Dr. BRR. GOVERNMENT COLLEGE, JADCHERLA, MAHABUBNAGAR (Dist.)

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Topic

Adsorption of Methyl Orange using *Pongamia* Carbon

Conducted by students

Name of the Student	Hall Ticket No.	Course
SONY	210330064452094	BZC TM I Year
S VEERANJANEYULU	210330064452095	BZC TM I Year
ADLA SRAVANI	210330064452001	BZC TM I Year
BEERLA MANJULA	210330064452011	BZC TM I Year
ERAPAGA SRAVANI	210330064452034	BZC TM I Year

Guided By

Sri N. Sai Kondalu
Asst. Prof, of Chemistry

Sign. of the Lecturer

Sign. of the HOD

Dept. of CHEMISTRY
Dr. BRR Govt. Degree College
JADCHERLA

Sign. of the PRINCIPAL

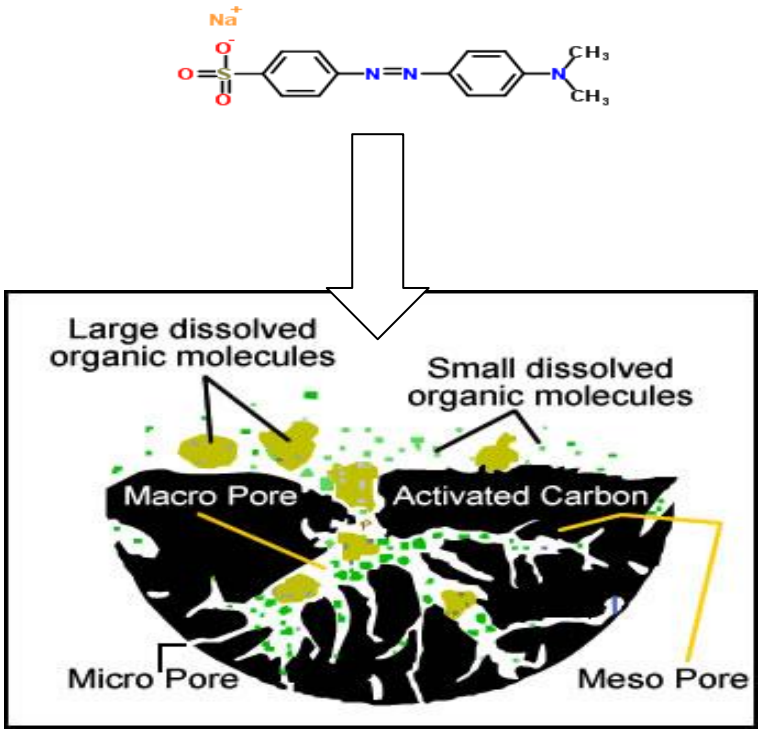
PRINCIPAL
Dr. BRR Govt. Degree College
JADCHERLA

ADSORPTION OF METHYL ORANGE USING PONGAMIA CARBON

ABSTRACT

In this study, *Pongamia pinnata* fruit hulls were used as a precursor to prepare low-cost activated carbon with a large surface area through H_3PO_4 activation. The prepared activated carbon was characterized through pore structural analysis and XRD. The adsorption performance of *Pongamia* carbon (PGC) was evaluated using methylene orange (MO) as the model adsorbate. The maximum adsorption capacities of MO were 154.8, 203.4, and 239.4 mg/g at 30 °C, 40 °C, and 50 °C, respectively. This study indicates that *Pongamia pinnata* fruit hull is a promising precursor for the production of low-cost and efficient activated carbon with a large surface area.

GRAPHICAL ABSTRACT:



1. INTRODUCTION

1.1 STATEMENT OF THE PROBLEM

Dyes have become one of the most prominent contaminants in the textiles, leather, paper, food, printing and plastics industries [1-3]. These dye wastes are hazardous, toxic, non-biodegradable, and sometimes carcinogenic [4]. It affects aquatic living organisms as well as human beings. It can cause headache, allergy and skin irritation, and even influence the normal functions of the liver in human beings. Among various dyes, azo dyes are the largest group of colorants, constituting 70% of all organic dyes produced in the world [5-7]. Methyl orange (MO) as an anionic dye, belongs to the azo dye group. The azo group of dyes contains nitrogen in the structure. Due to the existence of the –N=N- chromophore group and the aromatic structure, it is difficult to remove them from wastewater by chemical and biological degradation methods [8]. Therefore, the development of dye-removal techniques for the industry has long been a challenge.

Several conventional methods such as biological treatment, coagulation, chemical oxidation, ozonation, membrane filtration, ion exchange methods and photo catalysis have been employed for the removal of dyes from wastewater [9-12]. Although they have been widely used, these techniques suffer from several limitations including fairly large flow rates, producing a high-quality effluent that result in the formation of harmful substances. Among these techniques, adsorption process has been found to be superior to other techniques. It is used to make the physical and chemical adsorption of dyes in waste water by natural or synthetic adsorbents. The adsorption method is cheap, simple and effective to adapt. Its treatment period is short and no harmful effects in the environment. Therefore, adsorption can be considered as the most efficient technique for the removal of synthetic dyes because of the removal of complete dye molecules from aqueous effluents, while other methods destroy only the dye chromospheres leaving the harmful residues [13].

1.2 AIMS AND OBJECTIVES:

- The development cost effective adsorbent for the adsorption of methyl orange.
- Adsorption studies over activated carbon prepared from Pongamia Pinnata.

2. REVIEW OF LITERATURE:

Different types of fibrous adsorbents like chitosan [14-15] and polypropylene [16] have been developed in recent years for the adsorption of dyes. Activated carbon is a common and efficient adsorbent used to remove dyes from wastewaters because of its large surface area, high adsorption capacity, and diverse functional groups [17]. Nevertheless, large-scale application of activated carbon is hindered because this material is non-renewable and requires expensive precursors [18]. Thus, production of activated carbon from cheap and renewable precursors has been an interesting research subject. Lignocellulosic biomasses, such as Albizia lebbeck seed pod [18] , rattan sawdust [19] , rice husks [20] , waste tea [21] , biodiesel industry solid reside [22] , cotton stalk [23] , durian shell [24] , oil palm ash [25] , Iranian milk vetch [26] , Soy meal hull [27] , olive stone [28] , rambutan peel [29] , macadamia nut endocarp [30] , peach stone [31] , coffee ground [32] , *Posidonia oceanica* fiber [33] and apricot stones [34] , have been explored as possible pre- cursors for the production of activated carbon. Pongamia pinnata or Karanja is an evergreen, drought- resistant, nitrogen-fixing tree that belongs to the Leguminaceae family [35]. This fast-growing tree is commonly found in tropical and sub-tropical countries, such as Malaysia, India, Thailand, Vietnam, Philippines, China, Japan, Australia, New Zealand, and USA. Pongamia is famous for its seeds, which contain 25–50 wt% of oil [36]. The seeds, which are kidney shaped and brownish red, can be easily collected from the fruits by using a hammer. The fruits are naturally flat and elliptic, with a length of 7.5 cm [37]. Each fruit contains one to two seeds, and a single tree can produce 9–90 kg of seeds with 25–40 wt% of oil. With these properties, pongamia has been recognized as an invaluable non-edible source of bio-oil for medical purposes and as a new feedstock for biodiesel production. As the demand for pongamia bio-oil is predicted to increase in the near future, residual waste generated from oil extraction remains a major problem. During seed collection, large amounts of pongamia fruit hulls are disposed because they have no commercial value. In this regard, pongamia fruit hulls can be

used as a precursor to prepare activated carbon because this raw material is cheap, abundant, renewable and environment friendly.

This study aims to prepare a novel low cost activated carbon with a large surface area from pongamia fruit hulls through H_3PO_4 activation. The prepared adsorbent was characterized through XRD and pore structural analysis. Adsorption studies of Methyl orange are conducted over this activated carbon.

3. RESEARCH METHODLOGY:

3.1 Materials and methods:

Chemicals:

MO (molecular weight: 327.3 g/mol) was obtained from Sigma-Aldrich and used as adsorbate. H_3PO_4 was purchased from renowned suppliers.

3.2 Preparation of activated carbon:

Pongamia fruits were collected from our college Campus, GDC W Karimnagar. The matured fruits were separated from the seeds by using hammer. Seed-free pongamia fruit hulls were washed and rinsed with de-ionized water to eliminate adherents. KFH-R was air dried for 3 days and then oven dried at 105 °C. After drying, the samples were crushed and sieved into a uniform size. Activated carbon was prepared through carbonization and activation by using previously reported methods [26]. Dried KFH-R and crushed raw materials were placed in a stainless steel vertical tubular reactor and carbonized in a tubular furnace at 600 °C with a heating rate of 10 °C/min for 1 h N_2 gas (99.995%) was simultaneously supplied to the system at a flow rate of 150 cm^3 /min. After carbonization, the samples were cooled at room temperature under N 2 flow.

3.3 Characterization of activated carbon:

X-ray diffraction patterns were recorded on Rigaku X-ray diffractometer Ultima-IV having Ni filtered Cu Kα radiation in the scan range from $2\theta = 10 – 80°$ with scan speed 4°/min, step size 0.01°/sec having tube voltage 40 KV and current 30 mA. N_2 adsorption-desorption isotherms were performed at 77 K using Quantachrome Quadrasorb SI surface area analyzer after evacuating the sample at 473 K for 12 h. Multipoint Brunauer-Emmet-Teller (BET) surface area was measured in the relative pressure range 0.05-0.30, total pore volume was determined at a relative pressure of 0.95, micropore volume was determined by t-plot method.

3.4 Adsorption experiments:

Adsorption experiments were conducted in a 250 ml stop- per Erlenmeyer flask with 0.20 g of PGC and 200 ml of MO solution at various concentrations The flasks were shaken at 120 rpm in a thermostatic water bath shaker at 30 °C. The concentrations of MB were determined at different time intervals by using a single beam UV–vis spectrophotometer (Systronics, Model UV 118, Japan) at 464 nm.

4. RESULTS AND DISCUSSION OR FINDINGS:

4.1 XRD: Figure 1 represents the XRD pattern of activated carbon prepared from Pongamia. In this activated carbon was completely in amorphous phase.

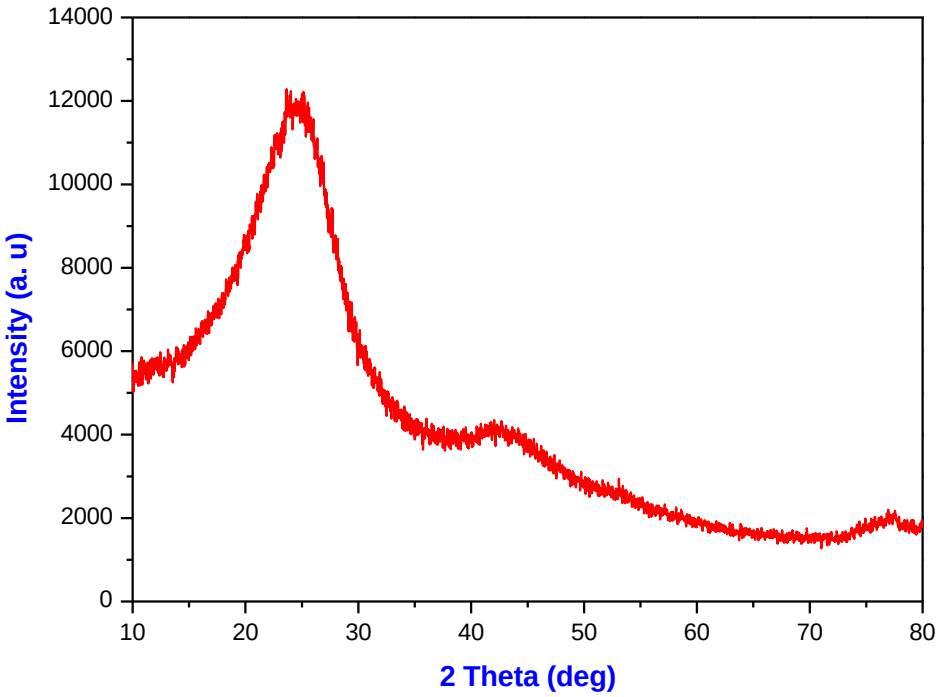


Figure 1: XRD pattern of Activated Carbon from Pongamia Pinnata

4.2 BET Surface area

N_2 adsorption desorption isotherms of PGC and textural properties were shown in table 1. PGC has shown surface area about 840 m^2/gm with total pore volume 0.93 cm^3/gm.

Adsorbent	S.A (m^2/gm)	Total pore volume (cm^3/gm)	Average pore size (nm)
PGC	840	0.93	4.4

Table 1: BET Surface area of Activated Carbon from Pongamia Pinnata

4.3 CONCLUSIONS AND SUGGESTIONS:

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