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Research Paper

Removal of Basic Organic Dyes from Effluent Water of Dyeing and Printing Units Using Some Bio-Adsorbent

Chemistry

KEYWORDS: NL(Neem leaves) ; BBB(Black Berry Bark)

Jain J. K	Govt. P.G. College, Neem ka thana. Distt. Sikar
Shrivastava Neha	P.G. Department of Chemistry, Agrawal Post Graduate College, Jaipur

ABSTRACT

To remove colouring impurities from the effluent waste water of Sanganeri dyeing and printing units, a green approach has been made. We tried single viz; fine powder of Neem (Azadirachta indica) leaves powder and Blackberry(Syzygium cumini)bark powder as well as their varied proportions as mixed bio-adsorbents. The efficiency to remove colour and certain heavy metals from effluent water, the application of mixed bio-adsorbents proved to be more useful than the application of single bio-adsorbents. The results were justified by the measurement of optical density, conductivity and pH of the effluent water before and after treatment with adsorbents. The effectiveness of adsorption is further justified by Freundlich and Langmuir adsorption isotherms.

Introduction:
Textile dyeing & printing industries are the big sources for polluting the eco-friendly environment1. These industries discharge waste water in gallons daily. The effluent water of these industries contains huge amount of pollutant that include basic organic dyes and various hazardous metal ions which are used as mordant in these industries. Since these dyes are the major pollutant thrown by these textile and dyeing printing mills as effluents water therefore the effluent discharged from textile dyeing and printing industries contain low BOD and high COD. Disposal of this coloured water into receiving water bodies can be toxic to aquatic life2. The dyes upset the biological activity in the water bodies. They may be mutagenic, carcinogenic and can cause severe damage to human beings, such as dissfunctioning of kidney, reproductive system, liver, brain and central nervous system3-4 . The heavy metal complexes which are used as mordants are mostly of persistent5 nature as they are non-biodegradable6, non-photodegradable and have low tendency to oxidise by oxidising agents7.The treatment of dye based effluents are considered to be most challenging in the environmental fraternity and the industries.

Various treatment methods including physical, chemical, physico-chemical have been investigated8-12. Among the various available methods of colour removal, adsorption currently appears to offer good potential. The adsorption process can be pictured as one in which molecules of adsorbate are held on the solid surface of adsorbent by chemical and physical bonding. Activated carbon is quite expensive and its regeneration produces additional effluent and result in considerable losses (10-15%) of the adsorbent13.Several other materials have been investigated for the adsorption of dyes bearing effluents with varying success 14-23.But there is still a need to use new low cost, easily available and highly effective adsorbents for the colour removal from the industrial effluents so that industries can use adsorption process for treatment of their waste before the final disposal. In our present study we have used Neem (Azadirachta indica) leaves powder and Blackberry (Syzygium cumini) bark powder as these are easily available materials for the colour removal from the effluent water of Sanganeri dyeing and printing units.

SELECTDE SITE:
For this study, Sanganer town nearly 14 km south of Jaipur city (Pink city) has been selected. Jaipur is most important tourist centre of northen India and Sanganer is one of the famous areas in which textile dyeing and printing small scale indrustrial units are being run by local chippa community and also by others for nearly past one hundred years. These units are famous all over the India for Sanganeri printing textiles. The effluents of these units are being pounded to open places in small ditches at backyard of these printing units. Some of these units throw their effluents in small canals and finally are collected in small river.

Material and Methods
Adsorbent Material: Neem (Azadirachta indica) leaves and Blackberry (Syzygium cumini) bark were collected, and were washed with tap water to remove dirt and other particulate matter. They were dried in sunlight. The collected materials were grounded and sieved to get the particle size of 60-250 μm.

CONCENTRATION OF DYE: An accurately weighted quantity (10 mg) of red dye was dissolved in 1 liter distilled water to prepare the solution for experimental analysis.

Experimental Methods and Measurements
Batch adsorption studies were carried out by using different single adsorbents and their combinations in different proportions using amount of all single and mixed adsorbents is 2 gm/lit.

The measurements as optical density, pH, conductivity & TDS were taken by the Systronics-113, Systronics-MV VI and Toshiniwal TCM-15 respectively.

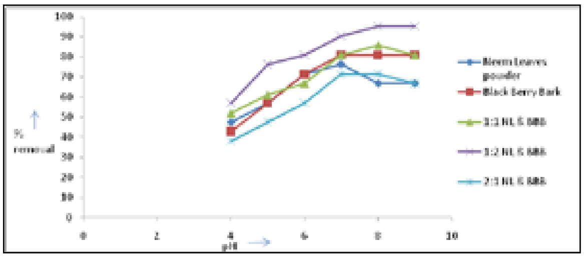
Results and Discussion

EFFECT OF PH:
The effect of pH on adsorption of dye solution is very important factor for controlling the adsorption of dye on to adsorbents. The optimum pH range for adsorption is 4.0 to 8.0 .The results obtained are summarized in Table 1 and Fig.: 1

Table: 1

S. No.	pH	% Removal				
		Neem Leaves	Black Berry Bark	1:1 NL & BBB	1:2 NL & BBB	2:1 NL & BBB
1.	4	47.62	42.85	52.09	57.15	38.09
2.	5	57.14	57.15	61.19	76.19	47.62
3.	6	71.42	71.43	66.67	80.95	57.14
4.	7	76.19	80.96	80.96	90.48	71.42
5.	8	66.66	80.96	85.72	95.24	71.42
6.	9	66.66	80.95	80.96	95.44	66.66

Figure-1
pH of dye solution Vs % Removal of dye



EFFECT OF CONTACT TIME
In the adsorption system contact time plays a vital role, irrespective of the other experimental parameters that affects the

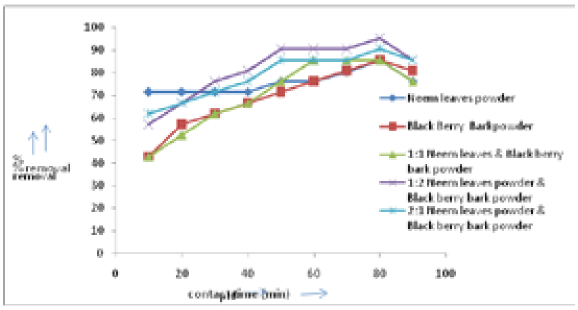
adsorption kinetics. The effect of contact time on the percent removal of dye was investigated at the optimum initial concentration of dye solution and the data are represented in Table 2 and Fig.:2.

It was found that the removal of dye increases with increase in contact time to some extent. The removal of dye by the adsorbents increases, reaches maximum value and then decreases with the increase in contact time (it may be due to desorption process). The relative increase in the extent of removal of dye (Qe) after 80 minutes of contact time is negligible and hence it is fixed as the optimum contact time.

Table: 2

S. No.	Contact Time (min)	% of Removal				
		NL Powder	BBB Powder	1:1 NL & BBB	1:2 NL & BBB	2:1 NL & BBB
1.	10	71.42	42.85	42.86	57.15	61.91
2.	20	71.42	57.15	52.36	66.67	66.67
3.	30	71.42	61.91	61.91	76.19	71.43
4.	40	71.42	66.67	66.67	80.95	76.20
5.	50	76.19	71.43	76.19	90.48	85.72
6.	60	76.19	76.20	85.20	90.48	85.72
7.	70	80.09	80.96	85.72	90.48	85.72
8.	80	85.71	85.72	85.72	95.24	90.78
9.	90	85.71	80.96	76.19	85.72	85.72

Figure-2
Contact time Vs % Removal of dye



Adsorption Isotherms: Adsorption isotherms are very useful to describe the interaction of dyes particles with different adsorbent surfaces and are useful to optimize the use of adsorbents for the colour removal. The equilibrium adsorption isotherm is one of the most important data to understand sorption mechanism. Several isotherm equations are available and two important isotherms are selected for the study which are Langmuir & Freundlich adsorption isotherms. Both Freundlich and Langmuir models were used for the evaluation of experimental results.

The Freundlich model is as follows:
qe = KfCe1/n

Freundlich adsorption in its usual logarithmic form is as following:

$$\log(q_e) = \frac{1}{n}\log(C_e) + \log k_f$$

Where log kf is a measure of the adsorption capacity and n is adsorption intensity. The function coefficient 1/n which should have values in the range of 0 to 1 for favorable adsorption. A plot of log qe v/s log Ce gives a slope of 1/n and intercept of log k shown in Fig.: 3. The value 1/n and k are calculated from slope and intercept respectively24 and are given in Table 3.

Langmuir Isotherm:

$$q = abCe/(1 + bCe)$$

Where the constant 'a' signifies the adsorption capacity (mg/g) and b is related to the energy of adsorption (1/mg). The linear plot of 1/qe v/s 1/Ce shows the adsorption follows Langmuir25 isotherm (Fig.: 4). Value of 'a' and 'b' were calculated from the slope and interact of the linear plots and are presented in Table 3.

Equilibrium parameters RL is represented as follows:

$$R_L = \frac{1}{(1 + bC_0)} \qquad \text{... (1)}$$

Where, C0 is initial dye concentration (mg/lit).

RL value obtained using equation (1) for 10 mg/lit dye concentration are 0.0620. RL values between 0 & 1 confirm that the adsorption isotherm is favorable. RL indicates isotherms shape and its favourable or unfavourable nature as per the criteria given below:

RL Values	Adsorption
RL > 1	Unfavorable
RL = 1	Linear
0 < RL < 1	Favorable
RL = 0	Irreversible

Table: 3

Adsorbents	Freundlich Coefficient				Langmuir Coefficient			
	Kf l/g	N	1/n	r2	a mg/g	b/mg	RL	r2
Neem Leaves powder	0.2565	9.009	0.111	0.9848	0.1276	0.210	0.9391	0.9658
Black berry Bark powder	0.4777	3.205	0.312	0.9301	0.1297	0.124	0.8526	0.9412
1:1 NL & BBB powder	0.4982	4.081	0.245	0.9892	0.4277	0.221	0.7882	0.9579
1:2 NL & BBB powder	0.2312	2.380	0.420	0.9904	0.0709	0.215	0.8840	0.9278
2:1 NL & BBB powder	0.2374	8762.000	0.500	0.8537	0.0969	0.230	0.8440	0.8602

FREUNDLICH ISOTHERMS
FIGURE -3(a)

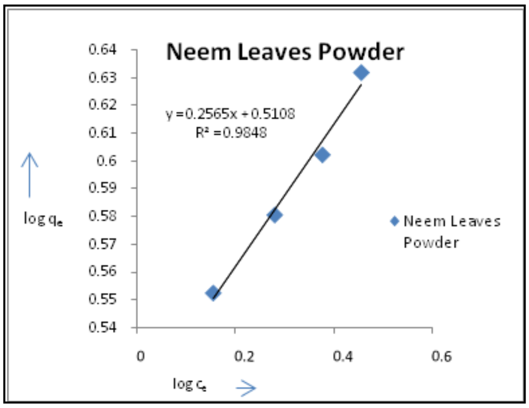


FIGURE -3(b)

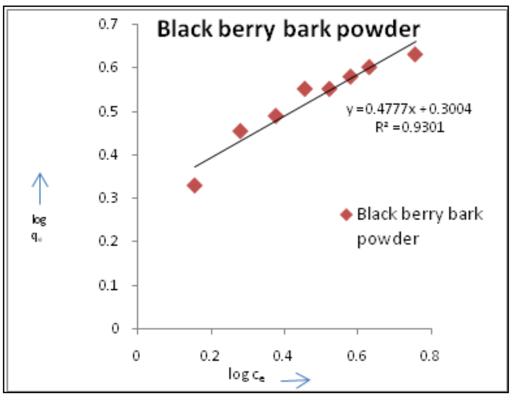


FIGURE 3(c)

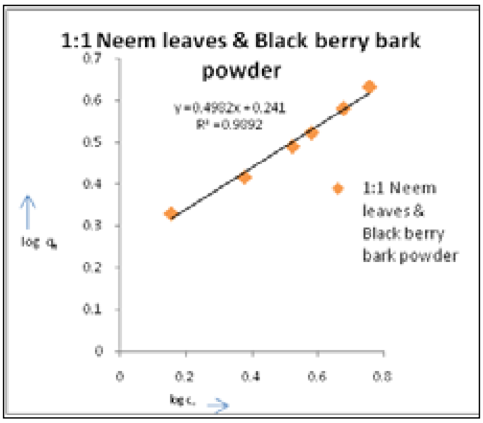


FIGURE 3(d)

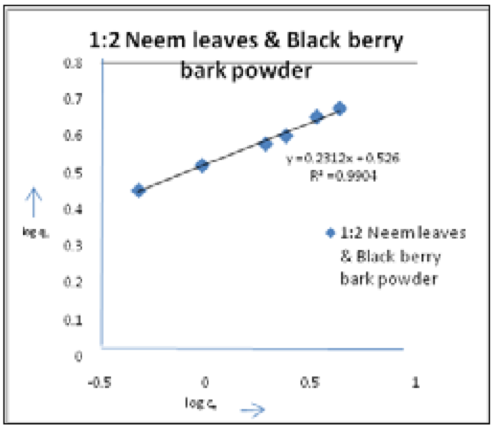
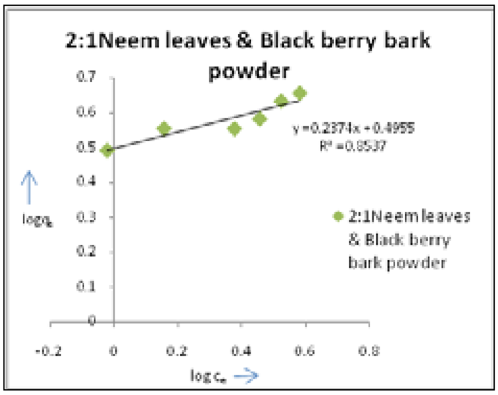
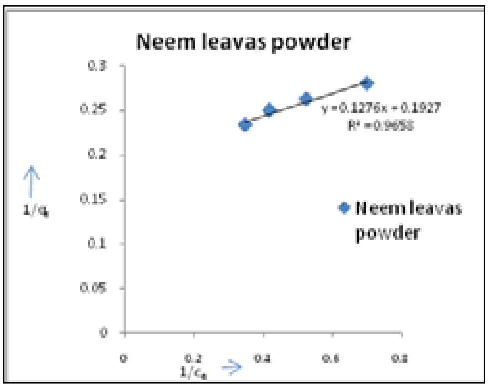


FIGURE -3(e)



LANGMUIR ISOTHERMS
FIGURE- 4(a)



3 FIGURE-4(b)

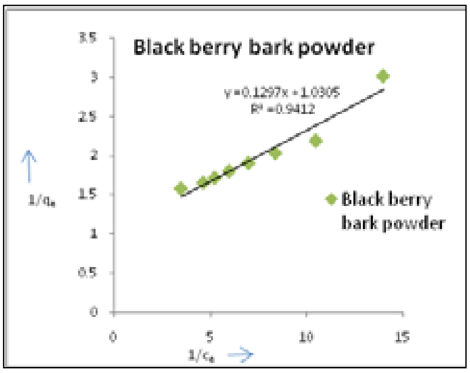


FIGURE-4(c)

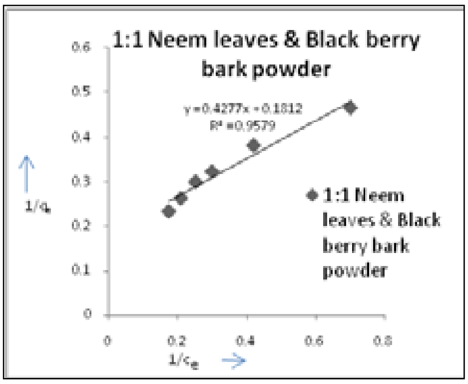


FIGURE-4(d)

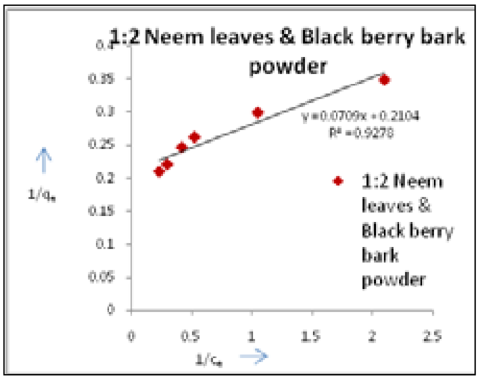
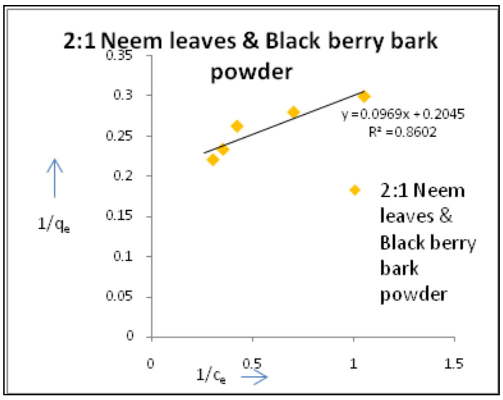


FIGURE-4(e)



We applied Freundlich as well as Langmuir isotherms for adsorption but Freundlich isotherm seems to fit more effectively than Langmuir isotherm as in evident from figure 3(a),3(c) & 3(d) and Table-3.

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Conclusion

The adsorbents used in the present study have proved to be very efficient and economical for removing colouring compounds from textile dyeing and printing industrial waste water. The substrate raw materials employed are widely available and inexpensive. The colour removal capacity of these adsorbents is appreciably high. Thus, it can be concluded that these alternative adsorbents seem to offer a very cheap and useful products for effective removal of colour from textile dyeing and printing effluents. It is also clear from the above data that mixed adsorbent give more effective and satisfactory results as compared to the single one.

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