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Volume I

Editors

Dr. A. Asrar Ahamed
Dr. Pabitra Kumar Kalita
Dr. S. Abbas Manthiri

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Bishnu Prasad Rabha Path, Bhetapara, Beltola, Guwahati - 781028, Assam, India
Email: natureacademygroup@yahoo.com

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Adsorption Studies on the Removal of Congo Red Dye from Aqueous Solution Using Cardia Sabestena Activated Carbon

A. Rathinavelu[1]*, N. Karpagam[2], M. Viswalingam[3], S. Sridharan[3], T. Meyvizhi[4], J. Jayanthi[5]

[1]Assistant Professor of Chemistry, K. S. Rangasamy College of Arts & Science (Autonomous), Tiruchengodu, Tamil Nadu, India.

[2]Assistant Professer of Chemistry, Nallamuthu Gounder Mahalingam College, Pollachi, Coimbatore, Tamil Nadu, India.

[3]Assistant professorof Chemistry, Periyar Maniammai Institute of Science and Technology, Vallam, Thanjavur, Tamil Nadu, India.

[4,5,6] M. Sc Chemistry, K.S. Rangasamy College of Arts & Science (Autonomous), Tiruchengodu, Tamil Nadu, India.

Abstract

This study investigated the adsorption of Congo Red dye from aqueous solution using Cardia sabestena activated carbonin adsorption experiments. The surface characterization of raw materials were analyzed the functional groups a, crystalline nature and surface morphology with elemental analysis using various physic-chemical analysis such FTIR, XRD, SEM.The operational parameters such as adsorbent dosage, pH, and initial concentration were investigated. Adsorption isotherm models and kinetics models were studied in batch experiment. The effect of initial dye concentration, flow rate, and bed height on biosorption capacity were investigated in fixed bed. The applicability of the adsorbent to treat Congo Red contaminated wastewater, in a fixed bed column, was examined by using simulated industrial wastewater.

Keywords: CARDIA SABESTENA, XRD, SEM, and FTIR

Introduction

Dyes are widely used by textile industries to color their products. One of the major problems concerning textile waste waters colored effluent. This wastewater contains a verity of organic compounds and toxic substances. which are harmful to fish and other aquatic organisms. Congo red dye causes eye burns, which may be responsible for permanent injury to the eyes of human and animals on inhalation, it can give rise to short periods of rapid or difficult breathing, while ingestion through the mouth produces a burning sensation and may cause nausea, vomiting, profuse sweating, mental confusion, painful mictuntion, and methemoglobinemia. Therefore, the treatment of effluent containing such dye is of interest due to its esthetic impacts on receiving waters.

Adsorption processes using activated carbons are widely used to remove pollutants from wastewaters. However, commercially available activated carbons is expensive. In the last years, special carbons from several agricultural by products has been given due to the growing interest in low cost activated carbons from renewable, copious especially for application concerning treatment of wastewater.

Experimental

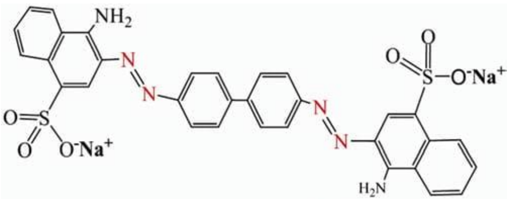
Adsorbent

Cardia sabestena materials were collected from in Erode Tamilnadu India. They were they sun dried and stored in air tight plastic container for chemical modification.

Preparation of Activated Carbon

Activated carbon was prepared from CSAC waste in Industrial collected which was locally procured at Salem. The material was washed with hot distilled water to remove early matter, cut into small pieces, and aired in sun. The active was prepared from the above material Impregnated with concentrated sulphuric acid and carbonized at 4000C. For Impregnator ratio of acid volume to weight of plant material of 1:1 (w/v) was employed. Before utilization the carbon was washed with distilled water and dried in a hot air oven at 100±50C. Finally, it was ground and sieved.

Structure of Congo Red



Result and Discussion

Characterization of nano material

Physico-chemical characterization of the nanomaterials were studied as per the included the following standard testing methods.

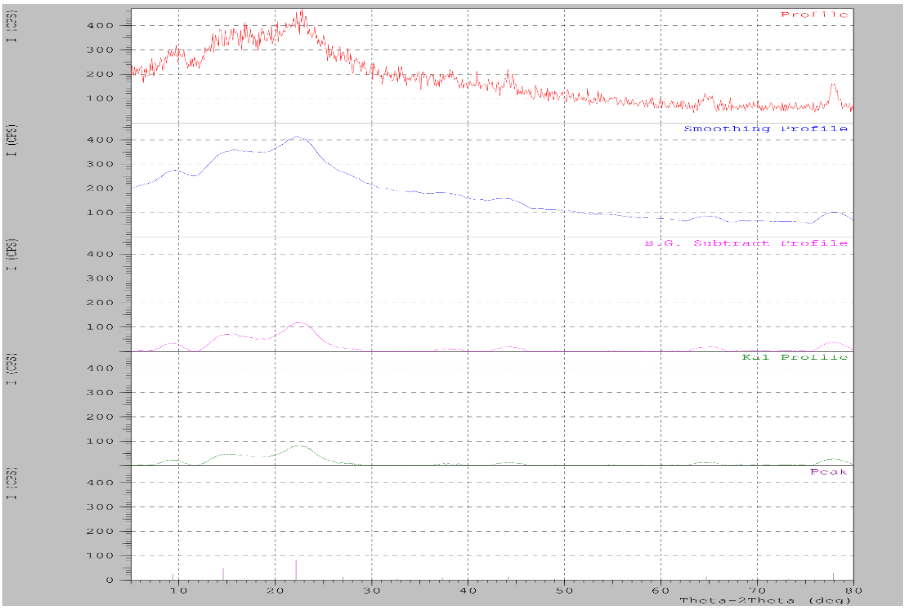
- XRD analysis
- SEM(Scanning Electron Microscopy).
- IR (Infra red spectroscopy).

XRD Analysis

The physicochemical characteristics of the adsorbents were studied as per the standard testing methods. Figures 1 & 2 shows the XRD pattern of before and after adsorption.

X-rays are electromagnetic radiation of wavelength about 1 A(10-10 m). which is about the same size as an atom. The discovery of X-rays in 1895 enabled scientists to probe crystalline structure at the atomic level. X-ray diffraction has been in use in two main areas, for the fingerprint characterization of crystalline materials and the determination of their structure. Each crystalline solid has its unique characteristic X-ray powder pattern which may be used as a fingerprint" for its identification.

Figure 1. XRD analysis of before adsorption



a) Before Adsorption

S.No	Peak	2 Theta(deg)	D(A)	Intensity(counts)
1	1	8.375	10.54908	28
2	5	25.125	3.54154	14
3	4	22.5	3.94843	10

b) After Adsorption

S. No	Peak	2 Theta (deg)	D (A)	Intensity(counts)
1	3	22.125	4.0145	49
2	2	14.6	6.06227	28
3	13	77.925	1.22501	16

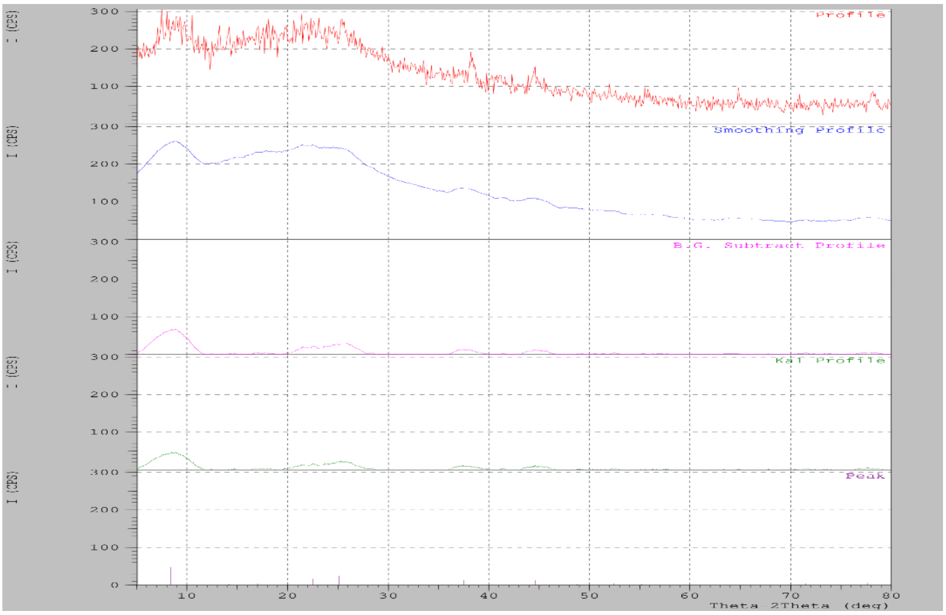
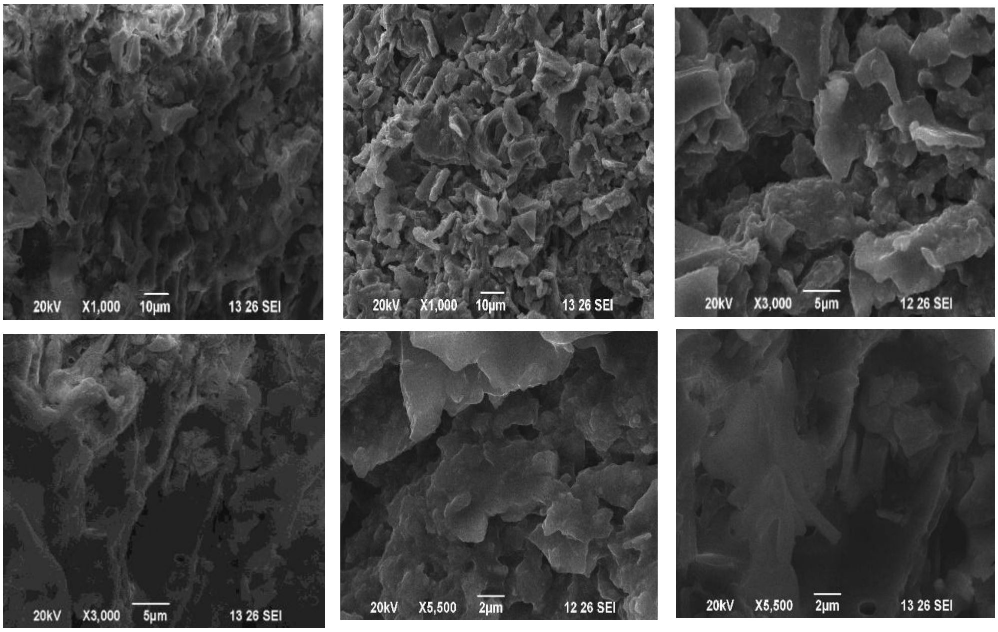


Figure 2. XRD analysis of after adsorption SEM (scanning electron microscopy).

Surface morphology were visualized by scanning electron microscope shown in figures.



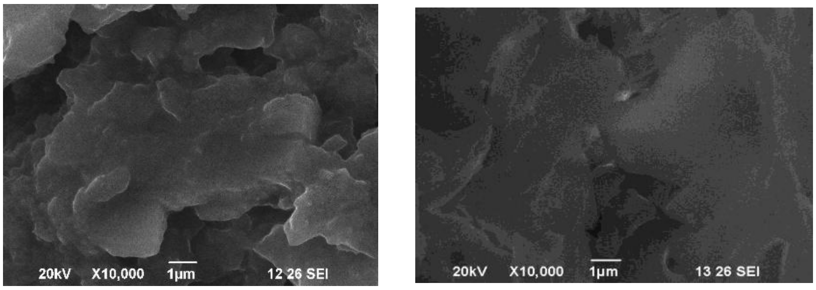
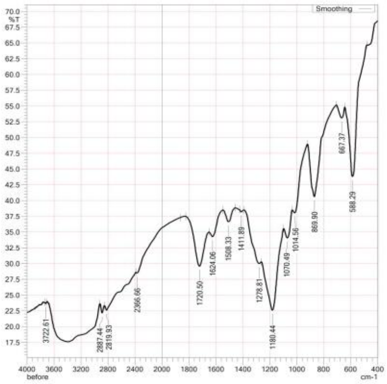


Figure 3. SEM analysis of before and after adsorption

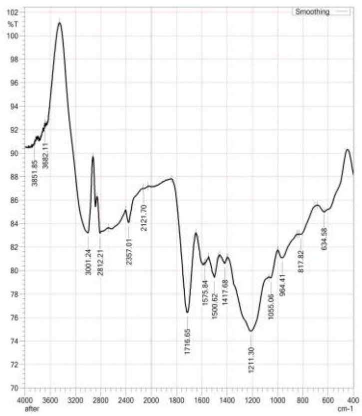
SPECTUM (infraredspectroscopy)

The infrared spectral analysis was carried out to understand the chemical bonding and it provides useful information regarding the molecular structure of the compound. Fourier transform infrared spectrum was taken for the powdered sample activated Cardia sabestena carbon. FT-IR spectra of activated Cardia sabestena shown in 400-4000.



Peak	Functional group	Compounds
588.29	C - Cl	Halogen Compound
667.37	C - Cl	Halogen Compound
1014.56	C - O - C, C - O	Ribose, Glycogen,
1070.49	C - O stretching	Vinyl ether
1180.44	C - O - C, C - O	Ribose, Glycogen,
1278.81	C - N	Nitriles
1411.89	C - H bending	Methyl group
1624.06	C = C stretching	Alkane
2819.93	C -H Stretching	Alkane
2887.44	C -H stretching	Alkane
3722.61	NH2	Amino acid group

Figure 4. IR analysis of before adsorption

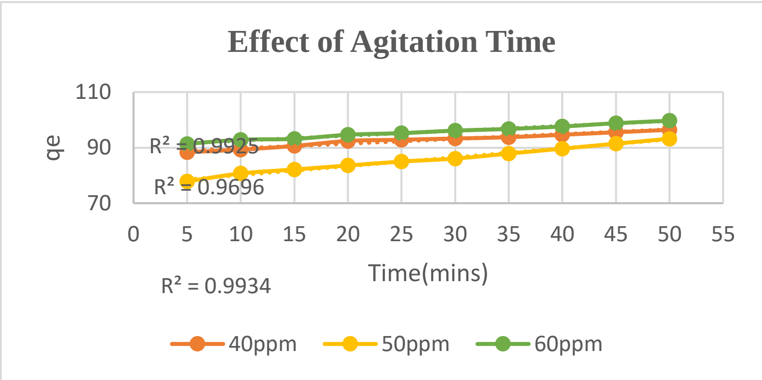


Peak	Functional group	Compounds
634.58	C = C bending	Alkyl di substituted(cis)
817.82	C -Cl	Organic chloride
964.41	C - O - C, C - O	Ribose, Glycogen,
1055.06	C - O stretching	10 alcohol
1211.3	C - O stretching	Vinyl ether
1417.68	C - H bending	Methyl group
1500.62	N - O stretching	Nitro conjugated
1716.65	C = O	Carbonyl group
2121.7	CH bending	Aromatic compound
2357.01	P - H stretching	phosphines
2812.21	CHO	Aldehydes
3001.24	C -H Stretching	Alkane
3682.11	OH	Alcohol
3851.85	OH -Stretching	Alcohol

Figure 5. IR analysis of after adsorption

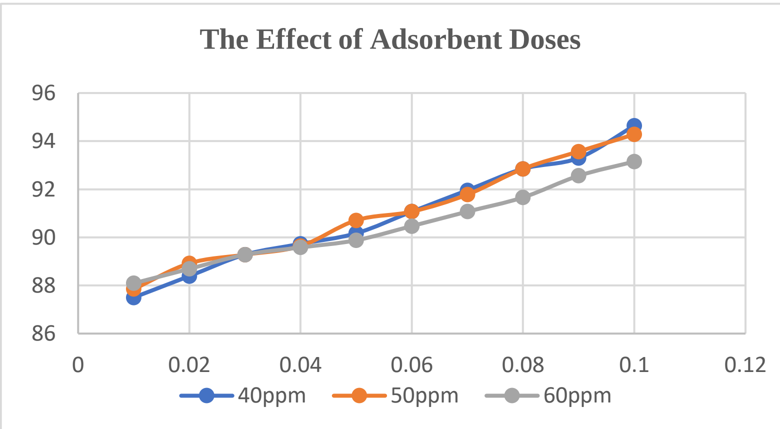
Effects of Agitation Time and Initial Dye Concentration on Adsorption

Adsorption isotherms are usually determined under equilibrium conditions. A series of contact time experiments congo red dye have been carried out at different initial concentration (40-60 mg lit) and at temperature of 30 C. Fig shows the contact time necessary for Congo red dye with initial concentrations of 50mg/lit to reach equilibrium is 150 minutes. However; for Congo red dye with higher initial concentrations (40-60 mg/lit); longer equilibrium time of 150 minutes is needed.



Effect of Adsorbent Dose

The effect of adsorbent dose on congo red dye removal was studied by keeping all other experimental conditions constant except that of adsorption dose. The results showed that with increase in adsorbent concentration there is a decrease in the amount adsorbed per unit mass of the adsorbent for both the activated carbon. This may basically be due to adsorption sites remaining unsaturated during the adsorption process.



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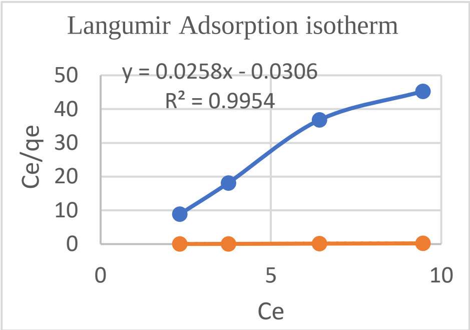
Adsorption Isotherms:

Langmuir Isotherm

The linear form of Langmuir's isotherm model is given by the following equation.

$$C_e/q_e = l/q_ob + (l/q_o) C_e$$



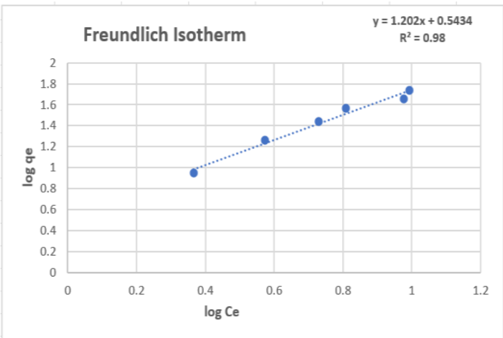
	CASC			
Concentration mg/L	R_L	Q^O	b	R^2
20	0.678			
40	0.5263			
60	0.4350			
80	0.3664	9.34	0.0176	0.9954
100	0.3064			
120	0.2683			

Freundlich Isotherm

The Freundlich isotherm, in its logarithmic form can be represented as;

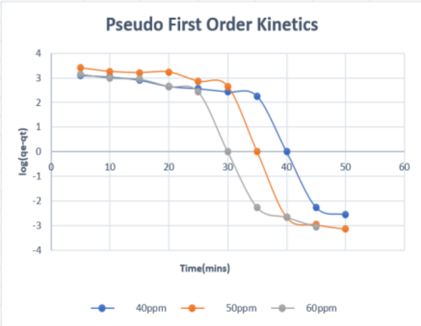
$$\log q_e = \log_f + 1/n \log C_e$$

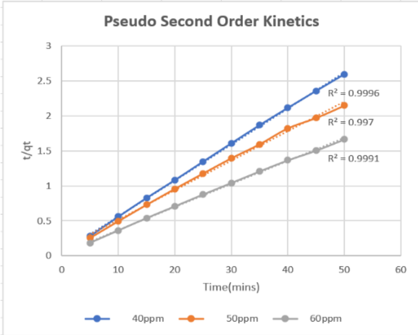
Parameters of Freuldlich adsorption isotherm constants for congo red dye using cardia sabestena activated carbon



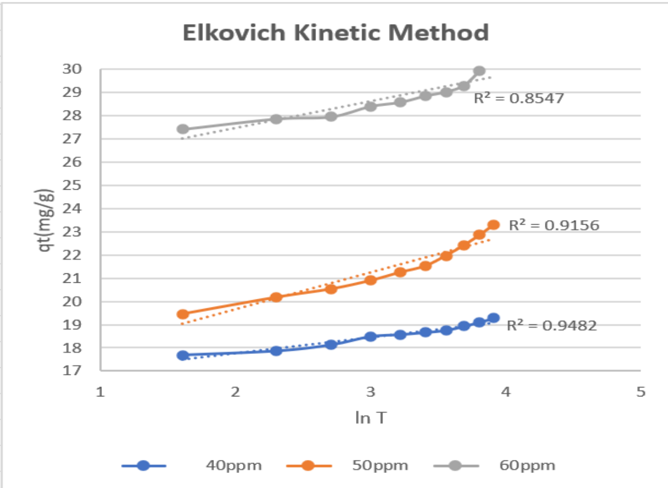
Kf	n	R^2
4.37	**1.65**	**0.98**

Adsorption Kinetics

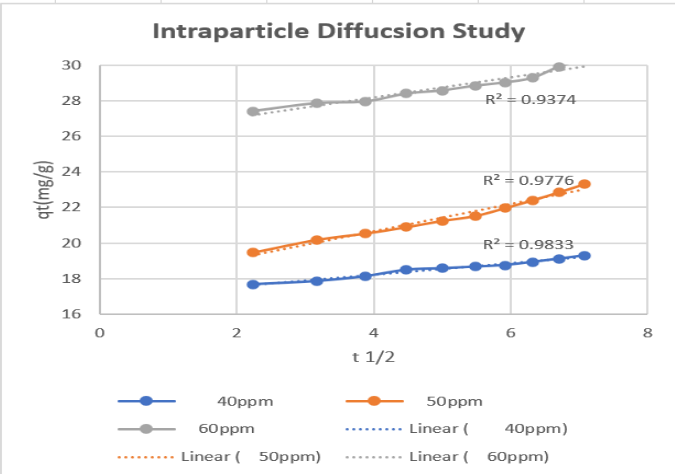




Elkovich kinetic method:



Weber-Morris intraparticle diffusion model:



Conclusion

This study shows that the congo red and activated carbon can be used effectively in the removal of through adsorption. The adsorption on both CASC followed Langmuir, Freundlich. Pseudo second order kinetic model was followed and does not fit for Pseudo First order. Elkovich kinetic model suggested that adsorption process is chemisorptive nature. The adsorption also followed by intraparticle diffusion model. The calculated values of different thermodynamic parameters clearly indicated that the adsorption process with CASC was feasible, spontaneous and exothermic nature. This study also reveals showed that congo red dye activated carbon exhibited higher adsorption capacity.

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