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SYNTHESIS OF ACTIVATED CHARCOAL FROM LOCALLY AVAILABLE ZIZIPHUS MAURITIANA SEED AND USE OF THEIR FOR REMOVAL OF METHYL ORANGE DYES IN SYNTHETIC WASTE WATER

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ABSTRACT

The adsorption of methyl orange dye into activated carbon made from Jujube (Ziziphus Mauritiana) seeds and treated with phosphoric acid was examined in this study. The effect of pH, contact time, adsorbent dosage, and initial dye concentration on adsorption was investigated using batch adsorption experiments. In 180 minutes, equilibrium is established. It was discovered that when the amount of adsorbent and the pH value grew, so did the amount of adsorbent. The experimental analysis revealed that Ziziphus mauritiana seeds have the potential to be employed as a low-cost adsorbent. Its adsorption capacity has been compared to that of other low-cost adsorbents in the literature. FTIR was used to characterize the adsorbent's surface characteristics.

KEYWORDS

Adsorption, FTIR, Jujube Seed, and Dye.

INTRODUCTION

Dyes are widely used in a variety of sectors, including textiles, printing, and paper, as well as dye houses. The discharge of wastewater containing dye into natural rivers, streams, and channels from industries such as textile, paper, leather, and distillery is a practical problem regarding the use of dyes [1]. Wastewater from dyeing processes is brightly colored, hot, and alkaline, as well as containing a high concentration of dissolved solids [2].

Even at low quantities, dyes have an impact on aquatic life and, as a result, on the food web. The dyes in wastewater have a limited biodegradability and are carcinogenic nature therefore their indiscriminate disposal causes harm to the ecosystem and are harmful to both aquatic and human life [3]. One of the disadvantages of discharging colored wastewater is that it interferes with the transmission of sunlight into streams, limiting aquatic life's photosynthetic activity while also harming the aesthetics. Most dyes are extremely resistant to photo and biodegradation, as well as the effects of oxidizing agents [4, 5]. Cationic (basic dyes), anionic (direct, acid, and reactive dyes), and nonionic dyes are all employed in the industries. Even at very low concentrations, even a very small amount of dye contained in water is usually highly apparent.

Sonochemical degradation, photochemical degradation, and electrochemical degradation are only a few examples of physical and chemical techniques.

Removal of dyes from wastewater is accomplished through electrochemical degradation, coagulation and flocculation, membrane separation, activated carbon adsorption, biodegradation, Fenton biological treatment scheme, photo-Fenton processes, oxidation, or ozonization. These strategies, on the whole, have some flaws [6]. Because of their great adsorption capacity, activated carbons are frequently used as dye adsorbents, and they are very effective. However, due of the related issues, such as disposal, the use of activated carbons for adsorption has been limited in practice. The process of regeneration is also fairly costly. Activated carbons are quite expensive, as evidenced by numerous research investigations, and they have been frequently employed to remove colors from wastewater. Researchers have used low-cost agricultural and forest materials and products as adsorbents.

The seeds of the Jujube (Ziziphus Mauritiana), which grows abundantly in western Rajasthan were used to make activated carbon in this study. The seeds are readily available and affordable, but their potential as an adsorbent material for dye removal from colored water has not been thoroughly researched.

Fig. No. 1 ziziphus Mauritiana Fruits

Fig. No. 2 Ziziphus Mauritiana fruit seeds

The goal of this research is to make activated carbon from jujube seeds using phosphoric acid as a chemical activator and investigate its potential for adsorption of methyl orange dye from synthetic wastewater in batch mode.

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MATERIAL AND METHOD

PREPARATION OF ADSORBENT

The sample (jujube seeds) was purchased. The seeds were cleaned and debris removed with distilled water before being dried in an oven at 80 degrees Celsius. Mortar and pestle were used to grind the dry material. 50 g of the pulverized sample was weighed into a beaker and digested in 50 ml of phosphoric acid, stirring continuously for 24 hours. After that, the sample was filtered, completely washed with distilled water, and dried in an oven at 80 degrees Celsius. The dried sample was placed in crucibles and carbonized for 1 hour at 500°C. The resulting activated carbon (adsorbent) was rinsed and dried.[7]

PREPARATION OF ADSORBATE

Methyl orange Dye Stock Solution Preparation (Adsorbate)

A 1000 ppm dye stock solution was made by dissolving 0.1 g of Methyl orange dye in a 100 ml volumetric flask and diluting with de-ionized water up to the calibration level. Methyl orange dye standard solutions of 10 ppm, 20 ppm, 30 ppm, 40 ppm, and 50 ppm were created using appropriate dilution.

Fig.No. 3 Methyl orange dye powder

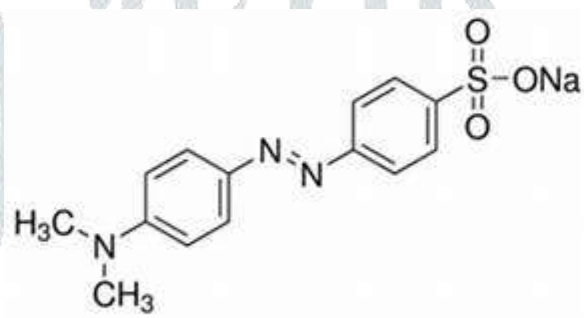

Fig. No. 4 Molecular Structure of methyl orange

$$\text{\% of ash content} = \frac{\text{weight of ash produced}}{\text{Weight of sample}} \times 100 \qquad (1)$$

$$\text{Bulk density} = \frac{\text{Weight of dry material (gm)}}{\text{Weight of packed dry material (cm}^3\text{)}} \times 100 \qquad (2)$$

Summarizes the physical parameters of activated carbon determined using Equations (1) and (2). The density of activated carbon shows that the plant material has been completely carbonized. The ash content indicated that enough activated carbon had been created.

The activated carbon's physical characteristics.

Value of a Property

0.425 g/m3 bulk density

Ash content (%) **4.25**

pH **6.30**

% removal of dye **77-80**

FTIR CHARACTERIZATION OF ADSORBENT

FTIR was used to investigate the adsorbent's surface morphology. On the surface of activated charcoal, FTIR reveals the presence of different functional groups. For different individuals, the trademark peaks were in different places. FTIR was performed to identify the functional groups present on the surface of the adsorbent which can potentially adsorption of dyes. The FT-IR spectra of activated carbon is shown in Figure 5. The physical and chemical reactivity of functional groups at the surface determines ziziphus seed biosorption capacity. The Van der Waals forces cause molecular biosorption as a result of this reactivity, which causes an imbalance between forces at the surface and those within the body. The biosorption capability of the ziziphus seed might be determined by understanding surface functional groups.

The presence of bounded hydroxyl (–OH) or amine (–NH) groups caused the primary peak in the spectra of IJSP at 3224 cm1. The symmetric and asymmetric C–H stretching vibrations of aliphatic acids are responsible for the peak at 2929 cm^{-1}. The peak at 1688 cm1 corresponds to the stretching vibration of a bond caused by nonionic carboxyl groups (–COOH, –COOCH3) and can be attributed to carboxylic acids or their esters. The C–O stretching in ether or alcohol, as well as the methoxy group, are indicated by the bands at 1315 $cm-^{1}$. The bands 1602 cm1 denote the functional group region of the C=O, C–O, and O–H groups, which exist as functional groups. A conjugated hydrogen linked carbonyl group is responsible for the peak at 1446 cm^{-1}. The presence of carboxyl groups (–COOH) is indicated by the peak at 1460 cm1. The existence of C–H aliphatic bending is indicated by the peaks at 1315 cm^{-1}.

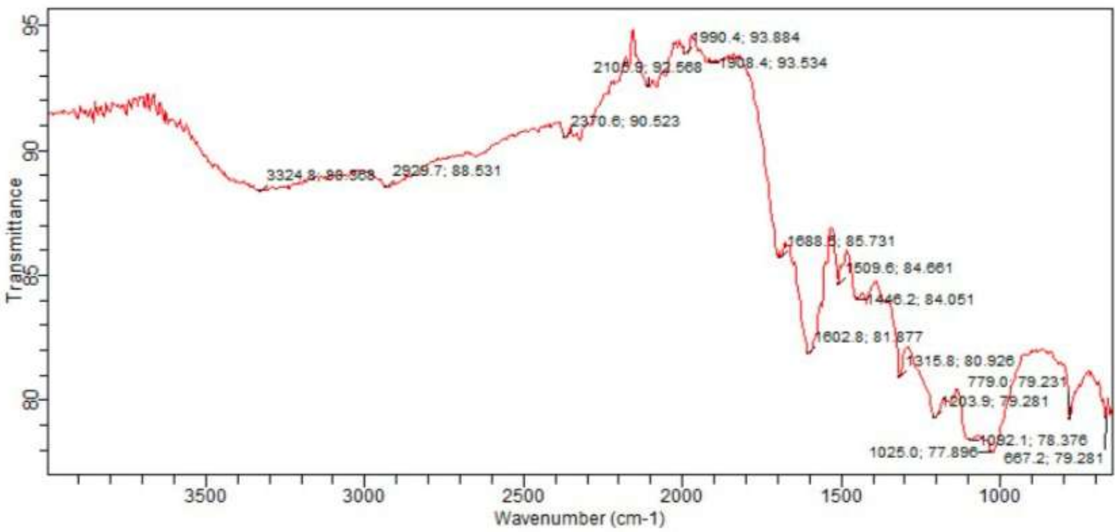

Fig. No. 5 FTIR characterization of adsorbent

BATCH STUDY

Batch investigations were carried out by contacting a specified amount of adsorbent in 50 ml of dye solution at a constant pH of 7.2. The samples were placed in an Inn over 4000 electric shaker and agitated at 200 rpm at a constant temperature.[8]

They were then removed from the shaker at the required time and filtered using Whatman No. 1 filter paper in the ambient environment. The filtrates were taken to a UV-visible spectrophotometer for absorbance measurements, which were used to calculate the final concentration. On the adsorption, the effects of contact time (30 - 150 minutes), adsorbent dosage (0.2 - 1.0 g), and beginning dye concentration (10 - 50 ppm) were studied. Equation (1) = dye adsorbed per unit mass of adsorbent (mg/g) was used to compute the quantity of dye adsorbed per unit bulk of adsorbent (mg/g) (2)

$$q_e \quad \frac{(C_o - C_e)V}{m} \qquad (1)$$

where Co is the initial adsorbate concentration (mg/L), Ce is the final adsorbate concentration (mg/L), m is the adsorbent mass in grammes (g), and V is the adsorbate volume in liters (L).

Adsorption effectiveness can be stated as a percentage of dye solution adsorption as follows:

$$q_e \quad \frac{(C_o - C_e)V}{C_o} \times 100 \qquad (2)$$

where Co is the starting adsorbate concentration in milligrams per liter (mg/L) and Ce is the ultimate adsorbate concentration in milligrams per liter (mg/L).

Temperature has an effect. At four different temperatures of 35, 45, 55, and 65°F, the effect of temperature on the amount of dye removal was investigated. In this experiment, 25 mL of 50 mg L methyl orange solution was placed in a screw type Erlenmeyer flask and agitated at 180 rpm with 0.1 g of 53 m methyl orange at various temperatures. In this investigation, the pH of the dye solution was kept at 5.44. At regular intervals, the samples were removed from the shaker, and the dye solution was separated from the bio sorbent by centrifugation at 10,000 rpm for 20 minutes. We measured the absorbance of the supernatant solution (9).

Dose of ziziphus seed has an effect. The effect of ziziphus seed dose on the amount of methyl orange adsorbed was determined by adding various amounts of ziziphus seed (10, 30, 50, 80, 100, 150, 200, and 250 mg) to a number of 50 mL Stoppered glass Erlenmeyer flasks containing a definite volume (25 mL in each case) of a fixed initial concentration (50 mg L1) of solution without changing pH (5.44) at 35 1 C. The flasks were placed in a Julabo shaking water bath with a thermostat and agitation at 180 rpm for 180 minutes. After reaching equilibrium, the bio sorbent and adsorbent were separated by centrifugation at 10,000 rpm for 20 minutes. We measured the absorbance of the supernatant solution.: (9)

Effect of pH

The pH of the solution affects the surface charge of the adsorbents as well as the degree of ionization of various contaminants. The effect of starting pH was investigated in this research in the pH range of 2 to 10. Increasing the solution pH from 2 to 10 enhanced the % elimination of methyl orange for ziziphus seed. This dye removal behavior in relation to pH can be attributed to a variety of factors.

The charge on the adsorbent surface, which is regulated by the solution pH, influences the adsorption of positively charged dye groups on the adsorbent surface. Based on the findings, it was determined that negatively charged groups on the adsorbent's surface are essential for basic dye adsorption.

CONCLUSION

The current work demonstrates that a low-cost biowaste adsorbent ziziphus mauritiana with good adsorption performance can be employed to remove the basic dye methyl orange without any pretreatment. The following are the findings of this research: The FTIR data demonstrate that certain functional groups, such as OH and CO, are described in the literature to be favorable for the adsorption process. The effect of adsorbent dosage is investigated for the dye in the range of 0.1 to 0.7g/50mL, revealing that as the number of active sites increases, dye adsorption increases, resulting in an increase in removal efficiency. The ideal pH for the adsorption process has been discovered to be approximately 6. The surface charge of the adsorbent, which is regulated by the pH solution, is the most important factor in the adsorption of positively charged dye on the adsorbent surface.

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