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Removal of Methylene Blue by Agricultural Waste of *Cicer arietinum*

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Two kinds of adsorbents were prepared from the agricultural waste of *Cicer arietinum*. Both adsorbents have good uptake capacity of methylene blue dye. It was observed that removal of dyes is dependent on concentration of the dye, time and amount adsorbent of material used.

Key Words: Methylene blue, Removal *Cicer arietinum*.

INTRODUCTION

In Maharashtra, the crops of Bengal gram, pulses, grapes, maize, cotton, wheat and bajara are harvested. Agricultural wastes from these crops are available in ample amount. The waste material after processing can be utilized in purification of water. Industrial effluents contain heavy metals, phenols, dyes etc. as pollutants. These pollutants have been reported as toxic for the living system. Dyes have been reported to have toxic effects[1–5]. The present study reveals cheaper and easily available soures from agricultural waste of *Cicer aritinum* for the purification of effluents without any chemical treatment.

The adsorption behaviour of the cationic dye methylene blue has been investigated on powderd material of agricultural waste of *Cicer arietinum*. Adsorption of dyes by insoluble salts and oxides has been studied during recent years mostly from the standpoint of the determination of adsorption isotherms related quantities like particle size, surface area, etc. The rate of the adsorption of dye is generally very fast and is completed within a short interval of time[6–10]. Newer low cost adsorbent materials like tree barks, cotton capsule shells, sawdust[11–16], rice straw, groundnut husk, carbon[17], tea leaves[18], waste wool[19], peanut skins, etc. have been tried out for the removal of pollutants from wastewater.

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EXPERIMENTAL

The solution of cationic dye methylene blue (3,9-bis-dimethylamino phenazothionium chloride) was prepared in different concentrations in distilled water. The agricultural waste of *Cicer arietinum* stalks was cut down into small pieces, dried in an oven at 105°C for 2 h and then crushed into powder, called powdered material (Pm). For adsorption study 63 mesh size sieved material (Sm) was used. In the adsorption experiments weighed quantity of powdered material as it is and sieved material 50, 100, 200 and 500 mg was used. To each of these, weighed material 25 mL of different concentrations (C_o) was added. The flasks were protected from light and stirred on magnetic stirrer for the period of 2, 4, 6, 8, 10, 12, 14, 30 and 60 min and filtered. The amount of dye adsorbed was calculated for both powdered material and sieved material. From the differences in the initial concentration (C_o) and equilibrium concentration (C_e) by measuring absorbance on Systronics photoelectric colorimeter-112 by using 640 nm filter, the factors affecting the extent of adsorption such as concentration, amount of dose and time were studied.

RESULTS AND DISCUSSION

The results obtained in this work indicate that the cationic dye methylene blue can be successfully removed by the simple adsorbent obtained from the stalk of *Cicer arietinum* without any chemical treatment. Simple physical processes like grinding and sieving seem to enhance the adsorption capacity of adsorbent. Removal of the dye from the solution of methylene blue of concentration 1E-04 M is about 90% within 15 min.

A study was carried out to study the optimum concentration of methylene blue, which could be successfully removed from the solution (Table-3). The study reveals that the maximum removal of the dye was seen when the initial concentration of the dye solution was 1E-04 M. The amount of adsorbent used also has a substantial effect on percentage removal. At equilibrium time 100 mg of powdered sample removes about 63% while 500 mg removes about 85% (Table-4). In all the cases with variation in material the process of removal of dye is almost complete within 1 h. The removal is rapid up to 10 min (Table-2). The results obtained using sieved material as the adsorbent for the same concentration of methylene blue indicate that the efficiency of removal of dye is enhanced when the material is sieved. Powdered material removes methylene blue by 51.9% within 2 min (50 mg material dose as shown in Table-1) while sieved material removes the dye by 73% (50 mg material dose as shown in Table-2) in the same time. A maximum removal of the dye is 68% by powdered material (Table-1) while it is 84% by sieved material (Table-2) using just 50 mg of the adsorbent. The removal of the dye increases to 91% when 50 mg of sieved material is used (Table-4). The maximum removal of methylene blue by adsorption was observed when the initial concentration was 1E-04 M. The rate of adsorption is higher for sieved material compared to powdered material.

The results obtained in this work prove beyond doubt that agricultural waste generated from *Cicer arietinum* can be effectively used for removal of dye and that too in an eco-friendly manner.

TABLE-1
VARIATION IN REMOVAL OF METHYLENE BLUE WITH TIME AND DOSE FOR POWDERED MATERIAL AS ADSORBENT (C_0 = 1.00E-04)

Time (min)	Material dose			
	50 mg	100 mg	200 mg	500 mg
	(% Adsorption)			
0.5	44.14	53.23	65.28	72.78
1	46.14	55.19	70.77	74.09
2	51.90	58.35	72.72	76.70
4	53.77	58.40	74.67	78.61
6	55.77	59.02	76.62	79.28
8	57.02	61.03	77.91	79.90
10	61.30	62.95	79.21	81.20
12	62.28	64.93	79.86	83.20
14	63.63	67.53	81.20	84.50
30	64.28	68.78	82.02	85.79
60	68.78	70.03	83.35	87.43

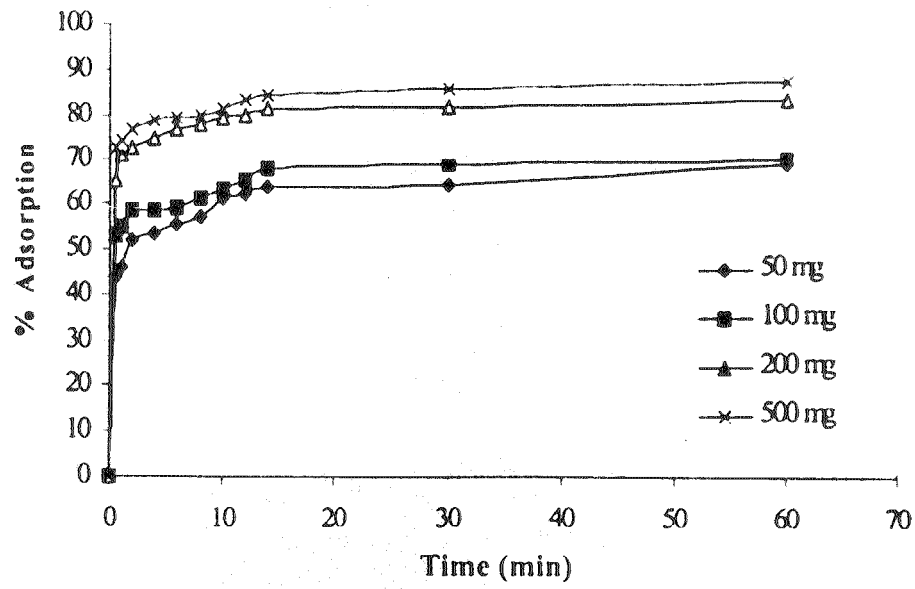

Fig. 1. Variation in removal of methylene blue with material dose for powdered material (1.00E-04)

TABLE-2
VARIATION IN REMOVAL OF METHYLENE BLUE WITH TIME AND DOSE FOR SIEVED MATERIAL AS ADSORBENT (C_0 = 1.00E-04)

Time (min)	Material dose			
	50 mg	100 mg	200 mg	500 mg
	(%) Adsorption			
2	73.39	75.40	78.66	82.00
4	74.69	76.70	80.00	83.35
6	76.00	78.00	81.40	84.70
8	77.40	79.40	83.40	85.99
10	78.70	80.70	84.57	87.39
12	80.00	82.02	85.99	88.69
14	81.40	82.70	86.69	89.29
30	83.4	83.4	87.39	89.99
60	84	85.4	87.59	90.69

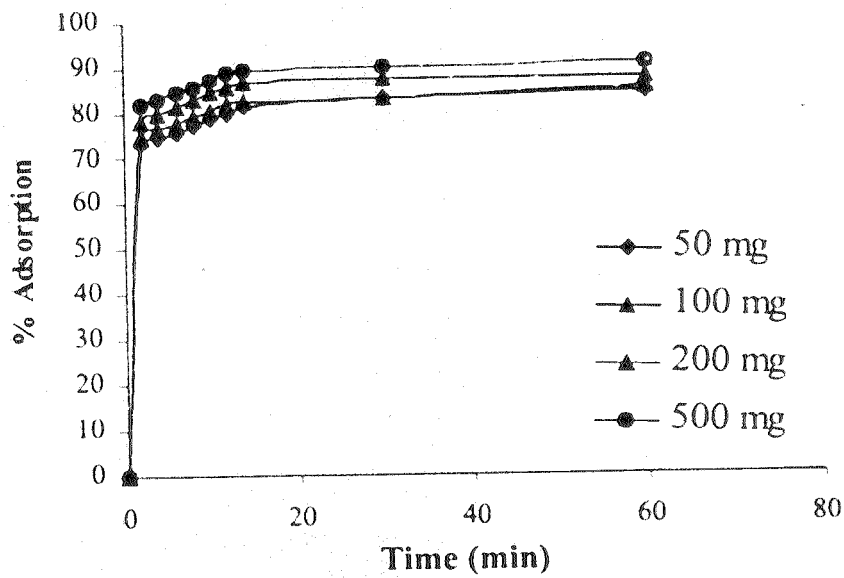

Fig. 2. Variation in removal of methylene blue with material dose for seived material (1.00E-04)

TABLE-3
COMPARISON OF AMOUNT OF ADSORPTION OF METHYLENE BLUE DYES ADSORBED ON STALK OF *CICER ARIETINUM* AT EQUILIBRIUM FOR POWDERED AND SIEVED MATERIAL (100 mg) WITH DIFFERENT INITIAL CONCENTRATIONS

Initial concentration (mol/L)	% Adsorption at equilibrium in powdered material	% Adsorption at equilibrium in sieved material
1.00E-03	21.43	40.66
5.00E-04	25.20	42.54
1.00E-04	68.90	82.70
1.50E-05	67.54	72.91

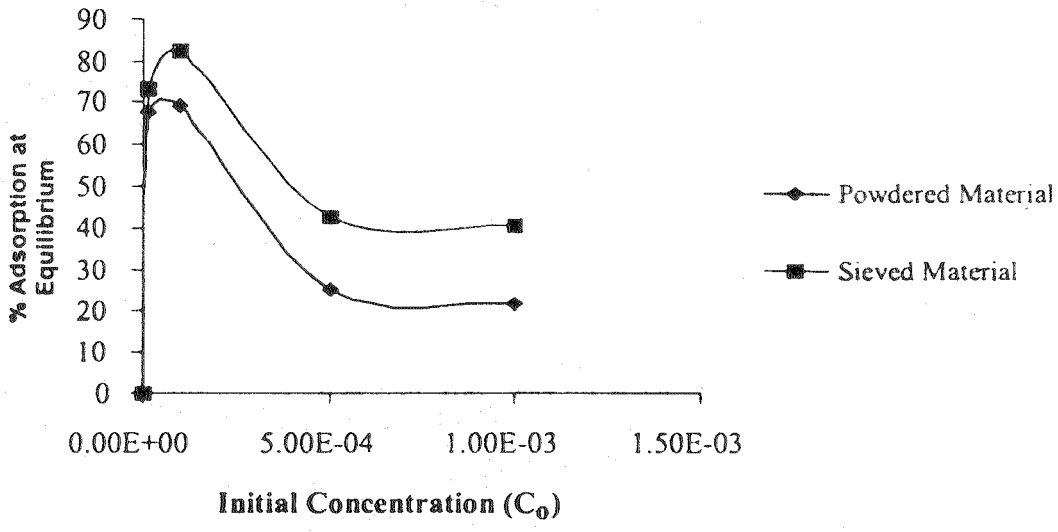

Fig. 3. Comparison of amount adsorbed of dyes on stalks of *Cicer arietinum* at equilibrium for powdered and sieved material (100 mg)

TABLE-4
COMPARISON OF AMOUNT OF DYES ADSORBED ON STALKS OF *CICER ARIETINUM* AT EQUILIBRIUM FOR POWDERED AND SIEVED MATERIAL (100 mg) INITIAL CONCENTRATION OF DYE 1E-04M

Material dose (mg)	% Adsorption at equilibrium in powdered material	% Adsorption at equilibrium in sieved material
50	63.65	81.45
100	67.64	82.71
200	81.22	86.62
500	84.55	90.69

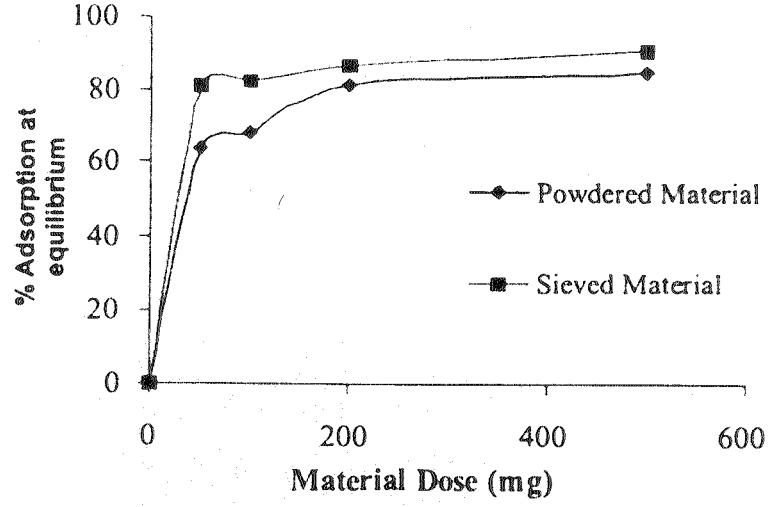

Fig. 4. Comparison of amount of adsorbed of dyes on stalks of *Cicer arietinum* at equilibrium for powdered and sieved material (100 mg)

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