A Study of Fluoride Contaminated Ground Water in Uniara Tehsil, District -Tonk, Rajasthan, India

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ABSTRACT
Water is an essential natural resource for sustaining life and environment that we have always thought to be available in abundance and the free gift of nature however the chemical composition of surface or subsurface water is one of the prime factors on which the suitability of water for domestic, industrial and agriculture purpose depends. Fresh water occurs as surface water and ground water contributes only 0.6% of the total water resources on earth. Ground water is the major and preferred source of drinking water in rural and urban areas particularly in India. Groundwater containing dissolved ions beyond the permissible limit is harmful and not suitable for domestic use. In India fluoride is a major inorganic pollutant which natural origin in groundwater. Fluoride is a fairly common element that does not occur in the elemental state in nature because of its high reactivity. This is the 17th element in order of abundance of element in the earth's crust found as a complex fluoride. Fluorine is most electronegative element hence never found in nature as fluorine. Fluoride occurs in combined form of minerals as fluoride and represents .06 to .09% of the earth crust (WHO, 1970).Serious problems are being faced in several parts of the world due to the presence of high concentration of fluoride in drinking water which causes dental and skeletal fluorosis. Rajasthan, one of the states in India, is known to have excessive fluoride content in groundwater. The present work involves assessment of water quality with special reference to fluoride in Uniara tehsil of Tonk district. 59 ground water samples have been analyzed of Uniara tehsil. The fluoride concentration in groundwater of this region ranged from 0.3 to 7.6 mg/l. About 19% of the samples collected were not suitable for human consumption.

1. INTRODUCTION

Water is an essential natural resource for sustaining life and environment that we have always thought to be available in abundance and the free gift of nature however the chemical composition of surface or subsurface water is one of the prime factors on which the suitability of water for domestic, industrial and agriculture purpose depends. Fresh water occurs as surface water and ground water contributes only 0.6% of the total water resources on earth. Ground water is the major and preferred source of drinking water in rural and urban areas particularly in India. Groundwater containing dissolved ions beyond the permissible limit is harmful and not suitable for domestic use. In India fluoride is a major inorganic pollutant which natural origin in groundwater. Fluoride is a fairly common element that does not occur in the elemental state in nature because of its high reactivity. This is the 17th element in order of abundance of element in the earth's crust found as a complex fluoride. Fluorine is most electronegative element hence never found in nature as fluorine. Fluoride occurs in combined form of minerals as fluoride and represents .06 to .09% of the earth crust (WHO, 1970). Fluorides frequently occur in igneous as well as in metamorphic rocks, especially in alkali rocks, granite, basalt, shale, clays and calcium phosphate rocks are the main sources of fluoride. Fluoride occurs in almost all water from trace to high concentrations. Fluoride beyond desirable amounts (0.6 to 1.5 mg/l) in groundwater is a major problem in many parts of the world. Around 200 million people from 25 nations have health risks because of high fluoride in groundwater (Ayoob and Gupta 2006). In India, the excessive presence of fluorides in groundwater is present in nearly 177 districts covering 19 states. It appears that high fluoride content may exist in many more districts (Muralidharan et al. 2002). The prominent states, which are severely affected, are Andhra Pradesh, Rajasthan, Gujarat, Uttar

Pradesh, and Tamilnadu (Arif et al. 2011, 2012; Hussain et al. 2005, 2007, 2011; Susheela 2001; Muralidharan et al. 2002). Earlier reports in different parts of India indicate certain instances of fluorosis (Subba Rao 2008; Arif et al. 2011, 2012; Hussain et al. 2005, 2007, 2011). Fluoride concentration is an important aspect of hydro geochemistry, because of its impact on human health. The main potential health risks from fluoride are considered to be fluorosis or bone disease. The recommended concentration of fluoride in drinking water is 1.50 mg/l (WHO 2004). Groundwater is the primary source of potable water supply in rural India. It is not readily available in most parts of India due to a hard rock shield that covers 70% of the country. Since the water is a limited resource, our future plan would have to be based on this fact. Fluoride at a level of about 1.5 ppm in drinking water is beneficial and controls metabolic bone diseases (WHO 2004). Deficiency of fluoride at less than 1 ppm level enhances the frequency of dental caries, and the problem has been discussed in several papers cited by Lag (1983). Dental fluorosis is seen in many parts of India when the fluoride concentration in water exceeds 1.5–2 mg L^{-1}, and crippling skeletal fluorosis may occur at contents >5 mg L^{-1} (Jacks et al. 1993).

Toxicological effects of prolonged and excessive fluoride intake are well known in plants, human, cattle, and sheep (Machoy and Machoy-Mokrzynska 1990; Marcus et al. 1996). The major health problems associated with excess fluorides in humans are dental fluorosis, mottling of teeth, skeletal fluorosis, and deformation of bones in all age groups (Susheela 1993; Suma Latha et al. 1999). Reproductive effects have also been shown in animals (National Research Council 1993). Fluorosis in grazing animals has been reported throughout the world; yet, bioaccumulation rates of fluorides vary among animals ingesting similar fluoride concentrations (Suttie and Faltin 1971). Other studies link ingestion of fluoride to adverse effects on renal function and the gastrointestinal and immune systems National Research Council (1993). In plants, fluoride inhibits germination and productivity and imposes physiological and biochemical disorders (Suma Latha et al. 1999; Elloumi et al. 2005). Fluoride contamination in ground water is one of the major environmental hazards in many districts of Rajasthan. In Rajasthan the existence of fluoride was first detected from jobner near Jaipur city, later during 1964 in the villages of nagour and in 1976 high fluoride content in drinking water were observed in Bhilwara district and Mathur et al reported the prevalence of fluorosis in Ajmer district (Mathur et al. 1976).

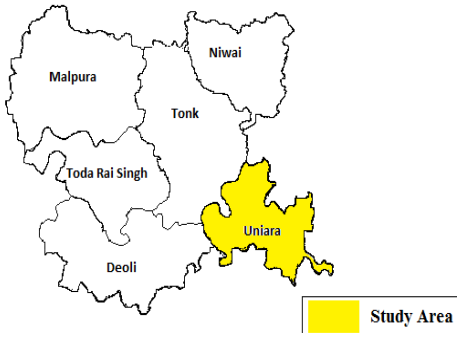
2. STUDY AREA

Tonk, one of the erstwhile princely states of Rajasthan is located in its north-eastern part between East longitudes 75°07' and 76°19' North latitudes 25°41' and 26°34' and is covered in the Survey of India degree sheets 45N, 45-0, 54 B and 54 C. The total geographical area of the District is 7194 sq kms. The district comprises of 7 sub divisions, Tonk, Niwai, Deoli, Uniara, Malpura, Toda Raisingh and Piplu. It is bounded in the north by Jaipur district, in the south by Bundi and Bhilwara district, in the west by Ajmer district and east by Sawai Madhopur. Physiographically the area is characterized by generally flat to undulating topography with small isolated ridges running in north- east to south-west direction between Gar and Banoli in the western part and the Aravalli hills towards Sawai Madhopur in the Southeast. The general elevation of the plain ranges from 231 to 337 m above mean sea level and trends from south-west to north-east. The hills on the south-eastern side rise to a height of 518.46 m amsl. The Rajmahal and Tordi hills in the west rise to elevation of 605.30 and 574.20 m amsl. In the central part there is a hill which runs for about 14 kms between Chauth ka Barwara and Bhagwantgarh and rises to a height of 150 to 180 m above the plains. Ridges of gneisses, schist and quartzite rising to a height of 190 m above the plains are seen at Gaunri and Tonk. At Gaunri these occur as isolated hills while in Tonk they are found as clusters trending in NE-SW and are extending up to Purtha. Small isolated hillocks are also seen at Um and Kabra. Except for these hills, the country is otherwise flat. On the bank of the Banas River there are sand dunes which rise to heights of 20 to 30 m above the plains (Census 2001).

Uniara is located at 25.92°N 76.02°E.It has an average elevation of 266 metres (872 feet). As per census 2001 the total population of Uniara is 143.343 in which 132,509 populace belongs to rural area. The main source of drinking as well as irrigation water in this area is ground water (Census 2001).

A bibliographic survey has shown that yet no studies have been undertaken in the study area with regard to the fluoride concentration in ground water, so the objective of the present study was to

investigate the fluoride concentration in ground water in Uniara tehsil of Tonk district, (Fig.1) Rajasthan, India.



3. EXPERIMENTAL METHODOLOGY

Groundwater samples of 59 villages located in Uniara tehsil of Tonk district were collected in pre cleaned polyethylene bottles with necessary precautions (Brown et al. 1974). The fluoride concentration in water was determined electrochemically, using fluoride Ion selective electrode (APHA 1991). This method is applicable to the measurement of fluoride in drinking water in the concentration range of 0.02–1,000 mg/L. The electrode used to be an Orion fluoride electrode, coupled to an Orion electrometer. All the experiments were carried out in triplicate and the results were found reproducible with ±2% error.

Preparation of TISAB-III

Take 250 ml de-ionized water and add 234 ml of concentrated hydrochloric acid. Add 385.4 g of Ammonium acetate. Add 17.3 g of 1, 2-cyclohexylene-diaminetetraacetic (CDTA). Stir to dissolve and cool at room temperature. Make it up to 1,000 ml.

Procedure

1. Calibration of instrument: Prepare a series of standards over the appropriate concentration range (0.1, 1.0 and 10.0 mg/L) Calibrate the instrument to obtain -59.2 ± 2 mv slop.

2. Take 10 ml sample, add 1 ml of TISAB III and measure fluoride concentration.

4. RESULT AND DISCUSSION

The physical observations of the samples indicated that they are colourless and odourless in nature. The fluoride levels in ground water of Uniara Tehsil in Various studied villages are listed in Table I. The fluoride concentration range is divided in five different category i.e. (i) <1, (ii) 1-1.5, (iii) 1.6 to 3, (iv) 3.1 to 5 and (v) >5 mg/l. Fig. 2 shows the no. of villages and their fluoride concentration range as per divided category. The minimum concentration 0.3 mg/l was recorded from Ramganj village while maximum concentration was recorded from village Jhoondwa (7.6 mg/L). It is clear from fig. 2 that the maximum villages belong to the concentration of <1.0 mg/L. 48 villages out of 59 is suitable for drinking purpose, reaming 11 villages are not.

Out of 59 villages of Uniara tehsil twenty villages (33.90 %) have fluoride concentration above 1.0 mg/l and below or equal to 1.5 mg/l. and fall in category II the maximum permissible limit of fluoride in standard for drinking water is 1.5 mg/l recommended by WHO.

The population of these habitations, fluoride intake through drinking water is more than 4 mg/day in an individual. Therefore, an incidence of first and second degree dental fluorosis is possible in local residents of these habitations.

Five villages (8.47%) have groundwater with fluoride concentration above 1.5 mg/l and below or equal to 3.0 mg/l., which is above the maximum permissible limit as recommended by WHO. At this concentration, the teeth lose their shiny appearance and chalky black, gray, or white patches develop known as mottled enamel (Dean 1942). In five villages (8.47 %) fluoride concentration in groundwater is above 3.0 mg/l and below or equal to 5.0 mg/l and this fall in category IV. The intake of fluoride per day by population in these habitations is very high and cause dental as well as skeletal fluorosis.

In the entire study the 1 village (1.69 %) falls in category V, in this village, fluoride concentration is above 5.0 mg/l, which may result in all types of fluorosis among inhabitants. In the second clinical stage, the affected persons may have pain in bones, which causes further calcification in ligaments. It has been reported that such persons may suffer from stiffness in joints. At this concentration, the vertebrae partially fuse together crippling the patient which is known as “crippling skeletal fluorosis”.

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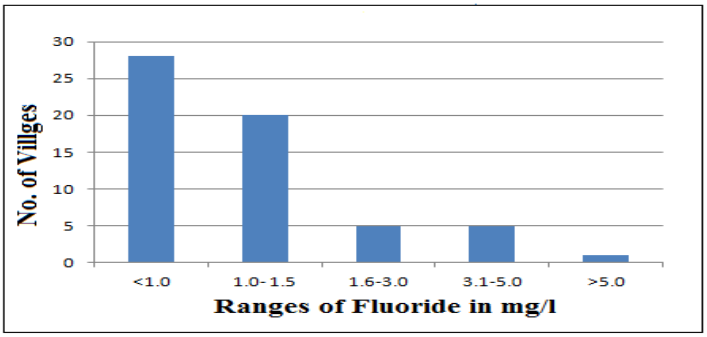

Fig.2 - No. of villages as per fluoride concentration ranges

As stated earlier that the excess fluoride concentration in our body has socio-economic implication as well. The disease fluorosis is non curable but preventable. Following are some of the mitigating measures, be adopted for abatement of the problem.

- Popularization of simple, economically viable method of domestic defluoridation using polyaluminium chloride and Nalgonda techniques.
- Blending of high fluoride with low fluoride water in endemic areas.
- Construction of wells/tubewells in the low fluoride area for drinking water supply.
- Urging rural people especially the lactating mothers to use fluoride safe water.
- Adequate use of vitamin C in diets.
- Periodic nutritional and epidemiological surveys be carried out in endemic areas.
- Promulgation of Aquifer Protection Policy (App) to avoid over exploitation of ground water to alleviate ingress of fluoride.
- Prohibition on use of fluoride rich tooth-pastes, mouth wash and other luxury items.
- Ban on Pan masala, gutka and other tobacco chewing preparations.

- Dental fluorosis can be vanquished by capping, bleaching or by laminated veneering of teeth. This practice may prove better in matrimonial matters.
- Public awareness and health education are the most important measures to be widely adopted. This can be done by using audio-visual aids, seminars, conferences, symposium and training.

Non-Government Organisations (N.G.O.'s) must be encouraged in such programme for public welfare.

Table 1 Fluoride concentration in villages of Uniara tehsil

S. No.	Name of main habitation	Fluoride	S. No.	Name of main habitation	Fluoride
1	Ahmad Nagar	0.5	31	Govindpura	4.1
2	Aleempura	3.1	32	Jhoondwa	7.6
3	Ameerganj	0.5	33	Nawabganj	1.4
4	Barodiya	0.7	34	Shahpura Khurd	2.3
5	Bhankarwari	1.3	35	Lasadiya	0.9
6	Amli	1.4	36	Ram Nagar	2.1
7	Beshki	0.9	37	Vijaipura	1.1
8	Balapura	3.2	38	Thikariya	1.1
9	Barana	2.4	39	Rasoolpura	1.1
10	Asalgaon	0.8	40	Roopwas	0.4
11	Ateekpura	0.8	41	Sardarpura	0.5
12	Bajoliya	0.7	42	Kotri	1.1
13	Balagarh	1.1	43	Kairod	1.6
14	Sedri Gujran	1.1	44	Haidaripura	4.2
15	Subhnpura	0.9	45	Gafoor Pura	0.5
16	Sitarampura	0.8	46	Shreepura	0.4
17	Ramganj	0.3	47	Daulatpura	1.4
18	Naya Gaon	4.2	48	Dhikoliya	0.5
19	Motipura	0.6	49	Asalgaon	1.3
20	Sindoli	1.2	50	Theekariya	0.6
21	Kotri	1.4	51	Shah Alampura	0.5
22	Deopura Kalan	2.1	52	Shapura Kalan	1.2
23	Solatpura	0.8	53	Ratanpura	0.5
24	Dabla	0.6	54	Sangrampura	1.4
25	Chainpura	1.2	55	Lachhmipura	1.1
26	Ateekpura	1.3	56	Manoharpura	0.8
27	Shyopura	0.6	57	Nazeerpura	0.8
28	Bheemganj	1.3	58	Mohammad Garh	1.4
29	Chhan	0.6	59	Kherli	0.6
30	Shyampura	0.7			

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