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Fluoride in Drinking Water

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ABSTRACT : *One of major problems associated with drinking water in different parts of the country is because of high contamination with fluoride, iron, salinity, guineaworm and bacteria. In this paper. fluoride contamination of drinking water and associated issues have been discussed. The permissible limits of fluoride in drinking water and the magnitude of the prablem in various states have been presented. The need for removal of excess fluoride, methods for removal, limitations & advantages have also been discussed.*

1. Introduction

The concept of water quality and safe drinking water have yet to get across to great majority of the people in India. Safe, potable water can be defined as that water which is odourless, tasty or 'sweet', enjoyable while drinking and does not cause any health problem(s). If the water has to meet with the above criteria, the water should not have or should only have in permissible limits chemical contaminants such as fluoride, iron, salinity, nitrate, sulphate, chloride, arsenic, manganese, magnesium, calcium, phenol and others*, if any. Besides chemical contaminants, the water should not have any biological pollutants** viz. bacteria and guineaworm. The total dissolved solids should be minimum.

In India today, the major problem with drinking water in different parts of the country is due to high contamination with fluoride, iron, salinity, guineaworm and bacteria. Besides, there are area having water with high content of nitrate, arsenic and phenol. This account is by no means complete, as information on chemical contamination of drinking water in rural areas is now forthcoming as there is considerable emphasis in the National Drinking Water Mission on water quality analysis.

This report is focussing on fluoride contamination of drinking water and associated issue viz.

- Reasons for drinking water contamination with fluoride
- Permissible limits of fluoride in drinking water in the Indian context.
- The magnitude of the problem
- Methods available for fluoride removal
- Importance of health education along with defluoridation

* Contaminants arising from industrial effluents and waste are becoming a serious threat to safe drinking water

** Unsanitary conditions are also posing a major threat to safe drinking water.

2. Reasons for drinking water contamination with fluoride :

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

1. High calcium granite : 520 ppm of fluoride contain
2. Low calcium granite : 850 ppm of fluoride contain
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

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 Group. A list of fluoride bearing minerals with its percentage fluoride content (Karunakaran, 1974) is listed in Table 1.

Table 1 : List of fluoride bearing minerals with percentage flourine content

Name	% Fluorine content (Range in analytical values)
A. Fluorides :	
1. Fluoride	48.18—48.61
2. Sellaite	60 Approx.
3. Fluocerite (Tysonite)	19.49—29.44
4. Cryolite	53.55—54.88
B. Phosphates :	
5. Fluor-apatite (Carbonate	2.57— 5.60
6. Wagnerite	5.06—11.48
7. Triplicate	6.02— 9.09
8. Amblygonite	0.57—11.26
C. Silicates ;	
9. Topaz	13.23—20.37
10. Humite group	Tr. — 13.55
11. Sphene	0.61— 1.40
12. Vesuvianite	Tr. — 3.22
13. Tourmaline	0.07— 1.16
D. Mica Group :	
14. Muscovite	0.00—2.06
15. Phlogopite	0.56—9.20
16. Biotite	0.32—5.02
17. Lepidolite	4.93—8.08
18. Amphibole group	Tr. —2.95

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.

The water obtained mainly through tube wells, open wells, streams and river, in 13 States of the Indian Union are heavily contaminated with fluoride. Excluding Kerala, Kashmir, Bengal and North-Eastern hill States in the rest of the country, fluoride is one of the major contaminants of drinking water.

3. 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 a 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 tooth-pastes 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 (Susheela 1989).

4. The magnitude of the problem

Andhra Pradesh : Among the 21 districts of the State, 17 are problem districts with high fluoride content in drinking water. The maximum fluoride contamination so far detected in Andhra Pradesh is 25 ppm.

Bihar & Orissa : The disease prevails as a result of fluoride contamination of drinking water.

Delhi : In the Union Territory of Delhi, there are several areas where the tube well water is contaminated with fluoride. Dental fluorosis, skeletal fluorosis and non-skeletal manifestations are prevalent.

Gujarat : Amreli, Mehsana, Banaskantha and Panch Mahal districts are having high contamination of fluoride in drinking water. The situation in certain villages in Amreli is so grave that nearly 50-70% population are crippled due to fluorosis.

Haryana : Among the 12 districts of the State, 7 are problem districts. The fluoride content in water alone ranges upto 38.5 ppm.

Karnataka : In Karnataka among the 20 districts, Dharwad, Gulbarga, Raichur are affected, There are more districts with high fluoride content but yet to be identified.

Madhya Pradesh : Shivpuri and Jhabua are having excess fluoride in drinking water. The fluoride content in drinking water in other districts are being assessed.

Maharashtra : Among the 30 districts in Maharashtra, 10 are problem districts with high contamination of fluoride in drinking water. The level of fluoride in water is high in Chanderpur.

Punjab : There are large number of districts in the Punjab afflicted with the problem of high fluoride in drinking water and associated health problems.

Rajasthan : All the 27 districts in Rajasthan are severely afflicted as a result of excess fluoride in drinking water,

Tamil Nadu : The health problems are very severe in Salem, Periyar, North and South Arcot districts due to excess fluoride.

Uttar Pradesh : In 11 districts in the State the water contaminated with fluoride; fluoride ranges upto 15 ppm. The highest amount of fluoride so far detected is in Unnao and Rae Bareilly with 15 ppm and 10 ppm respectively.

5. The need of removal for excess fluoride

As a result of drinking high fluoride containing water, the population in the 13 States are faced with a major threat to their well-being. Millions of people in the country as a result of ingestion of high fluoride are afflicted with a crippling malady known as skeletal fluorosis. The extent of affliction ranges from 50–75% of the population in certain villages of Gujarat. Besides skeletal fluorosis, the children as well as adults have discoloured and mottled teeth, which may be pitted/perforated and get either chipped off or they become edentulous at an early age.

Great majority of the people, in high fluoride areas, are afflicted with severe.

- Muscle weakness, loss of muscle power
- Gastro-intestinal problems viz. chronic constipation, diarrhoea, pain in the stomach, nausea, vomitting, loss of apatite and headache.

— Kidney problems
— Allergic problems
— Neurological manifestations viz. depression, excess thirst, tendency to urinate more frequently although the volume of urine may not be high.

The above mentioned non-skeletal (soft tissue) manifestations if detected early, the changes are reversible to a large extent, provided the source(s) of excess fluoride is withdrawn. However, skeletal and dental fluorosis once set in, are irreversible and the malady is incurable.

These observations strongly recommend that the people of the endemic States for fluorosis should only accept drinking water, which has least fluoride content. Under no circumstance the fluoride content should exceed 1 part per million (Susheela, 1988).

6. Methods available for fluoride removal

There are various methods currently available for fluoride removal :

1. Reverse Osmosis
2. Electrodialysis
3. Deep bore well
4. Defluoridation
5. Bring water through pipe line from a distance

The technologies listed at 1 and 2, however, are not cost-effective and therefore are not recommended.

The third alternative i.e. if the tube well is dug deeper, possibly one might obtain safe water. This possibility has been explored by Teotia and his associates in Uttar Pradesh and found feasible. An important message emerges from this is that, when tube wells are dug and when water is located, before the rig is pulled out, water should be tested in the field for fluoride content. This exercise is possible if portable Ion Meters are used. If fluoride is detected in high concentration, the well could be dug deeper straight away and there are chances one may get safe water.

Defluoridation : Nalgonda technique

The National Environment Engineering Research Institute, Nagpur has experimented the various possibilities of defluoridating the water over a period of 15-18 years and the method evolved based on the use of alum and lime which is popularly known as Nalgonda technique is the technology currently being practiced both at the domestic and community level. Community defluoridation plants have been set-up at Tartur village in Andhra Pradesh, Fazilpur village in Gurgaon and a few in Gujarat. 130 defluoridation plants in the country would be installed during the year 1989-1990.

7. Limitations of the technology

(i) Water sample can only be defluoridated provided the total dissolved solids (TDS) are below 1500 mg/litre.

(ii) Defluoridation is possible if total hardness of water is below 250 mg/litre

(iii) Water sample requires to be analysed for water quality. Fluoride content, alkalinity, TDS and hardness should be known for assessing and fixing the dosage of alum and lime. This is a one time exercise except in extreme summer months, when water levels have gone down, the fluoride content of water may be high and water quality analysis may have to be repeated.

8. Advantages of the Technology

(i) Can be implemented at domestic or community levels

(ii) Electricity is not required as it can be operated manually provided that the plant is of a small size i.e. 400-500 litre capacity.

(iii) Chemicals which are used in the municipal water treatment plant are only required and is inexpensive.

Defluoridation : Using Activated Aluminia

The defluoridation procedure using activated aluminia is considered to be superior to the Nalgonda technique. But unfortunately, activated alumina is not produced in the country and if this technology has to be adopted-India has to import activated alumina. Defluoridation plants using activated alumina is operating in South Western States of USA in Arizona and California.

9. Importance of health education along with implementing defluoridation plants

During the year 1987-'88 in the National Drinking Water Mission, 10 Training cum Awareness Camps have been organized in 7 States with certain specific objectives to introduce ameliorative, preventive and control measures for fluorosis which includes introducing defluoridation of water. It has emerged from the above exercises that the common man living in rural settings are unaware of the fact that the crippling malady from which they are suffering from, is mainly due to consuming fluoride contaminated water. Creating awareness among the people on the cause of the disease has become absolutely essential for them to accept the defluoridated water. In fact, when the non-skeletal manifestations such as gastro-intestinal problems disappear after consuming defluoridated water, the people are convinsed and the message spreads throughout the villages. The health educatlon programmes in rural areas endemic for fluorosis has thus become an integral part of the National Drinking Water Mission.

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