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A STUDY OF THE REMOVAL OF METHYLENE BLUE DYE POLLUTANT FROM AQUEOUS SOLUTION WITH SPECIAL REFERENCE TO BIO ADSORBENT DERIVED FROM TEMPLE WASTE

Minakshee Sawankara[1], Anita Singh[*2],Gurpreet Kour Gandhi[3] and Sonia Goswami[4]

[1]Department of Chemistry, Sharda Mahavidhyalaya Parbhani, Maharashtra, India
[2]Department of Chemistry, Career College, Bhopal, Madhya Pradesh, India
[3]Department of, Chemistry, Govt. Adarsh College, Harda, Madhya Pradesh, India
[4]Department of Chemistry, Oriental College of Technology, Bhopal, Madhya Pradesh, India
[*]Corresponding Author, emailid: a4anitasingh@gmail.com

ABSTRACT.

The wealth of the nation is depending on environmental factors such as clean air, water, and land**,** but now a few days, all environmental factors are highly polluted due to the dumping of wastes on the environment from various places such as industries, factories, mills, hospitals, hotels, temples, domestic places, recreational center, etc. The essential objective of the present examination was to assess the plausibility of insignificant exertion the adsorbent got from the **temple waste** for the **removal** of MB from the **Aqueous solution** in a group framework. The initial dye concentration (2,4,6,8 and 10 ml), marigold flower dose (0.1 to 0.5 g), and contact period (10 to 60 min) under room temperature were varied in the adsorption tests. To observe the impacts of different factors on the dye adsorption process, batch adsorption studies were conducted and contact time, adsorbent dosage, and initial dye concentration were all examined. The results are unconcealed that the surface assimilation furthest reach of motivated carbon of temple waste was high over chemical group blue. The adsorbent assessment was applied in group analysis as a district of contact time, adsorbent bit, arrangement, pH, and starting obsession, wherever the adsorption of MB is considerably full of the adsorbent segment, time, introductory MB fixation, and pH. The Langmuir and Freundlich models determined the maximum adsorption capacities to be 50 mg/g and 0.48 mg/g, respectively. The results exhibited a lot of vital level of MB ejection at lower starting shading fixation and therefore the balance between MB within the arrangement and the 0.5 adsorbent surface was in each sensible sense covered twenty min.

Keywords: Temple waste, methylene blue, bioadsorption kinetic isotherm, batch experiment, activated carbon.

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1. INTRODUCTION

Kinetics and method of elimination of methylene blue by adsorption on an assortment of carbons, the motivation behind this work were to concentrate on the kinetics and method for adsorption of methylene blue (MB), on different natively prearranged ACs (IPACs) from agricultural wastes and to assess their adsorption limit with regards to the derivation of MB under ideal trial conditions. Subsequently, this examination is focused on to concentrate on the kinetics and dynamics of adsorption of a fundamental color viz., methylene blue (MB) on CAC and (IPACs, for example, bamboo dust carbon (BDC), coconut shell carbon (CSC), groundnut shell carbon (GNSC), rice husk carbon (RHC) and straw carbon (SC) and to discover the chance of involving these carbonaceous materials as minimal expense adsorbents for the evacuation of colors overall and MB, specifically (Nagarethinam. K, 2001). Adsorption of essential color (methylene blue) onto enacted carbon arranged in rattan sawdust has been used as the adsorbent for the expulsion of methylene blue color from a fluid arrangement (Vijayaraghavan, G., Sivakumar, T., Vimal KA., 2011).

Watching out for several issues of compound purifiers gets out for a goliath extent of exploration to be facilitated to perceive unimaginable new frameworks for cleaning water at lower cost and with less criticalness, while simultaneously confining the utilization of designed mixes impact on nature (Packialakshmi, N., Suganya, C., Guru, V., 2011]. There are various strategies for dirtying water, the most noteworthy being the arrival of current wastewater through spillage from into water bodies. The sewage discharge from homes is not treated before being discharged to a condition that is moreover an essential driver of sullying. Wastewater is one of the significant common issues rising in various thickly populated and present-day locales of the world. The move of business and industry vehicle wash wastewater can speak to a gigantic hazard to the prosperity of our channels (Senthil, P., Vaibhav, K.N., Rekhi, S., Thyagarajan, A., 2016).

Colors have been excessively released into nature on account of speedy industrialization and have made a huge overall concern (Abdelkarim, S., Mohammed, H., Nouredine, B., 2017). T he number of material associations in Korea related to shading is 360,616 in 2015, equivalent to 3.6% of full-scale wastewater discharging workplaces. In any case, shading wastewater outpouring speaks to 22.2% of outright wastewater release (Choi, H., Yu, S.W., 2019). The removal of harmful i ons from wastewater typically involves using conventional techniques including filtratio n, chemical precipitation, electrochemical treatment, ion exchange, membrane technolog ies, evaporation, and adsorption of activated carbon, semiconductor photocatalysis such as ZnO, TiO2, WO3, and Fe2O3, etc. (Liu, P., Borrell, P., Bozic, M., Kokol, V., O ksman, K., and Mathew, A., J.,2015). However, these methods have some limitations, such as a limited operational range, expensive technical expenses, and significant ene rgy consumption. These restrictions can be removed via biosorption, which can reduce

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the concentration of metal ions in the solution (Tayebee, R., Esmaeili, E., Maleki, B., Khoshniat, A., Chahkandi, M. and Mollania, N.,2020).

Due to their hydrophilic nature, functionalization potential, and ease of tuning various parameters like surface area, aspect ratio, and chemical accessibility, ligno-adsorbent materials, have received a lot of attention (Isobe, N., Chen, X., Kim, U., S. Kimura, S., Wada, M., Saito, T., and Isogai, A,2013). A new application for adsorbent materials can be found in the removal of hazardous metal ions using hybrid fillers, and nitro-oxidized carboxy cellulose nanofibers produced from jute. Studies on adsorption have shown that powdered activated carbon has a far greater potential for adsorption than granular activated carbon. In the process of being created by ultrasonic waves, the nanoparticles are deposited on activated carbon. Different magnetic NH4Cl-induced activated carbon dosages were used during this process (Patel, D.K., Dutta, S.D., Lim, K.T., 2019; Sunil K. Sharma, Priyanka R. Sharma, Likun Wang, Micheal Pagel, William Borges, Ken I. Johnson, Aniket Raut, Kevin Gu, Chulsung Bae, Miriam Rafailovich, Benjamin S. Hsiao., 2022)
The standard objective of the present assessment was to overview the likelihood of insignificant exertion adsorbent got from the temple waste for the ejection of MB from a watery arrangement in the bunching system. The effects of different parameters including arrangement, pH, biosorbent estimation, starting color, focus, and contact time were considered. Additionally, the isotherm and engine parameters were researched to depict the exploratory data.

2. Materials and method

2.1 Sample collection

In the present examination, the samples of raw materials (Marigold flower waste) to prepare activated carbon were collected from the different temples of Bhopal. It is a minimal effort and richly accessible plant found in the timberland zone.

2.1.1 Preparation of activated carbon

Before the experiment, the activated carbon was prepared first. Half kg of the marigold flowers was dried at room temperature. After drying, put the flowers in a beaker. Then Ortho phosphoric acid was added to the beaker approx. 20ml. Stirred the beaker with the help of glass rods. Leave the beaker for 2 days. Burned flowers at high temperature until they converted into Activated Carbon. Washed the activated carbon through normal tap water to remove acid impurities and crushed the carbon in fine powder to find more surface area for adsorption and was dried in a hot air oven at 80^{o}C.

2.2 Batch experiment

2.2.1 Effect of contact time

ISSN PRINT 2319 1775 Online 2320 7876

Research paper UGC CARE Listed (Group -I) Journal Volume 11, Iss 8, Dec 2022

1. 1 ml of Methylene Blue dye was dissolved in 100 ml of distilled water. After that, 0.1g of Activated Carbon was added to the 50ml solution of Methylene Blue. Put the beaker on the magnetic stirrer after adding the Activated Carbon. The effect of contact time was investigated for 10, 20, 30, 40, 50, and 60 minutes at room temperature. Dye was filtered by the filter paper and its O.D. was taken at 620nm before and after adding the Activated Carbon.

2.3 Effect of dose

2. 1 ml of Methylene Blue was dissolved in 100 ml of distilled water. Then 20ml solutions were taken into 5 different test tubes. After that, different amount (100mg, 200mg, 300mg, 400mg, and 500mg) of Activated Carbon was added into the separate test tubes. Then each test tube was shaken uniformly for 20 min with the help of a vortex shaker so that the dye was adsorbed by the activated carbon. After that, the dye was filtered by the filter paper and its O.D. was taken at 620 nm.

2.4 Concentration of pollutants

3. A stock solution was prepared by adding 0.5 ml of Methylene Blue in 50 ml of distilled water. 5 separate test tubes were taken. In the 1st test tube, 2ml of stock solution and 18ml of distilled water in the 2nd, 4ml of stock solution and 16ml of distilled water, in the 3rd, 6ml of stock solution and 14ml of distilled water, in the 4th 8ml of stock solution and 12ml of distilled water, in 5th 10ml of stock solution and 10ml of distilled water were taken. Its O.D was taken at 620nm before and after adding the Activated Carbon into the test tubes.

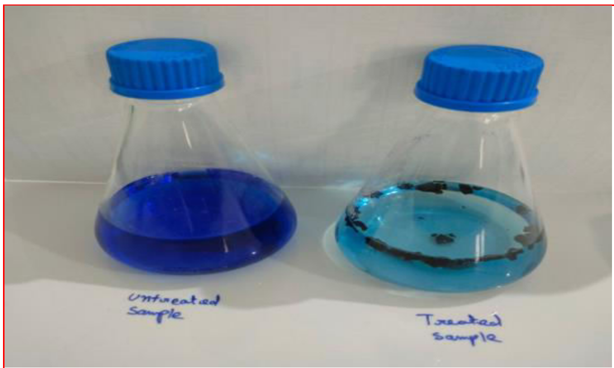

Fig. 1 Adsorption of methylene blue in the untreated sample and Treated sample by activated carbon.

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3. Result and discussion

3.1 Effect of contact time

The experimental runs **to** measure the effect of contact time (10-60 minutes) on the batch adsorption of methylene blue at an initial pH value of 6.0, methylene blue concentration of 1ml in 100ml and with 0.1g/100ml adsorbent dose indicated that an increase in contact time from 10-60 minutes enhanced the % adsorption of Methylene blue significantly. Figure **1** shows that over half of methylene blue adsorption happened in the first 30min, and from there on the pace of adsorption of methylene blue onto enacted carbon was slow, as displayed in Table 1 and Fig.1. The quick adsorption at the underlying contact time is ascribed to the profoundly adversely charged surface of enacted carbon for adsorption of cationic methylene blue in the arrangement at pH 6.0. The later sluggish pace of methylene blue adsorption is presumably because of the electrostatic obstacle or aversion between the adsorbed decidedly charged adsorbate onto the outer layer of enacted carbon and the accessible cationic adsorbate species in the arrangement, as well as the sluggish pore dispersion of the solute into the heft of the adsorbent. The harmony was accomplished at an hour when the most extreme adsorption onto actuated carbon was reached. Essentially, Amuda et al., dealt with the adsorption of methylene blue from an aqueous solution using steam-activated carbon produced from the Lantana Camara stem (Riahimanesh, F., Ahmad, A., Mehdi . B., Maleki, Behrooz., Mohammad, M. 2019). They saw that the color adsorption take-up was expanded as contact time expanded and arrived at harmony at an hour. The outcomes recommended that adsorption happens quickly at the underlying stage on the outside surface of the adsorbent followed by a slower inward dissemination process, which might be the rate-deciding step [13] (Amuda, **A.O.**, Olayiwola, **A.O.**, Alade, **A.O.**, Farombi, **A.G.**, Adebisi, **S.A.2014)**. Yasin et al., dealt with the adsorption of methylene blue onto treated actuated carbon (Yasin, Y., Hussein, M.Z. and Ahmad, F.A.,2007).The degree of color expulsion by enacted carbon expanded with the expansion of contact time. The expulsion of color by adsorption utilizing enacted carbon was viewed as quick at the underlying time of contact time and afterward turned out to be slower with the increment of contact time.

Table 1 Effect of contact time on Methylene blue by Activated carbon(marigold)

Time in (min)	% Absorbance
10	14.78
20	21.73
30	25.21
40	31.3
50	38.26
60	51.3

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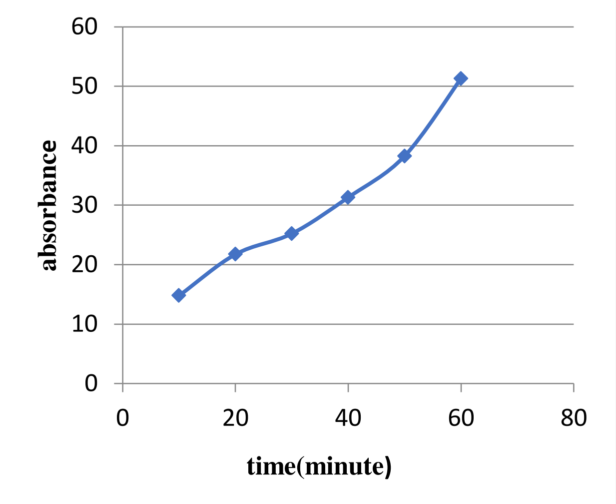

Fig. 2 Effect of contact time on Methylene blue by Activated carbon(marigold).

Table 2- Comparison of the effect of contact time on Methylene blue with the previous study

Observation	Comparison
Maximum absorption found in 30 min.	According to Ahmad et al., 2014 At contact time between volcanic ash and methylene blue for 15 minutes could remove methylene blue by a concentration of 10 mg L-1 until 81.68% or 8.168 mg L-1.
	85% dye removal takes place in 60 min for AC. The equilibrium was reached after 90 min (Pathania et al., 2017).
	Reaching equilibrium was 40 and 100 minutes at lower concentrations of 100 and 150 mg L−1, respectively, and 180 minutes for higher concentrations (Munir et al.,2020).

3.2 Effect of adsorbent dose

The adsorption of Methylene blue on Activated carbon was studied by changing the quantity of adsorbent (0.1, 0.2, 0.3, 0.4, and 0.5 g/20ml) in the test tube solution while

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ISSN PRINT 2319 1775 Online 2320 7876

Research paper UGC CARE Listed (Group -I) Journal Volume 11, Iss 8, Dec 2022

keeping the initial Methylene blue concentration (1ml in 100 ml) and contact time for 60 min at pH 7.0. The % adsorption(marigold) of Methylene blue increased from 14.03% to 82.45% as shown in Table 3 and Fig.2, as the adsorbent dose increased from 0.1g to 0.6g at the equilibrium time of 60 min. Maximum Methylene blue removal was achieved within 10 to 50 min, after which methylene blue concentration in the solution was almost constant. The expansion in the adsorption with the adsorbent portion can be credited to the expanded methylene blue surface region and accessibility of more adsorption locales, while the unit adsorbed of methylene blue diminished with the expansion in the adsorbent portion. The evacuation of the color expanded when the measurements were changed from 0.5 - 2.0 g·L−1, at various color focuses (50 - 200 mg·L−1). Pennebaker al., in 2015 chipped away at the adsorption of methylene blue onto treated enacted carbon. The impact of adsorbent mass on the adsorption of methylene blue color a progression of adsorption tests were done with various adsorbent measurements at a beginning color grouping of 50 and 100 ppm, the impact of adsorbent dose on the expulsion of methylene blue utilizing AC and 30% [19]. Similar results were showing in Table 4.

Table 3- Effect of Dose of Methylene blue by Activated carbon(marigold).

Dose in grams	% Absorbance
0.1	14.03
0.2	29.82
0.3	51.75
0.4	72.8
0.5	82.45

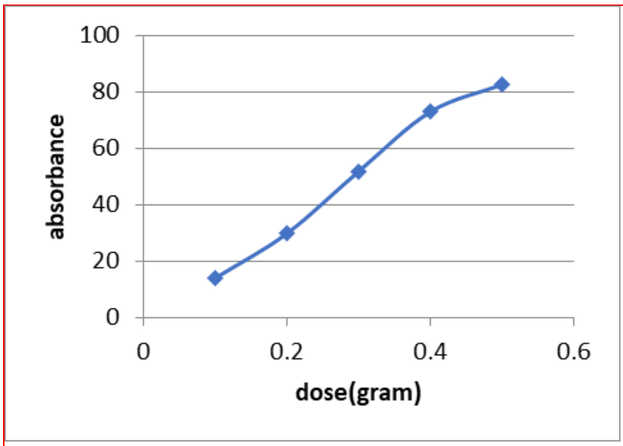

Fig. 3 Effect of dose on Methylene blue by Activated carbon(marigold)

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Table 4- Comparison of the dose of Methylene blue with the previous study

Observation	Comparison
The % adsorption of Methylene blue increased from 14.03% to 82.45% as shown in Fig.2, as the adsorbent dose increased from 0.1g to 0.6g at the equilibrium time of 60 min.	According to (Khodaie, M. et al., 2013) The results show that the percentage of adsorption was increased by increasing the dose of CHACZ to 3g/L [20].
	Similarly, along with the increase of adsorbent dosage prepared by Delonix Regia seeds from 0.1 g to 0.5 g, the percentage of dye adsorbed increased from 10% to 87.38%. This is because an increase in dosage increases the active sites for the adsorption of dye (Rajalakshmi et al., 2016) [21].
	As per the experiment conducted by Zhu, Y. et al., 2009 on bamboo charcoal. An increase in adsorption with an adsorbent dose can be attributed to increased adsorbent surface area and availability of more adsorption sites [22].

3.3 Effect of methylene blue concentration on adsorption

4. The effect of the initial concentration of methylene blue in the solution on the capacity of adsorption onto activated carbon was studied and the results are shown in Table 5 and Fig.3. The experiments were carried out at a fixed adsorbent dose of 0.5g/20ml) in the test solution at room temperature, pH 7.0 and at different initial concentrations of methylene blue (2, 4, 6, 8 and 10ml) for 60 minutes contact time. Table 5 and Fig 3. show that the % adsorption of activated carbon decreased with the increase of initial methylene blue concentration in the solution. Although the % adsorption decreased with the increase in initial dye concentration, the actual amount of methylene blue adsorbed per unit mass of adsorbent increased with the increase in methylene blue concentration in the test solution. It is evident from this figure that the amount adsorbed on the solid phase activated carbon at a lower initial concentration of

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methylene blue was smaller than the corresponding amount when higher initial concentrations were used. However, the % adsorption of methylene blue was greater at the initial concentration and smaller at higher concentrations. The adsorption capacity for Activated carbon was increased as the Methylene blue concentration increased from 0.1g to 0.5g/20ml. In the process of methylene blue adsorption, initially, the dye molecules have to first encounter the boundary effect, then they have to diffuse from the boundary layer film onto the adsorbent surface, and then finally they have to diffuse into the porous structure of the adsorbent. This phenomenon will take a longer contact time. Amuda et al., worked on the adsorption of Methylene Blue from an Aqueous Solution Using Steam-Activated Carbon Produced from the Lantana Camara Stem (Amuda et al., 2014) The results showed that the percentage of removal decreased with increasing initial dye concentration for SALC. At higher initial dye concentrations, the number of ions competing for the available sites on the surface of SALC was high, resulting in higher MB adsorption capacity. Karthik et al., in 2016 worked on the removal of Methylene blue by adsorption using Tribulusterrestris-activated carbon. They observed the initial MB concentration increased from 10 to 40 ppm, and the equilibrium percentage of dye removal decreased from 99.6 to 57.37%. The time taken to reach equilibrium was 120 minutes for 10ppm, 140 minutes for 20ppm, and 160 minutes for 30ppm. These findings are those reported by Riahimanesh et al., 2019 and the comparative study is shown in Table 6.

Table 5- Effect of concentration of pollutants on Methylene blue by Activated carbon (marigold)

Concentration of pollutant	Absorbance
0.2	52.38
0.4	80.48
0.6	81.66
0.8	84.28
1.0	83.78

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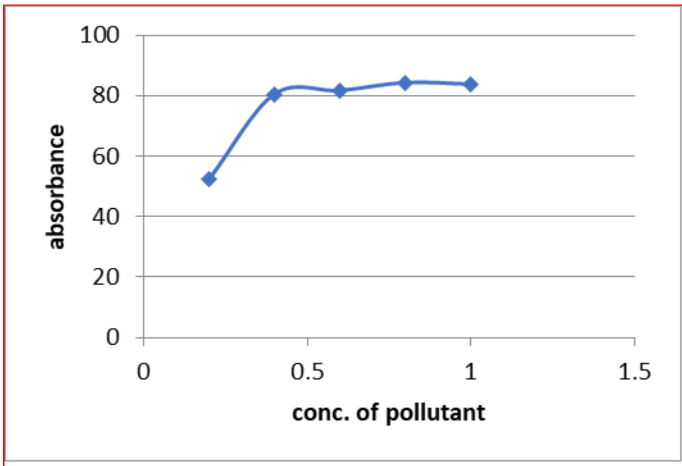

Fig. 4 Effect of concentration on Methylene blue by Activated carbon(marigold)

Table 6- Comparison of the concentration of pollutants in Methylene blue with the previous study

Observation	Comparison
The highest adsorption of dye was found at 0.5 mg/L concentration.	Karthik et al., in 2016 observed that the initial MB concentration increased from 10 to 40ppm, and the equilibrium percentage of dye removal decreased from 99.6 to 57.37%.
	The removal of dye was faster in the initial stages, was in a decreasing pattern, and became constant after equilibrium was achieved. The removal of dye was high in low concentration ranges and at a concentration of 150 mg L-1, the removal of dye was found to be 99.8%. The removal (%) decreased from 99.80 to 95.12% by increasing the concentration from 150 to 200 mg L-1 (Sharma et al., 2009).

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	The removal efficiency of the two adsorbents decreased with increasing initial dye concentration in the experiment conducted by Maghraby and Deeb, 2011.

3.4 Isotherm data analysis

5. The Langmuir and Freundlich isotherm are plotted and appeared in Figure 4 and Figure 5 and the outcomes got from the Langmuir and Freundlich isotherm model for the disposal of MB in enacted carbon are condensed in Table 7. The pertinence of the direct type of both models to initiate carbon was demonstrated by the high relationship coefficients, greater than 0.93. This recommends both models give a decent model of the sorption framework. It will be noticed that the estimation of 1/n was somewhere in the range of 0 and 1 showing the adsorbents arranged are good for the adsorption of the MB.

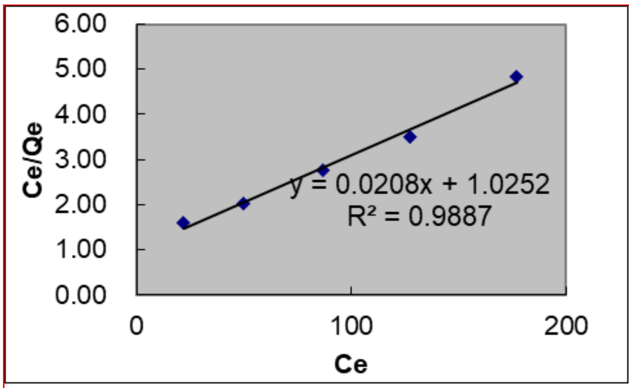

Fig. 5 Linear plot of Langmuir isotherm for MB adsorption

Isotherm Model	Coefficients Isotherm Parameters		
Langmuir	Qm (mg/g)	b (L/mg)	R2
	50	0.0195	0.988
Freundlich	1/n	Kf (mg/g)	R2
	0.48	2.07	0.938

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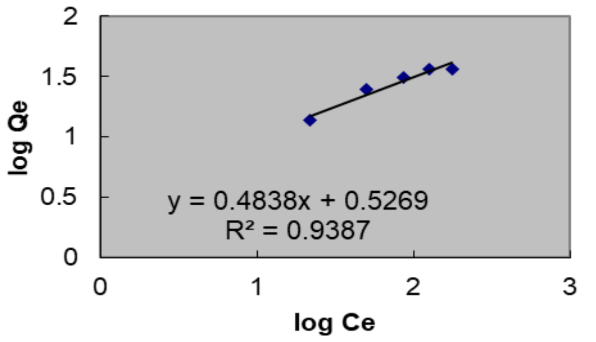
Table 7 Comparison of the Coefficients so the parameters for MB Adsorption



	First-order Kinetic Model			Second-order Kinetic Model			
Qe Experimental	k1	Qe Calculated	R2	k2	Qe Calculated	H	R2
13	0.015	1.70	0.98	0.0143	14	1.92	0.96

Fig.6 Linear plot of Freundlich Isotherm for MB Adsorption

3.5 Dynamic studies

The congruity between exploratory information and the model's anticipated worth was delineated through the relationship coefficients (R2 value close or equivalent to 1) [26]. Similarly, more prominent worth is the most extreme reasonable model for the energy of MB adsorption onto the initiated carbon.

The straight-line plots of log (Qe-Qt) against time for the pseudo-first-demand reaction and t/Qt against time for the pseudo-second-demand reaction of the adsorption of MB onto ordered carbon are shown up in Figure-6 and 7. The decided estimation of k1, k2, Qe and their related backslide coefficient regards (R2) are presented in Table 8

6. The association coefficients for the first and second solicitation engine models were 0.101 and 0.969, which drove us to expect that the pseudo-second solicitation dynamic model passes on a predominant relationship for MB adsorption on established carbon. The

ISSN PRINT 2319 1775 Online 2320 7876

Research paper UGC CARE Listed (Group -I) Journal Volume 11, Iss 8, Dec 2022

estimation of beginning sorption (h), shows that the level of early adsorption is 1.91 mg (g/min). These findings are those reported by Sulaiman et al 2021.

Table 8 Pseudo-First and Second order Kinetic Constants for Adsorption of MB

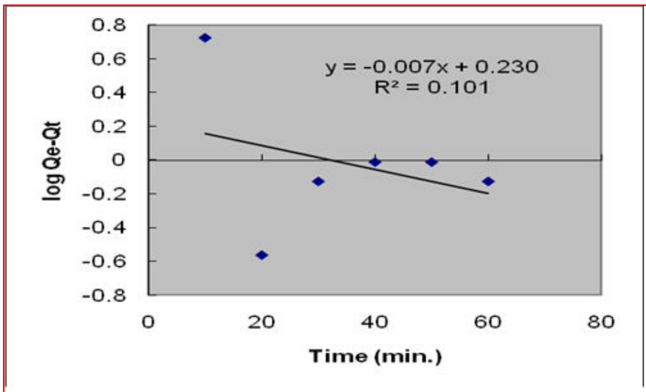


Fig.7 Pseudo First order Kinetic Plot for the Adsorption of MB

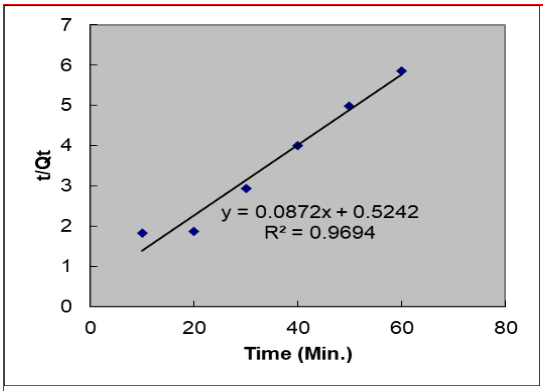


Fig.7 Pseudo Second order Kinetic Plot for the Adsorption of MB

4. CONCLUSION

Waste flowers from temples have the second-highest environmental and health effects after plastics. It is important to raise awareness of the improper disposal of waste flowers into the environment among temple officials and visitors and to encourage researchers to come up with creative uses for leftover flowers. The idea of using waste flowers as a source of raw materials for extensive applications currently has the interest of most academics. In the present examination, to think about the adsorption capability of initiated carbon arranged from the temple waste utilized for evacuation

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of methylene blue. The outcomes uncovered that the adsorption limit of enacted carbon of flower waste was high over methylene blue. The adsorptive assessment was applied in this group investigated as a segment of contact time, adsorbent bit, game plan pH, and starting center, where the adsorption of MB is particularly influenced by the adsorbent segment, time, introductory MB focus, arrangement pH. The results demonstrated a more elevated level of MB removal at lower beginning shading centers. The harmony between MB in the game plan and the hall half-absorbent face was drenched in 20 min. The kinetic studies revealed that both the kinetic model's pseudo-first order and pseudo-second order provided a good correlation for the adsorption of MB on the adsorbent. The present study showed that marigold adsorbent can be effectively used as a low-cost and efficient adsorbent for the treatment of dye effluents. Therefore, the temple floral waste can be utilized by preparing the adsorbent for the removal of MB dye from water bodies.

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