



ORIGINAL ARTICLE

Fluoride Contamination on Aquatic organisms and human body at Purulia and Bankura District of West Bengal, India

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ABSTRACT

Fluorides are widely distributed in the rivers, lakes, seas of the world. Most of the fluorides occur naturally. Ground water and pond water of Purulia and Bankura District is well known for its fluoride content in recent time. Freshwater invertebrates and fishes appear to be more sensitive to fluoride toxicity. Because, in soft waters with low ionic content, a fluoride concentration as low as 0.5 mg F⁻/l can adversely affect invertebrates and fishes, safe levels below this fluoride concentration are recommended in order to protect freshwater animals from fluoride pollution. Humans are also exposed to excessive amounts of fluoride through drinking water contaminated from natural geological sources. Higher doses of fluoride destroys teeth and accumulates in bones, leading to crippling skeletal damage. There is acute scarcity of water lying ahead and some serious thinking is necessary towards rational exploitation of the freshwater resources.

Keywords: Fluoride contamination, Aquatic organism, Fluorosis, Purulia, Bankura.

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INTRODUCTION

Fluoride is naturally occurring compound in the earth's crust, in various forms including Fluorspar (CaF₂), Cryolite (NaAlF₆) and fluorapatite [Ca₁₀F₂(PO₄)₆] and enters surface and ground water through the natural and anthropogenic sources. Fluoride is typically found in fresh water at concentration less than 1 mg/l; however natural concentration may exceed even 50 mg/L [1]. The benefits of fluoride were seen mostly in hardening of teeth and protection from dental caries [2]. However the world health organization (WHO) has recommended the upper limit of fluoride to be 1.5 mg/l. Aquatic life is continuously exposed to high concentrations fluorides in surface waters and harmful effects ensue when fluoride enters the food chain and accumulates in the exoskeleton of invertebrates and bone tissues of fishes. A review by Barbier et al, 2010, identified fluoride effect on disruption of enzyme activity, inhibition of proteins secretion and synthesis, alternation of gene expression. Fluoride accumulates in the bone tissues of fish and in the exoskeleton of aquatic invertebrates. In soft waters with low ionic content, invertebrates and fishes may suffer adverse effects from fluoride concentration as low as 0.5 mg/l. Negative affects are less in hard waters and seawaters, as the bioavailability of fluoride ions is reduced with increasing water hardness Seawater contains fluoride at a concentration of 1.3 mg/l [3].

The objective of this study was to determine the fluoride affected area of Purulia and Bankura district, and also study about the affected organisms of the fluoride contaminated area.

MATERIALS AND METHODS

Water sample (Tube well & Pond) from different block of Purulia & Bankura District, Test tube, Fluoride reagent, Spectrophotometer are used for testing the concentration of fluoride in water sample. The sample was collected in February to April 2015 from a groundwater & deep water in different block of Purulia & Bankura District. Fluoride was analysed colourimetrically using Reagent of MERCK as fluoride reagent and Systronics double beam spectrophotometer. In buffered, weakly acidic solution, fluoride ions react with alizarin complex one and lanthanum (III) to form a violet complex that is determined photometrically. The method is analogous to EPA 340.3 and APHA 4500-F⁻E.

RESULT AND DISCUSSION

Water samples were collected from 10 different blocks of Purulia spread over the five worst-affected blocks, viz. Joypur, Arsha, Puncha, Raghunathpur II & Jhalda II. Highest concentration of fluoride was recorded as follows: Joypur 2.8 mg/l, Arsha 2.6 mg/l, Puncha 1.9 mg/l, Raghunathpur II 1.9 mg/l & Jhalda II 1.8 mg/l. In Bankura water sample were collected from 5 different blocks. Among 5 different blocks of Bankura District highest concentration level of fluoride is Bankura-I 1.4 mg/l, Taldangra 1.3 mg/l, Simlapal 1.2 mg/l. Water sample was collected randomly for last three months (February to April 2015) (Figure 1). The concentration level of fluoride is comparatively high in the months of April at all the survey stations. High concentrated fluoride contaminated pond water showing higher algal bloom. Structural deformities in the fish were also reported from that contaminated ponds.

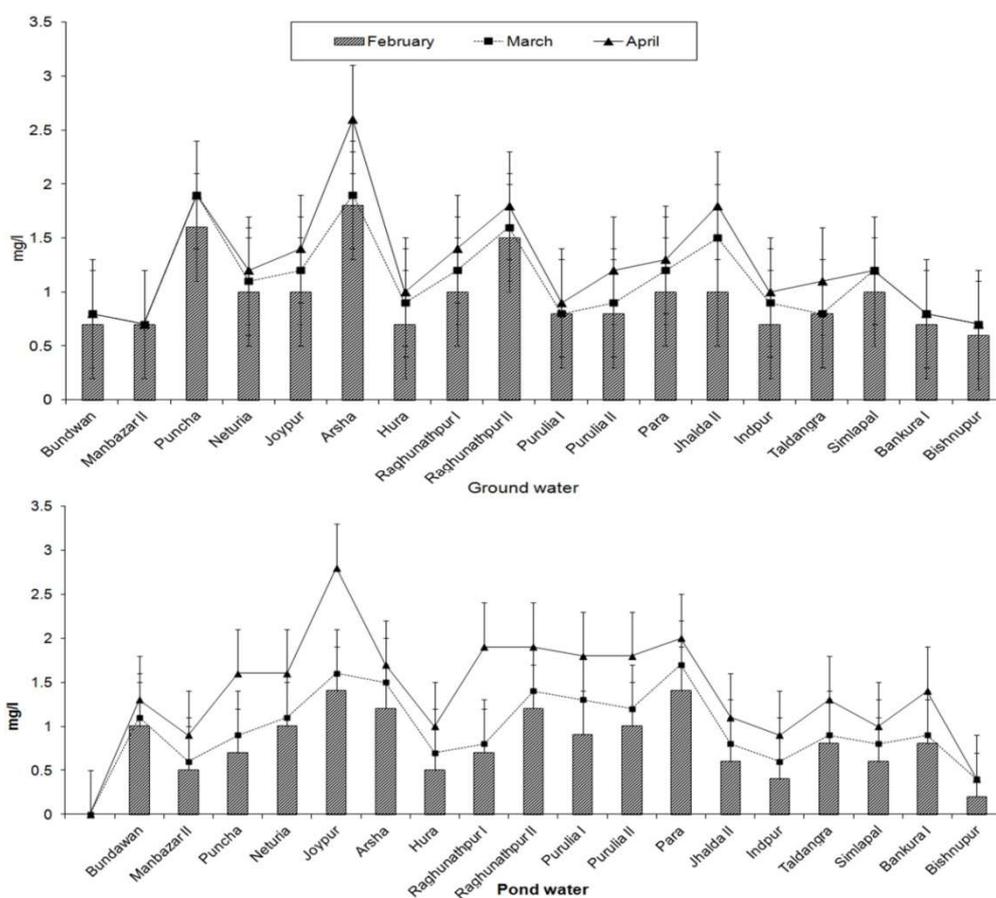


Figure 1: Fluoride concentration of ground water and pond water in different three months.

Deep ground water and pond water of Purulia & Bankura district is well known for its fluoride contamination. People from many of the villages have been marked with dental and skeletal fluorosis from consuming fluoride contaminated water. Fluoride is a well-known, non-decomposable and relatively persistent contaminant in the environment. Due to its high biological activity and small ionic radius, it penetrates easily into the organisms and tissues. It has adverse effects of high and chronic effects on different tissues. Human activities, such as aluminum smelters, discharges of fluoridated municipal waters, and plants manufacturing brick, ceramics, glass and fluoride chemicals, may cause significant increases in the fluoride concentration of surface waters [4].

Consumption of fluoride at levels beyond those used in fluoridated water for a long period of time causes skeletal fluorosis and dental fluorosis in children during the development of teeth. Generally ingestion of water having a fluoride concentration above 1.5 – 2.0 mg/l may lead to dental mottling, an early sign of dental fluorosis which is characterized by white patches on teeth. In advanced stages of dental fluorosis, teeth display brown to black staining followed by pitting of teeth surfaces. Skeletal fluorosis may occur when fluoride concentrations in drinkingwater exceed 4-8 mg/l, which leads to increase in bone density, calcification of ligaments rheumatic or arthritic pain in joints and muscles along with stiffness and rigidity of the joints, bending of the vertebral column and excessive bone formation or

osteosclerosis, a basis symptom of skeletal fluorosis. Crippling skeletal fluorosis can occur when a water supply contains more than 10 mg/l [4].

Fluoride can either inhibit or enhance the population growth of algae, depending upon fluoride concentration, exposure time and algal species. Some algae are able to tolerate inorganic fluoride levels as high as 200 mg F⁻/l. The toxic action of fluoride on algal growth may reside in the fact that fluoride ions can affect nucleotide and nucleic acid metabolism governing processes of algal cell division [5].

Aquatic animals such as fish and invertebrates can take up fluoride directly from the water or to a much lesser extent via food [6]. Although it may be eliminated (as F⁻) via excretory systems [7], fluoride tends to be accumulated in the exoskeleton of invertebrates and in the bone tissue of fishes.

Fluoride toxicity to fishes increases with increasing fluoride concentration in the aquatic medium, exposure time and water temperature. Conversely, fluoride toxicity decreases with increasing intraspecific fish size and water content of calcium and chloride [4]. Lethal concentrations of fluoride, causing acute intoxication in fish, bring on symptoms of fluorosis before death [8].

CONCLUSION

In order to enable sustainable development of groundwater and surface water resources, it is necessary to mark out the safe and unsafe zones with reference to F⁻ content. The problems associated with the excess fluoride in drinking water are highly endemic and widespread in districts like Purulia and Bankura. There is acute scarcity of water lying ahead and some serious thinking is necessary towards rational exploitation of the freshwater resources.

The situation of fluoride contamination of drinking water has already reached an alarming level and needs immediate intervention and attention of all people to mitigate the problem. In order to mitigate the rising problem of fluorosis, one has to ensure fluoride free, safe drinking water to the rural communities of Purulia & Bankura.

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