

Study on Fluoride Content in Groundwater of Newai Tehsil in Tonk District Located in Rajasthan and Its Impact on Human

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Abstract:

Fluoride in drinking water produces divergent health effects on the consumer. Various technologies are being used to remove fluoride from water but still the problem has not been solved to that extent such that the technology may become popular among poor rural people of India. In the present study attempts have been made to determine fluoride concentration in groundwater of Newai Tehsil of Tonk district which is located in the eastern part of Rajasthan and its impact on people of different age groups of this area. Fluoride concentration in ground water of this area has been found much more than the permissible limit (1.5mg/l) of drinking water. Substantial dental fluorosis and skeletal fluorosis in the form of mottling of teeth, deformation of ligaments, bending of spinal column and ageing problem have been found very common among more than 60% people of this area. Social responsibilities lead us to undertake the present study such that on the basis of experimental data, the user of ground water of this area may be educated on the issue of severe health problem and comparatively better alternative may be suggested.

Keywords: Fluoride, Fluorosis, Ion-Selective Electrode.

1.0 Introduction:

Worldwide very few people is fortunate enough to have safe drinking water. Rest people take more or less contaminated water. Not only industrial effluents but in many cases natural source also are found responsible for such contamination. One such contaminant is fluoride (Roy 2013). Naturally, the fluorides occurs in the combined form because of its high reactiveness. Fluorspar (CaF_2), Cryolite (Na_3AlF_6) and Fluor apatite ($\text{Ca}_3(\text{PO}_4)_2\text{Ca}(\text{F},\text{Cl})_2$) are the parent form taking berth in the surface water, groundwater and sea water. High fluoride groundwater occurs in many areas of the world including India (Reddy, 2010; Yidna, 2010; Young, 2011; Gao, 2012; Manikandan, 2012; Gopalakrishna, 2012; Reddy, 2013; Vikas, 2013). Modern agriculture practice, which involves the application of fertilizer coupled with pesticides, contributes the fluoride to the groundwater (Kim, 2011). Fluoride has dual significance. If the fluoride content is less then it may cause problems like dental caries. WHO has stated that it should be in the range of 0.1 to 0.5 ppm. The Indian Standard for fluoride contents is 1ppm. Groundwater is the

major source of fresh water on the earth. Groundwater containing dissolved ions beyond the permissible limit is harmful and not suitable for domestic use (Satpathy, 2013). Fluoride beyond desirable amounts (0.6 to 1.5mg/l) in groundwater is a major problem in many parts of the world (Brindha, 2010). Intake of more than 6mg of fluoride per day results in Fluorosis. Fluoride in drinking water is totally in an ionic form and hence it rapidly and passively passes through the intestinal mucosa and interferes with metabolic activities of the living system (Shekhar, 2006).

The fluoride contamination in drinking water of Rajasthan (Gangal, 2007) has been appeared as an alarming problem in this region. Almost 75% of the villagers in Sanganer area of Jaipur district are suffering from dental fluorosis and skeletal fluorosis (Sharma, 2006; Singh, 2003). Quality and problems related to the fluoride contamination in groundwater have also been studied in our

laboratory (Yadav, 2009). It has been found that groundwater of Tonk district is contaminated with Fluoride by naturally fluoride rich rock salt. Literature survey reveals that so far no significant study has been undertaken in the Newai Tehsil on fluoride content in ground water and its impact as fluorosis. In the present study attempts have been made to determine fluoride concentration in groundwater of Newai Tehsil of Tonk district and impact of fluoride contamination on people of different age groups of this area.

2.0 Material and Methods:

2.1 Study area

Newai Tehsil the study area 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 (Fig.1 Index Map). 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.

2.2 Water sampling

A total of twenty six groundwater samples were collected from hand pumps, open wells and bore wells of different sampling sites of Newai Tehsil. The groundwater samples were

collected during the post monsoon session (October 2011 to January 2012). The groundwater samples were collected systematically by using clear acid washed polythene bottles of one litre capacity.

2.3 Analysis

The determination of fluoride in groundwater is generally carried out following standard method (APHA, 1998), SPADNS Reagents method, Alizarin visual method and Ion Selective Electrode method. In the present study concentration of Fluoride was determined by SPANDS method. In this method fluoride concentration was determined spectrophotometrically by using acid Zirconyl and Sodium -2 para sulfophenyl azo -1, 8 dihydroxy -3, 6-napthalene (SPAND) reagents (Bellack and Schouboe, 1968).

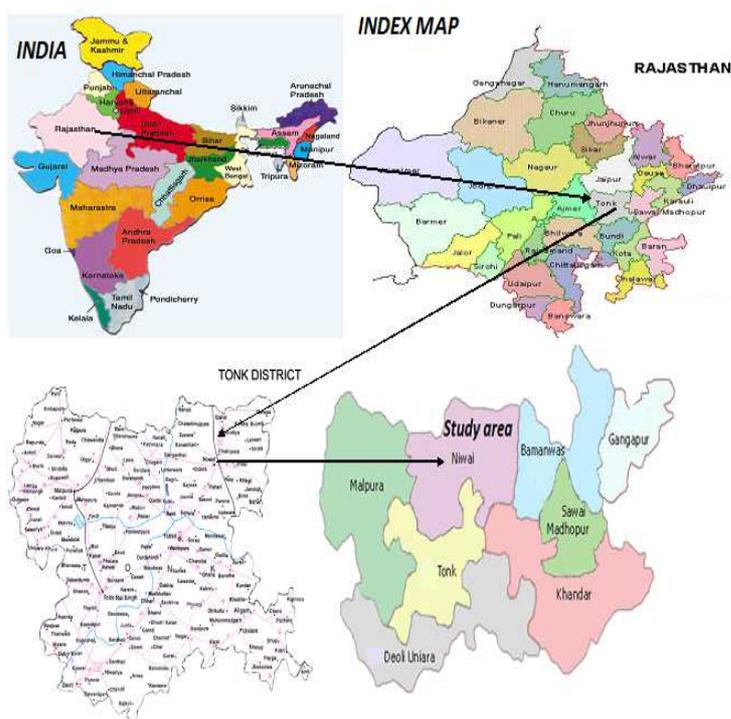


Fig.1 Index Map of the Study Area (Newai)

3.0 Results and Discussions:

Samples collected in the Newai Tehsil were clear without any visible colour, odour and turbidity. The fluoride concentration in groundwater varied greatly in different sampling sites of study areas (Fig. 1). The results of fluoride concentration in groundwater are presented in Table 1.

3.1 Fluoride monitoring

The variation of fluoride concentration in groundwater samples of study area is depicted in figure 2. The fluoride concentration in the groundwater samples showed a definite trends with respect to sampling sites of Newai Tehsil. Fluoride concentration varied from 1.10 to 14.62 mg/L in groundwater samples, with lowest value 1.10 mg/L (G11) and highest value 14.62 mg/L (G3). No sample in our study area showed fluoride concentration below 0.5 mg/L and 5%. Samples showed fluoride concentration in between 0.5 to 1.5 mg/L.(Table 2). It is evident from the research analysis data that it's obvious that the fluoride concentration in 95% of samples is more than permissible limit (> 1.5 mg/L, WHO) for drinking purpose (Table2). Almost all bore wells and hand pumps, which are exclusively used for drinking and cooking purpose, were found to be high in fluoride concentration.

3.2 Sources of Fluoride

The common fluoride bearing minerals i.e., Fluorspar (CaF_2), Cryolite (Na_3AlF_6) and Fluorapatite ($\text{Ca}_3(\text{PO}_4)_2\text{Ca}(\text{F,Cl})_2$) are main source of fluoride in the ground water of Newai.

3.3 Effect of fluoride on human health

Fluoride is the most exclusive bone seeking anion owing to its affinity for calcium phosphate, up to 99% of the body burden of fluoride is found in bone. Presence of fluoride in drinking water is both beneficial and detrimental to the consumer. Low levels of fluoride in drinking water results in incorporation of fluoride into teeth during the formative years of children, which makes the teeth resistant to decay and development of dental caries. However, mottling of teeth may occur when the concentration increases more than 1.5 mg/L. Long term intake of Water containing excessive concentration in the range of 4.0 to 10.0

mg/L causes skeletal fluorosis, in which the bone structure is affected causing bone deformation and crippling (Table2). So the various forms of fluorosis arising due to excessive intake of fluoride are briefly discussed below.

3.4 Dental fluorosis

Dental fluorosis occurs because of the excessive intake of fluoride either through fluoride in the water supply, naturally occurring or added to it; or through other sources. The damage in tooth development occurs between the ages of 06 months to 5 years, from the overexposure to fluoride. Excessive fluoride can cause yellowing of teeth, white spots, and pitting or mottling of enamel. The natural shine or lustre of the teeth disappears. In the early stage, the teeth appear chalky white and then gradually become yellow, brown or black. More than 90% children of the age group 5-8 were found badly affected by dental fluorosis.

3.5 Skeletal fluorosis

Skeletal fluorosis is a bone disease exclusively caused by excessive consumption of fluoride. In advanced cases, skeletal fluorosis causes pain and damage to bones and joints. Skeletal fluorosis affects the bones or skeleton of the body. Skeletal fluorosis affects both young and old. One can have aches and pain in the joints. The joints which are normally affected by skeletal fluorosis are neck, hip, shoulder and knee. More than 95% adults of the age group 40-75 years are severely affected by skeletal fluorosis.

3.6 Non-skeletal fluorosis

The soft tissues of the body may be affected by excessive consumption of fluoride. The symptoms include gastro-intestinal complaints, loss of appetite, pain in stomach, constipation followed by intermittent diarrhoea. Muscular weakness and neurological manifestations leading to excessive thirst tendency are common among the afflicted individuals. Unlike dental fluorosis and skeletal fluorosis the percentage of people affected by non-skeletal fluorosis is found significantly low. Less than 25 % people have been found affected by non-skeletal fluorosis which is surprisingly low.

Table 1: Fluoride concentration in sampling sites of Niwai Tehsil (Tonk, Rajasthan, India)

Sr. No	Source	Sampling Site	Fluoride concentration (mg/L)	S.No	Source	Sampling Site	Fluoride concentration (mg/L)
1	G1	Dr.K.N.Modi University, Campus-1	1.74	13	G13	Bhanwata	3.5
2	G2	Dr.K.N.Modi University, Campus-2	1.90	14	G14	Damodarpura	4.0
3	G3	Seepura	14.62	15	G15	Tilokpura	2.9
4	G4	Surajpura	10.32	16	G16	Batara	4.5
5	G5	Banasthali vidhyapeeth	2.80	17	G17	Shrigovindpura	5.0
6	G6	Sidra	11.26	18	G18	Madanmohanpura	3.1
7	G7	Niwai bus stand	4.32	19	G19	Rampura	3.2
8	G8	Karanpura	2.80	20	G20	Gopalpura	4.2
9	G9	Girdharipura	7.36			Minimum	1.10
10	G10	Gangapura	12.28			Maximum	14.62
11	G11	Khandewat	1.10			Average	5.17
12	G12	Maundiy	2.5				

Table 2. Concentration of Fluoride with WHO Standard

Parameter	Fluoride concentration (mg/L)	Representing Samples	Impact observed on the user
Fluoride	<0.5	Nil	Dental caries
	0.5-1.5	G11	Prevents tooth Decay
	1.5-4.0	G1,G2,G3,G8,G12,G13,G14,G15, G18, G19	Mottling and pitting of teeth (Dental Fluorosis)
	>4.0	G3,G4,G6,G7,G9,G10,G16, G17,G20	Pain in neck bones and back (Skeletal Fluorosis) and Crippling Fluorosis

Percentage of the total samples exceeding limits only 5 %

4.0 Conclusions:

This study provides an overview of the fluoride content in drinking water and show that there is an acute fluoride problem in Niwai Tehsil. The favourable factor which contributes to rise of fluoride in groundwater is presence of fluoride rich rock salt system. The result of current study as well as other available data from water quality should be taken in to account during the when development of strategies for safe drinking water supplies. Environmental awareness programme for health implication should be emphasized through education of the public and community participation.

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