A Novel Technique for Fluoride Removal from Drinking Water using Rice Husk Charcoal

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Abstract: Fluoride content in groundwater is now a global problem which, affect more than 21 states of India. Most of the ground waters in west Bengal and North Eastern states are contaminated with fluoride. When the recommended limit by WHO is 1.5 mg/L, in some parts of India fluoride levels are as high as 35 mg/l. Major health problems caused by fluoride are dental and skeletal fluorosis. It can interfere with carbohydrates, lipids, protein, vitamins, enzymes and mineral metabolism when the dosage is high. Major problems associated with fluoride remediation are lack of cheap readily available high capacity adsorbent affordable for poor community of India. In this paper, we present a novel cost effective defluoridation method using rice husk charcoal as the adsorbent. A simple cost effective model of filter has been designed using abundantly available and inexpensive raw material. Five drinking water samples with high fluoride content were collected from different parts of West Bengal and passed through this filter. The results showed excellent fluoride removal capacity upto 85%. The obtained results are better than the conventional adsorbents used for fluoride removal. The filter designed in this study not only removes fluoride but are also able to remove arsenic and improves the overall drinking water quality benefitting the entire poor community of our country.

Keywords: fluoride removal, rice husk charcoal, filter

1. INTRODUCTION

High fluoride content in groundwater is a matter of concern in many parts of the world. Fluoride is considered beneficial in drinking water at levels of about 0.7 mg/L but harmful once it exceeds 1.5 mg/L [1,2]. The Bureau of Indian Standards, BIS (IS-10500) [18], has prescribed a desirable limit and permissible limit of fluoride in drinking water as 1.0 and 1.5 mg/l respectively. It is estimated that 62 million people, including 6 million children, are presently suffering from fluorosis in India [2]. Rapid surveys conducted by the Public Health Engineering Department (PHED) in the state of West Bengal have revealed fluoride in the groundwater samples of which the worst affected districts of West Bengal are Birbhum, Purulia, Bankura, South Dinajpur [3]. The rural population

on this worst affected sector suffers because of the absence of centralized water treatment system in these areas.

De-fluoridation techniques are the topic of research of number of papers and techniques adopted are mostly by adsorption[4], chemical treatment[5,6], ion exchange, membrane separation, electrolytic de-fluoridation and electro dialysis[7] etc. Among these processes, adsorption was reported to be most effective [8] as this method have successfully reduced fluoride concentration to acceptable levels and its general acceptability is higher due to its low cost [7]. Thus even in the past decade, when interest in alternative defluoridation approaches has been increasing rapidly, many researchers have continued to explore the development of low-cost and effective adsorbents and to improve the efficiency of all adsorbents [9].

Rice husk rich in cellulose (28-36 %), crude fibre (34.5-45.9 %) and ash (13.2-21.0 %) [12] can serve as a low cost adsorbent of toxic elememts like fluoride, arsenic etc. Rice husk ash (RHA) is an end product of the combustion of rice husk. Rice husk ash has good adsorbent properties because of its high silica content [13]. The type of ash varies considerably depends on the techniques employed.

The present works involves collection of water samples from five schools (names withheld) of Birbhum district of West Bengal and defouridation was done of the collected water sample using simple water filter prepared using rice husk activated charcoal (RHAC) as an adsorbent.

2. MATERIALS & METHODS

Materials:

Rice husk was obtained from a local mill and was sieved through IS sieves of 150 µm and 300 µm size and the material passing through 150 µm and retained on 300 µm, which has a geometric mean size (Gm) of 212 µm was used in all experiments. The apparent density of rice husk is 0.4-0.7 g/cm3.

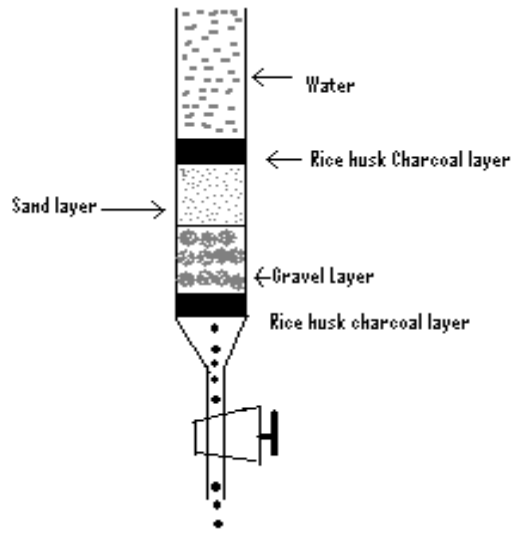
Fluoride contaminated water samples were collected from different schools of Birbhum district, West Bengal.

All chemicals and reagents used are all of AR grade and purchased from E-Merk (I) pvt.Ltd

Preperation of rice husk charcoal: Dried rice husk packed in a tin container with multiple pores on the surface were kept in a muffle furnace at 300°C for 3 hrs. The black husks obtained were RHAC (Rice husk activated charcoal).

Estimation of Flouride: Continuous down flow column studies were also conducted to study the practical applicability of rice husk for removal of Fluorides from water. All the experiments were conducted at room temperature (29±2°C). Fluoride concentration was estimated by SPADNS method [17] using a UNICAM-UV300, Thermospectronic spectrophotometer.

Construction of Laboratory scale filter



A filter was contructed following the above diagram with double layer of Rice husk activated charcoal. The column has a diameter of 8" and packed with layers of sand and gravel sandwiched between two RHAC bed.

3. RESULTS AND DISCUSSION

Table 1: Analysis of Flouride contaminated water

Samples	pH	TDS(mg/L)	Flouride(mg/l)
I	7.64	256	2.01
II	7.42	299	10.7
III	7.06	353	2.74
IV	7.30	313	11.0
V	7.27	261	9.39

Different samples collected at random from different schools of Birbhum district of West Bengal were initially analysed for three important drinking water quality parameters pH, Total Dissolved Solids and flouide content. The results (Table 1) showed that though there was a little variation in

the pH and TDS of the water samples there was a wide variation of fluoride content. TDS and pH are within the permissible limits whereas high ground water fluoride content was observed in the water samples.

Table 2: Fluoride content after passing through the rice husk activated (RHAC) charcoal filter

Samples	Initial Flouride content(mg/l)	Flouride content after passing Through RHAC(mg/l)
I	2.01	0.04
II	10.7	1.6
III	2.74	0.05
IV	11.0	2.1
V	9.39	1.3

All the collected water samples were passed through the column filter prepared with Rice husk charcoal (RHC). The results obtained were exceptionally good as indicated in Table 2. Water with 2.01mg/l, 10.7mg/l and 9.39mg/l of fluoride was reduced to 0.04mg/l, 1.6mg/l and 1.3mg/l of fluoride content respectively.

Table 3: Study of reusability of the RHAC filter

No. of Batches	Sample I(fluoride10.7 mg/l)	Sample II(fluoride 2.74 mg/l)
1	1.6	0.05
2	1.6	0.05
3	1.6	0.05
4	2.5	0.06
5	2.9	0.06
6	3.5	0.08
7		0.10

A reusability study of the rice husk charcoal bed was conducted with two samples of water having fluoride content of 2.74 mg/l and 10.7 mg/l. Table 3 shows that the sample with low fluoride content can be reused for more than seven times with a little drop in efficiency whereas the water with high fluoride content can be effectively reused for thrice without any change in deflouridation capacity of the adsorbent.

4. CONCLUSION

The low cost filter is ideal for using by the rural people living in the areas of high level of fluoride in ground water. The filter is able to remove many other toxic elements from water and has an efficiency more than 85%.

5. ACKNOWLEDGEMENT

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