
TOXICITY OF FLUORIDE IN PARTS OF INDIAN SUBSURFACE WATER

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ABSTRACT

Endemic fluorosis related with the presence of fluoride in water is a public health problem in most of the Indian States. Groundwater forms a major source of drinking water in urban as well as rural areas. More than 90% of the rural population uses groundwater for domestic purposes. Since, quality of public health depends on the quality of drinking water, therefore, an attempt has been made to collect in-depth information about the fluoride content in surface, subsurface and thermal water from a cross section of the localities from different States covering the entire India and discuss the results in the paper.

It is unfortunate that millions of people in India have no access to safe drinking water and consumes the water easily accessible to them without knowing the ill affects of such consumption. The fluoride content data in water belonging to nine different States which covers almost the entire country reveal an elevated concentration as high as 20 ppm which is much more higher than the permissible limits of 1.5 ppm set forth by the WHO for safe drinking water.

The probable sources of high fluoride in the water, its ill affects leading to fluorosis disease and other related health hazards, if consumed by human beings and certain necessary steps to reduce the high fluoride concentration to the level of safe consumable limits are discussed in the paper.

INTRODUCTION

Water is essential natural resource for sustaining life and environment which we have always thought to be available in abundance and free gift of nature. However, chemical composition of surface or subsurface, geothermal or non - thermal, is one of the prime factors on which the suitability of the water for domestic, industrial or agriculture purpose depends. Groundwater forms a major source of drinking water in urban as well as in rural

areas. More than 90% of the rural population uses groundwater for domestic purposes. However, around 300 million people still live in absolute poverty in both urban and rural areas, and often lack access to clean drinking water and basic sanitation ; nearly half the population is illiterate, not at all aware of the water borne diseases affecting their health. Seventy percent of infectious diseases in rural India are water borne and nearly fifty percent due to diarrhoea. Major problems are being faced by the country due to the presence of excess fluoride, arsenic and nitrate in groundwater in certain parts of country. Fluoride problems are wide spread in about nine States. Nearly 66 million people face the risk of which an estimated 6 million are children.

Though there has been tremendous progress in rural water supply infrastructure after setting up of the Rajiv Gandhi National Drinking Water Mission in 1986, the goal to provide safe drinking water to all is still to be achieved. India's population has recently crossed the one billion mark. Ever-increasing population and the increased need for agriculture and industries has resulted in water scarcity. The country thus faces a serious threat to the management of water resources. This leads the rural population and even urban also to depend upon water from local tanks and tube wells and the consumption of untreated water all purposes. In view to look into the aspects of water quality and related health problems, the water quality data from nine different States (1) Jammu and Kashmir (J&K), (2) Himachal Pradesh, (3) Rajsthan, (4) Haryana, (5) Bihar, (6) West Bengal, (7) Chattisgarh, (8) Orissa and, (9) Maharashtra ,covering almost the entire nation has been collected and analysed. Figure 1, depicts the locations of the area where from the data has been acquired.

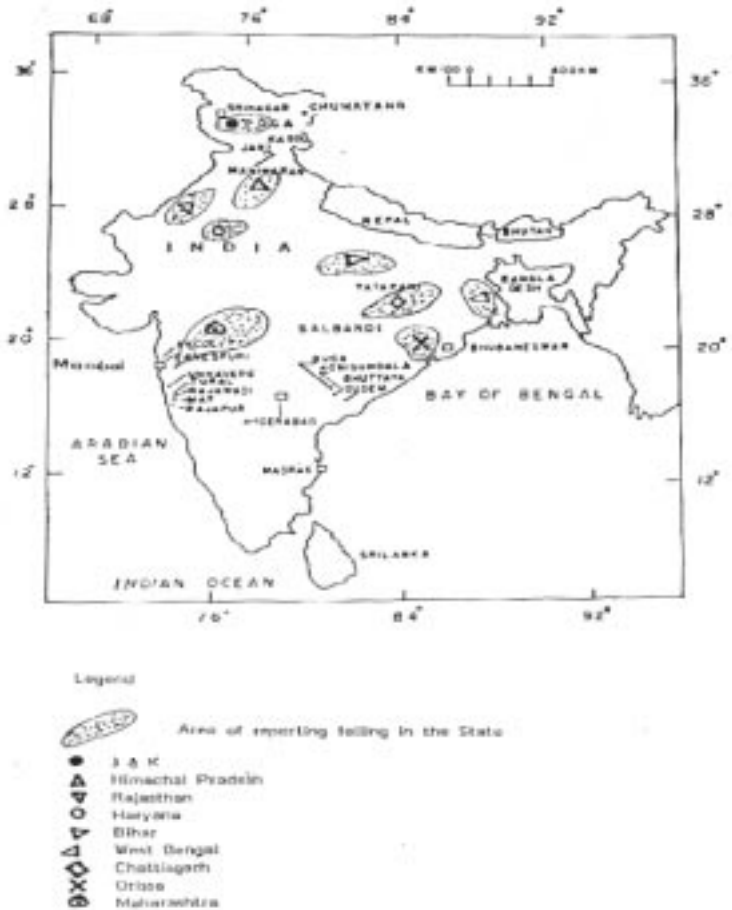


Figure 1. Location map showing areas of high fluoride content in water

Unlike bacteriological pollution, the effect of the excess chemical constituents (that may be present in the groundwater, like fluoride) on human health is chronic in nature and manifest after consuming the water over a long period of time. Long term ingestion of drinking water having fluoride beyond a limit of 1.5 ppm lead to dental and skeletal fluorosis as well as non skeletal manifestations.

RESULTS OF CHEMICAL ANALYSIS OF WATER

The surface, subsurface and thermal water sample analysis indicate the fluoride concentration ranging from < 0.2 to 18 ppm in the States of Jammu & Kashmir, < 0.2 to 6.5 ppm in Himachal Pradesh, > 1.5 ppm in Rajasthan, 0.2 to 0.6 in Haryana, 0.35 to 15 ppm in Bihar, on an average 12 ppm in West Bengal, 15 to 20 ppm Chattisgarh, 8.2 to 13.2 ppm in Orissa and 0.7 to 6.0 in Maharashtra, indicating that except in Haryana, the concentration of fluoride is very high up to 20 ppm. The results of chemical analysis of water are summarized in Table 1.

Table 1 Average fluoride concentration detected in water from different parts of India									
1	2	3	4	5	6	7	8	9	
Leh State (J&K)	Manikaran (Him.Prad.)	Bhilwara (Rajsthan)	Sohna (Har.)	antloi (Bihar)	atapani (Chattis.)	Bakreshwar (W.Bengal)	Khudra (Orissa)	Unkeshar (Mahar.)	
Con. ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	
Sample Nos.	20	12	15	10	30	25	60	50	65
Surface		>1.50		0.35 to 4.00			8.20 to 13.20	2.70 to 6.00	
Subsurface	<0.20 to 18.00	<0.2 to 6.50	0.20 to 0.60			0.60 to 15.00			
Thermal						15.00 to 20.00			

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Probable source of high fluoride in Indian waters

During weathering and circulation of water in rocks and soils, fluorine is leached out and dissolved in ground water. The fluoride content of ground water varies greatly depending on the type of rocks from which they originate. Among the various minerals responsible for high concentration of fluoride, the Fluor – apatite $3\text{Ca}-3(\text{PO}_4)-2$, CaF_2 ; Sellaite, MgF_2 and Fluorite, CaF_2 are important. However, the most important being the Fluorite, CaF_2 and the leaching of fluoride from the metamorphic rocks hornblende gneiss of Proterozoic age.

An attempt has been made to trace the State-wise geological reasons for high fluoride content in Indian waters :

In the State of Jammu and Kashmir, and Himachal Pradesh:

Geologically, the area where from the high fluoride concentration is reported has three distinct belts separated by major tectonic features. The Southern belt essentially consists of gneiss, schist, granite, lensoid of Proterozoic age and represents the Indian Subducted Plate. Several phases of igneous intrusions have been identified in these rocks. Therefore, in all probabilities, the high concentration of fluoride could be due to the presence metamorphic gneiss present in the region.

In the State of Rajsthan:

Again the presence of Bundel gneiss complex appears to be the cause of high fluoride content in waters from the Bhilwara region.

In the State of Haryana:

In Sohna, the main rock types are quartzite, schist, siliceous limestone, slate and phyllite (Singh et al., 1996) where from the water sample analysis results have been picked up does not show the presence of high fluoride due the absence of hornblende gneiss in the region.

In the State of Bihar and West Bengal:

The high fluoride values in the water may be due to leaching of fluoride from the hornblende gneiss and granulites (Mukhopadhyay, 1996) reported and well documented in the region.

In the State of Chattisgarh:

The area is covered by Proterozoic and Gondwana Group of rocks. The Proterozoic comprises grey, pink gneiss and hornblende gneiss. Therefore, the leaching of fluoride from the hornblende gneiss of Proteozoic age appears to be main source of fluoride in thermal water at Tattapani (Sarolkar, 1996).

In the State of Orissa and Maharashtra:

Composition of solution in these two areas appears to be the result of reaction of volcanic rocks like Basal, Andesite and Dacite with water at high temperature and pressure (Girhe, 1996) thus giving rise to high content of fluoride in the water.

ILL AFFECTS OF HIGH FLUORIDE CONTENT IN WATER

Endemic fluorosis is a public health problem in India. Around 25 million people of 150 Districts are affected by this disease (Survey report – Rajiv Gandhi National Drinking Water Mission, 1993). Medical advice recommends the drinking water should not contain more than 1.5 ppm of fluoride (WHO, 1994). Concentration of fluoride below 1.5 ppm are helpful in prevention of tooth decay, and such level of fluoride also assists in the development of perfect bone structure in human and animals. However, doses of fluoride above 1.5 ppm increases the severity of tooth mottling and induces the prevalence of osteoporosis and collapsed vertebrae. The disease resulting from excessive consumption of fluoride. Fluorosis has no treatment and is considered to be deadly disease.

High fluoride content in water even causes change in shape and colour of the fruits and vegetation.

RESULTS AND DISCUSSIONS

A much elevated concentration of fluoride, ranging from more than 1.5 ppm to 20 ppm in surface, subsurface and thermal waters in nine States in India, is beyond the permissible limit fixed by the WHO for human beings, the consumption which is bound to yield the deadly Fluorosis disease and if used for irrigation, may cause harm to the ecosystem and vegetation.

UNICEF (1996) has published a simple guide to identify a fluorosis diseased person for they can not perform some basic exercise related to body posture. The following Figure 2 clearly explains that if a person is not able to do the three body exercises illustrated in the figure, then the non-skeletal manifestation of the disease confirm that person to be chronic patient of the Fluorosis.

Left Column: Normal capacity person
 Right Column: Fluorosis diseased person
 Top – the person is unable to bend completely from the waist.
 Middle – unable to bend the neck to touch the chin on the chest and,
 Bottom – unable to bend arms to touch the back of the head.

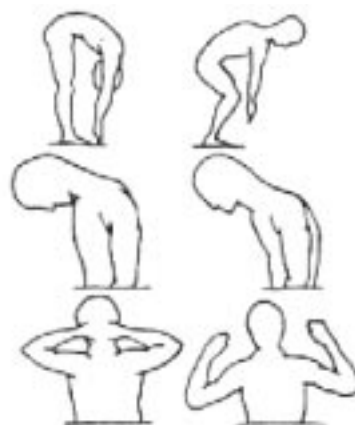


Figure 2. A simple guide to identify a fluorosis diseased person from body posture

High fluoride consumption leads to the fluorosis of the bones and affects the vegetation too. Hence, the possibility of reducing the fluoride content in water or effluent by *defluorination* process or by dilution with the surface water appears to be the feasible solution to mitigate the human sufferings from these affected areas. Solubility experiments carried out on fluorite in distilled water by Rao, *et al* (1993), revealed that addition of Ca ions to solution in contact with fluorite caused decrease in fluorine concentration. The fluoride reduction may be achieved by calcium ion treatment or by dilution.

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