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SUSTAINABLE ENVIRONMENTAL SANITATION AND WATER SERVICES

**Fluorides in Water of Rural Areas in Orissa**

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**Introduction :**

Health is one of the basic need to national progress as it is of greater significance for social and economic development of a country. Health of a person depends mainly on food, water and environment. Water is one of the major commodities which affects the health in so many ways. People in the rural areas judge the water quality only through the physical senses of sight, taste and odour not in the sense of chemical, biological and medical point. Ground water is one of the major sources of water supply for domestic purpose in the rural areas and in some urban areas. It is believed that ground water is purer and safer than surface water due to earth's mantle covering. Many natural inorganic, organic and radio nucleotide substances are present in the ground water either in the solution or in suspension state. These actually creates the health problems. In different time, the local news paper reported that in some of the rural areas of Orissa, people are affected with fluorosis. The major cause of fluorosis is intake of fluorine through water. So a survey and analysis of ground water samples of some of the endemic villages was undertaken to investigate the water quality with special reference to fluoride content.

**Geochemistry of Fluorides:**

Because of its highly reactive in nature, fluorine does not occur free in nature, rather it is widely distributed in combined state. It constitutes nearly 0.08% of lithosphere. The main source of fluorine in the lithosphere are the mineral like Fluorspar ( $\text{CaF}_2$ ), Cryolite ( $\text{AlF}_3 \cdot 3\text{NaF}$ ) and Fluoro apatite [ $\text{CaF}_2 \cdot 3\text{Ca}_3 \cdot (\text{PO}_4)_2$ ]. Analysis has shown that the other geochemical source of fluorine found in the ground water lies in the host rock called Hornblende syenite. This rock contains about 4240 ppm of fluoride. While the other rocks are Granite genesis, nepheline syenite and Amphibolite contain fluoride in the range of 460 to 1570 ppm. The break down of these rocks due to weathering results in the release of fluorine into the circulating ground water and the movement is facilitated by the presence of filiation and joints in the rocks. It is observed that the deeper the source of water, higher is the concentration of fluoride.

Most of the fluorides are sparingly soluble and are present in natural water in small amount. Due to its highly electronegativity it only forms  $\text{F}^-$ .  $\text{F}^-$  has the same charge

and radius as  $\text{OH}^-$ . Hence during chemical reaction fluoride can easily replace in many rocks and form a series of  $\text{F}^- - \text{OH}^-$  complexes with metals. In the weathering process, hydrolysis, dissociation and dissolution occur. As a result free fluorine is released into ground water.

**Effect of fluoride on Human Health**

Fluoride is beneficial when it is present in optimum concentration (0.8-1.0 mg/lit) by reducing the tooth decay specially for the children below 10 years of age. The fluoride make the enamel on teeth much harder by converting hydroxyapatite [ $3\text{Ca}_3(\text{PO}_4)_2 \cdot \text{Ca}(\text{OH})_2$ ] (the enamel of the surface of the teeth) into much harder, fluoroapatite [ $3\text{Ca}_3(\text{PO}_4)_2 \cdot \text{CaF}_2$ ]. But excessive intake of fluoride ( $>1.5$  mg/lit) lead to loss of calcium from the tooth matrix, aggravating cavity formation throughout life and so causing dental fluorosis due to which the teeth loose their shiny appearance and chalky white patches develop on them and later the white patches becomes yellow and turn brown or black. This is a clear indication of overexposure of fluoride during the childhood when the teeth were developing. But these effects are not apparent if the teeth were already fully grown prior to the fluoride overexposure. So it is a fact that an adult may not be affected by dental fluorosis which does not mean that his or her fluoride intake is within the permissible limit. At higher concentration (3 – 6 mg/lit) skeletal fluorosis occurs, which effects the bone and ligaments. At still higher concentration ( $>8$  mg / lit) osteosclerosis (hardening and calcifying of the bones) occurs and finally spine, major joints, muscles and nervous system are damaged. So the concentration of fluorine plays a key role in human health affecting not only through its deficiencies but also through excess quantities. Since, there is no proper treatment for dental and skeletal fluorosis, the only remedy is to take fluoride within safe limit. But the subject is more complicated since its curative and harmful dose are quite narrow.

**Area under study :**

The latest information shows that endemic fluorosis is a public health issue across 25 countries in the world. In India fluorosis problem was first detected in Andhra Pradesh. Presently, this problem has been reported from 15 states of India including Orissa where the people of

10 districts out of 30 districts are affected. Since, the government is not fully aware of this problem or convinced of its adverse impact on the people of the affected area, so the present study was carried out to find out the fluoride content in ground water (Dug wells & Tube wells) of some of the affected area. Also a primary survey of some of the villages was undertaken to investigate the nature of fluorosis and number of people affected.

#### Materials & Methods :

Water samples from different villages spread in 13 districts in Orissa were collected in Polyethylene bottles. The temperature, P<sup>H</sup>, conductivity, T.D.S, D.O were measured in the spot by using portable water analysis kit 191E and other parameters were measured in the laboratory within 3 - 4 days by standard methods (APPHA, AWWA, WPCF 1985) The exposure dose were calculated by the following equation.

$$E.D. = \frac{C}{B.W} \times W.I.$$

Where E.D = Exposure dose (mg/kg/day)

W.I = Water intake (Lit/day)

C = Fluoride concentration (mg/lit)

B. W = Body weight (kg)

#### Result & Discussion :

The fluoride levels in Dug well & Tube well of some of the districts of Orissa are given in the Table 1. The results show that the fluoride level in Ganjam, Koraput, Mayurbhanj is less than 1.5 mg/lit. This indicates that these districts are free from fluoride hazards. But in the undivided district of Balangir, Puri, Cuttack, Kalahandi, Sundergarh, people are exposed to fluorosis as the water sample contain more than 1.5 mg/lit of fluoride. Further it has been observed that the people from Balasing, Singipur (Bolagarh Block, Khurda district, F<sup>-</sup> = 5.7-8.3 mg/lit) and in Karlakot panchayat (Boden Block, Naupada District) which include Kirejhola, Sargimunda, Moodoonili, Tuduki Bahal, Baranga, Similpadar, Kotamal, Tangiripada, Kirkola (F<sup>-</sup> = 5.1 - 7.3 mg/lit) are severely affected both by dental & skeletal fluorosis.

Exposure dose to fluoride were estimated for infants, children and adults are given in table 2. The dose estimated for infants was between 0.2 mg/kg/day to 1.41 mg/kg/day (for F<sup>-</sup> > 1.5 mg/lit) against the standard value 0.05 mg/kg/day which is the minimum risk value (MRL). At this level a clear risk of dental fluorosis is noticed. Exposure dose to children (20 kg body weight) and adult (70 kg) are also calculated. In Balasing, Singipur and Karlakot district the dose for children and adults lie

Table 1 — High values of fluoride in Dugwell (DW) and Tube well (TW) water

District	Location	F mg/lit	Location	F mg/lit	Location	F mg/lit
Balesore	Biranarsinghpur(DW)	2.2	Chatrang (DW)	3.7	DRDOguest (TW)	1.07
	Defence Colony (TW)	3.0	Officers colony (TW)	2.4		
Cuttack	Nembal (DW)	2.6	Balituth(DW)	5.9	Bari(DW)	4.3
	Palai(DW)	3.5	Nehenga(DW)	1.6	Barayula(DW)	3.3
	Rajnagar(DW)	1.7	Raghunathpur(DW)	2.5	Sonagopalpur(DW)	1.7
Dhenkanal	Thakurgarh(DW)	3.1	Bantal(DW)	1.3		
Ganjam	Rambha(DW)	1.2	Tumbagarh(DW)	1.3		
Keonjher	Ranchipur(DW)	2.5	Jhangira(TW)	2.5	Panadapada(DW)	2.3
Kalahandi	Golamunda(DW)	2.7	Tundla(DW)	2.4	Utkela(DW)	4.2
	Golmunda(TW)	1.6	Lakhana(TW)	2.8		
	Ranmal(DW)	2.6	Koksora(DW)	2.7	Sanatpur(DW)	1.5
	Dharambandh(DW)	2.8	Boden(DW)	5.1-7.3	Karlakot(TW)	8.1
Khurda	Sagar Gaon(DW)	2.9	Singipur(DW)	8.1	Balasing(DW)	8.3
	Sagar Gaon(TW)	3.3			Balasing(TW)	5.7
Puri	Gargh Rupas(DW)	4.4	Konark(DW)	2.4	Puri Town(DW)	2.0
	Balakati(DW)	2.6	Kasarada(DW)	5.8	Gopinathpur(DW)	1.3
	Mahipur(DW)	3.9	Nuagaon(DW)	4.1	Kanas(DW)	1.7
	Astrarang(DW)	2.2	Alanda(DW)	3.7	Jaripada(DW)	2.7
			Satpara gaon(DW)	2.3	Jaripada(TW)	2.5
Phulbani	Charichaka(DW)	3.2	Nuagaon(DW)	4.0	Dandua(DW)	1.8
	Tikabali(TW)	2.6	Chohipata(TW)	1.5	Karanakata(TW)	3.8
Sambalpur	Balitikara(DW)	1.5				
Sundergarh	Subdega(DW)	1.8	Motto(DW)	6.9	Sargipalli(TW)	2.2
	Talsara(TW)	3.1	Ekma(TW)	1.4		
Balangir	Deogaon(DW)	3.6	Khaporkhol(DW)	2.3	Khari(DW)	1.8
	Sonopur(DW)	1.9	Jagimunda(DW)	3.3	Badmal(TW)	2.0

in between 0.457 - 6 and 0.174 - 2.28 respectively which indicate the possibility of Osteosclerosis.

### Conclusion:

To control the epidemic fluorosis in a visible impact within a reasonable time, either water can be brought from distant sources for domestic consumption or by the defluoridation of the contaminated water. In India defluoridation is done by Nalgonda process and by activated Alumina process. But in both these processes the treated water contains the residual aluminium in the range of 2.1 to 6.8 mg/lit which has again created another health risk. Aluminium even at a lower concentration of 0.08 ppm in drinking water causes Alzheimer's disease. Further the cost of defluoridation is so high that rural people cannot afford. Hence a low cost defluoridation technology should be developed which could avoid the major shortcoming of the above technology.

However, the following other steps may be taken to control fluorosis :

- a) By avoiding food items rich in fluoride like Maize, red grass, red chilli.
- b) By avoiding tobacco, bettle, Panmasala, Gudakhu, Supari.
- c) By avoiding fluoridated toothpaste and mouth rinse.
- d) By avoiding fluoride rich cosmetic products.
- e) Calcium enriched diet should be taken regularly so that it will form calcium fluoride which is an insoluble salt and absorption will be less.
- f) Vitamin C and D should be taken.

During primary survey in Balasingh and Singipur (Khurda district) the situation is so bad that the villagers did not allow us to take photographs and even the angry villagers initially refused to talk. "People from outside don't want to give their daughters in marriage nor do they accept our daughter as bride for the last fifteen years", said an angry Debraj Parida. Forty nine

Table — 2 Estimation of Exposure Doses for Fluoride

	Water intake lit/day	Fluoride mg/lit	Fluoride intake mg/kg/day	
			Minimum	Maximum
Infant(6kg)	1.0	1.0	0.16	0.25
Children(20kg)	1.5	to	0.09	0.11
Adult(70kg)	2.0	1.5	0.028	0.042
		1.6	0.26	0.5
		to	0.12	0.225
		3.0	0.045	0.085
		3.12	0.51	1.0
		to	0.23	0.45
		6.0	0.088	0.17
		6.1	1.01	1.41
		to	0.457	0.637
		8.5	0.174	0.242

year old Hadu Pradhan who was rarely able to stand on his badly twisted limbs said that he is forced to drink the poison as there was no alternative. Chhakradhar Baliarsingh (46), with his body badly disfigured tersely said that he did not need any one's sympathy. So due to fluorosis, not only teeth and bone are affected but also new psycho-sociological problems are created.

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