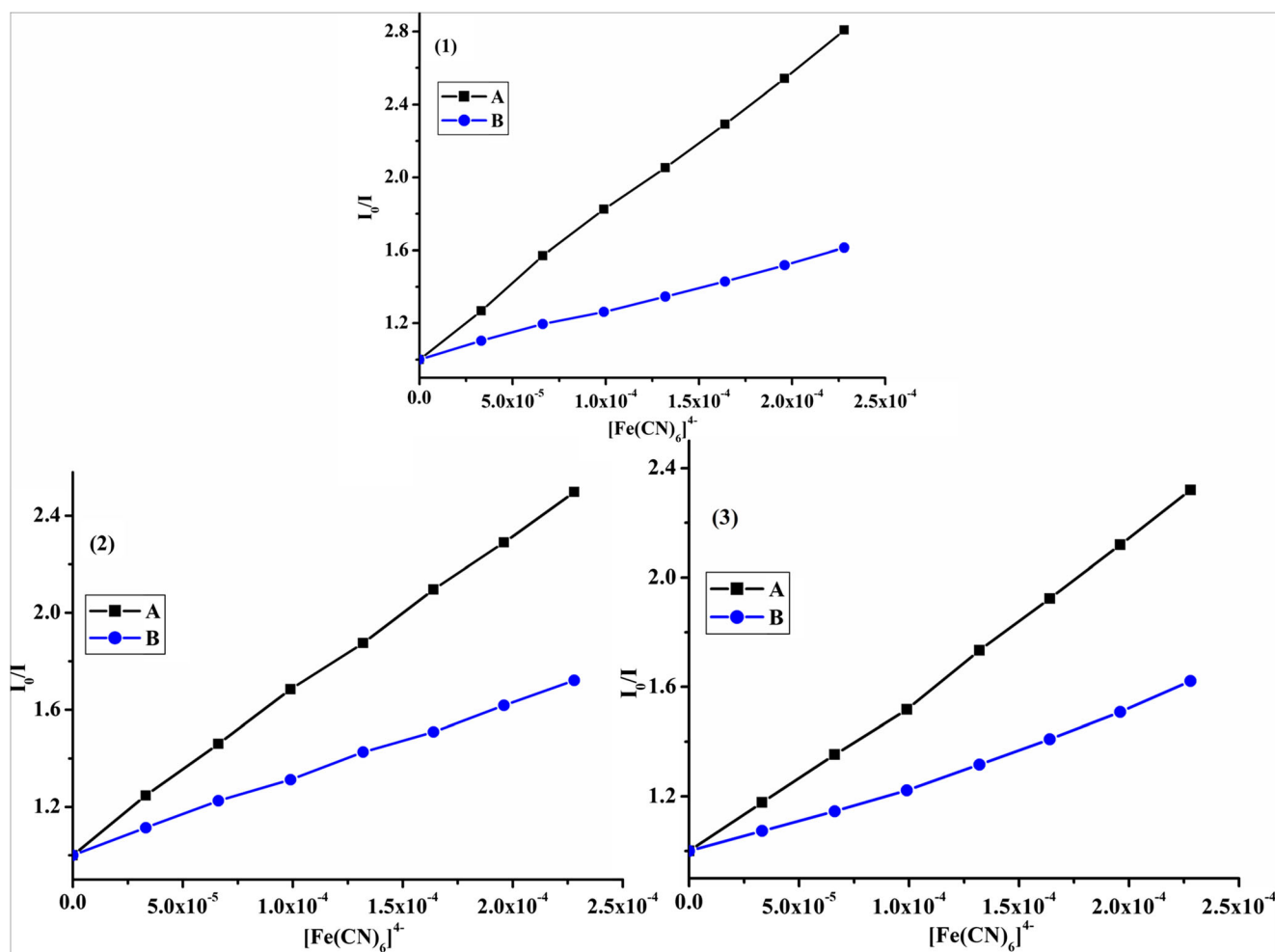


Fig. 3 Quenching studies of complexes in Tris-HCl with $[\text{Fe}(\text{CN})_6]^{4-}$ in the absence of DNA (A) and presence of DNA 1:100 (B)

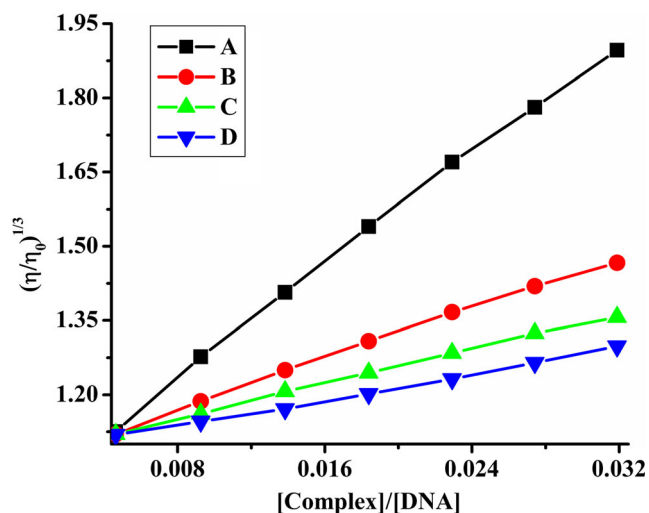


Fig. 4 Effect of increasing amounts of $[\text{Co}(\text{phen})_2(\text{FIPB})]^{3+}$ (a), $[\text{Co}(\text{bpy})_2(\text{FIPB})]^{3+}$ (b) and $[\text{Co}(\text{dmb})_2(\text{FIPB})]^{3+}$ (c) on the relative viscosity of calf-thymus DNA at $30(\pm 0.1)^\circ\text{C}$. $[\text{DNA}] = 3.0 \times 10^5 \text{ M}$, $\text{pH} = 7.0$, at room temperature

results. All these studies suggest that **1–3** have a strong interaction with DNA and the order of affinity is **1 > 2 > 3**.

Docking Studies

An aim to gain an adept info on the binding affinity of the metal complex-DNA, it is crucial to understand the molecular construction of the ligand and its metal complexes. The geometry optimization, conformational assessment and 3D molecular modeling of the proposed framework of the ligand, FIPB and its complexes was performed using Hyper Chem 7.5 software.

The correct stereochemistry was ensured through the exploitation and modification of the molecular coordinates to attain reasonable low energy molecular geometry. The analytical and spectral studies represent the octahedral coordination of Co(III) complexes which were further confirmed by their molecular modeling studies.

The 3D geometric structures of metal complexes were presented in Fig. 5. The energy minimization was iteratively repeated to find out the global minimum, which are as follows: 67.3833 (1), 78.5825 (2), and 79.1460 (3) kcal/mol. The total energy values show that phen complexes are more stable than bpy and dmb complexes.

The architectural information, M–N bond and metal–intercalator lengths of the reliable conformer of the metal complex are given in Table 1. The bond lengths of the Co–N (N of ancillary ligand and intercalator-FIPB) in $1.87\text{--}1.88 \pm 0.01 \text{ \AA}$ in complex **1**. The Co–N bond length (N of ancillary ligand) is $1.87 \pm 0.01 \text{ \AA}$, while (N of Intercalator) is $1.88 \pm 0.01 \text{ \AA}$ respectively. The Co–N bond lengths (N of intercalator) are a little longer in complex **1** and **2** in comparison to complex **1**.

The bond angles in all the complexes happened to be fairly near to an octahedral geometry $\sim 89.5\text{--}91.2^\circ$. It is actually assumed that molecules are strained, when their structural attributes (bond lengths, bond angles, torsion angles, vander Waals contacts) deviate from expected values such as bond angles (90°) as expected in octahedron, thereby results confirm that the optimized structures of the complexes investigated are distorted octahedrons. The zero energy geometry cannot be obtained for most of the molecules and, therefore MM models come across as mostly strained even in their lowest energy conformation [50].

Furthermore, the values of the dihedral angles show a divergence from 0° in all the complexes. The torsion angles C20–N2–C12–C13 & C28–N1–C12–C13 in complex **1** (Fig. 5a) shows a maximum deviation of 119.33 , and 113.25° , whereas complex **2** and **3** shows $\sim 179.01^\circ \pm 0.01$ respectively. The dihedral angle (Table 2) evaluation outline that the complex **2&3** are more disordered from planarity. This translates to conclude that complexes have slight conformational differences, which is confirmed by comparison of the values for dihedral angles. The literary mastery shows that M–N bond length preference is controlled by a proportion of coulombic attractions and vander Waals repulsions between the metal cation and the donor atoms, the N–M–N bond angle preference is dictated by non-bonded interactions between the ligands, and the bond angles and torsion angles result from a complex interplay of many pair-wise non bonded interactions as well [50].

The metal to intercalator lengths of complexes is as follows: 13.5224 , 13.5267 & 13.5264 \AA respectively. It is significant to note that the length of the Metal - intercalator is smaller which actually may potentially augment the stability of the conformer as well as the DNA binding affinity. The influence of metal complex (ancillary and intercalating ligand) was analyzed by docking with DNA using Patch Dock server [51]. The results were assessed and the best solution is picked based on the shape complementarity and interface shape. The shape complementarity is much more distinguished in the concave/convex interfaces and therefore convenient to detect.

The best solution was identified on the rationale of the Patch Dock areas of interface and desolvation energies. The assessment of desolvation energies (Table 3) reveals that the stable complex **1** forms a stronger complex with DNA than complex **2** and **3** which is persistent with the experimental data. The intrinsic binding constants (k_b) and desolvation energies for the complexes are in the order **1 > 2 > 3**.

The selective DNA binding properties of the particular metal complexes were owing to the variation in ancillary ligand, dihedral angle and intercalator length. The docked complex shows an intercalative mode [47] of binding as shown in Fig. 6. This is in accord to the previous experimental

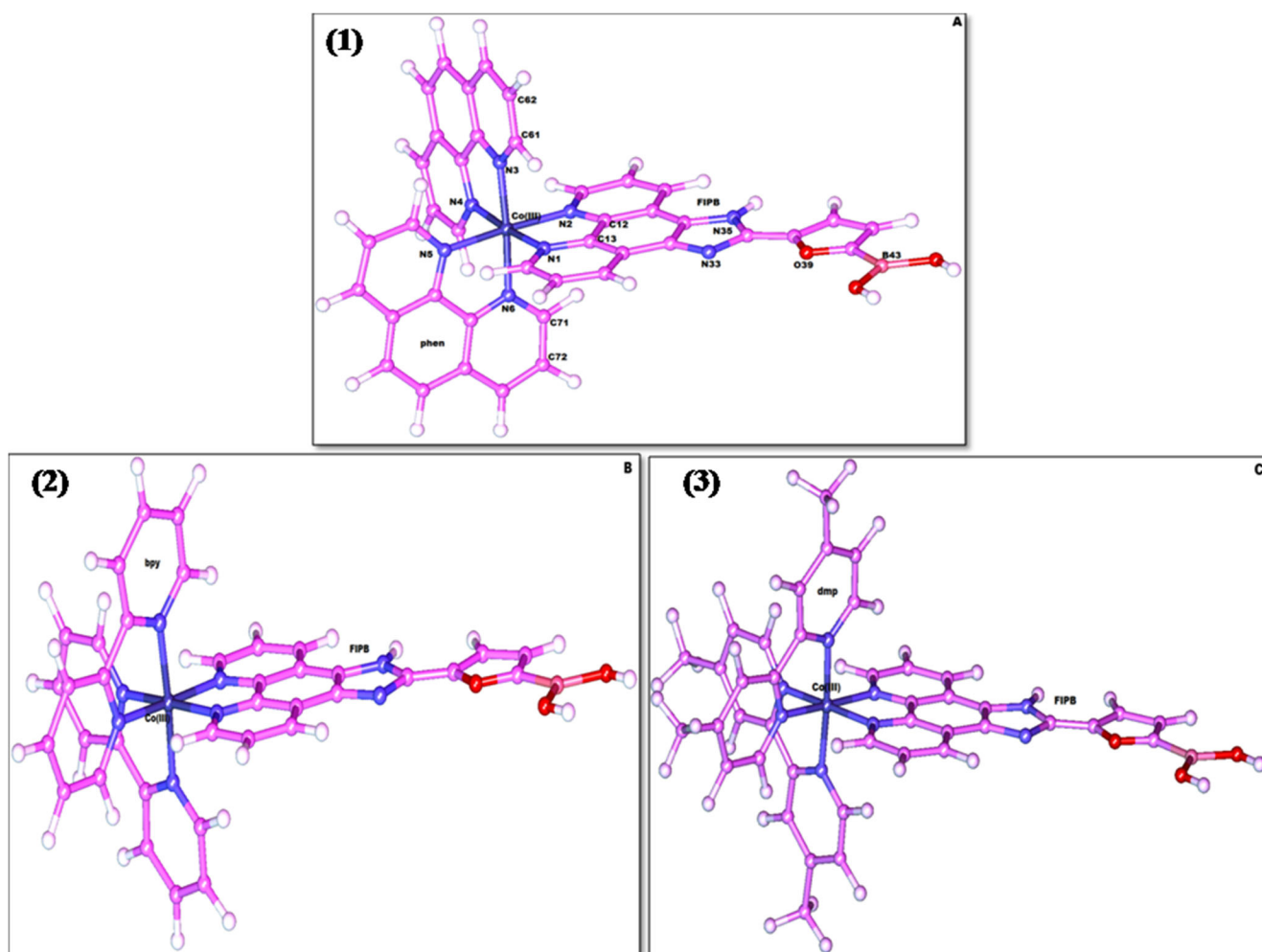


Fig. 5 3D Model of the Cobalt Polypyridyl complex. **a** $[\text{Co}(\text{phen})_2\text{FIPB}]^{3+}$ **b** $[\text{Co}(\text{bpy})_2\text{FIPB}]^{3+}$ **c** $[\text{Co}(\text{dmb})_2\text{FIPB}]^{3+}$

findings [26]. The fundamental interaction in the ideal solution for each of the complex is given in Table 4 and mentioned

below. Figure 6, bonding interactions concerning the docked positions of ds-DNA with complexes, it is noticed that all

Table 1 Bond lengths of the 3D conformers of Cobalt Polypyridyl complexes

S. No	Metal complex	Bond lengths (\AA°)					
		M–N ₁ ^a	M–N ₂ ^a	M–N ₃ ^a	M–N ₄ ^a	M–N ₅ ^b	M–N ₆ ^b
1.	$[\text{Co}(\text{phen})_2\text{FIPB}]^{3+}$	1.8783	1.8774	1.8780	1.8780	1.8780	1.8780
	Metal–intercalator length.	13.5224					
	Total energy (kcal/mol)	67.3833					
2.	$[\text{Co}(\text{bpy})_2\text{FIPB}]^{3+}$	1.8809	1.8800	1.8777	1.8763	1.8763	1.8777
	Metal–intercalator length	13.5267					
	Total energy(kcal/mol)	78.5825					
3.	$[\text{Co}(\text{dmb})_2\text{FIPB}]^{3+}$	1.8807	1.8798	1.8759	1.8759	1.8778	1.8772
	Metal–intercalator length.	13.5264					
	Total energy(kcal/mol)	79.1460					

The bond lengths were calculated using HYPERCHEM 7.5 program.

^a N3, N4, N5, N6 are polypyridyl(phen/bpy/dmb) nitrogen bonded to metal

^b N1 and N2, N of FIPB ligand bonded to metal

Table 2 Dihedral Angles in the 3D conformers of Cobalt Polypyridyl complexes

S. No	Dihedral Angle (°)	[Co(phen) ₂ FIPB] ³⁺	[Co(bpy) ₂ FIPB] ³⁺	[Co(dmb) ₂ FIPB] ³⁺
1.	N3-Co-N2-C12	81.70	97.42	82.66
2.	N6-Co-N1-C13	81.56	98.16	82.70
3.	C20-N2-C12-C13	119.33	179.10	179.88
4.	C28-N1-C12-C13	113.25	179.56	179.02
5.	N3-Co-N2-C20	95.28	81.28	95.15
6.	N6-Co-N1-C28	96.58	82.80	95.19
7.	Co-N3-C61-C62	179.88	179.98	179.86
8.	Co-N6-C71-C72	179.21	179.99	179.76

^a N3, N4, N5, N6 are polypyridyl(phen/bpy/dmb) nitrogen bonded to metal

^b N1 and N2, N of FIPB ligand bonded to metal

Table 3 Patch Dock score and desolvation energies

S.No.	Metal complex	Patch Dock score	ACE ^a (kcal/mol).
1.	[Co(phen) ₂ FIPB] ³⁺	5018	-571.25
2.	[Co(bpy) ₂ FIPB] ³⁺	4852	-490.04
3.	[Co(dmb) ₂ FIPB] ³⁺	5260	-450.43

^a Desolvation energy

complex exhibit a strong inclination to guanine, where as complex **1** also bind with adenine and cytosine as well.

Gel Electrophoresis by pBR322 DNA

It is reported that many metallo-complexes can interact with DNA and cause DNA strand scission and also the photocleavage activity of various Ru(II) and Co(III) complexes have been reported [26, 27, 50] for this reason we have also studied the capacity of the present complexes to cleave pBR322 DNA by gel electrophoresis as shown in Fig. 7. Gel

electrophoresis separation of pBR322 DNA was studied after incubation with complexes and irradiation at 365 nm. Two different concentrations of complexes 30 μM and 60 μM treated with pBR322 DNA, No DNA cleavage was observed for the control in which the complex was absent. When this circular DNA was subjected to electrophoresis, relatively fast migration was observed for the supercoiled form (form I). As scission occurred on one strand, the supercoiled DNA generated electrophoretically slower-moving open circular form (form II). When both strands were cleaved, a linear form (III) was generated that migrated between forms I and II [50].

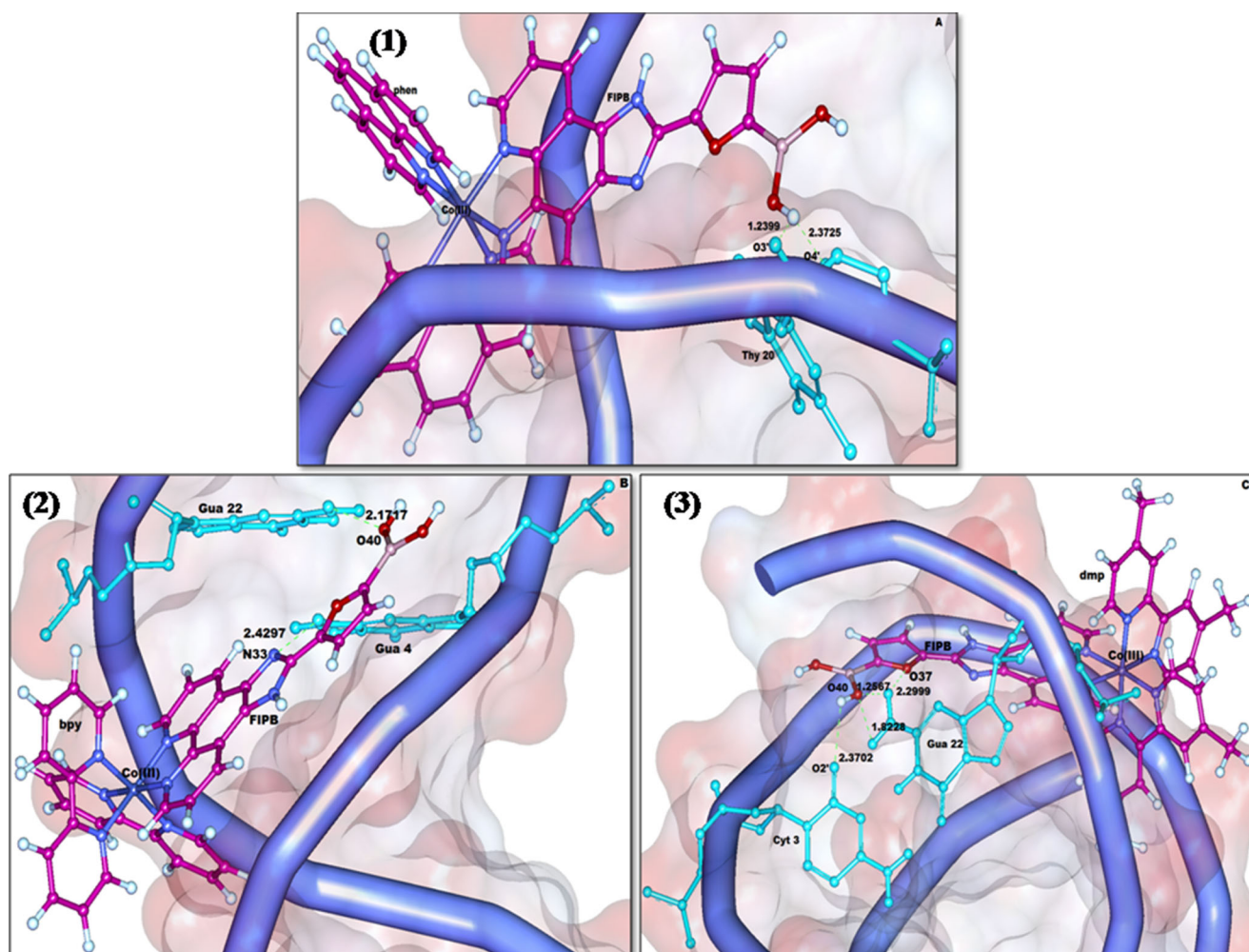
Antimicrobial Activity

The antimicrobial activities of synthesized three complexes were studied with two different microbes *Staphylococcus aureus* and *Bacillus subtilis*. From this we calculate the lower MIC (Minimum Inhibition Concentration) value; it indicates that the drugs required inhibiting the growth of the microbes. The complexes with two concentrations at 0.5 mg/mL and 1 mg/mL by the standard disk diffusion method. All

Table 4 Binding interactions involving the docked poses of dsDNA with metal complexes

S. No.	Metal complex	Binding interactions (donor group-acceptor group)	Bond length (Å ^o)
1.	[Co(phen) ₂ FIPB] ³⁺	:UNK74:H - B:DT20:O4' :UNK74:H - B:DT20:O3'	2.3725 1.2399
2.	[Co(bpy) ₂ FIPB] ³⁺	A:DG4:H21 - : UNK33:N B:DG22:H21 - : UNK40:O	2.4297 2.1717
3.	[Co(dmb) ₂ FIPB] ³⁺	B:DG22:H21 - : UNK37:O B:DG22:H21 - : UNK40:O B:DG22:H22 - : UNK40:O :UNK72:H - A:DC3:O2	2.2999 1.2567 1.8228 2.3702

^a Nucleic bases represented three letter code



Binding interactions in the docked complex are represented as green dashed lines, DNA as ribbon model (purple) with surface, Nucleotides as ball and stick model (cyan blue) and in metal complex—carbon (pink), metal ion (dark grey), nitrogen (blue) and hydrogen (grey).

Fig. 6 Docked complex of DNA with Cobalt polypyridyl complexes showing the interactions. **a** $[\text{Co}(\text{phen})_2\text{FIPB}]^{3+}$ - DNA complex; **b** $[\text{Co}(\text{bpy})_2\text{FIPB}]^{3+}$ - DNA complex; **c** $[\text{Co}(\text{dmb})_2\text{FIPB}]^{3+}$ - DNA complex. Binding interactions in the docked complex are represented as

green dashed lines, DNA as ribbon model (purple) with surface, Nucleotides as ball and stick model (cyan blue) and in metal complex—carbon (pink), metal ion (dark grey), nitrogen (blue) and hydrogen (grey)

the complexes were effectively exhibiting the zone of inhibition but less effective than the standard drug ampicillin as

shown in Table 5. These results are consistent beside results from earlier studies.

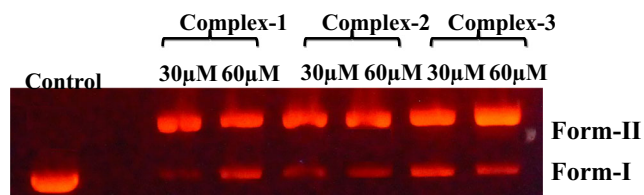


Fig. 7 Agarose gel electrophoresis of supercoiled pBR322 DNA in the absence (control) and in the presence of complexes 1, 2 and 3 at two different concentrations (30 and 60 μM) after irradiation at 365 nm for 30 min

Cytotoxicity Assay

All the three complexes were evaluated the concentration at which cells were 50% viable by performing MTT assay. After treatment of *HeLa* cells for 48 h with complexes 1, 2 and 3 in a range of concentrations (1.25–100 μM). The percentage inhibition of growth of the cancer cells was determined. The cell viabilities (%) of concentrations were obtained by plotting absorbance measured at different concentrations as shown in Fig. 8. The IC_{50} values of complexes 1, 2 and 3 are 4.99, 6.58 and 10.68 μM respectively.

Table 5 Antimicrobial activity of complexes (1–3) with their zones of inhibition in mm

Complex	<i>Staphylococcus aureus</i> (S.A)		<i>Bacillus subtilis</i> (B.S)	
	1000 μ L	500 μ L	1000 μ L	500 μ L
[Co(phen) ₂ FIPB] ³⁺ (1)	16	11	23	15
[Co(bpy) ₂ FIPB] ³⁺ (2)	14	09	20	12
[Co(dmb) ₂ FIPB] ³⁺ (3)	12	08	19	12
Ampicillin	20	14	30	21

Conclusion

Three new cobalt(III) polypyridyl complexes having FIPB as an intercalating ligand were synthesized and characterized. The absorption and emission studies revealed that all the three Co(III) complexes bind to DNA, viscosity studies confirms that these complexes bind to DNA through an intercalative mode. The binding affinity of three cobalt(III) complexes are follows the order **1 > 2 > 3**, it is due to the planarity and steric hindrance of the ancillary ligands(phen, bpy and dmb). The molecular docking studies confirm that the changes of the ancillary ligand lead to a profound influence on binding geometries. The binding selectivity and strength depends on the ancillary ligand width intercalator length, torsion angle of the metal complex. The computational methods complement the experimental studies of DNA–metal complexes, intercalation is the preferred binding mode involving guanine and follows the order is similar to theoretical data. The photocleavage studies of these complexes shows cleave the pBR322DNA in different forms effectively. Antimicrobial activity indicated that complex **1** was more active compared to other two complexes against the tested microorganisms. In vitro cytotoxicity

studies also support the experimental data. These complexes are more effective for further studies.

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Authors' Contributions The author SP conceived this research and designed experiments, wrote the paper and participated in the revisions of it; RKV participated in the design and interpretation of the data helped in writing the paper and participated in the revision of it; SG and VR are participated in analysis of data and revision of paper; NN investigated the molecular docking and interpretation of data; SSN Supervision the research, designed experiments correction of manuscript. The author(s) read and approved the final manuscript.

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Data Availability The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request. All data generated or analyzed during this study are included in this published article.

Declarations This article does not contain any studies involving human participants performed by any of the authors and does not contain any studies involving animals performed by any of the authors.

Conflicts of Interest “The authors declare that they have no potential conflict of interest in relation to the study in this paper”.

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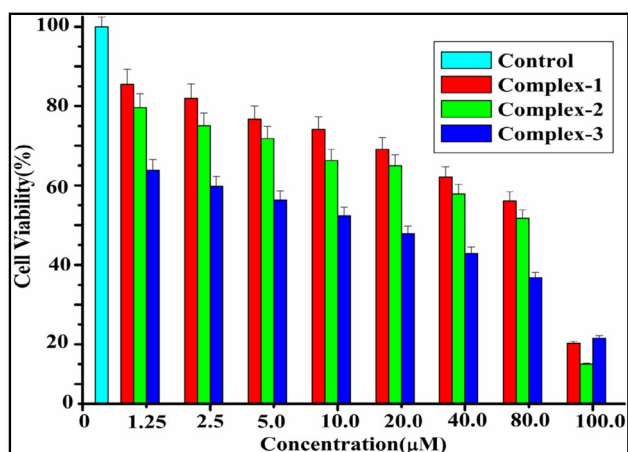


Fig. 8 Cell viability of *HeLa* cell lines treatment with complexes **1**, **2**, and **3**. Each data point is the mean \pm standard error obtained from at least three independent experiments

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The Environmental and Occupational Health Impacts of Unconventional Water

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Abstract

Access to water, in sufficient portions and of enough exceptional is crucial for human fitness. The United Nations Committee on Economic, Social and Cultural Rights (in General Comment 15, drafted 2002) argued that get right of entry to to water changed into a situation for the amusement of the proper to an ok fashionable of living, inextricably related to the proper to the best potential preferred of fitness, and as a result a human right. On 28 July 2010 the United Nations General Assembly declared secure and smooth consuming water and sanitation a human right vital to the whole entertainment of existence and all different human rights. This paper charts the worldwide felony improvement of the right to water and its relevance to discussions surrounding the increase of unconventional electricity and its heavy reliance on water. We recollect key statistics from the U.S. With arguably the maximum mature and extensive enterprise, America, and highlight the results for water usage and water rights. We conclude that, given the burden of testimony of neighborhood humans from our studies, along with data from clinical literature, non-governmental corporation (NGO) and different policy reviews, that the proper to water for residents dwelling near fracking websites is probably to be critically curtailed. Even so, from the information offered here, we argue that the main trouble concerning water use is the transferring of the aid from society to industry and the demonstrable lack of deliver-facet price sign that could call for that the industry lessen or stabilize its water call for in step with unit of energy produced. Thus, in the US context by myself, there is extensive proof that the human proper to water will be seriously undermined with the aid of the boom of the radical oil and gasoline enterprise, and given its spread around the world this may soon emerge as a international human rights trouble.

Keywords: unconventional energy; fracking, Waste water management, human rights to water

1. Introduction

Unconventional “Water”; This paper examines the development of the right to water in worldwide law and discusses its relevance to a key modern social, political and environmental task—the growth of unconventional electricity. Indeed, in analyzing the development of the right to water, and its cutting-edge felony fame, we are searching for to explore the ability effect on the human proper to water of a water-intensive unconventional resource extraction enterprise that could severely jeopardize people’s ability to recognize the proper in any significant way. At the outset it's far crucial that we outline our phrases. How can we outline ‘unconventional’ power? To solution that query, it's far perhaps pertinent to provide an explanation for first ‘conventional’ mineral extraction. In easy terms, it is the extraction of without difficulty available and relatively smooth to broaden oil and fuel from reservoirs trapped in herbal geological structures, usually sandstone and carbonate rocks. In the not too remote past, herbal geological tactics that passed off over masses of thousands of years provided abundant hydrocarbon assets. The method, widely coined as fracking, has been the situation of controversy because of the ability consequences that hydraulic fracturing and associated oil and gasoline manufacturing activities can also have on human fitness and the surroundings. The introduction of unconventional oil and fuel improvement (UOGD) poses threats to the herbal aid structures which might be important for existence, all life, specifically air and water. Here we're concerned with perceived threats to the planet’s water resources. Even so, below the technique of excessive strength, one of the most valuable assets this is being reallocated far from society to industry is water. Water affects are one of the most contentious and extensively publicized environmental, and as we argue herein, human rights troubles, linked with unconventional electricity extraction, which includes however now not limited to: groundwater contamination, water use, and contaminated water waste disposal. For instance, unconventional gas manufacturing is a fairly water-intensive technique, with a standard unmarried well requiring around five–eleven million gallons of water, and a median well-pad cluster up to 60 million gallons, to drill and fracture, depending at the basin and geological formation The full-size majority of this water is used all through the fracturing process, with huge volumes of water pumped into the properly with 3300–5000 thousand tons of sand (i.e., proppant) and chemicals to facilitate the extraction of the fuel; The massive portions of water utilized by the fracking enterprise is but one in every of many extreme issues. The infection of groundwater sources, from failure within the properly casing over time what enterprise refers to as ‘zonal isolation’ failure, is a very serious issue throughout areas which have seen full-size fracking improvement up to now, and has duly featured as a significant public family members battleground for enterprise and pro-fracking governments. Even so, arguably the most concerning difficulty with fracking’s use of water is the difficulty of produced/waste water treatment and disposal regularly actually referred to as ‘waste water control’. And but, the dangers on this regard move properly past the concerns of company chance minimisation. . The problem of the right to water encompasses both water satisfactory and quantity: each are essential facets to the right which, in turn, is essential to the ‘minimally appropriate lifestyles’ and the realisation of all human rights.

2. Status of the Right to Water in International Law

The modern-day felony foundation for a proper to water at an worldwide stage is imprecise and unsure. In examining the development of the right to water, and its modern prison reputation quo, we are seeking to explore the potential effect of the human right to water via the ‘fracking’ speak and the effect of UOGD on people’s capacity to comprehend the proper. The connection among UOGD and the right to water calls for consideration because the contrast gives a dramatic example of public selection-making diminishing perceived and guaranteed human rights.

In both human and environmental phrases, biology dictates that water—after air—is the most essential resource to guard human and ecological survival Freshwater is a essential useful resource for natural ecosystems, human physical and mental health, and numerous human socioeconomic wishes. The significance of a global sustainable deliver of freshwater is ubiquitous but ‘water resources are beneath stress to satisfy destiny demands because of populace growth and weather exchange’]. Furthermore, it's been argued that the hazard posed by means of global groundwater depletion to worldwide water safety is a ways more than is presently established .According to the United Nations, around 1.2 billion humans stay in areas of water shortage, and a in addition 1.6 billion humans stay in areas of monetary water shortages .In that admire, motion associated with disaster, struggle, or compelled migration constitutes human migration. With perceived threats regarding battle over resources, and the real possibility of ‘Water Wars’ as a result of food insecurity and water scarcity, a UN covenant recognising the human proper to water ‘will no longer resolve water shortage by means of itself, however it will set up the framework necessary for implementing any answer.’ In human rights terms, the ‘manipulate paradigm’ strikes on the very heart of human dignity, life and health. Within the narrative of the ‘wide variety’ of human rights files, specially for the reason that Seventies, elements of the proper to water are required to be adequate for human dignity, lifestyles and health. Indeed, as may be visible beneath, according with Article 11(1) and 12 of

The International Covenant on Economic, Social and Cultural Rights (ICESCR) these three key elements are all-pervading and encompass, possibly personify, the right to water’s normative content material in worldwide tender regulation documents. It is argued by using the ORG that a new approach to security is needed that addresses the drivers of conflict: ‘curing the disease’ in place of ‘combating the signs and symptoms’. The concept of ‘sustainable security’ is one feasible alternative and addresses human rights worries blanketed via the UDHR. Perhaps, the Bolivian alternative to the ‘control paradigm’ is the precursor to practical resource protection: Bolivia’s army already have a function within the ‘protection of Mother Earth’. . The summary of the development of the proper to water that follows will exhibit that the intentions of the Committee on Economic, Social and Cultural Rights (CESCR) has been to ‘articulate a pre-existing right’. Moreover, despite the life of a previous or contemporary self sufficient right being disputed, it is able to be confirmed that the proper has a firm felony standing, particularly while supported with the aid of environmental regulation,

worldwide water law and country-associated jurisprudence. This is evident in a huge variety of national prison instruments which include state duties/duties and entitlements of residents with reference to, amongst others, get entry to to water and sanitation.

3. The Development of the Right to Water

At the countrywide stage, regardless of the absence of a ubiquitous proper, the right to water and sanitation has been regularly more acknowledged in constitutions, legislation and courts globally. Some countries have vast provisions addressing no longer just the quantity of ingesting water, but the best of water and sanitation services holistically; but, universality is some distance from being carried out. It is noteworthy that maximum water laws that been adopted due to the fact that General Comment No. 15 (below) and which might be currently being drafted (or underneath revision) incorporate provisions based at the human rights measurement of get admission to to water. The origins of the 'proper to water' can be traced to 1946 whilst, while adopting its charter, the World Health Organization (WHO) declared that 'the amusement of the best doable well-known of health is one of the fundamental rights of each man or women'. In 1997, the 'Water Convention' coined the concept of 'important human wishes', which the International Law Association defined as 'waters used for immediate human survival, such as ingesting, cooking, and sanitary needs, as well as water needed for the instant sustenance of a household' ,Peter Beaumont denotes drinking water as the 'most' critical of human desires that's vital on this context, especially because the word is a shorthand expression for the 'minimum middle of the human proper to water'.

4. The Right to Water and 'Fracking'

Referring states to WHO recommendations, GC15 states that requirements have to make sure 'the protection of drinking water supplies thru the removal of, or discount to a minimal attention, of materials of water which can be recognized to be dangerous to health'. The General Comment additionally requires water to be of an appropriate color, odour and taste for each personal or home use'. Taking Pennsylvania as an example, attributable to the incidents and lawsuits that have been suggested to the Pennsylvania Department of Environmental Protection (DEP), it is clear that actual incidents have passed off wherein excellent troubles undermined GC15 and, in the long run, the ICESCR in this context. In a major have a look at of corporate violations, Inglis and Rumpler conclude: 'Drilling poses major dangers to our water materials, such as capacity underground leaks of toxic chemical substances and contamination of groundwater. There are at least 243 documented instances of contaminated drinking water components throughout Pennsylvania between December 2007 and August 2014 because of fracking activities, in step with the Pennsylvania Department of Environmental Protection (DEP)' .

5. Conclusion

Despite its enormous use within the United States for over a decade, hydraulic fracturing has only currently been scrutinized to decide the industry's outcomes on human rights. Under the unique processes of the HRC, the Special Rapporteur on the human proper to secure ingesting water and sanitation, Catarina de Albuquerque, concluded her 2011 project to america via outlining severe concerns over the effect of a number polluting activities related to the hydraulic fracturing procedure. Qualitative facts from Colorado has similarly found out proceedings of water contamination from residents dwelling close to fracking websites that are often deliberately misunderstood, assigned a unique motive, or diluted with the aid of nation regulatory our bodies . Recently, the Pennsylvania Department of Environmental Protection disclosed info of 243 cases in which fracking businesses were observed by means of nation regulators to have contaminated non-public drinking water wells within the ultimate four years. In a miles behind schedule survey of present scientific literature in this subject matter (not a brand new data set), the U.S. Environmental Protection Agency observed 'medical evidence that hydraulic fracturing activities can effect drinking water resources under some instances.

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Assessment of the Impact of Covid-19 Pandemic on Surface Water Quality in Manair River of Karimnagar

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Abstract

The goal of the special collection is to develop insights into the link between human activities and impact on water and associated ecological, environmental, and built the sociological human systems, both during the recovery of the natural systems during the pandemic. Three sampling stations were selected from the Manair River and are characterized as follows: Station I is located at the right side of the lake. Station II is situated at the left side of the lake. This station gets polluted due to anthropogenic activities. Station III is located 200 meter after station II. In the year 2018-19 the lake water was alkaline. Carbonates and dissolved oxygen were recorded in low concentration Organic matter, COD, phosphates and nitrates were recorded in high concentration. On the basis of physico-chemical the lake is polluted and eutrophic. But in the year 2020 due to COVID-19 impact all the physico-chemical parameters are well below the permissible limits. The water is fresh and it can be used for drinking and irrigation purpose.

Keywords: COVID-19, Corona Virus, Water, Environment and Ecology.

Introduction

Lower Manair Dam also known as LMD was constructed across the Manair River, at Alugunur village, Thimmapur mandal, Karimnagar District, in the Indian State of Telangana during 1974 to 1985. It provides irrigation to a gross command area of 163,000 hectares (400,000 acres). Water is the most abundant substance, covering more than 70 percent of the earth's surface and existing in many places and forms, mostly in the oceans and polar ice caps, but also as clouds, rain water, rivers, freshwater aquifers, and sea ice (Dhere and Gaikwad, 2006). Water is also found in the ground and in the air we breathe and is essential to all known forms of life

(Banakar et al, 2005). Water bodies, natural and built environment, and related sociological systems such as policy and governance, have experienced significant impact from the economic slowdown resulting from the Covid-19 pandemic. While human health and life are our primary and immediate concerns to address, water and environmental systems from local to regional scales have seen discernible positive impacts due to the reduction of pollutant loading from industries, vehicle emission, and other sources.

The present study deals with Impact on surface water quality in Manair River, Effluent management and water quality and virus transport in the terrestrial and aquatic environment.

Material and Methods

Lower Manair Dam Situated at Karimnagar District. Lower Manair Dam Works will start in 1974 and ending in 1985. In Manair Dam area at Kakatiya Canal 146 km to 234 km. Lower Manair Dam Waer will goes up to 2,62,32 6ac.s. The Dam is constructed across the Manair River at 18⁰ 24'N latitude and 79⁰ 20' E longitude in Karimnagar District at km.146 of Kakatiya Canal. Lower Manair Dam is a balancing reservoir builds across the river Manair is tributary of Godavari at Karimnagar. It is having a storage capacity of 24 TMC. The water is used for drinking, agriculture and supports fish culture.

Three sampling stations were selected from the Manair River and are characterized as follows: Station I is located at the right side of the lake. Station II is situated at the left side of the lake. This station gets polluted due to anthropogenic activities. Station III is located 200 meter after station II

The water samples from the surface were collected from the three sampling stations every month in polythene cans for a period of 6 months from June-2020 to November- 2020. Water samples were collected in separate 250 ml glass bottles (BOD bottles) for the estimation of dissolved oxygen. All the samples were carried to the laboratory. The samples were analyzed on the same day for different physico-chemical factors following the standard methods (APHA, 1995). The following factors has been analysed: 1) Temperature 2) pH 3) Carbonates 4) Bicarbonates 5) Chloride 6) Dissolved Oxygen 7) Biological Oxygen Demand 8) Chemical Oxygen Demand 9) Oxidizable Organic Matter 10) Total Hardness 11) Calcium 12)

Magnesium 13) Phosphates 14) Sulphates 15) Nitrates Material and Methods 13 16) Nitrites 17) Total Solids 18) Total Dissolved Solids 19) Total Suspended Solids

Results and Discussion

The main objective of physico-chemical analysis of water is to determine the nutrient status of the medium (Chaurasia and Pandey, 2007). Since the water contains dissolved and suspended constituents in varying proportions it has different physical and chemical properties along with biological variation (Hossain et al, 2013). The quality of water may be affected in various ways by pollution (Javid and Ashok, 2012). Anions like carbonates, bicarbonates, sulphates, chlorides and cations such as, calcium, magnesium contribute to the total alkalinity of water and act as buffer systems in preserving the natural alkaline nature of the fresh waters.

The physico - chemical characteristics exhibited certain interrelationships. The pH and carbonates are directly correlated. The pH and carbonates are inversely proportional to bicarbonates. Chlorides showed an inverse correlation with carbonates (Kamath et al, 2006 and Murugesan, S and Sivasubramanian, 2008). Dissolved oxygen shows an inverse correlation with organic matter and biological oxygen demand. The total hardness negatively correlated with carbonates. Sulphates and phosphates showed positive correlation with chlorides. Nitrates showed positive correlation with carbonates, bicarbonates, calcium and negatively correlated with total dissolved solids.

Conclusions

The goal of the special collection is to develop insights into the link between human activities and impact on water and associated ecological, environmental, and built and sociological human systems, both during the recovery of the natural systems during the pandemic and possible subsequent degradation pathways as economic activities pickup up, including assessment of niche habitats that may provide long residence times for the virus and/or adverse impacts on ecosystems. Direct impacts include water quality improvements owing to reduced industrial effluents while indirect impacts include changes in urban climate or land-atmosphere interactions owing to reduction in water pollution. Opportunities for assessing the cause and consequences of existing policies and practices, and development of alternate effective policies to

preserve the recovered systems or guide systems for recovery, mitigate adverse impacts or enhance resilience are also possible.

In the year 2018-19 the lake water was alkaline. Carbonates and dissolved oxygen were recorded in low concentration Organic matter, COD, phosphates and nitrates were recorded in high concentration. On the basis of physico-chemical the lake is polluted and eutrophic (Table-1). But in the year 2020 due to COVID-19 impact all the physico-chemical parameters are well below the permissible limits. The water is fresh and it can be used for drinking and irrigation purpose (Table-2).

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Table-1
COMPARISON OF THE 2018-19 DATA WITH ISI AND WHO AND STANDARDS

Parameters	Station-I	Station-II	Station-III	ISI 1991	WHO 1971
pH	8.25	8.20	8.18	6.5 - 8.5	6.5-8.5
CO ₃ ²⁻	17.30	14.13	12.62	.	.
HCO ₃ ⁻	213.14	217.63	216.68	.	.
Cl ⁻	364.95	375.99	365.72	.	250 mg/L
DO	2.90	3.10	2.95	6 mg/L	3 mg/L
OM	17.00	16.43	18.05	.	.
TH	529.27	530.08	530.94	300 mg/L	300 mg/L
Ca ²⁺	79.15	82.46	82.13	200 mg/L	75 mg/L
Mg ²⁺	67.14	70.78	71.21	75 mg/L	30 mg/L
PO ₄ ³⁻	3.60	3.10	3.50	.	.
NO ₂ ⁻	0.28	0.20	0.25		
NO ₃ ⁻	6.80	6.25	4.20	45 mg/L	.
SO ₄ ²⁻	43.00	38.00	33.00	200 mg/L	150 mg/L

Table - 2
COMPARISON OF THE JUNE - 2020 TO NOVEMBER- 2020 DATA WITH
ISI AND WHO STANDARDS

Parameters	Station-I	Station-II	Station-III	ISI 1991	WHO 1971
pH	8.02	8.10	8.06	6.5 - 8.5	6.5-8.5
CO ₃ ²⁻	6.30	12.13	6.62	.	.
HCO ₃ ⁻	113.54	117.63	116.60	.	.
Cl ⁻	224.82	235.99	214.22	.	250 mg/L
DO	4.90	3.12	4.96	6 mg/L	3 mg/L
OM	7.00	6.42	4.06	.	.
TH	328.26	330.08	313.96	300 mg/L	300 mg/L
Ca ²⁺	59.12	52.46	52.12	200 mg/L	75 mg/L
Mg ²⁺	37.12	40.78	22.21	75 mg/L	30 mg/L
PO ₄ ³⁻	1.60	1.80	1.52	.	.
NO ₂ ⁻	0.12	0.10	0.14		
NO ₃ ⁻	3.80	3.92	3.20	45 mg/L	.
SO ₄ ²⁻	23.00	28.00	23.00	200 mg/L	150 mg/L

**WOMEN FINANCIAL INCLUSION THROUGH MGNREGS : AN EMPIRICAL
ANALYSIS OF KARIMNAGAR DISTRICT OF TELANGANA**

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Karimnagar,Telangana

ABSTRACT

Financial inclusion is the key to empowerment of Women, underprivileged and low skilled rural households as they compose 70 percentage of Indian population. Financial Inclusion can truly lift the financial condition and improve the standards of lives of the poor women and the disadvantaged. To fasten the pace of financial inclusion, the Government of India in 2008 declared that wage payments, under the Mahatma Gandhi National Rural Employment Guarantee Act, the world's largest rural public works programme, would be made through banks and post offices. As MGNREGA is a widely discussed public policy and knowledge about it is the need of the hour, the present paper will analyze how the scheme is helping in promoting women financial inclusion via wage payment through banks and post offices. It will also highlight some of the problems that are encountered when banks and post offices are used as a means for wage payment to accelerate the speed of financial inclusion and remedial measures that could be taken to tackle these problems. A large number of projects have been taken up under MGNREG Act in the country that provides employment on a huge scale. Mostly Scheduled Castes, Scheduled Tribes and women workers are volunteering to work under the programme. The Government in Ministry of Finance has also launched a drive for financial inclusion by opening of accounts of households in unbanked and under-banked areas. In order to achieve the twin objectives of financial inclusion and timely and proper payment of wages to the MGNREGS workers this MOU is being entered into. It was mandated that NREGA payments should be done only through banks and the post office system in conjunction.

Keywords: Financial inclusion, Women, MGNREGs, empowerment.

Introduction

Financial inclusion enables improved and better sustainable economic and social development of the country. It helps in the empowerment of the underprivileged, poor and women of the society with the mission of making them self-sufficient and well informed to take better financial decisions. Financial inclusion takes into account the participation of vulnerable groups such as weaker sections of the society and low income groups, based on the extent of their access to financial services such as savings and payment account, credit insurance, pensions etc. Also the objective of financial inclusion exercise is easy availability of financial services which allows maximum investment in business opportunities, education, save for retirement, insurance against risks, etc. by the rural individuals and firms.

According to the Planning Commission , Financial inclusion refers to universal access to a wide range of financial services at a reasonable cost. These include not only banking products but also other financial services such as insurance and equity products. The household access to financial services includes access to contingency planning, credit and wealth creation. Access to contingency planning would help for future savings such as retirement savings, buffer savings and insurable contingencies and access to credit includes emergency loans, housing loans and consumption loans. On the other hand, access to wealth creation includes savings and investment based on household's level of financial literacy and risk perception.

Government of India defines Financial inclusion as the process of ensuring access to financial services and timely and adequate credit where needed by vulnerable groups such as weaker sections and low income groups at an affordable cost. The meaning of financial inclusion is delivery of financial services to the low income groups especially the excluded sections of the population with the provision of equal opportunities. The main target is the access of financial services for better standard of living and income.

According to Chakraborty (2011), Financial inclusion is the process of ensuring access to appropriate financial products and services needed by all sections of society including vulnerable groups such as weaker sections and low income groups at an affordable cost in a fair and transparent manner by mainstream institutional players. This issue started gaining importance recently in the news media. However, as is the case with several issues in India, financial inclusion has remained a pipe dream with a majority of Indians continuing to lack access to banking services

The issue of financial inclusion is not a new one. Financial inclusion was embedded in Indian credit policies in the earlier decades also, albeit in a more implicit manner. Recent technological

progress has changed the nature of banking in the country. However, access to such technological improvements is restricted to a few sections of society. Some scholars are also of the view that banking policies emphasis till late was on providing credit rather than financial products and services including savings and insurance to the poor to meet their simple requirements.

Financial inclusion among recipients of social transfers and employment guarantee schemes simplifies payment delivery. The benefits of this are that the cost of payment delivery is reduced for the government, there is an increase in convenience for the recipient, and this could reduce leakages in the system. Recipients of social transfers like MGNREGA are often excluded by banks and self-excluded due to low financial literacy. This basically leads to the formation of a supply-side constraint emerging from two interrelated ideas that dominate the conventional view. First is that given low-income levels and lagging social development, there is little profit potential in the low end of the financial markets; hence, the conclusion that market-based solutions cannot lead to improved financial services for low-income people and that the private sector has no significant role in this market segment. Second, because this market consists of low-income people, it must be served through government programs and programs of charitable institutions including social-mission-oriented nongovernment organizations

The penetration of financial services in the rural areas of India is still very low. The factors responsible for this condition can be looked at from both supply side and demand side and the major reason for low penetration of financial services is, probably, lack of supply. The reasons for low demand for financial services could be low income level, lack of financial literacy, other bank accounts in the family, etc. On the other hand, the supply side factors include no bank branch in the vicinity, lack of suitable products meeting the needs of the poor people, complex processes and language barriers.

Statement of Problem

Inclusiveness in the present time is one of the challenging issues for India. It is one of the biggest challenges before our nation today to ensure inclusive growth. The planning commission in the approach paper for the Eleventh and Twelfth five year plan specifically emphasized on the “inclusive growth” due to multidimensional aspect of growth. For the country to achieve inclusive growth target, inclusiveness must be translated into poverty reduction through providing livelihood opportunities. India fixed the target for the growth of 9.0 to 9.5 percent for the Twelfth plan, but it should be inclusive. Poverty, therefore, must be addressed at priority basis, because growth has no meaning without reducing misery and hunger to the large sections of the society. In India, more than 70 percent people live in rural areas and among rural population marginalized sections of the

society are more vulnerable. India already achieved a very impressive growth rate of more than 8 per cent in the Eleventh plan, but the country is still facing the problem of mass poverty, especially in the rural areas. This needs special attention by the government. India in this direction has done a commendable work by enacting employment guarantee act i.e. The Mahatma Gandhi National Rural Employment Guarantee Act, 2005. The Act gives the legal right to the rural people to get at least 100 days employment, which is expected to reduce the poverty level in the rural areas. The present study mainly deals with the Mahatma Gandhi National Rural Employment Guarantee Act, 2005, how it is helpful in reducing poverty through financial inclusion of women in rural areas by providing 100 days guaranteed wage employment.

Objectives

The following are the specific objectives of the study.

1. To understand the concept of financial inclusion with special reference to women.
2. To analyze the role of MGNREGS in financial inclusion with special reference to women.
3. To assess the impact of the MGNREGS on the financial inclusion of women beneficiaries.
4. To identify the bottlenecks in achieving the financial inclusion of women through MGNREGS and to offer suggestions for enhancing the financial inclusion of women.

Methodology

The Community Organization is one of the primary methods of social work. This method is considered to be the most suitable method for carrying out the present study. The other methodological aspects of the study such as sampling, the sampling method, sources of data, analysis of data.

Sampling

An integral component of research design is the sampling plan. Especially it addresses three questions: who to survey (sample unit) how many to survey (sample size) and how to select them (sampling procedure). Making the census study of the entire universe will be impossible on the account of limitations of time and money. Hence sampling procedures represents the data of the entire population.

Sampling Method

For the present study simple random sampling method is followed for selection of respondents. In all the universe of the sample constitutes 240 women respondents.

Period of Study

The study is confined to examine the progress of financial inclusion of women through MGNREGS in Karimnagar district during 2019-2020 financial year.

IMPACT OF MGNREGS ON FINANCIAL INCLUSION OF WOMEN

Gender equality and women's economic empowerment are high on the international political agenda and increasingly recognized as contributing to sustained inclusive and equitable economic growth, and sustainable development. The financial inclusion of women also has a role in reducing income inequality. Access to financial services enables consumption smoothing (by diversifying and increasing income flows and allowing for asset accumulation and protection), and reducing the impact of external shocks. This paper is devoted to assess the impact of MGNREGS financial inclusion on sample women.

Impact on Control/ Access to cash

The economic empowerment of women is possible only when they have the control/ access to cash. As such during field survey the impact of financial inclusion on their access to money was collected and presented in the Table 1.

Table-1
Impact of MGNREGS Financial Inclusion on Control/ Access to Cash

S. No.	Amount of Change	No. of Respondents	Percentage
1	No Change	20	8.33
2	Little Change	112	46.67
3	Moderate Change	83	34.58
4	Significant Change	21	8.75
5	Change of Worse	4	1.67
Total		240	100.00

Source: Field Data

It is evident from table 1 that 46.67 per cent of women reported little change in their control/access to cash due to financial inclusion through MGNREGS. Moderate change in access to cash is reported by 34.58 per cent of women. There is a significant change in the access/control to cash in case of 8.75 per cent of sample women. Status quo is reported by 8.33 per cent of sample women respondent. Negative impact is reported by 1.67 per cent of women in their control/access to cash due to financial inclusion.

Recognition of Economic Contribution to household

The main motive behind various financial inclusion programmes is to improve the reorganization levels of women contribution to their families. Table 2 gives the details of the impact of financial inclusion on reorganization levels of sample women contribution to their families.

Table- 2
Impact of MGNREGS Financial Inclusion on the Recognition Levels of Economic Contribution of Women to household

S. No.	Amount of Change	No. of Respondents	Percentage
1	No Change	11	4.58
2	Little Change	123	51.25
3	Moderate Change	88	36.67
4	Significant Change	11	4.58
5	Change of Worse	7	2.92
Total		240	100.00

Source: Field Data

It can be found from table 2 that nearly 92.5 per cent of sample women reported some amount of positive change in recognition of their economic contribution to household. Among them 51.25 per cent reported little change, 36.67 per cent reported moderate change and 4.58 per cent stated significant change in the recognition for their economic contribution to household. No change is reported by 4.58 per cent of sample women respondents. Change for worse or negative change is reported by 2.92 per cent of sample women.

Control over Assets

The economic empowerment of women is also influenced by the control of women over family assets. The table 3 given below gives a clear picture of amount of impact of MGNREGS financial inclusion with regard to the control of sample women over family assets.

Table-3

Impact of MGNREGS Financial Inclusion on Women's Control over Family Assets

S. No.	Amount of Change	No. of Respondents	Percentage
1	No Change	45	18.75
2	Little Change	126	52.50
3	Moderate Change	56	23.33
4	Significant Change	6	2.50
5	Change of Worse	7	2.92
Total		240	100.00

Source: Field Data

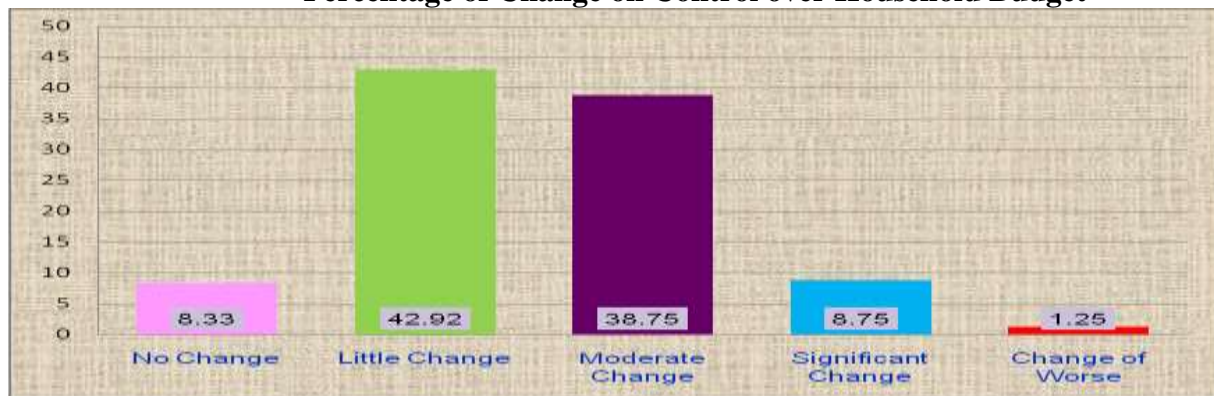
It can be inferred from table 3 that nearly 18.75 per cent of sample women reported that there is no change in their control of family assets due to financial inclusion through MGNREGS. About 2.92 per cent reported negative impact of financial inclusion efforts on their control over assets. However, 78.33 per cent of sample women reported some kind of positive change in their control over family assets due to financial inclusion through MGNREGS. Small change is reported by 52.50 per cent, moderate change by 23.33 per cent and significant change by 2.50 per cent of sample women.

Control on Household budget

The control on household budget allows the women to lead a economically independent life. The amount of change on control over household budget due to MGNREGS financial inclusion as state by sample respondents is presented in Chart 1.

Chart 1

Percentage of Change on Control over Household Budget



Source: Field Data

Chart 1 reveals that the MGNREGS financial inclusion has positive impact on 90.42 per cent of sample women in case of control over household budget. Little change is observed by 42.92 per cent of sample women in their control over household budget due to MGNREGS financial inclusion. The MGNREGS financial inclusion has moderate effect on women's control over household budget as stated by 38.75 per cent of sample respondent women. Significant change is observed by 8.75 per cent of sample women. The financial inclusion through MGNREGS has not shown any impact on women's control over household budget as reported by 8.33 per cent of sample women. Negative change in control over household budget is reported by 1.25 per cent of sample women.

Division of domestic labor

Table 4 gives the details of the impact of MGNREGS financial inclusion on the division of labour in sample women respondent households.

Table-4
Impact of MGNREGS Financial Inclusion on Division of Domestic Labour in Sample Households

S. No.	Amount of Change	No. of Respondents	Percentage
1	No Change	44	18.33
2	Little Change	76	31.67
3	Moderate Change	98	40.83
4	Significant Change	18	7.50
5	Change of Worse	4	1.67
Total		240	100.00

Source: Field Data

It is evident from table 4 that the MGNREGS financial inclusion brought moderate change in the division of domestic labour as stated by 40.83 per cent of total sample. It has brought little or small change in the division of domestic labour as reported by 31.67 per cent of sample women. Significant change in the division of domestic labour is reported by 7.50 per cent of sample women. The MGNREGS financial inclusion has brought either positive or negative change in the division of domestic labour as stated by 18.33 per cent of sample women. The remaining 1.67 per cent reported negative impact of MGNREGS financial inclusion in the division of domestic labour.

Sense of self worth

The impact of MGNREGS financial inclusion on self worth of sample respondents is given in Table 5.

Table-5
Impact of MGNREGS Financial Inclusion on Self Worth of Sample Women Respondents

S. No.	Amount of Change	No. of Respondents	Percentage
1	No Change	72	30.00
2	Little Change	68	28.33
3	Moderate Change	70	29.17
4	Significant Change	25	10.42
5	Change of Worse	5	2.08
Total		240	100.00

Source: Field Data

It is clear from table 5 that the impact of MGNREGS financial inclusion has not brought any change in the self worth of 30 per cent of sample MGNREGS women beneficiaries. Around 67.92 per cent of women reported little to significant changes in their self worth due to MGNREGS financial inclusion. Around 29.17 per cent of women reported moderate change, 28.33 per cent small change and 10.42 per cent significant change in their self worth due to MGNREGS financial inclusion. Change for worse is reported by 2.08 per cent of sample women respondents.

Political Participation

Generally, women in several rural households are kept out of political campaigning, contesting, canvassing etc. The impact of MGNREGS financial inclusion on political participation of women as stated by sample women respondents is presented in table 6.

Table-6
Impact of MGNREGS Financial Inclusion on Political Participation of Sample Women

S. No.	Amount of Change	No. of Respondents	Percentage
1	No Change	39	16.25
2	Little Change	75	31.25
3	Moderate Change	78	32.50

4	Significant Change	42	17.50
5	Change of Worse	6	2.50
Total		240	100.00

Source: Field Data

It is clear from table 6 that around 82.75 per cent of sample women reported that the MGNREGS financial inclusion has positive change in enhancing the political participation of women like casting vote independently, participating in the deliberations of Gram Sabha, canvassing in favour of a candidate etc. Among them 32.50 per cent, 31.25 per cent and 17.50 per cent reported moderate, little and significant changes respectively. Status quo is observed by 16.25 per cent of sample women. Around 2.50 per cent observed negative change in their political participation.

Possession of Household Durables

The level of change in the possession of household durables due MGNREGS financial inclusion as stated by sample respondents is presented in table 7.

Table-7
Impact of MGNREGS Financial Inclusion on Possession of Household Durables

S. No.	Amount of Change	No. of Respondents	Percentage
1	No Change	16	6.67
2	Little Change	64	26.67
3	Moderate Change	90	37.50
4	Significant Change	68	28.33
5	Change of Worse	2	0.83
Total		240	100.00

Source: Field Data

It is clear from table 7 that around 37.50 per cent of sample women reported that there is moderate change in possession of household durables like Television, Grinder, and Refrigerator etc due to MGNREGS financial inclusion. Small change in the possession of household durables is reported by 26.67 per cent of sample women. Significant change is reported by 28.33 per cent of sample women. No change or status quo is reported by 6.67 per cent of sample women respondents. 2 out of 240 reported negative change.

Appreciation in household

The following table 8 gives details of the impact of MGNREGS financial inclusion on the amount of change in appreciation levels of sample women at their household level.

Table-8
Impact of MGNREGS Financial Inclusion on Appreciation at Household level

S. No.	Amount of Change	No. of Respondents	Percentage
1	No Change	14	5.83
2	Little Change	69	28.75
3	Moderate Change	116	48.33
4	Significant Change	41	17.08
5	Change of Worse	0	0.00
Total		240	100.00

Source: Field Data

It can be inferred from table 8 that no women reported negative change in their appreciation levels at household level due to MGNREGS financial inclusion. Only 5.83 per cent of women reported no change or status quo and the remaining 94.17 per cent of women reported positive impact. Among the women who reported positive impact of MGNREGS financial inclusion in the

appreciation levels at households, 48.33 per cent reported moderate change, 28.75 per cent reported little change and 17.08 per cent reported significant change.

Table 9 MGNREGS in Karimnagar at a Glance 06-08-2020

Total No. of Blocks	15					
Total No. of GPs	313					
I Job Card						
Total No. of JobCards issued[In Lakhs]	1.4					
Total No. of Workers[In Lakhs]	2.97					
Total No. of Active Job Cards[In Lakhs]	0.78					
Total No. of Active Workers[In Lakhs]	1.19					
(i)SC worker against active workers[%]	19.62					
(ii)ST worker against active workers[%]	0.46					
II Progress		FY 2020-2021	FY 2019-2020	FY 2018-2019	FY 2017-2018	FY 2016-2017
Approved Labour Budget[In Lakhs]	17.07	28	28.3	18.75	91.54	
Persondays Generated so far[In Lakhs]	19.46	20.35	27.22	22.75	19.74	
SC persondays % as of total persondays	27.43	26.23	27.09	27.88	29.68	
ST persondays % as of total persondays	0.81	0.78	0.81	0.85	0.86	
Women Person days out of Total (%)	72.8	73.75	74.04	70.75	67.63	
Average days of employment provided per Household	29.68	37.1	43.17	36.66	30.69	
Average Wage rate per day per person(Rs.)	146.82	144.46	138.35	133.81	139.84	
Total No of HHs completed 100 Days of Wage Employment	265	2,848	5,471	3,650	2,013	
Total Households Worked[In Lakhs]	0.66	0.55	0.63	0.62	0.64	
Total Individuals Worked[In Lakhs]	0.95	0.77	0.92	0.92	0.97	
Differently abled persons worked	1676	1494	1881	1915	2076	

Source: <https://nrega.nic.in/netnrega/home.aspx>

It is clear from table 9 explain the Women work participation in Karimnagar in 2016-17 in total percent is 67.63 and 2017-18 is 70.75 , the Women work participation rate increased to 73.75 percent in total working person days.

This paper evaluates the impact of Impact of MGNREGS financial inclusion on control/ access to cash, on the recognition levels of economic contribution of women to household, women's control over family assets, on control over household budget, on division of domestic labour in sample households, on self worth of sample women respondents, on political participation of sample women, on possession of household durables, on appreciation at household level etc.

Findings of the Study

- ☞ It is evident from the study 46.67 per cent of women reported little change in their control/access to cash due to financial inclusion through MGNREGS. Moderate change in access to cash is reported by 34.58 per cent of women. There is a significant change in the access/control to cash in case of 8.75 per cent of sample women. Status quo is reported by 8.33 per cent of sample women respondent.
- ☞ It can be found from the study that 92.5 per cent of sample women reported some amount of positive change in recognition of their economic contribution to household. Among them 51.25 per cent reported little change, 36.67 per cent reported moderate change and 4.58 per cent stated significant change in the recognition for their economic contribution to household. No change is reported by 4.58 per cent of sample women respondents.
- ☞ It can be inferred from the study that 18.75 per cent of sample women reported that there is no change in their control of family assets due to financial inclusion through MGNREGS. 2.92 per cent reported negative impact of financial inclusion efforts on their control over assets. However, 78.33 per cent of sample women reported some kind of positive change in their control over family assets due to financial inclusion through MGNREGS.
- ☞ The study reveals that the MGNREGS financial inclusion has positive impact on 90.42 per cent of sample women in case of control over household budget. The financial inclusion through MGNREGS has not shown any impact on women's control over household budget as reported by 8.33 per cent of sample women.
- ☞ It is evident from the study that the MGNREGS financial inclusion brought moderate change in the division of domestic labour as stated by 40.83 per cent of total sample. It has brought little or small change in the division of domestic labour as reported by 31.67 per cent of sample women. Significant change in the division of domestic labour is reported by 7.50 per cent of sample women. The MGNREGS financial inclusion has brought either

positive or negative change in the division of domestic labour as stated by 18.33 per cent of sample women.

- ☞ It is clear from the study that the impact of MGNREGS financial inclusion has not brought any change in the self worth of 30 per cent of sample MGNREGS women beneficiaries. 67.92 per cent of women reported little to significant changes in their self worth due to MGNREGS financial inclusion.
- ☞ It is clear from the study that 82.75 per cent of sample women reported that the MGNREGS financial inclusion has positive change in enhancing the political participation of women like casting vote independently, participating in the deliberations of Gram Sabha, canvassing in favour of a candidate etc. Status quo is observed by 16.25 per cent of sample women.
- ☞ It is clear from the study that 37.50 per cent of sample women reported that there is moderate change in possession of household durables like Television, Grinder, and Refrigerator etc due to MGNREGS financial inclusion. Small change in the possession of household durables is reported by 26.67 per cent of sample women. Significant change is reported by 28.33 per cent of sample women. No change or status quo is reported by 6.67 per cent of sample women respondents.
- ☞ It can be inferred from the study that 5.83 per cent of women reported no change or status quo and the remaining 94.17 per cent of women reported positive impact.

Recommendations

- ❖ Initiatives for financial inclusion have come from the financial regulators, the governments and the banking industry. RBI has to ask banks to submit a plan for financial inclusion for the next few years. Several measures have to be taken by both the Reserve Bank of India and the Government to bring the financially excluded people to the fold of the formal banking services through other rural development programmes.
- ❖ RBI has to plan to issue permissions to launch new private sector banks in unbanked rural areas.
- ❖ Government should work towards encouraging mobile banking and look at every technology option to enable financial empowerment of each citizen.
- ❖ The government should pay all the social security payments through the bank account of the beneficiary.
- ❖ A special literacy education is to be provided in villages especially in unbanked areas to create awareness among rural illiterates. It should be made as a part of governing policies at Village Panchayat level to encourage and educate rural people.

- ❖ New biometric ATMs have to be established to assist the customers who are unable to memorize PIN.
- ❖ Banks should conduct financial inclusion campaigns so that it creates awareness among customers. It will help customers to know the importance and advantage of using banking services. Banks should make campaigning so that bank authorities should be in direct contact with the people who are not covered by banks so that they create an atmosphere to make people to come forward to clear their doubts. This will encourage them to be a part of banking.
- ❖ The government should also raise the Financial Inclusion Fund (FIF) and a Financial Inclusion Technology Fund (FITF).
- ❖ To reach banking services to the unbanked areas It should offer no frills account in order to turn unbankable into bankable.
- ❖ Banks should constitute Grievance Redressal Machinery to address and redress customer's discontent on time with promptness.
- ❖ Banks should use all types of media to reach customers, rural customers, unbanked areas customers through advertisement and awareness programmes etc.
- ❖ Banks should employ or designate a special force only to reach unreached areas.
- ❖ Banks should institute systems of reward and recognition for personnel initiating, innovating and successfully executing new products and services in the rural areas.
- ❖ It is important that adequate infrastructure such as digital and physical connectivity, Uninterrupted power supply, etc., is available.
- ❖ The government of India should help develop financial literacy among the population, particularly in low-income families of rural areas.
- ❖ Policies are to be evolved by the governments at different levels to strictly monitor the effective implementation of financial inclusion programmes. Besides, appropriate regulatory and risk management policies should be devised so as to ensure financial inclusion.
- ❖ Any government or social security payments or payments under all the government schemes should be strictly routed through the service area bank account. This will make people in rural areas to compulsorily have an account in their service area branch to avail the government benefit.

Conclusion

Poor people in general are financially excluded, but women in many countries are frequently more financially excluded at similar levels of income. Though micro level data regarding the extent of financial access are inadequate, further research (both market and policy)

should be conducted. More women oriented policies can be introduced to sideline the existing challenges to financial inclusion. There is an existing demand for extending financial products and services for women and their attitude towards the use of financial products. The scope of the study is unlimited as it has many significant dimensions. Addressing the extent of financial inclusion for women remains a complex area for intervention and research. Financial inclusion as a newer discipline of study involves new concepts and there remains considerable scope for development of better products, technologies and models. More research is needed to broaden the study of financial inclusion of women in India. There is a dearth of accurate ground level data about the quality and quality of financial access, and also regarding their use. There are unlimited opportunities to tap the potential of women as direct contributors of economic growth and are still the financially excluded lots.

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**WOMEN EMPOWERMENT THROUGH THE ENTREPRENEURSHIP
DEVELOPMENT IN TELANGANA**

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Abstract

Entrepreneurship in this sense may result in new organizations or maybe part of revitalizing mature organizations in response to a perceived opportunity. The most obvious form of Entrepreneurship is that of starting new business. The Government of India has defined women entrepreneurs as an enterprise owned and controlled by women having a minimum financial interest of 51 percent of the capital and giving at least 51 percent of the employment generated in the enterprise to women. A sense of independent decision-making is the motivational factor behind this urge. Saddled with household chores and domestic responsibilities women want to get independence. Under the influence of these factors, women entrepreneurs choose a profession as a challenge and as an urge to do something new. Such a situation is described as pull factors. Push factors pertain to women engaged in business activities due to family compulsions and family responsibilities. Today women entrepreneurs represent a group of women who have broken away from the beaten track and are exploring new avenues of economic participation. Among these reasons for women to run organized enterprises are their skill and knowledge, their talents and abilities in business and a compelling desire of wanting to do something positive. This paper examines the women empowerment through the entrepreneurship development in telangana.

Keywords: Women entrepreneurs, Entrepreneurship, enterprise ,business activities.

Introduction

Entrepreneurs play a key role in any economy. These are the people who have the skills and initiative necessary to take good new ideas to market and make the right decisions to make the idea profitable. The reward for the risks taken is the potential economic profits the entrepreneur could earn. The emergence of women on the economic scene as entrepreneurs is a significant development in the emancipation of women and securing them a place in the society, which they have all along deserved. The hidden entrepreneurial potentials of women have gradually been changing with the growing sensitivity to the role and economic status in the society. Women are increasingly becoming conscious of their existence, their rights and their work situations. In the traditional society, woman's role was naturally limited to the family. Since she was the beam of children, she was fully occupied with her duties as a mother and home maker. This was no small feat, since the traditional household may be described as both a production and a consumption unit. The man's responsibility was to provide the household with the raw materials which were then converted by the woman into consumable products or objects, under precarious housing conditions and by means of rudimentary methods and tools.

Women entrepreneurs in India represent a group of women who have broken away from the beaten track and are exploring new vistas of economic participation. They have long stories of struggle and hardships. Their task has been full of challenges. They have encountered public prejudices, family opposition and social constraints. Perform just like any other male entrepreneur. To be successful in the field of entrepreneurship, a woman needs to exhibit the traits, which are very much needed to compete and bear the pressure of business enterprises.

Several factors influence women to take up entrepreneurial ventures. The economic role is largely determined by the traditional division of labour by sex where women tend to undertake and specialize in work near the home such as food processing, Women entrepreneurs household maintenance, horticulture and handicrafts etc. The concept of women entrepreneurship is becoming a global phenomenon and in India it became prominent in the later half of the 1980s. There are various factors that motivate a woman to take on entrepreneurial activities. Prominently, it is not always easy for a woman to find a job that is compatible with her family responsibilities and household chores. This encourages women towards self-employment in enterprises adjoining their places of residence with flexible working hours, which allows them to take care of both home and business.

Mechanization and automation of many production processes have decreased the importance of man's physical ability over woman for performing a physical job. Further, it has not been scientifically proved that a woman is incomparable to a man either in skill or mental abilities. This has enabled women to take advantage of the industrialization process. This very same process of urbanization and industrialization has led to a consumer society,

where many desirable products are readily available. Women perceive more and more clearly that if they really want to contribute to the welfare of their family and society the most effective way is to go out of home and earn money.

The recent emphasis and perception is that women can also contribute to the economy of the nation as workers and producers, social Scientists, policy makers and administrators to devise the ways of developing planned entrepreneurship and economic development. Government has also been implementing schemes and programmes to ensure development of women.

Women Entrepreneurship

Entrepreneurship refers to the act of setting up a new business or reviving an existing business so as to take advantages from new opportunities. Thus, entrepreneurs shape the economy by creating new wealth and new jobs and by inventing new products and services. However, an insight study reveals that it is not about making money, having the greatest ideas, knowing the best sales pitch, applying the best marketing strategy. It is in reality an attitude to create something new and an activity which creates value in the entire social ecosystem. It is the psyche makeup of a person. It is a state of mind, which develops naturally, based on his/ her surrounding and experiences, which makes him/ her think about life and career in a given way.

The women have achieved immense development in their state of mind. With increase in dependency on service sector, many entrepreneurial opportunities especially for women have been created where they can excel their skills with maintaining balance in their life. Accordingly, during the last two decades, increasing numbers of Indian women have entered the field of entrepreneurship and also they are gradually changing the face of business of today, both literally and figuratively. But still they have not capitalized their potential in India the way it should be.

Women Entrepreneurship in Global Context

Worldwide, many women are entrepreneurs. Entrepreneurship emerges from an individual's creative spirit into long-term business ownership, job creation, and economic security. Women bring commitment and integrity because they care about economic empowerment, entrepreneurial development and innovation. Female entrepreneurs seek the professional and personal support that is found in business associations. Economic globalization has encouraged the expansion of female business ownership.

The growing economic power and influence of women-owned businesses are changing the shape of the global economy,” remarked Sakiko Fukuda- Parr, director of the UN Development Program’s Human Development Report. The global impact of women entrepreneurs is just beginning to gain intensity. Worldwide, the number of female business owners continues to increase steadily. For example, women produce more than 80 percent of the food for Sub-Saharan Africa, 50-60 percent for Asia, 26 percent for the Caribbean, 34 percent for North Africa and the Middle East, and more than 30 percent for Latin America. Female entrepreneurs are active at all levels domestically, regionally, and globally

Women Entrepreneurs in India

Women owned businesses are highly increasing in the economies of almost all countries. The hidden entrepreneurial potentials of women have gradually been changing with the growing sensitivity to the role and economic status in the society.

Skill, knowledge and adaptability in business are the main reasons for women to emerge into business ventures. ‘Women Entrepreneur’ is a person who accepts challenging role to meet her personal needs and become economically independent. A strong desire to do something positive is an inbuilt quality of entrepreneurial women, who is capable of contributing values in both family and social life. With the advent of media, women are aware of their own traits, rights and also the work situations.

The glass ceilings are shattered and women are found indulged in every line of business from pap pad to power cables. The challenges and opportunities provided to the women of digital era are growing rapidly that the job seekers are turning into job creators. They are flourishing as designers, interior decorators, exporters, publishers, garment manufacturers and still exploring new avenues of economic participation. In India, although women constitute the majority of the total population, the entrepreneurial world is still a male dominated one.

Characteristics of Women Entrepreneurs

Woman entrepreneurs tend to be highly motivated and self-directed. They also exhibit a high internal locus of control and achievement. Researchers contend that women business owners possess certain specific characteristics that promote their creativity and generate new ideas and ways of doing things. Women entrepreneurs share the following characteristics:

1. Sharp communication skills.

2. Intuitive skills.
3. Consensus building competencies.
4. Nurturing and integrating abilities.

Women need to use all these skills as they strive to make appropriate decisions for their families and for themselves. With the advent of media, women are aware of their own traits, rights and also the work situations. The challenges and opportunities provided to the women of digital era are growing rapidly-the job seekers are turning into job creators. Many women start a business due to some traumatic event, such as divorce, discrimination due to pregnancy or the corporate glass ceiling, the health of a family member, or economic reasons such as a layoff. However, a new talent pool of women entrepreneurs is forming today, as more women opt to leave the corporate world to chart their own destinies. They are flourishing as designers, interior decorators, exporters, publishers, garment manufacturers and still exploring new avenues of economic participation.

Review of Literature

Ammani S. et.al. (2016) made a comprehensive study on women entrepreneurs who have founded and run small non-profits and businesses in one city in India. The study findings show that while nonprofit entrepreneurs receive a high payoff from promoting social causes, we do not find single unifying payoff for-profit entrepreneurs. Family background, however, plays an important role in both sets of entrepreneurs in an interesting way. Furthermore, we find experience in the sector, social class and caste, and education also plays important roles. Policy implications are explored.

Hind Bouzekraoui and Driss Ferhane (2017) in their article presents the results of an exploratory study conducted among 80 Moroccan Female Entrepreneurs. The objective is to provide a general view on women entrepreneurship in Morocco through various indicators: the profile, the characteristics of the company created and the main barriers behind the low rate of women business creation in Morocco.

Chitra Sharma Mishra and Sukhmani Waraich, (2018) declares that the women are playing a vital role in the family, in society and in economy as well. They know actually how to balance the environment and work properly in the adverse situation. According to authors only a push is required to justify the women identity and sky is the limit. In this paper we go through the local and family support and the social economic conditions of women. The authors have taken the data of some working women who worked from their homes and have started their venture with little capital and successfully operating with proficiency with

the adverse philosophy of the family and society and also facing different kind barriers and try to tackle accordingly.

Research Gaps

A close examination of the literature on women entrepreneurs makes it clear that few studies discussed various factors that inspired the women to opt for starting an enterprise. Some studies concentrated on the status and major problems confronting by women entrepreneurs in running an enterprise. The membership of Self Help Groups has been identified as an important tool to run an enterprise by women. Some authors identified education, region, training and risk taking nature of women as essential ingredients for success as entrepreneurs. One study assessed the empower mental impact of entrepreneurship on women. There is a dearth of comparative studies on women entrepreneurship. As such the proposed study makes an attempt to study the empower mental impact of entrepreneurship on women inTelangana.

Statement of the Problem

The greatest deterrent to women entrepreneurs is that they are women. A kind of patriarchal- male dominant social order is the building block to them in their way towards business success. Male members think it a big risk of financing the ventures run by women .Male chauvinism is still prevalent in many parts of the country yet. Women are looked upon as “abala” i.e. weak in all respects. In a male dominated society, women are not treated equal to men that act as a barrier to woman’s entry into business. Women entrepreneurs have to face a stiff competition with the men entrepreneurs who easily involve in the promotion and development area and carry out easy marketing of their products with both the organized sector and their male counterparts. Such a competition ultimately results in the liquidation of women entrepreneurs. Lack of self-confidence, will-power, strong mental outlook and optimistic attitude amongst women creates a fear from committing mistakes while doing their piece of work. The family members and the society are reluctant to stand beside their entrepreneurial growth. Women in India lead a protected life. They are less educated, economically not stable nor self-dependent which reduce their ability to bear risks and uncertainties involved in a business unit. The old and outdated social outlook to stop women from entering in the field of entrepreneurship is one of the reasons for their failure. They are under a social pressure which restrains them to prosper and achieve success in the field of entrepreneurship. Unlike men, women mobility in India is highly limited due to many reasons. A single women asking for room is still looked with suspicion. Cumbersome

exercise involved in starting with an enterprise coupled with officials humiliating attitude towards women compels them to give up their spirit of surviving in enterprise altogether. Women's family obligations also bar them from becoming successful entrepreneurs in both developed and developing nations. The financial institutions discourage women entrepreneurs on the belief that they can at any time leave their business and become housewives again. Indian women give more emphasis to family ties and relationships. Married women have to make a fine balance between business and family. The business success also depends on the support the family members extended to women in the business process and management.

Significance of the study

The study of women's entrepreneurship assumes significance due to following conditions. The first reason is that women's entrepreneurship has been recognized during the last decade as an important untapped source of economic growth. Women entrepreneurs create new jobs for themselves and others and by being different also provide society with different solutions to management, organization and business problems as well as to the exploitation of entrepreneurial opportunities. The second reason is that the topic of women in entrepreneurship has been largely neglected both in society in general and in the social sciences. Not only have women lower participation rates in entrepreneurship than men but they also generally choose to start and manage firms in different industries than men tend to do. The industries (primarily retail, education and other service industries) chosen by women are often perceived as being less important to economic development and growth than high-technology and manufacturing. Furthermore, mainstream research, policies and programmes tend to be "men streamed" and too often do not take into account the specific needs of women entrepreneurs and would-be women entrepreneurs. As a consequence, equal opportunity between men and women from the perspective of entrepreneurship is still not a reality. In order for policy makers to address the situation the report makes a number of recommendations.

Objectives of the study

1. To analyze the need for Entrepreneurship skills of women entrepreneurs in telangana.
2. To identify the problems of Entrepreneurship Development on women empowerment in Telangana

3. To suggest some possible solutions for encouraging; developing, and improving the women empowerment in Telangana State.

Methodology

The research is based on secondary data. It's an exploratory and descriptive in nature. Given the nature of the present study, it was required to collect information from the secondary sources.. Secondary information was collected from research studies, books, journals, newspapers, ongoing academic working papers and websites of governments of India and Telangana.

Constraints Faced by Women

Women in advanced nations are recognized and are more prominent in the business world. However, the women entrepreneurs are facing some major constraints which are detailed below:

1. Socio-cultural Barriers: Family and personal obligations are sometimes a formidable barrier for success in business career for women. Only few women are able to manage both home and business efficiently.

2. Lack of Exposure to Training Programmes: Various training programmes and workshops for every type of entrepreneur are being organized by the Central and State Governments. Such programs are useful to new, rural and young entrepreneurs who want to set up a small-scale units on their own. However, not all potential women entrepreneurs are aware of these facilities,

3. Lack of Confidence: In general, women lack confidence in their strength and competence. The family members and entrepreneurial growth. Though this situation is changing yet women face a tremendous challenge to build their confidence.

4. Motivational Factors: Self-motivation can be realized through a mind set for a successful business, attitude to take up risk and behavior towards the business society by shouldering the social responsibilities. Other factors are family support, government policies, financial assistance from public and private institutions and also the environment suitable for women to establish business units.

5. Knowledge in Business Administration: Women must be educated and trained constantly to acquire the skills and knowledge in all the functional areas management. This can facilitate women to excel in decision making process and develop a good business network.

6. Lack of Awareness about Financial Assistance: Various institutions in the financial sector extend their support in the form of loans and other business promotional schemes.

Women entrepreneurs are generally not aware of all these programmes/schemes. Benefits of such schemes do not reach women entrepreneurs, particularly in rural and backward areas.

7. Market-oriented Risks: Stiff competition in the market and lack of mobility of women make the dependence of women entrepreneurs on middleman indispensable. Many business women find it difficult to capture the market and make their products popular. They are not fully aware of the changing market conditions and hence cannot effectively utilize the services of media and the internet.

The Telangana Government Approach:

The Telangana government has identified 14 as key sectors for promoting industrialization in the state, which includes, life sciences, automobiles, plastics, food processing, leather, textiles and apparels, transportation & logistics, IT hardware, etc., and provided sector specific incentives. Many initiatives are being undertaken to spread industries to the interior districts. Initiatives are on to set up nine leather parks, Auto Nagar and textile parks in different parts of the State. The IT and ITeS sectors have been the key engines of the state economy and employ skilled labor on a large scale. The government launched the overall IT Policy Framework providing incentives to set up IT related units in the state. Various measures are being taken up to establish IT units in tier-II cities and towns and to spread IT industry to rural areas. The new IT incubation hubs are being established in Warangal, Karimnagar, Nizamabad, and Khammam. The Rural Technology Policy incentivizes the large IT companies to set up their Technology and BPO centers in rural areas. This policy is expected to generate IT-related jobs in rural areas, thereby retaining the skilled workforce in rural areas. Various promotional incentives including exemption from Panchayat/ Municipal taxes, reimbursement of stamp duty, transfer duty, registration fee, and internet and telephone charges are being offered for such units'. With this backdrop of huge opportunities, we can see the Telangana government initiatives to achieve women empowerment through its innovative activities in the field of women entrepreneurship.

Government Initiatives:

The Government of Telangana has been taking various initiatives towards women entrepreneurs' development. They're as follows.

We Hub: The first-of-its-kind and solely State-run platform for Women Entrepreneurs. It helps women from various backgrounds by providing a soft-landing hub and mentoring them

to achieve success in their entrepreneurial journey. The first objective of WE HUB is to alter women entrepreneurs to succeed in their start-ups or businesses by overcoming structural challenges. Through its primary activity, it plans to form an eco-system that drives social change across India and the world. WE HUB is visualized to make an ancillary community for aspiring women entrepreneurs wherever they will interact with Venture Capitalists (VCs) for funding, connect with the company for scaling up their business, get the recommendation from mentors to fine-tune concepts, avoid expensive mistakes, and march forward on the trail to success with revived confidence. WE HUB provides 360-degree support for any aspiring women businessperson. Being a state-led initiative; it offers their services at affordable prices and in some cases no price in the least. Since empowering women and building women entrepreneurs could be a prime priority, the state has offered exciting edges for firms who wish to be a vicinity of this journey and partner with we HUB. At present we HUB providing the subsequent services for innovative startups they are:

- *Access to capital
- *Access to Mentors
- *Access to Infrastructure
- *Access to Support services
- *Access to venture capital pitch events
- *Guidance on Business branding, Partnerships, and promoting
- *Legal and auxiliary services support
- *Peer-peer/Founder's connections
- *Pre-accelerator programs
- *Strategic consulting

Industrial Incentives:

The Telangana government is committed to encouraging the process of industrial enterprise by creating numerous varieties of incentives out there to the entrepreneurs. There'll be increased incentive packages for scheduled Castes, scheduled Tribes, Physically disabled, and ladies entrepreneurs. Mega projects with an investment of over Rs. 200 crores in plant and machinery or employment on top of 1000 persons can receive tailored incentives additionally to straightforward massive class trade incentives. A number of those incentives for entrepreneurs conjointly helpful for women entrepreneurs are as follows...

*Women-owned Enterprises (Units established as sole owner or invariably having 100% shares in Partnership/Private restricted Companies) further 10 % investment grants on fixed capital investment subject to a most of Rs. 10.00 lakhs to MSE's.

*100% compensation of stamp duty and transfer duty paid by the business on a procurement of land meant for industrial use.

*100% compensation of stamp duty for Lease of Land/Shed/ Buildings and conjointly mortgages and hypothecations. 25th rebate in land price restricted to Rs.10.00 Lakhs in Industrial Estates/ Industrial Parks.

*25% Land conversion charges for industrial use restricted to Rs.10.0 lakhs.

Fixed power price compensation @ Rs. 1.00 per unit for five years from the date of commencement of economic production.

*15% investment grant on fixed capital investment subject to a most of Rs.20.00 lakhs.

* Reimbursement of 100% net VAT/CST or State goods and Services Tax (SGST) for an amount of five years from the date of commencement of economic production.

* Interest subsidy underneath Pavala Vaddi theme on the term loan taken on the fixed capital investment by new micro and small Enterprises in way over 3% per annum subject to a most reimbursement of 9% per annum for an amount of five years from the date of commencement of economic production.

* Seed capital help to 1st Generation Entrepreneurs to set-up small Enterprises @10% of the Machinery price, which can be subtracted from the eligible investment subsidy. → 50% reimbursement of the price concerned in ability up gradation and coaching the native work force restricted to Rs.2000 per person

Exclusive schemes for Telangana

The Telangana State Government is encourages the process of industrialization by implementing various kinds of incentives which benefits the entrepreneurs. The Telangana State Government also ensures an entrepreneur-friendly and graft-free regime of implementing the incentives. The State Government guarantees that the incentives are released on time, and directly to the bank account. There is a transparent on-line application system which is with minimum human interface. There is an improved incentive packages for Scheduled Castes, Scheduled tribes, Physically Handicapped, and women entrepreneurs. Mega Projects which have an investment of over Rs. 200 crores in plant and machinery or employment above 1000 persons are eligible to receive tailor-made incentives and large category industry incentives.

The State Government will provide incentives to the entrepreneurs in the following areas under its T-IDEA (Telangana State Industrial Development and Entrepreneur Advancement) incentive scheme:

Stamp duty reimbursement

Land cost rebate

Land conversion cost

Power cost reimbursement

Investment subsidy

VAT reimbursement

Interest subsidy

Seed capital for 1st generation entrepreneur

Training and skill development cost reimbursement

Quality/patent support

Clean production measures

Reimbursement of infrastructure development costs

Details of general and sector-specific incentives will be laid down under Government Orders from time to time and published on the website and through other means. The Government will also ensure that the existing industries are also benefited, while providing incentives to new industries

Special Assistance to Women Entrepreneurs

The number of existing women-owned industrial enterprises is very meager. The Telangana State Government encourages women entrepreneurs in a various ways. All the 9 districts of the state (excluding Hyderabad) have one or more than one industrial parks exclusively for women entrepreneurs. Organizations which are working for women entrepreneurs like COWE, ALEAP and FICCI-FLO are invited to partner with the government in order to identify and train women entrepreneurs, get their project proposals developed, link them to financial institutions and handhold and monitor the progress of their projects. The government would facilitate more number of women entrepreneurs to emerge from socially deprived categories like SCs, STs, BCs and Minorities.

New Industrial Policy for the State of Telangana,2014

This policy has laid down various schemes for women who belong to backward classes. The benefits included under this policy are as follows:

Women owned enterprises are those enterprises which are established as sole Proprietors or invariably having 100% share in Partnership/Private Limited Companies. An additional 10% investment subsidy on fixed capital investment subject to a maximum of Rs. 10.00 lakhs to MSE's. (total investment subsidy limited to Rs.50.00 lakhs only)

Telangana Women's Cooperative Development Corporation

It was established in the year 1975 with an objective of empowerment of rural women and is a registered co-operative under the Societies Act 1964. The major activities performed by this corporation are as follows:

- a) Structured training programme is imparted to unemployed women in vocational courses and trades which are organised by District Durgabai Mahila Sisu Vikasa Kendrams (DMSVKs)
- b) Training is imparted to field functionaries of Nutrition & Health sectors, i.e. Anganwadi workers, Asha workers, ANM etc
- c) Marketing facilities are provided to Women entrepreneurs through exhibitions, trade fairs, and buyer seller meets, design and display centers, etc
- d) Working Womens Hostels are managed by this corporation
- e) Bridge schools for school drop outs are organized.
- f) It serves as a Nodal Agency for processing the proposals of NGOs for setting up of Women Empowerment Programmes with the financial assistance of GOI.
- g) It provides shelter and short stay homes for destitute and deserted women
- h) Government is providing the financial assistance to the Corporation in meeting the establishment and contingent charges for the Head Office and Durgabai Mahila Sisu Vikasa Kendrams.

Problems of Women Entrepreneurs in Telangana:

*Entrepreneurs would like skilled steerage to assist them begin and grow their businesses. Within the us., they're fostering mentorship through programs like SCORE - a nationwide initiative wherever productive men and girls coach people who wish to become their own CEOs. And once it involves equitable laws, whereas many nations as well as Telangana have created tremendous strides, there's still abundant work to be done.

* Entire entrepreneurship epicenter centered in and around of Hyderabad, at a similar time policymakers neglected remaining a part of the State's resources to bring thought entrepreneurship path, particularly neglected rural ladies potential.

*Many of the ladies enterprises have imperfect set up. in an exceedingly high competitive market they need to fight arduous to survive not solely against organized sector however additionally against their male counterpart. They rely upon middleman for promoting and distribution of the merchandise because it is dominated by males and infrequently their security and safety considerations are available in the means.

* Availability of monetary capital is crucial to entrepreneurial method. In India parental stabile property goes to youngster by succession and so albeit girls desires to begin up her business she lacks adequate monetary resources and is additionally ineffectual to afford external finance thanks to absence of tangible security to function collaterals in monetary establishments.

*Perceived lack of time as a result of burden of assorted domestic chores and responsibility of raising kids. This dearth of time doesn't permit them to visit financial establishments for recommendation and credit info and to attend coaching programs for getting new skills.

Suggestions:

* Information and awareness regarding entrepreneurial opportunities and entrepreneurship as a career possibility got to be created in society at massive. In educational activity entrepreneurship ought to be created mandatory across all streams. Vocational education ought to begin from school level.

*Increasing awareness at the grass root level regarding the schemes and policies for ladies enterpriser and therefore the roadmap to avail them. Identification of self-made women entrepreneurs and creating them role models can facilitate in motivating and increasing the

sureness of prospective girl's entrepreneurs. For this building, a mentor network is important through that steering and training might be provided. Leadership ability development; that encompasses skills like social, risk-taking, crisis management, time and stress management, change management; workshops ought to be conducted.

*Training in varied areas involving entrepreneurial activities.

*Banks ought to have a definite quota for collateral free loaning to girls with a daily observance system.

*Efforts ought to be created to supply a safe and secure atmosphere to travel and run the business.

* Strict legal and regulative framework to examine for sexual abuses.

Conclusion

Entrepreneurship development is a very crucial factor for the acceleration of economic growth of any country and women entrepreneurship development is an essential part of human resource development, Women have started showing more interest in entrepreneurship because it provides them an opportunity to be their own boss.

Women's entrepreneurship holds sturdy potential for spurring economic chance and job creation in not solely India however conjointly in Telangana state. Additionally, growing proof suggests that economically empowering ladies might reap substantial advantages for the health and wellbeing of families and communities. Telangana has conjointly been parturition respectable emphasis on ladies entrepreneurship development. Since the formation of Telangana as a twenty ninth state, the standing of women in Telangana has been dynamical because of initiatives and pro-active ways adopted and enforced by the govt. With the unfold of entrepreneurial education and awareness, ladies have shifted from the extended kitchen, handicrafts and traditional cottage industries to non-traditional activities find it irresistible startups, drug company startups, and so on. As justly aforesaid by Neena Nigam, Director-General of income tax, the beginning for empowering ladies starts at home once parents provide equal rights and opportunities to their sons and daughters to pursue education and freedom to create choices. Women empowerment is that the empowerment of Telangana. We will conclude this paper in the words of K.T.Rama Rao Telangana State has the vision to empower rural and urban women and induce the required talent sets for them to become

independent. I feel the state's mission of Bangaru Telangana can return true once every woman is empowered in the state.

The subject of empowerment of women has becoming a burning issue all over the world including India since last few decades. Inequalities between men and women and discrimination against women have also been age-old issues all over the world. Thus, women's quest for equality with man is a universal phenomenon. They have demanded equality with men in matters of education, employment, inheritance, marriage, and even in politics. Women want to have for themselves the same strategies of change which men folk have had over the centuries such as equal pay for equal work. Hence, they are taking more personal decisions, for instance, about their further education, marriage, and in career. More and more women want freedom of work and control their own reproduction, freedom of mobility and freedom to define one's own style of life. It is contended that freedom leads to greater openness, generosity and tolerance. Entrepreneurship is an important tool to empower the women in the country by increasing Family, Economic, Financial and Social Status. From the above study it has been safely concluded that Entrepreneurship brings gender equality and also improves the overall status of women in the family, society and in the nation.

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The Trends in Mutual Fund Industry in India: An Analysis

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Abstract

The history of mutual funds dates support to 19th century when it was introduced in Europe, in particular, Great Britain. Robert Fleming set up in 1868 the first investment trust called Foreign and colonial investment trust which promised to manage the finances of the moneyed classes of Scotland by scattering the investment over a number of different stocks. This investment trust and other investment trusts which were afterward set up in Britain and the U.S., resembled today's close - ended mutual funds. The Indian Mutual Fund has passed through three phases. The first phase was between 1964 and 1987 and the only player was the Unit Trust of India, which had a total asset of Rs. 6,700 crores at the end of 1988. The second phase is between 1987 and 1993 during which period 8 Funds were established (6 by banks and one each by LIC and GIC). The total assets under management had grown to 61,028 crores at the end of 1994 and the number of schemes was 167. The third phase began with the entry of private and foreign sectors in the Mutual Fund industry in 1993. This paper aims to study the recent trends in mutual fund industry in India. It is observed that mutual funds have become an important part of investment matrix.

Introduction

Industrialization reflects nations self sufficiency's which is herculean task and requires judicious approach to justify factors involve. It can be possible by adopting balance economy structure which largely depends upon sound financial health of the nation and its economy. Liberalization multiplied global competition which translated into growth and resulted high earning and saving. To cater the universal economic and political competition, government has to play parental role in money supply which is possible through sound earning and social saving of the investor and their risk taking psychology. Generally decisions about investment are quiet crucial for an investors as they are influenced by many factors and have considerations like company goodwill, government policies, economics of sales and the trend in a particular sector, economic and social environment, risk and return, level of earning of the individual, his educational background, marital status and

demographic variables etc. Traditional finance and economic theory is based on the notion of "rational man" which is based on the assumption that individuals are smart enough to understand complicated puzzles and conduct endless instantaneous optimizations and classical economic literature consider human beings as rational entities with having incredible ability of making right decisions in the situation of complete transparency. Herbert Simon, on the other hand emphasizes that in decision making human beings are suffocated rational not absolute rational.

Trends in Mutual Fund Industry

The mutual fund industry maintained its growth momentum during 2018-19 as well. The industry saw gross resources mobilisation to the tune of ₹ 243.9 lakh crore during 2018-19 compared to ₹ 210.0 lakh crore during 2017-18. The AUM of mutual fund industry grew by 11.4 per cent to ₹ 23.8 lakh crore at the end of March 2019 from ₹ 21.4 lakh crore at the end of March 2018. The net resources mobilised by all mutual funds in India were ₹ 1.1 lakh crore during 2018-19.

Private sector mutual funds continued to retain their dominance in the mutual fund industry in 2018-19 as well, with a share of 80.6 per cent in gross resource mobilisation and 56.1 per cent in net resource mobilisation. The gross resource mobilisation by the private sector mutual funds rose by 13.1 per cent to ₹ 196.5 lakh crore in 2018-19, while that by public sector mutual funds rose by 31.1 per cent to ₹ 47.4 lakh crore in 2018-19 as compared to the last year. The share of public sector mutual funds in gross resource mobilisation increased to 19.4 per cent during 2018-19 from 17.2 per cent in the previous year. Similarly, the share of public sector mutual funds in net resource mobilisation increased to 43.9 per cent in 2018-19 from 15.9 per cent in the previous year. The net resource mobilisation by private sector mutual funds decreased by 73.1 per cent to ₹ 0.62 lakh crore in 2018-19 from ₹ 2.3 lakh crore in 2017-18, while that by public sector mutual funds increased by 11.2 per cent from ₹ 0.43 lakh crore to ₹ 0.48 lakh crore during the same period

The open ended schemes of private sector mutual funds witnessed a net inflow of ₹ 0.6 lakh crore in 2018-19 compared to ₹ 2.3 lakh crore in the previous year and open ended scheme of public sector mutual funds saw a net inflow of ₹ 0.43 lakh crore in 2018-19 compared to ₹ 0.37 lakh crore during previous year. In the close-ended schemes, both private sector and public sector mutual funds were recorded net inflows during 2018-19.

Review of Literature

Ravi Vyas (2012) in their paper made an attempt to examine on the number of factors that highlights investors' perception about mutual funds. It was found that mutual funds were

not that much known to investors, still investor rely upon bank and post office deposits, most of the investor used to invest in mutual fund for not more than 3 years and they used to quit from the fund which were not giving desired results. Equity option and systematic investment plan (SIP) mode of investment were on top priority in investors' list. It was also found that maximum number of investors did not analyse risk in their investment and they were depend upon their broker and agent for this work.

Shalini Goyal and Daully Bansal (2013) in their study focus on the entire journey of mutual fund industry in India. Its origin, its fall and rise throughout all these years and tried to predict what the future may hold for the Mutual Fund Investors in the long run. A mutual fund, also called an investment company, is an investment vehicle which pools the money of many investors. The fund's manager uses the money collected to purchase securities such as stocks and bonds. The securities purchased are referred to as the fund's portfolio. Restrictions on competing products may have acted as a catalyst for the development of money market and (short-term) bond funds. This study was conducted to analyze and compare the performance of different types of mutual funds in India and concluded that equity funds outperform income funds. This study further concludes that equity fund managers possess significant market timing ability and institutions funds managers are able to time their investments, but brokers operated funds did not show market timing ability. Further, it has been found empirically that fund managers are able to time their investments with the conditions in the market, and possesses significant timing ability.

Nilesh and Dipsh Dhanda (2015) describe the growth of mutual funds in India in terms of number of schemes and the net assets under management of mutual fund managers. The number of mutual fund schemes and the net assets under management of Indian mutual fund manages has increased during the study period. The growth of private sector mutual funds is restively high as compared to UTI and public sector mutual fund managers.

Poonam Gautam Sharma ((2016) in their study presents the attributes of mutual fund industry in India, its development since inception with UTI, entry of public sector, private sector and foreign enterprise, various schemes offered by companies especially started to meet small investor's needs. The author also explains the growth aspects of the mutual fund industry along with some guidelines that would result in safe investment and reasonable return. The study is to reveal the mutual fund industry from its inception to current position. The data used for the study is secondary in nature. To analyze the data various statistical tools like average, percentage and CAGR were used.

Shivangi Agarwal, Nawazish Mirza,m (2017) in their paper addresses the multiple research issues. These include measuring the performance of selected mutual schemes on the basis of risk and return and compare the performance of these selected schemes with benchmark index to see whether the scheme is outperforming or underperforming the benchmark. They also rank funds on the basis of performance and suggest strategies to invest in a mutual fund and therefore, our findings have significant relevance for investing public.

Uppily R. and K S Meenakshisundaram (2018) in their research work analysed their financial literacy level with respect to various debt mutual funds schemes. The study indicates that there is a significant relationship between age and awareness about gilt short term mutual fund, there is a significant relationship between age and awareness about hybrid debt oriented mutual fund. The study further indicates that there is significant difference between purpose of investment in debt mutual funds and source to know about mutual fund.

Udhayasankar R. and K. Maran (2018) in their research paper makes an attempt to identify various factors affecting perception of investors regarding investment in mutual funds. The study reveals that the investors feel that, the company should analysis perfectly before going to invest the specific fund schemes. The organization tries its level best to satisfy their customers by providing prompt services. The investors today are more sophisticated more selective and more demanding than ever before. Hence understanding the customer requirements can help the organization to survive and sustains and through in the long run.

Vasavi P and CH. Hema Venkata Siva Sree (2020) considers that the Mutual Fund industry is having its hands full to cater to various needs of the investors by coming up with new plans, schemes and options with respect to rate of returns, dividend frequency and liquidity. In view of the growing competition in the Mutual Funds industry, it was felt necessary to study the investor's orientation towards Mutual Funds i.e. their pattern of risk apatite and preferences in various schemes, plans and options in order to provide a better service.

Objectives of the Study

1. To trace the history and growth of mutual fund industry at global and national level.
2. To assess the progress of resource mobilization by the public and private sector mutual fund industries.

Methodology

The present study is descriptive in nature. The research method applied for the study is survey method.

Public and Private Sector Mutual funds

As on March 31, 2019, there are 45 mutual funds registered with SEBI, of which 37 are from private sector and eight (including UTI) are from public sector. To protect investor interests and to promote a fair and orderly securities market, SEBI ensures the integrity of the markets by detecting market frauds on a proactive basis, investigating abusive, manipulative or illegal dealings in the securities market and taking punitive action to punish the wrongdoers, while simultaneously reviewing policies and procedures to minimize the risk of recurrence of such practices.

The entry of private sector funds in Indian mutual fund industry Indian investors are give a wider choice of fund families. This was the year in which the first Mutual Fund Regulations came into being, under which all mutual funds, except UTI were to be registered and governed. The erstwhile Kothari Pioneer (now merged with Franklin Templeton) was the first private sector mutual fund registered in July 1993. The 1993 SEBI (Mutual Fund) Regulations were substituted by a more comprehensive and revised Mutual Fund Regulations in 1996. The industry now functions under the SEBI (Mutual Fund) Regulations 1996. The number of mutual fund houses went on increasing, with many foreign mutual funds setting up funds in India and also the industry has witnessed several mergers and acquisitions.

Results and Discussions

Table 1 presents the data with regard to category-wise resource mobilisation by mutual funds in India

Table 1
Category-wise Resource Mobilisation by Mutual Funds: Public/Private Sector

Period	Gross Mobilisation				Redemption*				Net Inflow				Assets at the End of Period
	Private Sector	Public Sector	UTI	Total	Private Sector	Public Sector	UTI	Total	Private Sector	Public Sector	UTI	Total	
2010-11	69,22,924	7,83,858	11,52,733	88,59,515	69,42,140	8,00,494	11,66,288	89,08,921	-19,215	16,636	13,555	-49,406	5,92,250
2011-12	56,83,744	5,22,453	6,13,482	68,19,679	56,99,189	5,25,637	6,16,877	68,41,702	-15,446	-3,184	-3,394	-22,024	5,87,217
2012-13	59,87,889	6,33,350	6,46,646	72,67,885	59,19,979	6,28,720	6,42,647	71,91,346	67,911	4,629	3,999	76,539	7,01,443
2013-14	80,49,397	8,02,352	9,16,351	97,68,101	80,00,559	8,01,951	9,11,808	97,14,318	48,838	401	4,543	53,783	8,25,240
2014-15	91,43,962	19,42,297	NA	1,10,86,260	90,40,262	19,42,710	NA	1,09,82,972	1,03,700	-412	NA	1,03,288	10,82,757
2015-16	1,11,26,277	26,39,279	NA	1,37,65,555	1,10,34,883	25,96,492	NA	1,36,31,375	91,394	42,787	NA	1,34,181	12,32,824
2016-17	1,42,47,937	33,67,612	NA	1,76,15,549	1,39,68,549	33,03,951	NA	1,72,72,500	2,79,388	63,661	NA	3,43,049	17,54,619
2017-18	1,73,82,189	36,16,463	NA	2,09,98,652	1,71,53,718	35,73,137	NA	2,07,26,855	2,28,471	43,326	NA	2,71,797	21,36,036
2018-19	1,96,52,989	47,41,374	NA	2,43,94,362	1,95,91,483	46,93,178	NA	2,42,84,661	61,505	48,196	NA	1,09,701	23,79,663
Apr 18-Dec 18	1,44,69,181	34,44,490	NA	1,79,13,671	1,44,32,854	33,94,115	NA	1,78,26,969	36,327	50,376	NA	86,702	22,85,912
Apr19-Dec 19	1,25,16,197	29,51,162	NA	1,54,67,359	1,24,00,687	28,84,797	NA	1,52,85,484	1,15,510	66,365	NA	1,81,875	2,29,40,962

Notes:

- * Includes repurchases as well as redemption
- Erstwhile UTI has been divided into UTI Mutual Fund (registered with SEBI) and the Specified Undertaking of UTI (not registered with SEBI). Above data contains information only for UTI Mutual Fund.
- Since April 2014, the figures for UTI Mutual Fund are being reported with those of public sector MFs.

Source: SEBI.

It is evident from table 1 that the share of private sector in gross mobilization of sources under mutual funds is higher than public sector. The share of gross mobilization of resources by private sector ranges between 83.34 per cent (2011-12) to 78.14 per cent ((2010-11). The share of UTI in gross mobilization resources in 201-11 is 13.01 per cent and its share is lowest (8.90 per cent) in 2012-13. With regard to redemption of mutual funds more or less same trends are noticeable. However the net inflow of funds in case of both public and private sectors is showing negative trends during the first 2 years of study. Further with regard to public sector in 2014-15 also negative trends are visible.

Transactions on Stock Exchanges by Mutual Funds

The trends with regard to transactions on stock exchanges by mutual funds are presented in table 2.

Table 2
Trends in Transactions on Stock Exchanges by Mutual Funds

Period	Equity			Debt			Total		
	Gross Purchase	Gross Sales	Net Purchase/Sales	Gross Purchase	Gross Sales	Net Purchase/Sales	Gross Purchase	Gross Sales	Net Purchase/Sales
2010-11	1,54,919	1,74,893	-19,975	7,64,142	5,15,290	2,48,854	9,19,060	6,90,183	2,28,879
2011-12	1,32,137	1,33,494	-1,358	11,16,760	7,81,940	3,34,820	12,48,897	9,15,434	3,33,463
2012-13	1,13,758	1,36,507	-22,749	15,23,393	10,49,934	4,73,460	16,37,150	11,86,440	4,50,711
2013-14	1,12,131	1,33,356	-21,224	15,38,087	9,94,842	5,43,247	16,50,219	11,28,197	5,22,023
2014-15	2,31,409	1,90,687	40,722	17,17,155	11,30,138	5,87,018	19,48,565	13,20,825	6,27,741
2015-16	2,81,334	2,15,191	66,143	14,97,676	11,21,386	3,76,290	17,79,010	13,36,577	4,42,433
2016-17	3,76,874	3,20,316	56,559	16,05,937	12,86,084	3,19,853	19,82,812	16,06,399	3,76,412
2017-18	6,67,009	5,25,240	1,41,769	18,25,231	14,54,515	3,70,716	24,92,240	19,79,755	5,12,485
2018-19	7,08,991	6,21,112	87,879	22,67,416	18,77,490	3,89,925	29,76,407	24,98,603	4,77,804
2019-20*	5,33,652	4,83,353	50,299	16,88,060	13,01,776	3,86,284	22,21,712	17,85,129	4,36,583

* as on December 31 2019 Source: SEBI

It is evident from table 2 that the net equity purchase/ sales of mutual funds in the country are showing negative trends during first four years of study. On the other hand the debt purchase/ sales of mutual funds in the country are showing positive trends during 10 years of study. The total net purchase/ sale of mutual funds in India were gradually increasing during first 5 years of study, there after it is unevenly distributed. The total gross purchase of mutual funds is highest in 2018-19 (₹ 24, 98,603) and touched lowest ebb in 2010-11 (₹. 9, 19,060). It means during 9 years of the gross purchases increased more than 3 times.

Unit Holding Pattern of Mutual Funds

The month-wise data on unit holding pattern of mutual funds is presented in table 3.

Table 3
Month Wise Unit Holding Pattern of Mutual Funds

Month	Total AUM (Rs. Crore)	AUM held by (Rs. Crore)				Percentage of AUM held (per cent)			
		Corporates	HNI's	Retail Investors	Banks	Corporates	HNI's	Retail Investors	Banks
Apr-10	7,98,290	3,89,182	1,19,825	1,58,636	1,30,647	48.8	15.0	19.9	16.4
May-10	7,07,377	3,48,508	1,20,821	1,59,357	78,690	49.3	17.1	22.5	11.1
Jun-10	6,32,293	3,28,703	1,23,945	1,60,265	19,381	52.0	19.6	25.3	3.1
Jul-10	6,63,864	3,34,715	1,26,575	1,58,522	44,052	50.4	19.1	23.9	6.6
Aug-10	7,07,913	3,31,437	1,29,363	1,60,632	86,481	46.8	18.3	22.7	12.2
Sep-10	6,67,324	3,29,140	1,34,504	1,71,385	32,296	49.3	20.2	25.7	4.8
Oct-10	6,47,519	3,08,909	1,34,968	1,68,256	35,386	47.7	20.8	26.0	5.5
Nov-10	6,62,660	3,18,824	1,36,357	1,61,362	46,117	48.1	20.6	24.4	7.0
Dec-10	6,24,282	2,94,136	1,40,470	1,64,617	25,060	47.1	22.5	26.4	4.0
Jan-11	6,86,361	3,18,854	1,34,883	1,50,360	82,264	46.5	19.7	21.9	12.0
Feb-11	7,03,975	3,23,700	1,36,096	1,45,710	98,468	46.0	19.3	20.7	14.0
Mar-11	5,94,720	2,72,562	1,43,636	1,56,751	21,771	45.8	24.2	26.4	3.7
Apr-11	7,81,791	3,49,588	1,46,576	1,56,054	1,29,573	44.7	18.7	20.0	16.6
May-11	7,29,503	3,38,543	1,49,277	1,53,391	88,291	46.4	20.5	21.0	12.1
Jun-11	6,73,443	3,13,474	1,51,661	1,56,007	52,301	46.5	22.5	23.2	7.8
Jul-11	7,24,009	3,39,516	1,57,476	1,56,179	70,837	46.9	21.8	21.6	9.8
Aug-11		3,35,698	1,54,054		60,732	48.2	22.1	20.9	8.7

Month	Total AUM (Rs. Crore)	AUM held by (Rs. Crore)				Percentage of AUM held (per cent)			
		Corporates	HNIs	Retail Investors	Banks	Corporates	HNIs	Retail Investors	Banks
	6,96,346			1,45,862					
Sep-11	6,42,438	3,04,175	1,55,785	1,45,944	36,533	47.3	24.2	22.7	5.7
Oct-11	6,94,916	3,28,825	1,62,074	1,51,886	52,131	47.3	23.3	21.9	7.5
Nov-11	6,83,214	3,35,436	1,61,094	1,41,881	44,803	49.1	23.6	20.8	6.6
Dec-11	6,12,140	3,01,648	1,54,582	1,35,498	20,412	49.3	25.3	22.1	3.3
Jan-12	6,61,236	3,13,912	1,59,706	1,50,308	37,309	47.5	24.2	22.7	5.6
Feb-12	6,74,905	3,18,558	1,66,646	1,55,547	34,153	47.2	24.7	23.0	5.1
Mar-12	5,88,955	2,55,695	1,63,132	1,54,435	15,692	43.4	27.7	26.2	2.7
Apr-12	6,81,633	3,18,719	1,67,403	1,54,443	41,069	46.8	24.6	22.7	6.0
May-12	7,02,267	3,39,982	1,67,797	1,46,603	47,886	48.4	23.9	20.9	6.8
Jun-12	6,90,199	3,40,531	1,72,047	1,53,352	24,269	49.3	24.9	22.2	3.5
Jul-12	7,31,948	3,50,906	1,75,340	1,53,211	52,490	47.9	24.0	20.9	7.2
Aug-12	7,54,891	3,72,619	1,79,533	1,50,592	52,147	49.4	23.8	19.9	6.9
Sep-12	7,27,348	3,45,474	1,84,378	1,62,194	35,302	47.5	25.3	22.3	4.9
Oct-12	7,71,701	3,71,240	1,87,613	1,60,634	52,214	48.1	24.3	20.8	6.8
Nov-12	8,03,041	3,91,761	1,95,148	1,66,010	50,122	48.8	24.3	20.7	6.2
Dec-12	7,69,071	3,77,081	1,94,961	1,66,600	30,428	49.0	25.4	21.7	4.0
Jan-13	8,27,213	4,05,585	2,00,351	1,66,066	55,210	49.0	24.2	20.1	6.7
Feb-13	8,16,724	4,11,386	1,97,886	1,55,686	51,766	50.4	24.2	19.1	6.3
Mar-13	7,05,148	3,35,296	1,98,891	1,54,461	16,501	47.5	28.2	21.9	2.3
Apr-13	8,25,815	4,13,673	2,18,086	1,41,411	52,645	50.1	26.4	17.1	6.4
May-13	8,68,094	4,43,488	2,26,718	1,38,990	58,898	51.1	26.1	16.0	6.8
Jun-13	8,11,403	4,23,307	2,27,671	1,34,836	25,588	52.2	28.1	16.6	3.2
Jul-13	7,73,089	3,99,593	2,23,691	1,31,031	18,774	51.7	28.9	16.9	2.4
Aug-13	7,66,684	3,98,963	2,23,246	1,28,218	16,256	52.0	29.1	16.7	2.1
Sep-13	7,62,549	3,83,696	2,29,130	1,33,844	15,879	50.3	30.0	17.6	2.1
Oct-13	8,48,258	4,23,395	2,36,438	1,41,852	46,573	49.9	27.9	16.7	5.5
Nov-13	8,90,143	4,55,002	2,38,214	1,42,878	54,049	51.1	26.8	16.1	6.1
Dec-13	8,45,387	4,36,467	2,38,197	1,45,700	25,023	51.6	28.2	17.2	3.0
Jan-14	9,04,965	4,66,979	2,43,986	1,39,104	54,896	51.6	27.0	15.4	6.1
Feb-14	9,17,438	4,74,483	2,46,492	1,42,593	53,871	51.7	26.9	15.5	5.9
Mar-14	8,27,786	4,08,135	2,48,549	1,52,843	18,260	49.3	30.0	18.5	2.2
Apr-14	9,47,252	4,80,880	2,51,873	1,52,871	61,627	50.8	26.6	16.1	6.5
May-14	10,12,787	5,14,634	2,61,354	1,68,912	67,887	50.8	25.8	16.7	6.7
Jun-14	9,85,403	5,08,257	2,73,695	1,81,862	21,589	51.6	27.8	18.5	2.2
Jul-14	10,26,707	5,06,635	2,76,572	1,81,699	61,801	49.3	26.9	17.7	6.0
Aug-14	10,36,604	5,00,909	2,83,327	1,88,015	64,353	48.3	27.3	18.1	6.2
Sep-14	9,96,838	4,82,911	2,88,398	1,92,850	32,679	48.4	28.9	19.3	3.3
Oct-14	11,00,020	5,30,044	3,00,836	2,02,309	66,830	48.2	27.3	18.4	6.1
Nov-14	11,18,311	5,30,198	3,10,258	2,10,410	67,446	47.4	27.7	18.8	6.0
Dec-14		5,18,695	3,17,483		27,708	48.2	29.5	19.7	2.6

Month	Total AUM (Rs. Crore)	AUM held by (Rs. Crore)				Percentage of AUM held (per cent)			
		Corporates	HNIs	Retail Investors	Banks	Corporates	HNIs	Retail Investors	Banks
	10,75,987			2,12,102					
Jan-15	11,60,971	5,65,689	3,05,811	2,33,860	55,611	48.7	26.3	20.1	4.8
Feb-15	11,81,205	5,72,669	3,18,338	2,29,488	60,709	48.5	27.0	19.4	5.1
Mar-15	10,63,588	5,02,564	3,18,489	2,28,392	14,142	47.3	29.9	21.5	1.3
Apr-15	11,64,698	5,53,585	3,20,989	2,25,109	65,016	47.5	27.6	19.3	5.6
May-15	11,95,428	5,60,540	3,30,935	2,32,574	71,377	46.9	27.7	19.5	6.0
Jun-15	11,71,132	5,58,007	3,35,846	2,33,577	43,701	47.6	28.7	19.9	3.7
Jul-15	12,90,611	6,16,754	3,48,187	2,42,359	83,310	47.8	27.0	18.8	6.5
Aug-15	12,61,019	5,84,209	3,54,084	2,45,226	77,500	46.3	28.1	19.4	6.1
Sep-15	11,92,734	5,61,115	3,55,880	2,47,739	29,621	47.0	29.8	20.8	2.5
Oct-15	13,28,988	6,32,744	3,64,174	2,53,841	78,228	47.6	27.4	19.1	5.9
Nov-15	13,00,407	6,02,330	3,71,683	2,57,226	69,168	46.3	28.6	19.8	5.3
Dec-15	12,80,041	6,20,996	3,72,119	2,60,119	26,807	48.5	29.1	20.3	2.1
Jan-16	12,79,000	5,98,330	3,66,522	2,50,714	63,434	46.8	28.7	19.6	5.0
Feb-16	12,68,111	6,07,211	3,55,679	2,37,099	68,124	47.9	28.0	18.7	5.4
Mar-16	12,38,115	5,88,160	3,72,464	2,61,137	16,354	47.5	30.1	21.1	1.3
Apr-16	14,27,335	6,86,124	3,85,758	2,69,837	82,497	48.1	27.0	18.9	5.8
May-16	13,86,876	6,32,030	3,96,359	2,79,195	78,537	45.6	28.6	20.1	5.7
Jun-16	13,86,131	6,43,573	4,08,234	2,90,123	44,201	46.4	29.5	20.9	3.2
Jul-16	15,23,558	6,97,920	4,23,294	3,04,960	97,384	45.8	27.8	20.0	6.4
Aug-16	15,68,680	7,37,335	4,30,247	3,14,226	86,872	47.0	27.4	20.0	5.5
Sep-16	15,85,581	7,93,205	4,35,961	3,18,017	38,397	50.0	27.5	20.1	2.4
Oct-16	16,34,439	7,53,193	4,48,073	3,27,056	1,04,649	46.1	27.4	20.0	6.4
Nov-16	16,55,324	7,87,519	4,49,102	3,21,559	97,144	47.6	27.1	19.4	5.9
Dec-16	16,51,522	8,38,569	4,51,894	3,22,185	38,875	50.8	27.4	19.5	2.4
Jan-17	17,42,394	8,22,064	4,71,689	3,41,090	1,07,550	47.2	27.1	19.6	6.2
Feb-17	17,94,409	8,39,385	4,88,632	3,58,447	1,07,946	46.8	27.2	20.0	6.0
Mar-17	17,59,898	8,59,316	5,01,545	3,75,190	23,847	48.8	28.5	21.3	1.4
Apr-17	19,31,598	9,27,079	5,20,053	3,91,327	93,140	48.0	26.9	20.3	4.8
May-17	19,09,188	8,71,029	5,39,415	4,01,443	97,302	45.6	28.3	21.0	5.1
Jun-17	19,01,446	9,04,131	5,49,834	4,09,643	37,838	47.5	28.9	21.5	2.0
Jul-17	20,02,152	8,89,918	5,78,436	4,33,963	99,835	44.4	28.9	21.7	5.0
Aug-17	20,64,622	9,23,873	5,85,990	4,36,526	1,07,584	44.7	28.4	21.1	5.2
Sep-17	20,45,668	9,58,142	5,98,145	4,46,289	43,091	46.8	29.2	21.8	2.1
Oct-17	21,46,734	9,37,135	6,24,649	4,75,374	1,09,576	43.7	29.1	22.1	5.1
Nov-17	22,84,327	10,33,233	6,39,260	4,91,381	1,20,454	45.2	28.0	21.5	5.3
Dec-17	21,31,897	9,32,631	6,58,028	5,14,003	27,235	43.7	30.9	24.1	1.3
Jan-18	22,46,475	9,88,464	6,72,249	5,23,511	62,066	44.0	29.9	23.3	2.8
Feb-18	22,24,624	9,67,508	6,70,592	5,16,908	69,615	43.5	30.1	23.2	3.1
Mar-18	21,40,246	9,43,335	6,65,417	5,10,303	21,191	44.1	31.1	23.8	1.0
Apr-18		10,09,996	6,93,546		83,657	43.4	29.8	23.3	3.6

Month	Total AUM (Rs. Crore)	AUM held by (Rs. Crore)				Percentage of AUM held (per cent)			
		Corporates	HNI's	Retail Investors	Banks	Corporates	HNI's	Retail Investors	Banks
	23,29,721			5,42,522					
May-18	22,63,743	9,57,948	6,93,330	5,38,752	73,713	42.3	30.6	23.8	3.3
Jun-18	22,90,489	10,17,372	6,91,456	5,36,131	45,531	44.4	30.2	23.4	2.0
Jul-18	23,09,559	9,47,146	7,14,527	5,60,853	87,034	41.0	30.9	24.3	3.8
Aug-18	25,24,493	10,85,798	7,45,059	5,86,212	1,07,424	43.0	29.5	23.2	4.3
Sep-18	22,08,379	9,05,183	7,26,601	5,39,917	36,678	41.0	32.9	24.4	1.7
Oct-18	22,27,476	9,10,600	7,13,708	5,42,812	60,356	40.9	32.0	24.4	2.7
Nov-18	24,07,021	10,37,226	7,29,730	5,62,643	77,423	43.1	30.3	23.4	3.2
Dec-18	22,89,842	9,34,876	7,34,062	5,75,686	45,219	40.8	32.1	25.1	2.0
Jan-19	23,41,091	9,54,983	7,33,370	5,71,121	81,617	40.8	31.3	24.4	3.5
Feb-19	23,20,430	9,45,708	7,38,063	5,74,409	62,250	40.8	31.8	24.8	2.7
Mar-19	23,83,848	9,71,098	7,65,209	6,19,848	27,692	40.7	32.1	26.0	1.2
Apr-19	24,83,498	10,26,332	7,68,675	6,18,169	70,322	41.3	31.0	24.9	2.8
May-19	25,98,824	10,97,866	7,79,197	6,37,583	84,178	42.2	30.0	24.5	3.2
Jun-19	24,30,808	9,78,238	7,79,035	6,30,948	42,587	40.2	32.0	26.0	1.8
Jul-19	24,60,056	10,10,736	7,63,976	6,05,615	79,730	41.1	31.1	24.6	3.2
Aug-19	25,54,899	10,88,055	8,57,208	5,11,075	98,561	42.6	33.6	20.0	3.9
Sep-19	24,58,783	9,96,324	8,83,361	5,35,641	43,457	40.5	35.9	21.8	1.8
Oct-19	26,41,655	10,97,478	8,99,851	5,56,061	88,265	41.5	34.1	21.0	3.3
Nov-19	27,14,329	11,53,815	9,18,685	5,50,285	91,583	42.5	33.8	20.3	3.4
Dec-19	26,64,684	11,45,588	9,23,174	5,55,601	40,320	43.0	34.6	20.9	1.5

Source: SEBI

The total assets managed under mutual funds are highest in the Month of November 2019 (₹. 27, 14, 329 crores). With regard to corporates also the highest value of assets is registered in the same month and year. In case of High Net Worth Individuals ((HNIs) the highest asset value is registered in December 2019. With regard to retail investors highest AUM (Assets under Management) is registered in May 2019((₹. 6, 37,583). With regard AUM under Banks the highest amount is registered in April 2019 (₹.1, 30,647 crores). The percentage share of AUM held by corporates varies between 40.2 per cent (June 2019) to 52.2 per cent (June 2013).The percentage share of AUM held by HNIs varies between 15 per cent (April 2010) to 35.9 per cent (September 2019).The percentage share of AUM held by retail ranges between 15.4 per cent (January 2014) to 26.4 per cent (December 2010). The percentage share of AUM held by Banks varies between 1 per cent (March 2018) to 16.6 per cent (April 2011).

The Indian mutual fund industry is one of the fastest growing segments of the financial sector. Buoyed by robust capital inflows and strong participation of retail investors,

the asset base of the mutual fund industry stood at ₹.26,64,684 crore as on December 31, 2019.

Conclusion

The modern mutual fund was first introduced in Belgium in 1822. This form of investment soon spread to Great Britain and France. Mutual funds became popular in the United States in the 1920s and continue to be popular since the 1930s, especially open-end mutual funds. Mutual funds experienced a period of tremendous growth after World War II, especially in the 1980s and 1990s. To promote direct investment by the investors in existing and new schemes, the SEBI directed mutual funds / asset management companies (AMC) to provide a separate plan for direct investments with a lower expense ratio. Furthermore, no commission or brokerage can be paid from such plans. Mutual funds need to be positioned appropriately as a long term product in the investor's mind. Distributors hence need to be incentivised adequately in order to sell the product correctly to investors.

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ROLE OF MIR OSMAN ALI KHAN (1911-1948 A.D.) IN PRINCELY STATE OF HYDERABAD – AN ANALYSIS

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Abstract

Mir Osman Ali Khan acceded because the Nizam of Hyderabad upon the death of his father in 1911. The state of Hyderabad was the most important of the princely states in pre-independence India. The state of Hyderabad was the most important of the princely states in pre-independence India. With a vicinity of eighty 6,000 sq. miles (223,000 km²), it had been roughly the dimensions of this day United Kingdom. The Nizam was the highest-ranking prince in India, was one of only five princes entitled to a 21-gun salute, held the unique title of "Nizam", and titled "His Exalted Highness" and "Faithful Ally of the British Crown". In this paper focus on the role of Mir Osman Ali Khan in Princely state of Hyderabad.

Key Words: Mir Osman Ali Khan, Nizam, Hyderabad state, etc.

Introduction

The city of Hyderabad supported in 1591 by the fifth Qutub Shahi ruler, prophet Quli Qutub crowned head via a stimulating role because the largest princely state in India. The erstwhile Nizam's dominion of Hyderabad comprised of this day Telangana region of Andhra Pradesh, the districts of Bidar, Gulbarga and Raichur in state and therefore the Marathwada region, comprising of Mannad, Aurangabad, Parbhani, Barsi, Nanded, Sholapur, Oamanabad and Akalkot of geographic region. The state was an intensive highland with a median elevation of concerning 12, 00 feet. The dominions farmed a lateral sq. placed between 15°10' and 21°50' north latitude and between 74°45' and 81°35' east longitude¹. A trigonometrically survey of the region shows the world to be 97,837 sq. miles. Its space is quite that of European country and Scotland place along, up to that of France and 5 times that of Swiss Confederation. The length of the State from solid to west is 456 miles. Its breadth from north to south is 384 miles. It a median elevation of 1,250 feet and is intersected by ranges of hills with summits rising from 2,500 ft. to 3,500 ft. The surface of the country includes a general slope from north to southeast.²

The role of Mir Osman Ali Khan (1911-1948 A.D.):

Mir Mahaboob Ali Khan died on twenty ninth August 1911 C.E. The death of Mir Mahaboob Ali Khan, his son Mir Osman Ali Khan was announced the Nizam by Nabob Shahab Carl Gustav Jung, the Minister of Police. The enthronement and room were continued twelfth Sep 1911 C.E. Osman Ali Khan was born on fifth Gregorian calendar month 1886 Mir Osman Ali Khan was nevertheless young, his father Mahaboob Ali Khan, WHO was anxious to coach his son for the good workplace that expected him within the very best manner, engaged the eminent students in Persian and Urdu languages as teacher. Sports and Physical coaching, riding, tent-pegging, shooting, cricket and alternative manly exercises were often instructed beneath the management of commissioned military officer Sir Afsur-ul- Mulk, Commander-in-Chief of the Nizam's Army, In 1899 Sir Brian Egerton, was appointed as teacher to Osman Ali Khan to show English. In 1912 C.E. Sir Kishan Prasad, the Prime Minister of Hyderabad state was alleviated from the serious responsibility of the task.

The Osman Ali Khan appointed Nawab Mir Yusuf Ali Khan, better known as Salar Jung III as the Prime Minister of Hyderabad in 1912; but he resigned his job in 1914. In the same year, the Nizam took over the charge directly under his control. For five years he conducted the affairs of the state without a Prime Minister. Osmania University which was established at Hyderabad on 28th August 1919 marked a new departure in Indian education as it imparted instruction in the faculties of Arts, Science, Law, Muslim Theology Medicine, Engineering and Education through the Medium of Urdu, English being a compulsory language in the B.A. and B.Sc. examinations and examinations leading up to is a stage. In addition to the university college comprising the faculties of Arts, Science, Muslim Theology and Law, it has a Medical College, and an Engineering College, a Training College for Teachers and a Women's College, teaching up to M.A. and M.Sc. and Dip-in-Ed and M.Ed. standards. The University also maintains five Intermediate Colleges two in the city of Hyderabad and one each at Aurangabad, Warangal and Gulbarga.

The Nizam and his forces contest an extremely commendable role within the 1st war. The Hyderabad troops fought aspect by aspect with British forces in Palestine, King George-V was prompt in handsome recognizing the Nizam services. In an exceedingly room continued seventeenth Nov 1919, the Nizam publicized the new constitution beneath that the manager Council became the Supreme unit within the State.

The Executive Council consisted of seven members, six ordinary and one extraordinary, exclusive of the President, Sir Ali Imam, who had been a member of the Bihar and the Viceroys Executive Councils was appointed the President of the Executive council in 1919. The other members were Nawab Ageel Jung, Mr. Glancy, Nawab Vilayat Jung, Nawab Latafat Jung, Rai Murlidhar, and Nawab Jilwat Jung of the royal family, Nawab Nizam Jung, and Sir Faridoon-ul-Mulk.

Sir Akbar Hyderi, as a Finance member was instrumental in strengthening the money administration of Hyderabad by a series of reforms that he introduced from time to time. To fulfil the national demand for self-government, the govt of India known as a round table conference in 1930. Its terms of reference were to think about what proportion power ought to be transferred to India's hands and beneath what conditions the British Indian Provinces and Indian states would be joined in an exceedingly Federation. At the invite of the

govt of India, the Nizam elect Sir Akbar Hydari, the Finance Member because the representative of the Hyderabad state and chief representative of the Hyderabad delegation. The delegation went thrice to European country in 1930, 1931 and 1932 and took part within the discussions at the spherical Table Conference. Sir Akbar Hyderi took a number one half within the conference. Sir Akbar Hydari's most notable action was departmentalization of finances, beneath that, every department was supplied with a allow 3 years and was allowed a freedom concerning its expenditure by carrying over the balance of the primary year to the second, and combined balances of the primary and second years to the third. This inspired careful disbursement and smart coming up with.

During the Second World War, to the gifts of the Nizam and the contribution of the public and other direct and indirect war expenditure, the state subscribed 21, 00,000 annually to the British war efforts. The direct and indirect expenditure connected with the War from its commencement to the end of 1944 amounted to nearly 5 $\frac{3}{4}$ crores³. The Nizam-VII sent a message to the Government of India, to continue Hyderabad as an independent state in India and not to merge it with either India or Pakistan. But on 29th November 1947, Hyderabad state entered into a standstill agreement with the Government of India. Under the agreement, defence and external affairs came under the control of the Indian Government.

After the sign language of the stand-still agreement, the Nizam appointed Mir Laik Ali because the Prime Minister and Pingali Venkatarama Reddy as Deputy Prime Minister. Laik Ali created a secret visit to metropolis and met the Asian country Prime Minister Liaquat Ali Khan and alternative leaders like Ghulam Muhammad and Zafrullah Khan. The latter suggested Laik Ali to refer the Hyderabad case to the protection Council. Laik Ali sent on tenth Sep a delegation to UNO headed by Moin Nawaz Carl Gustav Jung. The Hyderabad politics was dangerous to Indian Security and peace. Thus on thirteenth Sep 1948, the govt of India launched its 'Police Action' on Hyderabad. The Indian Army beneath the Command of J.N. Chaudary entered Hyderabad state from 5 directions. Within the Army Headquarters, the group action was codenamed as "Operation Polo". The complete action was completed in 5 days. On seventeenth Sep, Nizam's forces beneath El Edroos relinquished and Indian Army entered Hyderabad town on eighteenth Sep 1948. Laik Ali and Khasim Razvi were inactive. Later they at liberty to Asian country. J.N. Chaudary was created governor of Hyderabad. He continued in this position until the tip of 1949. In Gregorian calendar month 1950, M.A. Vellodi, a senior functionary was created the Chief Minister and therefore the Nizam was selected because the rule Pramukh.

Nizam-ul-Mulk amount was marked by a political consolidation. His death was followed by a war of succession. He was followed by Salabath Khan, Nizam Ali Khan, Sikandar Jah, Nasir-ul-dauwla, Afzal-ul-dauwla, Mir Mahaboob Ali Khan and Mir Osman Ali Khan. Throughout the last two Nizams, some systematic tries to rework the socio-economic life within the state were concerned.

The Lambadas of the Hyderabad state originated from north-west India. The first arrival of the Lambads in the south is mentioned in Perista's *A History of the rise and progress of the mahamadam faith in the country of hind*. In 1417, a large convoy of caravanner's bullock was seized by prince khan khanan, the brother of feroz shah Bahamani, when the former rebelled and made an attempt on the throne of Gulbarga, the Deccan capital⁴.

The three Karnataka wars between 1745 and 1763 saw the British emerging as the foremost power in the south, Anglo- Mysore wars between 1766-1799, which ended with Tippu's death in the battle and the annexation of a major part of Mysore by the British, and three Anglo- Maratha wars in the year 1775-82, 1803-05, 1817-18. After these wars, almost the whole of the Deccan came under the direct control of the British⁵. In all these wars, the Lambadas were the main grain suppliers to all sides. Their service was acknowledged by all the imperial power. They had particularly good relations with the Nizams, as they had served their armies from the time of Aurangzeb.

The first Nizam employed them in large numbers during his early consolidation of the Deccan. The Nizam constructed a separate gate for the Lambadas herds to pass into the Golconda fort. There was also the practice of the presenting the descendent of Bhangi with a khillat (a gift of turban cloth) from the Nizams of Hyderabad. It was considered a mark of great honour, when the Nizam used to present eight thanes of khadi (a than equal to sixteen yards) every year, which the chief Nayak used to tie his turban. The British also continued this practice; after every war the Lambada Nayaks and leaders were honoured with cloths, turban and swords. Whatever they faced, it was a kind of taming through which the imperial powers ensured the subordination of the Lambadas⁶.

Commitment to society and contributions

Educational drives: By giving to major instructive organizations all through India, he presented numerous instructive changes during his rule. Up to 11% of his spending plan was spent on schooling. The Nizam made huge gifts to numerous establishments in India and abroad with exceptional accentuation given to instructive foundations, for example, the Jamia Nizamia and the Darul Uloom Deoband . The Nizam at the initiation of the Osmania University Arts College, c.1937. He established the Osmania University in 1918 through an illustrious firman; it is perhaps the biggest college in India. Schools, universities and a Department for Translation were set up. Essential schooling was made obligatory and given free to poor people.

Gifts to educational organizations: He additionally gave Rs 1 million for the Banaras Hindu University, Rs. 500,000 for the Aligarh Muslim University, and 300,000 for the Indian Institute of Science.

Construction of major public buildings: Mir Osman Ali Khan Nizam VII was a progressive ruler and an enthusiastic patron of architecture. His reign ushered in a new era of construction of public buildings and he adorned the city of Hyderabad with a large number of beautiful buildings as Monuments of his wise administration. Among the earlier works, mention may be made of the town hall, the High Court, the Osmania General Hospital, the Jagirdar College and the Hyderabad Museum. The more important construction of later dates is the Jubilee Hall, the Industrial Museum, The Jubilee Pavilion, and the Central Military Hospital, Kachiguda Railway station, Secretariat Building, Health Museums, Nizamia Unani General Hosptial, Asafia Library, Moazam Jahi Market, Bella Vista, Mahaboobia Girls High School, the City High School etc. The expense involved in these constructions was tremendous. The town Hall cost was rupees 19, 00,000. The Osmania Hospital cost rupees 20, 00,000 the City High School 9, 00,000 and the

High Court rupees 21, 00,000.⁷ He also built the Hyderabad House in Delhi, now used for diplomatic meetings by the Government of India.

Establishment of Hyderabad State Bank: In 1941, he started his own bank, the Hyderabad depository financial institution. It had been later renamed depository state bank of Hyderabad and merged with the state bank of India because the state's financial institution in 2017. It had been established on 8 August 1941 under the Hyderabad State Bank Act. The bank managed the Osmania Sikka (Hyderabad rupee), the currency of the state of Hyderabad. It had been the sole state in India which had its own currency, and therefore the only state in British India where the ruler was allowed to issue currency. In 1953, the bank absorbed, by merger, the Mercantile Bank of Hyderabad, which Raja Pannalal Pitti had founded in 1935. In 1956, the Federal Reserve Bank of India took over the bank as its first subsidiary and renamed it state bank of Hyderabad (SBH). The Subsidiary Banks Act was passed in 1959. On 1 October 1959, SBH and therefore the other banks of the princely states became subsidiaries of SBI. It merged with SBI on 31 March 2017.

Flood prevention: After the good Musi Flood of 1908, which killed an estimated 50,000 people, the Nizam constructed two lakes to stop flooding the Osman Sagar and Himayat Sagar named after himself, and his son Azam Jah respectively.

Agricultural reforms: The Nizam founded agricultural research within the Marathwada region of Hyderabad State with the establishment of the most Experimental Farm in 1918 in Parbhani. During his rule, agricultural education was available only at Hyderabad; crop research centres for sorghum, cotton, and fruits existed in Parbhani. After independence, the Indian government developed this facility further and renamed Marathwada Agriculture University on 18 May 1972.

Contribution to Indian aviation: India's first airport the Begumpet Airport was established within the 1930s with the formation of the Hyderabad Aero Club by the Nizam. Initially, it had been used as a domestic and international airport by Deccan Airways Limited, the primary airline in British India. The air terminal was constructed in 1937.

Donations towards Hindu temples: The Nizam donated Rs. 82,825 to the Yadagirigutta temple at Bhongir, Rs. 29,999 to the Sita Ramachandraswamy temple, Bhadrachalam and Rs. 8,000 to the Tirupati Balaji Temple. He also donated Rs. 50,000 towards the re-construction of Sitarambagh temple located within the old city of Hyderabad, and bestowed a grant of 100,000 Hyderabad rupees towards the reconstruction of Thousand Pillar Temple. After hearing about the Golden Temple of Amritsar through Maharaja Ranjit Singh, Mir Osman Ali Khan started providing it with yearly grants.

Donation towards the compilation of the Holy Mahabharata: In 1932, there was a requirement for money for the publication of the Holy Mahabharata by the Bhandarkar Oriental Research Institute located in Pune. A proper request was made to Mir Osman Ali Khan who granted Rs. 1000 per annum for a period of 11 years. He also gave Rs 50,000 for the development of the institute's guest house which stands today because the Nizam Guest House.

Donation in Gold to the National Defence Fund:"The donation of 5 tonnes of gold is well documented within the meticulously researched book as follows: "In 1965, the Nizam donated five plenty of pure gold to Lal Bahadur Shastri, Prime Minister of India for the Chinese War Fund", The book is titled "The Nizam of Hyderabad and His Contributions" and therefore the donation is recorded on page 195 of the book. However, this was termed as a myth citing a piece of writing purportedly published within the Hindu. (This was proven false through an RTI the result of which was published within the Hindu.) The National Defence Fund under the Prime Minister's Office has no information of any such donation ever being recorded. In fact, the Nizam invested 425,000 grams (425 kg) of gold within the National Defence Gold Scheme, floated in October 1965 with a 6.5% rate of interest, to tide India over during the depression.

Conclusion:

Osman Ali Khan, Asaf Jah VII (6 April 1886 – 24 February 1967), was the last Nizam (ruler) of the Princely State of Hyderabad. He ascended the throne on 29 August 1911, at the age of 25 and ruled the dominion of Hyderabad between 1911 and 1948, until India annexed it. He was styled as His Exalted Highness-(H.E.H.) the Nizam of Hyderabad, and was one among the wealthiest individuals of all time. On 22 February 1937, Time featured him on its cover because the world's richest person, with inflation adjusted net worth of over \$200 billion. He was referred to as the "Architect of recent Hyderabad" and is credited with establishing many public institutions within the city of Hyderabad, including among others: Osmania University, Osmania General Hospital, and depository financial institution of Hyderabad, Begumpet Airport, and therefore the Hyderabad Supreme Court. Two reservoirs, Osman Sagar and Himayat Sagar, were built during his reign, to stop another great arrive the town.

The Nizam originally wanted to hitch India, but after its independence in 1947, he didn't wish to accede his state to the newly formed nation. By then, his power had weakened due to the Telangana Rebellion and therefore the rise of a radical militia referred to as the Razakars whom he couldn't put down. In 1948, the Indian Army invaded and annexed Hyderabad State, and therefore the Nizam had to surrender. Post-independence, he became the Rajpramukh of Hyderabad State between 1950 and 1956, after which the state was partitioned and have become a part of Andhra Pradesh, Karnataka and Maharashtra. In 1951, he not only started the development of Nizam Orthopedic hospital, Nizams Institute of Medical Sciences (NIMS)) and gave it to the govt on a 99-year lease for a monthly rent of just Re.1, he also donated 14,000 acres (5,700 ha) of land from his personal property to Vinobha Bhave's Bhoodan movement for re-distribution among landless farmers.

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Structural and magnetic properties of ZnFe₂O₄-Co₃O₄ nanocomposites

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Abstract

A series of (1-x) ZnFe₂O₄ + x Co₃O₄ (x = 0, 15, 30, 45, 60 to 100 wt%) nanocomposites were prepared by mixing the as synthesized ZnFe₂O₄ and Co₃O₄ powders at different weight percentages. The ZnFe₂O₄ and Co₃O₄ nanopowders were synthesised using microwave-hydrothermal method at 160°C/30 min. The X-ray diffraction peaks shows that both ZnFe₂O₄ and Co₃O₄ are cubic in nature. The composite samples shows diffraction peaks belongs to ZnFe₂O₄ and Co₃O₄. The lattice constant decreased from 8.161 Å (x= 15 wt%) to 8.078 Å (x = 100 wt%, Co₃O₄) with Co₃O₄ content. The unit cell volume (*V*) is decreased with increasing Co₃O₄ in the composite. For ZnFe₂O₄, the high frequency tetrahedral (*v*₁) and low frequency octahedral (*v*₂) bands appear in the range of 500 – 585 cm⁻¹ and 420 – 460 cm⁻¹, respectively. TEM shows that the particle size for ZnFe₂O₄, Co₃O₄ and composite samples is below 50 nm. The bright spots in SAED patterns indicates that the composite samples are polycrystalline in nature. The *M*_s is 7 emu/g, *M*_r and *H*_c are zero for ZnFe₂O₄ (x = 0 wt%), clearly shows the super paramagnetic nature. For Co₃O₄, *M*_s is 0.6 emu/g, *M*_r is 0.014 emu/g and *H*_c is 26 Oe. The *H*_c is increased from 15 Oe to 66 Oe with Co₃O₄ addition to ZnFe₂O₄ for x = 15 wt% to 60 wt%. Similarly *M*_r is also increased with Co₃O₄ from 0.25 emu/g (x = 15 wt%) to 0.85 emu/g (x = 60 wt%).

Keywords:-Nanocomposites, microwave-hydrothermal method, X-ray diffraction, Transmission electron microscopy, magnetic properties.

I. INTRODUCTION

The magnetic materials such as ferrites are technologically important materials due to their high permeability, high saturation magnetization, chemical stability, high curie temperature and high resistivity [1-3]. Due to its unique properties, ferrites are used in inductors, power transformers, phase shifters and as electromagnetic absorbers [4,5]. ZnFe_2O_4 has attracted much attention because of its applications in various fields such as gas sensors [6], catalyst [7], lithium batteries [8] and electromagnetic absorption [9]. The magnetic properties of ferrites depends on the synthesis method, sintering temperature, density, particle distribution and the dopant. It is known that the magnetic properties of the ferrite materials greatly dependent on the size of the crystals and superparamagnetic [10,11].

ZnFe_2O_4 nanostructures are used in high frequency region due to the low value of electrical conductivity [12]. It is reported that the grain size affect on the magnetic properties of ZnFe_2O_4 [13]. Recently, research reveals that ZnFe_2O_4 based composites are useful for electromagnetic absorption [14-17]. So far, ZnFe_2O_4 /polypyrrole core-shell nanoparticles [18], $\text{ZnO}/\text{ZnFe}_2\text{O}_4$ composites [19], $\text{ZnFe}_2\text{O}_4/\text{TiO}_2$ composite nanotube arrays [20], $\text{SrFe}_{12}\text{O}_{19}/\text{ZnFe}_2\text{O}_4$ composites [21], $\text{Co}_3\text{O}_4/\text{ZnFe}_2\text{O}_4$ hollow nanocomposites [22], etc were prepared for various applications. Different synthesis approach is used for the synthesis of zinc ferrites viz., Co-precipitation [23], sol-gel [24], hydrothermal synthesis [25], microwave heating [26] and thermal decomposition [27]. The microwave-hydrothermal method has attracted a lot of attention because of its simplicity, short time reaction process, higher yield and reproducibility [28,29].

Therefore, in the present investigation, a systematic study has been carried out on $(1-x)\text{ZnFe}_2\text{O}_4 + x\text{Co}_3\text{O}_4$ ($x = 0$ to 100 wt%) nanocomposites using microwave hydrothermal route. The structural, morphological studies were carried out using X-ray diffraction (XRD), fourier transform infrared spectroscopy (FTIR) and transmission electron microscopy (TEM). The effect of Co_3O_4 content on the structural and magnetic properties of $\text{ZnFe}_2\text{O}_4\text{-Co}_3\text{O}_4$ nanocomposites were reported.

II. Experimental Methods

Starting with pure chemicals (99.99%), the molar ratio of ferrite powders was adjusted to obtain the composition of ZnFe_2O_4 . Pure (99.99%) chemicals of Zinc nitrate [$\text{Zn}(\text{NO}_3)_2 \cdot 3\text{H}_2\text{O}$] and Ferric nitrate [$\text{Fe}(\text{NO}_3)_3 \cdot 9\text{H}_2\text{O}$] were dissolved in deionized water and stirred well to obtain homogeneous solution. An alkaline solution of 10 M NaOH was added drop-by-drop to this salt solution while the pH was maintained at ~ 11 and the stirring was kept sustained. The homogeneity of the mixture was maintained throughout by continuous stirring. The mixture was then taken in to Teflon vessels and then sealed. The mixture was then treated in a Teflon lined vessel using a Microwave Digestion System held at $160^\circ\text{C}/30$ min. After the Microwave- Hydrothermal treatment the pan bomb was cooled, the solid and solution phases were separated by centrifugation. Then the solids were washed with de-ionized water and ethanol for several times to remove any soluble salts. Washed precipitates were then dried in hot air oven (Universal itherm A1-7981) at a temperature of 80°C for overnight.

A similar procedure was followed for the preparation of Co_3O_4 powders. For the synthesis of Co_3O_4 , 17.46 g of $\text{Co}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$ was dissolved in 20 ml of deionized water and a pH of 11 was maintained with the help of NaOH.

The $(1-x)\text{ZnFe}_2\text{O}_4 + x\text{Co}_3\text{O}_4$ ($x = 0, 15, 30, 45, 60$ to 100 wt%) composites were prepared by mixing the as synthesized ZnFe_2O_4 and Co_3O_4 powders at different weight percentages. The powders were sintered at $850^\circ\text{C}/3$ h using conventional sintering method.

The X-ray diffraction patterns were recorded for the sintered samples using an X-ray diffractometer (Phillips PANalytical) with Cu- K_{α} irradiation (1.5406 Å) in the range of $2\theta = 20^{\circ}$ - 80° with a scan rate of $1^{\circ}/\text{min}$ at 40 kV and 30 mA. Rietveld refinement for all the samples were carried out using FULLPROOF SUITE software [30]. Fourier Transform Infrared (FTIR) spectrum was recorded on Bruker – Tensor 27 spectrometer in the mid-IR range of $4000 - 400 \text{ cm}^{-1}$ with a resolution of 4 cm^{-1} . The samples were prepared using the KBr pellet method. A 2 mg of sintered powder was mixed with 300 mg of KBr powder (spectroscopic grade) and ground thoroughly to get a homogeneous mixture. The mixed powders were pressed into pellets of 13 mm diameter at a pressure of 10 tons. The pellets were then heated at 110°C for 2 to 3 hours. The microstructural analysis was carried out using Field Emission Scanning Electron Microscope (FESEM) (FEI, Quanta 200). The magnetic properties such as saturation magnetization (M_s), remnant (M_r) and coercive field (H_c) were studied by measuring magnetization versus magnetic field (M–H) loops at room temperature using vibrating sample magnetometer (VSM) Lakeshore 7500, USA equipped with a magnet of 15 kOe.

III. Results and discussion

3.1 Structural and morphology analysis

The X-ray diffraction patterns of $(1-x) \text{ZnFe}_2\text{O}_4 + x \text{Co}_3\text{O}_4$ ($x = 0$ to 100 wt%) nanocomposites are shown in Fig.1. All the samples are crystalline in nature. The diffraction peaks were compared and matched well with the JCPDS card No.s 82-1042 (ZnFe_2O_4) and 76-1802 (Co_3O_4). The hkl : (311) are the characteristic peaks of spinel ferrite and Co_3O_4 . Both ZnFe_2O_4 and Co_3O_4 phases are cubic in nature with space group Fd-3m. No other phases except that belong to ferrite and Co_3O_4 were detected. It is also observed from the Fig.1 that as the Co_3O_4 wt % increased, the intensity of the diffraction peaks corresponding to it also increased and vice versa. Both the phases can be seen in composites $x = 15, 30, 45$ and 60 wt%. The lattice parameters such as lattice parameters (a, b & c), unit cell volume (V) and X-ray density were calculated and given in Table 1. The lattice constant a is 8.441 Å and 8.078 Å for ZnFe_2O_4 ($x = 0.0$ wt%) and Co_3O_4 ($x = 100$ wt%), respectively. The lattice constant decreased from 8.161 Å ($x = 15$ wt%) to 8.078 Å ($x = 100$ wt%, Co_3O_4) with Co_3O_4 content. The linear decrease in the lattice constant, a with Co_3O_4 wt % is may be due to the fact that ionic size of Co^{2+} (0.72 Å) is lower than that of Zn^{2+} (0.82 Å) [31,32] and it is also believed that Fe^{3+} and Zn^{2+} ions occupy the octahedral and tetrahedral sites whereas Co^{2+} ions prefers both tetrahedral and octahedral sites [33]. The unit cell volume (V) is obtained from the Rietveld refinement data and is found to be 601.42 for ZnFe_2O_4 and 527.12 for Co_3O_4 . It is also observed from the Table 1 that the unit cell volume (V) is decreased with increasing Co_3O_4 in the composite is due to the fact that the unit cell volume of Co_3O_4 is smaller than the ZnFe_2O_4 . The X-ray density (d_x) of the composite samples are varied anisotropically with x , Co_3O_4 as the density depends on the molar mass of the sample.

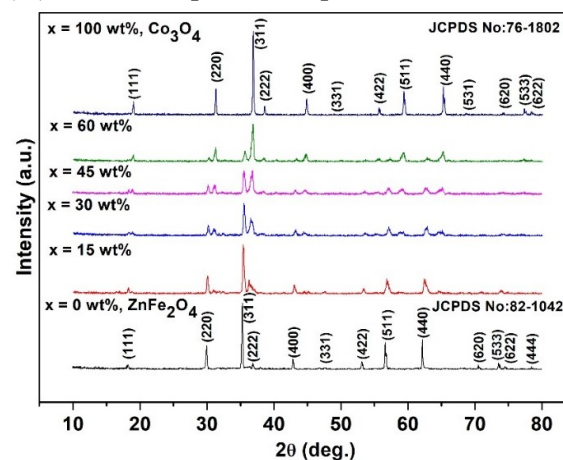


Fig. 1 X-ray diffraction patterns of (1-x) ZnFe₂O₄ + x Co₃O₄ (x = 0 to 100 wt%) nanocomposites.

Sample (x, wt %)	Lattice parameters (a = b = c) (Å)		Volume (V, Å ³)		Phase %		X-ray density (d _x) (g/cm ³)	
	ZnFe ₂ O ₄ Phase 1 Cubic	Co ₃ O ₄ Phase 2 Cubic	Phase 1	Phase 2	Phase 1	Phase 2	Phase 1	Phase 2
0	8.441	---	601.42	---	100	---	5.489	---
15	8.398	8.161	592.28	543.53	47.16	52.84	5.163	5.523
30	8.373	8.141	587.00	539.55	43.83	56.17	5.652	5.814
45	8.377	8.127	587.84	536.77	35.12	64.88	5.447	5.772
60	8.346	8.099	581.34	531.24	14.38	85.62	5.508	6.021
100	---	8.078	---	527.12	---	100	---	6.025

Table .1. The lattice parameters (a=b=c), unit cell volume (V) and X-ray density for of (1-x) ZnFe₂O₄ + x Co₃O₄ (x = 0 to 100 wt%) nanocomposites.

The room temperature FTIR spectra of (1-x)ZnFe₂O₄+xCo₃O₄ nanocomposite is shown in Fig. 2. The spectra was recorded in the range of 4000 – 400 cm⁻¹. The ZnFe₂O₄ spinel shows 431 cm⁻¹, 550 cm⁻¹, 641 cm⁻¹, 866 cm⁻¹, 1448 cm⁻¹, 1651 cm⁻¹, 2357 cm⁻¹ and 3452 cm⁻¹ absorption bands. It is known that spinel has ν₁, ν₂, ν₃ and ν₄ absorption bands [34]. For ZnFe₂O₄, the high frequency tetrahedral (ν₁) and low frequency octahedral (ν₂) bands appear in the range of 500 – 585 cm⁻¹ and 420 – 460 cm⁻¹, respectively [35]. These bands appear in all the composite samples. It is reported that the bands at 641 cm⁻¹ may be due to the Fe²⁺ ions present in the samples [36]. The stretching (O-H) and bending (H-O-H) vibrations of water molecules is observed at 3452 cm⁻¹ and 2357 cm⁻¹, 1651 cm⁻¹, respectively. The bands around 866 cm⁻¹ is associated with the characteristic peaks of CO₃²⁻ anions. The band at 1448 cm⁻¹ which becomes weak with the increasing temperature suggests that NO₃⁻ anions exist as free anions with high D3h symmetry. The main absorption bands at 579 cm⁻¹ and 663 cm⁻¹ corresponding to Co - O modes confirm the formation of Co₃O₄. The band at 3510 cm⁻¹ and 2351 cm⁻¹ are assigned to the O-H stretching and bending modes of water [37].

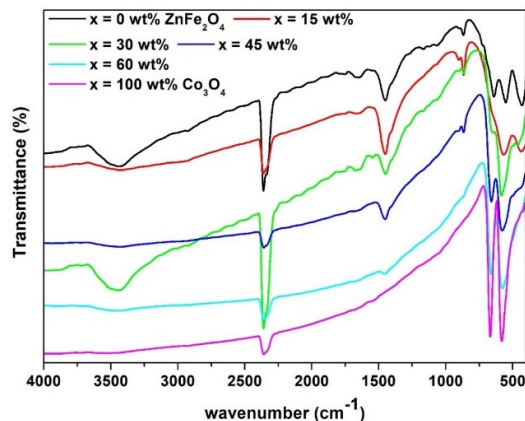


Fig. 2. FTIR spectra of $(1-x)\text{ZnFe}_2\text{O}_4+x\text{Co}_3\text{O}_4$ nanocomposite.

Fig. 3 shows the (a) TEM, (b) high resolution (HRTEM) images and (c) selected-area electron diffraction (SAED) pattern of $x = 0, 15, 45$ and 100 wt%. It can be seen that the particle size for all the samples is in nm range and is below 50 nm. The TEM images shows the large agglomeration due to the smaller particle size. It is difficult to estimate particle size as the agglomeration is more. The HRTEM images shows the existence of single phase for $x = 0$ and $x = 100$ wt% but two phases can be clearly visible in composite $x = 15$ and $x = 45$ wt%. The SAED patterns corresponds to $x = 0, 15, 45$ and 100 wt% shows spherical rings and few bright spots except for $x = 100$ wt%. The bright spots indicates that the composite samples are polycrystalline in nature. Fig. 4 shows the energy dispersive X-ray analysis (EDAX) for $x = 0, 15, 45$ and 100 wt%. The EDAX confirms that Zn, Fe, Co and O are present in the composite samples.

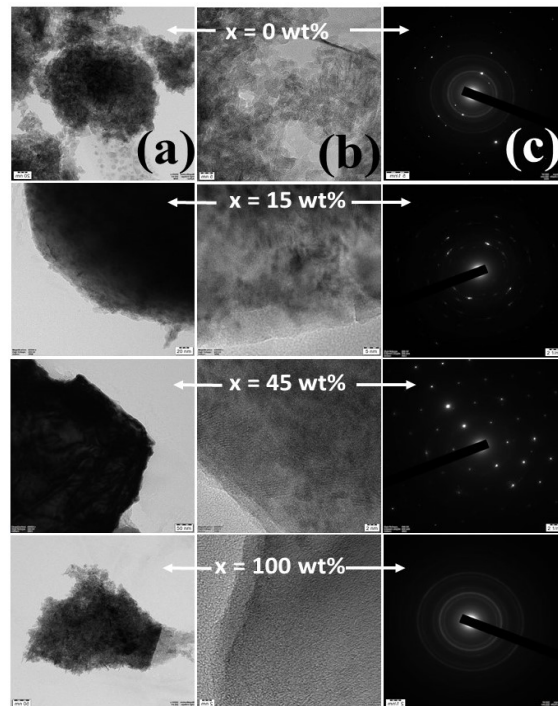


Fig. 3 (a) TEM, (b) high resolution (HRTEM) images and (c) selected-area electron diffraction (SAED) pattern for $x = 0, 15, 45$ and 100 wt%.

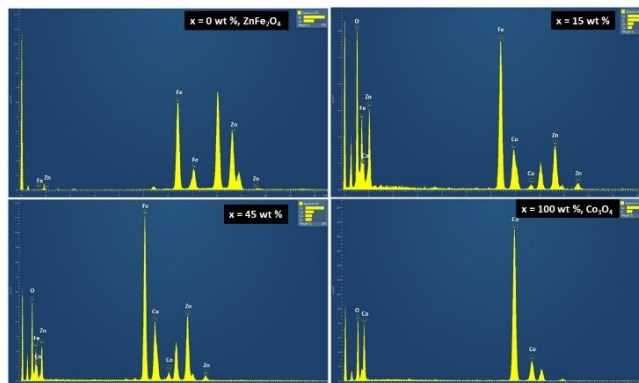


Fig. 4 EDAX spectra for $x = 0, 15, 45$ and 100 wt%.

The magnetic hysteresis loop of (a) ($x = 0$ wt%), (b) Co_3O_4 ($x = 100$ wt%) and (c) composite samples, respectively at room temperature is shown in Fig. 5. All the samples are magnetic in nature. It is also observed that magnetic hysteresis loops are in “S” shape. The magnetization of all the samples shown in Fig. 5 (a, b and c) did not saturate at maximum applied field, therefore the saturation magnetization (M_s) values are obtained from M vs $1/H^2$ using the law of approaching saturation (LAS) [38]. The values of M_s , M_r , and H_c were displayed in Table 2. The ZnFe_2O_4 (bulk sample) below 10 K shows antiferromagnetic nature and above it behaves as paramagnet [39]. In general, in normal spinel Zn^{2+} ions occupy A-sites (tetrahedral) and Fe^{3+} ions at B-sites (octahedral), respectively [40]. The magnetic properties of the material depends on their cation distribution in A and B sites, synthesis method, sintering temperature etc. The M_s is 7 emu/g, M_r and H_c are zero for ZnFe_2O_4 ($x = 0$ wt%), clearly shows the super paramagnetic and single domain nature of the particle [41]. The M_s of 10 emu/g was reported for ZnFe_2O_4 prepared by ball milling [39]. The ferromagnetic ordering in ZnFe_2O_4 observed in Fig. 5 (a) is due to the Fe^{3+} ions occupy A-sites and some Zn^{2+} ions at B-sites. A similar observation of Fe^{3+} and Zn^{2+} ions presence at A and B-sites, respectively is reported elsewhere for Co-precipitated ZnFe_2O_4 nanoparticles [42,43].

Fig. 5 (b) shows the hysteresis loop of Co_3O_4 ($x = 100$ wt%) at room temperature. The M_s is 0.6 emu/g, M_r is 0.014 emu/g and H_c is 26 Oe. The low magnetic moment of 0.6 emu/g indicates that the dipole interaction between the nanocrystals is negligibly small [44]. Umesh T. Nakate et al, reported M_s of 0.452 emu/g for microwave assisted synthesized Co_3O_4 nanoparticle [45,46] and which is comparable with our sample prepared by microwave-hydrothermal method.

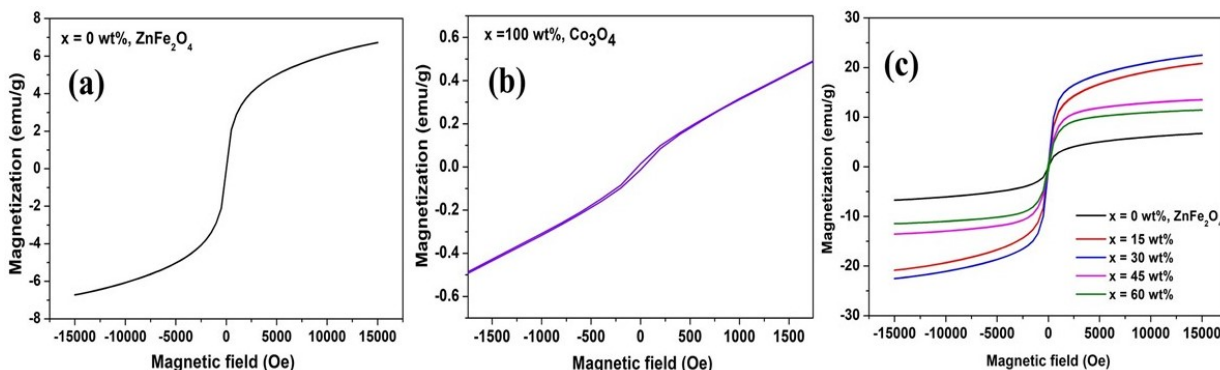


Fig. 5. M-H loops of (a) $x = 0$ wt%, (b) $x = 100$ wt%, and (c) $x = 15, 30, 45$ and 60 wt% nanocomposites recorded at room temperature.

x (wt %)	M_s (emu/g)	M_r (emu/g)	H_c (Oe)
0	7	--	--
15	22	0.25	15
30	24	0.52	24
45	14	0.82	64
60	11	0.85	66
100	0.6	0.014	26

Table 2. Magnetic data of $x = 0, 15, 30, 45, 60$ and 100 wt% samples.

Table 2 gives the magnetic data such as M_s , M_r , and H_c for all nanocomposite samples. Fig. 6 shows the zoom view of coercive field and all the nanocomposites exhibit ferromagnetic behavior at room temperature. It is observed that M_s is initially increased from 22 emu/g ($x = 15$ wt%) to 24 emu/g ($x = 30$ wt%) and then decreased to 11 emu/g for $x = 60$ wt%. It is reported that Zn^{2+} ions occupy A-site and Fe^{3+} and Co^{2+} ions at B-sites, respectively. With the initial addition of Co_3O_4 to $ZnFe_2O_4$ an enhancement in the M_s is observed till $x = 30$ wt% and it is because the lower concentrations of Fe^{3+} and Co^{2+} ions at B-site strength the A-B interactions as Zn^{2+} ions have zero magnetic moments at A-site [47]. The decrease in M_s for $x > 30$ wt% is may be due to the antiferromagnetic interaction between Co^{2+} ions at the surface which decreases the exchange coupling [48-50].

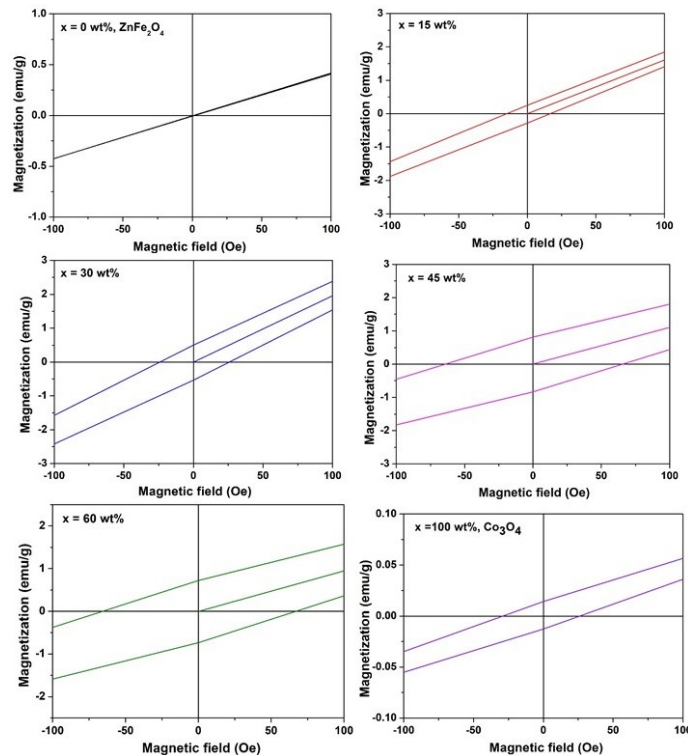


Fig. 6. Zoom view of magnetic hysteresis loops of $x = 0, 15, 30, 45, 60$ and 100 wt%.

From Table 2, the H_c is increased from 15 Oe to 66 Oe with Co_3O_4 addition to $ZnFe_2O_4$ for $x = 15$ wt% to 60 wt%. Similarly M_r is also increased with Co_3O_4 from 0.25 emu/g ($x = 15$ wt%) to 0.85 emu/g ($x = 60$ wt%). The parameters such as coercivity and magneto crystalline

anisotropy are also affected due to domain walls and magnetic moments of the substituted metal ions [51]. The magnetocrystalline anisotropy is strongly dependent on the particle morphology, size, surface effects and interface exchange coupling effects [52]. Therefore, the increase in H_c and M_r of the present nanocomposites is may be due to the surface and interface exchange coupling effects induced by the interfaces between the antiferromagnetic (AFM) Co_3O_4 and ferrimagnetic ZnFe_2O_4 nanoparticles [53,54]. A similar results were reported for $\text{Co}_3\text{O}_4/\text{ZnFe}_2\text{O}_4$ composites [55].

IV.CONCLUSION

The $(1-x)\text{ZnFe}_2\text{O}_4 + x\text{Co}_3\text{O}_4$ ($x = 0, 15, 30, 45, 60$ to 100 wt%) nanocomposites were prepared using ZnFe_2O_4 and Co_3O_4 . The lattice constant a is 8.441 Å and 8.078 Å for ZnFe_2O_4 ($x = 0.0$ wt%) and Co_3O_4 ($x = 100$ wt%), respectively. The lattice constant decreased from 8.161 Å ($x = 15$ wt%) to 8.078 Å ($x = 100$ wt%, Co_3O_4) with Co_3O_4 content. The unit cell volume (V) is found to be 601.42 for ZnFe_2O_4 and 527.12 for Co_3O_4 . The structural bands related to ZnFe_2O_4 and Co_3O_4 is identified in FTIR spectra. TEM shows that the particle size for ZnFe_2O_4 , Co_3O_4 and composite samples is below 50 nm. The bright spots in SAED patterns indicates that the composite samples are polycrystalline in nature. The HRTEM images shows the existence of single phase for $x = 0$ and $x = 100$ wt% but two phases can be clearly visible in composite $x = 15$ and $x = 45$ wt%. In nanocomposites, M_s is initially increased from 22 emu/g ($x = 15$ wt%) to 24 emu/g ($x = 30$ wt%) and then decreased to 11 emu/g for $x = 60$ wt%. The M_s is 7 emu/g, M_r and H_c are zero for ZnFe_2O_4 ($x = 0$ wt%), clearly shows the super paramagnetic nature. For Co_3O_4 , M_s is 0.6 emu/g, M_r is 0.014 emu/g and H_c is 26 Oe. The H_c is increased from 15 Oe to 66 Oe with Co_3O_4 addition to ZnFe_2O_4 for $x = 15$ wt% to 60 wt%. Similarly M_r is also increased with Co_3O_4 from 0.25 emu/g ($x = 15$ wt%) to 0.85 emu/g ($x = 60$ wt%).

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Structural and magnetic properties of microwave- hydrothermally synthesised ZnFe₂O₄-CuO nanocomposites

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Abstract

The (1-y) ZnFe₂O₄ + yCuO (y = 0, 15, 30, 45, 60 to 100 wt%) nanocomposites were prepared by mixing the ZnFe₂O₄ and CuO powders at different weight percentages. The as synthesized ZnFe₂O₄ and CuO nanopowders were prepared at 160°C/30 min using microwave-hydrothermal method. The structural and micro structural analysis was carried out using X-ray diffraction (XRD), Fourier transform infrared spectroscopy (FTIR) and transmission electron microscopy (TEM). The Rietveld refinement confirms the formation of composites and no impurity phases were observed. The ZnFe₂O₄ exhibits cubic phase with space group Fd-3m and CuO exists in monoclinic phase with space group C12/C1. The lattice constant *a* (cubic phase) is varied anisotropically with CuO content and similar variation can be observed for unit cell volume (*V*) and X-ray density (*d_x*). The structural bands related to ZnFe₂O₄ and CuO is identified in FTIR spectra. TEM shows that the particles are agglomerated due to the smaller particle size of ZnFe₂O₄, CuO and composite samples. The magnetization loops show the superparamagnetic behavior for ZnFe₂O₄, CuO and composite samples. The *M_s* is increased to from 7 emu/g (y = 0 wt%) to 10.26 emu/g (y = 15 wt%) and with further addition, *M_s* is

decreased to 4.03 emu/g ($y = 60$ wt%). The decrease in M_s for higher CuO addition is related to magnetic dilution, spin canting and weakening of AB-exchange interactions.

Keywords:-Nanocomposites, Magnetic materials, Rietveld refinement, transmission electron microscopy, magnetic properties.

I. INTRODUCTION

Ferrites having MFe_2O_4 ($M = Ni, Cu, Mn, Zn, Co$) also known as spinel ferrites have attracted a lot of attention due to its electrical and magnetic properties. The ferrites are low cost material and can be easily manufactured. Among all the ferrites, $ZnFe_2O_4$ is of interest due to its good magnetic [1], electrical [2], and optical properties [3] which makes it suitable for magnetic materials [4], semiconductor photocatalysis [5,6], ferrofluid technology [7], hot-gas desulfurization [8,9] and gas sensors [10] and so on.

Recently, studies have shown that $ZnFe_2O_4$ based composites are useful for electromagnetic absorption [11-14]. Studies on $ZnFe_2O_4$ /polypyrrole core-shell nanoparticles [15], $ZnO/ZnFe_2O_4$ composites [16], $ZnFe_2O_4/TiO_2$ composite nanotube arrays [17], $SrFe_{12}O_{19}/ZnFe_2O_4$ composites [18], $Co_3O_4/ZnFe_2O_4$ hollow nanocomposites [19], etc shows that zinc ferrites based composites are suitable for electromagnetic applications.

Different synthesis approach is used for the synthesis of zinc ferrites viz., Co-precipitation [20], sol-gel [21], hydrothermal synthesis [22], microwave heating [23] and thermal decomposition [24]. The microwave-hydrothermal method has attracted a lot of attention because of its simplicity, short time reaction process, higher yield and reproducibility [25,26]. Therefore, the nanocomposites of $(1-y) ZnFe_2O_4 + yCuO$ ($y = 0$ to 100 wt%) were prepared using microwave-hydrothermal method. A systematic study on the structural and magnetic properties of $(1-y) ZnFe_2O_4 + yCuO$ ($y = 0$ to 100 wt%) nanocomposites has been carried out. The structural, morphological studies were carried out using X-ray diffraction (XRD), Fourier transform infrared spectroscopy (FTIR) and transmission electron microscopy (TEM). The effect of CuO nanoparticles on the structural and magnetic properties of $ZnFe_2O_4$ -CuO nanocomposites were studied and the results were discussed.

II. Experimental methods

Starting with pure chemicals (99.99%), the molar ratio of ferrite powders was adjusted to obtain the composition of $ZnFe_2O_4$. Pure (99.99%) chemicals of Zinc nitrate [$Zn(NO_3)_2 \cdot 3H_2O$] and Ferric nitrate [$Fe(NO_3)_3 \cdot 9H_2O$] were dissolved in deionized water and stirred well to obtain homogeneous solution. An alkaline solution of 10 M NaOH was added drop-by-drop to this salt solution while the pH was maintained at ~ 11 and the stirring was kept sustained. The homogeneity of the mixture was maintained throughout by continuous stirring. The mixture was then taken in to Teflon vessels and then sealed. The mixture was then treated in a Teflon lined vessel using a Microwave Digestion System held at $160^\circ C/30$ min. After the Microwave-Hydrothermal treatment the pan bomb was cooled, the solid and solution phases were separated by centrifugation. Then the solids were washed with deionized water and ethanol for several times to remove any soluble salts. Washed precipitates were then dried in hot air oven (Universal iTherm A1-7981) at a temperature of $80^\circ C$ for overnight.

A similar procedure was followed for the preparation of CuO powders. For the synthesis of CuO, copper nitrate was dissolved in 20 ml of deionized water and a pH of 11 was maintained with the help of NaOH.

The $(1-x)\text{ZnFe}_2\text{O}_4 + x\text{Co}_3\text{O}_4$ ($x = 0, 15, 30, 45, 60$ to 100 wt%) composites were prepared by mixing the as synthesized ZnFe_2O_4 and Co_3O_4 powders at different weight percentages. The powders were sintered at $850^\circ\text{C}/3$ h using conventional sintering method.

The X-ray diffraction patterns were recorded for the sintered samples using an X-ray diffractometer (Phillips PANanalytical) with $\text{Cu-K}\alpha$ irradiation (1.5406 \AA) in the range of $2\theta = 20^\circ$ - 80° with a scan rate of $1^\circ/\text{min}$ at 40 kV and 30 mA. Rietveld refinement for all the samples were carried out using FULLPROOF SUITE software [27]. Fourier Transform Infrared (FTIR) spectrum was recorded on Bruker – Tensor 27 spectrometer in the mid-IR range of $4000 - 400 \text{ cm}^{-1}$ with a resolution of 4 cm^{-1} . The samples were prepared using the KBr pellet method. A 2 mg of sintered powder was mixed with 300 mg of KBr powder (spectroscopic grade) and ground thoroughly to get a homogeneous mixture. The mixed powders were pressed into pellets of 13 mm diameter at a pressure of 10 tons. The pellets were then heated at 110°C for 2 to 3 hours. The microstructural analysis was carried out using Field Emission Scanning Electron Microscope (FESEM) (FEI, Quanta 200). The magnetic properties such as saturation magnetization (M_s), remnant (M_r) and coercive field (H_c) were studied by measuring magnetization versus magnetic field (M-H) loops at room temperature using vibrating sample magnetometer (VSM) Lakeshore 7500, USA equipped with a magnet of 15 kOe.

III. Results and discussion

3.1 Structural analysis

Fig. 1 shows the Rietveld refinement of X-ray diffraction patterns of $(1-y)\text{ZnFe}_2\text{O}_4 + y\text{CuO}$ ($y = 0$ to 100 wt%) nanocomposites at room temperature. The sharp diffraction peaks shows the crystalline nature of the samples. The peak indexing was done using JCPDS card No.s 82-1042 (ZnFe_2O_4) and 78-0428 (CuO). The hkl s: (311) and (002/-111) are the characteristic peaks of spinel ferrite and CuO , respectively. ZnFe_2O_4 is cubic in nature with a space group $Fd - 3m$. CuO exists in monoclinic centered Bravais lattice in the space group of $C12/C1$. It is also observed from Fig. 1 that no impurity phases exists other than ferrite and CuO . As the amount of CuO increase the intensity of the peaks corresponding to CuO increased and vice versa. The cubic and monoclinic phases can be observed for composites $y = 15, 30, 45$ and 60 wt%. The Rietveld refinement of $(1-y)\text{ZnFe}_2\text{O}_4 + y\text{CuO}$ nanocomposites ($y = 0$ to 100 wt%) were carried out using FULLPROOF SUITE software with the help of the $P6_3/mmc$ space group and the refined patterns are given in Fig. 1. The refined parameters such as lattice parameters (a, b & c), R_p (profile fitting R value), R_{wp} (weighted profile R-Value), R_{exp} (expected value), R_B (Bragg value), χ^2 , X-ray density (d_x), and unit cell volume (V) are given in Table 1. The lattice constant (a) for ZnFe_2O_4 is 8.441 \AA . The lattice parameters for monoclinic phase of CuO is $a = 4.693 \text{ \AA}$, $b = 3.418 \text{ \AA}$ and $c = 5.133 \text{ \AA}$. It is observed that the lattice constant a is varied anisotropically with CuO addition and similar variation can be observed for unit cell volume (V) and X-ray density (d_x). The least values of R_p , R_{wp} and Sig(GOF) indicate good quality samples and effective refinement.

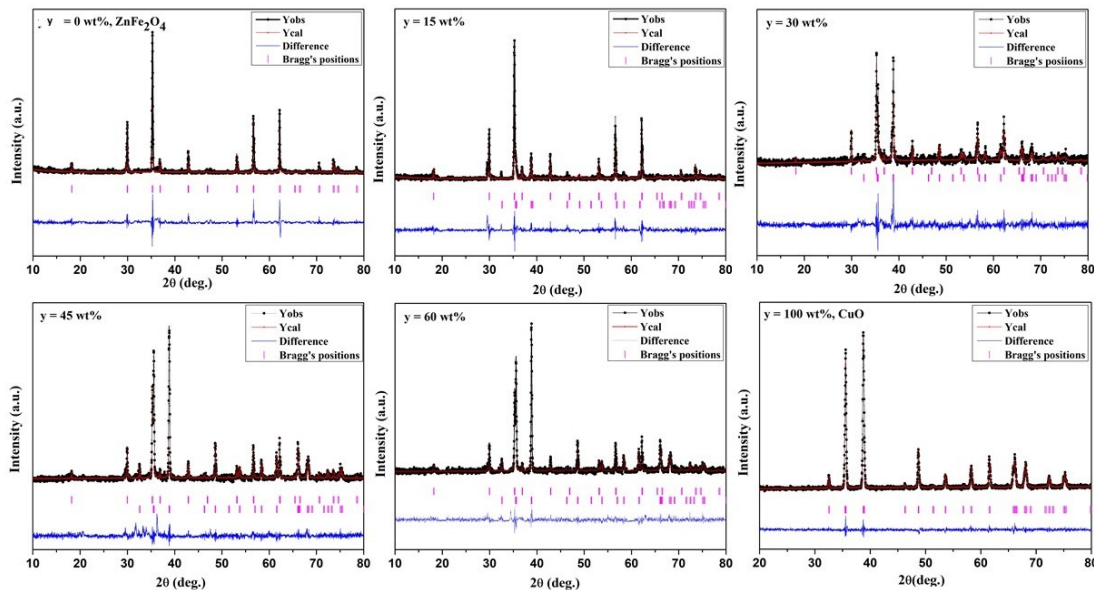


Fig. 1. Rietveld refinement of X-ray diffraction patterns of (1-y) ZnFe₂O₄ + y CuO

Sample (wt %)	y = 0 ZnFe ₂ O ₄ Phase 1	y = 100 CuO Phase 2	y = 15		y = 30		y = 45		y = 60	
Space group	Fd-3m	C12/C1	Fd-3m	C12/C1	Fd-3m	C12/C1	Fd-3m	C12/C1	Fd-3m	C12/C1
Lattice parameter (a, b, c)(Å)	a = 8.441 (a=b=c)	a = 4.693 b = 3.418 c = 5.133	a = 8.436	a = 4.661 b = 3.414 c = 5.118	a = 8.439	a = 4.705 b = 3.411 c = 5.139	a = 8.435	a = 4.699 b = 3.409 c = 5.131	a = 8.436	a = 4.702 b = 3.434 c = 5.138
Volume, V (Å ³)	601.482	81.239	600.427	80.398	601.182	81.329	600.348	81.042	600.397	81.051
R _p	24.2	7.11	19.1	-	17.9	-	11.2	-	11.8	-

(y = 0 to 100 wt%) nanocomposites.

R_{wp}	39.2	9.06	25.5	-	22.8	-	14.3	-	15.2	-
R_{exp}	29.18	8.11	21.87	-	18.09	-	12.81	-	12.74	-
Bragg R-factor	16.5	3.60	8.99	11.4	9.17	10.82	11.6	9.37	12.0	11.5
RF factor	13.9	3.74	7.77	8.92	8.63	9.47	9.92	8.48	11.8	7.34
χ^2	1.80	1.25	1.36	-	1.58	-	1.24	-	1.42	-
Density (d_x) (g/cm³)	5.489	6.560	5.333	6.572	5.327	6.497	5.334	6.520	5.340	6.527

Table .1. The Rietveld refinement parameters, lattice parameters ($a = b = c$), unit cell volume (V) and X-ray density for of $(1-y) \text{ZnFe}_2\text{O}_4 + y\text{CuO}$ ($y = 0$ to 100 wt%) nanocomposites.

The FTIR spectra in the range of $4000 - 400 \text{ cm}^{-1}$ for $(1-y)\text{ZnFe}_2\text{O}_4 + y\text{CuO}$ ($y = 0 - 100$ wt%) nanocomposites is shown in Fig. 2. The ZnFe_2O_4 ($y = 0$ wt%) spinel shows 431 cm^{-1} , 550 cm^{-1} , 641 cm^{-1} , 866 cm^{-1} , 1448 cm^{-1} , 1651 cm^{-1} , 2357 cm^{-1} and 3452 cm^{-1} absorption bands. It is known that spinel has ν_1 , ν_2 , ν_3 and ν_4 absorption bands [28]. For ZnFe_2O_4 , the high frequency tetrahedral (ν_1) and low frequency octahedral (ν_2) bands appear in the range of $500 - 585 \text{ cm}^{-1}$ and $420 - 460 \text{ cm}^{-1}$, respectively [29]. These bands appear in all the composite samples. The spectral analysis of CuO ($y = 100$ wt%) is discussed as follows. The bands at 476 cm^{-1} and 515 cm^{-1} are the Cu-O stretching vibrations of CuO nanoparticles [30]. The 3436 cm^{-1} , 2355 cm^{-1} and 1636 cm^{-1} , are assigned to stretching vibration of O-H groups of water molecules and H-O-H bending vibration of adsorbed water molecules, respectively [31,32]. It is observed from the Fig.2 that the octahedral band position is shifted to higher wavenumber with increasing CuO phase in the composite which shows that Cu^{2+} ions occupy the octahedral sites.

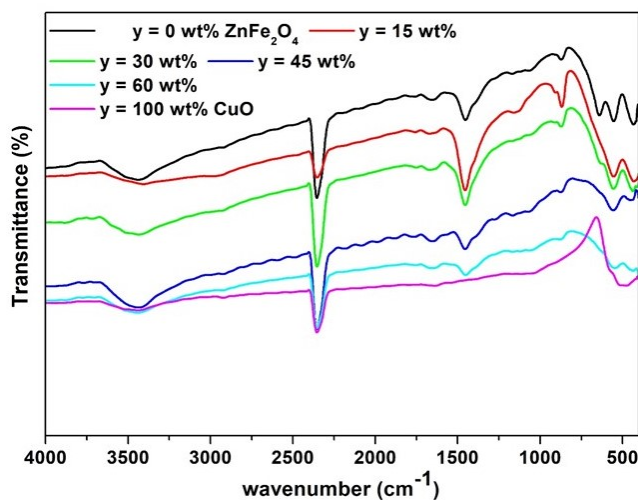


Fig. 2. FTIR spectra of $(1-y)\text{ZnFe}_2\text{O}_4 + y\text{CuO}$ nanocomposite.

Sample (wt%)	Octahedral (ν_2) (cm^{-1})	Tetrahedral (ν_1) (cm^{-1})	Tetrahedral force constant $K_T, 10^5$ (dyne cm^{-1})	Octahedral force constant $K_O, 10^5$ (dyne cm^{-1})
$y = 0$	431	550	2.212	1.358
$y = 15$	431	554	2.245	1.358
$y = 30$	435	555	2.253	1.384
$y = 45$	440	554	2.245	1.416
$y = 60$	441	544	2.164	1.422
$y = 100$	476	515	1.940	1.657

The values of the force constants (K_T and K_O) for the band $\text{Fe}^{3+} - \text{O}^{2-}$ at tetrahedral and octahedral sites were calculated using the relation [33]

$$K = 4\pi^2\nu^2C^2m$$

Where c is the speed of light, ν is the band wave number in cm^{-1} and m is the reduced mass for Fe^{3+} ions and O^{2-} ions (2.061×10^{-23} g). The force constant for tetrahedral (K_T) and octahedral (K_O) sites for $(1-y)\text{ZnFe}_2\text{O}_4 + y\text{CuO}$ ($y = 0 - 100$ wt%) nanocomposites are listed in Table 2. Fig. 3 shows the variation of (a & c) tetrahedral (ν_1) and octahedral (ν_2) absorption bands, (b & d) and their force constants (K_T & K_O) with ywt%. The force constant (K_T) and ν_1 for is increased upto 30 wt% of CuO and then decreased as CuO percentage is increased in the composite which may be due to the changes in the $\text{Fe}^{3+} - \text{O}^{2-}$ bond length. The shifting of ν_2 to higher wavenumber with CuO from Fig. 3 (c) shows that Cu^{2+} ions are occupy octahedral sites.

Table 2. Tetrahedral, Octahedral absorption bands and their force constants K_T & K_O of $(1-y)\text{ZnFe}_2\text{O}_4 + y\text{CuO}$ Nanocomposites.

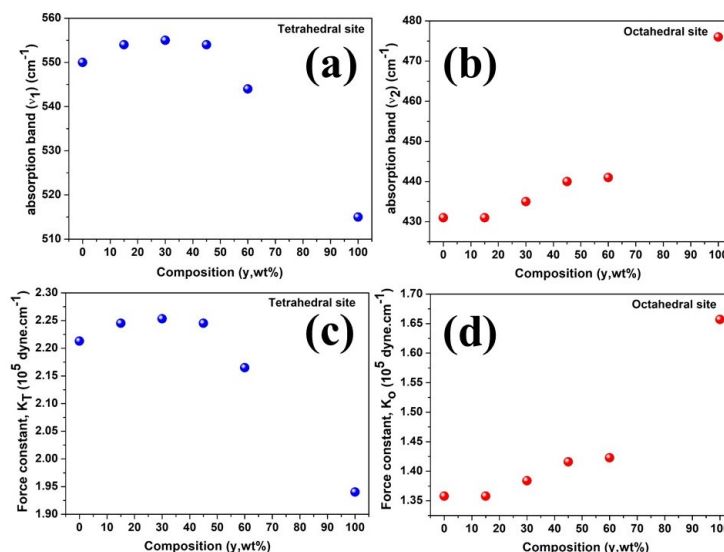


Fig. 3. Variation of (a & c) tetrahedral (ν_1) and octahedral (ν_2) absorption bands, (b & d) and their force constants (K_T & K_O) with ywt%.

3.2 Particle size and morphology studies

Fig. 4 shows the (a) TEM, (b) high resolution (HRTEM) images and (c) selected-area electron diffraction (SAED) pattern of $y = 0, 15, 45$ and 100 wt%. It can be seen that the particle size for all the samples is in nm range and is below 50 nm. The TEM images shows the large agglomeration due to the smaller particle size. It is difficult to estimate particle size as the agglomeration is more. The HRTEM images shows the existence of single phase for $y = 0$ and $y = 100$ wt% but two phases can be clearly visible in composite $y = 15$ and $y = 45$ wt%. The SAED patterns corresponds to $y = 0, 15, 45$ and 100 wt% shows spherical rings and few bright spots except for $y = 100$ wt%. The bright spots indicates that the composite samples are polycrystalline in nature. Fig. 5 shows the energy dispersive X-ray analysis (EDAX) for $y = 0, 15, 45$ and 100 wt%. The EDAX confirms that Zn, Fe, Cu and O are present in the composite samples.

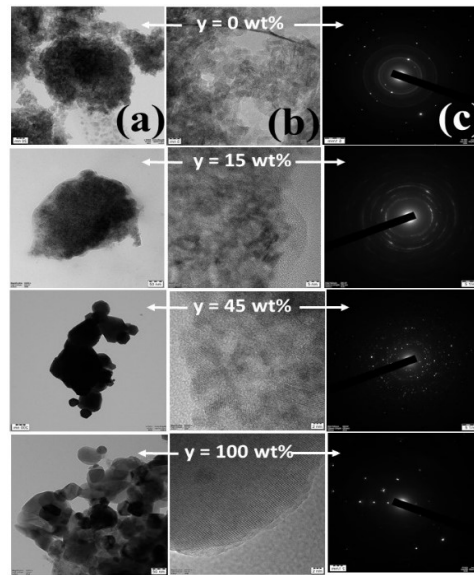


Fig. 4. (a) TEM, (b) high resolution (HRTEM) images and (c) selected-area electron diffraction (SAED) pattern for $y = 0, 15, 45$ and 100 wt%.

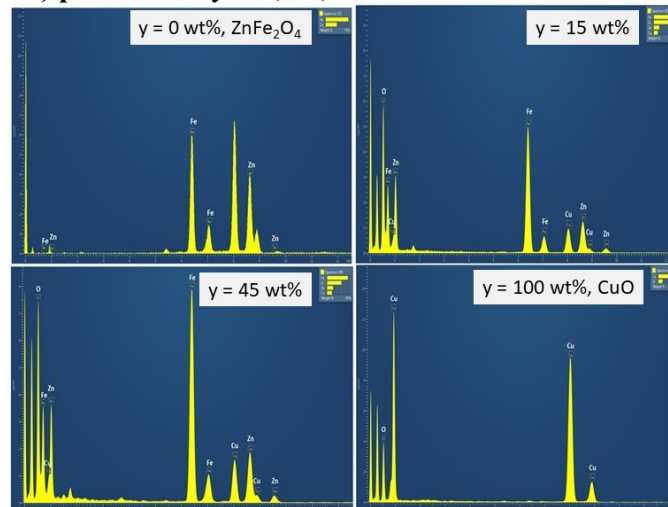


Fig. 5. Energy dispersive X-ray analysis (EDAX) for $y = 0, 15, 45$ and 100 wt%.

3.3 Magnetic properties

Fig. 6(a) shows the magnetic hysteresis loop of CuO ($y = 100$ wt%) nanoparticle at room temperature. All the samples are magnetic in nature and shows superparamagnetic behavior as M_r and H_c are found to be zero. It is also observed that magnetic hysteresis loops for all the samples shows “S” shape. The magnetization of ferrite and composite samples shown in Fig. 6(b) which did not saturate at maximum applied field. Therefore, the saturation magnetization (M_s) values are obtained from $Mvs1/H^2$ using the law of approaching saturation (LAS) [34] and graphs were shown in Fig. 7. The values of M_s were given in Fig.7. The M_s for CuO is 0.2 emu/g which is higher than the bulk value of CuO [35]. Shang et al. [35] suggested that the unpaired electron spins responsible for ferromagnetism in the CuO nanoparticles have their origin in the oxygen vacancies, especially on the surfaces of the oxide nanoparticles.

It is observed from the Fig.7 that for $y = 15$ wt% of CuO added to $ZnFe_2O_4$, the M_s is increased to from 7 emu/g ($y = 0$ wt%) to 10.26 emu/g and with further addition, M_s is decreased to 4.03 emu/g ($y = 60$ wt%). The CuO nanoparticles show M_s of 0.20 emu/g. The magnetic moment of spinel ferrites depends on the cation distribution among A-site (tetrahedral) and B-site (octahedral). In spinel ferrite with Zn^{2+} occupying the octahedral (B) and Fe^{3+} ions are equally distributed among tetrahedral (A) and octahedral (B) site. With increasing CuO addition to $ZnFe_2O_4$, the replacement of Cu^{2+} with Zn^{2+} ions leads to the transfer of Fe^{3+} ions from tetrahedral to octahedral site. This leads to the increase of $Fe^{3+} - O^{2-} - Fe^{3+}$ interaction and reduction of $Cu^{2+} - Cu^{2+}$ interaction over the octahedral site and would further disturb some magnetic coupling and lead to increase in magnetism [36]. The decrease in M_s for higher CuO addition is related to magnetic dilution, spin canting and weakening of AB-exchange interactions [37-39].

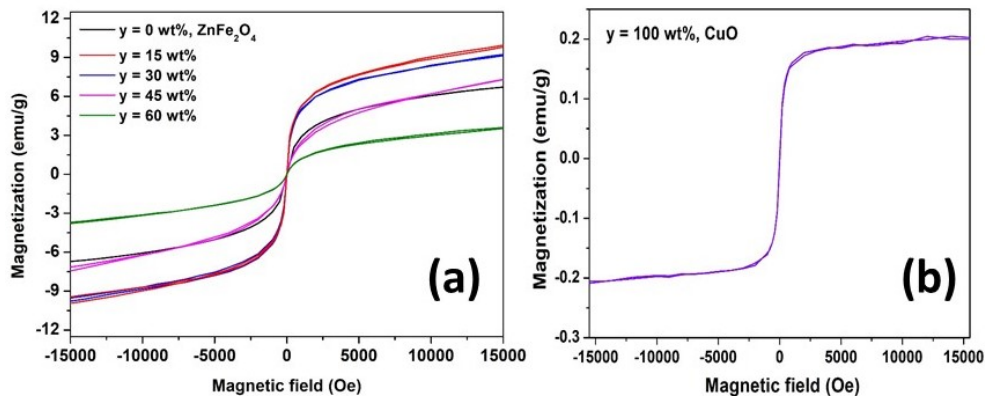


Fig. 6 M-H loop of (a) CuO ($y = 100$ wt%) (b) ferrite and nanocomposite recorded at room temperature.

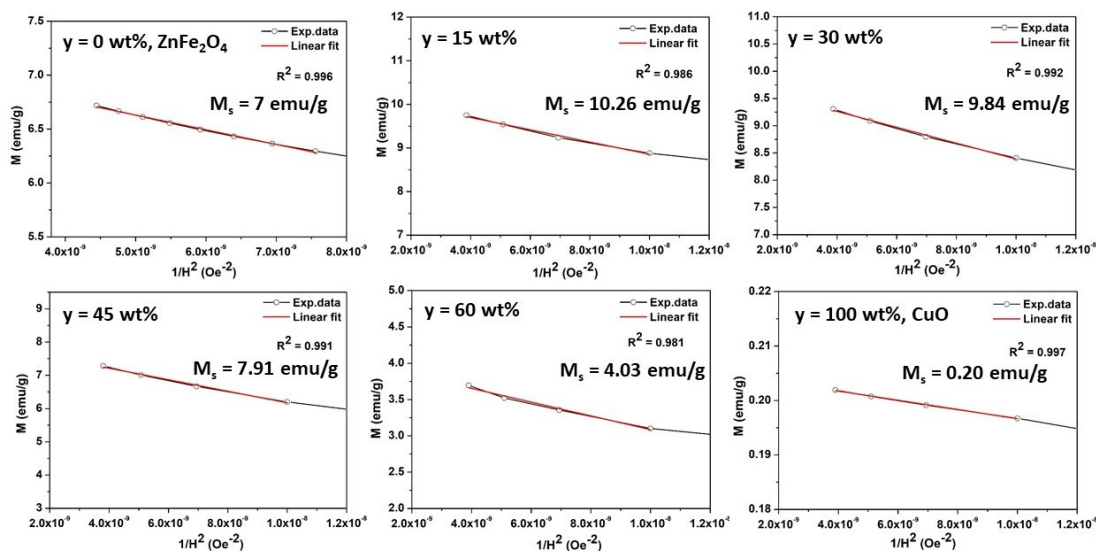


Fig. 7. Fitting of M-H data for $y = 0, 15, 30, 45, 60$ and 100 wt% in high magnetic field regime shows a straight line.

IV. CONCLUSION

The $(1-y)$ $\text{ZnFe}_2\text{O}_4 + y\text{CuO}$ ($y = 0, 15, 30, 45, 60$ to 100 wt%) nanocomposites were prepared using ZnFe_2O_4 and CuO . As the amount of CuO increase the intensity of the peaks corresponding to CuO increased and vice versa. The lattice constant (a) for ZnFe_2O_4 is 8.441\AA . The lattice parameters for monoclinic phase of CuO is $a = 4.693\text{\AA}$, $b = 3.418\text{\AA}$ and $c = 5.133\text{\AA}$. The structural bands related to ZnFe_2O_4 and CuO is identified in FTIR spectra. The bands at 476 cm^{-1} and 515 cm^{-1} are the Cu-O stretching vibrations of CuO nanoparticles. TEM shows that the particles are agglomerated and the particle size for ZnFe_2O_4 , CuO and composite samples is below 50 nm . The magnetic hysteresis loops for all the samples shows "S" shape. The magnetization loops shows the superparamagnetic behavior for ZnFe_2O_4 , CuO and composite samples. The M_s is increased to 7 emu/g ($y = 0$ wt%) to 10.26 emu/g ($y = 15$ wt%) and with further addition, M_s is decreased to 4.03 emu/g ($y = 60$ wt%). The CuO nanoparticles show M_s of 0.20 emu/g .

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DEEP LEARNING BASED INTELLIGENT PRODUCT RECOMMENDATION SYSTEM

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ABSTRACT: In recent years, technological enhancements in computing have semiconductor to the event of delicate call support systems to produce support to the purchasers United Nations agency are victimization social networks for obtaining services. At intervals the past, sure researchers classified product and building reviews into positive and negative slots, that were accustomed build picks to settle on out applicable hotels, product and services for patrons and to produce tips to the business personalities concerned in hotels. Today, folks kind on-line teams and overtly discuss not solely the professionals—of, as associate example, hotels—however in addition air complaints. If feedback isn't addressed properly by building service suppliers, it's about to possibly increase then the hotel's quality downsized. Food served to customers depends on the preparation still as results of the worth, location and times at that it's served. Further, the angle of the sales folks and building workers, in general, plays a key role in customers' picks. Thus, on-line shopper feedback through social media is beneficial for shopper behavior analysis, crucial for the success of business. A recommendation system that addresses of these problems will give customers higher picks in their alternative of hotels and services. Throughout this proposal, a try of recent classification algorithms unit of measurement projected. One depends on a modern kind of support vector machines spoken as cluster support vector machines to perform major, and sub classification, of sentiments, still as kind teams supported people's sentiments with connectedness changes in times and locations. The intelligent cluster support vector machine rule projected throughout this thesis improves classification accuracy to produce correct recommendations. The foremost advantage of the projected work is that it helps make sure folks with similar interests, supported sentiments well-known from tweets, and type interested teams for animated discussions on fascinating topics. A modern clump rule is projected throughout this analysis work that is helpful in forming teams supported clusters. Throughout this work, a modern genetic weighted K-means clump rule is projected to notice correct cluster structures from a try of datasets, Twitter and Face book. The genetic rule chosen here to perform clump is associate economical technique that improves classification accuracy.

Keywords: Recommender System, Deep Learning, K-means Algorithm, Neural Networks.

1. INTRODUCTION

With the explosion of blogs, forums, and online social networks, differing opinions about a particular topic can be easily found from millions of users. For example, users can discuss their current experiences, share their points of view on a specific fact, or praise or complain about a product that they have just bought. With a vast amount of available online data, sentiment analysis (SA) – a method to categorize text-based opinions to determine a user's attitude – can help

gain better understanding of the attitudes, opinions and emotions of the public in several domains such as business, government, and biomedicine. Several studies are summarized and discussed in [1] regarding the benefits of SA in obtaining feedbacks and determining the interests and opinions of customers.

Recommender systems, developed since mid-1990s based on users' ratings and preferences, has expanded widely in recent decades especially in e-commerce, media, banking and utilities. This type

of system is used by Amazon to suggest preferred products for customers, by YouTube to suggest related videos on the auto play function, and by Facebook to recommend people and webpages to connect and follow.

Sentiment analysis can be beneficial to recommender systems. A sample of this can be found in the work of Preethi et al. [2], in which a cloud-based recommender system uses recursive neural networks to analyze sentiments of reviews in order to improve and validate restaurant and movie recommendations. Along with behavioral analysis, sentiment analysis is also an efficient tool for commodity markets [3].

The problem of automatically extracting opinions from online user-generated texts – sentiment analysis – has been a growing research topic recently [1]. Social media data has been exploited in different ways to address some problems, especially associated with collaborative filtering approaches [4]. Methods in recommender systems are based on information filtering, and they can be classified into three categories: content-based; collaborative filtering (CF); and hybrid. Sparsity and gray-sheep problems are two of the main reasons CF methods do not provide the reliability required in some recommender systems [5]. In particular, when only sparse ratings data is available, sentiment analysis can play a key role in improving recommendation quality. This is because recommendation algorithms mostly rely on users' ratings to select the items to recommend. Such ratings are usually insufficient and very limited. On the other hand, sentiment-based ratings of items that can be derived from reviews or opinions given through online news services, blogs, social media or even the recommender systems themselves, are seen as capable of providing better recommendations to users. Sentiment-based models have been exploited in recommender systems to overcome the data-sparsity problem that exists in conventional recommender systems. Hence, integrating sentiment in recommender systems may significantly enhance the recommendation quality.

2. LITERATURE SURVEY

Rao et al. [8] designed a recommender system that contains the user list and item list with user reviews. Using the sentiment dictionaries, the researchers divided the items into three categories:

brand, quality, and price. They leveraged sentiment dictionaries to calculate sentiment of a particular user on item/product.

Gurini et al. [9] adopted a different approach to describe a user recommender system for Twitter. Their work emphasized the use of implicit sentiment analysis in order to improve the performance of the recommendation process. They defined a novel weighting function that takes into account sentiment, volume, and objectivity related to the users' interests.

Liu et al. [2] have discussed that, in recent past, some recommender systems are made in order to facilitate tourists to get a list of hotel recommendations before making any booking. The nature of most of the data on Internet and web is heterogeneous becoming a hurdle for recommender systems because conventional recommender systems are dealing with homogenous data only which compromises the performance of hotel recommendation systems. Complex data in the multiple forms such as numeric, text, and visuals require developers' attention to develop recommender systems dealing with the heterogeneity of data.

Zhang and Mao [4] suggested that recommender systems are developed to achieve true and relevant recommendations. Relevant recommendation means the recommendation which is according to the customer's preference and choice. Usually, a recommender system uses customer ratings and reviews from the previous data considering the hotel's attributes or features. So the main challenge in this paper is to develop an intelligent approach which processes and analyzes large heterogeneous web data to achieve true hotel recommendations which are relevant to the customer's choice.

Hsieh et al. [6] have explained in detail that different recommender systems are built using different methods and algorithms which uses customers' previous data consisting reviews and ratings about the different products to obtain true recommendations. Burke [7] has discussed about different types of recommendation algorithms. It explained that there are two recommendation techniques. First is collaborative filtering (CF), and the other is content-based filtering (CBF). Mixer of these two algorithms is called as hybrid filtering.

Ekstrand et al. [9] elaborate that collaborative filtering uses a class of methods and utilizes

preferences of other users which they have expressed for the same items to recommend items to the active user. This technique can also be beneficial in all other domains where the customer preferences can randomly change. Collaborative filtering algorithms can be of two kinds, i.e., item-based recommender system and user-based recommender system. Item-based recommenders compare item similarities, and the user-based recommenders instead compare user similarities in the recommendation process.

Chen et al. [13] devised a locally-connected wide & deep learning model for large scale industrial-level recommendation task. It employs the efficient locally-connected network to replace the deep learning component, which decreases the running time by one order of magnitude. An important step of deploying wide & deep learning is selecting features for wide and deep parts. In other words, the system should be able to determine which features are memorized or generalized. Moreover, the cross-product transformation also is required to be manually designed. These pre-steps will greatly influence the utility of this model. The above mentioned deep factorization based model can alleviate the effort in feature engineering.

In [8], proposed a sentiment analysis-based recommender system that provides improved recommendation using faith and sentiment implication from online social networks. This paper proposes a framework of implicit social trust and sentiment-based recommender system. This framework was verified by experimenting with real-time social data from Twitter. This recommender system uses machine learning methods such as naïve bayes, logistic regression, and decision trees. In [8], proposed a recommender system that uses opinions or sentiment of users regarding the services provided by E-shopping website. For classifying the sentiments provided by the user they used stochastic learning algorithm. This recommender system will find out and does not allow fake reviews by using the MAC address of the system. The main contribution of this framework includes the implementation of stochastic learning and context-based engine to overcome the drawbacks of traditional recommender system and for improved performance.

In [11], proposes utilization of supposition examination characterization as a powerful

strategy for analyzing literary information originating from assets of assets on web. Sentiment analysis is a strategy for information mining that assesses literary information expending AI strategies. Because of tremendous scope of assessments of clients, their surveys, feedback, and recommendations accessible over the web assets, it is such a great amount of irreplaceable to find, analyze and combine their perspectives for improved decision making. Sentiment analysis presents a compelling and proficient assessment of customers continuously which can enormously influence the dynamic cycle for business area.

3. RECOMMENDER SYSTEM

A recommender system works keen and identifies people and predicts the behavior of the user in selecting a particular product or item and also the list of products or items that are likely to be chosen by the specific user. This has created in developing a much better-personalized information filtering technology [2]. This information overload could be reduced and continue to provide the needed services on content and recommendations that will aid the day to day life activities of the user. This has led to the emergence of various websites and applications related to the purchase of items or products and E-commerce.

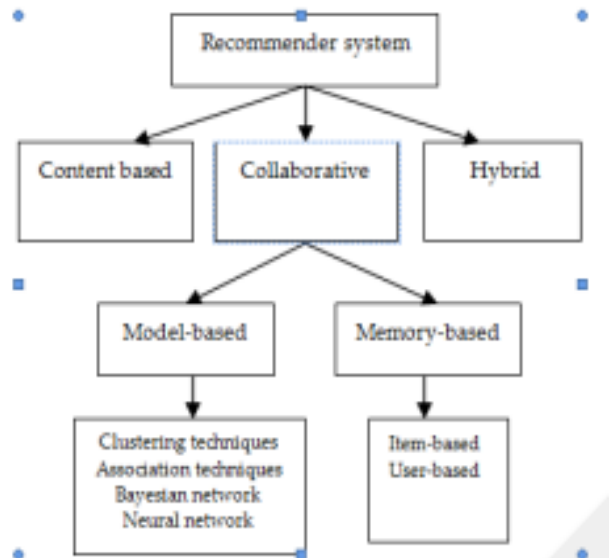
Usually, a recommendation for the questions for each user made from the anticipation of ranking for details or based on the user list the items in ranked order. A variety of techniques as shown in Figure are the traditional Content-based, Collaborative and others like Cross-Domain, Constraint-Based, Group Basically, for every user of the application, a ranked list for the items is collected, which then after analysis on the ranking, the top-ranked things will be predicted and provided as a recommendation to the users.

A variety of techniques have been proposed to perform recommendations, including the traditional Content Memory-based collaborative filtering finds the pattern of users of the same kind of behavior of similar users utilizes this liking to guess the ratings for that user. The positive aspects of this approach that can be considered to be advantageous is that collaborative filtering: scalability, simplicity to deploy for varied condition, upgrading the database on new data

easily and clear explanation about the working pattern of the recommender system by bringing out the descriptions or content that are suitable in a list of recommendations. But the cons of memory-based CF techniques include: slow in predicting due to the loading of the entire database; create defective and inexact prediction if no item found to be similar to other users' ratings of the thing.

The similarity between any two users or between two elements is calculated by Correlation-based similarity measures that utilize the computed Pearson correlation [2]. Model-based filtering may be machine learning or data processing primarily based model that identifies complicated rating patterns in coaching knowledge and thereby will intelligent predictions or recommendations for the user exclusively supported the learned model. The measure of benefits of model-based CF algorithms: improves prediction performance, scalable actual dataset, and avoids over fittings.

However, the existence of issues in model-based CF techniques: suffer from the sparseness downside so that it doesn't offer ratings for those users are haven't given any ratings, and it's not versatile for updating of the dataset supported the model. Bayesian models, clustering models, and dependency networks are the Model-based CF methods that exist to solve the issues discussed above. If the user ratings are categorical clustering algorithm can be used, and for numerical ratings, the regression models and Singular Value Decomposition (SVD) methods can be used. These algorithms can also group users or items. Then, the relative occurrence of ratings for an item can be designed among the groups. Naive Bayes, matrix factorization, locates regular factors for ratings given by users.



Summary of recommendation techniques recommenders.

Content-based recommender system

This approach on recommender is solely based on the profiles of users or descriptions of items on their major objective. For the sake of information related to the user, a user profile is created by acquiring the usage of the web, attribute and feature of the products under analysis using web usage mining. Content-based recommendation system filters items based on the similarity measures of the user's content that is shown on interest by the users. The utility of an item for a user can be a derivative done after a quantitative analysis of the metadata of the item. The content-based recommender system shows the advantage: users' autonomy in exclusive ratings with their profile; even if there are no ratings on items never being taken up any user, this approach seems to be interesting for the naïve users. However, the cons of the method include: the recommendation may turn to be incorrect, and attributes of items cannot be generated because of the lag in collecting feedback and also too many ratings on the same items.

Hybrid Recommender System

Hybrid recommendation system combines the above two approaches to gain improved prediction by scrutinizing items, thereby discovering the content regularities using heuristic methods or classification algorithms but have the start-up problem due to lack of information available to assemble a reliable classifier and overspecialization problem. Hybrid approaches

are implemented by deployment individually as well as accumulating ranking and predictions and build a general consolidative model that resolves the common problems in recommender systems.

Other Approaches

The techniques must also be able to consider other features while recommending based on which the following approaches can be built: Cross-Domain Recommendation aims to develop an integrated model of preference with diverse domain interaction preferences and not restricted only to specific domains. Constraint-Based Recommendation how to meet the overload and service to more people than it can handle. Group Recommendation considers a difference of opinions among groups, unlike individual ratings and also session-oriented interactions. Recommendation and Social Networks, which emphasis on social features, user preferences in a network are not only dynamic but interdependent too with the system Context-aware Recommendation aims to incorporate fine-grained information in recommender models like location, current activity, etc. which are real-time. The recommendation seems to have a great upshot on the rating propensity of individuals, but a lot of research is being carried on — for instance, movie recommendations by Netflix, video clicks for home page recommendation on YouTube. Deep learning has obsessed with an outstanding revolution in industrial recommender applications [3]. Many companies improve their recommendations through deep education like YouTube, Google Play, and Yahoo News. A significant improvement over traditional models has been witnessed.

4. DEEP LEARNING TECHNIQUES

It is deep learning under the research category of machine learning that solves both supervised and unsupervised learning errands with the aid of representation of the data in various forms.

Deep, dense networks

Reviews in the original form cannot be processed by any machine learning algorithms or other architectures. Any work requires numbers as inputs for classification, regression, etc. in broad terms. But vast data is available only in text

format, which is essential in extorting the knowledge for building applications. Sentiment analysis of reviews by Amazon, etc., news classification or clustering by Google, etc. is the realworld applications that include text. The texts can be converted into numbers by word embeddings [4]. The deep learning platform is used in the word2vec model. Where representation, the meaning is used as an input to a classifier. And hence considers the only single word and does not discuss relations between words that are unlike the bag of words approach. Therefore, it does not show much performance [6]. Thereby a deep, dense neural network can be used where the input vectors of words in the sentence but identified to produce only unsatisfactory results. Too many parameters, there is no adequate representation. It has lead to the usage of various neural network platforms.

Recurrent Neural Networks

One category of an artificial neural network is Recurrent Neural Network (RNN), with connections that resemble a directed graph on a sequence. These neural networks aren't the first natural acceptable representing sentences. Recursive neural networks area unit a higher suited the task, but it's helpful to explore [7]. The input considered here is the following words, and the output is the prediction under each category. A pooling layer between the softmax layer and the hidden layer will increase the accuracy. As an additional improvement, long short term memory (LSTM) unit can be used within the network, which referred to as an associate LSTM network. It consists of a correlated input and output, cell, and a forget gate. The battery acts as a "conventional" artificial neuron with three barriers, which can keep recalling the values over some time, i.e., the so-called "memory." Similarly, it worked as a regulator with the flow of importance in the feed-forward neural network and denoted as "gate." LSTM is suitable for classification based on the protracted amount of time, unknown time slices, and interval during events. Thus LSTMs, though aimed to reduce the degradation while learning RNN, showed no performance increase but overheads due to added units. However, a higher regularization technique may come through over 40% of accuracy.

Recursive Neural Networks

In a recursive neural network (RNN), structured format of input is considered where recursively we apply the weight which predicts data over variable-size that can be used for learning patterns in word embedding for language processing used in the network structure resembles like that of a sentence for which the parsing is done and represented as a tree[5]. Thus graphical representation is used to structure the given problem in RNN in which both information content and their logical relationships from the application context considered that take the significant part in explicitly modeling for machine learning problems. This information is rich in representation and also information content rather than being distributed in pieces. An inference system can be developed from this transferring of information through messages in both directions during learning that can be made as a computational model for recursive networks.

Convolution Neural Networks

A fully connected of one or more feed-forward networks forms a convolution neural network (CNN), max-pooling structures. It considers the 2D structure of input data and produces better results in image and speech applications hence suitable for two-dimensional data of audio. CNN's have few parameters and thereby are easier to train than others. In convolution neural networks [8], the data are filtered using a window of different sizes over the sentence, and the results produced are accumulated by a pooling layer, and these outputs can be used with a soft max layer to generate prediction probabilities. Convolution Neural Networks achieve higher accuracy but not significantly due to serious over fitting in the model that can be solved by the training phase. LSTM if given enough network units, proper weight matrix input will result in computations that cannot be done using a conventional computer can compute.

5. CONCLUSION

In this article, we provided an extensive review of the most notable works to date on deep learning based recommender systems. We proposed a classification scheme for organizing and clustering existing publications, and highlighted a bunch of influential research prototypes. We also discussed the advantages/disadvantages of using

deep learning techniques for recommendation tasks. Additionally, we detail some of the most pressing open problems and promising future extensions. Both deep learning and recommender systems are ongoing hot research topics in the recent decades. There are a large number of new developing techniques and emerging models each year. We hope this survey can provide readers with a comprehensive understanding towards the key aspects of this field, clarify the most notable advancements and shed some light on future studies.

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OCCUPATIONAL STRESS OF WORKING WOMEN DURING PANDEMIC- AN OVERVIEW

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Abstract

Women workforce constitutes a foremost share of human resource in every contemporary organisation. This could be true in India as well since there has been a progressive increase in women pursuing higher education over the past two decades. However, the number of women employees enduring their jobs compared to their male counterparts is found to be plummeting in the country. One of the numerous reasons leading to this scenario might be job-related stress. There have been numerous studies on occupational stress among employees; however, very few of them focus on the occupational stress of women in particular. This paper attempts to examine occupational stress as a key factor contributing to the turnover of women workforce. Further, an association between occupational stress and quality of work-life of women is examined. Job insecurity, the dearth of support from family and colleagues, poor health conditions and migrating to another location after marriage are a few factors causing occupational stress among women. The transformed job environment due to Covid19 has emerged as a novel factor adding to the stress of working women. It is felt that beating occupational stress is not an effortless task but should be approached lucidly.

Keywords: Occupational Stress, Quality of Work-life, Women Workforce

Introduction

Stress is incidental and inherent in any job or situation and is the reaction to changing or dynamic conditions. Stress occurs based on the individual's perception of an event and is more emotional or psychological in nature. Positive-stress sustains a person motivated to face any exigency. Negative-stress occurs when one is incapable of overcoming the challenges posed by a situation for a long time. Prolonged stress may cause emotional and physical disproportion in a person.

Women, Karimnagar Abstract Women workforce constitutes a foremost share of human resource in every contemporary organisation. This could be true in India as well since there has been a progressive increase in women pursuing higher education over the past two decades. However, the number of women employees enduring their jobs compared to their male counterparts is found to be plummeting in the country. One of the numerous reasons leading to this scenario might be job-related stress. There have been numerous studies on occupational stress among employees; however, very few of them focus on the occupational stress of women in particular. This paper attempts to examine occupational stress as a key factor contributing to the turnover of women workforce. Further, an association between occupational stress and quality of work-life of women is examined. Job insecurity, the dearth of support from family and colleagues, poor health conditions and migrating to another location after marriage are a few factors causing occupational stress among women. The transformed job environment due to Covid19 has emerged as a novel factor adding to the stress of working women. It is felt that beating occupational stress is not an effortless task but should be approached lucidly. Keywords: Occupational Stress, Quality of Work-life, Women Workforce Introduction Stress is incidental and inherent in any job or situation and is the reaction to changing or dynamic conditions. Stress occurs based on the individual's perception of an event and is more emotional or psychological in nature. Positive-stress sustains a person motivated to face any exigency. Negative-stress occurs when one is incapable of overcoming the challenges posed by a situation for a long time. Prolonged stress may cause emotional and physical disproportion in a person. Mukta Shabd Journal Volume XI, Issue I, JANUARY/2022 ISSN NO : 2347-3150 Page No : 545

Work is an integral component and state of accomplishment and helps an individual to lead a satisfying life. Occupational stress is immanent in any job, implies the proceeding stress an employee faces due to job responsibilities, work conditions, work environment and numerous other pressures at the workplace. The nature of occupational stress varies among people based on the nature of the job. Job stress is overblown when an employee feels he or she is a misfit to a particular domain. It prevents an employee from performing to his or her true potential creating a lag in the performance.

In an organization, both male and female workforce is vulnerable to occupational stress. However, the bearing of the factors causing job-related stress on both the genders may differ. Women constitute a shareable size in the workforce of any organization. It is a fact in India as well, given the burgeoning enrolment of women in higher education in recent years. The contributions of such well-educated and skilled women workforce are indispensable for the progress of the country as a major economic superpower.

Contribution of Women Workforce

India is one among the largest economies of the world and projected to be the most populous country in the world by 2050. Women constitute 48.1% of the country's total population. Female workforce participation in India does not reverberate with its high economic growth and upsurge in female education. Even though there is equality in the attainment of higher education among both the genders, the women workforce participation does not resonate with higher education between 2004 and 2018, it persists. The increased employment rate of women could further augment the average household income of Indian families which enhances the purchasing power and general economic growth.

Graph 1 depicts a steady growth in enrolment in higher education in India. It is evident that from nil enrolment in 1950-51, the female enrolment in higher education raised to 160 lakh in 2015-16. The enrolment of women in higher education displays a progressive trend when compared to males.

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One-pot synthesis and biological evaluation of novel 3-(5-((aryl) methyl) isoxazol-3-yl)-4H-chromen-4-one derivatives as potent antibacterial and anticancer agents

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Abstract

In search of better antibacterial and anticancer agents, a series of novel 3-(5-((aryl) methyl) isoxazol-3-yl)-4H-chromen-4-one derivatives was synthesized (4a-4l) by using 4-oxo-4H-chromene-3-carbaldehyde and alkyne via in situ generated nitrile oxide and evaluated for their antibacterial and anticancer activity in vitro. Antibacterial activity was evaluated against three G+ bacterial strains and anticancer activity against breast cancer cell line (MCF-7) and cervical carcinoma cell line (HeLa).

Among all the tested compounds, 4j and 4g exhibited potent antibacterial activity against tested gram-positive bacterial strains. 4g, 4i and 4j exhibited potent cytotoxic activity against MCF-7 with IC₅₀ values nearer to the standard drug doxorubicin.

Keywords: One-pot synthesis, Chromone, Isoxazole, Anticancer, Antibacterial activity.

Introduction

The identification of new structures for effective cancer treatment remains a major challenge for researchers in medicinal chemistry.^{2,5,20} Cancer is a chronic disease and is the main cause of human death in the modern world.^{16,18} The treatment for cancer treatment still remains an important and

challenging problem for researchers worldwide. Hence, the scientific communities are highlighting the need for the search and discovery of new and more effective anticancer agents. Nowadays the aim of the researchers is to develop new motifs which are structurally modified from the basic structure that can effectively inhibit the growth of cancer cells.

On the other hand, treatment of bacterial infections still remains an important and challenging therapeutic problem, due to the emergence of bacterial resistance to current therapeutic agents. Therefore, there is a need for new class of drugs in treating the pathogenic microorganisms and cancer causing cells. The chemistry of chromone and its derivatives is reported to be physiologically and pharmacologically active and finds applications in the treatment of several diseases.²⁵ For example, substituted chromone derivatives play a significant role in the medical field with many pharmacological activities such as anticancer^{4,7,23,24}, anti-HIV³, antibacterial⁸ and antioxidants activities.¹⁴

Isoxazole is one of the essential structural scaffolds in many pharmacologically active drugs such as zonisamide, leflunomide, valdecoxib and Paliperidone (Figure 1). Among the various biologically active isoxazole derivatives, substituted 3,5-isoxazoles occupy an extremely important role in the pharmaceutical and medicinal fields.^{11,12,22}

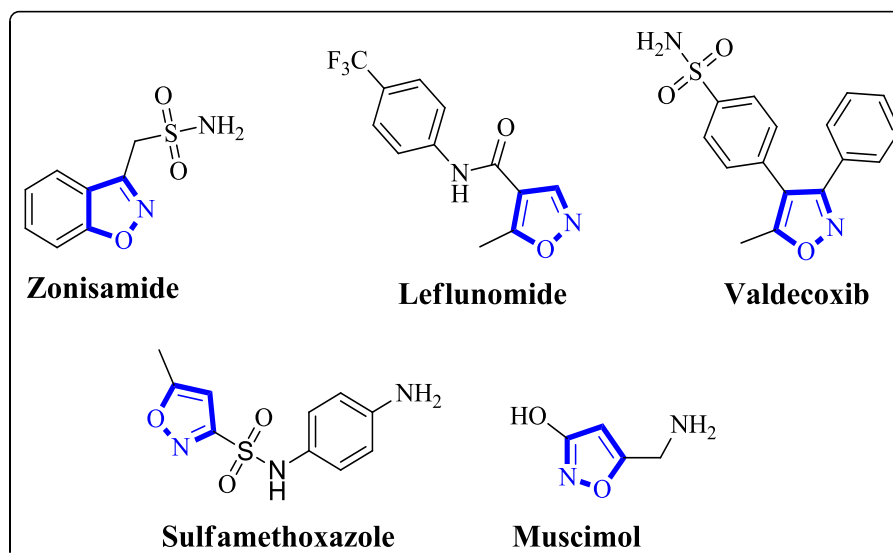


Figure 1: Structures of isoxazole-containing drugs.

In view of all the above facts and the applications of microwave irradiations and ionic liquids for the sustainable organic synthesis,^{1,10,21} our goal was to design a unit that would integrate both active pharmacophores into a single molecular platform and in particular to evaluate their anticancer and antibacterial activities. In the present work, we report herein the synthesis of isoxazole linked chromone derivatives screened for their anticancer and antibacterial activity.

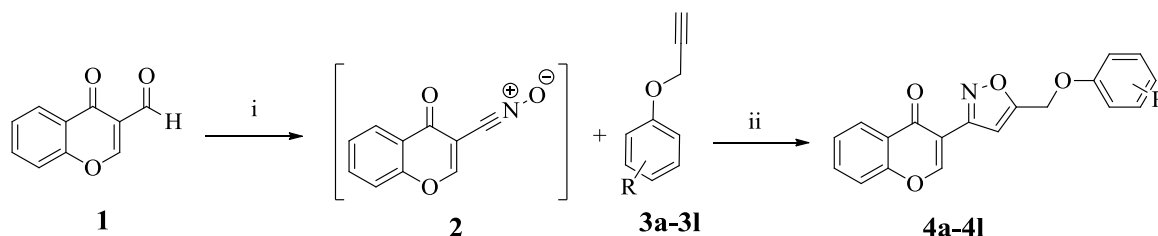
Results and Discussion

The designed chromones containing isoxazoles (4a-4l) were synthesized as outlined in scheme 1. 4-oxo-4*H*-chromene-3-carbaldehyde (1) was converted to the corresponding aldoximes using hydroxylammonium chloride and 1M NaOH in [Bmim]BF₄ at room temperature. These aldoximes were converted to the corresponding nitrile oxide using chloramine-T trihydrate.^{6,19} The *in situ* generated nitrile oxide and alkyne(3) in the presence of CuI in [Bmim]PF₆ at room temperature yielded 3-(5-((aryl)methyl)isoxazol-3-yl)-4*H*-chromen-4-one (4a-4l) in good yields.¹⁰ The structures of the newly synthesized compounds (4a-4l) were confirmed by spectral data (nuclear magnetic resonance [NMR], infrared [IR] and electrospray ionization-mass spectrometry [ESI-MS]). All the spectral data of the synthesized

compounds were in full agreement with the proposed structures and are discussed for a representative compound 4a.

In the IR spectrum, the appearance of sharp absorption bands at 3034, 1652, 1609 and 1221, 1115 cm⁻¹ is ascribed to -Ar-H, -C=O, -C=N and (C-O-C) stretching frequencies. In the ¹H-NMR spectrum, the signals at δ 8.15–7.13 (m, 9H, Ar-H), 6.80 (s, 1H, iso-H), 5.32 (s, 2H, O-CH₂) and the electron ionization mass (EI-MS) spectra showed [M+H]⁺ ion peak at *m/z* 320, which confirmed the structure of compound 4a. The CHN (Carbon, Hydrogen and Nitrogen) analyses data (C, 71.49; H, 4.17; N, 4.33) confirmed the purity of compound 4a.

Antibacterial activity: The title compounds (4a–4l) were screened for their *in vitro* antibacterial activity against gram-positive (G+) bacterial strains by the standard broth microdilution technique by using streptomycin as positive controls.^{13,26} The minimum inhibitory concentrations (MICs) for all the synthesized compounds were reported in μg/mL and the results are illustrated in table 1. It is evident from table 1 some of the tested compounds exerted significant *in vitro* antibacterial activity against tested bacterial strains with MICs ranging from 1.56 to 12.5 μg/mL.



Scheme 1: Reagents and reaction conditions: i) a) NH₂OH·HCl, NaOH, Chloramine-*T* trihydrate, [Bmim]BF₄, r.t., 20-30 min. ii) Cu(I), r.t., 8–10 h.

Table 1
In vitro antibacterial and anticancer activity data of compounds 4a-4l.

Analog (R)	MIC(μg/mL)			IC ₅₀ (μM)		
	<i>B. subtilis</i>	<i>S. aureus</i>	<i>S. epidermidis</i>	<i>MCF-7</i>	<i>Hela</i>	<i>HEK-293</i>
4a (H)	>50	>50	25 ± 0.56	69.62 ± 1.64	67.55 ± 1.17	NT
4b (2-Me)	>50	>50	50 ± 0.87	81.63 ± 1.43	76.65 ± 1.65	NT
4c (3-Me)	25 ± 1.08	>50	25 ± 1.06	74.88 ± 1.49	67.45 ± 1.42	NT
4d (3,5-diMe)	25 ± 1.03	50 ± 1.27	25 ± 0.98	49.15 ± 1.32	57.44 ± 1.32	NT
4e(3,4-diMe)	25 ± 0.32	>50	50 ± 1.21	58.41 ± 1.17	47.80 ± 1.85	NT
4f (4-OMe)	25 ± 1.04	50 ± 1.11	25 ± 1.09	38.44 ± 1.22	42.29 ± 1.44	NT
4g (2-F)	6.25 ± 0.21	25 ± 0.89	6.25 ± 0.35	13.82 ± 1.78	27.46 ± 1.02	24.84 ± 1.32
4h (3-Cl)	25 ± 1.68	25 ± 1.51	12.5 ± 1.14	26.12 ± 1.46	32.17 ± 1.14	NT
4i (3,5-diCl)	12.5 ± 1.19	12.5 ± 1.47	6.25 ± 0.25	15.32 ± 1.39	29.42 ± 1.31	60.08 ± 1.18
4j (3-CF₃)	3.12 ± 0.45	6.25 ± 0.68	3.12 ± 0.44	11.32 ± 1.03	19.84 ± 1.02	42.03 ± 1.54
4k (4-Br)	25 ± 1.09	25 ± 1.22	50 ± 1.25	25.39 ± 1.11	32.41 ± 1.31	NT
4l (4-NO ₂)	12.5 ± 0.45	25 ± 1.68	12.5 ± 0.35	28.13 ± 1.64	29.86 ± 1.82	NT
Streptomycin	6.25 ± 0.22	6.25 ± 0.21	3.12 ± 0.15	NT	NT	NT
Doxorubicin	NT	NT	NT	2.61 ± 0.18	1.32 ± 0.41	6.11 ± 0.66

^aMIC (μg/mL), i.e., the lowest concentration of the test compound to inhibit the growth of bacteria completely,

^b Values are mean ± SD of three replicates; NT - not tested

Compound 4a with the MICs ranging from 25 ± 0.56 to $50 \pm 1.88 \mu\text{g/mL}$ was selected as starting point for our initial SAR studies, which focused on phenoxy methyl group in 5th position of isoxazole ring. A wide variety of substituents were introduced to phenoxy group. As shown in table 1, some of the tested compounds demonstrated significant *in vitro* antibacterial activities. The trifluoromethyl group at meta position of phenoxy group (4j) led to increase of activity showed more potent activity against *B. subtilis* (MIC = $3.12 \pm 0.45 \mu\text{g/mL}$), *S. aureus* (MIC = $6.25 \pm 0.68 \mu\text{g/mL}$) and *S. epidermidis* (MIC = $3.12 \pm 0.44 \mu\text{g/mL}$) compared to standard streptomycin. Also, compound 4g effectively inhibited the *B. subtilis* (MIC = $6.25 \pm 0.21 \mu\text{g/mL}$) and good activity against *S. epidermidis* (MIC = $6.25 \pm 0.35 \mu\text{g/mL}$). The rest of the compounds exhibited good to moderate with MIC values ranging from 12.5 to $50 \mu\text{g/mL}$.

Anticancer activity: *In vitro* anticancer activity was performed against two cancer lines (MCF-7 and HeLa) and normal cell line (HEK-293) by MTT assay using doxorubicin as a positive control¹⁵ and the results are tabulated in table 1.

From the screening results in table 1 (Compounds 4a-4l), it was observed that majority of compounds exhibited good to moderate anticancer activity against MCF-7. Among all compounds 4g, 4i and 4j showed good activity against MCF-7 with IC₅₀ values ranging from 11.32 ± 1.03 to $15.32 \pm 1.39 \mu\text{M}$. Remaining compounds have shown moderate to poor activity against MCF-7 and HeLa with IC₅₀ values ranging from 19.84 ± 1.02 to $81.63 \pm 1.43 \mu\text{M}$ respectively. Based on SAR, it was observed from experimental data compounds derived from 2-fluoro and 3-trifluoromethyl phenoxy groups on isoxazoles and have exhibited good anticancer activity against MCF-7 when compared with the others.

Material and Methods

FTIR-spectra were recorded on a PerkinElmer BX series FT-IR spectrometer in KBr pellets. ¹H spectra were recorded on a Bruker Avance spectrometer (400 MHz) in CDCl₃ with TMS as internal standard. Mass spectra were recorded on a Jeol JMC-300 spectrometer (ESI, 70 eV). Elemental analyses were performed on Carlo Erba 106 and Perkin Elmer model 240 analyzers. Melting points were determined using a Cintex apparatus and are uncorrected. TLC was performed using Merck silica gel 60 F254 precoated plates (0.25 mm); silica gel (100–200 mesh) was used for column chromatography. The progress of the reactions as well as purity of the compounds was monitored by TLC eluent EtOAc–hexane. All reactions were carried out in a round bottom flask under room temperature.

Synthesis of 3-(5-((aryl)methyl)isoxazol-3-yl)-4H-chromen-4-one (4a-4k): 4-oxo-4H-chromene-3-carbaldehyde (1) (2.3 mmol) was added to a solution of hydroxylamine hydrochloride (3.5 mmol) in 15 mL of [Bmim]BF₄. To this was added NaOH (3.5 mmol) and after stirring for 30 min at ambient temperature, TLC analysis indicated that the oxime

formation was complete. Chloramine-T trihydrate (2.0 mmol) was added in small portions over 10 min followed by CuI (10 mol%). Alkyne (3) (3.00 mmol) was added, the pH was adjusted to 6 by the addition of a few drops of 1M NaOH and stirring was continued for a further 8-10 h.

The reaction mixture was poured into cold water (50 mL) and 5 mL of dilute NH₄OH was added to remove all copper salts. Isoxazoles 4a-4l were collected by filtration, redissolved and passed through a short plug of silica gel (25% ethyl acetate/hexane) affording 3-(5-((aryl)methyl)isoxazol-3-yl)-4H-chromen-4-one as a white solid. The residue ionic liquid was washed with water and reused for the cycloaddition reaction.

3-(5-(phenoxy)methyl)isoxazol-3-yl)-4H-chromen-4-one

(4a): White solid, yield: 69 %, m.p.: 114-116 °C; IR (KBr, cm⁻¹): 3034 (C–H, Ar), 1652 (C=O, chromene), 1609 (C=N), 1221, 1115 (C–O–C); ¹H-NMR (400 MHz, CDCl₃, δ in ppm): 8.15-8.10 (m, 1H, Ar-H), 7.97-7.92 (m, 2H, Ar-H), 8.82-7.76 (m, 2H, Ar-H), 7.67-7.60 (m, 1H, Ar-H), 7.50-7.27 (m, 3H, Ar-H), 7.13 (s, 1H, Chr-H), 6.80 (s, 1H, iso-H), 5.32 (s, 2H, O-CH₂); ESI-MS m/z: 320 [M+H]. Anal. Cal for C₁₉H₁₃NO₄; C, 71.47; H, 4.10; N, 4.39. found: C, 71.49; H, 4.17; N, 4.33.

3-(5-((o-tolyloxy)methyl)isoxazol-3-yl)-4H-chromen-4-one

(4b): White solid, yield: 69 %, m.p.: 169-171 °C; IR (KBr, cm⁻¹): 3022 (C–H, Ar), 1657 (C=O, chromene), 1621 (C=N), 1223, 1154 (C–O–C); ¹H-NMR (400 MHz, CDCl₃, δ in ppm): 8.15 (d, *J* = 8.0 Hz, 1H, Ar-H), 7.90 (d, *J* = 8.0 Hz, 1H, Ar-H), 7.88 (t, *J* = 4.0 Hz, 1H, Ar-H), 7.74 (t, *J* = 4.0 Hz, 1H, Ar-H), 7.50-7.40 (m, 1H, Ar-H), 7.39-7.27 (m, 3H, Ar-H), 7.13 (s, 1H, Chr-H), 6.79 (s, 1H, iso-H), 5.33 (s, 2H, O-CH₂), 2.18 (s, 3H, Ar-CH₃); ESI-MS m/z: 334 [M+H]. Anal. Cal for C₂₀H₁₅NO₄; C, 72.06; H, 4.54; N, 4.20. found: C, 72.09; H, 4.58; N, 4.23.

3-(5-((m-tolyloxy)methyl)isoxazol-3-yl)-4H-chromen-4-one

(4c): White solid, yield: 69 %, m.p.: 169-171 °C; IR (KBr, cm⁻¹): 3023 (C–H, Ar), 1627 (C=O, chromene), 1611 (C=N), 1231, 1112 (C–O–C); ¹H-NMR (400 MHz, CDCl₃, δ in ppm): 8.16 (d, *J* = 8.0 Hz, 1H, Ar-H), 7.96 (d, *J* = 8.0 Hz, 1H, Ar-H), 7.75 (t, *J* = 8.0 Hz, 1H, Ar-H), 7.75 (t, *J* = 8.0 Hz, 1H), 7.61 (s, 1H, Ar-H), 7.44-7.27 (m, 4H, Ar-H), 7.14 (s, 1H, Chr-H), 6.79 (s, 1H, iso-H), 5.38 (s, 2H, O-CH₂), 2.18 (s, 3H, Ar-CH₃); ESI-MS m/z: 334 [M+H]. Anal. Cal for C₂₀H₁₅NO₄; C, 72.06; H, 4.54; N, 4.20. found: C, 72.02; H, 4.59; N, 4.24.

3-(5-((3,5-dimethylphenoxy)methyl)isoxazol-3-yl)-4H-chromen-4-one

(4d): White solid, yield: 65 %; m.p.: 184-186 °C; IR (KBr, cm⁻¹): 3022 (C–H, Ar), 1627 (C=O, chromene), 1608 (C=N), 1229, 1118 (C–O–C); ¹H-NMR (400 MHz, CDCl₃, δ in ppm): 8.16 (d, *J* = 8.0 Hz, 1H, Ar-H), 7.91 (d, *J* = 8.0 Hz, 1H, Ar-H), 7.75 (t, *J* = 4.0 Hz, 1H, Ar-H), 7.74 (t, *J* = 8.0 Hz, 1H), 7.35 (t, *J* = 8.0 Hz, 1H, Ar-H), 7.30 (s, 2H, Ar-H), 7.16 (s, 1H, Ar-H), 7.11 (s, 1H, Chr-

H), 6.75 (s, 1H, iso-H), 5.34 (s, 2H, O-CH₂), 2.41 (s, 6H, Ar-CH₃); ESI-MS m/z: 320 [M+H]. Anal. Cal for C₂₁H₁₇NO₄; C, 72.61; H, 4.93; N, 4.03. found: C, 72.69; H, 4.98; N, 4.08.

4-((1-(3,4-Dimethylphenyl)-1H-1,2,3-triazol-4-yl)-methyl)-2H-benzo[b][1,4]thiazin-3(4H)-one-1,1-dioxide(4e):

White solid, yield: 73 %; m.p.: 179-181 °C; IR (KBr, cm⁻¹): 3061 (C-H, Ar), 1627 (C=O, chromene), 1618 (C=N), 1223, 1134 (C-O-C); ¹H-NMR (400 MHz, CDCl₃, δ in ppm): 8.18 (d, J = 8.0 Hz, 1H, Ar-H), 7.95 (d, J = 8.0 Hz, 1H, Ar-H), 7.74 (t, J = 8 Hz, 1H, Ar-H), 7.38 (t, J = 8 Hz, 1H, Ar-H), 7.30 (d, J = 8.0 Hz, 1H, Ar-H), 7.19 (t, J = 8 Hz, 1H, Ar-H), 7.13 (s, 1H, Chr-H), 7.07 (d, J = 8.0 Hz, 1H, Ar-H), 6.76 (s, 1H, iso-H), 5.38 (s, 2H, O-CH₂), 2.33 (s, 3H, Ar-CH₃), 1.94 (s, 3H, Ar-CH₃); ESI-MS m/z: 320 [M+H]. Anal. Cal for C₂₁H₁₇NO₄; C, 72.61; H, 4.93; N, 4.03. found: C, 72.67; H, 4.99; N, 4.00.

3-(5-((4-methoxyphenoxy)methyl)isoxazol-3-yl)-4H-chromen-4-one (4f):

White solid, yield: 79 %; m.p.: 206-208 °C; IR (KBr, cm⁻¹): 3024 (C-H, Ar), 1659 (C=O, chromene), 1601 (C=N), 1229, 1135 (C-O-C); ¹H-NMR (400 MHz, CDCl₃, δ in ppm): 8.15 (d, J = 8.0 Hz, 1H, Ar-H), 7.93 (d, J = 8.0 Hz, 1H, Ar-H), 7.74 (t, J = 8 Hz, 1H, Ar-H), 7.68 (d, J = 8.0 Hz, 2H, Ar-H), 7.34 (t, J = 8 Hz, 1H, Ar-H), 7.14 (s, 1H, Chr-H), 7.00 (d, J = 8.0 Hz, 2H, Ar-H), 6.76 (s, 1H, iso-H), 5.38 (s, 2H, O-CH₂), 3.85 (s, 3H, O-CH₃); ESI-MS m/z: 350 [M+H]. Anal. Cal for C₂₀H₁₅NO₅; C, 68.76; H, 4.33; N, 4.01. found: C, 68.81; H, 4.39; N, 4.03.

3-(5-((2-fluorophenoxy)methyl)isoxazol-3-yl)-4H-chromen-4-one (4g):

Pale red solid, yield: 68 %; m.p.: 158-160 °C; IR (KBr, cm⁻¹): 3033 (C-H, Ar), 1657 (C=O, chromene), 1611 (C=N), 1219, 1133 (C-O-C); ¹H-NMR (400 MHz, CDCl₃, δ in ppm): 8.16 (d, J = 8.0 Hz, 1H, Ar-H), 7.95-7.85 (m, 3H, Ar-H), 7.77-7.72 (m, 3H, Ar-H), 7.34 (t, J = 8 Hz, 1H, Ar-H), 7.14 (s, 1H, Chr-H), 6.76 (s, 1H, iso-H), 5.38 (s, 2H, O-CH₂); ESI-MS m/z: 338 [M+H]. Anal. Cal for C₁₉H₁₂FNO₄; C, 67.66; H, 3.59; N, 4.15. found: C, 67.70; H, 3.54; N, 4.19.

3-(5-((3-chlorophenoxy)methyl)isoxazol-3-yl)-4H-chromen-4-one (4h):

Pale yellow solid, yield: 67 %; m.p.: 181-183 °C; IR (KBr, cm⁻¹): 3029 (C-H, Ar), 1653 (C=O, chromene), 1605 (C=N), 1213, 1127 (C-O-C); ¹H-NMR (400 MHz, CDCl₃, δ in ppm): 8.14 (d, J = 8 Hz, 1H, Ar-H), 7.95 (d, J = 8 Hz, 1H, Ar-H), 7.79-7.70 (m, 2H, Ar-H), 7.65-7.55 (m, 1H, Ar-H), 7.50-7.30 (m, 3H, Ar-H), 7.14 (s, 1H, Chr-H), 6.81 (s, 1H, iso-H), 5.35 (s, 2H, O-CH₂); ESI-MS m/z: 354 [M+H]. Anal. Cal for C₁₉H₁₂ClNO₄; C, 64.51; H, 3.42; N, 3.96. found: C, 64.57; H, 3.47; N, 3.92.

3-(5-((3,5-dichlorophenoxy)methyl)isoxazol-3-yl)-4H-chromen-4-one (4i):

Pale yellow solid, yield: 84 %; m.p.: 222-224 °C; IR (KBr, cm⁻¹): 3022 (C-H, Ar), 1644 (C=O, chromene), 1613 (C=N), 1210, 1122 (C-O-C); ¹H-NMR (400 MHz, CDCl₃, δ in ppm): 8.13 (d, J = 8 Hz, 1H, Ar-H), 7.99 (d, J = 8 Hz, 1H, Ar-H), 7.74 (t, J = 8 Hz, 1H, Ar-H),

7.68 (s, 2H, Ar-H), 7.46 (s, 1H, Ar-H), 7.33 (t, J = 8 Hz, 1H, Ar-H), 7.15 (s, 1H, Chr-H), 6.82 (s, 1H, iso-H), 5.37 (s, 2H, O-CH₂); ESI-MS m/z: 389 [M+H]. Anal. Cal for C₁₉H₁₁Cl₂NO₄; C, 58.78; H, 2.86; N, 3.61. found: C, 58.72; H, 2.89; N, 3.59.

3-(5-((3-(trifluoromethyl)phenoxy)methyl)isoxazol-3-yl)-4H-chromen-4-one (4j):

Yellow solid, yield: 53 %; m.p.: 130-132 °C; IR (KBr, cm⁻¹): 3022 (C-H, Ar), 1623 (C=O, chromene), 1614 (C=N), 1220, 1112 (C-O-C); ¹H-NMR (400 MHz, CDCl₃, δ in ppm): 8.18 (d, J = 8 Hz, 1H, Ar-H), 7.94 (d, J = 8 Hz, 1H, Ar-H), 7.78-7.68 (m, 2H, Ar-H), 7.56-7.49 (m, 2H, Ar-H), 7.48-7.40 (m, 1H, Ar-H), 7.33 (t, J = 8 Hz, 1H, Ar-H), 7.15 (s, 1H, Chr-H), 6.81 (s, 1H, iso-H), 5.35 (s, 2H, O-CH₂); ESI-MS m/z: 388 [M+H]. Anal. Cal for C₂₀H₁₂F₃NO₄; C, 62.02; H, 3.12; N, 3.62. found: C, 62.08; H, 3.18; N, 3.55.

3-(5-((4-bromophenoxy)methyl)isoxazol-3-yl)-4H-chromen-4-one (4k):

Yellow solid, yield: 73 %; m.p.: 174-176 °C; IR (KBr, cm⁻¹): 3031 (C-H, Ar), 1612 (C=O, chromene), 1609 (C=N), 1230, 1132 (C-O-C); ¹H-NMR (400 MHz, CDCl₃, δ in ppm): 8.15 (d, J = 8 Hz, 1H, Ar-H), 7.93 (d, J = 8 Hz, 1H, Ar-H), 7.74 (t, J = 8 Hz, 1H, Ar-H), 7.69-7.59 (m, 4H, Ar-H), 7.36 (t, J = 8 Hz, 1H, Ar-H), 7.14 (s, 1H, Chr-H), 6.76 (s, 1H, iso-H), 5.38 (s, 2H, O-CH₂); ESI-MS m/z: 397 [M+H] & 399 [M+3H]. Anal. Cal for C₁₉H₁₂BrNO₄; C, 57.31; H, 3.04; N, 3.52. found: C, 57.36; H, 3.09; N, 3.47.

3-(5-((4-nitrophenoxy)methyl)isoxazol-3-yl)-4H-chromen-4-one (4l):

Yellow solid, yield: 73 %; m.p.: 174-176 °C; IR (KBr, cm⁻¹): 3033 (C-H, Ar), 1657 (C=O, chromene), 1601 (C=N), 1233, 1120 (C-O-C); ¹H-NMR (400 MHz, CDCl₃, δ in ppm): 8.49 (d, J = 8 Hz, 2H, Ar-H), 8.25 (d, J = 8 Hz, 2H, Ar-H), 8.16 (d, J = 8 Hz, 1H, Ar-H), 7.95 (d, J = 8 Hz, 2H, Ar-H), 7.68 (t, J = 8 Hz, 1H, Ar-H), 7.46 (t, J = 8 Hz, 1H, Ar-H), 7.14 (s, 1H, Chr-H), 6.81 (s, 1H, iso-H), 5.40 (s, 2H, O-CH₂); ESI-MS m/z: 365 [M+H]. Anal. Cal for C₁₉H₁₂N₂O₆; C, 62.64; H, 3.32; N, 7.69. found: C, 62.60; H, 3.27; N, 7.62.

Conclusion

A series of novel 3-(5-((aryl)methyl)isoxazol-3-yl)-4H-chromen-4-ones was synthesized by the Cu(I)-catalyzed reaction between *in situ* generated nitrile oxides with different alkynes in good yields. All compounds were selected for their *in vitro* cytotoxic activity against MCF-7 and HeLa cancer cell lines. Compounds 4g, 4i and 4j exhibited potent cytotoxic activity against MCF-7 with IC₅₀ values closer to standard doxorubicin. *In vitro* antibacterial activity against three gram-positive bacterial strains and compounds, 4j and 4g showed a potent antibacterial activity against the bacterial strains analyzed.

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ROLE OF MIR OSMAN ALI KHAN (1911-1948 A.D.) IN PRINCELY STATE OF HYDERABAD – AN ANALYSIS

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Abstract

Mir Osman Ali Khan acceded because the Nizam of Hyderabad upon the death of his father in 1911. The state of Hyderabad was the most important of the princely states in pre-independence India. The state of Hyderabad was the most important of the princely states in pre-independence India. With a vicinity of eighty 6,000 sq. miles (223,000 km²), it had been roughly the dimensions of this day United Kingdom. The Nizam was the highest-ranking prince in India, was one of only five princes entitled to a 21-gun salute, held the unique title of "Nizam", and titled "His Exalted Highness" and "Faithful Ally of the British Crown". In this paper focus on the role of Mir Osman Ali Khan in Princely state of Hyderabad.

Key Words: Mir Osman Ali Khan, Nizam, Hyderabad state, etc.

Introduction

The city of Hyderabad supported in 1591 by the fifth Qutub Shahi ruler, prophet Quli Qutub crowned head via a stimulating role because the largest princely state in India. The erstwhile Nizam's dominion of Hyderabad comprised of this day Telangana region of Andhra Pradesh, the districts of Bidar, Gulbarga and Raichur in state and therefore the Marathwada region, comprising of Mannad, Aurangabad, Parbhani, Barsi, Nanded, Sholapur, Oamanabad and Akalkot of geographic region. The state was an intensive highland with a median elevation of concerning 12, 00 feet. The dominions farmed a lateral sq. placed between 15°10' and 21°50' north latitude and between 74°45' and 81°35' east longitude¹. A trigonometrically survey of the region shows the world to be 97,837 sq. miles. Its space is quite that of European country and Scotland place along, up to that of France and 5 times that of Swiss Confederation. The length of the State from solid to west is 456 miles. Its breadth from north to south is 384 miles. It a median elevation of 1,250 feet and is intersected by ranges of hills with summits rising from 2,500 ft. to 3,500 ft. The surface of the country includes a general slope from north to southeast.²

The role of Mir Osman Ali Khan (1911-1948 A.D.):

Mir Mahaboob Ali Khan died on twenty ninth August 1911 C.E. The death of Mir Mahaboob Ali Khan, his son Mir Osman Ali Khan was announced the Nizam by Nabob Shahab Carl Gustav Jung, the Minister of Police. The enthronement and room were continued twelfth Sep 1911 C.E. Osman Ali Khan was born on fifth Gregorian calendar month 1886 Mir Osman Ali Khan was nevertheless young, his father Mahaboob Ali Khan, WHO was anxious to coach his son for the good workplace that expected him within the very best manner, engaged the eminent students in Persian and Urdu languages as teacher. Sports and Physical coaching, riding, tent-pegging, shooting, cricket and alternative manly exercises were often instructed beneath the management of commissioned military officer Sir Afsur-ul- Mulk, Commander-in-Chief of the Nizam's Army, In 1899 Sir Brian Egerton, was appointed as teacher to Osman Ali Khan to show English. In 1912 C.E. Sir Kishan Prasad, the Prime Minister of Hyderabad state was alleviated from the serious responsibility of the task.

The Osman Ali Khan appointed Nawab Mir Yusuf Ali Khan, better known as Salar Jung III as the Prime Minister of Hyderabad in 1912; but he resigned his job in 1914. In the same year, the Nizam took over the charge directly under his control. For five years he conducted the affairs of the state without a Prime Minister. Osmania University which was established at Hyderabad on 28th August 1919 marked a new departure in Indian education as it imparted instruction in the faculties of Arts, Science, Law, Muslim Theology Medicine, Engineering and Education through the Medium of Urdu, English being a compulsory language in the B.A. and B.Sc. examinations and examinations leading up to is a stage. In addition to the university college comprising the faculties of Arts, Science, Muslim Theology and Law, it has a Medical College, and an Engineering College, a Training College for Teachers and a Women's College, teaching up to M.A. and M.Sc. and Dip-in-Ed and M.Ed. standards. The University also maintains five Intermediate Colleges two in the city of Hyderabad and one each at Aurangabad, Warangal and Gulbarga.

The Nizam and his forces contest an extremely commendable role within the 1st war. The Hyderabad troops fought aspect by aspect with British forces in Palestine, King George-V was prompt in handsome recognizing the Nizam services. In an exceedingly room continued seventeenth Nov 1919, the Nizam publicized the new constitution beneath that the manager Council became the Supreme unit within the State.

The Executive Council consisted of seven members, six ordinary and one extraordinary, exclusive of the President, Sir Ali Imam, who had been a member of the Bihar and the Viceroys Executive Councils was appointed the President of the Executive council in 1919. The other members were Nawab Ageel Jung, Mr. Glancy, Nawab Vilayat Jung, Nawab Latafat Jung, Rai Murlidhar, and Nawab Jilwat Jung of the royal family, Nawab Nizam Jung, and Sir Faridoon-ul-Mulk.

Sir Akbar Hyderi, as a Finance member was instrumental in strengthening the money administration of Hyderabad by a series of reforms that he introduced from time to time. To fulfil the national demand for self-government, the govt of India known as a round table conference in 1930. Its terms of reference were to think about what proportion power ought to be transferred to India's hands and beneath what conditions the British Indian Provinces and Indian states would be joined in an exceedingly Federation. At the invite of the

govt of India, the Nizam elect Sir Akbar Hydari, the Finance Member because the representative of the Hyderabad state and chief representative of the Hyderabad delegation. The delegation went thrice to European country in 1930, 1931 and 1932 and took part within the discussions at the spherical Table Conference. Sir Akbar Hyderi took a number one half within the conference. Sir Akbar Hydari's most notable action was departmentalization of finances, beneath that, every department was supplied with a allow 3 years and was allowed a freedom concerning its expenditure by carrying over the balance of the primary year to the second, and combined balances of the primary and second years to the third. This inspired careful disbursement and smart coming up with.

During the Second World War, to the gifts of the Nizam and the contribution of the public and other direct and indirect war expenditure, the state subscribed 21, 00,000 annually to the British war efforts. The direct and indirect expenditure connected with the War from its commencement to the end of 1944 amounted to nearly 5 $\frac{3}{4}$ crores³. The Nizam-VII sent a message to the Government of India, to continue Hyderabad as an independent state in India and not to merge it with either India or Pakistan. But on 29th November 1947, Hyderabad state entered into a standstill agreement with the Government of India. Under the agreement, defence and external affairs came under the control of the Indian Government.

After the sign language of the stand-still agreement, the Nizam appointed Mir Laik Ali because the Prime Minister and Pingali Venkatarama Reddy as Deputy Prime Minister. Laik Ali created a secret visit to metropolis and met the Asian country Prime Minister Liaquat Ali Khan and alternative leaders like Ghulam Muhammad and Zafrullah Khan. The latter suggested Laik Ali to refer the Hyderabad case to the protection Council. Laik Ali sent on tenth Sep a delegation to UNO headed by Moin Nawaz Carl Gustav Jung. The Hyderabad politics was dangerous to Indian Security and peace. Thus on thirteenth Sep 1948, the govt of India launched its 'Police Action' on Hyderabad. The Indian Army beneath the Command of J.N. Chaudary entered Hyderabad state from 5 directions. Within the Army Headquarters, the group action was codenamed as "Operation Polo". The complete action was completed in 5 days. On seventeenth Sep, Nizam's forces beneath El Edroos relinquished and Indian Army entered Hyderabad town on eighteenth Sep 1948. Laik Ali and Khasim Razvi were inactive. Later they at liberty to Asian country. J.N. Chaudary was created governor of Hyderabad. He continued in this position until the tip of 1949. In Gregorian calendar month 1950, M.A. Vellodi, a senior functionary was created the Chief Minister and therefore the Nizam was selected because the rule Pramukh.

Nizam-ul-Mulk amount was marked by a political consolidation. His death was followed by a war of succession. He was followed by Salabath Khan, Nizam Ali Khan, Sikandar Jah, Nasir-ul-dauwla, Afzal-ul-dauwla, Mir Mahaboob Ali Khan and Mir Osman Ali Khan. Throughout the last two Nizams, some systematic tries to rework the socio-economic life within the state were concerned.

The Lambadas of the Hyderabad state originated from north-west India. The first arrival of the Lambads in the south is mentioned in Perista's *A History of the rise and progress of the mahamadam faith in the country of hind*. In 1417, a large convoy of caravanner's bullock was seized by prince khan khanan, the brother of feroz shah Bahamani, when the former rebelled and made an attempt on the throne of Gulbarga, the Deccan capital⁴.

The three Karnataka wars between 1745 and 1763 saw the British emerging as the foremost power in the south, Anglo- Mysore wars between 1766-1799, which ended with Tippu's death in the battle and the annexation of a major part of Mysore by the British, and three Anglo- Maratha wars in the year 1775-82, 1803-05, 1817-18. After these wars, almost the whole of the Deccan came under the direct control of the British⁵. In all these wars, the Lambadas were the main grain suppliers to all sides. Their service was acknowledged by all the imperial power. They had particularly good relations with the Nizams, as they had served their armies from the time of Aurangzeb.

The first Nizam employed them in large numbers during his early consolidation of the Deccan. The Nizam constructed a separate gate for the Lambadas herds to pass into the Golconda fort. There was also the practice of the presenting the descendent of Bhangi with a khillat (a gift of turban cloth) from the Nizams of Hyderabad. It was considered a mark of great honour, when the Nizam used to present eight thanes of khadi (a than equal to sixteen yards) every year, which the chief Nayak used to tie his turban. The British also continued this practice; after every war the Lambada Nayaks and leaders were honoured with cloths, turban and swords. Whatever they faced, it was a kind of taming through which the imperial powers ensured the subordination of the Lambadas⁶.

Commitment to society and contributions

Educational drives: By giving to major instructive organizations all through India, he presented numerous instructive changes during his rule. Up to 11% of his spending plan was spent on schooling. The Nizam made huge gifts to numerous establishments in India and abroad with exceptional accentuation given to instructive foundations, for example, the Jamia Nizamia and the Darul Uloom Deoband . The Nizam at the initiation of the Osmania University Arts College, c.1937. He established the Osmania University in 1918 through an illustrious firman; it is perhaps the biggest college in India. Schools, universities and a Department for Translation were set up. Essential schooling was made obligatory and given free to poor people.

Gifts to educational organizations: He additionally gave Rs 1 million for the Banaras Hindu University, Rs. 500,000 for the Aligarh Muslim University, and 300,000 for the Indian Institute of Science.

Construction of major public buildings: Mir Osman Ali Khan Nizam VII was a progressive ruler and an enthusiastic patron of architecture. His reign ushered in a new era of construction of public buildings and he adorned the city of Hyderabad with a large number of beautiful buildings as Monuments of his wise administration. Among the earlier works, mention may be made of the town hall, the High Court, the Osmania General Hospital, the Jagirdar College and the Hyderabad Museum. The more important construction of later dates is the Jubilee Hall, the Industrial Museum, The Jubilee Pavilion, and the Central Military Hospital, Kachiguda Railway station, Secretariat Building, Health Museums, Nizamia Unani General Hosptial, Asafia Library, Moazam Jahi Market, Bella Vista, Mahaboobia Girls High School, the City High School etc. The expense involved in these constructions was tremendous. The town Hall cost was rupees 19, 00,000. The Osmania Hospital cost rupees 20, 00,000 the City High School 9, 00,000 and the

High Court rupees 21, 00,000.⁷ .He also built the Hyderabad House in Delhi, now used for diplomatic meetings by the Government of India.

Establishment of Hyderabad State Bank: In 1941, he started his own bank, the Hyderabad depository financial institution. It had been later renamed depository state bank of Hyderabad and merged with the state bank of India because the state's financial institution in 2017. It had been established on 8 August 1941 under the Hyderabad State Bank Act. The bank managed the Osmania Sikka (Hyderabad rupee), the currency of the state of Hyderabad. It had been the sole state in India which had its own currency, and therefore the only state in British India where the ruler was allowed to issue currency. In 1953, the bank absorbed, by merger, the Mercantile Bank of Hyderabad, which Raja Pannalal Pitti had founded in 1935. In 1956, the Federal Reserve Bank of India took over the bank as its first subsidiary and renamed it state bank of Hyderabad (SBH). The Subsidiary Banks Act was passed in 1959. On 1 October 1959, SBH and therefore the other banks of the princely states became subsidiaries of SBI. It merged with SBI on 31 March 2017.

Flood prevention: After the good Musi Flood of 1908, which killed an estimated 50,000 people, the Nizam constructed two lakes to stop flooding the Osman Sagar and Himayat Sagar named after himself, and his son Azam Jah respectively.

Agricultural reforms: The Nizam founded agricultural research within the Marathwada region of Hyderabad State with the establishment of the most Experimental Farm in 1918 in Parbhani. During his rule, agricultural education was available only at Hyderabad; crop research centres for sorghum, cotton, and fruits existed in Parbhani. After independence, the Indian government developed this facility further and renamed Marathwada Agriculture University on 18 May 1972.

Contribution to Indian aviation: India's first airport the Begumpet Airport was established within the 1930s with the formation of the Hyderabad Aero Club by the Nizam. Initially, it had been used as a domestic and international airport by Deccan Airways Limited, the primary airline in British India. The air terminal was constructed in 1937.

Donations towards Hindu temples: The Nizam donated Rs. 82,825 to the Yadagirigutta temple at Bhongir, Rs. 29,999 to the Sita Ramachandraswamy temple, Bhadrachalam and Rs. 8,000 to the Tirupati Balaji Temple. He also donated Rs. 50,000 towards the re-construction of Sitarambagh temple located within the old city of Hyderabad, and bestowed a grant of 100,000 Hyderabad rupees towards the reconstruction of Thousand Pillar Temple. After hearing about the Golden Temple of Amritsar through Maharaja Ranjit Singh, Mir Osman Ali Khan started providing it with yearly grants.

Donation towards the compilation of the Holy Mahabharata: In 1932, there was a requirement for money for the publication of the Holy Mahabharata by the Bhandarkar Oriental Research Institute located in Pune. A proper request was made to Mir Osman Ali Khan who granted Rs. 1000 per annum for a period of 11 years. He also gave Rs 50,000 for the development of the institute's guest house which stands today because the Nizam Guest House.

Donation in Gold to the National Defence Fund:"The donation of 5 tonnes of gold is well documented within the meticulously researched book as follows: "In 1965, the Nizam donated five plenty of pure gold to Lal Bahadur Shastri, Prime Minister of India for the Chinese War Fund", The book is titled "The Nizam of Hyderabad and His Contributions" and therefore the donation is recorded on page 195 of the book. However, this was termed as a myth citing a piece of writing purportedly published within the Hindu. (This was proven false through an RTI the result of which was published within the Hindu.) The National Defence Fund under the Prime Minister's Office has no information of any such donation ever being recorded. In fact, the Nizam invested 425,000 grams (425 kg) of gold within the National Defence Gold Scheme, floated in October 1965 with a 6.5% rate of interest, to tide India over during the depression.

Conclusion:

Osman Ali Khan, Asaf Jah VII (6 April 1886 – 24 February 1967), was the last Nizam (ruler) of the Princely State of Hyderabad. He ascended the throne on 29 August 1911, at the age of 25 and ruled the dominion of Hyderabad between 1911 and 1948, until India annexed it. He was styled as His Exalted Highness-(H.E.H.) the Nizam of Hyderabad, and was one among the wealthiest individuals of all time. On 22 February 1937, Time featured him on its cover because the world's richest person, with inflation adjusted net worth of over \$200 billion. He was referred to as the "Architect of recent Hyderabad" and is credited with establishing many public institutions within the city of Hyderabad, including among others: Osmania University, Osmania General Hospital, and depository financial institution of Hyderabad, Begumpet Airport, and therefore the Hyderabad Supreme Court. Two reservoirs, Osman Sagar and Himayat Sagar, were built during his reign, to stop another great arrive the town.

The Nizam originally wanted to hitch India, but after its independence in 1947, he didn't wish to accede his state to the newly formed nation. By then, his power had weakened due to the Telangana Rebellion and therefore the rise of a radical militia referred to as the Razakars whom he couldn't put down. In 1948, the Indian Army invaded and annexed Hyderabad State, and therefore the Nizam had to surrender. Post-independence, he became the Rajpramukh of Hyderabad State between 1950 and 1956, after which the state was partitioned and have become a part of Andhra Pradesh, Karnataka and Maharashtra. In 1951, he not only started the development of Nizam Orthopedic hospital, Nizams Institute of Medical Sciences (NIMS)) and gave it to the govt on a 99-year lease for a monthly rent of just Re.1, he also donated 14,000 acres (5,700 ha) of land from his personal property to Vinobha Bhave's Bhoodan movement for re-distribution among landless farmers.

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IMPACT OF WOMEN'S EDUCATIONAL LITERACY IN HYDERABAD STATE -AN ANALYSIS

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ABSTRACT

In early 19th century, women's education was limited to family matters and religious knowledge. The Christian missionary introduced Women's education especially Western education. The Muslim women of the royal family entered their education mostly in their palaces and Dowries. The middle-class women substantially learned sewing, embroidery, cooking, acclimatizing, etc. Indeed in Hindu society, the education of girls wasn't of prominent significance. The education of boys was given further significance than that of girls. The original Indian educated class was in favour of women's education; Sir Syed Ahmad Khan supported Western education among Muslims, that effect was also seen in the Hyderabad State. In the early days of the twentieth century, a many women surfaced who went beyond their traditional customs and conservative thinking and worked for women's education. Sughra Humayun Mirza, Tayyaba Begum, Sakina Begum, Illandala Saraswati Devi. These are the names of those who spent their lives in promoting women's weal and education. Sarojini Naidu and Yellapragada Seetakumari were the women who set an example for coming generations. Education brought in a new life to women, which in turn helped them to see the outside world with a new eye. The VII Nizam also allocated a huge amount of funds for Girl's Education. The present paper focus on the beginning of Western education in the Hyderabad State and the support and encouragement of women's education.

Key Words: *Women education, Muslim Women, Women of the Twentieth Century.*

INTRODUCTION

The princely countries existed in India before independence had a distinct identity among the Hyderabad State and its ruling autocrats. From the beginning of the twentieth century, Hyderabad State has been making tremendous progress in every field. One of them was development in the field of education. Modern education and western education started in Hyderabad State under the guidance of Diwan Sir Salar Jang. In the early nineteenth century, the centers of education in this period were mosques and the temple. But in 1855, Sir Salar Jang established a western- style educational institution Darul Uloom, Hyderabad, Where Urdu, Iranian and English were tutored. City High School was established in 1870 CE and Chadarghat High School was established in 1872. Latterly, Chadar Ghat High School and School of Engineering were intermingled. Which was latterly renamed Nizam College in 1887. In 1859 CE, the government announced in a proclamation that two seminaries would be opened in each quarter center and taluka. One academy will educate in Persian and the other in local language. The year 1884 CE marks the beginning of a new chapter in the history of the state in the field of education. This time Nizam Mir Mehboob Ali Khan appointed Syed Hussain Bilgrami as the Director of Public Education After the appointment of Bilgrami the annual budget of the education department has been increased to about 2.5 million. Modern high seminaries were opened in every provincial capital. In addition, a large number of lower, upper middle and primary seminaries were opened in different corridor of the district. In India female education before 1858 CE was very the concern of missionary societies. In Bombay, the American missionary society opened an academy in 1824 CE. In 1851 CE one private school for girls was opened at Poona and two at Ahmadabad. In 1854, about eight thousand girls were attending missionary schools in Madras presidency. In 1851 CE, the Protestant mission was conducting 86 boarding schools for girls and 286- day schools for girls with registration of and respectively. (Gupta, 2000).

Christian missionaries and domestic philanthropists played an important part in spreading education in the State of Hyderabad. Just as Christian missionaries introduced education to other parts of the country, the first English grammar school for Western education was established in Hyderabad in 1834 CE. The mission schools had aim in starting girl's schools; they hoped that the educated girls would in future establish schools for educating women. Raja Ram Mohan Roy was the first feminist in India and his book, "Detail remarks regarding modern encroachments on the ancient right of ladies" (1822), is a reasoned argument in favour of the quality of women.

No significant work was done by the government for the education of women till 1890. Until 1885, there was only one Qur'anic madrassa for Muslim women outside Hyderabad, with only 30 girls. By 1901, there were only 77 girls studying in the state of Hyderabad. There were numerous reasons for this. In the Muslim community, traditional religious education was considered necessary for girls at that time. A large section of the society wasn't in favour of girls 'western education. The purdah system, the system of child marriage and the general incuriosity of parents to the education of their daughters acted as a check to the progress of female education

Sir Syed Ahmad Khan was the first Muslim to support Western education in India. He supported the cause of modern education at a time when Indian Muslims considered it as in to get modern education and that too through English language. He started Aligarh movement with an aim to elevate the position of Muslim in India. He was always promoting women education. Sheikh Abdullah and his woman were the authors of the Zenana Madrasa at Aligarh Muslim University, which was established in 1906. In Calcutta, Rokiya Shikawat Hussain established Shikawat Memorial Girls School. (Pernu, 2004).

In Hyderabad, Aghorenath Chattopadhyaya established a Hindu-Anglo Vernacular Girls School there was about 76 Hindu and Muslim girls. Another school, “ Aizza Niswan” was also established, but the two schools didn't serve for many times and closed down. In 1907, a new Zenana girl's school was established, innovated by Noor Unisa Begum. The New Zenana School, first girl's school in Hyderabad, later renamed the Mahubia girl's school. (Sudha Rani E., 2015).

In 1909, Florence Wyld arrived from England with three faculty members to take up the post of the star. On the first day of school, only 4 girls arrived to study. Most of the girls who came to this school were daughters of government officials. Ms. Wyld plants a lot of support in Khujitsa Begum, the India representative assigned by the British government to interact with Indian families. By the time Ms. Wyld left Hyderabad in 1919 Mahubia School, as it was known, had 100 students. (Pande, Muslim Women and Girls Education A Case Study of Hyderabad, 2006).

Objective of the study

- a) To analysis the role of Women Education early nineteenth century and Twentieth Century.
- b) To look at the literacy among women of Hyderabad.
- c) To assess the part of voluntary efforts in creation of women education.

The present study is substantially grounded on secondary data. The data has been collected from various journals, reports, books, and official website.

WOMEN'S EDUCATION LITERARY WRITINGS INSPIRATION

Hyderabad State was counted among the major Homeric states of India with a population of around 17 million. People of different religions and different languages lived together here. Indeed today, the Ganga-Jamani civilization of Hyderabad is very famous each over the world. It has had its own culture. The passion to promote women education among women of Asif Jahi Ear has been there from the very beginning. The best example of this is Mahlqa Chanda. She was the first women poet to author a diwan, a complete collection of Urdu Gazal. The collection named Gulzar E Mahlaqa, the collection was published 1824 after her death. Actually, Mahalaqa Chanda was a tawaif. She was associated with six royal courts Mahlqa Chand was one of the richest women of her period. She fabricated one Ashur Khana, a Chowdi, aNakkar.Khana and a Dalan. Mahalqa Chanda library was well known for her collection of rare books and manuscripts. (The heritage lab, 2019). She wasn't simply an artist but a largely educated person.

According to historical records Mahlaqa Chanda bai is known to have donated ten million towards educating girls, at the time of her death, she left her wealth towards the homeless girls. Part of her estate (jagir) was also given to the present- day Osmania University. (The heritage lab, 2019).

In the twentieth century, there were many Women who wanted Western education, during this period numerous magazines were written in which “ Annisa” is very important. Annisa had the subtitle Women’s and girls’ yearly Urdu journal and had around forty pages in a standard issue. The usual fare included childcare, health and educational information.

Some of which are mentioned below

1. “Talim e Niswan” (Women Education)
2. “MardonkiTaleem Muqaddam Haiya Auratonki”? (Is Men Education or Women Education More important?)
3. “Kya Purdah Nashin e Hind ki Taleem Angrezi Zabanke Zaria Zaroori Hai” (Should the Education of India’s Veiled Women Necessarily be through the English Language). (Pande, Journal of History and social lores, 2012).

Sughra Humayun Mirza

Sughra Humayun Mirza was from Turkey. She was born in 1882. Her father's name was Safdar Ali Mirza. He was a doctor and Captain Surgeon was serving in the Nizam Army. Sughra Humayun Mirza was married to Syed Humayun Mirza. She had complete and particular freedom from her husband due to which she worked for the welfare of women. She must have been told by the Tayyiba Begum Khedive Jung. They start an institution Anjuman – E Khawateen Deccan. With the help of this institution, she also established two schools where girls were educated. Sughra Humayun Mirza was also a very good writer and one of the sympathizers of girls' education. She made her point clearly in her articles. She established an Urdu medium school for girls in 1934 notice named Safdaria Girls School. (Pande, Journal of History and social sciences, 2012). The school still exists in Asif Nagar, Hyderabad. Sughra Humayun Mirza wrote an article in Annisa through which he tried to convey his message to the nation that education is essential for development.

The name of the article was “ Ahle Mulk kiTaraqqi ka Ek Tariqa” Her most famous novels “ Zohra” and “ Saruzisht e Hajira” (Anwaruddin, 1997).

By writing similar articles, Sughra Humayun Mirza and other educated women like him tried to make the society understand that it's veritably important for girls to be educated because, when a man is educated, he supports his family, but when a girl is educated, she can improve the coming seven generations.

Tayyaba Begum

Tayyaba Begum was brought up by her mother as her father failed in her childhood. She was a student of Mahubia Girls School, the first Women's School in Hyderabad State. In 1930CE Tayyaba Begum was married to Baqir Ali Khan who was working as an English lecturer in City College. She had complete freedom to work outside as her husband was of liberal minded. Tayyaba Begum established the first Art and Craft School in Hyderabad State. She also served as star of the Domestic Science College. She had been a role model for Muslim women since the early twentieth century. She wrote a novel “ Anvari Begum” in 1905. It's the story of a prosperous Hyderabad family who got influenced by the Western culture. In the twentieth century the novel became more popular and women were very important inspired by it.

Tayyaba Begum Bilgrami

Tayyaba Begum Bilgrami was the first woman in India to get aB.A degree from the University of Madras. She did a lot of work on Islam and Islamic teachings. She tried to reach out to women through his lectures she did a lot of work on Islam and Islamic training. She says “ Women can shape their own destiny if they want to empower themselves financially, they must get education” Tayyaba Begum Bilgrami supported the institutions financially so that public welfare work could be done. Many educational institutions of Hyderabad were depending on her cooperation.

Sarojini Naidu

Sarojini Naidu was born in a Bengali family on 13th February 1879 in Hyderabad. Their family migrated to Hyderabad in 1878. Meer Mahaboob Ali Khan the 6th Nizam of Hyderabad invited her fatherDr. Aghore Nath Chattopadhyay to develop the education system in Hyderabad. Nizam of Hyderabad liked the drama “ Maher Muneer" written by Sarojini Naidu and gave her a scholarship to go to foreign countries in First Class. She wrote several poems. Primarily to promote the glory of India, she always talked about political equivalency of Indian women. British government awarded her the title of” Kaiser E Hind” medal. The house she lived in at Hyderabad becomes a temple of Hindu Muslim fellowship after her demise. (Sudha RaniE., 2016). She gave away her house to the University. During her lifetime itself she became an icon and leading lady in the whole of Asian Continent.

Princess Durru Shevar

Princess Durru Shevar belonged to the Ottoman family of Turkey. She was married to Prince Azam Jaha Bahadur, son of Mir Osman Ali Khan of the 7th Nizam of Hyderabad. After her marriage, she was culminated Princess of Barar. She was a largely reputed and educated woman. She completed her education in France. She was fluent in Turkish, English and French as well as Urdu. (Seshan, 2018). Despite being a foreigner, she loved the people of Hyderabad. She had a special concern for the health of the people, so she set up a children's Hospital at the point of the Purani Haveli, Hyderabad and a girls' junior college established in Yaqutpura, Hyderabad. Mir Osman Ali Khan had great respect for his son-in-law. He'd given the title of “ Nigina” to Princess DurruShevar. She actively participated in the welfare of the people. She had a special interest in Hyderabad social life and especially Women.

Premalata Gupta

Premalata Gupta was married to L.N. Gupta, who was the Secretary of the Education Department of Nizam government. She also devoted her life to public welfare and social reform. She served as Vice President in the All India Family Planning Branch. She worked considerably in Hyderabad for social welfare.

Piecemeal from them, there had been a few women in Hyderabad State who took part in national movements in their lifetime and showed a new path to the women. In which women included Y. Seetakumari, N. Sundaramma, S. Lakshmi Baramma. They dedicated their lives to social welfare too. Y. Seetakumari, also worked as a teacher at Keys High School in Secunderabad, her most important thing was to promote Women's Education.

Arutla Kamaladevi

Arutla Kamala Devi native of Nalgonda completed her education at Madapati Hanumantha Rao School. She started a school for the adults in the name Kamala Devi Vantashala. She won the 1952 general election and became a member of the Assembly, and in 1962 she was the deputy leader of the Communist Party. (Sudha Rani E., 2016). In addition to the women mentioned above, there had been women in Hyderabad State in the early days of the twentieth century who had left their traditional customs and entered the modern world. Notable among such women were women like Masooma Begum, Sakina Begum, Anisa Begum, Jamal Salma who had taught the next generation that they can make their lives better through education.

Many women organizations had worked to promote women's welfare and education the first women society was Bharata Mahila Samajam. This was established in 1907. It worked for the development of women for one year. When the Andhra Mahila Sabha was formed in Telangana, women like M. Manikyamba and Illandala Saraswati Devi played a significant role in it. Andhra Mahila Sabha women condemn dowry curse, condemn child marriage and at the same time emphasize education of girls in Telugu language. Women like Illandala Saraswati Devi, Sangam Lakshmi Bai, Yellapragada Sitakumari played an important role in the formation of Andhra Yuvathi Mandali. As a result of the efforts of women, Shishuvihar was started in Asif Nagar, Hyderabad. Where women trained in tailoring crafts and music, there was a library in the Mandali where women are reading was arranged.

In 1931, the Hyderabad branch of the All India Women's Conference started a women's quarters in Hyderabad the institute covered villages ten to fifteen miles apart. Dispensaries were provided in the villages and educational facilities would also be provided in the villages. Employment opportunities were provided for professionally trained women. Amina Begum, Hydari, Rustumji, Phardun and Sarojini Naidu founded "Hyderabad Women's Social Development Association". Along with Hindu organizations Muslim organizations also sprouted. "Anjuman e Islam", Lady Hyder Club, etc. These societies and organizations try to remove the bad practices, to change the social condition of women and for development of women education. In this way women's organizations not only helped women but also created a socio-political consciousness in them.

It was as a result of the search for women in the twentieth century that the government established the University of Women's College. The college was established on August 15, 1924 initially BA class was taken in Women's College, later this college was shifted to Himayat Nagar Hyderabad in 1939. The college was then moved to the Residency Building. In the Mir Osman Ali Khan period the rapid expansion of women's education, the primary school, secondary school, training school for women were increased. As part of the development of women education the Nizam government provided special facilities for girls to appear for the H.S.C examination. In 1937 the 300 new government schools had been established; the strength of students had 3, 62,150. And special attention was given by the Nizam VII towards the girl's education and 720 schools were opened for them where the number of girl students was 52000.

In 1941 the total number of girl's schools and pupils increased from 687 to 789 and from 43,569 to 63939 respectively during the decade. (Hussain,1945). This table shows the number of school and the number of students.

S.No	Schools	Female students
1	11 High school	4,312
2	25 Middle school	6,769
3	753 Primary school	52,858

SOURCE: Census of India 1941. Volume XXI

Whereas in the first decade of the early twentieth century the school enrolment rate in the city of Hyderabad was 3.5 per cent, (Imperial Gazetteer of India Provincial Series Hyderabad State, 1991). It will increase to 17.6 per cent in 1941. (Hussain, 1945). This is a testament to the fact that in these forty years, the importance of Western education began to increase rapidly in the Hyderabad State. The importance of education among women was highlighted and a sense of self-confidence was created.

CONCLUSION:

Raja Ram Mohan Roy and Sir Syed Ahmed Khan were among the personalities who openly supported Western Education and Women Education. The British government also adopted a liberal policy for promoting girl education.

In the early decades of the twentieth century, only a few people were in favour of educating their daughters, by the middle of the twentieth century, there was a rapid-fire increase in educational awareness in Hyderabad State. 1901 CE. In Hyderabad alone, 3.5 of girls started their education. By the middle of the twentieth century, the same rate had reached 17.2%; simultaneously women's college was established. The efforts of many important women to remove the narrow-mindedness in Deccan society and link women to Western education redounded in the opening of not only women's schools but also the importance of education in the society.

As a result, we are gifted with personalities like Sarojini Naidu. Women made progress in the field of education and after independence they had access to the state assembly. But it is worth nothing here that

most of the women who emphasized the importance of education in the twentieth century came from the upper cast families. The importance of education in the middle and lower classes was not yet very clear. As part of the development of women education the Nizam government provided special facilities for girls to appear for the H.S.C examination. In 1937 the 300 new government schools had been established, the strength of the students was 3, 62,150. And special attention was given by the Nizam VII towards the girl's education and 720 schools were opened where the numbers of girl students were 52000. Along with the government, private organizations and Christian missionaries also played a vital role in promoting women education in Hyderabad State. The mission schools had an aim in establishing schools for girls. They hoped that the educated girls would establish schools for educating women.

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Emerging Trends in Finance, Human Resource & Marketing

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Abstract

Trends are general directions of a market or an asset price. Trends are of two types - Uptrend and downtrend. Up trends and downtrends occur in all markets, stocks. Finance, Human Resource, Marketing, supply chain, & logistics are parts of an organization. To run an organization, these are essential. Organizations are nothing but, Social Systems are comprised of a collection of people, organized into structured grouping & managed to meet collective goals. This article discusses the emerging trends in finance, human resource (HR), and marketing.

Introduction

Finance is a broad term that describes activities associated with banking, debt, credit, capital markets, money, and investments. Finance represents money management and the process of acquiring needed funds. In simple words, Finance is providing funds for a person or enterprise. A business concern has to keep a systematic record of its business transactions. In India, the introduction of GST was a major economic policy change and caused major disruption in the way business activities are conducted in the country. Due to the digital India drive of the Indian government, the entire GST filing process is online. People who did not have knowledge of online technology have had to take help. This and more has been causing changes in the finance segment of business management and 2020 will see the following trends emerge.

Trends in Finance

The growth of technology will hit the market in 2020. The growth of financial businesses is expected to be concerned on their ability to mold the sharing economy and customer intelligence, and deal with advances in technologies such as block chain , robotics , Artificial Intelligence etc .

Block Chain Technology: Block chain will increase the Financial efficiency by reducing manual manipulation. Blockchain will create one version of the ledger allowing intercompany transparency and settlement at the same instant. This will allow Finance to focus more towards value creation activities. Block chain technology is a form of Distributed Ledger Technology (DLT), has the potential to transform well-established financial institutions and bring lower costs, & faster execution of transactions.

Robotic Process Automation: Use of robots helps in reducing costs and increasing operational efficiency. Robot Process Automation should help banks improve efficiency and avoid wasting time, especially if repetitive and easily reproducible activities are at stake.

Data Analytics: Data is has become very important in every industry sector. Financial Analysts use data to spot trends and extrapolate into the future, helping their employers and clients make the best investing decisions. Data analysts perform a similar role, the primary distinction being that these professionals analyze data that may or may not relate to investing decisions. Better Analysis leads to better decisions, which leads to an increase in profit for financial institutions. Companies analyse trends in data through intelligence tools.

Artificial Intelligence: AI has the potential to super-charge financial services and transforms the way services are delivered to customers. It could allow more informed and tailored products and services, internal process efficiencies, enhanced cyber security, and reduced risk. AI in finance is taking the industry by storm. In the next decade, AI will help financial service sources, decrease risk, and generate more revenue, in trading, investing, banking, lending.

Human Resource

Human Resources are the set of people who make up the workforce of an organization. Similar terms include people, work force, labour, personnel. HRM is the strategic approach to the

effective management of people in a organization such that they help their business gain a competitive advantage.

Trends in HR

- **Providing Flexible workspaces**

Allowing people to tailor and customize their work environments to best suit their working preferences helps to improve employee productivity. In 2020, we will see that the modern office has evolved beyond a physical place to become a function that could be carried out from anywhere. This will challenge employers to reconsider adjustments to their company policies around flexible work options, from offering work-from-home days to being open to hiring remote workers.

- **Providing Holistic Health Benefits**

Work related stress will impact the overall engagement and well being of employees. Holistic benefits plans and programs will be constructed to address all aspects of health and wellness care, from mind and body components and extending to include financial wellness and personal coaching. Companies that take on this responsibility for their people will see the benefits upon employee recruitment, retention, and productivity.

- **Digital Human Resources**

The department's responsibility is to roll out new digital initiatives to the entire workplace, implement new mobile applications (Slack, Workplace, Microsoft Teams, Gamelearn, etc.), software and tools that help change the way the company works. On this point, even chatbox services that use artificial intelligence for recruitment have found a niche in the most innovative companies.

- **Use of Data Analytics**

In the next decade, HR Teams will Focus of using of Data Analytics in a more focused manner to increase productivity , innovation , and revenue at the workplace . This will facilitate the creation of employee-centric environments, in turn driving up the role and importance of data driven strategies. For example, through access to the organization's

large database of employee information, specialized HR personnel will be able to understand employee behavioral patterns with regards to retention, recruitment, development and engagement, satisfaction, performance, and productivity, among others.

- **Chatbots**

Chatbot is software that conducts a conversation via auditory or textual methods. It uses natural language processing and can initiate a human-like communication. Candidates can get their all FAQs answered through this tool. Implementation of chatbot in the HR industry ensures 24*7 availability and 'on-demand' availability.

- **Continuous Transformation through Re-skilling**

Although a Re-skilling worker is important, it is not enough. Companies today are moving toward continuous transformation, not just one-time change initiatives. More than people development, they are redesigning their jobs and structures for more agility and scalability. Moreover, any time a company makes a strategic change that requires people to do things differently, they need to closely examine how those changes impact company culture and amend as necessary. This is critical because culture drives strategy execution. If this doesn't happen, re-skilled people who go back to their old jobs and culture will create a recipe for failure. Transformation must occur at every level of the organization. Middle managers—and even entry-level employees—are being given more control in how to structure their own work, as well as the work of their teams and colleagues.

Trends in Marketing

Marketing is the activity, set of institutions, and processes for creating, communicating, delivering, and exchanging offerings that have value for customers, clients, partners, and society.

- **Virtual and Augmented Reality:** In 2019, both augmented reality (AR) and virtual reality (VR) have become popular and are emerging as top trends in marketing. In 2020, AR is expected to surpass VR in popularity, despite VR's early lead. Already, many major companies are making use of AR. **IKEA**, for example, has an app that allows users to visualize what a piece of furniture would look like in their home before making a purchase

- **Content Marketing:** For years, “content is king” has been the axiom of digital marketing. As we are in 2020, it continues to be true. High-quality content allows you to show your expertise and communicate with your customers from a place of authority. Your content is also, what search engines provide to searchers online, so continuing to produce high-quality content is necessary.
- **Programmatic Advertising:** Programmatic Advertising means using AI to automate ad buying so you can target audiences that are more specific. Real-time bidding, for example, is a type of programmatic ad buying. This automation is much more efficient and fast, which means higher conversions and lower customer acquisition costs.
- **Social Media:** Social messaging apps can be very useful in sending messages to customers directly, as they allow personalization and add value to the user experience. In addition, people expect businesses to have a presence on messaging apps because it’s a direct and easy way to interact with them.
- **Omni channel Marketing:** Omni channel Marketing is the process of marketing across multiple platforms (such as social media, apps, email and blog) so you can connect with prospects on more touch points. When you do Omni channel marketing right, you can offer an enhanced user experience and cohesive brand message that drives people to action. To stay ahead, brands must present a seamless, consistent voice and message across all available mediums, including physical storefronts, social media channels, online, in catalogs and anywhere else you can imagine. All channels should be linked in one all-encompassing strategy for the best results.
- **Voice Search Marketing:** E-commerce is the way of the future, and with search interaction having increased, leading companies will find voice a profitable technology to drive sales and revenue. This has already been evidenced in the huge investment Amazon has put into Alexa and Google into Google Home and its Google Assistant. Businesses will see voice user interface as an innovative tool that enables faster, more efficient customer engagement as voice commands surround every sphere of life, driving purchases, & payments.

Conclusion

A PWC report predicts 77 percent of Financial Institutions will adopt some form of Blockchain technology in 2020. In addition, a recent study revealed that banking industry will derive \$1 billion of business value from the use of Blockchain based Crypto currencies in 2020. AI and Machine Learning technologies have become new trends in the HR industry. HR Industry is expecting AI & cognitive technologies to mature further in the next decade. Technologies such as AI driven Marketing will certainly be big trends in the upcoming years. The focus of marketing is on the people, not on the technology. The Marketing trends that will dominate in the next 12 months will include, content visualization, programmatic Advertising, social media and Omni channel Marketing. In the next decade, Artificial Intelligence and robots will be playing very important role in Human Resource, Finance, and Marketing sectors.

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