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Defluoridation of Water by using Low Cost Activated Carbon Prepared from Lemon Peels

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Abstract—*Presence of excess fluoride in drinking water is a serious problem faced by mankind. Fluoride in excess can cause skeletal and dental fluorosis since many other available methods of defluoridation are expensive this work asses the suitability of inexpensive lemon peel activated carbon to effectively remediate fluoride contaminated water .Lemon peel activated carbon was synthesized by adopting physical activation methods. Batch process was adopted*
To study the removal of fluoride from synthetically prepared fluoride solution using indigenously prepared lemon peel activated carbon under room temperature and various operating parameters were taken into consideration such as pH, adsorbent dosage, contact time rotation speed and their influence on percentage removal of fluoride was obtained.

Keywords*: Fluorosis, Defluoridation, Lemon peel, Activated carbon, Batch process"*

1. INTRODUCTION

"Pure water is scarce and is not easily accessible to all. Deprived sections of the society consume contaminated water resulting in epidemics. The water may be contaminated by natural sources or by industrial effluents. One such a contaminant is fluoride. Fluoride is often considered as a "two edged sword" because deficiency of fluoride intake leads to dental caries while excess consumption leads to dental and skeletal fluorosis. Fluorosis is an important clinical and public health problem in several parts of the world. Geological formation is the main source of fluoride in the groundwater. The other sources of fluoride occurrence in water are industrial discharge from aluminium industries, phosphate industries, coal plants as well as due to water, food, air, and cosmetics.

Removal of fluoride from water is important because of the ill effects it causes. Defluoridation is removal of fluoride from water. Although there are several sources of fluoride intake, it is roughly estimated that 60% of the total intake is through drinking water [1]. Since many other available methods of defluoridation are costlier, there is a greater need of developing a low cost method. The most commonly adopted method in India is a Nalgonda technique of community defluoridation, which is based on precipitation process [2]. The existing traditional methods like chemical precipitation, ion exchange, membrane separation and electro deposition have been used for the removal process of fluoride [3].The method of adsorption is used worldwide because of its cost effectiveness and good removal efficiency for the removal of different ions from water. Use of lemon peel has an added advantage over the chemical treatment of water because it is organic and found to be non- harmful in any of the possible ways.

2. MATERIAL AND METHODS

2.1 Preparation of the adsorbent

Lemon peels were collected from local juice centers and were washed thoroughly and sun dried for 5-6 days [4]. Dry lemon peels were oven-dried at 80±5˚c for 24hours.The dried lemon peels were powdered by using an electric mixer and this material was then thermally activated (carbonized) at 500±5˚C in a muffle furnace for 1 hr in the presence of air. After activation, the ash content was removed by washing it with distilled water until the pH was 7-7.8 and dried in an oven at 100±5˚C for 24 hr and resulting activated carbon material was kept in a desiccator for 24 hr and stored in air tight glass bottle for further use.

2.2 Fluoride content analysis

Stock solution of fluoride was prepared by dissolving 0.221 gm of sodium fluoride (NaF) in one liter of distilled water. This stock solution is used to prepare required concentration of fluoride solution standard. In each case, after the adsorption, the solution was filtered through Whatman no 42 filter paper and the filtrate were analyzed through SPADNS photometric method [4, 11], at 570 nm using the UV–spectrophotometer. Percentage of fluoride removal was calculated by adopting fallowing formula:

Percentage removal = 100 (Ci-Ce)/ Ci

Where Ci is the initial concentration and Ce is the final concentration of the fluoride respectively.

3. EXPERIMENTAL SETUP

The fluoride removal studies were carried out by using prepared lemon peel activated carbon using 250ml Stoppard conical flask using 100ml of synthetically prepared fluoride solutions of known initial concentration and the solutions were subjected to batch adsorption to study the effect of various operating parameters like adsorbent dosage, pH, contact time and rotation speed [5]. One parameter was varied in each case keeping the rest constant. An open air platform shaker was used to agitate the mixture and to alter the pH 0 0.5N HNO_3 and 0.1N NaOH were used. After giving a required contact time, the contents of the flasks were filtered using Whatmann's filter paper number 42. The filtrate was used for final fluoride content estimation using SPADNS method in UV-spectrophotometer at 570nm [6].

The pH was altered from 2 to 12.The contact time was varied from15 to 150 min along with adsorbent dose altering from 0.5gm/l to 6 gm/l and rotation speed was altered from 125 rpm to 325 rpm. Synthetically prepared fluoride solution sample had initial concentration of 10 mg/l. These parameters were varied to find their influence on removal efficiency of adsorbent.

4. RESULTS AND DISCUSSION

4.1. Effect of pH

The pH of the aqueous solution is a controlling factor in the adsorption process. Thus, the role of hydrogen ion concentration was examined at pH values of 2, 4, 6, 8, 10 and 12. This was adjusted by adding 0.5N HNO_3 or 0.1N NaOH with 1000 ml of standard solution of 10 mg/l of fluoride for a contact time of 100 min with a dose of 10 g/l of activated carbon. The influence of pH on the adsorption rate is shown in Fig. 1.

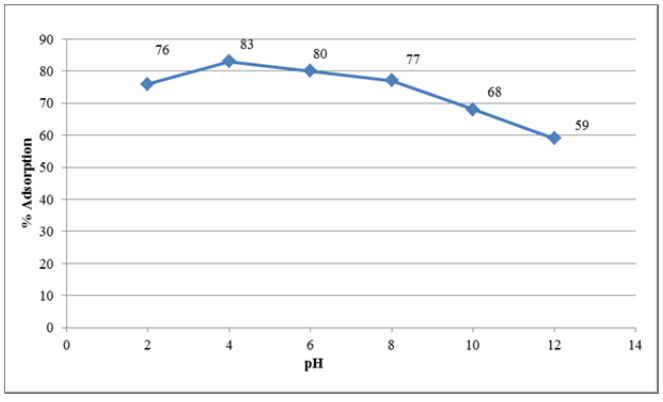

Fig. 1

Maximum removal was obtained at pH 4.0 in 100 min of contact time at a rotation speed of 125rpm .In this case, the result may be due to neutralization of the negative charges at the surface of the activated carbon by greater hydrogen ion concentration at lower pH values. This reduces hindrance to diffusion of the negatively charged fluoride ions on to the increased active surface of activated carbon [7].

Table 1

pH	% Ads.
2	76
4	83
6	80
8	77
10	68
12	59

3.2 Effect of adsorbent dose

From Fig. 2, it is observed that the maximum removal of 58.5% of fluoride was obtained by 1gram of adsorbent. For all these runs, initial fluoride ion concentration was fixed at 10 mg/l. The amount of adsorbent dose was varied between 0.5 to 6 g/l in aqueous solution at neutral pH values at a room temperature of 29 ± 0.5°C and contact period of 100min and rotation speed of 125 rpm were maintained as constant [8].

Table 2

Sample	*Ci* (ppm)	Cf (ppm)	(%) Ads.
1	10	4.39	56.1
2	10	4.15	58.5
3	10	5.35	46.5
4	10	6.5	35
5	10	6.85	31.5

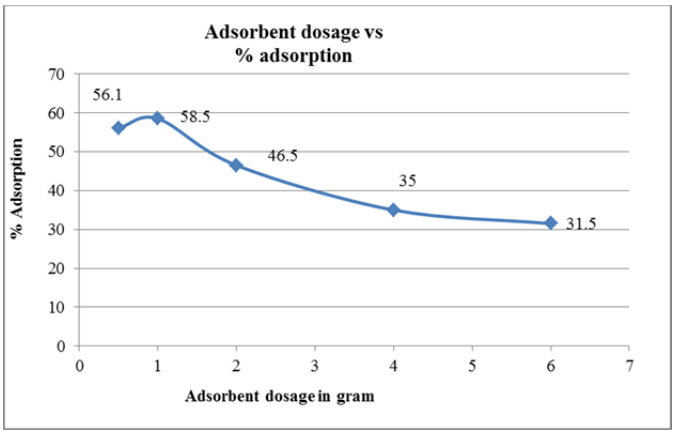

Fig. 2

3.3 Effect of contact time

From Fig. 3, it is observed that contact time dint had more impact on removal efficiency and maximum removal of 70.6% was obtained at 120 min. Adsorbent dose of 10 g/l was adopted and kept constant throughout the experimental work. The contact time was varied from 15 to150 min. [9]

Table 3

Time(min)	% Ads.
15	68.8
30	66
60	67.4
90	64.4
120	70.6
150	66.4

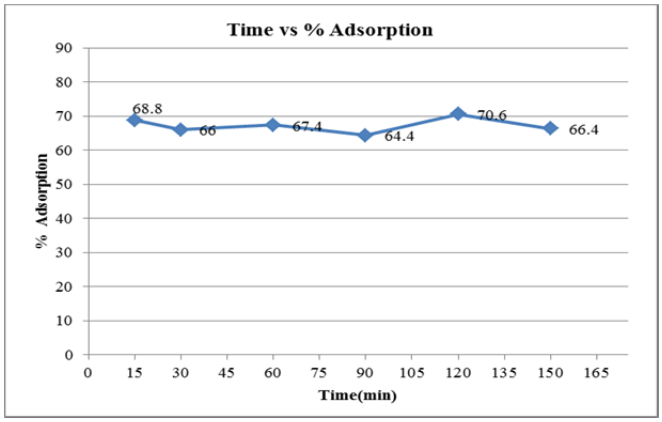

Fig. 3

3.4 Effect of rotation speed

From Fig.4, it is observed that at 225 rpm fluoride removal percentage was 82% .For further increase in rotation speed reduced adsorption was observed. The adsorption was found to be sufficiently influenced by the rotation speed. All the other operating parameters like dosage, contact time, initial concentration were kept constant altering the rotation speed from 175to 375rpm. [10]

Table 4

RPM	%Ads
175	80.7
225	82
275	78.5
325	76.6
375	71.2

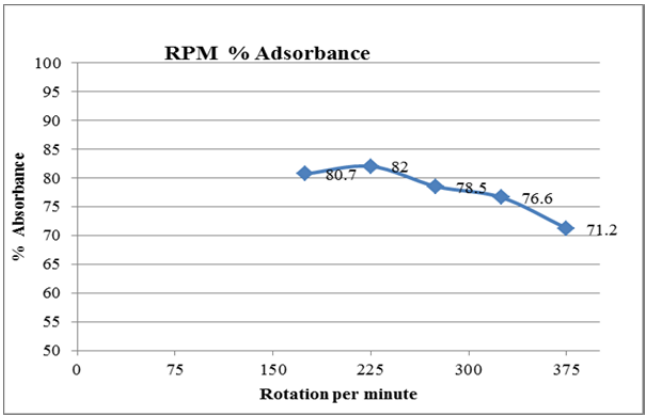

Fig. 4

5. CONCLUSION

This works investigate the adsorption of fluoride onto lemon peel activated carbon. Experiments were made as a function of different adsorption parameters (pH, adsorbent dosage, contact time, rotation speed) results show that the low cost lemon peel activated carbon could be fruitfully used for fluoride removal from water. Results indicate that fluoride adsorption was higher in the pH range of 4 and further increase in pH resulted in decrease of adsorption percentage. Maximum fluoride removal percentage was obtained at a contact period of 120 min. similarly maximum fluoride removal for adsorbent dose of 10g/l and maximum removal of fluoride at a rotation speed of 225rpm.

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