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REMOVAL OF FLUORIDE FROM GROUND WATER OF HISAR CITY, USING BRICK POWDER (AN INDUSTRIAL WASTE) AND WHEAT HUSK (AN AGRICULTURAL WASTE) AS ADSORBENTS: A COMPARATIVE STUDY

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ABSTRACT

Ground water accounts for 1.7 % of total available water but it is not utilized properly and unsafe for drinking purposes due to multiple reasons of contaminations. One such contaminant is fluoride. Since fluoride is present in all form of water but the permissible limit for drinking water as per BIS standard is 0.6-1.5 mg/L. Therefore excessive intake of fluoride by human through drinking water raises certain complicated health issue in the form of dental, skeletal and non-skeletal fluorosis. In the present study sincere endeavor is made to use easy to use, cheap and effective adsorbents Wheat Husk an agricultural waste and Brick Powder an industrial waste, readily available in Haryana State (India), which otherwise accounts for environmental pollution if not utilized properly. The investigation was carried out with comparative batch adsorption study of removal of Fluoride from ground water using Brick Powder and Wheat Husk adsorbents by analyzing the effect of parameters contact time, adsorbent dose and initial concentration. The experiment studies shows removal of fluoride percentage increased with increase in adsorbent dose and maximum percentage removal of fluoride ion occurred at 120 minutes contact time and adsorbent dose 1.0 gm/100 mL for Brick Powder and in case of Wheat Husk optimum conditions for maximum percentage removal of fluoride ion was 90 minutes contact time and adsorbent dose 1.0 gm/100 mL.

KEY WORDS : Ground Water, Fluoride, Brick Powder, Wheat Husk, Defluoridation

INTRODUCTION

Water is essential component for living organisms. But there are limited sources of safe water on earth. Factors such as urbanization, industrialization, population growth, poor municipal waste management, sanitation, illiteracy, lack of coordination among government institutions/ organizations and regulatory bodies etc. accounts for scarcity and poor quality of drinking water to common man (WHO, 1985). Situation is alarming in developing and poor countries. In India there are limited sources of natural water. Most of population rely on ground water. Factors as discussed above are root cause of water contamination. One such component is fluoride (Feenstra and Griffioen, 2007). It is the lightest element of the halogen family. Fluoride is found in abundance in earth crust. Owing to its high electronegativity, fluorine does not exist in Free State. Fluoride is found in bed of rocks, in the form of fluorite, petite, topaz, petite, rock phosphate, gneiss etc. Most fluorides are sparingly soluble and are present in natural water in small amounts. Fluoride flows through rocks and soil and dissolves in ground water. Depending upon the constituents of rocks, socio-economic and environment conditions, the extent of fluoride varies in ground water (WHO Geneva, 1984).

Fluoride Content in Indian Sub-Continent - Due to geographical and climatic conditions Indian

sub-continent is rich in granites and volcanic rocks which are rich source of fluoride minerals and in arid areas there is high evaporation of shallow aquifers and easy occurrence of geochemical reactions in sedimentary aquifers also accounts for high conc. of fluoride in ground water of the region.

The natural presence of chemical content of ground water is influenced to a great extent by depth of the soils and sub-surface geological formations through which ground water run-off. In general, large portion of the country, ground water is of good quality and suitable for use for drinking, agricultural or industrial purposes.

India has 18% of the world's population, it has 4% of water resources of the world. India is the largest user of groundwater in the world. Urban residents increasingly rely on groundwater due to unreliable and inadequate municipal water supplies. World Bank estimates that 21% of communicable diseases in India are related to unsafe water, 10% diseases can be controlled only on the availability of clean water. Without change, the problem may get worsen, as India is projected as third largest economy of the world after U.S.A. and China and by 2028 would be the world's most populous country.

Central Water Control Board is the monitoring agency for ground water quality in the country. Once in a year the physicochemical parameters are being checked/monitored by the board from 15000 observation wells all across the country. The data is shared with concerned states. According to the latest report of the board, in 19 states fluoride in ground water is beyond the desirable limits. Rajasthan is in the top of the tally with 30 affected districts. In Haryana, situation is also not good (Arlappa *et al.,* 2013).

Since fluoride is present universally in almost every water however higher concentrations are found in groundwater, earth crust, many minerals, rocks etc. Therefore, providing water, with optimal fluoride (WHO, 1984) concentration (0.6-1.5 mg/L) is the only way by which the generation yet to be born can be totally protected against the fluorosis disease (Tewari *et al.,* 2012). There are lot of defluoridation methods but adsorption methods are most appropriate due cost effectiveness, easy to operate and readily available raw material (Manjeet and Sharma, 2014; Pali Shahjee *et al.,* 2013).

Status of Ground Water in Haryana

Haryana is a small state in north India with 22 districts According to Central Ground Water Board, Haryana is one of the 19 states where fluoride content in ground water is more than the permissible limits as prescribed by BIS (1.5 mg/L.). Out of 22 districts 14 districts, namely Faidabad, Gurgaon, Hisar, Jhajjar, Jind, Kaithal, Kurukshetra, Mahaendergarh, Panipat, Rewari, Rohtak, Sirsa and Sonepat are most affected. A lot of research work is being carried out for the last few years to reveal the status of fluoride in ground water in different districts of Haryana.

Study Area Hisar City

The geographical area of Hisar District is 2234 Km^2. A total number of villages is 2380. City Population is 301249. It is situated 164 km. west of New Delhi national capital of India. It is situated in NCR region and considered as counter magnet city. It was established in 1354 A.D. by Firoz Shah Tughlaq. The city is rapidly growing urban center in Northern India. It is a medical and educational hub.

Hisar is located at 29°9'11" north latitude and 75°43'6" east longitude

Area	2234 km^2		
Altitude	431 meters		
Temperature:	maximum	minimum	
	48 °C	25 °C	Summer
	22 °C	02 °C	Winter
Language	Hindi, English		
Population Status (as per 2011 Census)			
Total Population	17,43,931		
Urban	5,53,488		
Rural	11,90,443		
Male	9,31,562		
Female	8,12,369		

Hisar City has a tropical monsoon climate, receiving over 450 millimeters of rainfall annually but most rains occur in the monsoon months between June and September. The summer are very hot and winter are relatively cold, winter are from December to February and summer are from March to May. SW monsoon also known as summer monsoon brings rain during last week of June to mid-September. The main characteristics of climate Temperature remains relatively high throughout the year, with the summer months of April to early July having average daily temperatures of around 30 °C. The winter months of November to February are mild and pleasant, with average temperatures ranging from 15–18 °C Dust-storms are very common in the months of April and May and thunder storms are experienced in rainy season.

According to the census of 2011 literacy rate of the district is 72.89%.

Total eight samples taken from different locations of Hisar City (Haryana India) to study the effect of adsorbents for de-fluoridation of ground water.

Experiment Study Mode for Effect of Adsorbents

The study conducted by opting standard APHA methods (APHA, 1995) and analytical grade chemicals used through the study. Double glass distilled water used for preparing all the reagents. Each sample was analyzed thrice for accuracy and the results were found reproducible with ± 3% error.

Preparation of Adsorbent (Brick powder) (Renu *et al.*, 2008)

Bricks, the raw material collected from a local Brick Kiln of Hisar City of Haryana (India) and washed with distilled water, dried and grinded into fine particles as Brick Powder. The powder was washed many times with distilled water till clear water was obtained and was dried in oven at 105 °C for 12 h. The dried material was sieved to separate less than 300 micro meter size of particles for the present study.

Preparation of Adsorbent (Wheat Husk, 2013)

Wheat Husk which is readily available in Haryana (INDIA) collected from the nearby fields of Hisar City of Haryana, in the month of May and washed with distilled water several times then dried in sunlight for 3-4 days Wheat Husk, a byproduct of wheat crop is readily available in Haryana, Punjab, West Utter Pradesh, Rajasthan, Tamil Nadu, Maharashtra states of India. It is non-biodegradable product and causes environment pollution if not utilized properly. On burning it produces approximately 10% Ash.

The absorbent suspensions are equilibrated by shaking in horizontal shaker for time interval 120 and 90 minutes for the study of Brick Powder an industrial waste and Wheat Husk an agricultural waste respectively for 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.

Spectrophotometric Method

Spectrophotometric method (Barghouthi and Sameer, 2012) used to study the effect of varying conc. of Brick Powder adsorbent for Vikas Nagar, Vegetable Market, Railway Colony and Azad Nagar and Wheat Husk adsorbent for locations Grain Market, Surya Nagar, New Model Town and Professor Colony for removal of fluoride in the collected samples. Standard SPADNS solution used during the experiment to find fluoride content in the samples. Samples were taken in clean and sterilized 100 mL beakers. Prepared the 10 mL Blank of deionized water. Similarly prepared the 10 mL sample and 2 mL. of the standard SPADNS reagent solution added in each sample Standard procedure followed to find fluoride ion concentration in the samples. Experiment repeated for each sample prepared for Brick Powder and Wheat Husk adsorbents.

Batch study method opted by using Brick Powder an industrial waste and Wheat Husk an agricultural waste to determine the optimum conditions and study the effect of initial concentration, adsorbent dose and contact time on test fluoride samples for de-fluoridation. The removal of fluoride from drinking water by using Brick Powder and Wheat Husk was determined by using dose of adsorbent for each sample of each zone 0.1, 0.2, 0.4, 0.6, 0.8, 1.0 g100 mL respectively and contact time for each sample of each zone was 120 minutes for Brick Powder and 90 minutes for Wheat Husk respectively. The experiments carried out at room temperature

RESULTS AND DISCUSSION

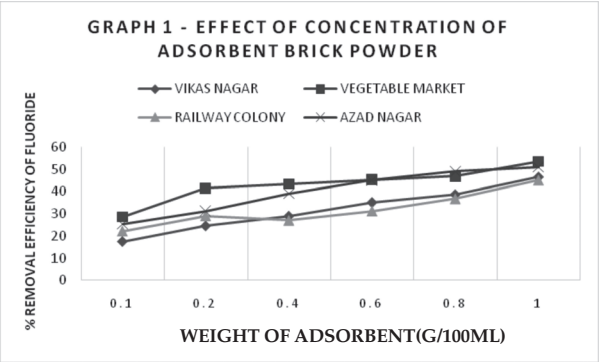
Effect of adsorbent dose on removal of fluoride

The effect of adsorbents dosage on adsorption of fluoride was studied The removal of fluoride from drinking water by using brick powder and wheat husk was determined by using dose of adsorbent for each sample of each zone 0.1, 0.2, 0.4, 0.6, 0.8, 1.0 gm/100 mL respectively and contact time for each sample of each zone was 120 minutes for brick powder and 90 minutes for wheat husk respectively. In case of brick powder the %age removal efficiency for Vikas Nagar location was 17.54 at 0.1 g/100 mL adsorbent dose and increased with increase of dose and at 1.0 g/100 mL it was 46.49. Similarly in vegetable market location studies on effect of adsorbent doses are conducted by varying adsorbent doses between 0.1 g to 1 g/100 mL. Results show the % age removal efficiency was 30.62 at 0.1 g/100 mL adsorbent dose, maximum 53.48% removal of fluoride ion occurs at 1.0 g/L concentration and 120 minutes contact time. In

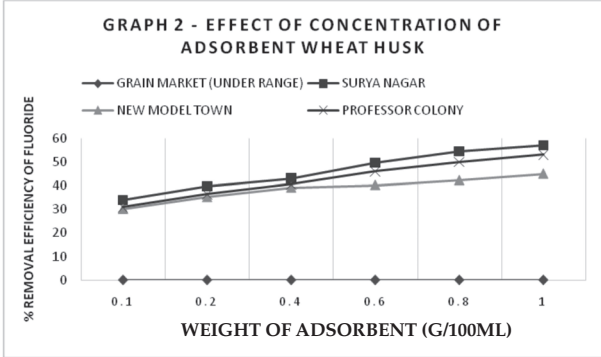
Railway colony and Azad Nagar locations studies on effect of adsorbent doses are conducted by varying adsorbent doses between 0.1 g to 1 g/100 mL Results show the %age removal efficiency was 22.22 and 24.49 at 0.1 mL/100 mL adsorbent dose and maximum 45.13% and 50.98 % removal of fluoride ion occurred at 1.0 g 100 mL concentration and 120 minutes contact time respectively.

In case of wheat husk the studies on effect of adsorbent doses are conducted by varying adsorbent doses between 0.1 g/100 mL to 1 g/100 mL. The initial fluoride ion concentration was 0.5 mg/L for Grain Market location and contact time was kept 90 minutes. The results revealed that since the conc. of fluoride in the given water sample is below 0.5 mg/L, so it is under range as per Spectrophotometer Reading. Surya Nagar location, results show the %age removal efficiency was 33.88% at 0.1 gm/100 mL adsorbent dose, maximum 57.02% removal of fluoride ion occurs at 1.0 g/100 mL concentration and 90 minutes contact time. In New Model Town and Professor Colony locations the % age removal efficiency was 30.20 % and 30.95 % at 0.1 g/100 mL adsorbent dose and maximum 44.97% and 53.17 % removal of fluoride ion occurred at 1.0 g/100 mL concentration and 90 minutes contact time respectively.

Effect of Brick Powder as Adsorbent



Effect of Wheat Husk as Adsorbent



COMPARATIVE STUDY OF EFFECT OF BRICK POWDER (AN INDUSTRIAL WASTE) AND WHEAT HUSK (AN AGRICULTURAL WASTE) AS ADSORBENT FOR DEFLUORIDATION OF GROUND WATER

Brick Powder an Industrial Waste as adsorbent

The study of the samples taken from the locations Vikas Nagar, Vegetable Market, Railway Colony and Azad Nagar reveals that in all the four samples removal of fluoride percentage increased with increase in adsorbent dose and maximum percentage removal of fluoride ion occurred at 120 minutes contact time and adsorbent dose 1.0 mg/L for each location. This is due to the availability of active site on the adsorbent and high solute gradient conc. The maximum %age removal was observed 53.48% for contact time 120 minutes and 1.0 g/100 mL concentration dose of Brick Powder adsorbent for Vegetable Market

Wheat Husk an Agricultural Waste as adsorbent

The study reveals that in all the four samples of the locations Grain Market, Surya Nagar, New Model Town&Professor Colony studied, removal of fluoride percentage increased with increase in adsorbent dose and maximum percentage removal of fluoride ion occurred at 90 minutes contact time and 1.0 g/100 mL adsorbent dose for each location.

Table 1. Maximum Percentage Removal of Fluoride by using Brick Powder as adsorbent

Sr. No.	Adsorbent used	Conc. of Adsorbent used (g. /100 mL)	Name of Place	Fluoride before treatment (mg/L)	Fluoride after treatment (mg/L)	Max. Fluoride removal after treatment (%)
1	Brick Powder	1.0	Vikas Nagar	1.14	0.61	46.49
2			Vegetable Market	2.58	1.20	53.48
3			Railway colony	1.44	0.79	45.13
4			Azad Nagar	1.02	0.50	50.98

Table 2. Maximum Percentage Removal of Fluoride by using Wheat Husk as adsorbent

Sr. No.	Adsorbent Used	Conc. of Adsorbent used (g. /100 mL)	Name of Place	Fluoride before treatment (mg/L)	Fluoride after treatment (mg/L)	Max. Fluoride removal after treatment (%)
1	Wheat Husk	1.0	Grain Market	0.5	U.R.	U.R
2			Surya Nagar	1.21	0.52	57.02
3			New Model Town	2.98	1.64	44.97
4			Professor Colony	1.26	0.59	53.17

The maximum fluoride % removal was observed 57.02 % for contact time 90 minutes and 1.0 g/100 mL conc. dose of Wheat Husk adsorbent at Surya Nagar location.

This increase is due to increase in surface area, as more active sites are available for the adsorption of fluoride ion. The comparative study also shows that in case of Brick Powder the% removal was low at locations having low initial fluoride concentration but increased with increase of conc. at same contact time but in case of Wheat Husk the% removal was high at locations having low initial fluoride conc. but increased with increase of conc. at same contact time. The maximum fluoride removal for each location by using Brick Powder and Wheat Husk adsorbents are shown in Table 1 and Table 2 respectively.

CONCLUSION

Both Wheat Husk, a byproduct of wheat crop and Brick Powder, which is brick kiln waste, are readily available in Haryana (India) and causes environment pollution if not disposed-off properly. Therefore, keeping in view the availability, socio-economic needs and geographical conditions, sincere efforts was made to use these adsorbents for de-fluoridation of drinking/ground water and the results show that Brick Powder and Wheat Husk both are economical and effective adsorbents in removing fluoride from ground water to permissible range. In both the cases effect of adsorbent dose was positive for fluoride ion removal. In case of Brick Powder the optimum condition for removal of fluoride are found to be 120 minutes contact time, 1.0 g adsorbent dose and maximum 53.48% removal of fluoride was observed. Similarly the optimum condition for removal of fluoride by using Wheat Husk are found to be 90 minutes contact time, 1.0 g adsorbent dose with maximum 57.02% removal of fluoride-ion. The comparative study shows different optimum conditions for both the adsorbents Therefore on the basis of experimental investigation, it is recommended to use these low cost, easily available and effective adsorbents for de-fluoridation of ground water in local areas to protect the population from the disease fluorosis.

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