FLUORIDE CONCENTRATION GROUNDWATER: A CASE STUDY OF KOLAKHURD VILLAGE AT JAGDISHPUR BLOCK, BHAGALPUR, BIHAR INDIA

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ABSTRACT

The present study was carried out to understand the present status of groundwater quality in Kolakhurd village in Jagdishpur Block, Bhagalpur district and also to assess the possible causes for high concentration of fluoride in groundwater. Fluoride concentration over permissible limit (1.5mg/L) in drinking water lead to human health hazards such as dental fluorosis and skeletal fluorosis affecting people. The fluoride concentration in groundwater of this region ranged from 0.7 to 12.6 mg/L. The severity of the effects is more in the young and aged group people. Majority of the cases affected with fluoride in different sites were from dental and skeletal fluorosis.

Keywords*:* Fluoride, Kolakhurd village in Jagdishpur Block, Bhagalpur

Introduction

Ground water is considered as purest and majorly available source of water and is used to fulfill the 50% urban and 80% rural water demand of India besides irrigation (Sahu and Sikdar, 2008). Ground water is also used to irrigate around two fifth of India's total agricultural land (Yogendera and Puttaiaha, 2007). The composition of ground water is influenced mainly by geology, climate and hydrology and also by human activities. Ground water quality has been deteriorating day by day because of shrinking water table, improper sanitation, introduction of chemical compounds, inefficient or less efficient irrigation practices, bad industrial waste management practices, and mixing of leachate being produced by indiscriminate disposal of industrial wastes on land (Cude, 2001). The natural concentration of fluoride in ground water depends on the geological, chemical and physical characteristics of resources, types of the soil and rocks, temperature and action of other chemical substances (IPCS, 1984). Fluorine, chlorine, bromine, iodine and astatine are members of Group 17.These are collectively known as the halogens. The halogens are highly reactive non-metallic elements. Fluorine and chlorine are fairly abundant while bromine and iodine less so. Fluorine is present mainly as insoluble fluorides (fluorspar CaF_2, cryolite Na_3AlF_6 and fluoroapatite $3Ca(PO4)_2.CaF_2$) and small quantities are present in soil, river water plants and bones and teeth of animals. More than 28 developed and developing countries including India and its 19 states are facing fluoride problem.

According to Susheela (1987), 30-50% of districts of Bihar are affected by fluorosis. A very few reports have been published on this aspect from Bihar (Mandal *et al.* 1993, Khandare *et al*. 2005, Yasmin *et al*. 2011, Yasmin and Ranjan, 2015, Kumar and Kumar, 2015, Kumar and Seema 2016, Kumari Gouri and Choudhary,2017). Keeping this in view the present study was undertaken to estimate the fluoride (F) level in groundwater and to determine the extent of fluorosis in the human population of Kolakhurd village of Jagdispur Block, Bhagalpur where ground water is the main source of drinking water.

Study area

Bhagalpur is Second largest city of Bihar state (25° 15' 0" North latitude and 87° 0' 0" East longitude). Kolakhurd village is under Jagdishpur Block (25° 7 ' North latitude 86° 46 ' East longitude) of Bhagalpur districts. This village is situated approx 13 km. from Bhagalpur. In this village the main sources of water for drinking purposes are hand pump and deep boring. The population of the village is 1100 as per Census 2011. The climate is tropical and is characterized by hot summer (19.4°C - 38°C) and pleasant winter (8.6°C - 28.4°C).

Sample collection

Regular monthly survey were made to collect water samples from ten sampling point in the village for the periods from July, 2011 to June, 2013. A total of 240 samples were collected in two years. Out of ten sampling points seven are private hand pump, three are government deep boring and one is well. The depth of deep boring was considered up to depth of 190 feet in present study and whereas more than that was counted as deep boar sources. The minimum depth of 80 feet was recorded in hand pump sources. Samples were collected in cleaned bottles which were again rewashed at sampling sites. Hand pump and deep bore well

water samples were collected after pumping the water for 10-15 minutes. In the case of open wells, water samples were collected at 30 cm below the water level. For analysis, collected samples were transported to Environmental Biology Research Laboratory of University Department of Botany, T. M. Bhagalpur University, Bhagalpur. Fluoride analysis was done by Spectroquant Colorimeter Picco (Merck 1.73606.0001).

Results and Discussion

The variations in fluoride concentration of selected groundwater sources are depicted in Table-1, Table-2 and Figure in 1. Table-1 shows the average values of the year 2011-12 and 2012-13 and Table-2 shows average seasonal values of fluoride concentration from 2011-13. On the basis of average data of two years, the concentration of fluoride was higher in the months of October, November, December and June (7.7, 12.6, 9.89 and 10.035mg/L) respectively at site -1. At site- 2 higher value was recorded only in the month of May (12.45 mg/L) while at site-3 higher values were found in January, March and April (12.09, 12.1, 10.8 mg/L) respectively. At site-4 higher value was found in the month of July (4.59 mg/L). At site-6 the higher value was obtained only in the month of February (5.21 mg/L). At site-8 and 10 the higher values were found in the months of August and June (4.75 and 7.105 mg/L) respectively. On the basis of seasonal variations at site-1, winter months showed maximum value (7.66 mg/L) and minimum value was found to be 3.03 mg/L while at site-2 the maximum value (4.86 mg/L) was obtained during summer and minimum value was found to be 1.95 mg/L. The values at site-3 was higher during summer (7.97 mg/L) and lower during monsoon (2.04 mg/L) while at site-4 higher value (3.42 mg/L) was found during monsoon and lower value during winter and summer months. On the basis of above results the higher concentration of fluoride levels were recorded at sites- 2,3,8,9,and 10 during the summer seasons followed by sites – 1,5,6 and 7 during winter season. Only site – 4 shows higher value during in monsoon season. On the basis of above results most of the sites indicate that fluoride in groundwater of Kolakhurd was higher and alarming. This is the cause of severe fluorosis revealed in the population of Kolakhurd. The permissible limit of fluoride in tropical countries like India is 1mg/L and maximum limit in the absence of alternate source is 1.5 mg/L set by the Bureau of Indian Standard (BIS, 2012).

In the present study, majority of the cases affected with fluoride at different sites were from dental and skeletal fluorosis. The severity of the effects is more in the young and aged group people. Weathering of rocks and evaporation of groundwater are responsible for high fluoride concentration in groundwater in Kolakhurd village. Various minerals are also responsible for high concentration for fluoride. Overall all water sources were found to be unsatisfactory for drinking purpose at Kolakhurd. So there is an urgent need to educate the people about the causes of fluorosis and to encourage rain water harvesting. Defluoridation technique for providing fluoride free water in the study area is the utmost need.

The present study was carried out to understand the present status of groundwater quality in Kolakhurd village of Jagdispur Block, Bhagalpur district and also to assess the possible causes for high concentration of fluoride in groundwater.

Table 1: Average value of fluoride (mg/L) during 2011-12 and 2012-13

2011-12	Site- 1	site -2	Site- 3	site -4	site -5	Site-6	site -7	Site- 8	site -9	Site- 10
July	1.49	1.11	1.34	4.59	1.31	0.745	1.33	0.94	1.69	1.89
August	1.25	1.45	3.45	3.35	1.5	1.5	2.15	4.75	3.3	4.05
September	1.66	1.835	1.245	2.55	1.145	1.705	3.65	4.3	5.2	5.3
October	7.7	3.4	2.13	3.2	4.09	1.345	6.5	3.55	4	2.55
November	12.6	2.18	1.765	3.5	6.05	1.915	3.92	2.645	2.205	3.65
December	9.89	7.2	7.9	3	4.15	6.7	8.3	3.7	2.5	3.05
2012-13										
January	5.085	1.685	12.09	2.45	2.9	2.86	4.22	2.33	2.535	2.95
February	3.065	1.645	2.11	2.585	2.85	5.21	2.33	2.23	2.39	3
March	7.35	1.095	12.1	3.4	1.95	1.75	4.35	3.55	1.65	2.15
April	7.825	3.42	10.875	1.72	1.58	2.2	1.7	2.2	4.7	2.45
May	4.15	12.45	1.66	2.35	5.1	4.165	4.41	5.2	4.1	3.245
June	10.035	2.49	7.235	4.065	1.8	4.335	1.85	7.94	7.14	7.105

Table 2: Seasonal value of fluoride concentration (mg/L) during Monsoon, winter and summer

SEASONS	MONSOON	WINTER	SUMMER
site - 1	3.03	7.66	7.34
Site - 2	1.95	3.18	4.86
site - 3	2.04	5.97	7.97

site - 4	3.42	2.88	2.88
site - 5	2.01	3.98	2.61
site - 6	1.32	4.17	3.11
site - 7	3.41	4.69	3.08
site - 8	3.38	2.73	4.72
site - 9	3.55	2.41	4.40
site - 10	3.45	3.16	3.74

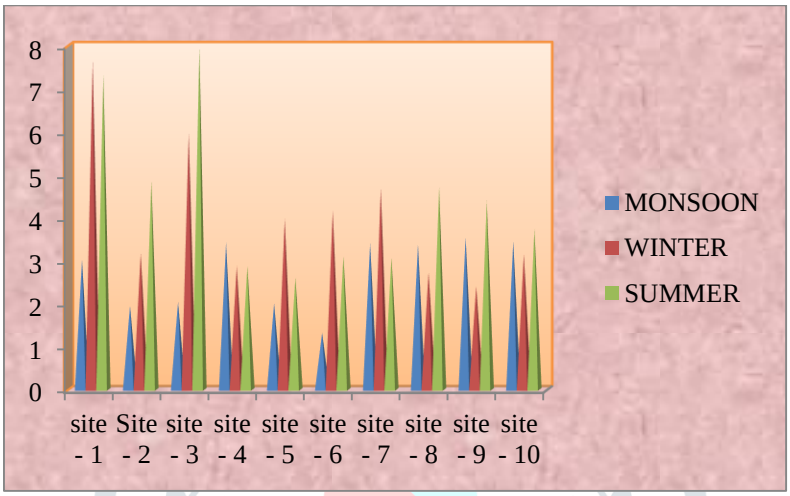

Figure: 1 Shows concentration of fluoride during different seasons

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