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Contributed Paper

Preparation of Eco-friendly and Low-cost Activated Carbon from *Gracilaria corticata* Seaweeds for the Removal of Crystal Violet Dye from Aqueous Solution: Equilibrium and Modeling Studies

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ABSTRACT

In this paper, a compatible, eco-friendly and low-cost activated carbon prepared from the *Gracilaria corticata* seaweed materials was used for the effective removal of crystal violet dye in an aqueous solution. FTIR spectroscopy was used to detect the presence of functional groups such as hydroxyl and carboxyl and other groups. Morphological studies were carried out using SEM and EDX analysis while the physical nature of the material was analysed with XRD pattern studies. The batch mode dye adsorption properties of activated carbon as a function of dosage, solution pH, initial dye concentration, temperature, and contact time were investigated. Freundlich and Langmuir adsorption isotherms were used to calculate the uptake capacity of dye removal at equilibrium condition and also for evaluating the dimensionless separation factor (R_L). The adsorption data evaluated using Freundlich and Langmuir adsorption isotherm equations confirm that Langmuir was the most fitted model as compared to Freundlich. The adsorption dynamics was predicted with Lagergren's pseudo-first order and pseudo-second order equations and intra particle diffusion model. The adsorption dynamic results show that the adsorption process follows pseudo-second order kinetics and the adsorption process depends on both time and concentration. Thermodynamic parameters, like standard Gibbs energy (ΔG^0), enthalpy (ΔH^0), and entropy (ΔS^0), were determined for assessing the feasibility of the adsorption process. Enthalpy ΔH^0 shows a positive value, indicating that the adsorption process is endothermic in nature, while the negative value of the Gibbs free energy change ΔG^0reveals that at different temperatures the adsorption process was spontaneous in nature and the positive value of ΔS^0 confirms the increasing randomness between the solid-solution boundaries throughout adsorption. The experimental and correlation results revealed that the activated carbon prepared from *Gracilaria corticata* seaweeds, proved to be an excellent and low-cost adsorbent material for the dye removal.

Keywords: adsorption, gracilaria corticata, activated carbon, modelling, crystal violet

1. INTRODUCTION

During the past few decades, the production of dyes and pigments have been increasing due to the rising needs of the textile, paper, plastics, paints, leather, rubber, food, drug and cosmetics industries [1].These industries are the major producer of wastewater into the aquatic environment such as rivers, lakes and marine water. The colored effluents released from the wastewater of these industries cause water pollution that are harmful to the aquatic life. Most of the released dyes are highly stable to thermal degradation, photo-degradation, biodegradation and oxidizing agents, due to their complex aromatic molecular structure [2]. Moreover some dyes are highly toxic and cause acute and chronic disorders to aquatic organisms. Uptake of industrial effluents through food chain in aquatic organisms and human beings may cause various chromosomal fractures, respiratory, mutagenic and carcinogenic problems [3]. Therefore it becomes essential that the wastewater containing dyes must be properly treated before being discharged into the water bodies.

Currently various methods are employed for the treatment of wastewater containing dyes and are based on the principles of filtration, precipitation, coagulation, chemical oxidation, sedimentation, osmosis, ion exchange, adsorption etc. [5]. Among these, adsorption is an effective process for dye removal due to its low cost, ease of operation, high adsorption capacity and eco-friendly nature [6, 7].Numerous novel adsorbents, such as natural minerals [8], bio-adsorbents [9], agricultural waste products [10], activated carbon [11] have been used by several researchers. Among the adsorbent materials, activated carbon is used for the efficient removal of various dyes from aqueous solutions due to their high adsorption capacity, high degree of porosity and extensive surface area [12]. Unfortunately, commercial activated carbon has some disadvantages like high cost, poor desorption and difficulties in regeneration [13]. Therefore, it is of great importance to develop cost-effective and environmental friendly activated carbon prepared from various locally available biomaterials which would make them good sources for the adsorption process.

In the present work, the focus is on the preparation of low-cost activated carbon from a seaweed waste biomass material *Gracilaria corticata*. The seaweed was collected from the seashore area of Rameshwaram which is one of the world's richest marine biodiversity regions and the first marine biosphere reserve in South East Asia [14].

The survey of literature had shown that, activated carbon prepared from *Gracilaria corticata* has not been used as an adsorbent material especially for the removal of crystal violet dye. Therefore in this study *Gracilaria corticata* activated carbon was chosen for the removal of crystal violet dye from aqueous solution by using batch mode study. Crystal violet is a cationic dye which is used in the production of biological stains, dermatological agents, veterinary medicines and used as an additive in poultry feed to inhibit the propagation of mould, intestinal parasites, fungus etc., [15]. Also It is extensively used in textile, paper and printing industries [16].

The objective of the present study, is to prepare a low-cost activated carbon from the *Gracilaria corticata* seaweed material and characterise it using FT-IR spectroscopy, XRD and SEM. It was then studied for its effectiveness in the removal of crystal violet dye in an aqueous solution. The dynamic behaviour of the adsorption was investigated with the respect to dye concentration, temperature, adsorbent dose, pH and contact time. The kinetic parameters were evaluated from the adsorption measurements. Modelling studies based on Langmuir and Freundlich adsorption isotherms, were also studied.

2. MATERIALS AND METHODS

2.1 Preparation of Adsorbent

The *Gracilaria corticata* activated carbon (GCAC) was prepared from the naturally available biomass seaweed material collected from the Gulf of Mannar Biosphere Reserve off Rameswaram. The collected material was first washed with tap water several times followed by hot distilled water to remove all kinds of impurities present in it and then it was dried in sunlight for 7 days. It was impregnated with 1:1 sulphuric acid. After that, the charred product was washed several times with double distilled water until the pH of the washings become neutral. The washed material was then dried in hot air oven at 110°C for 12 hours and then carbonized in a muffle furnace at 450°C for 6 hours. Finally, the activated carbon was ground and sieved using 180-300 μm standard sieves which was used in this study.

2.2 Preparation of Dye Solution

Crystal violet dye(CV) (Molecular formula : $C_{25}H_{30}N_3Cl$, M.W.: 407.979, IUPAC Name: Tris (4-(dimethylamino) phenyl) methylium chloride) was used as the adsorbate material (structure is shown in Figure 1). A stock solution of the dye was prepared by accurately calculating and weighing Crystal violet dye and dissolving it in one litre of distilled water. Different concentrations were prepared by diluting the stock solution with distilled water and keeping the natural pH of the stock solution at around 6-7. Commercially available analytical grade other reagents (SD-fine chemicals, India) were used for this study and distilled water was used for all experiments.

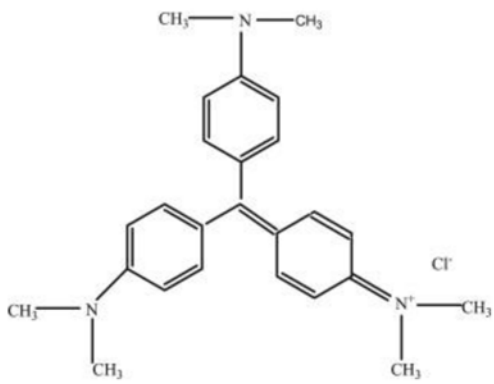

Figure 1. Structure of crystal violet.

2.3 Experimental Procedure

The batch mode experiments were carried out by varying pH from 2 to 10 using NaOH or HCl solution, Concentration of the CV dye from 20 to 100 mg/L with variations of 20 mg/L and adsorbent dose from 0.1g to 0.5g.Crystal violet solution (25 ml) and GCAC adsorbent (0.1 g) mixture was stirred and the adsorbent material was separated by a centrifuge (Remi Scientific Works, Mumbai) at 4500 rpm for 5 min at a temperature of 30 ± 0.5 °C. The absorbance of the supernatant solution was estimated to determine the residual dye concentration and measured before and after the adsorption experiment with double beam spectrophotometer (HITACHI U 2000 Spectrophotometer). The adsorption studies were carried out with different temperature ranges from 30 to 70 °C with 10 °C variation. All the experiments were carried out twice and the readings are given as average values.

The percentage removal of dye was calculated using the equation

$$R\ (\%) = \frac{C_0 - C_t}{C_0} \times 100 \quad (1)$$

where C_0 and C_t are the initial concentration and final concentration of dye at time t.

2.4 Isotherm, Kinetics and Thermodynamic Studies

The adsorption equilibrium data of the process was predicted using the commonly used isotherm equations like Freundlich and Langmuir. In both isotherm equations a linear least-square method was examined with various experimental conditions. The amount of sorption at time t, q_t (mg/g) was calculated using the following equation

$$q_t = \frac{(C_0 - C_t)V}{M} \quad (2)$$

where C_0 is initial dye concentration, C_t is the concentration of dye at a time t, V is the volume of dye solution in litre and M is weight of GC activated carbon in g.

The attraction between the CV dye and the adsorbent material was predicted using the Lagergren's kinetic equations like pseudo-first order and pseudo-second order equations. The nature of diffusion of dye molecule through the adsorbent material was found using the intra-particle diffusion model. The feasibility of the adsorption process was calculated from the thermodynamic factors such as enthalpy change(ΔH^0), entropy change (ΔS^0) and Gibbs free energy change(ΔG^0) using Van't Hoff plot.

3. RESULTS AND DISCUSSION

3.1 Analytical Studies

The surface morphology, presence of functional groups, elemental composition and physical phase of the *Gracilaria corticata* activated carbon was analysed using Fourier Transform Infrared Spectroscopy (FTIR) Scanning Electron Microscope (SEM), Energy, dispersive X-ray (EDX) spectra and X-ray diffraction spectrum (XRD) before and after the adsorption experiment.

3.1.1 FTIR studies

The FTIR analysis was carried out in order to identify the various types of functional groups and to determine the variation in the functional groups of the activated carbon as the presence of functional groups not only affects the adsorption behaviour, but also modifies the adsorption mechanism of the process [17]. The FTIR spectrum of GCAC (Figure 2)shows the peaks at 3968.05 cm^{-1}, 3782.68 cm^{-1} and 3390.33 cm^{-1} indicating the presence of stretching vibration of the O-H group or free hydroxyl groups. The peaks at 2923.44 cm^{-1}, at 2291.16 cm^{-1} and 1618.08 cm^{-1} and at 1403.81 cm^{-1}, 1331.40 cm^{-1} and 1058.85 cm^{-1} shows the presence of C-H stretching vibration, C=C stretching vibration and C-O stretching vibrations respectively. After adsorption process, the spectrum (dotted line) shows reduction of peak heights and shifting of peak positions which confirms the existence of physical or chemical adsorption process between crystal violet and activated carbon.

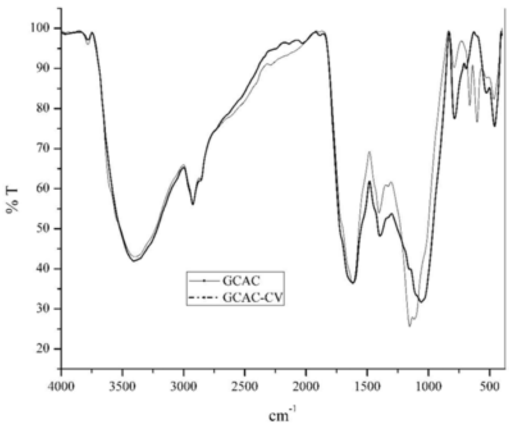

Figure 2. FTIR spectra of GCAC before and after adsorption of CV dye.

3.1.2 SEM and EDX studies

The surface morphological images of the adsorbent material, taken before and after adsorption using Scanning Electron Microscope (SEM) is shown in Figure 3a and 3b. Figure 3a reveals a porous structure on the surface layer of the adsorbent material but after adsorption (Figure 3b) the surface appears smooth with almost no pores which could be due to the adsorption of CV dye molecules onto the surface of the adsorbate.

The elemental composition of the adsorbent material is determined from the Energy dispersive X-ray (EDX) spectra and is shown in Figure 4a and 4b. From the spectrum, the elemental composition of the adsorbent material is found to be C=48.63%,O=43.61%,Si=2.17%, Cl=0.34% and Ca=2.42%. After adsorption, the EDX peak shows an increase in the carbon content and changes in the composition of other elements and which could be taken as an evidence for the adsorption of CV dye onto GCAC.

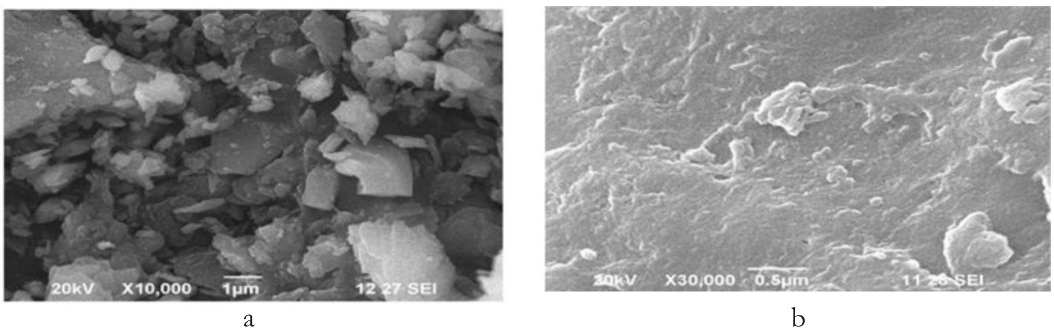

Figure 3. SEM image of GCAC a) before adsorption, b) after adsorption.

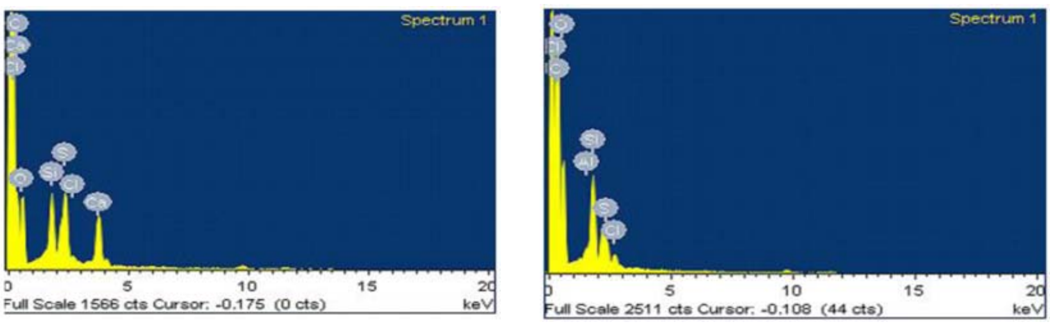

Figure 4. a) EDX image of GCAC before adsorption, b) EDX image of GCAC after adsorption.

3.1.3 XRD studies

The absence of characteristic peaks in the XRD pattern studies (Figure 5) of GCAC before adsorption, indicate that GCAC has an amorphous structure. After the adsorption of CV dye, the XRD spectrum shows a high intensity peak at a 2 theta value of 32 and another small peak at 51 thus indicating the emergence of crystalline nature. This crystalline nature may be attributed to the adsorption between activated carbon and CV dye.

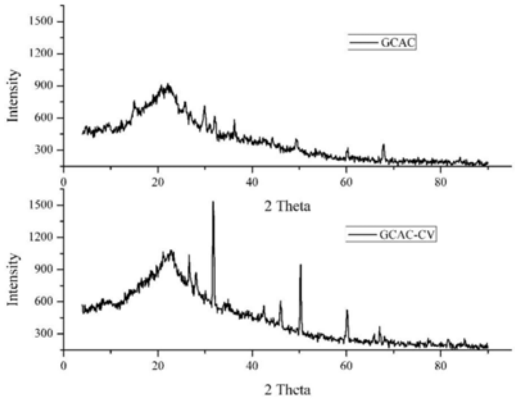

Figure 5. XRD pattern of GCAC and GCAC-CV dye.

3.2 Effect of pH

The determination of pH is very important in any adsorption process since the solution pH will tremendously affect the nature as well as progression of the adsorption process. The variation of the solution pH (from 2 to 10) and its effects are presented in Figure 6. It could be seen that among the various pH values, the pH value of 6 shows a higher percentage of removal of CV dye as compared to other pH values (Figure 6) and hence is chosen as the optimum value. At pH higher than 6, the dye removal decreases gradually, due to the hydrolysis of adsorbent surface, resulting in the creation of positively charged sites, that are responsible for the electrostatic repulsion between the dye and the adsorbent [18].

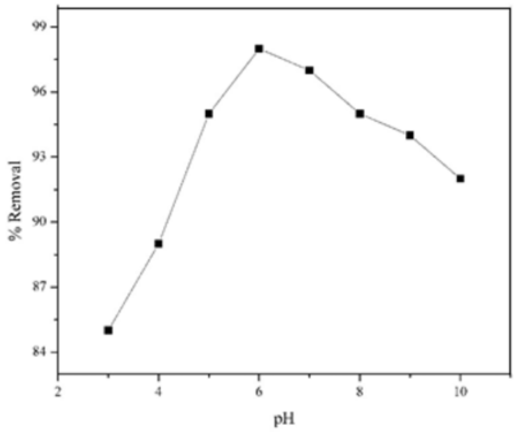

Figure 6. Effect of pH for the adsorption of CV dye on GCAC.

3.3 Effect of Dose of the Adsorbent

The adsorbent dose is a major factor which can provide information about the efficiency of the adsorption process. With increase in the adsorbent dose, the effectiveness of the adsorbent also increases gradually due to the increase in the number of available sites for adsorption on the adsorbent surface. By varying the adsorbent dose from 0.1 to 0.5 g in increments of 0.1 g, it is observed that 0.4 g dosage gives 95% removal of crystal violet dye (Figure 7) as compared with other adsorbent dosages. The increasing CV dye removal with increasing dosage of adsorbent reaches an equilibrium stage and there after the removal percentage remains constant due to the unavailability of the adsorbent sites on the adsorbent surface.

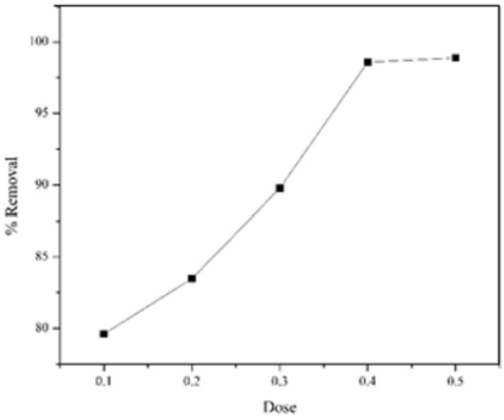

Figure 7. Effect of dose for the adsorption of CV dye on GCAC.

3.4 Effect of Concentration of Dye and Contact Time

The concentration of dye and agitation time on the adsorption process was determined by varying the concentration of dye in the range of 20 to 100 mg/L with 20 mg/L incremental variation and also by varying the contact time from 10 to 90 min with 10 min variation intervals. Figure 8 shows the various quantities of dye used, with the 100 mg/L dye concentration showing excellent dye removal percentage as compared to other concentrations, while 50 min of contact time shows the highest percentage of removal as compared to other time interval values. Hence, the optimum concentrations of dye and contact time chosen in this study are 100 mg/L and 50 min respectively.

3.5 Effect of Temperature

The effect of temperature was investigated at different temperatures from 30 °C to 70 °C with the increments of 10 °C. Figure 9 shows that 30 °C was the optimum temperature for the effective removal of crystal violet dye. The decrease in adsorption with increasing temperatures may be due to the enhancement of the desorption step in the sorption process. Also increasing thermal energy may weaken the physical forces of attraction between the active sites on the activated carbon and the dye species and also between adjacent dye molecules on the adsorbed phase.

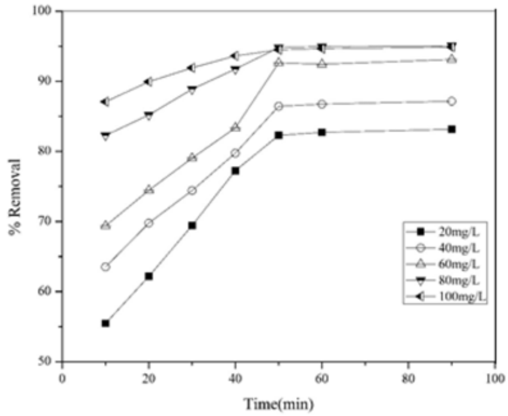

Figure 8. Effect of time and concentration for the adsorption of CV dye on GCAC.

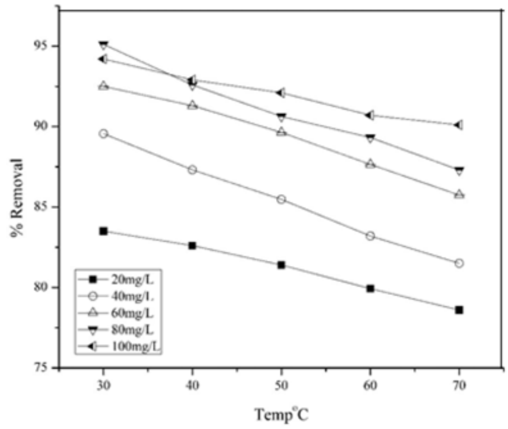

Figure 9. Effect of Temperature for the adsorption of CV dye on GCAC.

3.6 Equilibrium Modelling Studies

The equilibrium adsorption process was evaluated with the help of Freundlich and Langmuir adsorption isotherm equations. The Freundlich isotherm is an assumption that the ratio of amount of solute molecules adsorbed on a mass of adsorbent molecules to the concentration of solute in the solution and it is vary with different concentrations [19]. The non-linear form of Freundlich equation is given by

$$q_e = K_F C_e^{1/n_F} \quad (3)$$

The linearized form of Freundlich equation is given by

$$\log q_e = \log(K_F) + \frac{1}{nF}\log(C_e) \quad (4)$$

where q_e is the amount of adsorbate adsorbed at the equilibrium condition (mg/g), C_e is the equilibrium concentration of the adsorbate (mg/L), K_F is the Freundlich adsorption isotherm constant that relates the adsorption capacity of the adsorbent $((mg/g)(L/mg)^{1/n})$ and 1/n is the adsorption intensity. The values of K_F and 1/n were calculated from the intercept and slope of the plot of C_e/q_e *vs* C_e (Figure 11)

The Langmuir isotherm is an assumption of uniform distribution of energies of the sorption on the surface and there is no transmigration of sorbate particles in the plane of the surface of the adsorbent [20]. The non-linear form of Langmuir equation is

$$q_e = \frac{q_m K_a C_e}{1 + K_a C_e} \quad (5)$$

The linearized form of Langmuir equation(Langmuir 1 to Langmuir 4)

$$\frac{C_e}{q_e} = \frac{1}{q_m} C_e + \frac{1}{K_a q_m} \quad (6)$$

where q_e (mg/g) and C_e(mg/L) are the amounts of dye adsorbed per unit mass of adsorbent and unabsorbed dye concentration in solution, q_m is the maximum amount of dye adsorbed per unit mass of adsorbent at entire monolayer on surface bound, and K_a is a constant related to the affinity of the binding sites. Linear regression is the most common method to evaluate the adsorption process, so the adsorption constants were obtained by using linear least square method (Figure 10).

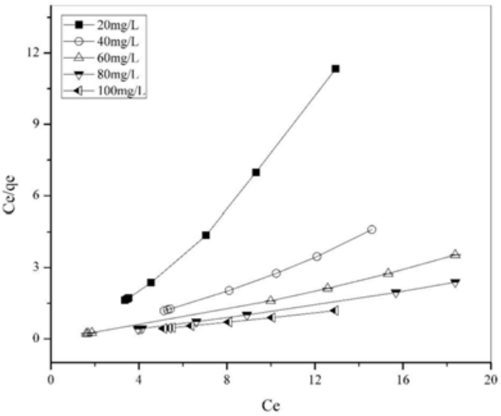

Figure 10. Langmuir 1 isotherm for the adsorption of CV dye on GCAC.

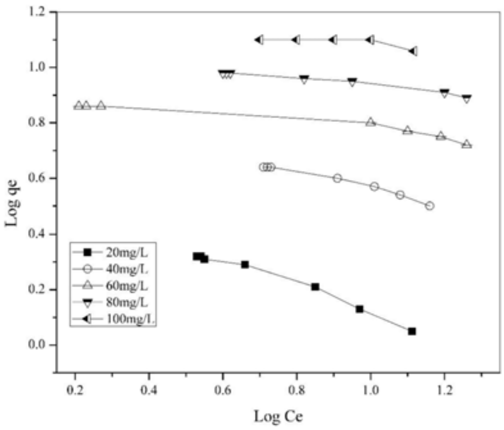

Figure 11. Freundlich isotherm for the adsorption of CV dye on GCAC.

The experimentally calculated values of Freundlich and Langmuir isotherm parameters are presented in Table 1. From the table, it is seen that the Freundlich isotherm shows the correlation coefficient value (r^2) is 0.9738 and the Langmuir isotherm shows the correlation coefficient value (r^2) as 0.9990. These values conclude that the Langmuir isotherm was the most suited isotherm rather than the Freundlich isotherm for determining the removal of CV dye.

Hence, Langmuir-1 is a best suited model compared to other forms of Langmuir and Freundlich isotherms, as there is a specific monolayer adsorption along with slight multilayer adsorption. The correlation results supports that both isotherms are favourable for the adsorption process of CV onto GCAC[21].

Table 1. Isotherm parameters for the adsorption of GCAC-CV dye.

		Concentration (mgg^{-1})				
Isotherm		20	40	60	80	100
Langmuir 1	q_m(mgg^{-1})	1.0055	2.8526	5.2806	7.4024	10.374
	K_a(Lmg^{-1})	0.4988	0.5064	1.4275	0.9456	1.437
	r^2	0.9863	0.9905	0.9908	0.9973	0.9992
Langmuir 2	q_m(mgg^{-1})	0.9157	2.9698	5.540	7.6787	10.490
	K_a(Lmg^{-1})	0.4901	0.5824	2.580	1.212	1.6145
	r^2	0.6655	0.8705	0.8103	0.8257	0.8902
Langmuir 3	q_m(mgg^{-1})	8.2877	16.107	0.4340	1.6540	11.943
	K_a(Lmg^{-1})	0.9108	0.6492	2.1005	1.7782	0.4569
	r^2	0.8482	0.9435	0.8741	0.9234	0.8759
Langmuir 4	q_m(mgg^{-1})	0.5294	1.8040	13.559	9.7028	16.988
	K_a(Lmg^{-1})	1.8801	1.6648	0.4097	0.7956	0.6186
	r^2	0.8741	0.9234	0.8759	0.8482	0.9435
Freundlich	1/n	0.4524	0.2935	0.1158	0.1279	0.0670
	K_F(mgg^{-1})(Lg^{-1})	0.5626	0.15667	0.1166	0.0590	0.1404
	r^2	0.9738	0.9645	0.9211	0.9613	0.4221

The favourability of the adsorption isotherm process was furthermore checked using the dimensionless separation factor (R_L) and the R_L values were calculated. The values of R_L indicates the favourability of adsorption process. If the R_L values lies between 0 to 1 ($0 < R_L < 1$), the adsorption process is favourable. If the value of R_L possess beyond one ($1 < R_L$), the adsorption process is not favourable. Whereas if the R_L value equals unity ($R_L = 1$), then the process is linear and if R_L reaches a value of zero ($R_L = 0$) then the adsorption process is irreversible [22] Figure 12 shows the calculated value of R_L lying between 0 and 1. Therfore the adsorption process is favourable.

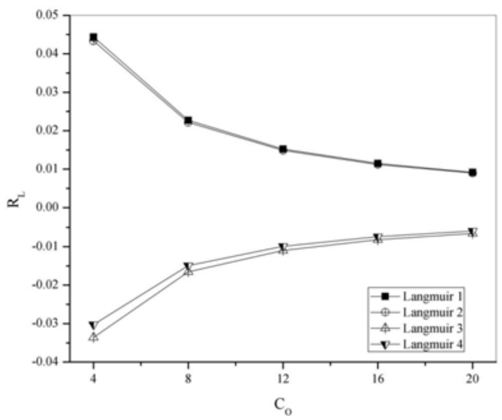

Figure 12. Dimensionless separation factor (R_L) for the adsorption of CV dye on GCAC.

3.7 Kinetic Studies

Adsorption kinetic profiles were correlated in order to determine the rate limiting steps involved in the sorption process of CV dye onto GCAC. Lagergren's pseudo first order (Eq. (7) and pseudo second order (Eq. (8) kinetic models were used for the kinetic modelling studies [23].

$$\log(q_e\text{-}q) = \log(q_e) - \frac{K_1 t}{2.303} \quad (7)$$

where, K_1 is the pseudo first order adsorption rate constant, q_e is the amount of dye adsorbed on the GCAC at equilibrium (mgg^{-1}), qt is the amount of CV dye adsorbed on the GCAC at any time t (mg/g):

$$\frac{t}{q} = \frac{1}{K_2 q_e^2} + \frac{1}{q_e} t \quad (8)$$

where, K_2 is the pseudo-second order adsorption rate constant, q_e amount of dye adsorbed on the GCAC at equilibrium (mg/g), q^2_e is the pseudo second order adsorption rate constant (g/mg/min).

The calculated values of pseudo-first order rate constant (K_1), pseudo-second order rate constant (K_2), equilibrium uptake capacity (q_e) and their corresponding regression coefficient (r^2) values are presented in Table 2. From the table the coefficient values of pseudo-first order rate constant and the q_e values are found to be very low. The Pseudo-first order (Figure 13) correlation coefficient value is 0.5072, while the pseudo-second order kinetics (Figure 14) correlation coefficient value is very high at 0.9923. this confirms that the sorption process follows second order rate of reaction mechanism rather than the first order. These results conclude that the rate of the process not only depends on the concentration factor (Pseudo-first order) and the rate of the process only but also depends on both concentration as well as time (Pseudo-second order).

Table 2. Kinetic parameters for the adsorption of CV dye onto GCAC.

pseudo-first order			Pseudo second order- I		
K_1	q_e	r^2	K_2	$q_{e.}$cal	r^2
0.0097	0.4683	0.7439	0.2258	0.3611	0.9802
0.0122	0.7037	0.6923	0.1376	0.6354	0.9853
0.0118	0.3179	0.7563	0.1091	0.7329	0.9798
0.0064	0.1163	0.6257	0.1728	0.4150	0.9670
0.0046	0.0077	0.6551	0.1791	0.5733	0.9923

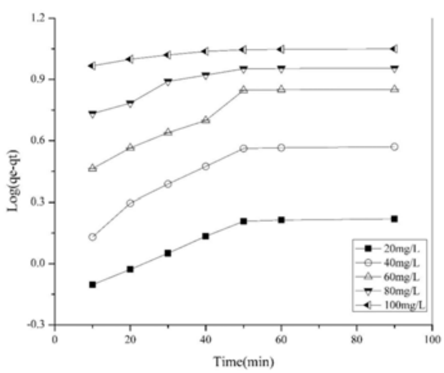

Figure 13. Pseudo-first order plot for the adsorption of CV dye on GCAC.

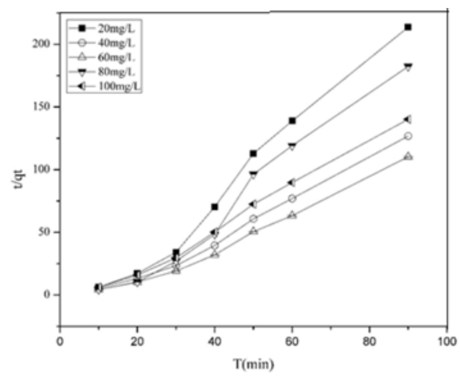

Figure14. Pseudo-second order plot for the adsorption of CV dye on GCAC.

3.8 Intraparticle Diffusion Model

The commonly used and well suited intraparticle diffusion model was used for the prediction of the mechanism of diffusion process[24]in this study. The mathematical expression for the intra-particle diffusion equation is:

$$q_t = K_{id}\, t^{1/2} + C \quad (9)$$

Where, k_{id} is the intraparticle diffusion rate constant (mg/g/min$^{1/2}$) and C is the intercept. By plotting a graph between q_t *vs* $t_{1/2}$ provides a straight line. The adsorption process proceeds with the intraparticle diffusion mechanism and the parameters k_{id} and C are calculated from the linear regression analysis of the slope and intercept values. The graph (Figure 15)is not a straight line indicating that the adsorption of CV dye on activated carbon may involve several modes of sorption, rather than a single mode. Hence, the results show that the adsorption process involved is a multi-mode of diffusion process rather than a single mode of diffusion process.

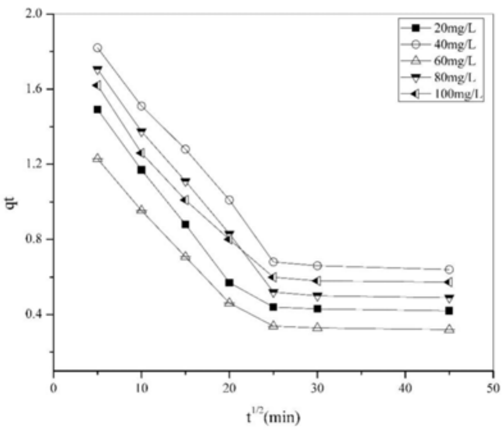

Figure 15. Intra particle diffusion plot for the adsorption of CV dye on GCAC.

3.9 Thermodynamic Parameters

The thermodynamic parameters are generally used to predict the inherent energy changes of the process and are also associated with the adsorption dynamics. The thermodynamic parameters, like standard Gibbs energy (ΔG^0), enthalpy (ΔH^0), and entropy (ΔS^0), were determined by using the following equations [25].

$$K_{id} = \frac{q_e}{C_e} \quad (10)$$

$$\Delta G^0 = -RT\ln K_{id} \quad (11)$$

$$\ln K_{id} = \frac{\Delta S^0}{R} - \frac{\Delta H^0}{RT} \quad (12)$$

where, K_{id} is the distribution coefficient, T is the temperature, and R is the gas constant (8.314 J/mol/K), respectively. ΔG^0, ΔS^0 and ΔH^0 were calculated from the slope and intercept of Van't Hoff plot such as ln K_{id} vs 1/T (Figure 16).

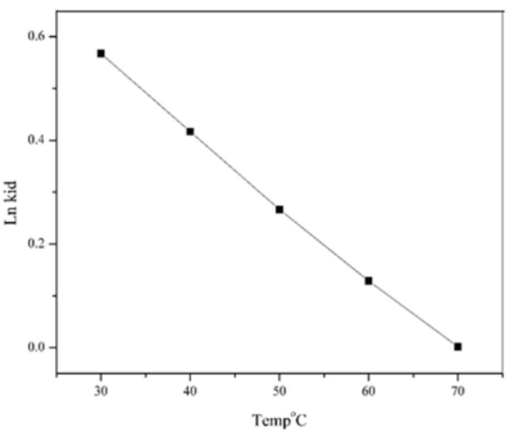

Figure 16. Van't Hoff plot for the adsorption of CV dye on GCAC.

The calculated values of thermodynamic parameters are shown in Table 3. The negative and more negative ΔG^0 values at different temperatures indicate that the adsorption of CV onto GCAC is a spontaneous process. The positive value of ΔH^0 found in the temperature range of 30 °C to 70 °C indicates the endothermic nature of adsorption involved in the adsorption process. The positive value of entropy (ΔS^0) shows the increased disorder between the CV dye and the activated carbon interface with significant affinity of GCAC-CV dye towards the activated carbon.

Table 3. Thermodynamic parameters for the adsorption of CV dye.

T(°C)	ΔG° (KJ/mol)	ΔH° (KJ/mol)	ΔS° (KJ/mol)
30	-0.14	1.03	8.19
40	-0.14		
50	-0.11		
60	-0.06		
70	0.00		

4. Conclusion

The FTIR study supports the presence of various functional groups in the GCAC and also the evidence for an adsorption of CV on the GCAC. The SEM and EDX images of CV on to GCAC show well defined morphological evidence for the adsorption process. The batch mode experimental study was carried out by varying adsorbent dose, dye concentration, pH and temperature. From the study a pH value of 6, contact time of 50 min, 100 mg/mL dye concentration, 0.4 g dosage and a temperature of 30 °C were found to be most suited parameters for dye removal. The adsorption data evaluated with Freundlich and Langmuir adsorption isotherm equations, It confirms that Langmuir-1 was the most fitted model as compared to others indicating that the adsorption process follows the monolayer adsorption. The kinetic data results show that the pseudo-second-order kinetic model provides a best correlated value as compared with the pseudo-first order kinetic equation indicating that the rate determining step may be governed by the chemical forces of attraction and the rate of the process depends both on concentration as well as time. From the investigations of the thermodynamic parameters, the spontaneous and endothermic natures of the adsorption process are confirmed from the negative value of ΔG° and the positive value of ΔH° respectively. The positive value of ΔS° confirms that a good affinity exists between the CV dye and GCAC. From the experimental and correlation data obtained in this study, it is concluded that the activated carbon prepared from *Gracilaria corticata* seaweeds could be used as an efficient, eco-friendly and low cost adsorbent material for the removal of dye from aqueous solution.

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