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STUDY OF FLUORIDE CONCENTRATION IN THE RIVER (GODAVARI) AND GROUNDWATER OF NANDED CITY

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ABSTRACT

A study is conducted to asses the Fluoride Concentration in the River (Godavari) and Groundwater of the Nanded City, in Maharashtra, which is a prominent city of Marathwada Region. The Fluoride is responsible for many diseases ranging from simple Dental Carries Reduction to Kidney Failures and Deaths. In the City, the Fluoride was found to be in the range of 0.43 mg/L to 2.0 mg/L. While in River water it was found to be in the range of 0 .23-1.76 mg/L. It is thereby established that the River, Groundwater and even Municipal tap water in Nanded, is found to cross the permissible limits of Fluoride contamination in some seasons.

KEYWORDS: Fluoride, River, Groundwater, Water Pollution, Nanded City, Osteoscleorosis, Fluorosis.

INTRODUCTION

Fluoride, a naturally occurring element, exists in combination with other elements as fluoride compounds and is found as a constituent of minerals in rocks and soil. When water passes through and over the soil and rock formations containing fluoride, it dissolves these compounds, resulting in the small amounts of soluble fluoride present in virtually all water sources.

Fluoride is extensively distributed in nature and enters the human body through both drinking water, that is, river and groundwater. Fluoride concentration in groundwater fluctuates from more than 1 to 25 mg or more per liter (1). The levels of fluoride much higher than 25 mg/L have been reported from India, Kenya, and South Africa. (2)

The Indian Council of Medical Research (The Indian Council of Medical Research, 1975) has given the highest desirable limit of fluoride as 1.0 mg/L and the maximum permissible limit as 1.5 mg/L. The Bureau of Indian Standards has recommended the limit of 1.5 mg/L. (3).

Dental caries reduction, mottled enamel, osteoscleorosis, crippling fluorosis, kidney changes, these types of diseases may cause due to fluoride, at different concentrations. When fluoride is ingested, approximately 93% of it is absorbed into the bloodstream. A good part of the material is excreted, but the rest is deposited in the bones and teeth, (4) and is capable of causing a crippling skeletal fluorosis. This is a condition that can damage the musculoskeletal and nervous systems and result in muscle wasting, limited joint motion, spine deformities, and calcification of the ligaments, as well as neurological deficits (5).

Not only human beings, animals can also be affected by high consumption of fluoride. Excess concentration affects animal breeding and causes mottled teeth of the young animals. At very high concentration of fluoride, plants prevent the accumulation of chlorophyll 'a' and 'b' and photochlorophyll. Fluoride has long been known to undermine fertility in animals and man.

Fluoride in drinking water cannot be detected by taste, sight or smell. Testing is the only way to determine the fluoride concentration.

SOURCES OF FLUORIDE

The main source of fluoride in natural waters are Fluorite ($CaF_{2)}$, Fluorapatite [$3Ca_3 (PO_4)_2$, CaF_2], Cryolite (Na_3AlF_6), Magnesium fluoride (MgF_2) and as replacement of ions of crystal lattic of micas and many other minerals.

As rainwater percolates through the soils, it comes in contact with the rocks and minerals present in the aquifer materials. Due to the presence of acid in the soils, dissolution of fluoride from the country rocks occurs.

PERMISSIBLE LIMITS OF FLUORIDE IN DRINKING WATER IN THE INDIAN CONTEXT

The maximum level of fluoride which the body may tolerate is 1.5 parts per million (ppm). This is often based on water fluoride content. This practice of basing maximum permissible levels of fluoride in drinking water is concept borrowed from the West.

This is not a practical proposition in India for the simple reason that food items, mainly agricultural crops are also heavily contaminated with fluoride. Besides, cosmetics like toothpastes and certain drugs do contain fluoride. Keeping in view the various sources through which fluoride finds entry into the body, 1.5 ppm of fluoride in water is considered to be on the higher side. But in India, it refers to total daily intake irrespective of the source (s). However, the maximum permissible limit of fluoride in drinking water should not exceed 1.00 ppm/or lesser the better (6).

EFFECTS OF INTAKE OF FLUORIDE

Fluoride is not actively transported into animal cells, it is second only to iron in concentration in the human body, and thus should not be classified as a micro-trace element for humans. The total fluoride found in a typical adult human body is approximately 2.6 gms, which puts it above the concentration range for micro-trace elements.

As defined in the medical dictionary (7), fluorosis is a hazardous condition resulting from ingestion of excessive amounts of fluorine. It is an endemic problem in most of the developing countries. Fluorosis caused by high intake of fluoride has been prevalent in India for last six decades. It is highly toxic to humans and animals when consumed in more than prescribed quantities.

Fluorosis is known to take three forms namely Skeletal fluorosis, Dental fluorosis and Non-skeletal fluorosis. The Crippling malady of fluorosis not only affects the bones and teeth but every tissue and organ of the body leading to death after prolonged illness. Fluoride can also damage a foetus if the pregnant woman consumes water or food with high concentration of fluorides. Ingestion of high fluoride content during breast- feeding can cause infant mortality due to calcification of blood vessels.

When fluoride is naturally present in drinking water, the concentration should not increase more than 1.0 mg/L. The Indian Council of Medical Research (8)has given the highest desirable limit of fluoride as 1.0mg/L and maximum permissible limit as 1.5 mg/L. The Bureau of Indian Standards has recommended the limit of 1.5mg/L (3). Manufacturers of products for internal consumption generally restrict the F^- concentration of water to about 1.0mg/L. The effect of F^- on livestock is same as in human beings and should not exceed 2.0mg/L, since excess concentration affects animal breeding and causes mottled teeth of the young animals. In a concentration it is not significant in irrigation water, but higher concentration in plants prevents the accumulation of chlorophyll ‘a’ and ‘b’ and photo chlorophyll. (9)

Effects of Excess Fluoride on Human Body

F^- mg/L	Physiological effect.
1	Dental carries reduction
2	Mottled enamel
5	Osteoscleorosis
8	Osteoscleorosis
20-80	Crippling fluorosis
125	Kidney Changes
2500	Death

REASONS FOR DRINKING WATER CONTAMINATION WITH FLUORIDE

The earth’s crust is known to contain abundance of fluoride due to the presence of following:

1) High calcium granite contain: 520 ppm of fluoride
2) Low calcium granite contain: 850 ppm of fluoride
3) Alkaline rocks: 1200-8500 ppm of fluoride
4) Shale: 740 ppm of fluoride
5) Sandstone: 270 ppm of fluoride
6) Deep sea clays: 1300 ppm of fluoride
7) Deep sea carbonates: 540 ppm of fluoride (6)

India is considered to be one of the richest countries in the world for the presence of fluoride bearing minerals. The fluoride bearing minerals are broadly classified as -----

A) Fluorides

B) Phosphates

C) Silicates and

D) Mica Groups (10)

Depending upon the depth at which water pockets are located and the chemical composition of the earth's crust in that zone, the water may or may not be contaminated.

In Maharashtra among 30 districts 10 are problem districts with high contamination of fluoride in drinking water.

MATERIALS AND METHODS

The fluoride content of groundwater and river water sample was analysed by spectrophotometer in the laboratory. Standard solution having 1.0, 2.0, 3.0, 4.0, 5.0, 6.0, 7.0, 8.0 and 9.0 ml fluoride standard solution was taken in 50 ml Nessler's tubes and then distilled water was added upto the mark. 5 ml Zirconyl chloride ($ZrOCl_2.8H_2O$) and 5 ml SPANDS solution was added in each standard. A standard curve of absorbance against concentration was prepared by running those solutions on spectrophotometer.

In 50 ml of sample, 5 ml Zirconyl chloride and 5 ml of SPANDS solution was added. (For sample same procedure was followed). The reading were taken on spectrophotometer at 570 nm. Concentration of fluoride was calculated by comparing the absorbance with the standard curve. (11)

DISCUSSIONS

Gupta and Gupta (12)studied physico-chemical and biological characteristics of drinking water in Satna (M.P.). They found the fluoride values within permissible limit in river water. Fluoride was 0.03 mg/L at one station and at another station it was 0.08 mg/L.

Amalan et.al., (13) recorded fluoride in the range of 0.36 to 3.5 mg/L in the surface water at industrial area.

Dahiya et.al., (14) studied prevalence of fluorosis among children in district Bhiwani and noted fluoride in the range of 0.8 to 8.6 mg/L in ground water of that area.

Bhosle et.al., (15) studied on fluoride content in Godavari river and noted the minimum fluoride concentration 0.75 mg/L and maximum 1.69 mg/L. Adak and Purohit (16) noted fluoride in the range of 0.46 to 0.47 mg/L in pond water of Mandikudar, Orissa.

The fluoride concentration ranged from 0.60 to 2.20 mg/L in groundwater of Hyderabad. (17)

Muthu et.al, (18) studied on an improved method defluoridation, recorded fluoride concentration between 0.75 to 4.05 mg/L in bore wells of thirty different villages of Natrampalli Tiruvannamalai Circle, (Tamil Nadu). Das et.al., (19) recorded minimum fluoride 0.42 mg/L and maximum 6.88 mg/L

from ground water of Guwahati, Assam. Gangal and Magara (20) surveyed 30 villages of Jaipur Rajasthan. The fluoride concentration varies from 1.5 to 16 mg/ L in ground water.

RESULTS

Table: 1 Monthly Mean Values of Fluoride in Mg/L in River Water of Nanded 2001-2002

Months	Station 1	Station 2	Station 3
Aug	0.39	1.49	0.23
Sep	0.4	0.68	0.28
Oct	0.55	0.63	0.41
Nov	0.51	1.28	0.35
Dec	0.62	1.32	0.73
Jan	1.31	1.31	0.89
Feb	1.42	1.43	1.12
Mar	1.52	1.65	1.43
Apr	1.68	1.72	1.46
May	1.76	1.75	1.47
Jun	1.3	1.61	1.37
Jul	0.42	1.52	1.21

2002-03

Months	Station 1	Station 2	Station 3
Aug	0.48	0.69	0.28
Sep	0.51	0.73	0.31
Oct	0.5	0.82	0.35
Nov	0.61	0.72	0.32
Dec	1.28	1.18	0.42
Jan	1.16	1.28	0.6
Feb	1.28	1.3	0.8
Mar	1.46	1.66	1.46
Apr	1.78	1.76	1.36
May	1.72	1.73	1.44
Jun	1.28	1.5	1.44
Jul	1.3	1.6	1.26

Site – I Govardhan Ghat (Up Stream)

Site – II Radha Govindh Ghat (Down Stream)

Site – III Municipal water

Table: 2 Monthly mean values of Fluoride in mg/L in ground water of Nanded during 2001-2002

Months	Station 1	Station 2	Station 3	Station 4	Station 5
Aug	1.63	1.51	1.62	1.65	0.52
Sep	1.53	1.53	1.53	1.62	0.5
Oct	1.21	1.4	1.51	1.57	1.23
Nov	1.1	1	1.47	1.52	1.35
Dec	1.24	1.39	1.57	1.58	1.38
Jan	1.35	1.43	1.59	1.62	1.45
Feb	1.42	1.53	1.65	1.69	1.5
Mar	1.68	1.54	1.7	1.97	1.52
Apr	1.69	1.55	1.98	1.99	1.53
May	1.74	1.57	2	1.98	1.49
Jun	1.7	1.5	1.78	1.73	1.37
Jul	1.68	1.43	1.63	1.68	1.33

Table: 3 Monthly mean values of Fluoride in mg/L in ground water of Nanded during 2002-2003.

Months	Station 1	Station 2	Station 3	Station 4	Station 5
Aug	1.71	1.5	1.61	1.46	0.49
Sep	1.63	1.43	1.42	0.73	0.55
Oct	0.43	0.83	0.67	0.5	0.58
Nov	1.02	1.13	1.5	1.35	0.59
Dec	1.32	1.36	1.46	1.36	1.25
Jan	1.32	1.28	1.36	1.34	1.3
Feb	1.35	1.3	1.42	1.35	1.32
Mar	1.66	1.46	1.6	1.62	1.42
Apr	1.66	1.36	1.74	1.94	1.51
May	1.72	1.45	1.81	2	1.48
Jun	1.78	1.54	1.66	1.89	1.48
Jul	1.75	1.49	1.62	1.5	1.5

Groundwater Station 1: CIDCO-I (Sambhaji Chowk)

Groundwater Station 2: CIDCO-II (Hedgewar Chowk)

Groundwater Station 3: HUDCO-42

Groundwater Station 4: Gadipura-19

Groundwater Station 5: Bhagirat Nagar.

The monthly mean values of fluoride during two years (August 2001 to July 2003) from two river water, one municipal water and five ground water sampling stations are shown in Tables No 5-1,5-2 and 5-3 and depicted in Figures No 5-a, 5-b, 5-c and 5-d respectively.

The Govardhan Ghat (Station I) showed the range of fluoride 0.39 to 1.78 mg/L. The maximum fluoride of 1.78 mg/L was noted in April 2003 while the minimum was noted as 0.39 mg/L in August 2001.

The maximum fluoride recorded was 1.75 mg/L in the month of May 2002 at Radha Govindh Ghat (Station II) and the minimum of 0.63 mg/L in the month of October 2001.

In municipal water the maximum fluoride was recorded 1.47 mg/L in the month of May 2002 while minimum fluoride noted as 1.47 mg/L in May 2002.

The maximum fluoride of river water was noted as 1.78 mg/L during April 2003 at Station I and minimum fluoride recorded was 0.39 mg/L during August 2001 at Station I.

The fluoride of ground water from Nanded city at different stations selected were in the range of 0.43 to 1.78 mg/L at Station I, 0.83 to 1.57 mg/L at Station II, 0.67 to 2.00 mg/L at Station III, 0.50 to 2.00 mg/L at Station IV and 0.49 to 1.53 mg/L at Station V respectively.

In ground water of Nanded city maximum fluoride noted as 2.00 mg/L in May 2003 at Station IV and in May 2002 at Station III, and minimum fluoride recorded as 0.43 mg/L at Station I.

In river water fluoride content was above the permissible limit. The municipal water also content fluoride in small amounts. It touches to the permissible limit of fluoride.

All the ground water stations having fluoride concentrations were found to be very close to prescribed limit in other seasons and even crossing the permissible limit during summer season.

CONCLUSIONS

To summarise, the baseline results of present investigation into the river (Godavar) and ground water quality of Nanded city, showed that in ground water the maximum fluoride concentration was recorded 2 mg/L from station IV during summer. The minimum fluoride concentration was noted as 0.43 mg/L from station I. All the ground water stations having fluoride concentrations were found to be very close to prescribed limit in other seasons and even crossing the permissible limit during summer season. In river water fluoride content was above the permissible limit The municipal water also contained fluoride in small amounts. Its content was in the range of 0.23 to1.47 mg/L. It touches to the permissible limit of fluoride.

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