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Research Article

REMOVAL OF FLUORIDE FROM GROUND WATER BY USING WHEAT HUSK, AN AGRICULTURE WASTE: A CASE STUDY OF HISAR (HARYANA)

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A B S T R A C T

Water is one of the vital components for all living organisms on the earth. As the source of drinking water including ground water is dwindling day by day, therefore, providing safe drinking water to every human being is a big challenge worldwide. The factors responsible for water contamination are rapid growth of population, urbanization, industrialization, improper waste management, etc. One such contaminant is naturally occurring fluoride. Fluoride beyond permissible limits in ground water leads to major health problems in many parts of the world. The present study focuses on use of economical wheat husk (an agricultural waste) as bio-adsorbent to reduce fluoride contamination from ground water to make it safe for drinking. Batch adsorption study was conducted to analyze effect of various parameters such as contact time, adsorbent dose temperature initial concentration etc for defluoridation of fluoride in ground water.

INTRODUCTION

Fluoride is one of a natural contaminant. It exists in combined form in rocks, soil, and ocean water. It is outcome of runoff from weathering of alkali, igneous and sedimentary fluoride-containing rocks and soils and leaching from soil into groundwater[1], fluoride occurs naturally in ground/drinking water. A large number of fluoride contaminated areas are founded throughout the world where ground waters contain exceeded levels of fluoride. Excessive fluoride (beyond 0.6-1.5 mg/l) in ground water leads to many health problems such as dental fluorosis, skeletal fluorosis, non skeletal fluorosis. The situation is alarming in developing countries including India[2]. The only way of protection is to maintain desirable limits of fluoride concentration in water by de-fluoridation of fluoride-contaminated water[3]. Defluoridation methods are broadly classified into following categories[4]

- Adsorption technique-Bone charcoal, processed bone, tricalcium phosphate, activated carbons, activated magnesia, tamarind gel, serpentine, activatedalumina, plant materials, burnt clay.etc.
- Precipitation technique-Nalgonda technique, Lime. etc..
- Ion-Exchange technique-Anion/Cation exchange resins
- Miscellaneous methods. Reverse Osmosis Filtration Activated Alumina Defluoridation Filter Distillation Filtration etc

Out of all these techniques, adsorption techniques have more advantages because of their greater accessibility; economical, do not require complicated hardware, inexpensive and capable of removing fluoride from water up to maximum extent[5]. However, none of the methods is successful at a large scale in most part of the world. Therefore, it is better to select an appropriate de-fluoridation technique taking into account the local conditions, economic status, adoptability of the method, awareness of community, easy availability of materials and reuse of exhausted materials for treatment purpose etc[6-7]. The present study focus on use of low-cost Wheat Husk (an agricultural waste) to use as an Adsorbent for defluoridation of ground water.

The present study scope covers following aspects of defluoridation using bio-adsorbent as a medium:

1. The exploration of the bio-adsorption process as a commercial solution for defluoridation of drinking water
2. The basis for studies for exploring various sustainable, green and environment friendly mediums for defluoridation of drinking water
3. The search of low cost, economic and easily available medium for defluoridation of drinking water

Experiment

Study Area: HisarHaryana (India)[8]

Hisar is a major fast growing city in Haryana, It is located at 29°9'11" north latitude and 75°43'6" east longitude. Haryana is a small state in North India, with total area 44, 212 sq km and Hisar is approximately 165 kilometers northwest of national capital Delhi.

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Sampling: Water Sample

The groundwater sample was collected from New Model Town location of Hisar City of Haryana (India). The samples were collected in pre-clean sterilized polyethylene bottles of one-liter capacity. These collected samples were stored in an ice cooled box.

Wheat Husk (An Agriculture Waste): A Bio-Adsorbent[9]

Wheat Husk, byproduct of wheat crop is found abundantly in Haryana, Punjab, Rajasthan and Western Utter Pradesh States of India. Wheat Husk are considered to be non-biodegradable therefore the husk just take up a lot of space in the environment and can be considered as pollution to the environment just as synthetic materials like plastics are considered as pollution when deposited into the environment. The chemical composition of the wheat husk depends upon the type of fertilizer used, geographical conditions and the soil chemistry

- It accounts for 20% of the paddy in weight and contains 10-12% ash.
- It is highly resistant to moisture penetration and fungal decomposition.
- It has a high average calorific value and high silica content (80-90%).
- Wheat husk contains a high amount of organic volatiles

Table No1 Effect of contact time on percentage removal of fluoride ion by wheat husk

ADSORBENT- WHEAT HUSK					
Effect of Contact Time					
Location - New Model TownHisar					
(a)					
Dose gm/100ml	**Contact time (min)**	**Initial conc. (mg/litre)**	**Final fluoride (mg/l)**	**Reduction of Fluoride (mg/litre)**	**% Removal efficiency**
0.1	15	2.98	2.36	0.62	20.80
0.1	30	2.98	2.34	0.64	21.48
0.1	45	2.98	2.30	0.68	22.82
0.1	60	2.98	2.26	0.72	24.16
0.1	75	2.98	2.19	0.79	26.51
0.1	90	2.98	2.08	0.90	30.20
(b)					
Dose gm/100ml	**Contact time (min)**	**Initial conc. (mg/litre)**	**Final fluoride (mg/l)**	**Reduction of Fluoride (mg/litre)**	**% Removal efficiency**
0.2	15	2.98	2.27	0.71	23.83
0.2	30	2.98	2.22	0.76	25.50
0.2	45	2.98	2.20	0.78	26.17
0.2	60	2.98	2.11	0.87	29.20
0.2	75	2.98	2.02	0.96	32.22
0.2	90	2.98	1.93	1.05	35.23
(c)					
Dose gm/100ml	**Contact time (min)**	**Initial conc. (mg/litre)**	**Final fluoride (mg/l)**	**Reduction of Fluoride (mg/litre)**	**% Removal efficiency**
0.4	15	2.98	2.21	0.77	25.84
0.4	30	2.98	2.17	0.82	27.52
0.4	45	2.98	2.11	0.90	30.20
0.4	60	2.98	2.07	0.96	32.22
0.4	75	2.98	1.99	1.06	35.57
0.4	90	2.98	1.81	1.17	39.26
(d)					
Dose gm/100ml	**Contact time (min)**	**Initial conc. (mg/litre)**	**Final fluoride (mg/l)**	**Reduction of Fluoride (mg/litre)**	**% Removal efficiency**
0.6	15	2.98	2.19	0.79	26.51
0.6	30	2.98	2.11	0.82	27.52
0.6	45	2.98	2.04	0.87	29.19
0.6	60	2.98	1.97	0.88	29.53
0.6	75	2.98	1.89	0.97	32.55
0.6	90	2.98	1.78	1.20	40.27
(e)					
Dose gm/100ml	**Contact time (min)**	**Initial conc. (mg/litre)**	**Final fluoride (mg/l)**	**Reduction of Fluoride (mg/litre)**	**% Removal efficiency**
0.8	15	2.98	2.12	0.86	28.86
0.8	30	2.98	2.02	0.96	32.21
0.8	45	2.98	1.97	1.01	33.89
0.8	60	2.98	1.90	1.08	36.24
0.8	75	2.98	1.84	1.10	36.91
0.8	90	2.98	1.72	1.26	42.28
(f)					
Dose gm/100ml	**Contact time (min)**	**Initial conc. (mg/litre)**	**Final fluoride (mg/l)**	**Reduction of Fluoride (mg/litre)**	**% Removal efficiency**
1.0	15	2.98	2.09	0.89	29.87
1.0	30	2.98	2.02	0.96	32.21
1.0	45	2.98	1.88	1.10	36.91
1.0	60	2.98	1.72	1.26	42.28
1.0	75	2.98	1.69	1.30	43.62
1.0	90	2.98	1.64	1.34	44.97

In the present study it is collected from the nearby fields of Hisar City in the month of May and washed with distilled water several times then dried in sunlight for 3-4 days. Now grinded this dry waste with mixer & sieved with suitable mesh size (30 bss size) taken for analysis

Experiment Parameters

- Hatch Spectrophotometer Model DR-2900
- Standard SPANDS solution used to find fluoride content
- The absorbent suspensions are equilibrated by shaking in horizontal shaker for different time interval ranging from 15 to 90 minutes for the study of various control parameters like temperature, adsorbent dose, initial concentration of fluoride in samples etc. At the end of the shaking period, the suspension centrifuged and filtered using Whatmann filter paper 42.

Experiment Study Mode: Batch mode adsorption studies

Batch study conducted to determine the optimum conditions and to study the effect of contact time, initial concentration, adsorbent dose, temperature etc. on test solutions.

RESULTS AND DISCUSSION

The removal of fluoride from ground water by using wheat husk was determined by various parameters such as contact time, adsorbent dose, initial concentration, temperature etc. which was shown in Tables (1-3) below[10-11]:

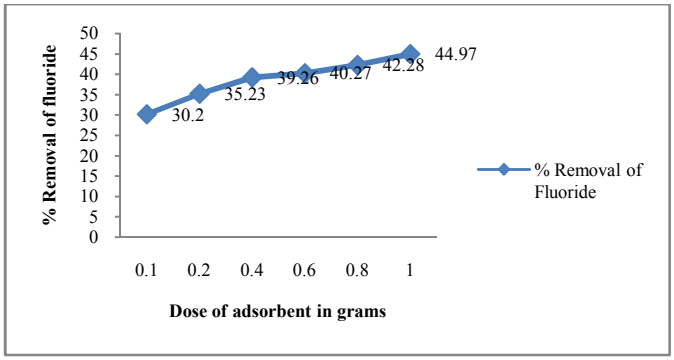
Effect of contact time

Adsorption of fluoride ion by using wheat husk at different contact times 15, 30, 45, 60, 75, 90; minutes are shown in Table No. 1. Experiment shows the removal of fluoride ion percentage increased with increase in contact time. The result also reveals that maximum percentage removal of fluoride ion occurs at 90min contact time.

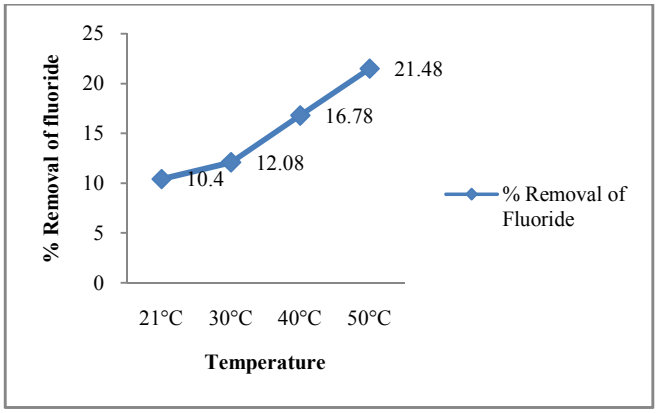
Effect of adsorbent dose

The results for adsorptive removal of fluoride ion with respect to adsorbent dose are Table No.2. Studies on effect of adsorbent doses are conducted by varying adsorbent doses between 0.1 g to 1 g/100 mL. The initial fluoride ion concentration was 2.98 mg/lit and contact time was kept 90 minutes.

Increase the adsorbent dose the removal efficiency will also increase due to increase in surface area, there is more active sites are available for the adsorption of fluoride. Studies shows maximum 44.97 percentage removal of fluoride ion occurs at 1.0 gm/100ml. adsorbent concentration and contact time 90 minutes.



Graph 1 Percentage of Fluoride removal v/s weight of adsorbent



Graph 2 Percentage of Fluoride removal v/s Temperature

CONCLUSION

- The results demonstrate that wheat husk is economical and effective adsorbent in removing fluoride from water to acceptable levels.
- The efficiency of the adsorbent in the removal of fluoride depends on dose of adsorbate, characteristics of adsorbent, temperature, contact time, etc.

Table No 2 Effect of dose of Adsorbent on percentage removal of fluoride ion by wheat husk.

Dose of Adsorbent (Wheat Husk)						
Sr. No.	**Wt of adsorbent in ml**	**Amount of water**	**intial concentration before treatment (mg./l)**	**after 90 minutes (mg/l)**	**Reduction of fluoride(mg/l)**	**% Fluoride Removal**
1	0.1	100 ml	2.98	2.08	0.90	30.20
2	0.2	100 ml	2.98	1.93	1.05	35.23
3	0.4	100 ml	2.98	1.81	1.17	39.26
4	0.6	100 ml	2.98	1.78	1.20	40.27
5	0.8	100 ml	2.98	1.72	1.26	42.28
6	1.0	100 ml	2.98	1.64	1.34	44.97

Table No 3 Effect of Temperature on % removal of fluoride ions by wheat husk.

Effect of Temperature						
S. No.	**Dose gm/100ml**	**Temperature (in C)**	**Initial fluoride (mg/l)**	**Final fluoride (mg/l)**	**Reduction in fluoride(mg/l)**	**% Removal efficiency**
1	0.2	21	2.98	2.67	0.31	10.40
2	0.2	30	2.98	2.62	0.36	12.08
3	0.2	40	2.98	2.48	0.5	16.78
4	0.2	50	2.98	2.34	0.64	21.48

- The study indicates that the optimum condition for removal of fluoride is found to be 90 minutes contact time and 1.0 gm adsorbent dose. Maximum 44.97 % removal of fluoride was found at initial 2.98 mg. /litre concentration.
- The need of the hour is to give emphasis and to aware common people to use these low cost, economical and effective defluoridation methods at large, realizing the alarming situations of scarcity of safe drinking water to all sections of the society, in particular to poor people of developing countries.

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