INTERNATIONAL JOURNAL OF RESEARCH IN PHARMACY AND CHEMISTRY

Available online at www.ijrpc.com

Research Article

ADSORPTION OF MALACHITE GREEN DYE ONTO ACTIVATED CARBON OBTAINED FROM THE GLORIOSA SUPERBA STEM

C. Pragathiswaran[1*], N. Anantha Krishnan[2], B. Mahin Abbubakkar[1], P.Govindhan[1] and KA.Syed Abuthahir[3]

[1]Department of Chemistry, Periyar E.V.R College (Autonomous), Trichy-23 Tamilnadu, India.
[2]Department of chemistry, Saranathan College of Engineering Panjappur, Trichy, Tamilnadu, India.
[3]Department of Chemistry, Dr.Zakir Hussain College, Ilyangudi -630 702, Tamil Nadu, India.

ABSTRACT
The present work deals with adsorption of Malachite Green (MG) dyes carried out in the presence of Activated Gloriosa Superba stem Carbon (AGSC). Various parameters such like the effect of initial concentration, contact time have been studied. The result reveals when the amount of adsorbent increases, the percentage removal of dye also increases. The applicability of Freundlich and Langmuir adsorption isotherms has also been tested.

Keywords: Adsorption, Malachite Green (MG), Activated Gloriosa Superba stem Carbon (AGSC).

1. INTRODUCTION
Dyes are commonly used in different industries like paper, textile, plastic, food, cosmetics and coloring industries. These industries commonly use synthetic dyestuff as a colorant. $7x10^5$ tones of dye stuff are being produced annually [1,2]. The discharge of dye containing waste water poured into the environment contaminated surface water and ground water. The dyes in the waste water even at a very low concentration affect the aquatic life and human health by polluting the environment. The toxicity and carcinogenicity have lead to exploration of possible detoxicants [3, 4]. The present study tries to evaluate the efficiency of an activated gloriosa superba adsorbent in the removal of malachite green dyes from dye solution.

2. Experimental methods
2.1 Adsorbent
Gloriosa superba stem is collected from the nearby Trichy district has carbonized with concentrated sulphuric acid and washed with water and activated around 1000°C in a muffle furnace for 6 hrs then it has been taken out and stored in a vacuum desiccators.

2.2 Adsorbate
The stock solution of malachite green concentration 1000 mg/L is prepared by dissolving 1 g of malachite green in 1000 ml of double distilled water. Different concentration of dye solutions which

begin from the range of (50 to 250 mg/L) have been prepared from the stock solution by appropriate dilution.

2.3 Batch adsorption experiments

Batch adsorption is being tested by adding 25 mg of AGSC to 50 ml of the MG dye solution of different initial concentration (50 to 250 mg/L) at a particular pH. The experiment has been carried out by using a wrist action shaker for a period of 180 min and 120 rpm using 250 ml stopper glass flasks at (30^oC to 60^oC). The residual concentration of dyes in each sample after adsorption at different time intervals have determined by UV-Visible spectrophotometer. The equilibrium q_e (mg/g) is calculated by the following mass balance principle.

$$q_e = (C_0 - C_e) V/M \quad \ldots\ldots (1)$$

Where C_0 and C_e are the initial and equilibrium concentrations (mg/L) of dyes, V is the volume (L), M is the weight (g) of the adsorbent. The removal efficiency of the adsorbents on dyes is being calculated by using the following expression.

$\%R = (C_0 - C_t) \times 100/C_0$ …………………. (2).

3. RESULTS AND DISCUSSION

3.1 Effect of contact time and initial dye concentration

The experiment results of adsorption of various dye concentrations with contact time are shown in table 1 and figure.1. This figure 1 shows that the % removal initially increases and reaches the limiting value. So that the equilibrium have been constituted within 50 minutes. Hence all the remaining experiments are also carried out at 50 minutes.

Table 1: Percentage removal of MG with contact time

Time (in min)	Removal %
10	52
20	72
30	81
40	89.5
50	90
60	90.2

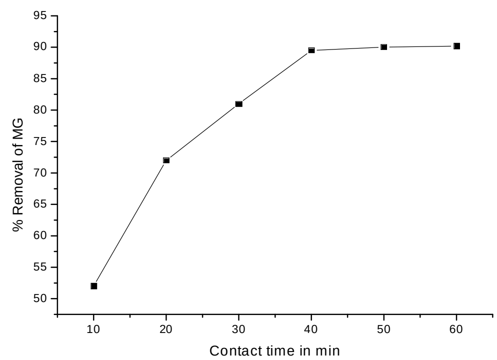


Fig. 1: Effect of contact time on the removal of MG dye [MG]=50mg/L; Temp:30^0C; Adsorbent dose=25mg/50ml.

The equilibrium data is given in Table.2 reveals that, the percentage removal has decreases with an increase in initial dyes concentration. This happen due to the number of available active sites have been remain constant but the initial concentration of dyes increases, so that % removal decreases [5,6].

Table 2: Equilibrium parameter for the adsorption of MG dye onto AGSC

MG (mg /L)	Ce (mg / L)				Qe (mg / g)				% Removal of MG dye			
	30°C	40°C	50°C	60°C	30°C	40°C	50°C	60°C	30°C	40°C	50°C	60°C
50	2.6911	2.3383	2.0370	1.8501	94.618	95.3234	95.926	96.2998	94.618	95.3234	95.926	96.2998
100	12.740	11.246	9.2337	7.7914	174.52	177.508	181.5326	184.4172	87.260	88.754	90.7663	92.2086
150	28.504	25.175	21.978	19.156	242.99	249.65	256.044	261.688	80.9973	83.2166	85.348	87.2293
200	55.448	51.229	21.978	42.394	289.1040	297.542	356.044	315.212	72.276	74.3855	89.011	78.803
250	86.524	81.183	46.794	70.942	326.9520	337.634	406.412	358.116	65.3904	67.5268	81.2824	71.6232

3.2 Adsorption isotherm studies

The most commonly used isotherms, Freundlich and Langmuir isotherms are used in this study to quantify the sorption capacity of the absorbent in the removal of dyes.

3.2.1 Freundlich isotherm

Linear form of Freundlich isotherm model [7] is represented by the equation

$\log q_e = \log k_f + 1/n + \log C_e$ ……………………….(4)

Where q_e is the amount of dyes adsorbed per unit weight of the adsorbent (mg/g) K_f is the measure of adsorption capacity and 1/n is the adsorption intensity. The value of K_f and n are calculated from the intercept and slope of the plot of log Q_e Vs log C_e respectively. The graphs are shown from figure 2 to 5 indicates the freundlich model and the values are given in tables from 3 The constant K_f and n values are given in Table. 3. In general, the K_f value increases when the given adsorbate increases. The magnitude of the exponent 1/n gives an indication in the favorability of adsorption. The value of n > 1 represents a favorable adsorption condition [7] (or) the value of n are in the range of 1 to 10 confirms the favorable condition for adsorption. The adsorption co-efficient k_f of MG dye on AGSC is being found from 68.1239 to 82.3379 L/g. The K_f value indicates that the saturation time for adsorption of dyes is attained rapidly due to the high affinity of AGSC towards the adsorbate. The values of n are in the range of 2.7662 to 2.7540 (mg/L) for MG dyes adsorption. So Freundlich isotherm is suitable for this adsorption. The K_f values also indicate the multilayer adsorption is possible. This reveals that the activated Gloriosa Superba has more efficiency in the removal of MG dyes.

Table 3: Freundlich isotherm parameter for adsorption of MG dye onto AGSC

Temperature (°C)	Freundlich parameter		
	K_f	n	R^2
30	68.1239	2.7662	0.9906
40	72.5771	2.7723	0.9880
50	67.4838	2.1132	0.9389
60	82.3379	2.7540	0.9665

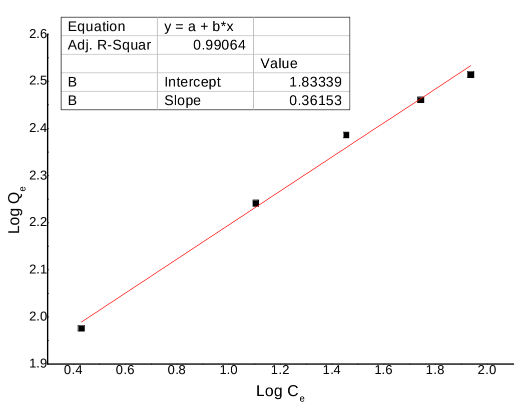


Fig. 2:

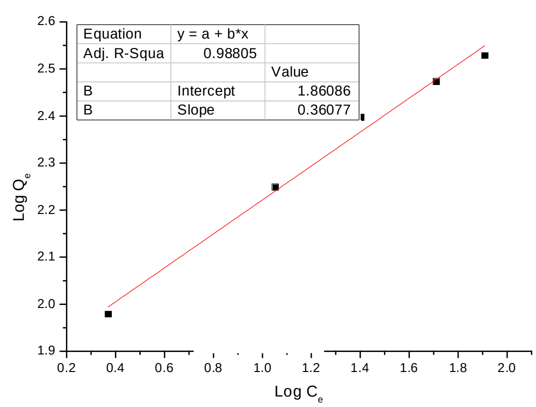


Fig. 3:

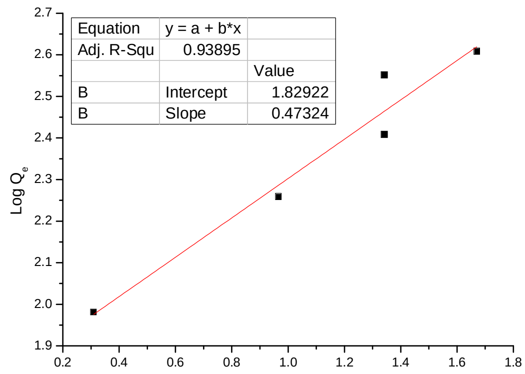


Fig. 4:

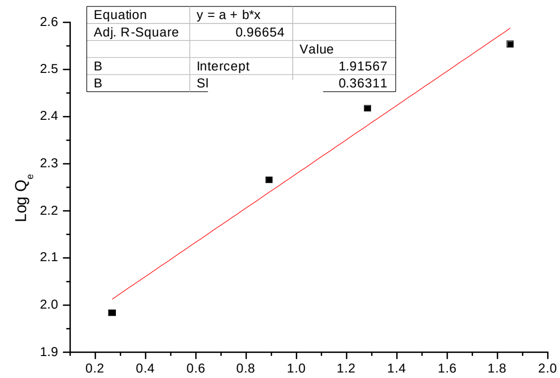


Fig. 5:

Fig. 2,3,4,5: Langmuir isotherm parameter for adsorption of MG dye on to AGSC

3.2.2 Langmuir isotherm

The Langmuir isotherm model [8] is based on the assumption that maximum adsorption corresponds to a saturated monolayer of solute molecules on the adsorbent surface. The linear form of the Langmuir isotherm equation can be described as

$$C_e/q_e = (1/Q_m b) + (C_e/Q_m) \quad .....(5)$$

Where C_e (mg/L) is the equilibrium concentration of the dye, q_e (mg/g) is the amount of dye per unit weight of adsorbent, Q_m and b are Langmuir constants related to adsorption capacity and rate of adsorption respectively.

Q_m is the amount of dye in a complete monolayer coverage (mg/g) which gives the maximum adsorption capacity of the adsorbent and b (L/mg) is the Langmuir isotherm constant that relates to the energy of adsorption or rate of adsorption. The linear plot of C_e/Q_e against the equilibrium concentration C_e shows the Langmuir model and the figures are shown from 6 to 9 . The Langmuir constant Q_m and b are determined from the slope and intercept of the Langmuir plot and these values are given in Table.4.

Table 4: Langmuir and Freundlich isotherm parameter for adsorption of MG dye onto AGSC

Temperature (°C)	Langmuir parameter		
	Q_m	b	R^2
30	370.3703	0.0833	0.9894
40	384.6153	0.0918	0.9900
50	526.3157	0.0722	0.8792
60	400	0.1207	0.9937

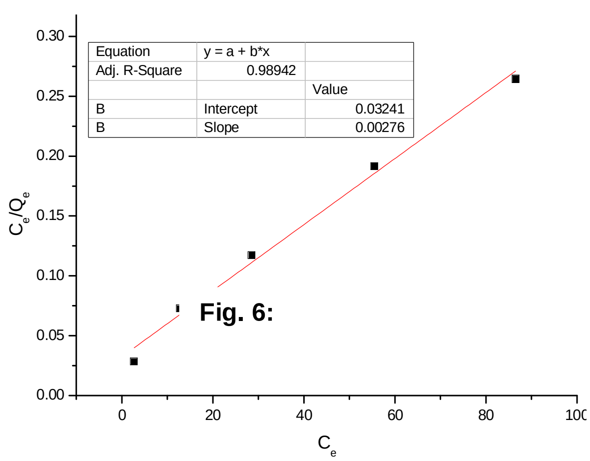


Fig. 6:

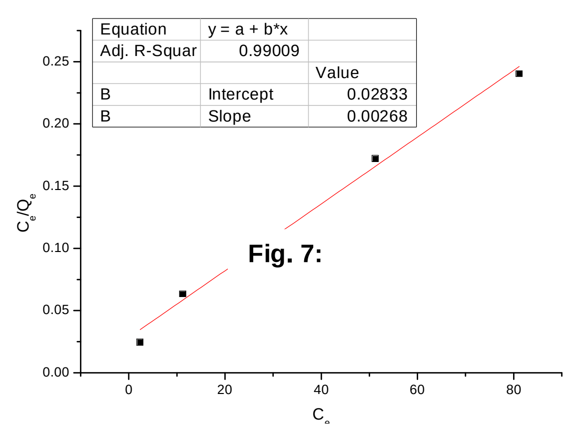
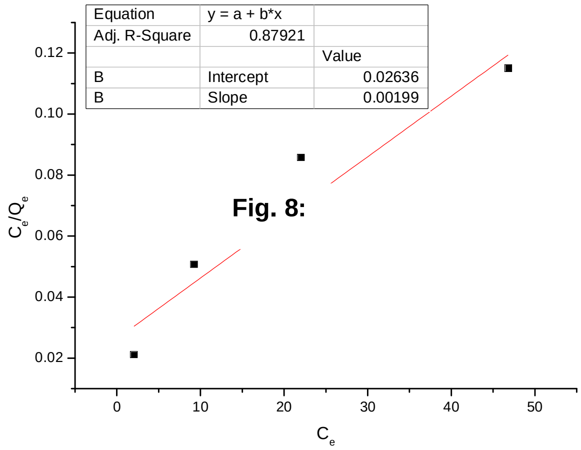


Fig. 7:



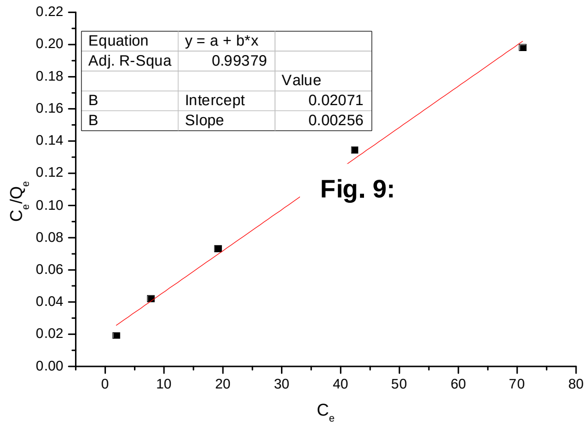


Fig. 6,7,8,9: Freundlich isotherm parameter for adsorption of MG dye on to AGSC

The feasibility of the Langmuir isotherm can also be expressed in terms of the dimensionless constant separation factor R_L [9] by the equation

$$R_L = \frac{1}{1+bC_0} \quad \text{..................(6)}$$

Where C_0 (mg/L) is an initial concentration of adsorbent and b (L/mg) is Langmuir isotherm constant. The parameter R_L indicates the nature of the isotherm.

$R_L > 1$ unfavorable
$R_L = 1$ Linear
$0<R_L< 1$ Favorable
$R_L= 0$ Irreversible

The R_L values lies between 0 and 1 indicate a favorable adsorption in all initial concentration study. The calculated R_L values appear within the range of 0.0458 to 0.1936. So the adsorption of MG follows the Langmuir isotherm.

CONCLUSION

The adsorption characteristics of MG dye onto Activated Gloriosa Superba are strongly affected by the initial dye concentration. The R_L values and other adsorption parameters indicate both Langmuir and Freundlich isotherms favorable for AGSC adsorption.

REFERENCES

1. Pearce CI. The removal of colour from textile waste water using whole bacterial cells review, Dyes and Pigments. 2003;58:179-196.
2. McMullan G. Mini- review: Microbial decolourisation and degradation of textile dyes, Appl, Microbiol. Biotech. 2001;56:81-87.
3. Clarke EA and Ankiler R. The handbook of environment chemistry Part A-Anthropogenic compounds. 1980;3.
4. Bughman G and Perenich TA. Fate of dyes in aqueous systems Solubility and partitioning of some hydrophobic dyes and related compounds. J Env Toxicol Chem. 1988;7:183-199.
5. Namasivayam C, Munisamy N, Gayathri K, Rani M and Renganathan K. Biores Technol. 1995;57:37. Namasivayam C and Yamuna RT. Environ pollut. 1995;89(1):1-7.
6. Frendlich H. The dye adsorption is losungen (Adsorption in Solution). Z Phys Chem. 1906;57:385 – 470.
7. Langmuir I. The adsorption of gases plane surfaces of glass, mica and platinum. J Am Soc. 1918;579:1361–1403.
8. Weber TW and Chakravorti RK. Pore and Solid diffusion models for fixed bed adsorbers. J Am Inst Chem Eng. 1974;20:228.
9. McKay G, Blair HS and Gardner JR. Adsorption of dyes on chitin. I. Equilibrium Studies. J. Appl Polym Sci. 1982;27:3043–3057.