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Effect of Fluoride Contamination in Public Drinking Water Sources in villages of Arasikere taluk, Hassan District, Karnataka, India

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Abstract: The presence of fluoride and its impact on human health is documented. When consumed in limited quantity, fluoride prevents dental caries, assists in the formation of dental enamels, and prevents deficiencies in bone mineralization. At excessive exposure levels, ingestion of fluoride causes dental fluorosis skeletal fluorosis, and manifestations such as gastrointestinal, neurological, and urinary problems. The distribution of fluoride in the environment is uneven and largely is believed to derive from geogenic causes. The natural sources of fluoride are fluorite, fluorapatite, and cryolite, whereas anthropogenic sources include coal burning, oil refining, steel production, brick-making industries, and phosphatic fertilizer plants, among others. Among the various sources of fluoride in the environment, those of anthropogenic origin have occasionally been considered to be major ones. The groundwater is more susceptible to fluoride accumulation and contamination than are other environmental media.

Keywords: Fluoride, Agricultural soil, Drinking water, Tooth decay , Ground water.

Introduction

Water found on the Earth approximately 3 billion years ago. That was the time when the oceans were formed, the first life forms originated in the oceans through a process called Abiogenesis. It is the most abundant substance on the earth and is universally present in air, clouds, oceans, streams, springs, or glaciers. On the globe nearly 80% of the water is present in the oceans and most of the fresh water is trapped in the Icebergs. We have hardly around three percent as fresh water and only 0.3% of that water is accessible for our day-to-day usage and consumption. It is the only substance that simultaneously occurs in the three states namely solid, liquid and gaseous. One of the important function of water is that it acts as a heat regulator of the planet by the absorption and release of heat. (Gowda *et al.*,2023). Fluoride is the simplest anion of fluorine. Its salts and minerals are important chemical reagents and industrial chemicals, mainly used in the production of hydrogen fluoride for fluorocarbons. In terms of charge and size, the fluoride ion resembles the hydroxide ion.

Many archaeological evidences reveal that the birth and growth of any civilization always took place either on the bank of a river or in the vicinity of a good water source. Water is used for irrigation, domestic needs and shipping of goods and other purposes. The Roman Empire had a system of pipelining. They used Lead pipes to supply water to the houses, which is evident from the Lead pipes which are preserved even today. (Elizabeth *et al*., 1987).

Fluoride ions occur on earth in several minerals, particularly fluorite, but are only present in trace quantities in water. Fluoride contributes a distinctive bitter taste. It contributes no color to fluoride salts. Chemical formula is F- Molar mass is18.9984 g/mol Soluble in Water.

Fluoride is widely dispersed in nature and a common constituent of most soils, rocks, plants and animals. Due to its high electro-negativity, it forms only fluorides and no other oxidation states are found.

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Fluorine is a common element representing about 0.38 g/kg of the earth's crust (WHO, 2008), which exists in the form of fluoride in a number of minerals. Fluorides are used in the production of aluminum, bricks, tiles, ceramics, phosphate fertilizers and toothpaste. The high concentration of fluoride causes mottling of teeth, skeletal fluorosis, bending of vertebral column, deformation of knee joints and other bones of the body and even causes paralysis. (Taresh *et.al*., 2011).

Industries like oil refinery, plastic, pharmacy, cosmetics, glass, refrigeration and automobile use fluoride containing salts as raw material or produce fluoride in any form which emits exhaust gas, dust or fumes rich in fluoride as by-product. (Beck, 1985)

Fluoride enters environment through natural as well as anthropogenic sources. The chief sources of fluoride are minerals viz., fluorite, fluorospar, fluorapatite, crylolite, micaand hornblende; rocks and sediments. Fluoride bearing minerals occur in all geological rocks such as sedimentary, metamorphic and igneous deposits. The ordinary soil that contains clay minerals may be the main source of fluoride. Natural concentration of fluoride in groundwater depends on the availability of fluoride in rocks and minerals encountered by the water as it moves along the flow path. The distribution of fluoride in groundwater depends on a number of factors, such as amount of soluble and insoluble fluorine in source rocks, rainfall, vegetation, redox potential, pH and ion exchange process.Fluorides are more common in groundwater than surface water. (Sunil, *et.al*., 2011).

Phosphate fertilizers like super phosphate and rock phosphate, being extensively used in India, are the major culprits for fluoride concentration of the environment. These contain fluoride as an impurity and lead to high fluoride accumulation in soil. Fluoride enters human beings through drinking water, food, air, industrial exposure, drugs, cosmetics, tooth paste and mouth rinses etc.

Naturally, fluorides occurring in groundwater are a result of the dissolution of fluoride containing rock minerals by water while artificially high soil fluoride levels can occur through contamination by application of phosphate fertilizers, sewage sludge or pesticides.

Materials and methods

Fluoride above permissible levels (i.e 1ppm) in drinking water causes Dental and Skeletal fluorosis in humans. This kind of a contamination is present in more than 60 countries around the world and in more than 15 Indian states including Karnataka. Hence, villages of Arasikere Taluk, Hassan District, Karnataka was taken as a pilot area to study and analyze the scenario of fluoride contamination in drinking water bore wells in the State of Karnataka. The study was conducted in 15 villages, where every village, public bore water samples was analyzed for fluoride contamination. Out of the 15 villages, 9 villages showed fluoride above permissible levels (i.e. above 1ppm) in which 8 villages were in a critical level (i.e. More than 3ppm). All the data collected were plotted in a map and the fluoride pockets were found out. A portable kit prepared by the Centre for Development Alternatives (Jal TARA), New Delhi was used to test the kits.

Study area

Arasikere Taluk Hassan District, Karnataka in the state of Karnataka, India. It is a major railway junction on the South Western Railway and a central place of visit to places of tourist interest like Belur (40 km), Halebidu (25 km) and Shravanabelagola (80km). it is known for its coconut production and Malekall Tirupathi hill. Hosadurga town with an area of 8.0sq.kms sits at the foot Tirupathi hills and is surrounded by many other smaller hills which rise to 797mm above mean sea level. I have been selected 15 study sites around Arasikere Taluk.

Physiography

Arsikere is located at 13°18′52″N 76°15′25″E. It has an average elevation of 812 meters (2,664 feet). about 48 km from Hassan city. The groundwater quality of Arsikere region is being over stressed in order to fulfill the heavy demand for fresh water. Even though the Hemavathi and the Yagachi flow through the district, it is deprived of potable drinking water and the water table has decreased due to successive years of drought. The ground water quality of this region is being over stressed in order to meet the heavy demand for water because of pollution of surface water bodies, inadequate sanitary and drainage systems, septic tanks, disposal of municipal and domestic sewage without treatment, disposal of solid wastes and improper management etc. This may lead to depletion and water quality deterioration. (Yogananda *et al*., 2016).

Land Use

In the study area, the agricultural activity depends mainly on rainy season which is not uniform throughout the taluk. Even the climatic and the soil conditions also vary considerably. Hence, diversity of very high order in cultivation is observed in this taluk. Cultivation comprises of 65 to 70% of the total land area. Short-term crops like paddy, maize, groundnut, ragi, cotton and tobacco are being cultivated in this region. Besides, some horticulture crops like coconut and areca are also grown. Vegetables, fruits and other crops are also grown in small quantities in this area.

Health effects of Fluoride

The effects of fluoride on human health can be either positive or negative depending on the amount of fluoride that has been ingested. WHO 2008 recommends that drinking water should ideally contain 0.5-1.0 mg/L fluoride, as it helps to prevent dental caries. When the teeth are fully developed fluoride will still help to protect the teeth. It will dissolve in the saliva and help to repair teeth that have been attacked by dental caries. The fluoride can also attach to the surface of the teeth and then be released to help and protect the teeth when needed. Osteoporosis is an illness where bones become very fragile and breaks very easily. Fluoride can be used to treat that condition as it affects the enzyme that controls the production and degradation of bone. It will lead to a faster production than degradation and the bones will become less fragile. Low concentration provides protection against dental caries, especially in children. This protective effect increases with concentration up to 2 mg/l of drinking water. The minimum concentration of fluoride in drinking water required to produce the effect is approximately 0.6 mg/l. High fluoride concentrations exert a negative effect on the course of metabolic processes and consequently individuals may suffer from dental fluorosis, skeletal fluorosis (This can cause joint pain, restriction of mobility, and possibly increase the risk of some bone fractures) and non-skeletal manifestations. Excessive intake of fluoride affects the teeth and the bones. This is because fluorine is very electronegative and thus easily binds to the positively charged calcium ions in teeth and bone. In large quantities fluoride can also affect the kidneys and the thyroid gland and in the most extreme cases it can lead to death.

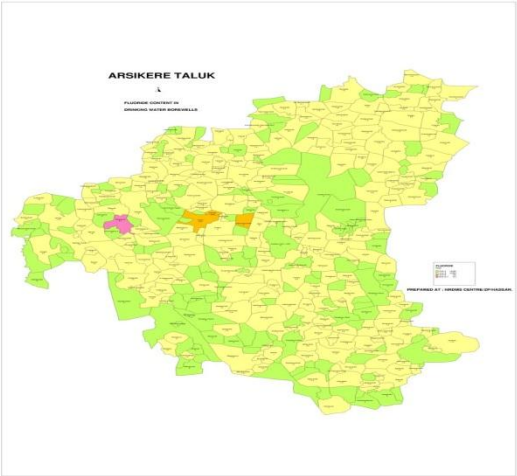

Figure 1: Map showing the fluoride content in villages of Arasikere Taluk.

Sampling Location

Sampling locations in and around villages of Arsikere taluk have been selected using random grid or spatial network method based on geographical ground map of Arsikere (Figure 1) shows the different sampling stations, which have been selected from 15 different localities. in the present study for generation of analytical data, which can be used as baseline data for many years in this region. Water samples from different location were collected as per the guidelines of random sampling techniques; collected ground water samples were transferred into pre-acid washed transparent 1 or 2 Liter plastic can. The samples from 15 sampling sites were collected and analyzed during pre-monsoon, monsoon and post monsoon seas during 2018 to 2019 to determine the fluoride content in the study area (Table 1). The water samples were collected from bore wells. analyzed in departmental laboratory for fluoride concentration .

Table 1: fluoride content in the study area

S.No	Sampling Station	Locations
1.	S1	Aggunda
2.	S2	Bageshpura
3.	S3	Doddaghatta
4.	S4	Doddenahalli
5.	S5	Gollarahalli
6.	S6	Hiriyur
7.	S7	Kallanaikanahalli
8.	S8	Madalu
9.	S9	Kolagunda
10.	S10	Kallugundi
11.	S11	Jannavara
12.	S12	Narasipura
13.	S13	Yerehalli
14.	S14	Thalalur
15.	S15	Undiganalu

Laboratory analysis

The analysis were carried out in the laboratory. The method used for the detection of fluoride content in the ground water by using pocket colorimeter II method, having standard wave length of 580 nm.

Figure 2: Portable Pocket colorimeter II used for analysis of fluoride concentration.

Pocket colorimeter is small in size big on precision and easy operation. Pocket calorimeter is light weight

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and battery operated suitable for extended field work or quick on the spot process monitoring. It acts as an portable photometer .

Results and Discussion

The study was conducted To analyses the concentration of fluoride in ground water in the study area in all the seasons. The fluoride concentration in ground water samples was determined in various villages of Arasikere Taluk, Hassan District, Karnataka. since in most of the villages it is the only source of drinking water. The fluoride concentrations in these villages varied from 0.5 to 6 mg/L with highest fluoride level at different villages. There was found a positive correlation of pH with fluoride and a negative relationship of fluoride with bicarbonate which is generally observed in deep ground water.

The Fluoride content in the groundwater samples in various locations of the study area has been shown in Table 2 .From the results, The fluoride concentrations varied from a minimum of 0.5 mg/L to maximum 6.1 mg/L in the study sites samples have the value of minimum 0.5 mg/l in Mansoon seasons in all the study sites in pre-mansoon seasons the fluoride level is slightly shows high and in post mansoon seasons the fluoride content cross the excessive limit. the highest fluoride content is recorded in Kolganda village is around 6.1 mg/l in Post monsoon season and lowest is in aggunda and Udiganalu village is around 1.5 mg/l.

In the current study, all the samples of all the three seasons of the study period were having fluoride content high in some places and also less than the permissible limits of BIS for drinking water standards. The BIS permissible limits for drinking water sample is 1.5 mg/L. (BIS, 2012).

Table : 2 The observed values of fluoride in ground water in pre-monsoon, monsoon and post monsoon seasons during 2018 to 2019

S.No	Sampling Station	Locations	Pre-Monsoon	Monsoon	Post monsoon
1	S1	Aggunda	1.0	1.2	1.5
2	S2	Bageshpura	0.8	1.0	1.1
3	S3	Doddaghatta	1.5	1.5	2.2
4	S4	Doddenahalli	1.4	1.2	2.3
5	S5	Gollarahalli	1.6	1.2	2.4
6	S6	Hiriyur	2.3	1.8	3.0
7	S7	Kallanaikanahall	2.8	2.3	3.8
8	S8	Madalu	1.9	1.4	2.1
9	S9	Kolagunda	5.0	3.2	6.1
10	S10	Kallugundi	1.8	1.3	2.0
11	S11	Jannavara	1.7	1.2	2.0
12	S12	Narasipura	1.4	1.2	1.6
13	S13	Yerehalli	1.3	1.1	1.8
14	S14	Thalalur	1.9	1.2	2.4
15	S15	Undiganalu	1.0	0.6	1.5

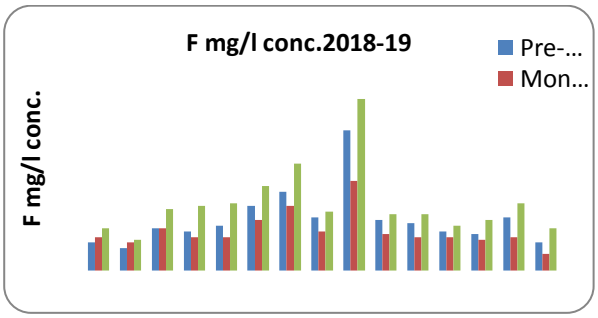

Figure 3: Concentration of fluoride in the year 2018-19

Conclusion

In the present investigation, an attempt has been made to understand the concentration of fluoride in the ground water of some selected villages of Arasikere, Hassan District, Karnataka..

Fluorine is a salt which is formed by combining with other elements. Its concentration in ground water differs from region to region. Fluorine is a highly relative element, with readily forms the bond with other elements.

There is a required of optimum amount of fluoride for human consumption. If there is consumption of fluoride above permissible limit, it is very harmful to life. When fluoride enters the body, they become most exclusive bone seeking element, owing to its affinity for calcium phosphate when the fluoride is more than (BIS, 2012) 1.5mg/L which accumulate in body, its exhibit mainly dental fluorosis and other nerve related diseases.

In this investigation, high level of fluoride concentration has been noticed in some of the sampling stations. We observed the high-level fluoride concentration and also the zero level of fluoride concentration in some area. This is due to the geological strata of the study area.

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