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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 leading 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 that 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 duel 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, georaphical 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, it 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 it 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 ware house 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 AWRENESS 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.
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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 (**Y**ou **O**nly **N**eed **O**ne) 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	28
	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**
MARITAI STATUS	Married	22	37
	Un-Married	38	63
	Total	**60**	**100**
OCCUPATION	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-19pandemic affects people psychologically. It is still continuing tremendously day by day. Increase of death rates comes to a pauseof 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, Educationaland 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 bypandemics is different. But one thing that is apparent is that pandemics cause psychological effects such asdepression, anxiety, fear of death, losing loved ones, post-traumatic stress disorder, psychoticsymptoms and mourning in general. However, some people learnt how to control the negativeemotions of pandemics and continue their lives normally. But some people cannot cope up with thesefeelings 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 andMillions 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 andother limitations due to COVID-19 caused negative psychological disorders such as anxiety, andfearaffecting the well-being of students and parents. Most governmentsaround the world have temporarily closed educational institutions in an attempt to contain the spreadof the COVID-19 pandemic. These nationwide closures are impacting over 60% of the world'sstudent population. Several other countries have implemented localized closures impacting millionsof additional learners (UNESCO, 2020). Millions of students have not been able to continue

learningin 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 toCOVID-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 educationadministrators want students to be accessible through distance or online education, which requires an excellentinfrastructure, 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 unfortunatelyaccess 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 problemsare resolved in some way, the constant exposure of students to distance or online education is tediousto them. For this reason, the motivation of the students for learning decreases and the learning goalsare not achieved. Not only students but also teachers and their families are affected by the negative effectsof the COVID-19 pandemic on education. Families may not have enough support for their childrento learn at home. This may be due to low socio-economic level of families, as well as low educationallevel of family members and low infrastructure. Likewise, teachers have an important role in the success of the educationalprocess. But most teachers lacked pedagogical competence about how to manage the teacher distanceor 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-19pandemic affects people psychologically because the spread of it still continues, death rates increaseday by day, life comes to a halt and its control is unpredictable. The effect will cause manyproblems in the short and long term. The lockdown curfews, self-isolation, social distancingand quarantine have affected the overall physical, mental,spiritual and social wellbeing of the people. With thebeginning 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 pandemichas disordered the normal mourning processes offamilies. The economic recessions have putsignificant financial pressure on many families, whichmight increase unhealthy conflict, family breakdown,abuse, depression and domestic violence. The psychologicalimpacts of the COVID-19 lockdown might be a challengefor an indefinite time, hence it is necessary toemphasize 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 adequatehealth logistics, technologies and skilled manpower, andneeds to develop its capacity in health financing to foreseefuture opportunities and challenges. By strengthening thehealth care workforce, conducting mandatory healtheducation and training in schools, wisely utilizing existinghealth manpower, investing and expanding the scopeof 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 policy[1].

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 district [2] 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 Yotopoulus 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, respectively[3].

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 Committees 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 lack of awareness, lack of knowledge, information and the ability to contact for 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 Maharastra. 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 40.3^{0} C in the month of May and 19.1^{0} C in the month of December respectively[4]. 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, minumu* 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 39ºC in the month of May 2003 and mean minimum of 23ºC 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 51 acres 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 potatos), *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	~	***Kandi (yellow grams)***	***Minumu (block grams)***	Others	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)
Sunfl-ower	-	-	-	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)
Sunfl-ower	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 others[5]. 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, 11households 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 sources[6] 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 worlds 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 in adequate 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. Where as 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)-1H-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)-1H-1,2,3-triazol-4-yl)methyl)-1*H*-indol-2-yl)isoxazole(**VId**) showed more potent activity against *B. subtilis* and *S. aureus*, whereas, the compound 5-((3-chlorophenoxy)methyl)-3-(1-((1-(3,5-dichlorophenyl)-1H-1,2,3-triazol-4-yl) methyl)-1H-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 bioisteros 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-butyldimethylsilylspiroaminooxatiole-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-triazolederivatives 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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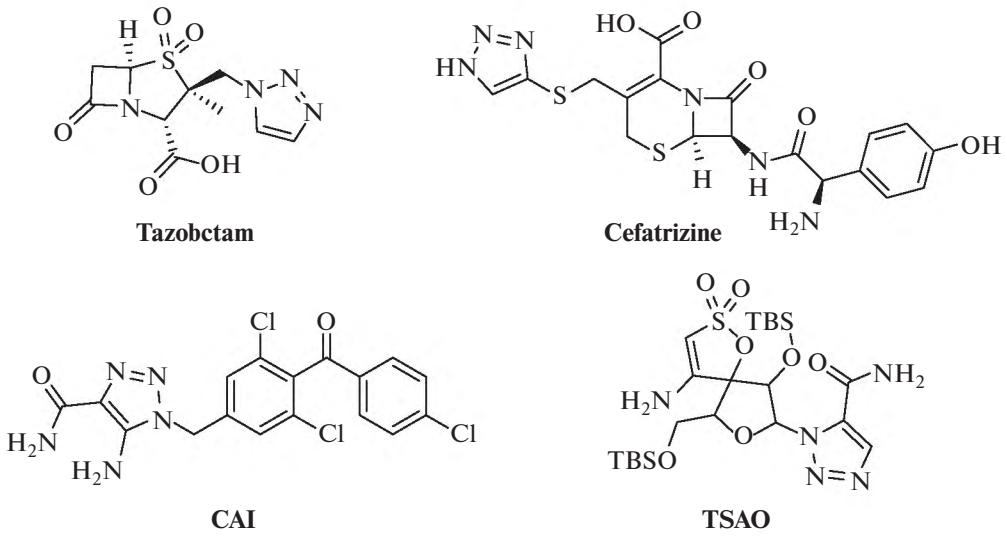


Fig. 1. Some of 1,2,3-triazole ring containing drugs in the market.

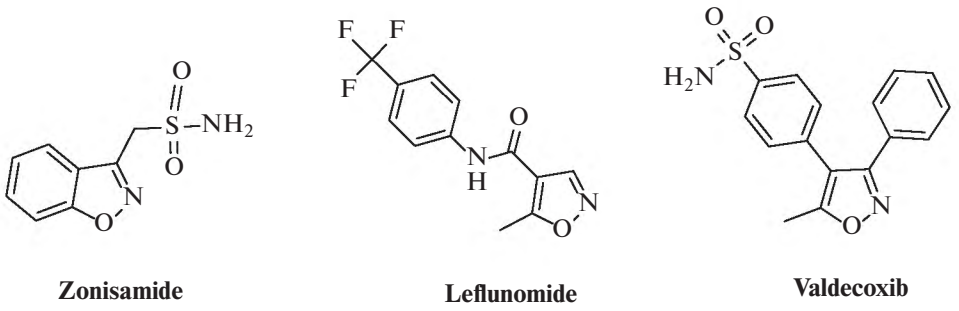


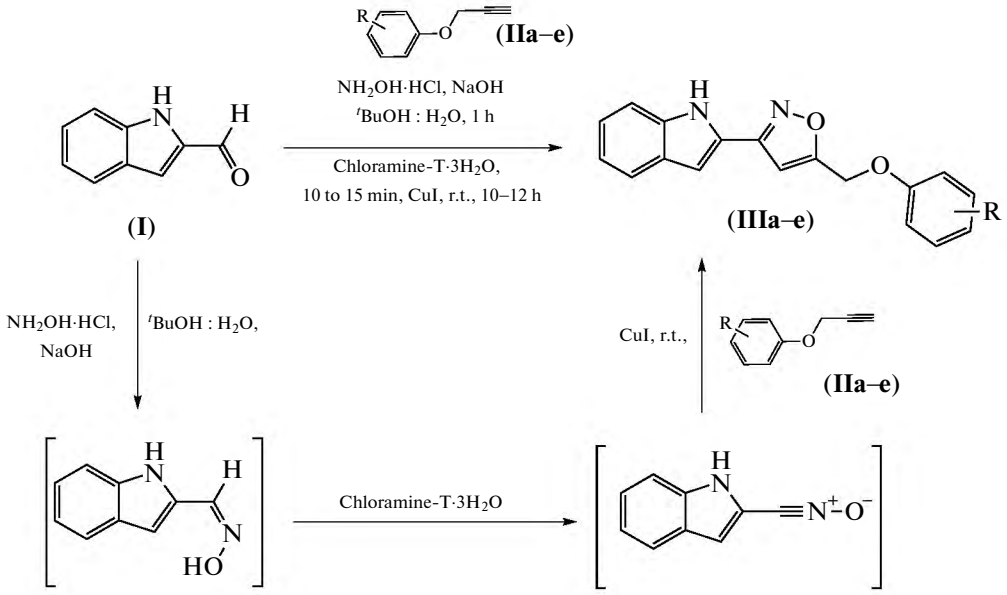
Fig. 2. Structures of isoxazole-congaing drugs.

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:H_2O solvent media at room temperature after 60 min which then consequently converted into corresponding nitrile oxides by the portion wise addition of chloramine-T trihydratefor 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 regioselectiveindole-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 K_2CO_3 in DMF at room temperature yielded 5-((3-chlorophenoxy) methyl)-3-(1-((1-(aryl)-1H-1,2,3-triazol-4-yl)methyl)-1H-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 (^{1}H-NMR, ^{13}C-NMR, ESI-MS) and elemental (CHN) analysis.

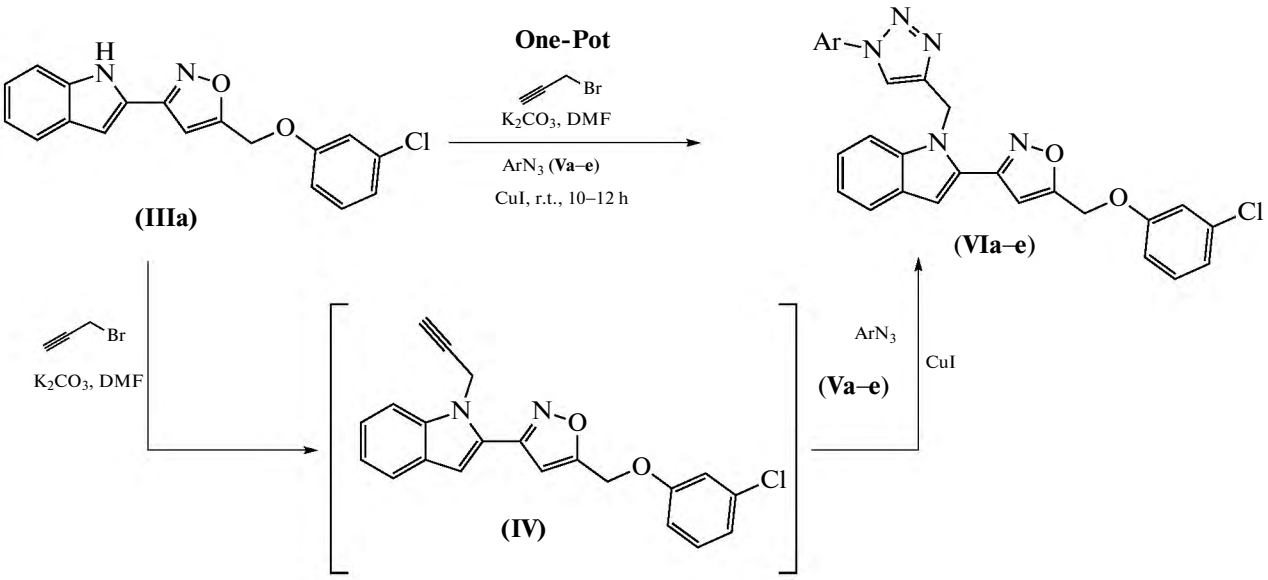
All the spectral and analytical data of the synthesized compounds were in full agreement with the proposed structures and also discussed for a representative compound (**IIIa**). From the ^{1}H-NMR spectrum, the presence of the signals that appeared at δ11.25 (s, 1H, -NH), δ7.95-7.05 (s, 9H, Ar-H), δ 6.80 (s, 1H, Isoxazole-*H*) and δ5.45 (s, 2H, OCH_2) confirmed the presence of required protons. From the ^{13}CNMR, the presence of carbon signals at 102.89, ppm (Isoxazole-**C***H*), and 58.35 ppm (-O***C***H_2) 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 ($C_{18}H_{13}ClN_2O_2$) of compound (**IIIa**).



(**IIa**), R = 3-Cl
(**IIb**), R = 4-OMe
(**IIc**), R = 2,3-diMe
(**IId**), R = 3,5-diMe
(**IIe**), R = 4-NO_2

(**IIIa**), R = 3-Cl
(**IIIb**), R = 4-OMe
(**IIIc**), R = 2,3-diMe
(**IIId**), R = 3,5-diMe
(**IIIe**), R = 4-NO_2

Scheme 1. One-pot synthesis of Isoxazole-Indole hybrids (**IIIa**–**e**).



(**Va**), Ar = 4-ClC_6H_4
(**Vb**), Ar = 3,5-diClC_6H_3
(**Vc**), Ar = 4-$OMeC_6H_4$
(**Vd**), Ar = 3-$CF_3C_6H_4$
(**Ve**), Ar = 3,5-diOMe, 4-ClC_6H_2

(**VIa**), Ar = 4-ClC_6H_4
(**VIb**), Ar = 3,5-diClC_6H_3
(**VIc**), Ar = 4-$OMeC_6H_4$
(**VId**), Ar = 3-$CF_3C_6H_4$
(**VIe**), Ar = 3,5-diOMe, 4-ClC_6H_2

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]		
	B. subtilis	*S. aureus*	*E. coli*
(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
(VId)	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

[a]Minimum 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 are 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 (**VId**) 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**) andisoxazole-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(**VId**), (**VIb**) and (**VIa**)were found to bemost activein 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 precoated plates (0.25 mm), and silica gel (particle size 60–120 mesh) was used for column chromatography. ^{1}H-NMR spectra were recorded on a Varian Gemini 400 MHz spectrometer.^{13}C-NMR spectra were recorded on a Bruker 100 MHz spectrometer.^{1}H NMR spectra were reported relative to Me_4Si and residual DMSO. ^{13}C 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 bondong	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 uM	1	ARG A:310,	7
(VIc)	–8.86	321.41	1	HIS A:271	2
(VId)	–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). 1*H*-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 : H_2O. To this was added NaOH (5.17 mmol), and after stirring for 1hour 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**) (5.17mmol) 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 NH_4OH 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; ^{1}H NMR (400 MHz, DMSO)δ: 11.25 (s, 1H, -N*H*), 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, OCH_2); ^{13}C 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 $C_{18}H_{13}ClN_2O_2$: C, 66.57; H, 4.03; N, 8.63; found C, 66.51; H, 4.09; N, 8.55.

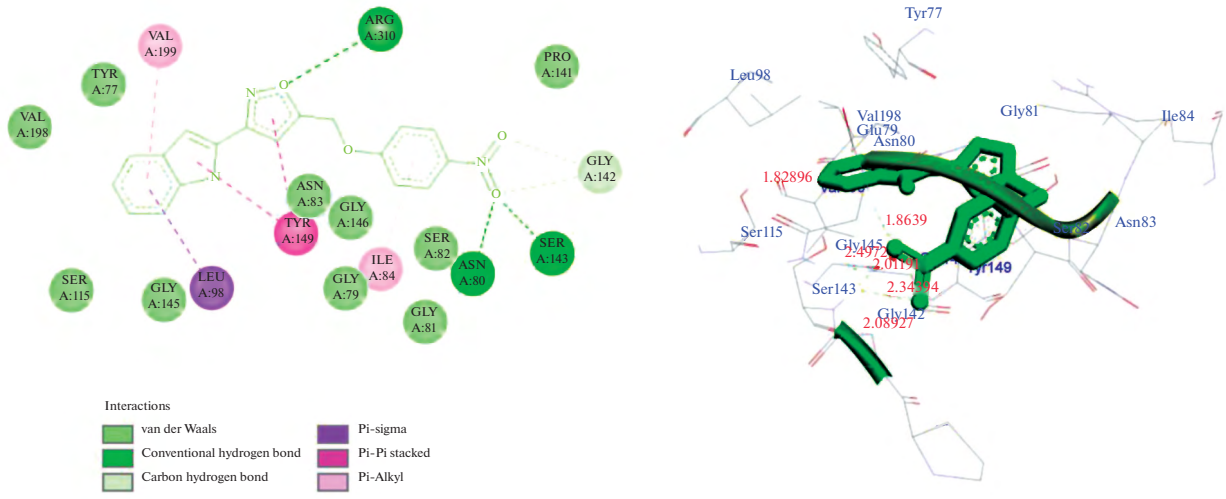


Fig. 3. 2D &3D interaction diagram for the ligand **(IIIe)** with *S. AUREUS MURB*.

3-(1*H*-indol-2-yl)-5-((4-methoxyphenoxy)methyl)-isoxazole(IIIb). Whitesolid (78%); mp 123–125°C; ^{1}H 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-CH_2), 3.83 (s, 3H, O-CH_3); ESI-MS m/z: 321 [M + H]. Anal.Cal for $C_{19}H_{16}N_2O_3$; 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-(1H-indol-2-yl)-isoxazole(IIIc). White solid (65%); mp 110–112°C; ^{1}H 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-CH_2), 2.37 (s, *3H*, Ar-CH_3), 1.97 (s, *3H*, Ar-CH_3); ^{13}C 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 $C_{20}H_{18}N_2O_2$; 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-(1H-indol-2-yl)-isoxazole(IIId). White solid (76%); mp 115–117°C; ^{1}H NMR (400 MHz, DMSO)δ: 11.25 (s, 1H, -N*H*), 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-CH_2), 2.34 (s, 6H, 2Ar-CH_3); ^{13}C 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 $C_{20}H_{18}N_2O_2$; C, 75.45; H, 5.70; N, 8.80; found C, 75.52; H, 5.76; N, 8.73.

3-(1H-indol-2-yl)-5-((4-nitrophenoxy)methyl)-isoxazole (IIIe). Yellow solid (71%); mp 134–136°C; ^{1}H NMR (400 MHz, DMSO)δ: 11.26 (s, 1H, -N*H*), 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-CH_2);ESI-MS m/z: 336 [M + H]. Anal.Cal for $C_{18}H_{13}N_3O_4$; 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)-1H-indol-2-yl)isoxazole (IV). A mixture of 5-((3-chlorophenoxy)methyl)-3-(1H-indol-2-yl)isoxazole (**IIIa**) (1.54 mmol) and K_2CO_3 (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; ^{1}H 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-CH_2), 4.26 (d, *J* = 8.0 Hz, 2H, N-CH_2), 3.30 (t, *J* = 4.0 Hz, 1H, -CH); ESI-MS m/z: 363[M + H]. Anal. Cal for$C_{21}H_{15}ClN_2O_2$: C, 69.52; H, 4.17; N, 7.72; foundC, 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-(1H-indol-2-yl)isoxazole (**IIIa**) (1.54 mmol), propargyl bromide (2.00 mmol), substituted 1-azidobenzene (**V**) (2.20 mmol), and K_2CO_3 (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)-1H-1,2,3-triazol-4-yl)methyl)-1H-indol-2-yl)-isoxazole (VIa). Pale yellow solid (78); mp 148–150°C; ^{1}H 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-CH_2), 5.26 (s, 2H, N-CH_2); ^{13}C 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 $C_{27}H_{19}Cl_2N_5O_2$; 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)-1H-1,2,3-triazol-4-yl)methyl)-1H-indol-2-yl)isoxazole(VIb). Yellow solid (69%); mp 161–163°C; ^{1}H 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-CH_2), 5.25 (s, 2H, N-CH_2); ^{13}C 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 $C_{27}H_{18}Cl_3N_5O_2$; 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)-1H-1,2,3-triazol-4-yl)methyl)-1H-indol-2-yl)-isoxazole (VIc). White solid (0.66g, 76%); mp 125–127°C; ^{1}H 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-CH_2), 5.24 (s, 2H, N-CH_2),3.83 (s, 3H, O-CH_3);ESI-MS m/z: 512 [M + H]. Anal.Cal for $C_{28}H_{22}ClN_5O_3$; 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 (VId). Yellow solid (71); mp 162–164°C; ^{1}H 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-CH_2), 5.25 (s, 2H, N-CH_2); ^{13}C 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 $C_{28}H_{19}ClF_3N_5O_2$; 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; ^{1}H 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-CH_2), 5.26 (s, 2H, N-CH_2), 3.84 (s, 3H, O-CH_3), 3.80 (s, 3H, O-CH_3); ESI-MS m/z: 576 [M + H]. Anal.Cal for $C_{29}H_{23}Cl_2N_5O_4$; 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 doesnot contain any studies involving human participants performed by any of the authors and doesnot 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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ORIGINAL ARTICLE

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,^{1}H-NMR, ^{13}C-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 evaluatedby 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 $CoCl_2.6H_2O$, 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 °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 DMSO-d_6 and TMS (^{1}H 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 Schimadzu 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], cis-$[Co(phen)_2Br_2]Br.2H_2O$, cis- $Co(bpy)_2Br_2]Br.2H_2O$ and cis-$[Co(dmb)_2Br_2]Br.2H_2O$ [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 $C_{17}H_{11}BN_4O_3$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. ^{1}H NMR (400 MHz, ppm, 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).

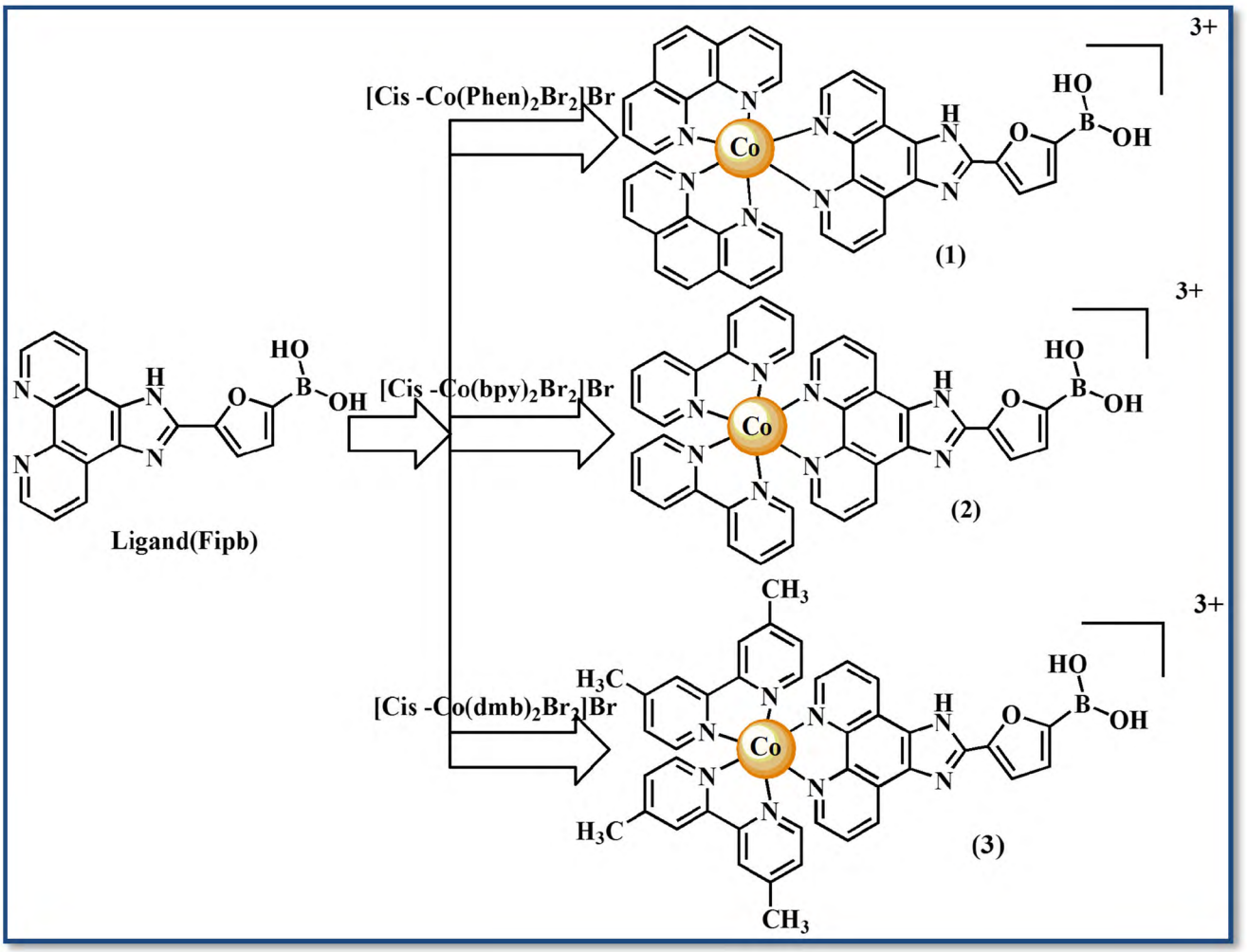
Synthesis of the $[Co(L\text{-}L)_2FIPB]^{3+}$ Complexes

The metal complexes of the type $[Co(L\text{-}L)_2TIPB]^{3+}$ 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 $[Co(phen)_2Br_2]^{3+}$, $[Co(bpy)_2Br_2]^{3+}$ and $[Co(dmb)_2Br_2]^{3+}$(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, ^{1}H &^{13}C NMR.

$[Co(phen)_2FIPB]^{3+}$(1): Yield = 79%, Elemental Analysis for $C_{41}H_{26}BN_8O_3Co$, 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.^{1}H NMR (400 MHz, ppm, 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).

$[Co(bpy)_2FIPB]^{3+}$(2): Yield = 74%, Elemental Analysis for $C_{37}H_{26}BN_8O_3Co$, 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.^{1}H NMR (400 MHz, ppm, 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).

$[Co(dmb)_2FIPB]^{3+}$(3): Yield = 72%, Elemental Analysis for $C_{41}H_{34}BN_8O_3Co$, 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. ^{1}H NMR (400 MHz, ppm, DMSO-d_6, TMS): δ8.99(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; $[Co(phen)_2FIPB]^{3+}$ (**1**), $[Co(bpy)_2FIPB]^{3+}$ (**2**) and $[Co(dmb)_2FIPB]^{3+}$ (**3**).

DNA Binding Studies

All experiments involving the interactionwith 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 °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].

$$[DNA]/\left(\varepsilon_a - \varepsilon_f\right) = [DNA]/(\varepsilon_b - \varepsilon_f) + 1/[K_b(\varepsilon_b - \varepsilon_f)]$$

where [DNA] is the concentration of DNA in base pairs, ε_a, ε_b and ε_f correspond to the apparent absorption coefficient A_{obsd}/[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 $[DNA]/(\varepsilon_a-\varepsilon_f)$ versus [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 $C_b = C_t[(F-F_0)/(F_{max}-F_0)]$. 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/[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

$$F_{cor} = F_{obs}\, e^{(Aex+Aem)/2}$$

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 (6mMNa_2HPO_4, 2 mM NaH_2PO_4, 1 mM Na_2EDTA, 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, wherein 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.

$$E_{Total} = E_{BL} + E_{BA} + E_{DA} + E_{VdW} + E_{SBI} + E_{EE}$$

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, Mg^{2+} 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 gelelectrophoresiswith supercoiled pBR322 DNA.TAE-buffer (pH 8.0, 40 mM Tris-base, 20mMacetic acid, 1 mM EDTA) was used forSupercoiled pBR322 DNA(0.1 mg/mL) was treated with cobalt complexes (**1–3**), and the mixtures were irradiatedat 365 nm for 1 h. The samples were then analyzed by 0.8% agarosegel electrophoresis at 50 V for 2 h. The gel was stained with 4 mL(from 1 mg/100 mL) ethidium bromide (EtBr) and photographed underUV 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 sterilizedin an autoclave. The paper disks were saturated with 10mLof 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 zoneinhibitions were recorded after 24 h. The results were alsocompared with standard antibacterial drug Ampicillin at thesame 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 dilutedwith DMEM media to the required concentration. Concentrations of 2.5–100 μM were addedto wells ensuring equal volumes across the plates in triplicates. Cell number/proliferation wasmeasured after 24 h b of incubation using standard MTT assay. The cells exhibited dose-dependent growth inhibitory effect against the tested cell lines and IC 50 values werecalculated.

Results and Discussion

Synthesis and Characterization

We were 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-Nand 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 δ6.80–9.09 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 theabsence and presence of CT-DNA at constant concentration is givenin Fig. 1. These spectral characteristics suggested that they caninteract with DNA that involves astacking 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 Fig. 1. Binding constant values for **1–3** are 4.9×10^5, 4.6×10^5 and 4.1×10^5 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 metallointercalators [24–27].

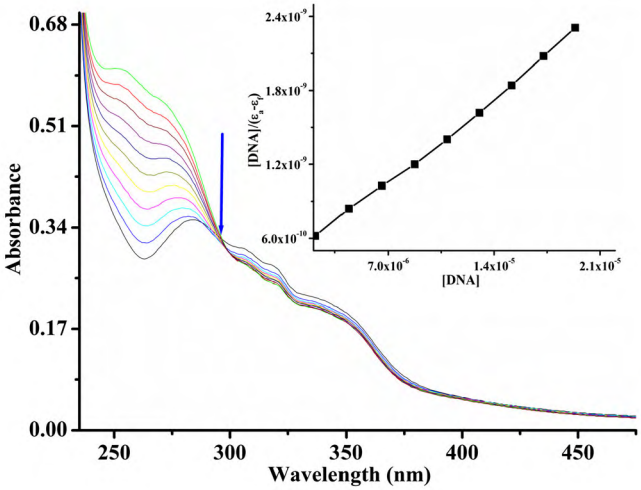


Fig. 1 Absorption spectrum of complex $[Co(phen)_2FIPB]^{3+}$ (**1**) in Tris-HCl buffer upon addition of CT-DNA. Inserted plot, $[DNA]/(\varepsilon_b-\varepsilon_f)$ versus []DNA] for the titration of DNA with Co(III) complex, which gives intrinsic binding constant (K_b). [DNA] = 2.5×10^{-4} M, [Complex] = 40 μM

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, $C_b/[DNA]$ and C_f is the free ligand concentration and the emission binding constant values are 4.4×10^5, 4.1×10^5 and 3.9×10^5 M^{-1}. The order of the binding constants is **1 > 2 > 3**,

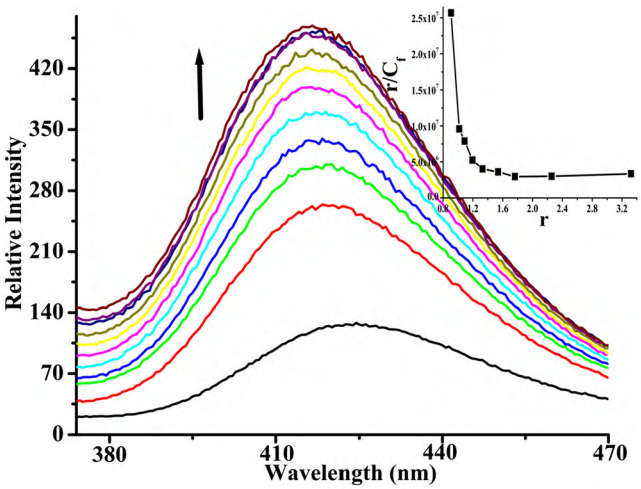


Fig. 2 Luminescence spectrum of complex $[Co(phen)_2FIPB]^{3+}$ (**1**) in Tris-HCl buffer upon addition of CT-DNA. Arrow shows the intensity change upon the increase of DNA concentration. Inset: Scatchard plot of above complex, which gives binding constant (K_b). [DNA] = 2.5×10^{-4} M, [Complex] = 20 μM

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 $[Fe(CN)_6]^{4-}$ 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 $[Fe(CN)_6]^{4-}$ resulting in linear Stern-Volmer plots. In the presence of DNA quenching was less, because of the highly negatively charged $[Fe(CN)_6]^{4-}$ would be repelled bythe 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 theslope.

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

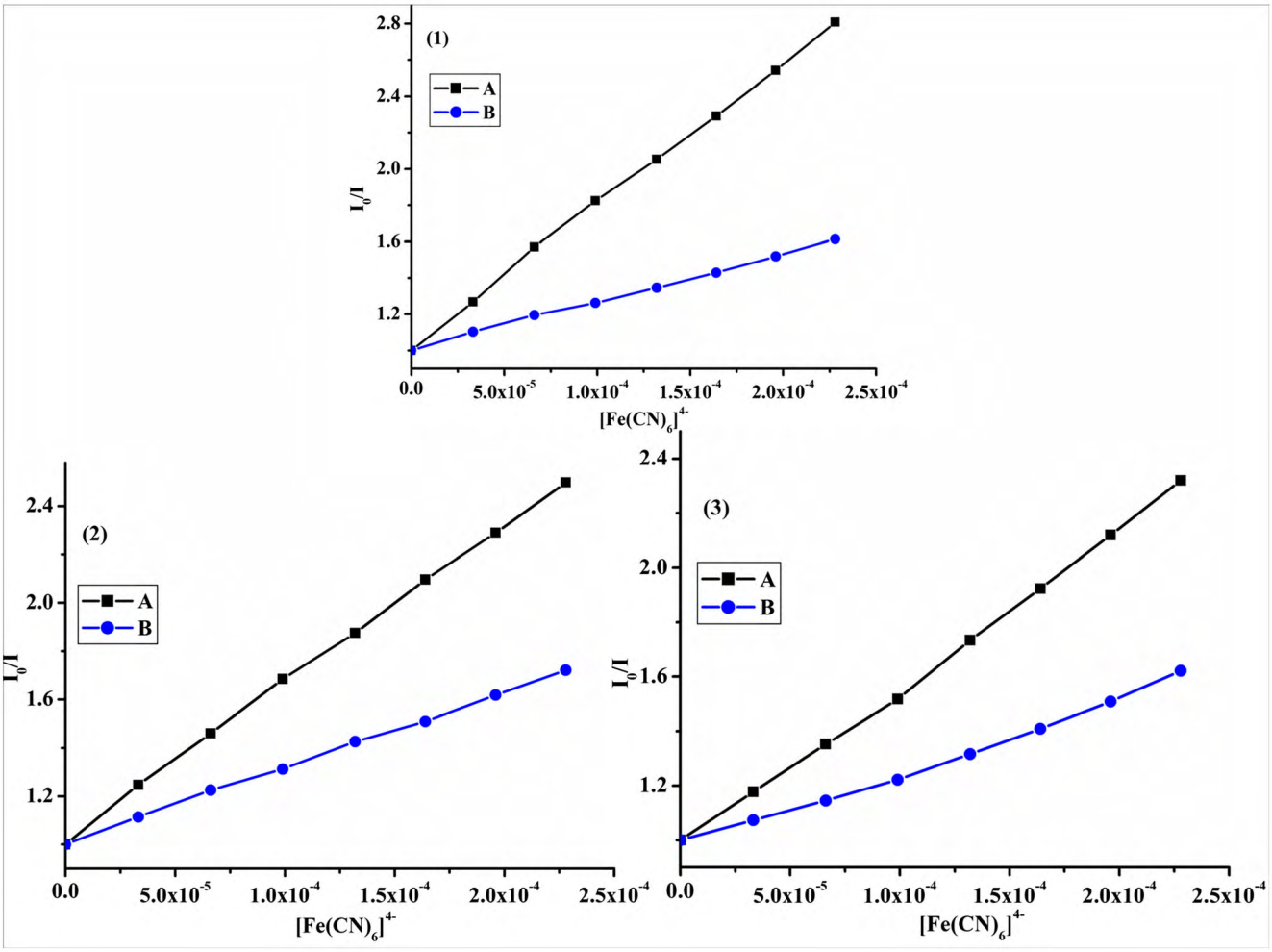


Fig. 3 Quenching studies of complexes in Tris-HCl with $[Fe(CN)_6]^{4-}$ in the absence of DNA (A) and presence of DNA 1:100 (B)

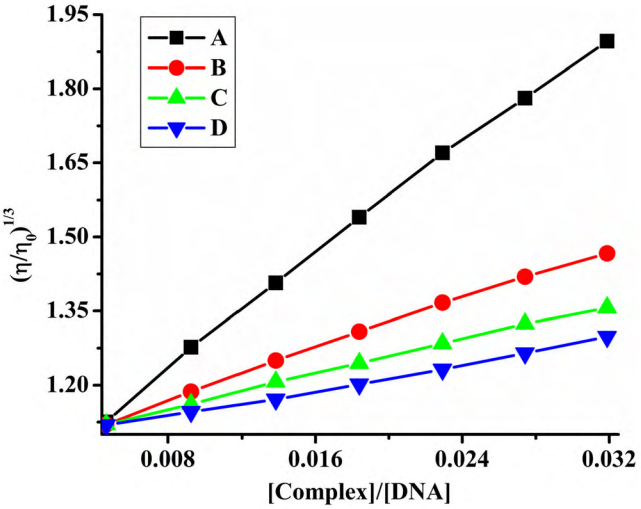


Fig. 4 Effect of increasing amounts of $[Co(phen)_2(FIPB)]^{3+}$ (**a**), $[Co(bpy)_2(FIPB)]^{3+}$ (**b**) and $[Co(dmb)_2(FIPB)]^{3+}$ (**c**) on the relative viscosity of calf-thymus DNA at $30(\pm 0.1)^0$C. ([DNA] = 3.0×10^5 M), pH = 7.0, atroom temperature

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 1.87–1.88 ± 0.01 Å in complex **1**. The Co-N bond length (N of ancillary ligand) is 1.87 ± 0.01 Å, while (N of Intercalator) is 1.88 ± 0.01 Å 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 ~89.5–91.2°. 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 n 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 ~179.01 ° ± 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 columbic 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 Å 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 owning 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

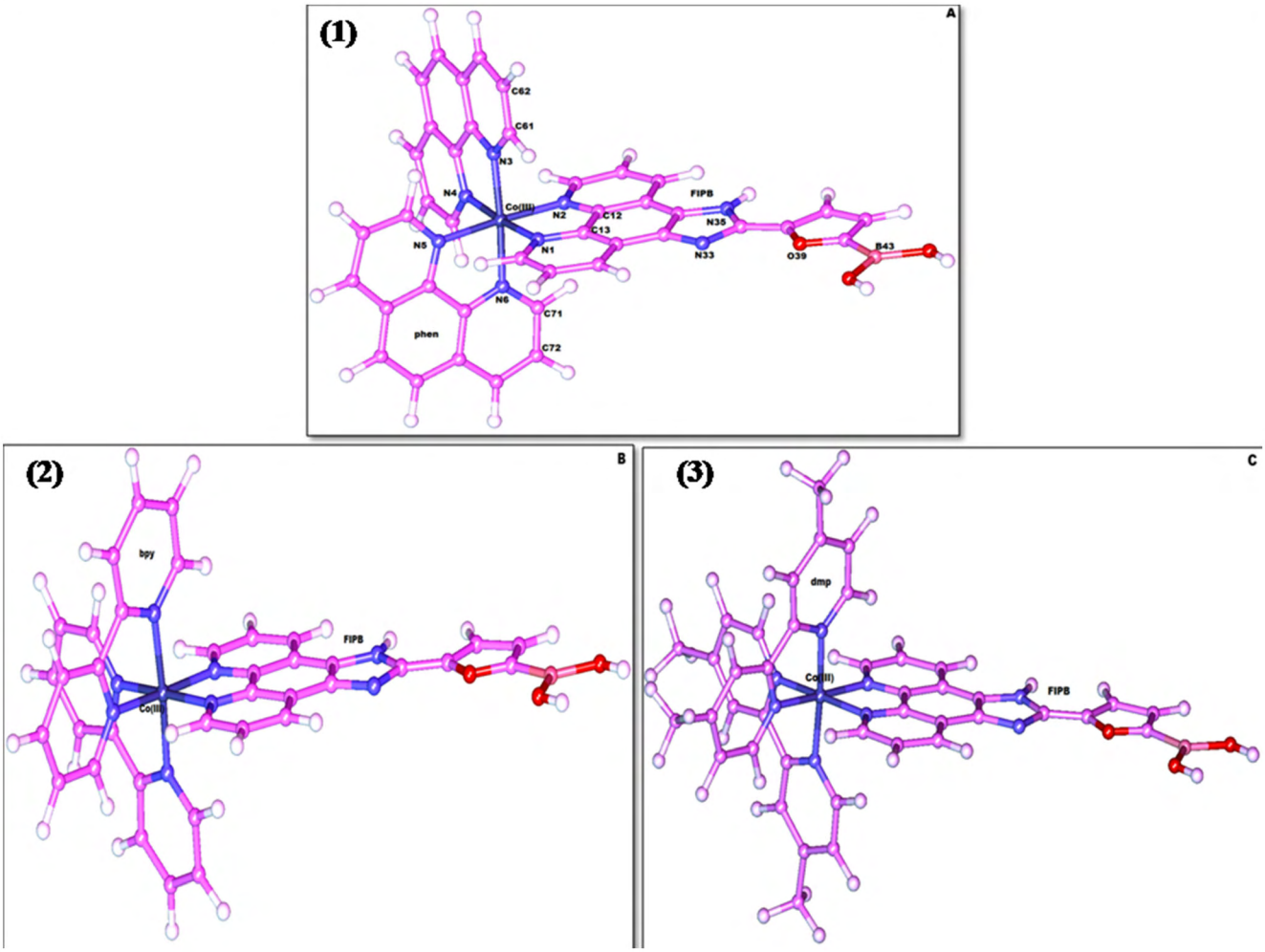


Fig. 5 3D Model of the Cobalt Polypyridyl complex. **a** $[Co(phen)_2FIPB]^{3+}$ **b** $[Co(bpy)_2FIPB]^{3+}$ **c** $[Co(dmb)^2FIPB]^{3+}$

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 (A°)					
		$M–N_1$ [a]	$M–N_2$ [a]	$M–N_3$ [a]	$M–N_4$ [a]	$M–N_5$ [b]	$M–N_6$ [b]
1.	$[Co(phen)_2FIPB]^{3+}$	1.8783	1.8774	1.8780	1.8780	1.8780	1.8780
	Metal–intercalator length.	13.5224					
	Total energy (kcal/mol)	67.3833					
2.	$[Co(bpy)_2FIPB]^{3+}$	1.8809	1.8800	1.8777	1.8763	1.8763	1.8777
	Metal–intercalator length	13.5267					
	Total energy(kcal/mol)	78.5825					
3.	$[Co(dmb)_2FIPB]^{3+}$	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( )	$[Co(phen)_2FIPB]^{3+}$	$[Co(bpy)_2FIPB]^{3+}$	$[Co(dmb)_2FIPB]^{3+}$
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.	$[Co(phen)_2FIPB]^{3+}$	5018	−571.25
2.	$[Co(bpy)_2FIPB]^{3+}$	4852	−490.04
3.	$[Co(dmb)_2FIPB]^{3+}$	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 DNAand 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 thepresent complexes to cleave pBR322 DNA by gel electrophoresis asshown in Fig. 7. Gel electrophoresis separation of pBR322 DNA wasstudied 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 complexwas absent. When this circular DNA was subjected to electrophoresis,relatively fast migration was observed for thes upercoiled 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].

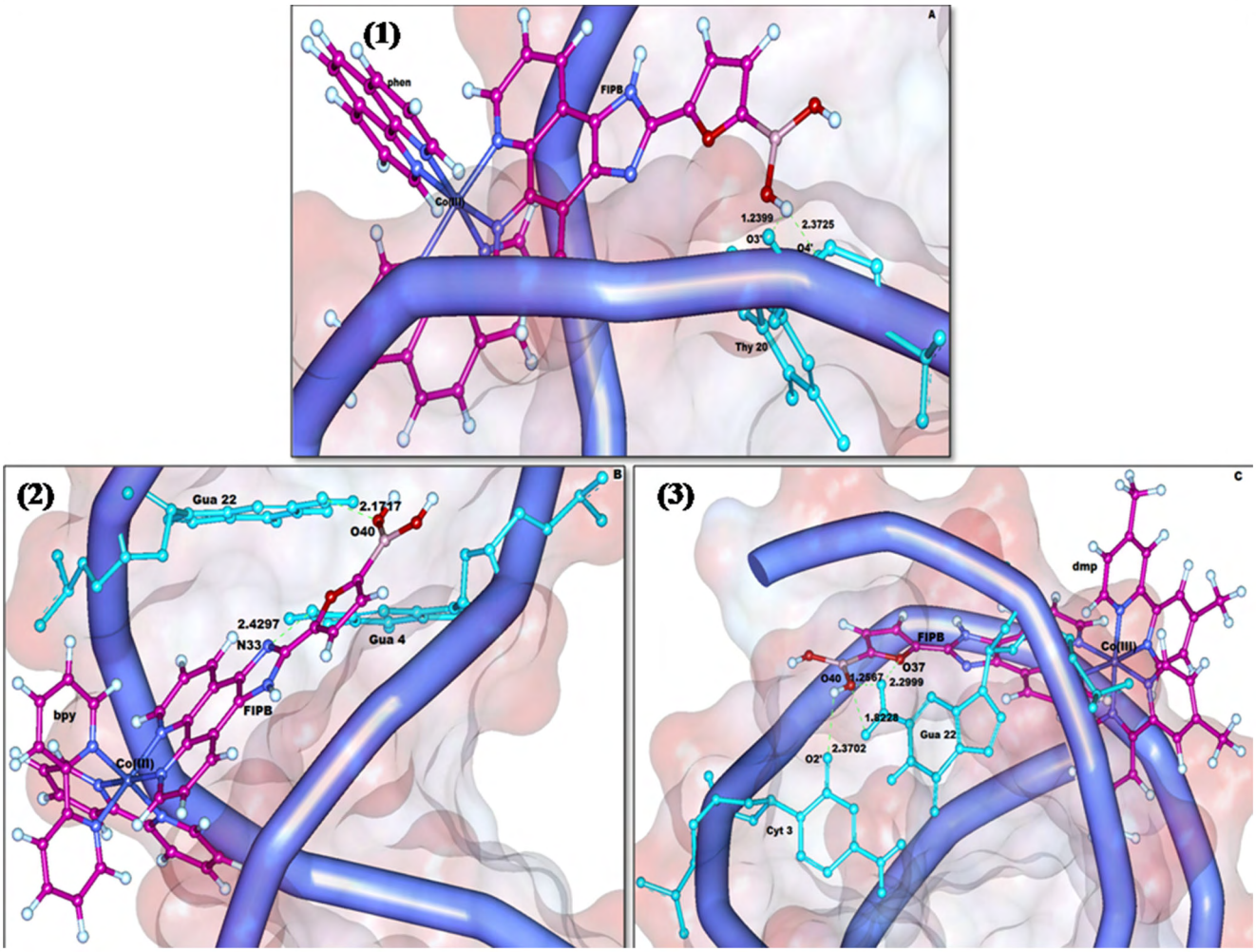
Antimicrobial Activity

The antimicrobial activities of synthesized three complexes were studies 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 and1mg/mL by the standard disk diffusion method. All

Table 4 Binding interacFIons involving the docked poses of dsDNA with metal complexes

S. No.	Metal complex	Binding interactions (donor group–acceptor group)	Bond length(A°)
1.	$[Co(phen)_2FIPB]^{3+}$	:UNK74:H - B:DT20:O4'	2.3725
		:UNK74:H - B:DT20:O3'	1.2399
2.	$[Co(bpy)_2FIPB]^{3+}$	A:DG4:H21 -: UNK33:N	2.4297
		B:DG22:H21 -: UNK40:O	2.1717
3.	$[Co(dmb)_2FIPB]^{3+}$	B:DG22:H21 -: UNK37:O	2.2999
		B:DG22:H21 -: UNK40:O	1.2567
		B:DG22:H22 -: UNK40:O	1.8228
		:UNK72:H - A:DC3:O2	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** $[Co(phen)_2FIPB]^{3+}$ – DNA complex; **b** $[Co(bpy)_2FIPB]^{3+}$ – DNA complex; **c** $[Co(dmb)_2FIPB]^{3+}$ – 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.

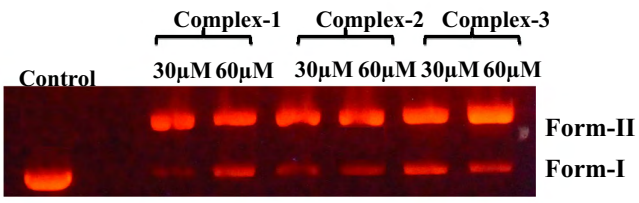


Fig. 7 Agarose gel electrophoresis of supercoiled pBR322 DNA in the absence (control) and in the presence of complexes **1**, **2** and **3** at two different concentrations(30 and 60 μM) after irradiation at 365 nm for 30 min

Cytotoxicity Assay

All the three complexes were evaluate 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 IC50 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	*Staphylococcus aureus(S.A)*		*Bacillus subtilis(B.S)*	
	1000 μL	500 μL	1000 μL	500 μL
$[Co(phen)_2FIPB]^{3+}$ (1)	16	11	23	15
$[Co(bpy)_2FIPB]^{3+}$ (2)	14	09	20	12
$[Co(dmb)_2FIPB]^{3+}$ (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.Invitro cytotoxicity studies also support the experimental data. These complexes are more effective for further studies.

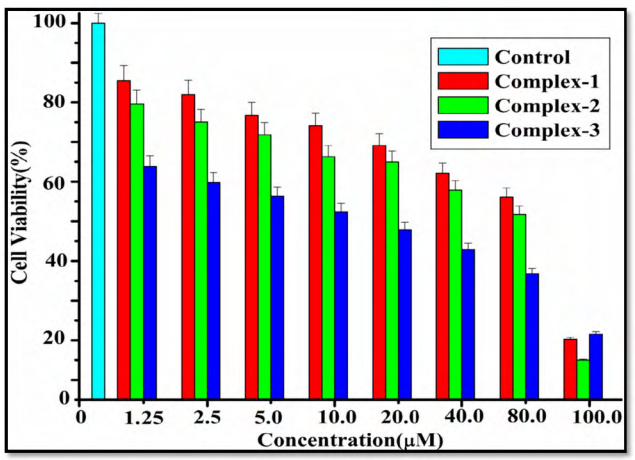


Fig. 8 Cell viability of *HeLa* cell lines treatment with complexes **1**, **2**, and **3**. Each data point is the mean ± standard error obtained from at least three independent experiments

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Authors' Contributions The author SPconceived 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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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 surfaceand existing in many places and forms, mostly in the oceans and polar ice caps, but also asclouds, 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 18^0 24'N latitude and 79^0 20' E longitude in Karimnagar District at km.146 of Kakatiya Canal. Lower Manair Dam is a balancing reservoir builts 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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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 form 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

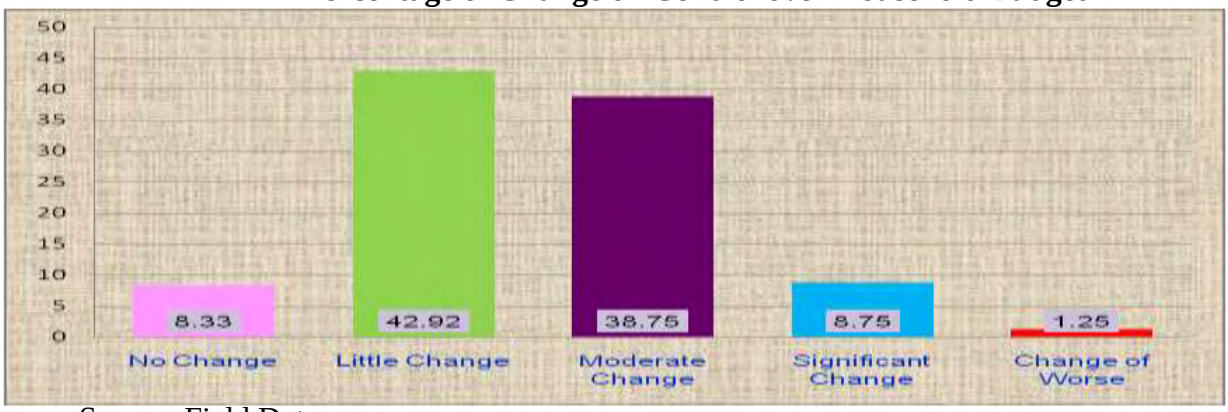
It can be inferred from table 3 that nearly 18.75 per cent of sample women reported that there is no change in their control of family assets due to financial inclusion through MGNREGS. About 2.92 per cent reported negative impact of financial inclusion efforts on their control over assets. However, 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 1reveals 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 26.67per 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 26.67per 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 examine 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 eco-system. 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 Women Entrepreneurs in the Global Economy 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 Dauly 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 wrong-doers, 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 1presents 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

(₹ Crore)

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:
1. * Includes repurchases as well as redemption
2. 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.
3. 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

(₹ crore)

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	HNIs	Retail Investors	Banks	Corporates	HNIs	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	HNIs	Retail Investors	Banks	Corporates	HNIs	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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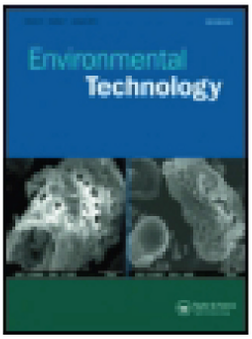

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Porous carbon supported calcium oxide for CO_2 adsorption and separation of CO_2/CH_4

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Porous carbon supported calcium oxide for CO_2 adsorption and separation of CO_2/CH_4

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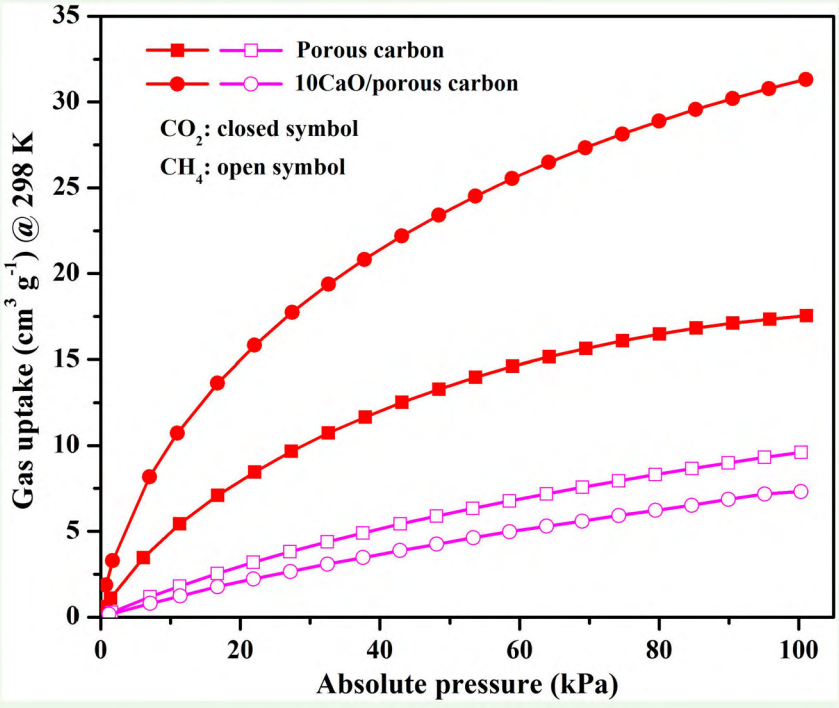
ABSTRACT

Calcium oxide incorporated porous carbon materials were synthesized by the impregnation method to study CO_2 adsorption and separation of CO_2/CH_4. The X-ray diffraction, Raman analysis, N_2 isotherms at 77 K, and SEM with EDX analysis were used to characterize synthesized materials. XRD and N_2 isotherm results have confirmed that synthesized carbon has porosity, and EDX analysis has reported that the presence of CaO on porous carbon. 10CaO/porous carbon has shown 31 $cm^3\ g^{-1}$ of CO_2 adsorption which was higher than bare porous carbon CO_2 adsorption 17.5 $cm^3\ g^{-1}$ at 298 K, 1 bar. It was attributed to electrostatic interaction between CaO and CO_2. However, CH_4 adsorption was decreased by a decrease in surface area. The selectivity of CO_2/CH_4 was higher for 10CaO/porous carbon and the heat of CO_2 adsorption was 36 KJ/mol at high adsorption of CO_2. Moreover, CO_2 adsorption was the same in each adsorption cycle.



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KEYWORDS
CaO; porous carbon; carbon dioxide; adsorption and separation; heat of adsorption

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1. Introduction

CO_2 is one of the pollutant gases which causes global warming worldwide [1]. It is liberated by the consumption of fossil fuel and the high growth of petrochemical and coal industries. The concentration of CO_2 in the atmosphere can be diminished by absorption, membrane separation, and adsorption techniques [2–4]. Out of these, adsorption is the most prominent method which reduces the high consumption of energy for the regeneration and no corrosion of the equipment. Adsorbents such as activated carbon [5], silica [6], clay [7,8] and zeolites [9–11] were used for CO_2 adsorption and separation. The activated carbon material was hindered because of the unavailability of renewable sources. So, researchers have been using other resources such as rice husk [12], cotton stalk [13], waste tea [14], pongamia pinnata fruit hulls [15] and biodiesel solid residue [16] to synthesize carbon material.

Among these, we have chosen pongamia pinnata fruit hulls to synthesize porous carbon by pyrolysis. The carbon material can be used in research areas such as catalysis [17], gas adsorption and separation [18,19], and optical property study [20]. In the gas adsorption study, the adsorption capacity of carbon material can be increased by the incorporation of metal oxide [21]. Isahak et al have studied CO_2 adsorption using Cu-MgO/carbon nanocomposite and reported 58.5 $cm^3\ g^{-1}$ of CO_2 adsorption at 303 K, 1 bar [22]. Chamila et al have synthesized mesoporous MgO-SiO_2 composite for CO_2 adsorption at ambient and elevated temperatures. The CO_2 adsorption capacity was 40.3 $cm^3\ g^{-1}$ at 298 K, 1 bar by physisorption [23]. Kenji et al have also reported CO_2 adsorption capacity 40 $cm^3\ g^{-1}$ for ZnO supported on activated carbon at 303 K, 1 bar [24].

Recently, our research group has studied CO_2 adsorption and separation of CO_2/N_2 on MgO incorporated mesoporous carbon and reported 37.6 $cm^3\ g^{-1}$ of CO_2 adsorption at 298 K, 1 bar [25]. In the above reported all adsorbents, CO_2 adsorption was higher on composite material compared to bulk material due to the electrostatic interaction between adsorbent and CO_2. In this article, we have studied CaO incorporated porous carbon for CO_2, CH_4 adsorption, and separation of CO_2/CH_4. Along with this, the selectivity of CO_2/CH_4, heat of CO_2 adsorption, CO_2 adsorption cycles were also studied.

2. Experimental

2.1. Chemicals

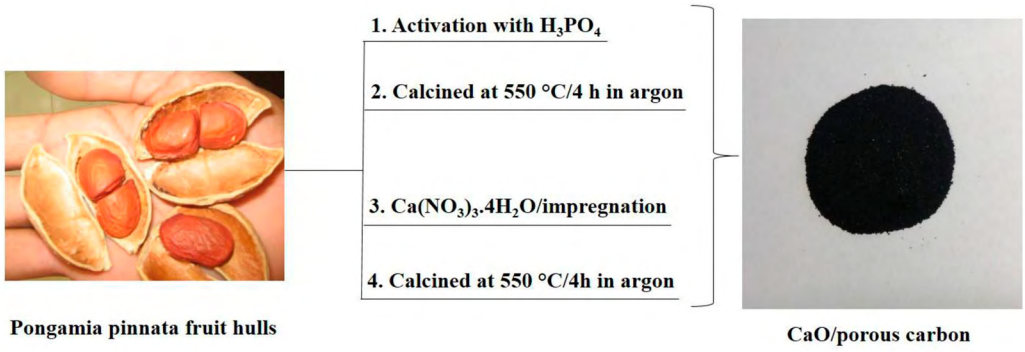
Chemicals such as calcium nitrate tetrahydrate ($Ca(NO_3)_3.4H_2O$, ≥99%) and phosphoric acid (H_3PO_4, 85 wt%) were purchased from M/s. Sigma-Aldrich, India, and used without purification. Pongamia pinnata fruit hulls were purchased from a local vendor, India. Double distilled water was used for the synthesis of adsorbents. Gas cylinders such as carbon dioxide, nitrogen, helium, and methane with ultra-high purity were purchased from the local vendor, India.

2.2. Synthesis of porous carbon and CaO/porous carbon

Porous carbon was synthesized from pongamia pinnata fruit hulls by activation and pyrolysis in inert gas. Firstly, pongamia pinnata fruit hulls were dried and crushed into a fine powder. The powder was activated using phosphoric acid at room temperature for 24 h. The activated sample was calcined at 723 K for 4 h with a heating rate of 10°C/min in argon flow then cooled to room temperature slowly. The obtained sample was washed with distilled water until pH reached to neutral and dried at 373 K for 12 h. Finally, we obtained porous carbon and denoted as PC [26]. Porous carbon supported calcium oxide was synthesized by the impregnation method using calcium nitrate tetrahydrate as a precursor [27]. The desired amount of Ca $(NO_3)_3.4H_2O$ was dissolved in 5 mL distilled water then 1 g of porous carbon was added. The mixture was stirred at room temperature for 1 h then dried at 373 K for 12 h. The dried material was calcined at 723 K for 4 h with a heating rate of 10°C/min in argon flow. Finally, we obtained calcium oxide incorporated porous carbon (Scheme 1). It labelled as xCaO/PC. (x = 2, 5 and 10 wt %).

2.3. Characterization

Rigaku Ultima-IV X-ray diffractometer was used to record the X-ray diffractions for each sample using X-ray source having Cu K_α radiation operated at voltage 40 kV and current 30 mA. The porosity of the sample was determined by measuring N_2 adsorption–desorption isotherms at 77 K using Micromeritics ASAP 2020 Surface area and porosity analyzer. Before isotherm measurement, the sample was activated at 473 K for 2 h under vacuum. Multipoint BET surface area was calculated at $P/P_0 = 0.05–0.3$ and total pore volume at $P/P_0 = 0.99$. The t-plot method was used to calculate the micropore volume. Mesopore volume was obtained by subtracting micropore volume from total pore volume. LabRam HR 800 Raman spectrometer was used to record the Raman spectra. Hitachi S-4800 scanning electron microscopy analyzer was used to obtain morphological images and chemical composition of the sample.



Scheme 1. Stepwise synthesis of CaO incorporated porous carbon.

2.4. Gas adsorption measurement

Micromeritics ASAP 2020 gas adsorption analyzer was used to measure CO_2 and CH_4 adsorption isotherms in low pressure from 0 to 100 kPa at 298 K. Thermostatic bath was connected to water circulating jacket to control sample temperature. Helium gas was used to measure the free space of the sample in the sample tube. About, 0.1 g sample was activated at 473 K for 2 h under vacuum, before measurement of CO_2 and CH_4 adsorption. The initial slope method was used to calculate the selectivity of CO_2/CH_4. The Clausius–Clapeyron equation was used to calculate the heat of adsorption using adsorption isotherms measured at 283, 298, and 298 K. The CO_2 adsorption cycles were studied by desorbing adsorbed CO_2 in each adsorption cycle at 473 K for 2 h in a vacuum.

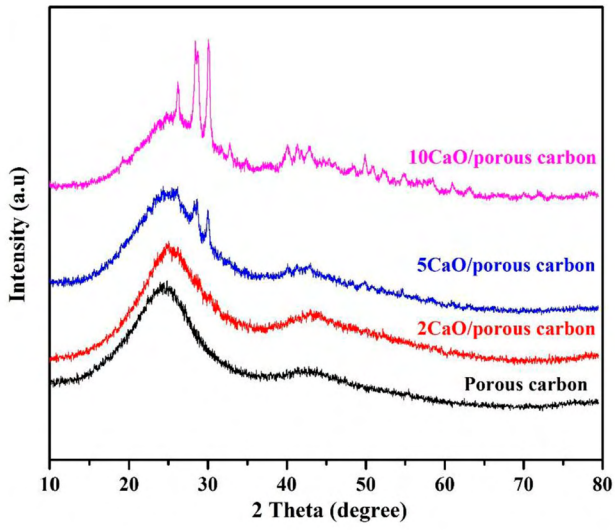


Figure 1. XRD patterns of porous carbon and CaO incorporated porous carbon.

3. Results and discussion

Figure 1 shows the X-ray diffraction patterns of porous carbon and CaO loaded porous carbon.

Broad diffraction peaks were obtained at $2\theta = 24.18°$ and 43.62° which were matched with previously reported porous carbon material [28]. In CaO loaded porous carbon material, the major diffraction peaks of porous carbon were present. Along with this, a few new diffraction peaks have appeared with the increase in CaO loading. The diffraction peaks of CaO were $2\theta = 28.9°$, 32.7°, 41.3°, 49.8°, 54.8°, and 63.1° (JCPDS card no. 00-037-1497) [29]. In the low content of CaO, the diffraction peaks of CaO were not undetectable by XRD. Kingkaew et al have reported similar results of iron oxide doped MCM-41 for CO_2 adsorption [30].

The N_2 adsorption–desorption isotherms were measured to know the porosity of the synthesized materials. Figure 2 shows the N_2 adsorption–desorption isotherms of porous carbon and CaO incorporated porous carbon at 77 K. The textural properties such as surface area, pore-volume, and pore size was presented in Table 1. The bulk porous carbon material has shown a high amount of N_2 adsorption below the relative pressure 0.1 and a hysteresis loop in between the relative pressure 0.4–1. From the classification of porous materials by IUPAC, the isotherm pattern of bulk porous carbon comes to the category of type-I and type-IV which indicated that the presence of micro and mesopores in the synthesized carbon material [31]. The specific surface area, pore-volume, and pore size of porous carbon were 630 $m^2\ g^{-1}$, 0.72 $cm^3\ g^{-1}$ and 4.6 nm respectively. In CaO incorporated porous carbon materials, N_2 adsorption was decreased with an increase in CaO loading. It was attributed to the blockage of pores by incorporated CaO. Consequently, there was a change in the textural properties. The specific surface area was decreased to 494 $m^2\ g^{-1}$, pore volume to 0.48 $cm^3\ g^{-1}$ and pore size to 3.9 nm.

Raman spectra of porous carbon and 10CaO/porous carbon were shown in Figure 3. Two Raman bands were obtained at 1337 and 1585 cm^{-1} which correspond

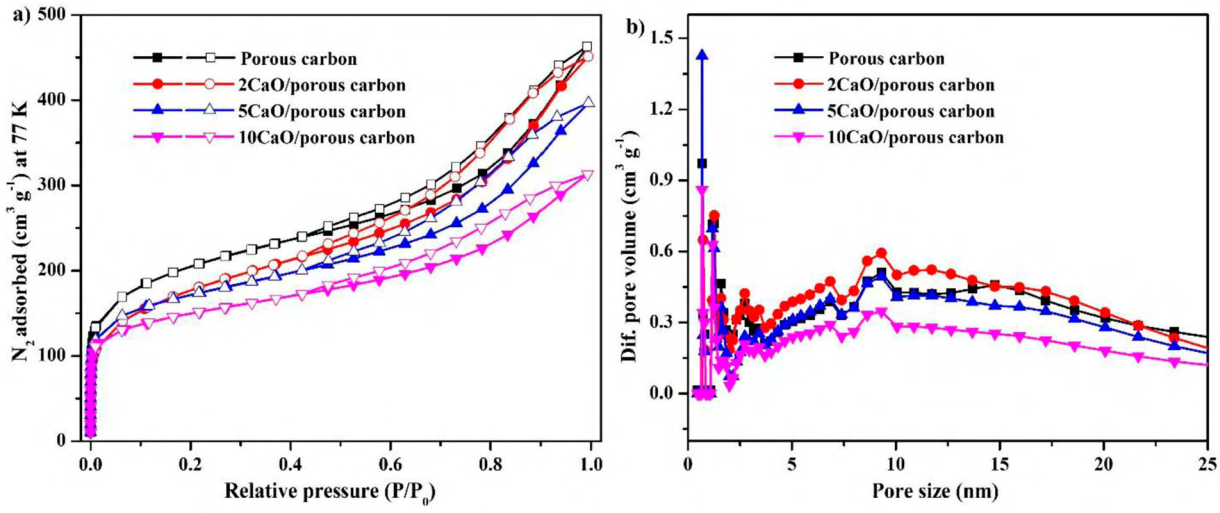


Figure 2. (a) N_2 adsorption-desorption isotherms at 77 K (closed symbol: adsorption; open symbol: desorption) and (b) pore size distribution of porous carbon and CaO incorporated porous carbon.

Table 1. Textural properties of all synthesized adsorbents.

Sample	S^a_{BET} (m^2 g^{-1})	V^b_{total} (cm^3 g^{-1})	V^c_{meso} (cm^3 g^{-1})	V^d_{micro} (cm^3 g^{-1})	Pore size[e] (nm)
Porous carbon	630	0.72	0.61	0.11	4.6
2CaO/porous carbon	616	0.70	0.65	0.05	4.5
5CaO/porous carbon	571	0.61	0.49	0.12	4.3
10CaO/porous carbon	494	0.48	0.37	0.11	3.9

[a]BET surface area, [b]Total pore volume at $P/P_0 = 0.98$, [c]Mesopore volume = $V_{total} - V_{micro}$, [d]Micropore volume by t-plot method, [e]Average pore size by BET.

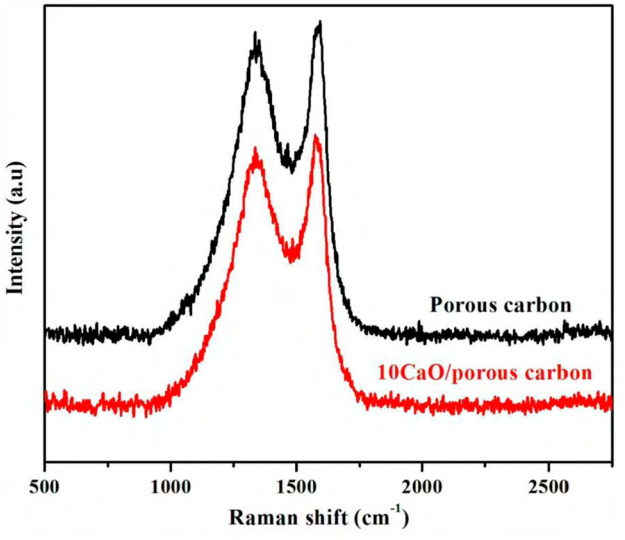


Figure 3. Raman spectra of porous carbon and 10CaO/porous carbon.

to D-band and G-band respectively and the intensity of G-band was higher [32]. The ratio of the intensity of D and G-bands for porous carbon and 10CaO/porous carbon was 0.91 and 0.94 respectively. It indicated that a decrease in the graphitic nature of porous carbon material by the incorporation of CaO. Morphological images and chemical composition of porous carbon and 10CaO/porous carbon were measured using SEM with EDX and showed in Figure 4. Disordered carbon particles were observed in porous carbon material (Figure 4a). The incorporated CaO has covered the surface of disordered porous carbon material (Figure 4b). From EDX analysis, the wt% of the calcium in 10CaO incorporated porous carbon material was 0.93 wt%. In both samples, phosphorous was also detected due to the use of phosphoric acid in the activation of dry pongamia pinnata fruit hulls.

The CO_2 adsorption for all synthesized samples was shown in Figure 5a. With the increase of pressure, the amount of CO_2 adsorption capacity was increased and no equilibrium was attained. The CO_2 adsorption for bulk porous carbon was 17.5 cm^3 g^{-1} at 298 K, 1 bar. For CaO incorporated porous carbon, the CO_2 adsorption was higher compared with bulk porous carbon. Moreover, the CO_2 adsorption was also increased with an increase of CaO loading. It was due to the electrostatic interaction between CaO and acidic CO_2 molecules. The CO_2 adsorption capacity for CaO incorporated porous carbon samples was 20 cm^3 g^{-1} for 2CaO/porous carbon, 23 cm^3 g^{-1} for 5CaO/porous carbon, and 31 cm^3 g^{-1} for 10CaO/porous carbon at 298 K, 1 bar. High CO_2 adsorption was obtained for 10CaO/

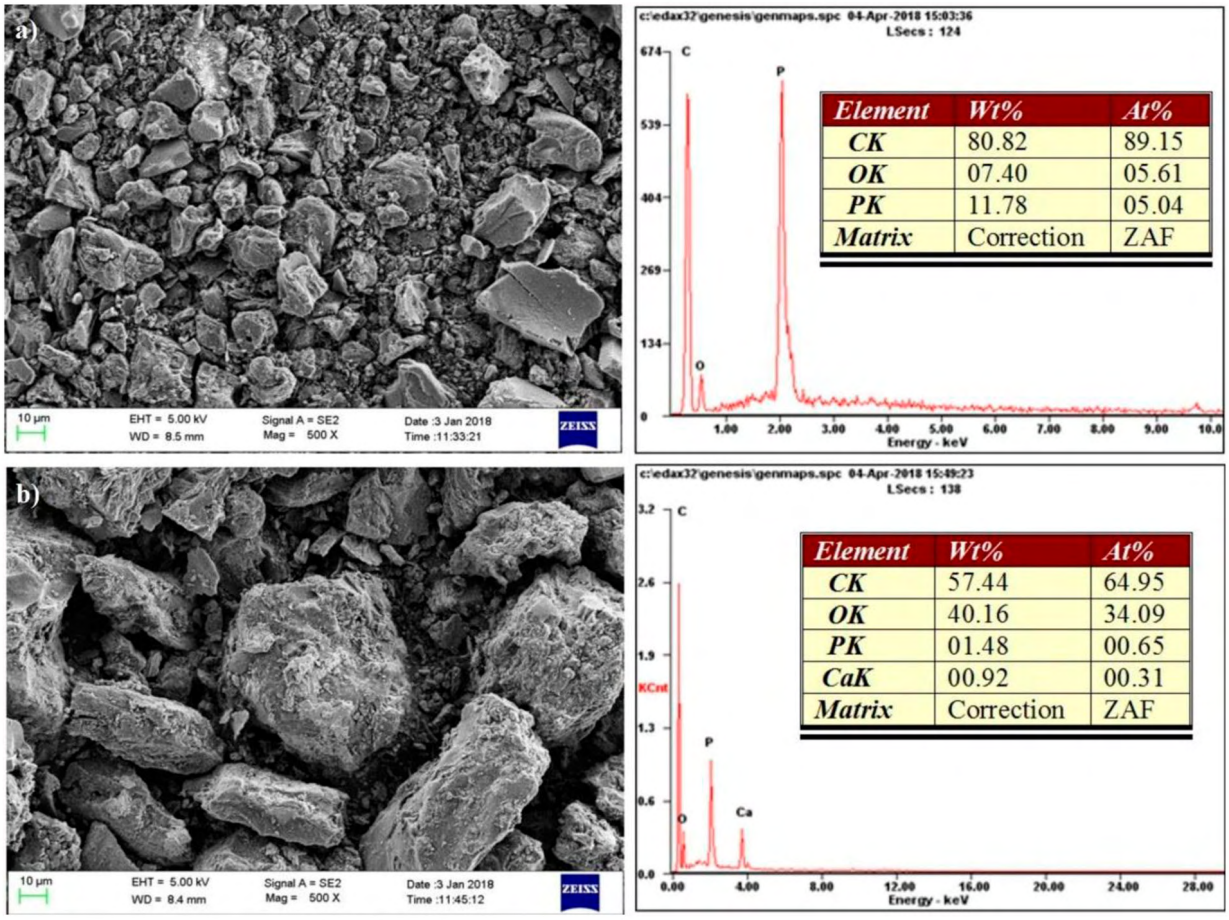


Figure 4. SEM with EDX of (a) porous carbon and (b) 10CaO/porous carbon.

porous carbon by the presence of more number of CaO molecules.

In CaO incorporated porous carbon samples, CO_2 adsorption was dependent on surface chemistry (nature) of the material instead of surface area. We have confirmed by calculation of CO_2 adsorption per unit surface area of the adsorbent (Figure S1). The CO_2 adsorption per unit surface area was higher for CaO incorporated porous carbon compared with bulk porous carbon. Apart from CO_2 adsorption, we have also measured CH_4 adsorption for porous carbon and 10CaO/porous carbon similar to the CO_2 adsorption study (Figure 5b). CH_4 adsorption was increased with an increase in pressure. For porous carbon, CH_4 adsorption was 9.6 and 7 $cm^3\ g^{-1}$ for 10CaO/porous carbon at 298 K, 1 bar. CH_4 adsorption was decreased in 10CaO/porous carbon by the decrease in surface area and no interaction between adsorbent and CH_4 molecule.

The change in CO_2 and CH_4 adsorption capacity of porous carbon and 10CaO/porous carbon was useful to calculate the selectivity of CO_2/CH_4. The initial slope method was used to calculate the selectivity [33,34]. It was shown in Figure 6. The selectivity of CO_2/CH_4 for porous carbon and 10CaO/porous carbon was 3 and 9 respectively at 298 K, 1 bar. The CO_2/CH_4 selectivity obtained on 10CaO/porous carbon was higher than some of the previously reported adsorbents such as ZIF-68 [35], MOF-177 [36], and PAF-1 [37]. The experimental CO_2 adsorption data of porous carbon and 10CaO/porous carbon was fitted with the Langmuir-Freundlich model and the Freundlich model to know the adsorption behaviour of CO_2 (Figure S2) [38]. The fitting model equations were presented in supplementary material and fitting parameter values were presented in Table S1. Good fitting was obtained in the Langmuir-Freundlich model with regression coefficient $R^2 > 0.999$ and maximum CO_2 adsorption capacity (Q_{max}) was higher for 10CaO/porous carbon.

The heat of adsorption is an important parameter in gas adsorption studies. From the heat of adsorption, we can know the interaction of adsorbate with the adsorbent. It can be calculated using the Clausius–Clapeyron equation reported in the reported article [39].

$$\ln P = -\frac{Q_{st}}{RT} + C$$

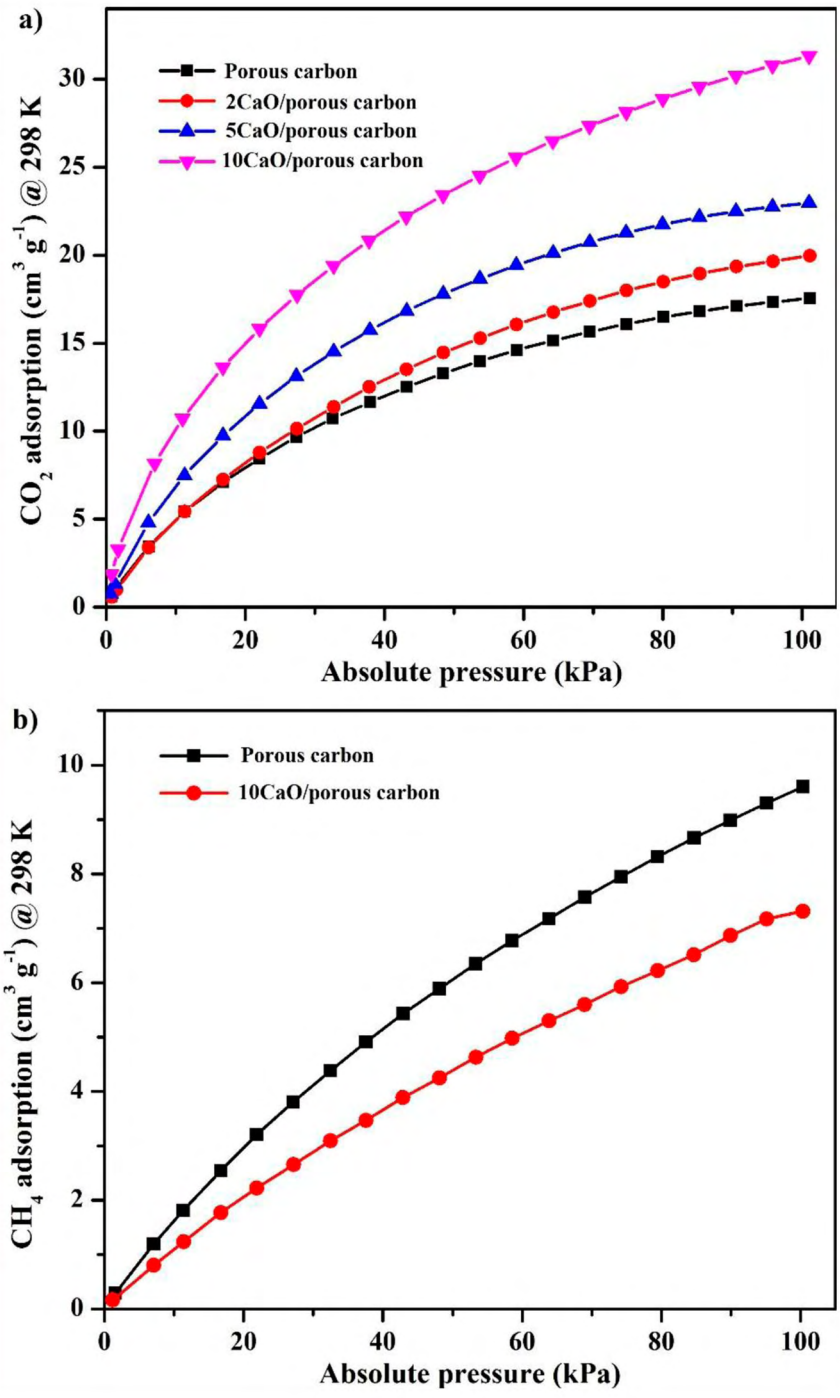


Figure 5. (a) CO_2 adsorption of porous carbon and CaO incorporated porous carbon at 298 K (b) CH_4 adsorption of porous carbon and 10CaO/porous carbon at 298 K.

Where Q_{st} is the heat of adsorption (KJ/mol), R is the universal gas constant (8.314 J/K.mol), P is pressure (kPa), T is the temperature (K) and C is constant. The slope obtained by drawing a graph between ln P vs 1/T with strait line fitting was used to calculate the heat of adsorption. To calculate the heat of CO_2 adsorption for 10CaO/porous carbon, CO_2 adsorption at 283 and 303 K was also measured (Figure S3). With an increase in temperature, CO_2 adsorption was decreased by an increase in the kinetic energy of CO_2. The heat of CO_2 adsorption for 10CaO/porous carbon was shown in Figure 7a. The Q_{st} was 20–36 KJ/mol. At high adsorption of CO_2, Q_{st} was higher due to the non-uniform distribution of CaO on the surface of porous carbon material.

The CO_2 adsorption cycles of 10CaO/porous carbon were shown in Figure 7b to know the CO_2 adsorption stability. Before the study of each adsorption cycle, the sample was heated at 473 K for 2 h under vacuum

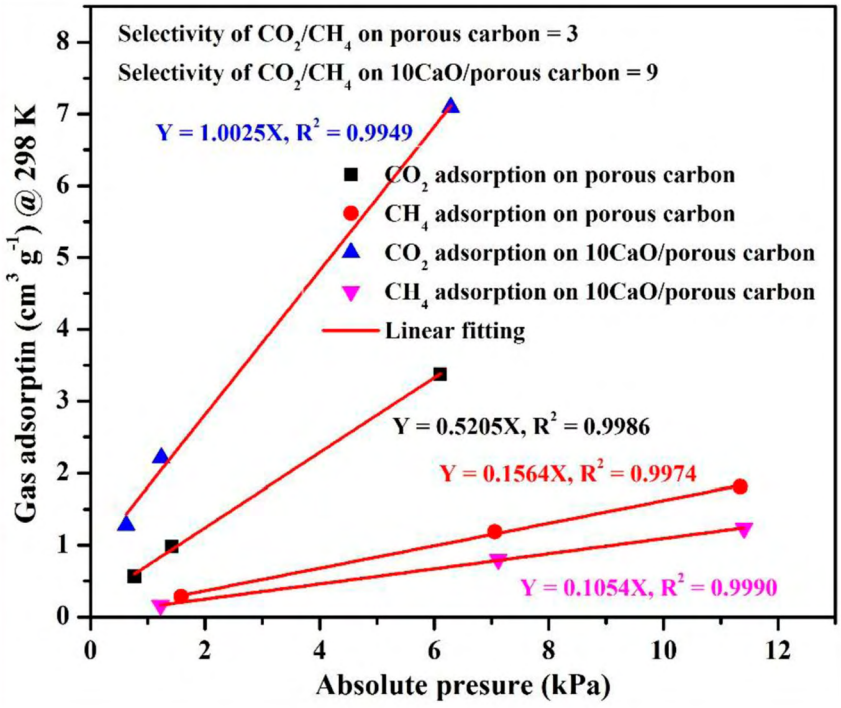


Figure 6. CO_2/CH_4 selectivity of porous carbon and 10CaO/porous carbon.

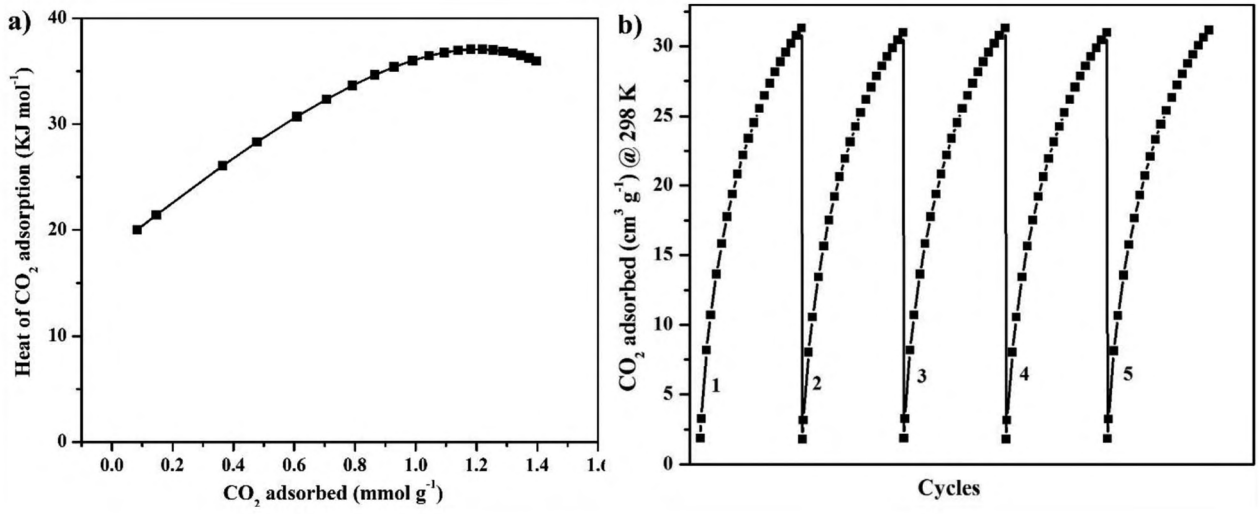


Figure 7. (a) The heat of CO_2 adsorption and (b) CO_2 adsorption cycles of 10CaO/porous carbon.

Table 2. Comparison of CO_2 adsorption of 10CaO/porous carbon in reported articles.

Adsorbent	Adsorption method	CO_2 adsorbed at 298 K, 1 bar ($cm^3\ g^{-1}$)	Reference
Zeolite-13X	Volumetric	38	[42]
CuO/polymer	Volumetric	28	[43]
Amine modified Mg-Al LDH	Gravimetric	26	[44]
Mesoporous Al_2O_3-organosilica	Volumetric	22	[40]
Mesoporous CaO-SiO_2	Volumetric	38	[23]
CaO/porous carbon	Volumetric	31	Present work

to remove adsorbed CO_2. The CO_2 adsorption capacity was constant in each adsorption cycle which indicated that the adsorbent has good adsorption stability. 10CaO/porous carbon CO_2 adsorption capacity was compared with previously reported adsorbents CO_2 adsorption capacity (Table 2). It was in between CO_2 adsorption capacity of mesoporous Al_2O_3-organosilica [40], mesoporous CaO-SiO_2 [41], and mesoporous MgO-Al_2O_3 [23]. Hence, CaO incorporated porous carbon is also one of the adsorbents to study CO_2 adsorption and separation.

4. Conclusion

In this work, we have synthesized porous carbon and CaO incorporated porous carbon materials to study CO_2 adsorption and separation of CO_2/CH_4. High adsorption of CO_2 was obtained for CaO incorporated porous carbon compared with bulk porous carbon because of electrostatic interaction between CaO and CO_2. Moreover, the selectivity of CO_2/CH_4 was also higher for 10CaO incorporated porous carbon. The heat of CO_2 adsorption was 36 KJ/mole at high coverage of CO_2 by non-uniform distribution of CaO on the porous carbon support. The CO_2 adsorption capacity was constant for 10CaO/porous carbon in multiple adsorption cycles. Therefore, porous carbon supported basic metal oxides can be used for CO_2 adsorption and separation.

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Disclosure statement

No potential conflict of interest was reported by the author(s).

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