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Fluoride Removal by Activated Carbon Prepared From Prosopis Cineraria Leaves

Suneel Kumar[1]* Anil Kumar[2]

[1] Assistant Professor, Department of Chemistry, Govt. P. G. Lohia College, Churu, Rajasthan

[2] Department of Chemistry, Bipin Bihari College, Jhansi, Uttar Pradesh

Abstract – Fluoride is the major inorganic ion of halogen family naturally found in groundwater. Fluoride ion in least quantity is an essential chemical ion for normal mineralization of human being bones and formation of dental enamel. Since then noticeable work has been done in disparate parts of world and India to explore the fluoride contaminated water sources and their impacts on human being as well on various animals. The safe limit of fluoride in drinking water is 1.5 mg/litre. Groundwater with high fluoride ion concentration is generally has high pH and contains large amount of silica and other chemical ions. In groundwater, the concentration of fluoride ion rely on the geological presence of various ions and chemical and physical characteristics of the aquifer, alkalinity and acidity of the soil and rocks of earth crust, temperature, the porosity ,the action of other chemicals and the depth of tube wells or hand pumps and other water sources. The solution to the problem is removing the excess of fluoride from contaminated groundwater. There are various techniques that are used for the De-fluoridation purpose. Some of these techniques used are: natural ion and Synthetic ion exchange, Precipitation methods, and Activated alumina filters, Reverse osmosis, adsorption and absorption techniques. Some of these are more effective. Predominantly applied technique is absorption either with the biological chemical or physical adsorbents. These bio-adsorbents have the physical property of adsorbing different type of negative ions like fluoride ion and various metal ions. Here different type of naturally occurring adsorbents are used which have appeared a desirable amount of degradation in Fluoride ion concentration of groundwater samples. In this experimental study, we present a novel cost effective defluoridation method using Prosopis Cineraria leaves charcoal as the adsorbent. The data obtained reveals that Prosopis Cineraria leaves are highly efficient in fluoride ion removal by contaminated ground water.

Keywords: Prosopis Cineraria, Bio-Adsorbents, Defluoridation, Fluoride Ion.

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1. INTRODUCTION

Water is free gift of nature for all creatures. It is an essential natural resource for all living beings to alive. It is also beneficial for environment of our earth. We have always thought to be available in abundance and waste water without tension. Chemical composition of surface or earth crust is one of the prime factors on which the appropriateness of water for domestic, industrial or agricultural purpose depends. The High concentration of fluoride ion in drinking water is a matter of concern in various parts of the world. Fluoride ion is considered valuable in drinking water at levels of about 0.7 mg/lit. But hazardous once it exceeds 1.5 mg/lit.[1,2].The Bureau of Indian Standards (BIS) has prescribed a permissible limit and desirable limit of fluoride ion concentration in portable water is 1.5 mg/lit and 1.0 mg/lit respectively . It is estimated that 62.1 million people of 20 states of India are suffering from different type fluorosis. Rapid surveys conducted by the PHED (public health engineering department in the state of Rajasthan have revealed fluoride in the groundwater samples of which the worst affected districts of Rajasthan are Nagaur, Churu, Sikar, Ajmer, Bhilwada [3]. The extent of fluoride ion contamination in groundwater which is varies from 0.01 mg/lit to 17.50 mg/lit. in Rajasthan[3,4]. Fluoride ion with other ions is one of the most important chemical for both human being and other living being. Fluoride ion serves to maintain white and healthy teeth and bones within permissible limit. On the other hand, at high level of fluoride concentration can cause diseases such as skeletal fluorosis and dental fluorosis. The most soberly affected states in India are Tamilnadu, Uttar Pradesh, Haryana, Punjab, Andhra Pradesh. The highest concentration observed in Rewari district of Haryana [5,6].Removal of fluoride ion from contaminated water is done by several methods such as membrane separation, electrolytic decomposition , sedimentation, precipitation but

found expensive and non-suitable for third world countries.[7,8]. The biomass from shrubs, plants and agricultural wastes can be used for removal of fluoride ion from ground water as well as solving their disposal problem[9].A variety of adsorbents have been tried to find out an economical and efficient de-fluoridation agent[10].Different bio-adsorbents such as coconut husk, leaves of Neem etc. may be used as a de-fluoridation agent[11.]

The present work involves collection of water samples from five tube wells of different villages of Fatehpur Shekhawati block of Sikar district in Rajasthan and de-fluoridation was done using simple water filter prepared using Prosopis Cineraria activated charcoal as an adsorbent.

2. MATERIALS AND METHODS

Prosopis cineraria leaves used in the present work was collected from the dry land area of Fatehpur Shekhawati block of Sikar district in Rajasthan, India. Charcoal prepared from collected leaves of this plant. Fluoride contaminated water samples were collected from different villages of Fatehpur Shekhawati block. All chemicals and reagents used are all of AR grade.

Preparation of Prosopis Cineraria leaves charcoal:

Collected Prosopis Cineraria leaves were washed with water to remove dust and other different types of impurities. These were dried in the sunlight and then burnt in a muffle furnace at 350 ^{0}C for 2 hours. After this, leaves material were washed with 1% formaldehyde solution to remove the colour. The dried material was ground and sieved through sieve to obtain particle of sizes upto 0.4 and 1.5 mm. After it, the material were again dried in an oven maintained temperature range of 100-130^{0}C for a period of 10 hours- 12 hours.

Estimation of Fluoride:- The continuous down flow column was used to study the practical applicability of Prosopis Cineraria leaves charcoal (PCLC) for removal of fluorides from water. All the experiments were conducted at atmospheric pressure and room temperature. Fluoride concentration was estimated by spectrophotometer. A filter was constructed with double layer of PCLC. It was packed with layers of sand and gravel sandwiched between two layers of PCLC.

3. RESULT AND DISCUSSION

Different samples collected at random from various villages of Fatehpur Shekhawati block of Sikar district were initially analysed for ground water physicochemical parameters pH, TDS and concentration of fluoride ion. The results (Table-A) showed that though there was not more variation in pH and TDS but very high fluoride ion concentration was observed in the water samples.

Table- A: Physicochemical parameter of contaminated water.

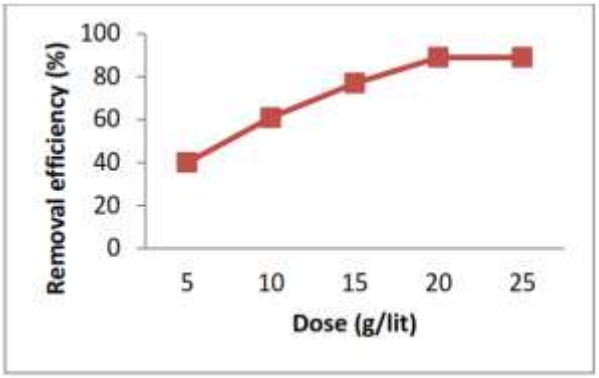
S. No.	Samples	pH	TDS	Fluoride ion concentration(mg/l)
1.	M26	7.05	300	7.63
2.	M27	7.75	402	6.75
3.	M28	7.39	530	5.93
4.	M29	7.28	542	6.81
5.	M30	7.19	421	7.52

All samples were passed through the column prepared with PCLC. The results obtained were indicated in table B. The fluoride ion concentration was reduced dramatically by using PCLC as adsorbent

Table-B : Fluoride ion concentration after passing through the PCLC filter.

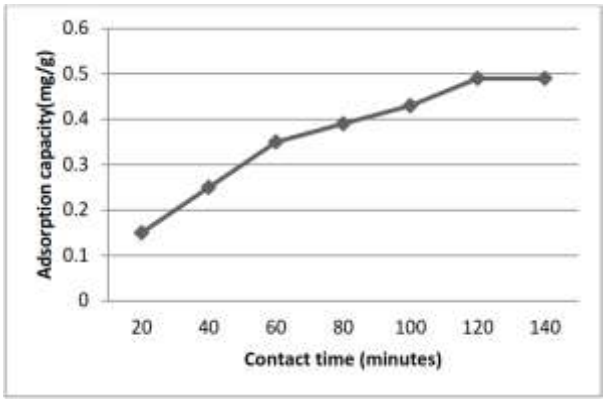
S. No.	Sample	Initial Fluoride ion concentration (mg/l)	Fluoride ion concentration after passing through PCLC (mg/l)
1	M26	7.63	0.84
2	M27	6.75	0.74
3	M28	5.93	0.65
4	M29	6.81	0.75
5	M30	7.52	0.83

Effect of adsorbent dose:- The effect of activated charcoal (PCLC) dose on the fluoride adsorption was carried out at 25 ^{0}C. Figure 1 demonstrate that there was an increase in fluoride % removal by increasing dose of the PCLC. It is due to increase in surface area and more active sites of adsorbent were available for fluoride ion adsorption. But after a specified dose, the percentage removal did not increase. The optimum dose was 12 g/l for adsorbent with fluoride ion removal efficiency 89 % for PCLC. It may be represented by following graph. After a specified dose graph flattened due to saturation.



Effect of contact time:-The effect of contact time on fluoride ion adsorption is shown in figure 2.As the contact time with adsorbent increased the adsorption capacity increased.The increase in adsorption capacity of PCLC in the first 70 minutes was very fast.This might to be diffusion of ions into

surface pores of PCLC.This adsorption reached equilibrium after one hour and 40 minutes.



4. CONCLUSION

The study area affected by health hazards such as dental fluorosis and skeletal fluorosis due to high concentration of fluoride ions.The low cost filter performed by PCLC is very useful for rural areas of this region which is highly effected by fluoride contamination.The filter is able to remove high content of fluoride ion from ground water and has an efficiency of 89 %.The study indicates that removal of fluoride ion from water sample depends on quantity of PCLC and contact time.

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Corresponding Author

Suneel Kumar*

Assistant Professor, Department of Chemistry, Govt. P. G. Lohia College, Churu, Rajasthan

sunilkinsar@gmail.com