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Original Research Article

Removal of dye by using activated charcoal prepared by kitchen waste

Shravani Sunil Sontakke[1,*], Anushka Shailesh Rupwate[1], Mohini Baile[1], Ashish Jain[1]

[1] *Dept. of Pharmacy, D. D. Vispute College of Pharmacy & Research Center, Panvel, Maharashtra, India*

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ABSTRACT

The given research study explains about the removal of methyl red dye from aqueous solution. Using activated carbon prepared from kitchen waste. Garlic husk which was used in this work is cost effective and easily available kitchen waste for the production of activated carbon. HCl solution was used as activating agent. Various characterization procedures such as FT-IR, XRD, moisture content, ash value, volatile matter content, pH, iodine value of prepared activated carbon was studied. The adsorption property of activated carbon using different measurement studies like contact time study, effect of concentration, effect of dose of adsorbent was also studied.

1. Introduction

Industrialization is a sign of development and urbanization. There are numerous benefits of this but it leads to harmful effects on our natural ecosystem such as spoil, water and air. Contamination of water is one of the major problems all over the world. Water is one of the renewable resources for maintaining all types of life, has harmful effects on both marine life as well as on human beings.[1–3] Water pollution is characterized by alteration in water's physical, chemical and biological characteristics which causes harmful effects on both human and aquatic life.[4] Textile industry is one of the oldest and technologically advanced sectors. Due to this the textile mills and their waste products have increased throughout the world and are the major reason for pollution.[5,6] Most commonly used dyes for dyeing in these textile industries are azo dyes, acidic dyes, basic dyes, etc. along with many chemicals like bleaching agents, detergents etc. which are released in water bodies.[7,8] The pollution caused can be minimized by adsorption techniques. For adsorption method, activated carbon can be used. This activated carbon can be synthesized by using various precursors such as wood, coconut shell, agricultural wastes, etc. These precursors undergo various physical and chemical methods for activation. Carbon having excellent surface properties and specific functionalities can be developed to create a high affinity for adsorption. In this study, activated carbon is derived from Garlic peels using a green method. Its analysis is carried by FT-IR (Fourier Transformation Infrared Spectroscopy), XRD (X Ray Diffraction) to understand its property.[9] The objective of this paper is to investigate the adsorption properties of the synthesized activated carbon and to use it for treating the wastewater.

2. Experimental

2.1. Preparation of activated carbon

The garlic husks were washed with tap water to remove the dirt and then rinsed with distilled water. They were then dried at 50 for 6 hours. The dried garlic husk was taken in an iodine flask and 100ml of 2N HCl was added in iodine flask and was stored in dark for 24 hours. After 24 hours,

* *Corresponding author*.
E-mail address: shravanisontakke14@gmail.com (S. S. Sontakke).

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the soaked garlic husks were washed with distilled water until removal of acid and rinsed twice with distilled water. The soaked and washed garlic husks were placed in hot air oven for 24hrs at 150°C for the process of activation[10]. The activated garlic husks were removed and triturated and placed in muffle furnace at 450°C for the process of carbonization, activated carbon was obtained.

2.2. Preparation of dye solutions

The stock solution of methyl red and methyl violet was prepared by dissolving 50mg of the respective dyes in 100ml of distilled water each.

2.3. Characterization of activated carbon

1. Moisture content: — A small amount of sample was weighed using weighing balance and placed in petri plate or crucible. The crucible was placed in hot air oven at 105°*C* for 1.30hrs. The crucible was taken out immediately, covered with lid, cooled in desiccator and weighed.
2. Ash content: - A weighed amount of sample was ignited in muffle furnace at 750 ± 25°*C* for 1.5 hours. The crucible was taken out immediately, covered with lid, cooled in desiccator and weighed.
3. Volatile Matter content: — A weighed amount of sample was placed in crucible. The crucible was ignited at 920± 25°C for exactly 7 mins. The crucible was taken out immediately, covered with lid, cooled in desiccator and weighed.
4. Iodine Number: -Iodine number is a widely used parameter for activated carbon testing for its simplicity and a rapid assessment of adsorbent quality. It gives an estimate of its surface area and porosity. Iodine number is the milligrams of iodine adsorbed by 1 gm of activated carbon from a 0.1N iodine solution when the equilibrium iodine concentration is exactly 0.02N.

2.4. Investigation of the removal of selected dyes by the green adsorbent

1. Contact time study: A solution of methyl red having concentration of 20ppm was prepared. 0.1 gm. of activated carbon sample was taken in a beaker along with 50 ml of the prepared methyl red solution. This was then kept on a magnetic stirrer at a room temperature and at 600 rpm. So, 5ml of sample of above said concentration was taken in 5 different beakers. The contact time for 5 beakers were taken as 20,30,40,50 & 60 min. The % absorbance of UV at 410 nm was determined for the samples.
2. Effect of concentration of methyl red: 50 ml methyl red solution of concentrations 25 ppm, 50 ppm, 75 ppm & 100 ppm were taken in 5 different beakers, to which 0.1 gm of activated carbon was added and stirrer in magnetic stirrer at 600 rpm and room temperature. Samples were collected at regular intervals for 60 minutes. The % absorbance at 410nm and 590nm was found out using a UV-spectrophotometer.
3. Effect of dose of adsorbent: Various amounts of concentration of adsorbent was taken in 5 different beakers of 0.2gm, 0.4gm, 0.6gm & 0.8gm respectively. 50 ml of 20 ppm concentration Methyl red was taken in that beaker. The beakers were put on a magnetic stirrer at 600 rpm and room temperature. Samples were taken from each beaker after a period of 60 min. The % absorbance at 410 nm was found out using a UV-spectrophotometer.

3. Result and Discussion

3.1. Characterization of activated carbon

Table 1: Values for the characterization of prepared activated carbon.

SR No.	Parameters	Value
1.	Moisture content	4%
2.	Ash value	5.73%
3.	Volatile Matter Content	2.3%
4.	Fixed carbon Content	87.97%
5.	pH	6.23 (acidic)
6.	Iodine value	75.77mg/g

3.2. IR analysis of activated carbon

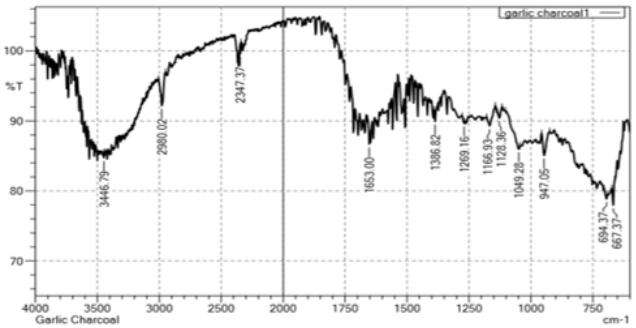

Fig. 1: IR analysis of prepared activated carbon

IR study confirms the presence of hydroxy function as most dominant and characteristic of all the frequencies. The band at 3550-3200cm[1] is attributed to O-H stretching pattern as seen in alcohols. The band between 1658-1648cm^{-1} shows weak to medium C=C stretching indicating possibility of presence of alkene. The saturated hydrocarbon C-H stretching adsorptions all occur below 3000 cm[10]

3.3. XRD analysis of activated carbon

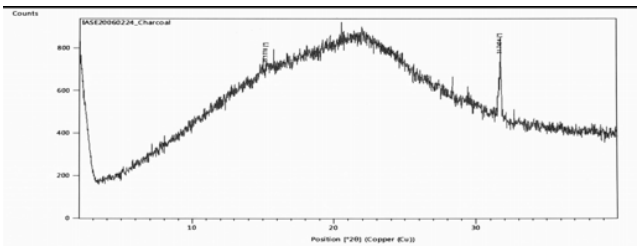

Fig. 2: XRD analysis of prepared activated carbon

The nature of synthesized AC was analyzed by XRD studies. This figure exhibits broad diffraction peaks (i.e., the absence of sharp peaks) which indicated the amorphous structure of activated carbon. Around two diffraction peaks were found at ř2θ= 15.1778^o and 31.7434^o in spectrum.

3.4. Investigation of removal of dyes

3.4.1. Contact time study

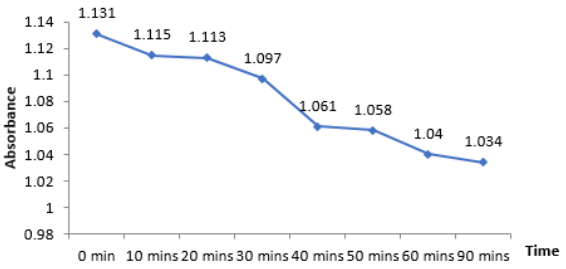

Fig. 3: Graph for contact time study of prepared active carbon.

0.5 g of adsorbent id taken in a flask containing 20ppm of methyl red solution. From the above graph we can observe that, initially within first 10 min there was increase in adsorption till 20 mins after which there was exponential increase in adsorption maximum slope for the next 10 min (40 mins) after which a steady state equilibrium was observed. Hence, we can say that the rate of adsorption activity by the adsorbent increases with increase in contact time.

3.4.2. Effect of concentration (Methyl Red)

0.5 g of adsorbent was taken in varying concentration of methyl red solution (25ppm, 50ppm, 75ppm, 100ppm) in a flask. From the above graph, we can observe that maximum adsorption was observed at 75ppm concentration.

3.4.3. Effect of dose of adsorbent

From the graph we can observe that increasing the dosage of adsorbent increases the removal of methyl red and there was no drastic increase in the adsorption rate on increasing

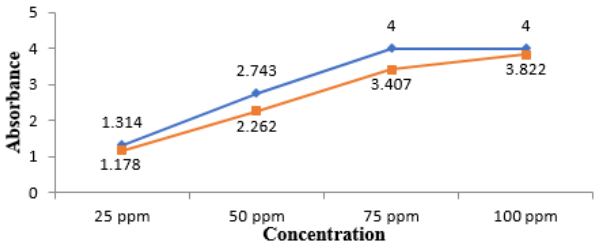

Fig. 4: Graph for the effect on concentration (methyl red solution)

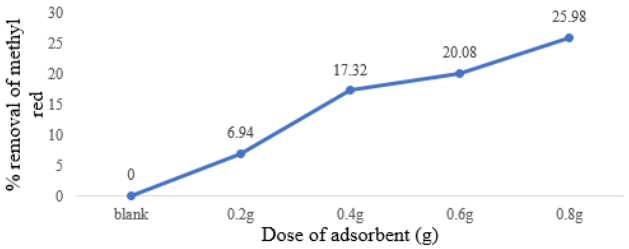

Fig. 5: Graphfor effect of dose of adsorbent

Table 2: Depiction of values for dose of adsorbent

Dose of adsorbent	Absorbance	% Removal of dye
Blank	2.101	0
0.2g	1.955	6.94
0.4g	1.737	17.32
0.6g	1.679	20.08
0.8g	1.555	25.98

the dosage of adsorbent beyond 0.4 gm of adsorbent, hence, it was taken as optimum dosage for removal of methyl red.

4. Conclusion

In the present study, an attempt was made to prepare activated carbon from garlic husks which is the easiest kitchen waste available. The green adsorbent (activated carbon) was prepared by chemical activation and carbonization process from garlic husks and was investigated for its adsorbent properties using methyl red dye. It was characterized by carrying out analysis like moisture content, ash value, volatile matter content, iodine number and pH. From the characterization study, it was found that, the prepared carbon contained 87.97% of fixed carbon content and by pH, iodine number analysis, it was found that the prepared activated carbon was acidic in nature with a good iodine number. The presence of functional groups was predicted by FTIR analysis, amorphous nature was confirmed by XRD analysis. From the contact time studies, it was seen that removal of methyl red for first 10 minutes increases but for the next 20 minutes, there was an exponential increase in the adsorption slope and thereafter the slope decreases and attain a steady for the next time

period. This indicated that as the contact time increases, more is the adsorbate- adsorbent interaction and hence removal of methyl red also increases. From the studies of dose pf adsorbent, we can suggest that as the dose of the adsorbent increases, the % removal of methyl red dye from the solution also increases. This indicates that the surface area which is exposed to dye solution can be adsorbed into the pores of the adsorbent and hence the adsorption of dye increases.

Further, works may include preparation of activated carbon from various other kitchen or agricultural waste and investigation for removal of different dyes, metal ions like Pb, Cu and other toxic metals from dye waste water or removal of pesticides, detergents and herbicides from ground water. The removal of active pharmaceutical ingredient (API) from the waste effluents can also be investigated.

5. Source of Funding

None.

6. Conflict of Interest

None.

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Author biography

Shravani Sunil Sontakke, Student

Anushka Shailesh Rupwate, Student

Mohini Baile, Assistant Professor

Ashish Jain, Principal

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