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Fluoride Removal from Water Using 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 (NaCl) prepared from Phoenix Dactylifera (Date Plam) seeds have been carried out at room temperature 32 ± 1°C. 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 45min, 160mg and 7.00 respectively, with fluoride removal efficiency of 85%, 87.0% and 88.5% respectively has been observed.**

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

1. INTRODUCTION

Earth is the most beautiful planet of our solar system, abundance of clean air, water and soil help in sustaining life on the planet. Man's quest for securing his future, along with his today, coupled with population explosion, and industrialization is leading to over exploitation of all the resources of earth. This over utilisation of the natural resources is leading to pollution of air, soil and water. Water is one of the most important elements on earth. Every living being needs water for its survival. Without water everything (plants, animals, human beings, other living beings etc) will perish. Ground water is one of the major sources of water for domestic purposes in India. It was believed that ground water is purer and safer than surface water due to earth covering which works as a natural filter. But it is not true. Few decades back, water was considered to be pure and unpolluted if it was odorless, free from turbidity and good from aesthetic point of view. But now, the whole concept of water pollution has changed. Even if the water is clear, it may be polluted. Besides that, the surface water is also contaminated by the effluents from industries, municipalities and other places. Water is life for all living beings. But nowadays, pure drinking water is available to very few people. Others take more or less contaminated water. The contamination may be caused either by natural forces or by industrial effluents. One such contaminant is fluoride. Fluorine is the most highly reactive element of the halogen family. It exists in water mainly as fluoride ion. Fluoride has been described as more toxic than lead and less toxic than arsenic and is considered as an accumulative toxin. The occurrence of high fluoride concentrations in ground water is a problem faced by many countries, notably India, Sri Lanka, and China, the Rift Valley countries in East Africa, Turkey, and parts of South Africa. Fluoride related health hazards are a major environmental problem in many regions of the world. India is among the 25 nations around the globe, where health problem occurs due to the consumption of fluoride-contaminated water. At least 20 states in India-Andhra Pradesh, Rajasthan, Gujarat (70-100% districts are affected), Bihar, Punjab, Haryana, Karnataka, Maharashtra, Madhya Pradesh, Tamil Nadu, Uttar Pradesh and some parts of Delhi (40-70% districts are affected), Assam, Kerala, Orissa, West Bengal, Jammu & Kashmir (10-40% districts are affected) and even Uttranchal, Jharkhand and Chattisgarh- are identified as significantly affected. In Karnataka (Gadag , Tumkur , Kolar , Raichur , Gulbarga, Chitradugra & Bellary) are affected. As per the Indian Standards, acceptable limit of fluoride in consumable water is 1.0 mg/L. The high fluoride levels in drinking water and its impacts on human health have increased the importance of defluoridation studies. Nalgonda technique developed by NEERI is commonly preferred at all levels because of its low price and ease of handling. Various processes tried so far for the removal of excess fluoride from water are ion exchange, precipitation, and membrane process. However, most of these methods have high operational and maintenance cost, low fluoride removal capacities, lack of selectivity for fluoride, undesirable effects on water quality, generation of large volumes of sludge and complicated procedures involved in the treatment. Adsorption is the process considered to be efficient

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to defluoridate the water. Researches were carried on different adsorbents, viz. activated carbon, processed bone char powder, activated alumina, magnesia, activated bauxite, fly ash, granular calcite, alum, lime, etc. Fluoride is well recognized as an element of public health concern. Fluoride is present universally in almost every water (higher concentrations are found in ground water), earth crust, many minerals, rocks etc. It is also present in most of everyday needs, viz. toothpastes, drugs, cosmetics, chewing gums, mouthwashes, and so on. Though a small amount of it is beneficial for human health for preventing dental carries, it is causes Skeletal fluorosis or Dental fluorosis or Non-skeletal fluorosis when present in excess of 1 mg/L. World Health Organization (WHO) and IS : 10500 recommend that the fluoride content in drinking water should be in the range of 1-1.5 mg/L.

Objectives:

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

Literature Review:

Materials like commercially available activated carbon(A.R.Tembhurkar and Shilpa Dongre,2006), 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

Materials:

The material used for preparing carbon was fruit of Phoenix Dactylifera (Date Plam) seeds. The scientific name was derived from "Phoenix', the legendary bird of ancient Greece. The specific name dactylifera came from the shape of the fruit, 'dactylos' being the ancient Greek word for finger. The Phoenixdactylifera (date palm) is believed to have originated in the lands around the Persian Gulf and in ancient times was especially abundant between the Nile and Euphrates rivers. The Phoenixdactylifera (date palm) must have full sun. It cannot live in the shade it will grow in all warm climates where the temperature rarely falls to (6.67°C).The data thrives in sand, sandy loam, clay and other heavy soils. It needs good drainage and aeration. It is remarkably tolerant of alkali. Dates ripen from late September through December and there are 6 to 8 pickings per palm.

The seed of date as an agro waste have potential to be a very good and cheap source for a carbonaceous raw material. So in present work phoenix dactylifera (date palm) seeds are used to prepare low cost activated carbon. Activated carbon made from phoenix dactylifera (date palm) seeds not import any colour, taste and odour to water, when it is added to it. So it is a suitable adsorbent for waste water treatment. Physical characteristics of carbon like moisture content, decolourising power, pH, surface area, bulk density and specific gravity has been carried out and shown in table1 below**.**

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 (NaCl) (I.R.'s)		
		0.25	**0.50**	**0.75**
1	Moisture content (%)	4.00	4.00	4.00
2	Ash content (%)	14.00	13.25	11.67
3	Decolorizing power (mg/g)	3.00	6.00	7.50
4	Surface area (m^2/g)	513.44	528.61	564.02
5	pH	7.24	7.10	6.94
6	Specific gravity	1.086	1.543	0.946
7	Bulk Density (g/cm^3)	0.405	0.459	0.385

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

Methods:

Preparation of Activated carbon using NaCl as activating agent:

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

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

The distilled water was

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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^{o}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^{0}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^{o}C and packed in polythene bags and kept in desiccator.

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.

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.

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 optium contact time, filtrate was analysed for residual fluoride concentration.The pH at which maximum fluoride removal forms optimum pH.

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. For chemically activated carbon (NaCl) of I.R. 0.25, 0.50 and 0.75 are 55, 50, 45 minutes with removal efficiency of 76%, 80% and 85% respectively in 100 mL of sample. 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.

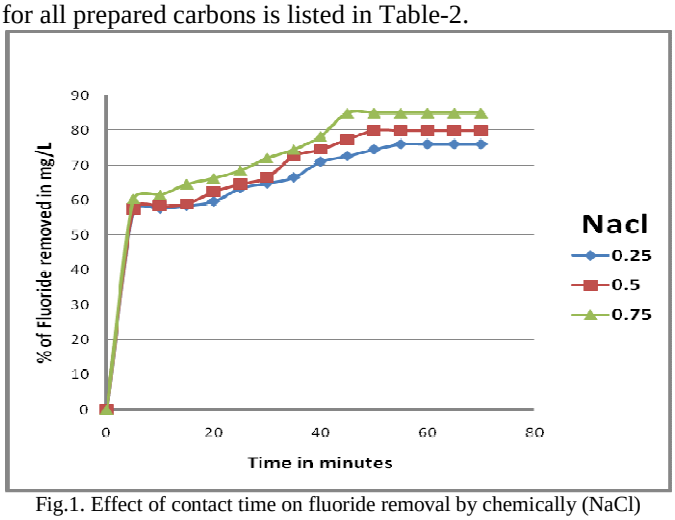

Fig.1. Effect of contact time on fluoride removal by chemically (NaCl) activated carbon

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. For chemically activated carbon i.e. NaCl activated carbons of I.R. 0.25, 0.50 and 0.75 are 200mg, 180mg, 160mg with removal efficiency of 78.5%, 85.2% and 87.0% respectively in 100 mL of sample. 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.

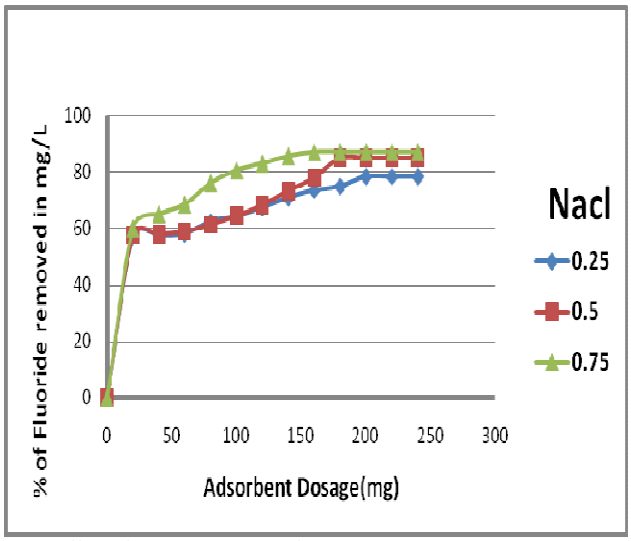

Fig.2.Effect of contact dosage on fluoride removal by chemically (NaCl) activated carbon

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c) Effect of pH on Fluoride Removal:

The extent of adsorption is strongly influenced by pH at which adsorption is carried out. For chemically activated carbon i.e. NaCl activated carbons of I.R. 0.25, 0.50 and 0.75 with removal efficiency of 79.5%, 86.0% and 88.5% respectively in 100 mL of sample. 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.

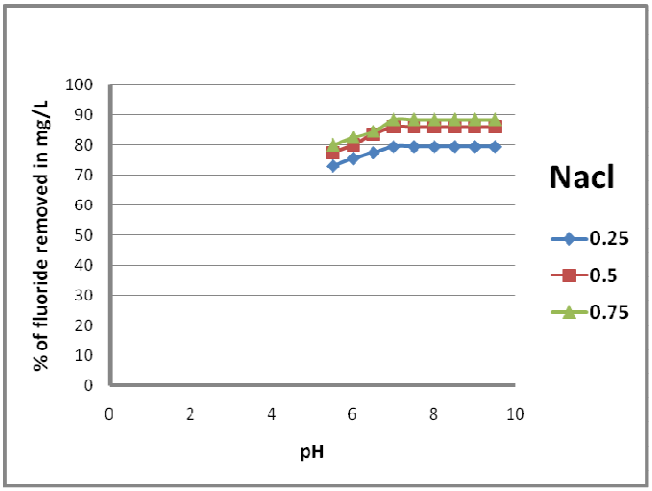

Fig.3., Effect of pH on fluoride removal by chemically (NaCl) activated carbon

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 (NaCl) Carbon for different I.R's	0.25	55	200	7.00
	0.50	50	180	7.00
	0.75	45	160	7.00

CONCLUSIONS

Based on the experimental study following conclusions were drawn:The optimum contact time for NaCl activated carbon of I.R's. 0.25, 0.50 and 0.75 are 55, 50, 45 minutes with removal efficiency of 76%, 80% and 85% 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 NaCl activated carbons of I.R's. 0.25, 0.50 and 0.75 are200mg, 180mg, 160mg with removal efficiency of 78.5%, 85.2% and 87.0% 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 NaCl activated carbons of I.R's. 0.25, 0.50 and 0.75 with removal efficiency of 79.5%, 86.0% and 88.5% respectively.

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