Environmental Forensic Studies on Fluoride Toxicity in Groundwater of Dharmapuri District,Tamilnadu,India

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Abstract

The aim of the present study is to assess the hydrogeochemical characteristics of groundwater in Pennagaram taluk of Dharmapuri district, Tamil Nadu, India. In order to assess the groundwater quality, 158 groundwater samples were collected from bore well during monsoon and post monsoon season in the year of 2018 December to 2018 June. Fluoride is found in water samples and fluorosis in people were observed in Pennagaram, Attukaranpatty in Dharmapuri District.Fluoride concentration in Pennagaram, Dharmapuri District ranges 12.5 mg/L in ground water samples. The intake of fluoride per day by population in these habitations is very high and cause dental as well as skeletal fluorosis. Fluoride concentration in Attukkaranpatty ranged from 6.2 to 10.45 mg/L. The dental fluorosis is present in 30% of children and 40% of adults. A direct relationship between the levels of fluoride in drinking water and magnitude and severity of the fluorosis problems is evident.

Keywords: Water quality, Groundwater, Dental fluorosis, Fluoride ions, Toxicity,

1.INTRODUCTION

Fluoridation of water has been common practice in various countries like Australia, Brazil, Malaysia, USA, India and Vietnam. In Central Asia, usage of fluoride is profoundly extant, thus occasioning the citizens' exposure to various health risks. An excessive level of fluoride causes various health issues, mostly on dental and skeletal fluorosis which often leads to vulnerabilities in the bones and teeth. Studies also indicate that excessive levels of fluoride have been known to contribute to poor neurological development among children, hip fractures to older adults, as well as osterosclerosis.

Moreover, the review has concluded that fluoride contamination in groundwater is very high in India, Pakistan and Sri Lanka. In contrast, fluoride levels are below threshold value of 1.5 mg/L in Bangladesh. In India, staks such as Kerala, Gujarat, Bakresh (West Bengal), Khudra (Orissa), Manikaran (Him Pradesh), Unkeeher (Mahar) and Tattapani (Chattisgarh) are currently facing a high level of fluoride.
At low concentrations, fluoride is beneficial to the teeth, mostly in helping eliminate teeth decay, admittedly, it also does decontaminate water as it kills various bacteria which may present there

(Rwenyonyi et.al.2000). However, at excessive levels, fluoride can cause negative health effects, such effects mainly include dental and skeletal fluorosis. Dental fluorosis, yellowish striations on the teeth enamel, is often the first evidence of high fluoride consumption; and high levels of fluoride have also been associated with the erosion of the enamel (Saparamadu and Dinesh, 2000).

Fluoride in water derives mainly from dissolution of natural minerals in the rocks and soils with which water interacts. The most common fluorine-bearing minerals are fluorite, apatite and micas. Fluoride problems therefore tend to occur where the element is most abundant in the host rocks. Ground waters from crystalline rocks, especially granites are particularly susceptible to fluoride build up because they often contain abundant fluoride-bearing minerals.

In India alone, endemic fluorosis is thought to affect around 1 million people (Teotia et.at., 1981) and is a major problem in 17 out of the country's 22 states, especially Rajasthan, Andhra Pradesh, Tamilnadu, Gujarat and Uttar Pradesh.

Fluoride has been found to have a significant mitigating effect against dental caries and it is accepted that some fluoride presence in drinking water is beneficial. Optimal concentrations are around 1 mg/1. However, chronic ingestion of concentrations much greater than 1.5 mg/1 (the WHO guideline value) is linked with development of dental fluorosis and, in extreme cases, skeletal fluorosis. High doses have also been linked to cancer. Health impacts from long-term use of fluoride-bearing water have been summarized (Dissanayake, 1991).

In Tamilnadu, the high concentration of fluoride in ground water is found to be in Dharmapuri and Salem district closely followed by Coimbatore, Madurai, Trichy, and Dindigul districts. It is reported that 17 districts in Tamilnadu are endemic for fluorosis. Despite the fact, this study was under taken to assess the levels of fluoride in drinking water supply in the study area and to assess the knowledge and attitude of fluorosis and its control measures.

2.Study Area:

The study area form a part of Dharmapuri district. The sub area of our experimental studies is bounded by Pennagaram, Attukkaranpatty in Dharmapuri distric.

3.Preparatory work and Collection of Information:

The preparatory work started at Dharmapuri by literature studies, concerning contaminated ground water, the chemistry of fluoride in water and geology with fluoride bearing minerals. The work included searching background information about geology, soil type and land use, and also looking for information about previous test results and finding maps over the study areas. It was continued with TWAD where more information was available, but since the information gathering is an extensive task, it continued all through the project.

4.Methodology:

Fluoride contamination where evaluated using two type of methods. They are the following:

1. Public Health Survey Method
2. Ground Water Sample Analysis Method

4.1.Public Health Survey Method:

Sample survey sheet was framed based on few journals as reference, the same sheet was checked for the data collections with the department of statistics corrected sheet was used for survey. The survey analysis which is collected in the study area is used to collect the details of people who are affected by Dental fluorosis, Skelton mottling and also its severity in study area.

4.2.Ground Water Sample Analysis Method:

Collection and Sampling Technique:

Water samples were collected in clean Jerri can bottles of 2 liters capacity. The sampling bottles were soaked in 1:1 diluted HCl solution for 24h, washed with distilled water, and were washed again prior to each sampling with the filtrates of the sample. In the case of bore wells, water samples were collected after pumping the water for 10 min. In the case of open wells, water samples were collected 30 cm below the water level. The sample bottle are closed tightly and labeled. The samples were preserved, cooled and protected from breakage while transporting the bottles to the laboratory. Within 24 hrs the sample is shifted to the Lab for analysis. Fluoride was analyzed using a MERCK SQ118 Photometer. When using this instrument, the sample was firstly mixed with the F1 reagent and then with the F2 reagent. The reaction time was approximately five minutes during which the sample turns a bluish-purple color, and it is then poured in to a glass cuvette which is inserted in the Photometer. A light beam passes through the sample and a certain amount of light is absorbed. The absorbed light is proportional to the concentration of fluoride in the sample, which is shown on the display.

4.3.Statistical Analysis:

In the present study Minimum, Maximum, Average, Standard Deviation and Correlation coefficient (r) has been calculated for each pair of water quality parameters by using Excel spreadsheet for the

experimental data. The standard formulae were used in the calculation for statistical parameters are as follows (Gupta, 1999).

5.RESULTS AND DISCUSSION

The TWAD of Dharmapuri district identified 50 to 60 villages are impacted by the fluoride in the range 1.6 mg/L to 2.4 mg/L. Pennagaram and Attukkaranpatty show high level of fluoride level in drinking water.

The elevated levels of fluoride in ground water result in endemic fluorosis pose a public health problem in India. The statistics revealed that around 15 states in India are affected with fluorosis (Kotechal et.al.2012). An adult human body consists of approximately 2.6g of total fluoride and highly toxic to humans and animals when taken in more than its prescribed quantities.

The enamel of human tooth (hardest part of the human body) consists of the mineral hydroxyl apatite [Ca5 (PO4)3OH] that reacts with excessive ingested fluoride and replaces the hydroxyl ions in the apatite structure, thereby converting it to fluoroapatite [Ca5 (PO4)3F]. It makes the tooth brittle and brings discoloration which is a clear indication of over exposure to fluoride during childhood. A child with severe dental fluorosis are marked as less intelligent, less social, less attractive, less careful, less happy, less hygienic and less reliable and ultimately drops the confidence of the children.

Analysis of Fluoride in water sample

A – Pennagaram, Dharmapuri District

Fluoride concentration in Pennagaram, Dharmapuri district ranges from 0.1 to 12.5 mg/L in ground water samples. The study reveals that out of 50 villages of Pennagaram area have fluoride concentration above 1.0 mg/L and below or equal to 1.5 mg/L. Population of these habitations, fluoride intake through drinking water is more than 4 mg/L in an individual. Therefore, an incidence of dental fluorosis is possible in local residents of these habitations. 14 villages (28%) have ground water with fluoride concentration equal to 1.6 mg/L and below or equal to 3.0 mg/L which is above the maximum permissible limit prescribed by BIS and WHO.

At this concentration, teeth lose their shiny appearance and chalky black, gray, or white patches develop known as mottled enamel. In 6 villages (12%) fluoride concentration in ground water is equal to 3.1 mg/L and below or equal to 5.0 mg/L. The intake of fluoride per day by population in these habitations is very high and cause dental as well as skeletal fluorosis.

TABLE – 1

Fluoride Concentration in Pennagaram, Dharmapuri District:

Sample No	Fluoride Concentration (mg/L)	Mean	SD
S1	12.10	1.50	0.37
S2	11.3	1.02	0.14
S3	12.41	1.62	0.18

S4	12.26	1.74	0.74
S5	10.08	0.98	0.52
S6	12.82	1.80	0.89

B-Attukkaranpatty, Dharmapuri District

Fluoride concentration in Attukkaranpatty ranged from 6.2 to 10.45 mg/L. The range and mean values of fluoride for each of the sample are shown in Table – 2.

The fluoride concentrations of all the drinking water sources are significantly higher in summer months. There is little dilution of fluoride in ground water during summer and significant dilution during the rainy season.

The water fluoride levels in control areas 1 and 2 (mean values 0.65 and 0.53 mg/L, respectively in non-summer months) are below the tolerance limit of 1 ppm, which explains the virtual absence of fluorosis in these areas. The water fluoride level of fluorotic area 1 (mean value 0.70 mg/L non-summer) is within the tolerance limit but dental fluorosis is present in 30% of children and 40% of adults. A direct relationship between the levels of fluoride in drinking water and the magnitude and severity of the fluorosis problem is evident.

TABLE – 2

Fluoride Concentration in Attukaran Patty, Dharmapuri District:

Sample No	Fluoride Concentration (mg/L)	Mean	SD
S1	10.04	0.80	0.27
S2	10.38	0.04	0.31
S3	10.02	0.43	0.38
S4	6.02	0.21	0.12
S5	10.26	0.98	0.29
S6	10.74	0.90	0.45

6. CONCLUSION

The effects of fluoride on the drinking water and human health were studied in this study.

Fluoride is found in water samples and fluorosis in people were observed in Pennagaram, Attukaran Patty in Dharmapuri District.Fluoride concentration in Pennagaram, Dharmapuri District ranges 12.5 mg/L in ground water samples. Population of these habitations, fluoride intake through drinking water is more than 4 mg/day in an individual. The present study finds that, the incidence of dental fluorosis in the lowest age is 8 years and the highest age is 67 years. Children are found as the most vulnerable age group, when damage due to fluorosis is widely seen in Pennagaram. The intake of fluoride per day by population in these

habitations is very high and cause dental as well as skeletal fluorosis.The effects of fluoride on the drinking water studied in Attukaranpatty, Dharmapuri district also shows high level of fluoride concentration. Fluoride concentration in Attukkaranpatty ranged from 6.2 to 10.45 mg/L. The dental fluorosis is present in 30% of children and 40% of adults. A direct relationship between the levels of fluoride in drinking water and magnitude and severity of the fluorosis problems is evident.

7.Recommendations:

There are several options available for providing fluoride-free water to the people of this area. People can harvest rain water from their own rooftop for meeting the drinking and cooking requirements. Building of large number of ground water recharge structures for diluting the fluoride levels in aquifers at appropriate locations are another option to minimize the problem.

A Government based common treatment plant will have to be installed to supply fluoride free water for public. Conducting awareness programs and educating people on fluorosis and promotion of calcium and phosphorus rich diet are recommended which are directly associated with a reduced risk of dental fluorosis. Vitamin C ingestion also safeguard against the risk of fluorosis. Apart from this, free medical camps can be arranged to provide right treatment to the victims.

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