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High fluoride concentration in the ground water of Niwai region, Tonk: A comparative study

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ABSTRACT

Most of the people in rural areas depend on groundwater for drinking water. The aim of this present investigation is to study the level of fluoride in the groundwater of Newai tehsil in Tonk district of Rajasthan state and its comparison with the water of bore wells, hand pump and surface water by collecting ten samples of the water from seven different villages during April 2013 to January 2014. The fluoride level in the underground water of Newai region was exceeding the permissible limit (>1.5 mg/L). It was found that all the ten villages of Newai region was under serious fluoride contamination than bore well and hand pump water which causes adverse effect like dental and skeletal fluorosis. Removal of excess fluoride by defluoridation techniques and supply of high-quality groundwater with safe concentration of fluoride is urgent necessity.

***Key words:* Groundwater, Fluoride, Newai region, Fluorosis, Defluoridation**

Introduction

Fresh water occurs as surface water and ground water. In this, groundwater contributes only 0.6 % of total water resources on earth [1]. The sources of surface water are like pond, river and sea are available for agricultural, domestic and industrial purposes. The sources of ground water are bore wells, open wells and hand pumps which are available for drinking water in urban as well as in rural areas because more than 90% of the rural population uses ground water for domestic purposes. Fluoride is a common constituent of groundwater. It is the most electronegative of all chemical elements and is never encountered in nature in the element form [2]. Fluoride is an ion of the chemical element fluorine which belongs to the halogen group of minerals and is natural constituents of the environment. Fluorine is the13th most abundant element of the earth's crust and represents about 0.3 g/kg of earth's crust [3]. It occurs mainly in the form of chemical compounds such as sodium fluoride or hydrogen fluoride which are present in minerals like fluorspar, fluorapatite, topaz and cryolite. The high concentration of fluoride is caused by excess alkalinity and low calcium content [4]. India is also confronting the same problem and about 25 million people in 8700 villages are consuming water having high fluoride. Assessment the water quality with special references to fluoride in Majhiaon block of Garwa district in Jharkhand [5]. The association between water fluoride levels and prevalence of dental fluorosis among school children of the Jhajjar District, Haryana, India. Rajasthan with an area of 3.42 lakh sq. km., is the largest state of country having 10.41% of the country's area and 5.5% of the nation's population but has low water resources (just 1% of the country's resources). In most of the parts of the state, groundwater is either saline or has excess fluoride. In Rajasthan, all 33 districts are endemic for fluorides [6]. The fluoride contamination in drinking water in rural habitations of Northern Rajasthan. Fluorosis has been appeared as an alarming problem in this region [7]. The ground water quality of Sanganer area of Jaipur District. 75% of the villagers are suffering from dental fluorosis and skeletal fluorosis [8]. Study of ground water quality and pollution problems in ground water have also been studied in our laboratory and found that ground water of Tonk district is contaminated with Fluoride by naturally fluoride rich rock salt system. Estimation finds that 65% of India's villages are suffer from fluorosis [9,10-12]. Use of phosphatic fertilizers in agriculture

and industrial activities like clays used in ceramic industries or burning of coal also contribute to high fluoride content in groundwater. The fluoride from the groundwater can be removed by defoliation technique namely Activated charcoal (adsorption) technique. Fluoride at lower concentration (0.6-1.5mg/L) is essential element for the development of teeth and bones in growth, fertility, prevention of anemia in pregnancy and infancy [13] .Excess intake of fluoride taken over a long period of time exerts negative effects on the course of metabolic processes and an individual may suffer from skeletal fluorosis, dental fluorosis, non skeletal manifestation or combination of the above [14,15]. This can cause joint pain, restriction of mobility, bending of vertebral column, deformation of knee joints, bone fracture and even paralysis.

Materials & Methods

The study area (Newai tehsil) is situated in the semi-arid region. On the North it is bounded by Jaipur district, on the east by Sawai Madhopur district, on the west by Ajmer and on the south by Bundi district. It is located between latitude 26˚23'N and longitude 75˚54' E in Tonk district in the Indian state of Rajasthan. Newai is situated at Jaipur - Kota route, 60 km from Jaipur. There are no major surface water sources in the study area; however, main sources of drinking water are open wells, hand pumps and bore wells. The main purpose of this study is to highlight the excess fluoride level in the groundwater of this area.

Experimental

The study was carried out in seven villages of Newai Region because the people of this region use ground water for drinking and also for irrigation fields. The groundwater samples were collected from hand pumps, bore wells and open wells at every month during the study year from April 2013 to January 2014 from seven different sampling stations of villages Seepura, Surajpura, Sidra, Newai Main, Bhanwata, Batara, Gopalpura. The water samples were collected in clean polyethylene plastic bottles of 200 ml capacity and before filling, bottles were rinsed with water under study. They were labeled, coded and brought to the laboratory for fluoride determination on the same day. Water sample were analysed by using the Sodium-2-parasulphophenylazo-1-8-dihydroxy-3 [16], naphthalene disulphonate (SPADNS) spectrophotometric method [17]. The AR-grade reagent and chemicals, distilled water and Borosil glassware's were used throughout the work.

Table 1: Fluoride in ground water from different villages of Newai Region

Months	Fluoride Ion Concentration						
	Seepura	Surajpura	Sidra	Newai Main	Bhanwata	Batara	Gopalpura
April 2013	14.62	10.32	11.26	4.32	3.50	4.50	4.20
May 2013	14.20	10.12	11.17	4.17	3.35	4.44	4.21
June 2013	13.90	10.13	11.14	4.18	3.32	4.43	4.19
July 2013	13.96	10.05	10.95	4.12	3.27	4.39	4.17
Aug. 2013	13.92	10.07	10.90	4.07	3.24	4.38	4.15
Sept. 2013	13.85	10.00	10.96	4.05	3.20	4.41	4.13
Oct.2013	13.90	9.95	10.98	4.11	3.22	4.47	4.23
Nov.	14.10	10.10	10.07	4.19	3.19	4.42	4.27

2013							
Dec. 2013	14.63	10.35	11.30	4.34	3.56	4.56	4.24
Jan. 2014	14.64	10.40	11.31	4.37	3.60	4.59	4.22

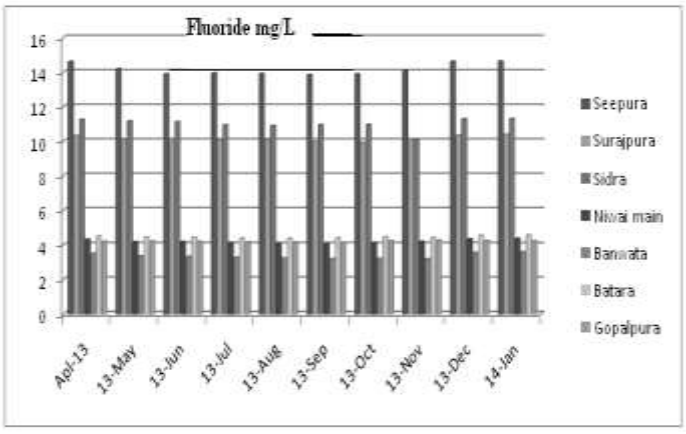
Results and Discussion

The monthly values of fluoride ion concentrations in groundwater of the study area are tabulated in the Table-1 and compared statistically as shown in Figure-2. The fluoride concentration values were variable during the study period (Figure-1). The higher concentration was found in the groundwater of Newai region. The fluoride concentration at Newai region ranged from 3.19 to 14.64 mg/L with highest fluoride level in month January (14.64mg/L) and lowest in Nov. (3.19 mg/L). Fluoride concentration at Seepura, Surajpura, Sidra, Newai Main, Bhanwata, Batara and Gopalpura were shows the observations and ranged from 13.85 to 14.64 mg/L, 9.95 to 10.40 mg/L, 10.90 to 11.31 mg/L, 4.05 to 4.37mg/L, 3.19 to 3.60mg/L, 4.38 to 4.59 mg/L, 4.13 to 4.27 mg/L respectively with maximum in the month of monsoon and winter and minimum in the months of summer and summer end. Out of total samples of 7 villages, all samples were observed above the permissible values of fluoride. Fluoride concentration of 4 villages were shows contrast results and ranged from 3.19 to 4.59 mg/L which were very low as compared to the values of 3 villages. Most of the water samples analysed for fluoride had higher concentrations of fluoride compared to the prescribed permissible values (>1.5 mg/L) while all the samples of bore wells, hand pump and open wells analyzed had fluoride concentration above the permissible limit (< 1.5 mg/L). It was found that all these different villages were under very serious fluoride contamination. This paper also investigates the health risks involved with higher concentrations of fluoride in drinking water. Deformations of bones in children as well as in adults, weakening of joints and knees in adults, teeth molting in inhabitants were observed in the study area indicating the consequences of excess fluoride concentration (Figure-1).

Figure 1: Images showing the study and it's observations

This fact is confirmed by taken through a questionnaire to peoples of this union and also to those peoples who were admitted to nearby primary health centre as well as rural hospital.

Figure 2: Comparative analysis of fluoride in the groundwater of Newai Region



Removal of flouride from ground water

- Analysis of water quality of Newai region of Tonk district and the prevalence of the bones in children as well as in adults, weakening of joints and knees in adults, teeth molting in inhabitants that the removal of fluoride from water may be the best way to decrease the dental fluorosis in the Newai region of Tonk district. For the removal of fluoride from the surface and ground water of Newai region to be used for domestic purposes, neem stem charcoal in its fine powder form has been investigated as an affordable means. It has been found that neem stem charcoal significantly removes the fluoride from the ground and surface water of the Newai region. In the investigation it has been found that it works efficiently in the pH range of surface and ground water of Newai region. Total capacity of the neem stem charcoal in terms of the maximum absorption of fluoride ion per gram of neem stem charcoal has also been investigated. Considering different critical parameters of surface and ground water of Newai region the removal of fluoride ion with neem stem charcoal has been optimized. The easiest way of regeneration of neem stem charcoal has been investigated. Finally how the idea can be transferred to house hold technology with low cost affordable house hold items has also been developed and the same has been demonstrated to the rural under privileged community of Newai region. The optimum condition for the removal of fluoride from the surface and ground water of Newai region has been determined. Best result was obtained when 10L water (average daily family consumption for drinking) was passed through the column of transparent PVC of dia. 6.36 inches and length of 50 inches). Column was packed with sand of length 4 inches, neem stem charcoal of length 8 inches and sand of length 2 inches respectively. Output flow rate of water was maintained to 100 mL/min such that 10L water may be purified by 2h. Results and the proposed house hold technology for the removal of fluoride ion have been presented in table 2.

Table 2: Fluoride ion concentration in water samples before and after passing through Neem Stem Charcoal

Sl.No.	Sample no.	Ci	Cf
1	Seepura	14.62	1.25
2	Surajpura	10.32	1.10
3	Sidra	11.26	1.15
4	Newai main	4.32	0.90
5	Bhanwata	3.50	0.80
6	Batara	4.50	0.92
7	Gopalpura	4.20	0.95

*Ci (mg/L) - initial concentration, Cf (mg/L) - final concentration of fluoride ion in mg/L

Conclusion

In this region probable source of fluoride in ground water is due to weathering and circulation of water in rocks and soils. Fluoride is leached out and dissolved in ground water. According to World Health Organization WHO 1994 and Indian Standard Drinking Water specification ISI 1991 the maximum permissible limit of fluoride in drinking water is 1.5 mg/L and highest desirable limit is 1.0 mg/L[18]. Fluoride concentrations above 1.5 mg/L in drinking water cause fluorosis. It was found that among these Seven different locations, ground water of villages are under serious fluoride contamination where fluoride concentration in most of the months was exceeding the permissible limit whereas fluoride in bore wells, hand pump and open wells water was within a permissible limit throughout the study period. After evaluating the data of the study, it is concluded that the ground water of Newai Region is polluted with excess amount of fluoride and can result in dental and skeletal fluorosis. To reduce the adverse effects removal of excess fluoride by defluoridation techniques from drinking ground water of Seepura, Surajpura, Sidra, Newai Main, Bhanwata, Batara and Gopalpura villages but it has been found from the survey that this technology is not affordable to the rural under privileged community. Neem stem charcoal has been found very effective to remove the fluoride ion from the surface and ground water of Newai region of Tonk district. Technology has been found very affordable and the transfer of technology to the grass root level may be easy. Also the ground water management as well as environmental awareness in public through educational programmes is suggested.

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Conflict of Interest: None