Short Notes

The Harmful Effects of Fluoride Pollution in India

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1. INTRODUCTION
Environmental pollution by fluoride either through water, soil, air or combination of all three has serious consequences on fauna, flora and mankind. The problem of excess fluoride in the environment and its consequent health hazards was detected in India as early as 1937. To understand the magnitude of the problem at the present time one must examine such factors as the sources of fluoride, the geographical distribution of fluoride and its dispersion.

2. PRINCIPAL SOURCES OF FLUORIDE

The major sources of fluoride are: fluoride-bearing minerals, industrial processes and drug therapy.

2.1 FLUORIDE-BEARING MINERALS
In nature the element fluoride occurs in fluorspar, in apatite/rock phosphate and in phosphorites. All three minerals occur in various parts of India. In fact, from a global perspective, India has some of the largest deposits of fluoride-bearing minerals in the world.

Large deposits of fluorspar are found in Gujarate, Rajasthan, Andhra Pradesh, Bihar, Himachal Pradesh, Kashmir, Madhya Pradesh, West Bengal and Tamil Nadu. There are two major apatite and rock phosphate-producing states: Bihar and Andhra Pradesh. Minor occurrences of apatite and rock phosphate have also been reported in Gujarate, Tamil Nadu, Orissa, Rajasthan and West Bengal. Finally, there are abundant deposits of phosphorites in Utter Pradesh, Jammu-Kashmir, Rajasthan and Tamil Nadu.

2.2 INDUSTRIAL PROCESSES
Various industries including aluminum, chemicals, fertilizers, steel, plastics, pharmaceuticals and pesticides use fluoride containing salts and minerals. In some processes, the dust of fluoride containing salts and/or the fumes of hydrofluoric acid arise as by-products and pollute the environment within and outside the factory. Inhaling fluoride dust, gas or fumes is as harmful to health as ingesting food and water containing large amounts of fluoride. It should be noted that the medical effects of exposure to fluoride-bearing dust, gas or fumes may not show up until there have been several years of exposure to such contaminants. Where industrial processes require the use of fluorides, it is important therefore that workers have periodical health check-ups which include laboratory testing of blood, urine and nails for fluoride.

2.3 DRUG THERAPY
Throughout the world, sodium fluoride (50–80 mg/day or even higher dosages) is administered with or without vitamin D, calcium and estrogen for the treatment of osteoporosis and otosclerosis. The use of sodium fluoride therapy for dental caries is also practised widely. Medications
containing fluoride such as fluorosteroids for arthritis, allergic diseases, fluorouracil for cancer, and fluoride containing antibiotics, anaesthetics, tranquilizers and diuretics are commonly prescribed and used. C. A. Baud (1982) and others have actually described the malady of 'drug induced skeletal fluorosis'.

In an environment where the population is exposed to high fluoride levels in drinking water, it is important that the additional risk of using medications containing fluorides be avoided.

2.4 SECONDARY DISPERSIONS

Secondary dispersions of fluoride are known to occur in soils, rivers, groundwater and the atmosphere. These dispersions correlate well with the primary presence of fluoride minerals in rocks.

3. EFFECT OF FLUORIDE ON FLORA

Some agricultural crops and fodder for livestock are known to contain large amounts of fluoride. In corn plants different parts of the plant accumulate different amounts of fluoride. The leaf blade accumulates the highest amounts. In the leaf sheath, the cobs and husks, slightly lesser amounts of fluoride accumulate. The remaining parts of the plant have a comparatively low fluoride content. The presence of fluoride affects the plant. When agricultural crops are irrigated by waters which have no fluoride content, the percent germination, the height of the plant and the grain yield is far greater than it is when the plants are irrigated with fluoride-containing waters (Paliwal and Somani, 1974).

A recent study by Dr. K. Rajyalakshmi (1982) for the Institute of Preventive Medicine, Hyderabad, analysed the fluoride content of agricultural crops grown in the endemic areas of India. The study found the following amounts of fluoride in plants grown for food and/or fodder:

<table>
<thead>
<tr>
<th>Material</th>
<th>mg F⁻/kg dry wt.</th>
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<tbody>
<tr>
<td>Bajra (Pearl Millet)</td>
<td>74.0</td>
</tr>
<tr>
<td>Red gram</td>
<td>52.8</td>
</tr>
<tr>
<td>Til (Seasame)</td>
<td>45.2</td>
</tr>
<tr>
<td>Yellow Jawar (Sorgum)</td>
<td>41.6</td>
</tr>
<tr>
<td>White Jawar (Sorgum)</td>
<td>23.0</td>
</tr>
<tr>
<td>Green gram</td>
<td>21.2</td>
</tr>
<tr>
<td>Paddy</td>
<td>20.5</td>
</tr>
<tr>
<td>Bengal gram</td>
<td>14.8</td>
</tr>
<tr>
<td>Vegetables</td>
<td>4.0</td>
</tr>
</tbody>
</table>

It should be noted that ten ppm of fluoride (1 ppm = 1 mg/kg) is considered to be safe upper limit for plants.

4. EFFECTS OF FLUORIDE ON ANIMALS

Fluoride toxicity and fluorosis in livestock and other animals can be traced to a variety of fluoride containing sources: forages, vegetation, feed concentrates and drinking water.

The early symptoms of ingesting excess fluoride are mottling and abrasion of teeth. In addition, the skin loses luster and becomes rough. The animal loses its appetite. There is a decrease in milk yield and the joints become swollen, painful and stiff resulting in lameness. The threshold limit of fluoride varies from species to species. It is 30 ppm in cattle, 50 ppm in sheep and 150 ppm in poultry.

5. EFFECTS OF FLUORIDE ON HUMANS

Excessive ingestion of fluoride through drinking water is known to cause a well defined clinical disorder in humans known as fluorosis. When severe manifestations occur in the teeth and the skeleton, the disorder is termed as dental fluorosis and skeletal fluorosis respectively. An individual may have dental fluorosis, skeletal fluorosis or both.

As a result of ingestion of excess fluoride for prolonged period of time, the teeth become discoloured, yellow and brown patches develop, and the teeth may even become black. In a later stage the teeth become pitted and eventually chip off.

In skeletal fluorosis, the individual is likely to complain of pain in the backbone, hip region and joints as well as muscle weakness. As the disease
progresses, the bones become denser and the ligaments covering the backbone, joints and interosseous membranes become calcified, resulting in stiff back and immobile joints. The intervertebral foramen is constricted and exerts pressure on the spinal nerves. A patient with fluorosis in the terminal stages may be crippled and paralysed. The disease has no treatment and is incurable.

6. MAGNITUDE OF THE PROBLEM OF FLUOROSIS

Because there are excellent clinical descriptions of cases of skeletal fluorosis in Andhra Pradesh and Punjab, the impression has been created that fluorosis is localized to just those regions of India and that it is therefore not a national problem. There is mounting evidence to show that this impression is wholly unjustified. There is clear epidemiological and clinical evidence that the disease exists in at least ten Indian states.

In those states, the people living in the metropolitan areas do not face the problem as there is provision for the supply of protected water. The people who were and are still affected are those living in the rural areas, where there is no protected water supply and where the only means of obtaining water is through open wells or bore holes, streams or rivers. The water in the endemic areas is contaminated by from 2 to 25 ppm of fluoride. To understand the severity of the situation it should be noted that potable water containing fluoride as low as 2 ppm can cause dental fluorosis and skeletal fluorosis of a crippling nature.

The collecting of statistical data on the incidence of fluorosis in a country as vast as India is by no means an easy task, so the data is not precise. The exact number of people affected in the problem areas is rather difficult to project as there is no up-to-date information available. However, we do know that probably 80-90% of the population of the villages in the endemic areas are afflicted with fluorosis. This estimate is based on the surveys conducted in selected villages which were the subject of epidemiological and other scientific investigations during the past several years. The estimate on the total number of individuals in India afflicted with fluorosis is approximately 20 million, and an equal number of people although asymptomatic are exposed to the risk of becoming afflicted in the years to come.

A few examples from states in India will show how widespread the problem is and how large is the number of person afflicted by fluorosis. A recent report from the Institute of Preventive Medicine, Hyderabad, revealed that the 21 districts of the state of Andhra Pradesh, there is not one district were the drinking water is free of fluoride contamination. In Andra Pradesh, well water samples have a fluoride content ranging from 0.8 to 25 ppm. Of 339 inhabitants examined in a village near Delhi, fluorosis was found prevalent in 82.2% of the adults and 58.8% of the children. Gupta (1979) surveyed 1818 persons in two villages near Delhi and found dental fluorosis in 64.5% of the subjects.

The drinking water in Dayalpur, Atali, Chhainsa, Machgar and Sotai villages, Haryana state, has a fluoride content of between 1.89 and 3.83 ppm. At Sotai village where the fluoride content of the water is 3.83 ppm, 98% of the children suffer from dental caries and 77% of those from dental fluorosis. In Machgar village, where fluoride content of the drinking water is 0.64 ppm, 65% of the children suffer from caries and 13% of those suffer from dental fluorosis (Meena, 1983). Similar data was found wherever the fluoride content of the drinking water is high. In such areas, fluoride contaminated water is being consumed because there is no alternative source of water.

India is not alone in having the problem of fluoride-contaminated water; fluoride pollution of drinking water is a serious public health problem in several other countries in the world as well. In Algeria, the fluoride content of some of the groundwater used for drinking and irrigation is as high as 5.90 ppm. In the province of La Pampa in Argentina, the groundwater contains 3 to 9 ppm of fluoride. In China, fluorosis has been reported to be endemic to many areas. In the province of Guizhou, the staple food items: rice, corn, cabbage, soya beans, potatoes and wheat have a fluoride content ranging from 8.3 to 11.7 mg/kg. Tea has the highest fluoride content of all, between 35.1 and 59.2 mg/kg. It is not surprising that food-borne fluorosis is very common in China.

The problem of fluoride pollution and fluorosis is a major problem in many African nations as well. In Kenya, for example, the drinking water is highly contaminated by fluoride and a nationwide
fluoride survey is now underway to determine the magnitude of the problem. So widespread is fluorosis that the country has banned the advertising of fluoride tooth paste. In neighbouring Tanzania, the fluoride content of the drinking water ranges from 3.2 to 92 ppm.

7. CONTROL AND METHODS OF ERADICATION

One of the most important and urgent measures is to provide protected water to the people living in endemic zones. This could be achieved by locating alternative sources of safe water, by bringing in water from a distance, digging deeper wells, or failing that, installing defluoridation plants or using domestic defluoridation units in homes.

Providing defluoridated water is the only way by which the future generations can be protected from the disease of fluorosis. For those afflicted with it, complete reversal of its pathological changes and its clinical manifestations is not possible. In those cases, we may at least hope that by providing defluoridated water, the disease does not get worse.

8. CONCLUSIONS

The importance and urgency of providing safe uncontaminated drinking water as well as developing a meaningful therapy for hydro-fluorosis, food-borne fluorosis, industrial fluorosis and drug-induced fluorosis should not be overlooked.

While a population may continue to lead an apparently normal life after the ingestion of fluoride in excess, it is prone to develop clinical manifestations sooner or later. Once afflicted, the victim will lead a vegetative life until death even if protected water and nutritional supplements are provided. As it may not be possible to eliminate entirely fluoride contamination of drinking water or foods, there is a need to develop a meaningful therapy for fluorosis.

Although the disease has drawn the attention of some specialists, the efforts regarding fluorosis have been grossly inadequate. The resources that have been applied to it have been meager. However, with a goal-oriented, multi-disciplinary program, the problem can be ameliorated.

REFERENCES