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Research Article

ADSORPTION OF METHYLENE BLUE DYE USING ACTIVATED CARBON FROM THE GLORIOSA SUPERBA STEM

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ABSTRACT

The analysis of this work was to research the removal of methylene blue dyes from solution by using Acid Gloriosa Superba stem Carbon (AGSC). Generally, dyes are organic compounds used as colouring products in chemical, textile, paper, printing, leather, plastics and varied food industries. The requirement for the treatment of dye contaminated waste water passed out from the trade. During this study, acid gloriosa superba stem carbon was studied for its potential use as associate degree adsorbent for removal of a cationic dye methylene blue. The assorted factors poignant surface assimilation, like initial dye concentration, contact time, adsorbent dose and result of temperature were evaluated. The equilibrium of surface assimilation was shapely by the Langmuir and Freundlich isotherm models. The scope of this work suggests the AGSC is also utilized as a low cost adsorbent for methylene blue dye removal from aqueous solution.

Keywords: Acid Gloriosa Superba stems Carbon (AGSC), Methylene blue, Adsorption isotherm.

1. INTRODUCTION

Dyes square measure wide used, usually within the textiles, plastics, paper, leather, food business to paint product. In method of laundry and finishing colored product, waste water contaminated with dyes is generated. The contaminated waste waters square measure dangerous, which may be a nice threat to atmosphere[1-3]. Dye contamination in waste material causes issues in numerous ways: the presence of dyes in water, even in terribly low quantities, is extremely visible and undesirable; color interferes with penetration of daylight into waters; retards photosynthesis; inhibits the expansion of aquatic aggregation and interferes with gas solubility in water bodies. These materials square measure the sophisticated organic compounds and those they resist against light, laundry and microorganism invasions[4-7]. The requirement for the treatment of dye contaminated waste water arose from the environmental impact[8]. Activated minerals square measure one amongst the foremost widespread adsorbents used for the removal of deadly substances from waste water. This might be associated with their extended extent[9]. The key use of AGSC is in resolution purification and for the removal of color, odors and alternative unpleasant impurities from liquids, water supplies and vegetable and animal oils.

In recent years it's been more and more used for the bar of environmental pollution and environmental condition laws have augmented the sales of affordable activated minerals for management the of air and pollution. Varied techniques like precipitation, natural process, chemical reaction and surface assimilation are used for the removal of venomous waste product from, wastewater. Methylene Blue (MB) is chosen as a model compound for evaluating the potential of AGSC to get rid of dye from solution.

2. MATERIALS AND METHODS
2.1 Adsorption studies
Methylene blue (MB) was used for the adsorbate within the adsorption experiments. Adsorption from the liquid section was administrated to verify the character the consistency and therefore the capacities of the samples. A solution with quantity 50-250 mg/L was ready by intermixture an approximate amount of MB with distilled water. Adsorption experiments were conducted by putting 0.025 g of the AGSC samples and 50 mL of the aqueous solution in a exceedingly 250 ml of glass-stoppered flask. The flask was then place in an exceedingly constant-temperature shaker bath with a shaker speed of 150 rpm. The isothermal adsorption experiments were carried out at 30 ±2°C.

2.2 Preparation of adsorbent materials
The poisonous plant Stem collected from agricultural space close Trichy district was with sulphuric acid and washed with water and activated around 1000°C in a muffle furnace for 4 hrs then it had been taken out, ground well to fine powder and kept in a vacuum desiccators.

2.3 Preparation of Adsorbate
Methylene blue was chosen during this work due to its robust surface assimilation onto solids and it recognized quality in characterizing adsorptive material stain is utilized to judge the surface assimilation characteristics of carbon. A famed weight of a 1000 mg of MB was dissolved in concerning one liter of water to urge the stock solution.

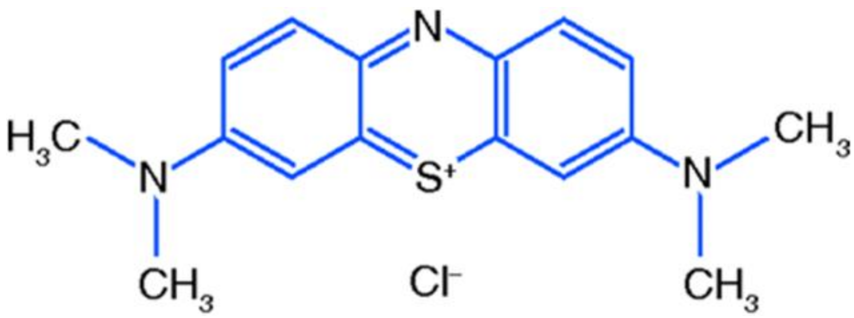

Fig. 1: Structure of Methylene Blue

2.4 Batch equilibrium method
The adsorption experiments were distributed during a batch method at 30, 40, 50 and 60˚C. A known weight of AGSC was added to 50 mL of the dye solutions with associate initial concentration of 50-250 mg/L that is ready from a 1000 mg/L of stock solution. The contents were agitated completely employing a mechanical shaker with a speed of 150 rpm. The solution was then filtered at present time intervals and also the residual dye concentration was measured.

4. RESULT AND DISCUSSIONS
4.1 Characteristics of the adsorbent
Acid Gloriosa superba stem is an efficient adsorbent for the abatement of the many waste material compounds (organic, inorganic, and biological) of concern in water and wastewater treatment. Most of the solid adsorbents possess small porous and fine structure, high surface assimilation capacity, high surface area and high degree of surface, which consists of pores of various sizes and shapes. The wide quality of AGSC may be a result of their specific extent, high chemical and mechanical stability. The chemical nature and pore structure typically determines the adsorption activity. The physico-chemical properties of the chosen adsorbent area unit listed in Table 1.

Table 1: Characteristics of the Adsorbent

Properties	AGSC
Particle size(mm)	0.0115
Density (g/cc)	0.2235
Moisture content (%)	0.2157
Loss in ignition (%)	0.0217
pH of aqueous solution	6.500

4.5. Adsorption isotherms

4.5.1 The Freundlich isotherm

The Freundlich isotherm model is that the earliest far-famed equation describing the adsorption method. It associate in nursing empirical equation and may be used for non-ideal natural process that involves heterogeneous surface assimilation. The Freundlich equation was used for the adsorption of MB dye on the adsorbent. The Freundlich isotherm was expressed by the following equation

$$\log Q_e = \log K_f + 1/n \log C_e \ \ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Where Qe is that the quantity of MB dye adsorbed (mg/g), C_e is the equilibrium concentration of dye in solution (mg/L), and K_f and n area unit constants incorporating the factors affecting the adsorption capability and intensity of adsorption, respectively. Linear plots of log Q_e vs log C_e shows that the adsorption of MB dye obeys the linear plots of Freundlich adsorption isotherm. The graphs are shown from Figure 2 to 5 and the values are given in Table 2to 5.The values of K_f and n are given in Table 6 shows that the rise of negative charges on the adsorbent surface makes electrostatic force like Vanderwaal's between the AGSC surface and dye ion. The relative molecular mass and size either limit or increase the chance of the adsorption of the dye onto adsorbent. However, the values clearly show the dominance in adsorption capability. The intensity of adsorption is a sign of the bond energies between dye and adsorbent, and therefore the risk of slight chemisorptions instead of physisorption[10,11]. However, the multilayer adsorption of MB through the percolation method is also attainable. The values of n are less than one, indicating the physisorption is way additional favorable[12,13].

Table 2: Freundlich at 30^0C

Log C_e	Log Q_e
0.3756	1.9788
1.0508	2.2492
1.4006	2.3973
1.6896	2.4801
1.8828	2.5406

Table 3: Freundlich at 40^0C

Log C_e	Log Q_e
0.3146	1.9816
0.9967	2.2556
1.3467	2.4074
1.6552	2.4907
1.8552	2.5523

Table 4: Freundlich at 50^0C

Log C_e	Log Q_e
0.2547	1.9840
0.9111	2.2641
1.2877	2.4169
1.2877	2.5577
1.6159	2.6205

Table 5: Freundlich at 60^0C

Log C_e	Log Q_e
0.2129	1.9855
0.8373	2.2700
1.2280	2.4251
1.5730	2.5121
1.7966	2.5737

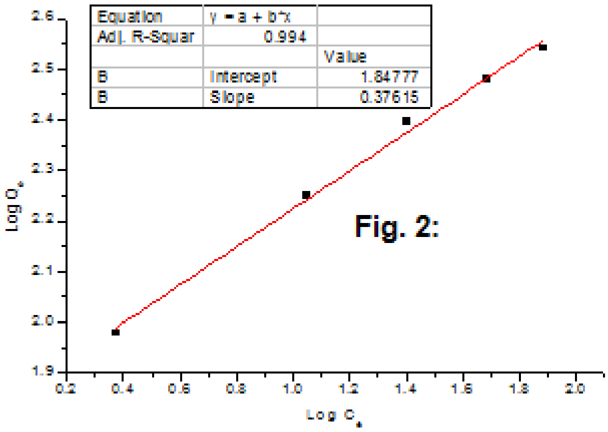

Fig. 2:

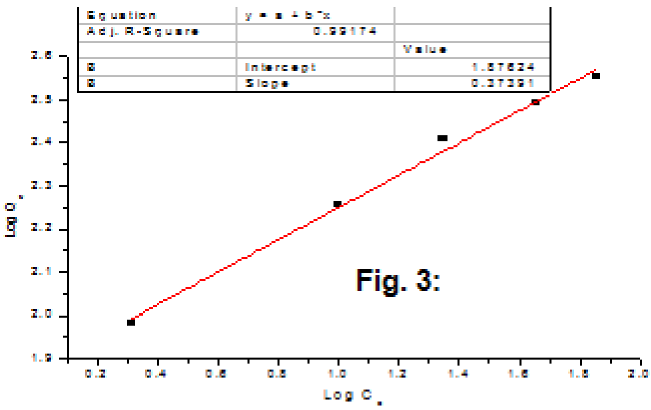

Fig. 3:

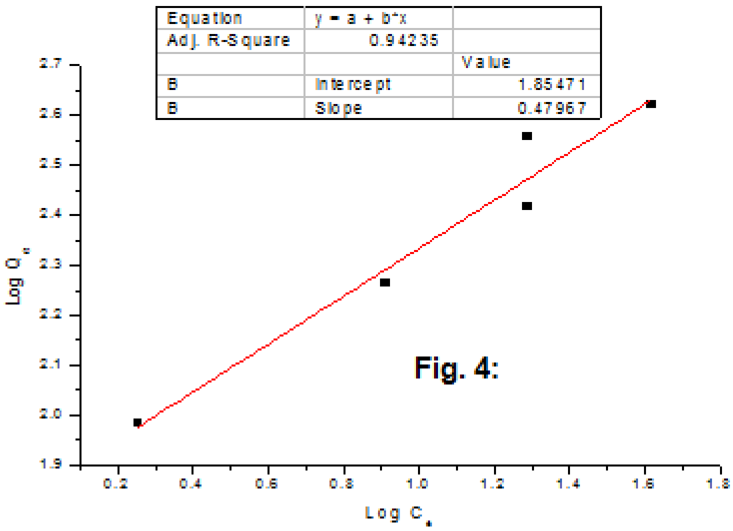

Fig. 4:

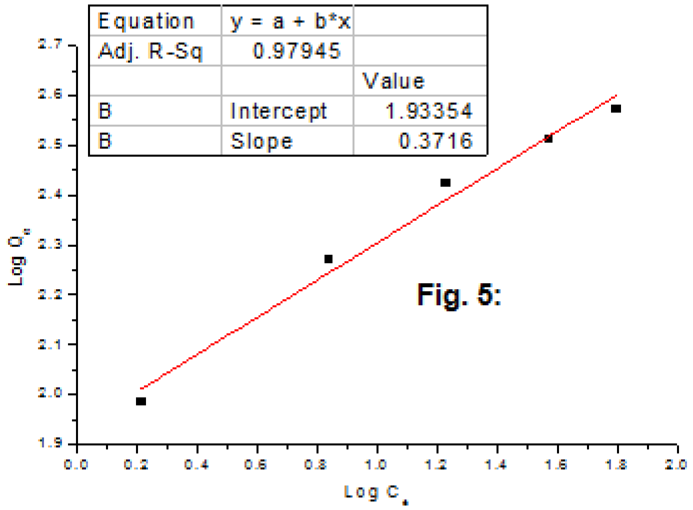

Fig. 2, 3, 4, 5: Freundlich isotherms for adsorption of MG dye on to AGSC

Table 6: Freundlich isotherm parameter for adsorption of MB dye on to AGSC

Temperature (°C)	Freundlich parameter		
	K_f	n	R^2
30	70.4206	2.6588	0.9940
40	75.1969	2.6745	0.9917
50	71.5648	2.0850	0.9423
60	85.8025	2.6910	0.9794

4.5.2 Langmuir isotherm

The theoretical Langmuir isotherm is employed for adsorption of a solute from a liquid solution as monolayer adsorption on a surface containing a finite range of identical sites. Therefore, the Langmuir isotherm model was chosen for estimation of the most adsorption capability such as complete monolayer coverage on the adsorbent surface. The Langmuir isotherm non-linear equation is often expressed as follows:

$$C_{eq}/Q_{eq} = 1/Q_m b + C_{eq}/Q_m \text{ .... (2)}$$

Where C_{eq} is that the equilibrium concentration of adsorbate in the solution (mg/L), Q_{eq} is that the quantity adsorbed at equilibrium (mg/g), Q_m and b are Langmuir constants associated with adsorption potency and energy of adsorption respectively. The linear plots of C_{eq}/ Q_{eq} vs. C_{eq} counsel the applicability of the Langmuir isotherms. The graphs are shown from Figure 6 to 9 and the values are given in Table 7 to 10. The values of Q_m and b were calculated from slope and intercepts of the plots are given in Table 11. From the results, it is obvious that the worth of sorption potency Q_m and adsorption energy b of the AGSC will increase on increasing the temperature. The values will conclude that the most adsorption corresponds to a saturated monolayer of adsorbate molecules on adsorbent surface with endothermic nature of sorption[14]. To verify the favorability of the adsorption method, the separation factor (R_L) decided and given in Table 12. The values were established to be between 0 and 1 and make sure that the continuing adsorption method is favorable[15].

Table 7: Langmuir at 30^{0}C

C_e	C_e/Q_e
2.3750	0.0249
11.243	0.0633
25.156	0.1007
48.936	0.1619
76.361	0.2198

Table 8: Langmuir at 40^{0}C

C_e	C_e/Q_e
2.0637	0.0215
9.9251	0.055
22.218	0.0869
45.212	0.146
71.648	0.2008

Table 9: Langmuir at 50^{0}C

C_e	C_e/Q_e
1.7977	0.0186
8.1492	0.0443
19.397	0.0742
19.397	0.0537
41.298	0.0989

Table 10: Langmuir at 60^{0}C

C_e	C_e/Q_e
1.6328	0.0168
6.8763	0.0369
16.9060	0.0635
37.4140	0.1150
62.6100	0.1670

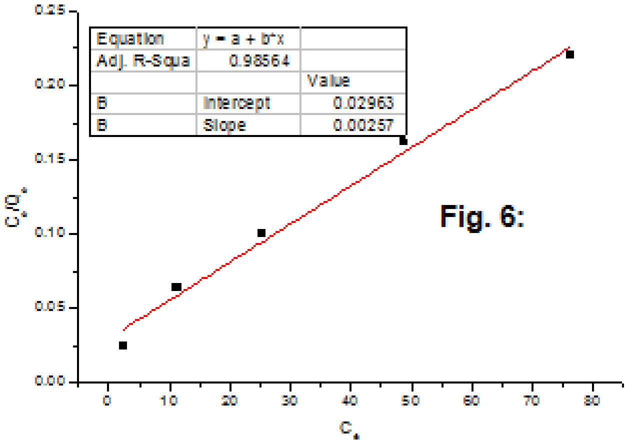

Fig. 6:

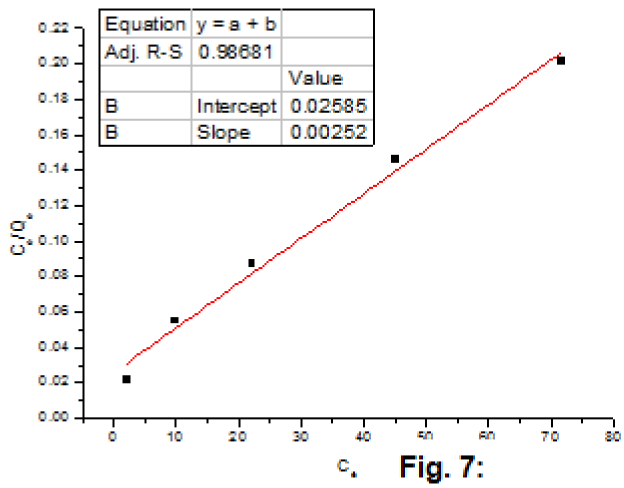

Fig. 7:

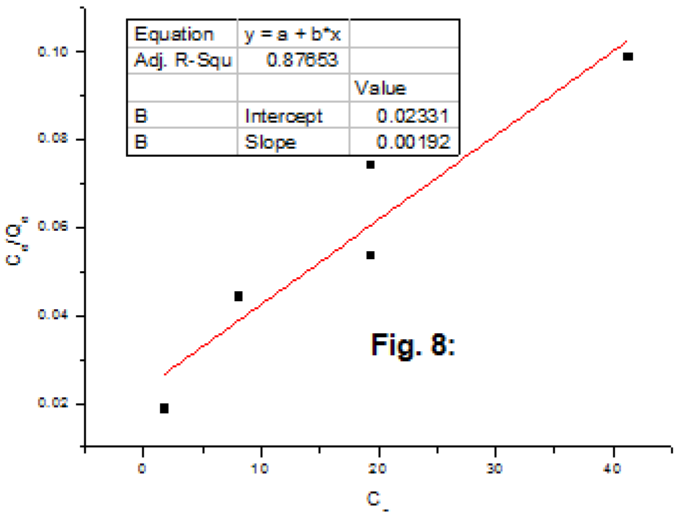

Fig. 8:

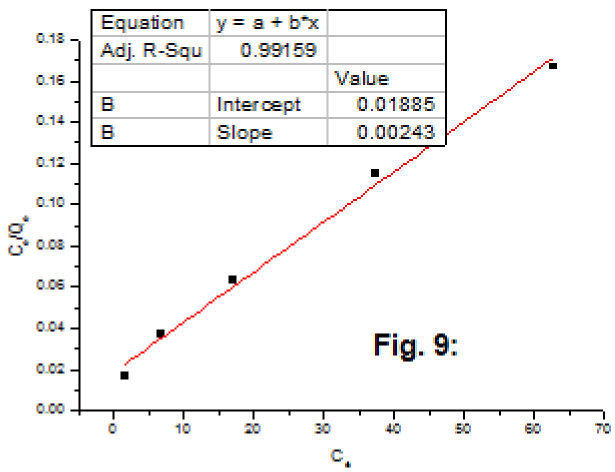

Fig. 9:

Fig. 6, 7, 8 and 9: Langmuir isotherms for adsorption of MG dye on to AGSC

Table 11: Langmuir isotherm parameter for adsorption of MB dye on to AGSC

Temperature (°C)	Langmuir parameter		
	Q_m	B	R^2
30	389.1050	0.0868	0.9856
40	396.8253	0.0976	0.9868
50	520.8333	0.0824	0.8765
60	411.5226	0.1292	0.9915

Table 12: Dimensionless separation factor (R_L) for adsorption of MB dye onto AGSC

C_0 (mg/L)	Temperature (°C)			
	30	40	50	60
50	0.1872	0.1700	0.1953	0.1340
100	0.1033	0.0929	0.1082	0.0718
150	0.0713	0.0639	0.0748	0.0490
200	0.0544	0.0487	0.0572	0.0372
250	0.0440	0.0393	0.0462	0.0309

5. CONCLUSION
The present study has shown the effectiveness of using AGSC is the removal of MB dye from aqueous solutions. Acid Gloriosa Superba stem in numerous forms contains a great role in trendy life to clean surroundings. Gloriosa Superba stem is often sensible precursors for manufacturing extremely porous Acid Gloriosa Superba stem by easy preceding strategies. An adsorption check has been administrated for industrial pollutants (MB dye) below different experimental conditions in batch mode. The experimental optimized for Langmuir isotherm and Freundlich isotherm the result can be confirmed by Freundlich isotherms favorable.

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