ADSORPTION STUDIES OF FLUORIDE ON ACTIVATED CARBON DERIVED FROM PHOENIX DACTYLIFERA (DATE PLAM) SEEDS

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Abstract

The removal of Fluoride from synthetic sample by adsorption on chemical activated carbon ($CaCl_2$) prepared from Phoenix Dactylifera (Date Plam) seeds have been carried out at room temperature 32 ± 1 ^oC. Batch tests were conducted for the removal of Fluoride on chemically activated carbon with Impregnation ratio's (I.R) 0.25, 0.50 and 0.75 for optimum time, optimum dosage and optimum pH. The maximum removal efficiency was obtained at an I.R. ratio of 0.75. The optimum contact time, adsorbent dose and pH for carbon with I.R-0.75 was 40min, 140mg and 7.00 respectively, with fluoride removal efficiency of 93%, 93.5% and 94.5% respectively has been observed.

Keywords: *Fluoride, Activated carbon, Contact time, Dosage, pH, Phoenix Dactylifera (Date Plam) seeds.*

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1. INTRODUCTION

Water is important life sustaining material for all living beings. But nowadays, pure drinking water is available to very few people. Others take more or less contaminated water. The concept of proving safe drinking water is assuming lot of concern globally in general and developing and underdeveloped nations in particular. India being a developing nation, where the majority of people live in the villages with bare infrastructural facilities, high degree of illiteracy and lack of awareness of sanitation and hygiene, the concept of safe drinking water assumes greater significance. But most of the rural population depends on ground water sources for drinking purposes which are contaminated with a variety of salts and minerals. One among them is the excess content of fluoride which causes a deleterious impact on the health of the people. Fluoride has been described as more toxic than lead and less toxic than arsenic and is considered as an accumulative toxin. The continuous use of contaminated water results in dental and skeletal Fluorosis primarily and many other health effects like gastrointestinal complaints secondarily. As the "Fluorosis" considered to be an incurable disease, prevention is the only solution to this problem.Thus, the studies regarding the defluoridation of water using a variety of adsorbents gained importance nowadays.

Defluoridation can be done using different techniques viz., Reverse Osmosis, Electro dialysis and ion exchange methods. The Nalgonda technique of defluoridation developed by NEERI has become popular recently, but it has its own drawbacks. Several adsorbents are also tried for the defluoridation activity. Activated Alumina is reported to have high defluoridation capacity. But most of these techniques and methods are worked out to be expensive.

1.1 Objectives:

The main objective of the study is removal of fluoride from the drinking water by chemically activated carbon(calcium chloride) derived from date palm seeds, to study the physico-chemical properties of the prepared carbon. Fluoride removal as a function of contact time, dosage and pH

1.2 Literature Review:

Materials like thermally activated Neem and thermally activated Kikar leaves(Sunil Kumar1,et al.,2008), Graphite (M Karthikeyan & K P Elango*,2008), Gulmohar fruit shell(Pallavi Vijyakumar & S.R.Mise,2008-09), Rice Husk (Waheed S. Deshmukh,et al,2009), Cynodon Dactylon(G. Alagumuthu*, et al,2010), Phyllanthus Emblica (Veeraputhiran V. and Alagumuthu G.*2011), by Multani Matti and red soil (Gandhi N.1, et al, 2012), Acacia Auriculiformis scrap wood char (Monal Dutta, et al,2012) have been used as adsorbents. Activated carbon prepared from various raw materials exhibits good capacity for removal of fluoride from drinking water. No reports on use of Phoenix Dactylifera (Date Plam) seeds have appeared for defluoridation.

Hence it is aimed in the present work, to study the suitability of the carbon prepared from Phoenix Dactylifera (Date Plam) seeds to be used as an adsorbent for the removal of the Fluorides from the drinking water.

2. MATERIALS AND METHODS

2.1 Materials:

The material used for preparing carbon was fruit of Phoenix Dactylifera (Date Plam) seeds. Physical characteristics of carbon like moisture content, decolorizing power, pH, surface area, bulk density and specific gravity has been carried out and shown in table1 below.

2.1.1 Characteristics of Phoenix Dactylifera (Date Palm) Seeds:

Before using Phoenix dactylifera (Date Palm) seed carbon as an adsorbent, it is essential to know some of the characteristics such as moisture content, ash content, decolorizing power, surface area, pH, specific gravity, bulk density and of the prepared carbons. The results are shown in Table-1.

Table.1 Characteristics of Prepared Activated Carbons

Sl.No.	Characteristics	Chemically activated (CaCl2) (I.R.'s)		
		0.25	0.50	0.75
1	Moisture content (%)	4.00	4.00	5.00
2	Ash content (%)	15.26	15.05	13.10
3	Decolorizing power (mg/g)	6.00	9.00	10.50
4	Surface area (m2/g)	541.26	576.67	588.05
5	pH	6.80	6.64	6.44
6	Specific gravity	0.994	1.040	1.001
7	Bulk Density (g/cm3)	0.416	0.256	0.285

The analysis has been carried out as per the "Standard Methods", 20th edition.

2.2 Methods:

2.2.1 Preparation of Activated Carbon Using $Cacl_2$ as Activating Agent:

The known quantity of washed and dried Phoenix Dactylifera (Date Plam) seeds powder was mixed with the activating agent ($CaCl_2$), in required quantity, depending upon the impregnation ratio (I.R).

$$\text{Impregnation ratio (I.R)} = \frac{\text{Weight of the active agent added}}{\text{Weight of carbonizing material}}$$

The distilled water was added and boiled on hot plate till most of the water evaporated and slurry like mixture was retained. The mixture was oven dried in a clean tray for 24 hours maintained at 105±5°C which helps in evaporation of moisture from the mixture. Preheated carbonizing material was filled in small container in three layers, by compacting each layer without any air space. The small container is then placed into a big container, such that sand surrounded the small container completely, the lid of the big container was tightly fitted. Pin hole has been made on the lids of the containers. The container set-up was kept in Muffle furnace and heated at steady rate to attain the temperature of 800°C. The container was taken out after allowing 10 hours for cooling. Activated carbon thus prepared was washed with 0.1N HCl to remove the activating agent, followed by hot distilled water for about 8 times to remove the excess HCl present in the activated carbon. The activated carbon was dried at 105 ± 5°C and packed in polythene bags and kept in desiccators.

2.2.2 Determination of Optimum Contact Time:

The adsorption is strongly influenced by the contact time. To study the effect of contact time, 100mL of 5mg/L fluoride solution was mixed with 100mg of activated carbon, stirred at different contact times varying from (10mins, 20mins, 30mins up to 120mins). Then filtrate was analyzed for fluoride concentration by using UV-visible spectrophotometer.

2.2.3 Determination of Optimum Dosage of Adsorbent:

To determine the optimum dosage of activated carbon of Phoenix dactylifera (Date Palm) seed, it was added to the conical flask in different dosages varying from (20mg, 40mg, 60mg up to 180mg), containing known concentration of fluoride solution 5 mg/L in 100mL. The solution in the conical flasks was subjected to stirring for optimum contact time, filtrate is analyzed for residual fluoride concentration using spectrophotometer.

2.2.4 Determination of Optimum pH on Fluoride:

The extent of adsorption is strongly influenced by the pH at which adsorption is carried out. The effect of pH on fluoride

adsorption was studied by performing equilibrium adsorption tests at different initial pH values, i.e. from 2.0 to 9.0. The pH of solution was adjusted by using 0.1N H_2SO_4 or 0.1N NaOH. The activated carbon of Phoenix dactylifera (Date Palm) seed were mixed and stirred to optimum contact time, filtrate was analyzed for residual fluoride concentration.The pH at which maximum fluoride removal forms optimum pH.

3. RESULTS AND DISCUSSIONS

The efficiency of removal of Fluoride is studied in terms of:

a) Effect of contact time.
b) Effect of dosage.
c) Effect of pH.

a) Effect of Contact Time:

Contact time has greater influence on the adsorption process. The effect of contact time on removal of Fluoride from synthetic sample is shown in Fig 1. It is observed that the extent of Fluoride adsorption increases with increase in time and attains equilibrium at particular time. Hence optimum contact time for all prepared carbons is listed in Table-2.

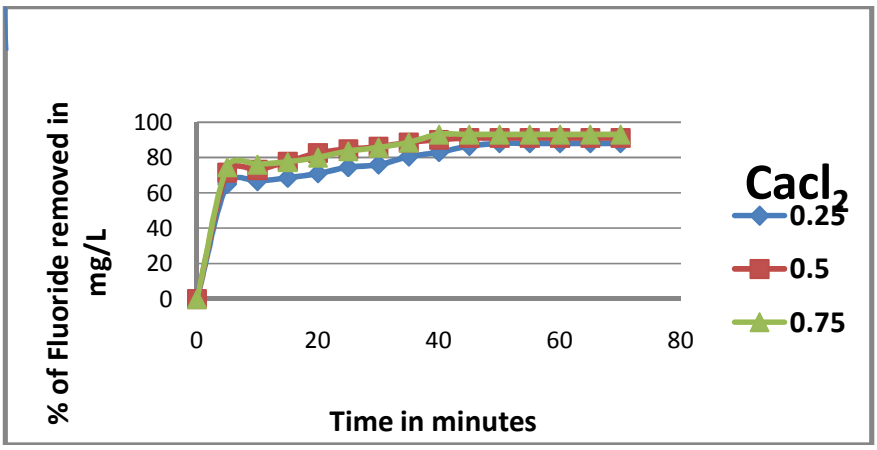

Fig.1. Effect of contact time on fluoride removal by chemically (CaCl2) activated carbon

b) Effect of Adsorbent Dosage:

Effect of adsorbent dosage is studied and graph of percentage of Fluoride removal versus dosage is plotted as shown in Fig 2. From the graph it is observed that, as the dosage of carbon increases, amount of residual fluoride decreases sharply and attains equilibrium. The dosage, at which maximum removal is attained, is taken as optimum dosage. Hence optimum dosages for all prepared carbon are listed in Table-2.

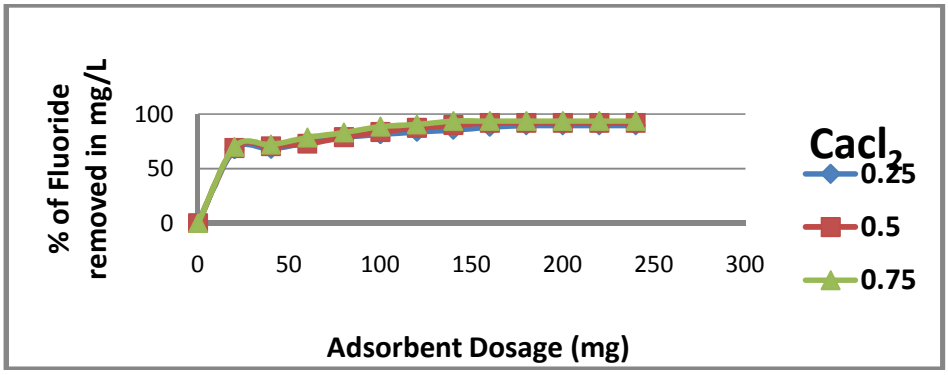

Fig.2. Effect of contact dosage on fluoride removal by chemically (CaCl2) activated carbon

c) Effect of pH on Fluoride Removal :

The extent of adsorption is strongly influenced by pH at which adsorption is carried out. The pH of the solution as influenced on extent of adsorption removal effiencies of Fluoride by prepared activated carbon at different pH values as shown as in Fig 3 and Table-2.

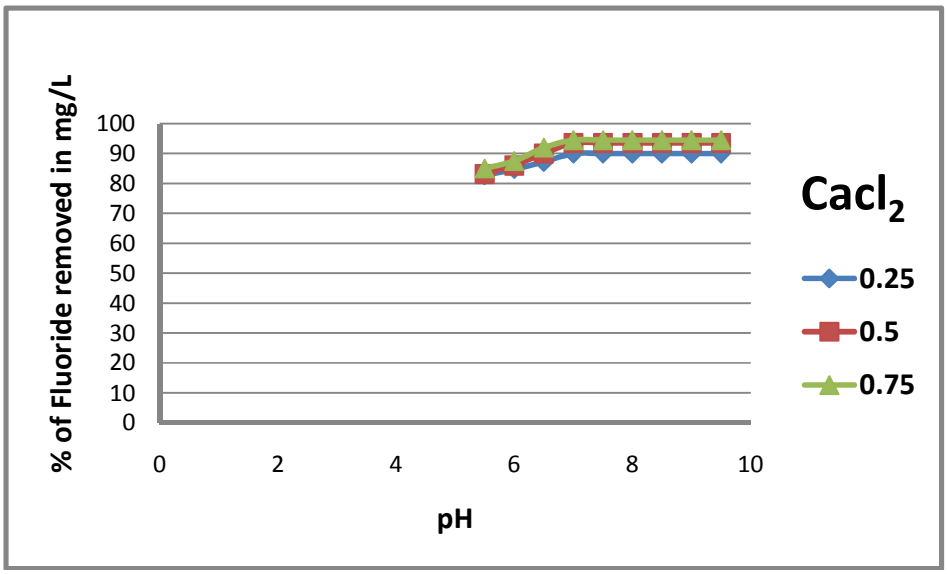

Fig.3 Effect of pH on fluoride removal by chemically (CaCl2) activated carbon

Table.2: Optimum time, dosage and maximum pH for prepared carbon

Initial concentration C_o= 5 mg/L Temperature= 32±1°C Volume of sample = 100 mL				
Types of carbon	**I.R.**	**Optimum time (min)**	**Optimum dosage in (mg)**	**Optimum pH**
Chemically activated ($CaCl_2$) Carbon for different I.R's	0.25	50	180	7.00
	0.50	45	160	7.00
	0.75	40	140	7.00

CONCLUSIONS

Based on the experimental study following conclusions were drawn:

- The optimum contact time for $CaCl_2$ activated carbon of I.R's. 0.25, 0.50 and 0.75 are 50, 45, 40 minutes with removal efficiency of 88%, 91.0% and 93% respectively.
- The result of experiment on optimization of dosage of adsorbent reveals that, increase in amount of adsorbent added, increases the removal of fluoride from the solution. Optimum dosage for $CaCl_2$ activated carbons of I.R's. 0.25, 0.50 and 0.75 are180mg, 160mg, 140mg with removal efficiency of 89.5%, 92.0% and 93.5% respectively.
- The adsorption of fluoride is mainly pH dependent. The removal efficiency of adsorbent increases with decrease in pH value. It has been observed that maximum adsorption taken place around pH 7.00 for $CaCl_2$ activated carbons of I.R's. 0.25, 0.50 and 0.75 with removal efficiency of 90.0%, 93.5% and 94.5% respectively.

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