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Research Article

## Effect of bio-adsorbents (*Strychnos potatorum* seed) for elimination of methyl orange dye from polluted waters

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### ABSTRACT

The use of cheap, high efficiency and ecofriendly adsorbent has been studied as an alternative source of activated carbon for the removal of dye from wastewater. Bio-adsorbents derived from plant materials of *Strychnos Potatorum* Seed have been probed for their surface sorption abilities towards Methyl Orange Dye using simulated waters. The parameters studied were the effect of pH, amount of adsorbent, contact time and concentration of adsorbate. Equilibrium data were fitted to the Langmuir and Freundlich isotherm models. The data were best represented by the Langmuir model with an adsorption capacity and adsorption intensity. The adsorption was found to be concentration dependent and the maximum adsorption was occurred in 3 hrs. Thus, from the results of adsorption data, it was concluded that the *Strychnos potatorum* seed powder was found to be excellent adsorbent for the adsorption of methyl orange dye from industrial waste water.

**Keywords:** *Strychnos Potatorum*, Methylene orange, Removal, Adsorption, Isotherm

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### INTRODUCTION

Progress in industrialization in particular textile industries have led to the discharge of unprecedented amount of wastewater containing synthetic dyes, which pollutes the rivers and consequently causes harm to human and other living organisms<sup>1</sup>. A majority of the used dyes are azo reactive dyes which are bright in color due to the presence of one or several azo ( $-N=N-$ ) groups associated with substituted aromatic structures<sup>2</sup>. These dyes or their breakdown products are toxic to living organisms<sup>3</sup>. Furthermore, dyes in wastewater are difficult to remove because they are stable to light, heat and oxidizing agents. In short, they are not easily degradable<sup>4</sup>. Physical adsorption techniques are generally considered as the preferred means for removing and purifying organic substances due to their high efficiency and ability to separate a wide range of chemical compounds<sup>5-7</sup>. This has prompted enormous research interest in the use of agricultural waste as starting materials because of their low-cost and widespread availability. Methyl orange (MO) is a commonly used monoazo dye in laboratory assays, textiles and other commercial products and has to be removed from water due to its toxicity<sup>8-9</sup>. *Strychnos potatorum* (Nirmali) tree is grown in southern and central part of India, Sri Lanka, and Burma. It is known as Nirmali tree or Clearing nut tree.

Seeds are widely used in Ayurvedic and traditional medicine. Apart from its medicinal properties the seed powder is being used for clearing muddy water by the rural community. They are reported to be very effective as natural coagulant aids<sup>10</sup>. In the present work, application of *Strychnos potatorum* for the removal of MO from various aqueous solutions has been studied.

### MATERIALS AND METHODS

#### Preparation of Bioadsorbent

*Strychnos potatorum* seeds were collected from Local market from Bhopal India and were utilized as a raw material for the preparation of surface modified adsorbent. The seeds of *Strychnos potatorum* were thoroughly washed with double distilled water to remove the impurities and were then allowed to dry in sun light. The bio-adsorbent *Strychnos Potatorum* powder is prepared from the seeds of the *Strychnos Potatorum*. The seeds are collected, cleaned thoroughly, and dried for 3-4 days. The dried leaves are crushed into fine powder by using a mechanical grinder. The resultant powder is sieved and fractionated using a series of sieves with different sizes. The powder is then again dried in an air oven at 60-70 °C for 12 h and washed with distilled water to remove all the color pigments so that it will not

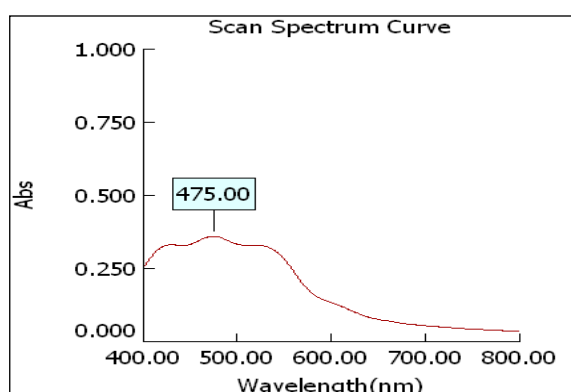
interfere in spectroscopic studies. Then the sample is kept at room temperature and used for further experiments.

### Collection and preparation of dye solution

Methyl orange, 4-dimethylaminoazobenzene-4'-sulfonic acid (MO), a bright orange crystalline powder with a molecular weight of 327.34 and melting point around 300 °C, was used as an adsorbate in the present study. It is a basic dye and it was purchased from Hi Media. A 100mg of dye was dissolved in 100 ml of distilled water to prepare a stock solution. Desired concentration of dye solution was obtained by diluting this stock solution. Concentration of dye solution was measured by Lab India 3000 plus spectrophotometer.

### Determination of $\lambda_{max}$ of Drugs

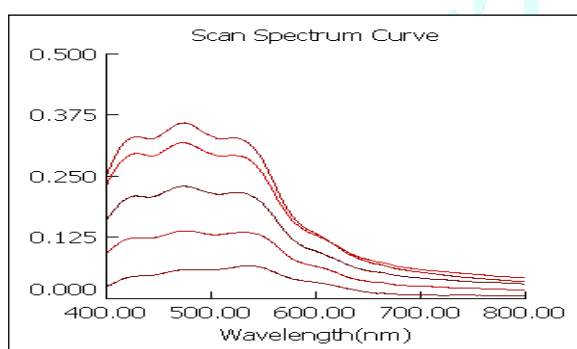
Standard solution (10 $\mu$ g/ml) of pure, methyl orange was prepared. The pure drug solution was scanned on UV spectrophotometer (Lab India 3000 plus), and  $\lambda_{max}$  determined.



### Determination of $\lambda_{max}$ of methyl orange

### Linearity and Calibration Graph

To establish the linearity of analytical method, a series of dilution ranging from 5-25  $\mu$ g/ml was prepared. All the solutions were filtered through 0.2 $\mu$ m membrane filter and injected, chromatograms were recorded at 475.0 nm and it was repeated for three times. A calibration graph was plotted between the mean absorbance and respective concentration and regression equation was derived.



## RESULTS AND DISCUSSION

### Effect of pH

In a 100-mL conical flask, the required amount of *Strychnos Potatorum* seed powder is taken and 50 mL of dye solution (methyl orange) of a particular concentration is added. It is then agitated in a shaker at a constant speed for some time. As soon as the adsorption is over, the mixture is filtered off and the amount of un-adsorbed dye is estimated spectrophotometrically at 475 nm. Effects of pH on dye

sorption is studied in the pH range of 3.0, 4.0, 8.0 and 9.0 with a bio-adsorbent amount of 10mg/ml, dye concentration of 10mg/ml.

### Effect of Initial Concentration and contact time

The effect of initial concentration and contact time was studied by agitating 0.5 gm of *Strychnos Potatorum* seed powder having particle size of 150  $\mu$ m in 100 ml dye solution of different concentration (10, 20, 30 and 40 mg) over a time period of 1, 2 and 3 hrs at a room temperature.

### % Absorption was calculate using following formula

$$\% \text{ Absorption} = \frac{\text{Control Abs.} - \text{Test Abs.}}{\text{Control Abs.}}$$

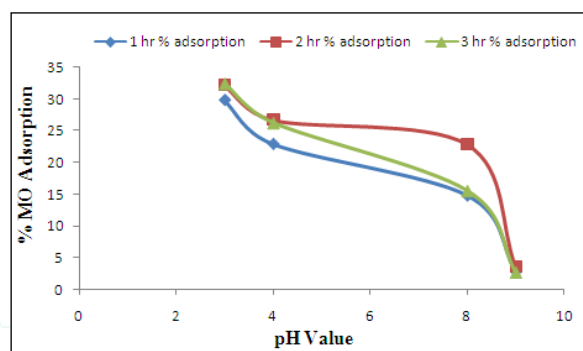


Figure -1. Effect of pH on adsorption of MO dye

### Effect of Adsorbent Dose

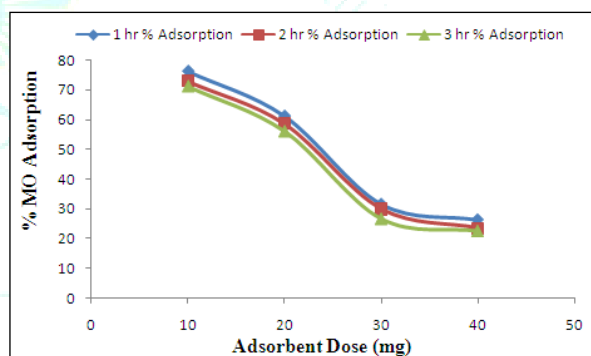


Figure -2. Effect of Adsorbent Dose on adsorption of MO

### Effect of Contact Time

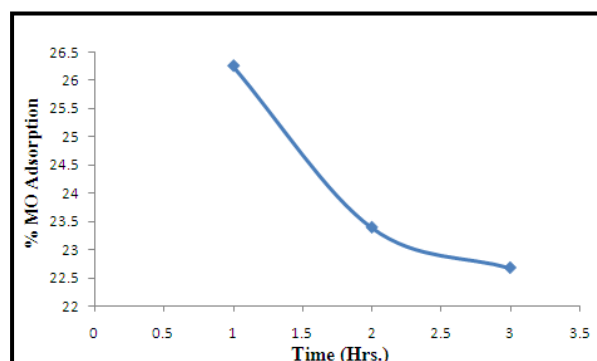


Figure -3. Effect of Contact Time on adsorption of MO

### Isotherm Data Analysis

The Langmuir and Freundlich equations are commonly used for describing adsorption equilibrium in waste water treatment applications. The linearised form of Langmuir isotherm is given by the following equations.

**Langmuir equation**  $C_e/Q_e = 1/Q_m B + C_e/Q_m$ .....1

**Freundlich equation**  $\log Q_e = \log kf + 1/n \log C_e$ .....2

Where  $C_e$  is the equilibrium concentration (mg/L);  $q_e$  is the amount of dye adsorbed at equilibrium (mg/g) and  $Q_m$  (mg/g) and  $b$  (L/mg); the Langmuir constants related to

adsorption capacity and energy of adsorption respectively. Straight lines were obtained by plotting  $C_e/q_e$  against  $C_e$  as shown in the figure. It indicates the applicability of the Langmuir isotherm over the entire concentration range studied with  $R^2$  value of 0.992.

#### Langmuir constants and equilibrium parameter

v	conc.	Time (hr)	dose mg	% adsorption	co-ce	ce	co-ce*v	qe= co-ce*v/m	ce	ce/qe
1	10	3	40	71.122	7.112	2.89	7.1122	0.178	0.1	0.84
1	20	3	40	56.086	11.22	8.8	11.217	0.28	0.9	3.03
1	30	3	40	26.73	8.019	22.0	8.0191	0.2	2.1	10.48
1	40	3	40	22.673	9.069	30.9	9.0692	0.227	4.9	21.61

#### Freundlich constants and equilibrium parameter

ce	qe	log ce	log qe
0.15	0.18	-0.824	-0.75
0.85	0.28	-0.071	-0.552
2.1	0.20	0.3222	-0.698
4.9	0.23	0.6902	-0.644

**Table-1. Comparison of the coefficients isotherm parameters for MO adsorption**

Isotherm Model	Coefficients Isotherm Parameters		
	$Q_m$ ( $\mu\text{g/g}$ )	$b$ (mL/ $\mu\text{g}$ )	$R^2$
Langmuir	0.224	58.6	0.992
Freundlich	$1/n$	$K_f$ ( $\mu\text{g/g}$ )	$R^2$
	0.145	0.7638	1.000

## CONCLUSION

The adsorption of methyl orange dye increased while increases the concentration of adsorbent indicating that the adsorption capacity of seeds. The adsorption data described well linear Langmuir isotherm equation indicating monolayer coverage of the dye molecules on the outer surface of the adsorbent. The adsorption was found to be concentration dependent and the maximum adsorption was occurred in 3 hrs. Thus, from the results of adsorption data, it was concluded that the *Strychnos potatorum* seed powder was found to be excellent adsorbent for the adsorption of methyl orange dye from industrial waste water.

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