

2-4 5-4

9 0 D E

126/7651



Safe Water 2000

**THE GLOBAL CONSULTATION ON SAFE WATER
AND SANITATION FOR THE 1990s**

NEW DELHI, 10 - 14 SEPTEMBER, 1990

**DEFLUORIDATION OF DRINKING WATER :
A REALITY AND NOT A CONTROVERSY IN INDIA**

LIBRARY
INTERNATIONAL REFERENCE CENTRE
FOR COMMUNITY WATER SUPPLY AND
SANITATION (IRC)

BY

G. GHOSH
JOINT SECRETARY
(TECHNOLOGY MISSION)

&

DR. A.K. SUSHEELA
PROFESSOR, AND HEAD OF DEPARTMENT
ALL INDIA INSTITUTE OF MEDICAL SCIENCES

NEW DELHI
6.9.1990

245-4-90DE-7651

LIBRARY, INTERNATIONAL REFERENCE
CENTRE FOR COMMUNITY WATER SUPPLY
AND SANITATION (ICWS)
P.O. Box 90120, 2309 AH The Hague
Tel. (070) 814911 ext. 141/142
RN: 7651
LO: 245.4 90DE

DEFLUORIDATION OF DRINKING WATER : A REALITY AND NOT A CONTROVERSY IN INDIA

G. Ghosh & A.K. Susheela

Newsweek deserves compliment for the lead article on fluoride. It is now shocking to know that the "legal standard" for fluoride in drinking water in U.S. has been raised from 2 ppm to 4 ppm and in toothpaste to 1100 ppm (Newsweek, February 5th, 1990, page 51). We are also aware of the fact that West Germany discontinued fluoridation after 15 years as a result of legal and health considerations (Muller, Elisabeth, Acting Consulate-General of Federal Republic of Germany, Melbourne, Australia : Letter Of Australian Dental Association : Ref. RK654, 1st September, 1977). A representative of Greece has written that "it has been proved that fluoridation of water results in many pathological disorders" (Kontovounissios, Christos, Second Secretary, Embassy of Greece, Canberra, Australia : Letter to Mr. Reynolds REf. No. F 960/22/AS641, 4th June, 1985). The French Ministry responsible for the environment "has confirmed that France is opposed to fluoridation" (Olivier, M. Consultate-General of France, Melbourne, Letter to Committee of Inquiry into fluoride of Victoria Water Supplies, 17th July, 1979). The national agency for Environmental Protection in Denmark recommended to the Minister for the Environment "not to permit fluoridation of drinking water in Denmark" (Denmark: National Agency of Environmental Protection : Soc. Sci. Med. 16:2155-2158, 1982). There is no fluoridation in Japan and in many other countries.

The realities in India are totally different. Due to the earth's crust being extremely rich in fluoride bearing minerals, the water is naturally fluoridated. The maximum fluoride content so far detected is 38.5 ppm (mg/litre) in drinking water. In India about 85% of rural as well as urban population are solely dependent on ground water as the drinking water source, a large part of which has high concentration of fluoride. This is desirable as ground water sources would be economical and could be depended upon.

The origin of fluoride, like most other minerals, is associated with volcanic and plutonic activities in the crust of the earth. Fluoride occurs as calcium fluoride. In the acid plutonic rocks like granites, it occurs in the form of fluor-apatite. It also occurs in micas and calcium phosphate deposits. Basalts contain 100 ppm (parts per million), whereas granites contain as high as 500 to 850 ppm of fluoride. Shales and deep sea clay deposits contain 740 and 1300 ppm of fluoride respectively. Alkaline rocks contain the highest percentage of fluoride (1200 to 8500 ppm). Alkaline water also shows high enrichment of fluoride.

Drinking water containing fluoride ranging from 1.5 to 38.5 ppm has caused severe health problems in India since the last 50 years. Initially the health problems were known to exist in 4 States of India, two in the Southern and two in the Northern parts of India and nowhere else. But today, 13 States of the Indian Republic have been identified endemic for fluorosis and associated health problems as a result of drinking

fluoride contaminated water. It has become an urban as well as a rural health problem; affecting the poor and rich alike.

What did the Government of India do, to deal with this public health problem? Since early 1930s, the major focus has been to promote basic researches, epidemiological studies and clinical research to understand fluoride action on body tissues and the health problems in its totality. Researches in this field are still being promoted by various national agencies. International Agency viz. the International Development Research Centre (IDRC), Canada has supported fluorosis research in India in the recent past.

India is possibly the first country to launch a National programme on Fluorosis Control or Defluoridation. To tackle the drinking water problem, on a war footing, the Government of India during 1986, has set-up a Technology Mission on Rural Drinking Water and related water management in the Department of Rural Development as the nodal agency. The strategy adopted for visible results is to focus on Sub-Missions, countrywide. The major Sub-Missions operating are (1) Control of Fluorosis (2) Eradication of Guinea worm (3) Removal of Excess Iron (4) Removal of Salinity and Brackishness (5) Source Finding and Water Management and (6) Water Quality Surveillance. The methodologies adopted are (1) purification of water (2) improvement of technical methods (3) improvement of materials and design (4) improvement of maintenance methods (5) computerized management information system (6) scientific source finding (7) continuous monitoring and evaluation (8) community involvement and (9) awareness programmes.

The activities are essentially an update programme which include information on clinical manifestations, diagnosis, early warning signs of fluorosis, procedure to identify subjects afflicted with fluorosis under field conditions, without having to carry out sensitive laboratory based tests, besides educating the people on the importance of drinking safe water. Water quality assessment and defluoridation procedures both at the domestic and community defluoridation installations, are dealt with. Even some of the textbooks on Public Health Engineering still describe procedures to fluoridate drinking water rather than defluoridation. Fluorosis is considered as a disease which has no treatment or cure and preventative aspects are often neglected. It is also true that the disease was very often misdiagnosed as arthritis, spondylosis or joint pain. We are not surprised to note the statement in Chemical Engineering News (Page 37, August, 1988) that most Doctors in U.S. have not studied the disease and do not know how to diagnose it. It therefore emerges that even in U.S. the early warning symptoms of fluoride toxicity/poisoning may not be understood at all.

- In an endemic area for fluorosis, it is not necessary that every source of water is contaminated with fluoride. The good sources are identified, labelled and the people are informed to consume water

from the good sources only; whereas the fluoride contaminated sources are used for washing and cleaning purposes. If the yield of water is less for consumption at the rate of 20 Litres per capita per day (LPCD) for human consumption, possibilities are also explored for mixing the water from alternative sources, thereby diluting the concentration of fluoride to permissible levels.

- We have also data in India to suggest that with 0.4 ppm of fluoride in drinking water is causing mild, moderate and severe forms of dental fluorosis and therefore we are looking for water with less and less fluoride contamination.
- It is also a fact that due to atrophy of muscle fibre and connective tissue of the body including the oral cavity caused by the use of fluoride, people living in endemic areas for fluorosis, become edentulous (loose teeth) at an early age; looks much older and many (who can afford) resort to the use of denture.
- We also have health problems with excess ingestion of fluoride associated with kidney function which has been confirmed by leading Nephrologists in the country.
- Muscular weakness, loss of muscle power and neurological manifestations leading to excessive thirst, tendency to urinate more frequently, although the volume of urine is not too large, are not uncommon among the afflicted individuals.
- Severe and widespread gastro-intestinal problems viz. anorexia, pain in the stomach, intermittent diarrhoea, chronic constipation, gas formation and bloated feeling in the stomach (Non-Ulcer Dyspepsia) caused due to drinking fluoridated water have been confirmed. Changing the source of water with low levels of fluoride (below 1 ppm) provides relief from the gastro-intestinal problems within a period of 2-3 weeks.
- Under the Water Mission, in the affected areas where there are no good sources(s) of water, domestic defluoridation procedures are being popularized among lactating mothers as well as pregnant (expectant) mothers besides erecting community defluoridation tanks for the public. Alternate source(s) of safe drinking water, either by bringing in from a distance through pipelines (if economically viable)/or look for alternate underground sources are also considered for implementation.

The excess fluoride can be removed from water by what is known as the "NALGONDA PROCESS" which involves rapid mixing of water with lime (NaCO_3 or CaCO_3), alum and bleaching powder (for disinfection). The process removes fluoride by flocculation. Lime ensures adequate alkalinity needed for

hydrolyses of aluminium salts. If the water is more alkaline, lime is not needed. This process has however, certain limitations and is not effective if the TDA of water is above 1500 ppm and the hardness is above 250 ppm. The method is otherwise simple and can be used at domestic or community level. The only precaution needed is not to add excess alum otherwise a residual metallic taste becomes perceptible. The Nalgonda process involves removal of excess alkalinity and bicarbonates also which is an added advantage.

The "fill and draw" type of community defluoridation system is used when the requirement of water is more. The cost works out to Rs. 3 to 5 per 1000 litres, that is US\$ 3 to US\$ 4.5 per year per person. This also uses the same chemical process as that of Nalgonda process. Defluoridation units attached with handpumps have also been designed and put for field operation in the rural areas of India.

The wrong communication strategy also creates problems and results in misconception regarding the role of fluoride in water, toothpaste and even in salt. The recent general pamphlets issued by WHO is one such example where advice is given to use flouridated water, toothpaste and salt. When such communications are circulated all over the world it gives the wrong message for the general public. In fact, in major parts of the globe excess fluoride is a problem. China has reported to have nearly 32 million people affected with dental fluorosis and 1.75 million people affected with skeletal fluorosis. It would be worthwhile if WHO can take a leading role in giving the correct message to avoid this confusion and misconception. In the developing countries to prevent dental caries, the need of the hour is not fluoride but adequate awareness on the importance of oral health and hygiene besides improving adequate calcium and vitamin C in the diet.

Some developing nations are now reporting on the unsuitability of WHO guidelines for fluoride concentration in drinking water. A recent report from Netherlands, based on a study in Senegal has shown dental fluorosis in children where fluoride in water ranged from 1.0 to 7.4 ppm, prevalence of mild dental fluorosis is 68.5% at 1 ppm of fluoride in drinking water; when fluoride exceeded to 4 ppm, the prevalence of dental fluorosis reached 100%. It has been suggested that the WHO guidelines for fluoride concentration in drinking water in Senegal is unsuitable and the upper limit should be reduced to 0.6 ppm (Lancet : 11, 223-225, 1988). It is now quite gratifying to note that in India the Regional Office of WHO has extended support to the Water Mission activities particularly the Sub-Mission on "Control of Fluorosis".

It is unfortunate that the use of fluoride for prevention of caries although formulated and brought out 50 years ago by US based Dentists, is still being promoted world over without questioning, the rationale or the health hazards which have been emerging due to fluoride poisoning. It has been shown by Indian Dentists that by use of fluoridated toothpaste for brushing the teeth, in young and old, the serum fluoride levels are enhanced within minutes (Rajan *et al*, Fluoride in toothpaste : Cause for Concern, Fluoride

21:4, 1988; Rajan *et al*, Serum and Urine Fluoride in Toothpaste Users, *J. Ind. Dent. Assoc*, 59:137-142, 1987). The oral mucosa rich in blood vessels do absorb fluoride ions rapidly. The sub-lingual blood vessels (the one below the tongue) drains the stuff directly to the superior venecava and then to the heart. *It is not true that toothpaste never enters the body unless it is swallowed/ingested. Fluoride does enter circulation directly from the oral cavity through the fine blood vessels of the mouth. Fluoride being a persistant bioaccumulator, even small amounts that enter through fluoridated toothpaste is a guaranteed entry not only in children but even among the adults and the cumulative or additive effects of fluoride is causing serious concern.*

It has been discovered in India recently that there is no toothpaste, marketed which is free of fluoride whether labelled or otherwise. The amount of fluoride arising as a contaminant from the raw materials used viz. chalk, talc and calcium cabonate, may be as high as 80 ppm. Over and above the contamination, different manufacturers add fluoride to the extent of 2000-2500 ppm. It has also been observed in India as a result of extensive laboratory investigations that the fluoride is not mixed homogenously in the paste. When the paste is squeezed out from different depths of the tube, the amount of fluoride in the fluoridated brand of paste is highly variable. In none of the so called fluoridated brands of the toothpaste, the quantity of fluoride in the paste is revealed on the carton or the tube. It is also a fact that, when sodium monofluorophosphate (SMFP) is added to the paste, it is known to decompose and the expiry date of the toothpaste is never revealed either.

In order to ensure quality control procedures in manufacturing, a maximum contaminatnt rate of 800 ppm may be permitted in Indian toothpastes, but we are insisting on having a warning inscribed on the carton which should read as "excess fluoride is injurious to health". This would alert the consumer to look for a paste with least flouride contamination. We are also aiming at curtailing the false publicity for promoting the use of fluoride in the name of prevention of caries. Although children below the age of 6 years, are not supposed to use fluoridated brands of tooth paste, as per the recommendation of the Indian Council for Medical Research, invariably the advertisements are aimed at children, misguiding the public.

Perhaps due to the STRONG publicity CAMPAIGN promoting fluoride for prevention of caries on Television, Radio and other media, people do not quite realize the damage that excess fluoride can do to them. It has been shown that excess ingestion of fluoride leads to the accumulation of a particular chemical substance viz. dermatan sulphate, both in bone and teeth. The substance on Accuulation tends to demineralize the area around, both in human teeth as well as in bone. Such demineralized zones in the teeth get pitted and perforated in dental fluorosis besides being discoloured (Susheela, *et al*, *Arch. Oral Biol.*, 33, 10, 765, 1987). The belief that cavity formation occurs only in dental caries is an outdated information. In fact, cavity formation may be aggravated in some due to excess ingestion or use of fluoride, leading to dermatan sulphate formation and ensuing demineralization of the tooth matrix.

In reality the statement that using fluoride for caries prevention only makes the enamel strong, no longer holds good, because fluoride also causes demineralization of the teeth and they get pitted, perforated and chipped off. In other words, the damage it causes to the teeth, is never taken into account. As Roger S. Fajer of US, points out in Pacific News Service (No. 5274, 1989) that much of the researches used to support fluoridation in the West dates back 20-50 years when Western Biomedical Research was much more primitive than today and certainly for statistical analysis much looser.

In addition to the above, it has also been reported that fluoride may induce cholesterol production in males and can also lead to blocking/calcification of blood vessels, specially in the region of the main vessel leading from the heart viz. the aorta, causing cardiac problems. This certainly means that the toxic effects of fluoride far out weigh its benefits in the Indian situation.

There are reports on high incidence of cancer due to fluoride in US (Cancer Mortality in Relation to Fluoridation and Population Changes, Data from 140 largest US cities from 1940-1980, Burgstahler, Int. Conference of the Fluoride Society, Utah, 1986). Animal experiments from Japan and other parts of the world, also suggest that fluoride is cancer causing (Mutation Research, 139, 193-198, 1984; Cancer Research, 44, 938-941, 1984; Science of Total Environment 68, 79-96, 1988). These are serious problems that a nation ought to take into account before it starts adding fluoride in massive doses to drinking water and toothpaste just because a few Dentists and of course the manufacturers promote the outdated concepts on the use of fluoride.

ABOUT THE AUTHORS

G. Ghosh is presently working as Joint Secretary in the Ministry of Agriculture, Department of Rural Development, New Delhi. He is also shouldering the prestigious assignment as the Mission Director of the National Drinking Water Mission launched by the Government of India in 1986. He is a Geologist by training.

A.K. Susheela, Ph.D. is a Professor at the All-India Institute of Medical Sciences, New Delhi. She is associated with the National Drinking Water Mission as she co-ordinates the activities in the Sub-mission "Control of Fluorosis" specially the health activities. She has spent nearly 20 years researching in the field of fluorosis at the AIIMS. She is presently the President of the International Society for Fluoride Research, besides being a Fellow of the Indian Academy of Sciences as well as that of the National Academy of Medical Sciences (India).

EXPLANATION FOR FIGURES

- Fig. 1 A young girl of 12 years from Delhi, afflicted with skeletal fluorosis. She has painful backbone and joints. Her movement within her house is restricted.
- Fig. 2 A young adult of 30 years afflicted with skeletal fluorosis and living in a rural area. He has become a slave of the stick, being unable to walk without help.
- Fig. 3 A picture of dental fluorosis. Note the brown discolouration of the teeth due to fluoride toxicity.
- Fig. 4 A piece of backbone (3 vertebrae) from an individual who died of fluorosis. Note the extension of bony outgrowths which are nothing but calcified ligaments (arrow) developed due to fluorosis. Flexibility of the backbone is lost due to calcified ligaments.
- Fig. 5 A scanning electron micrograph of a normal human intestinal mucosa (lining). Each polygonal surface (cell surface) is having microvilli in abundance, which absorb the nutrients. Mucus droplets are also seen in plenty (black arrow).
- Fig. 6 Scanning electron micrograph of human intestinal mucosa after ingestion of water contaminated with fluoride upto a maximum of 11.36 ppm. SEM picture shows the loss of microvilli and the cell surfaces are exposed; absorption of nutrients can hardly take place through such mucosal surface.
- Fig. 7 Human intestinal mucosa after ingestion of fluoride through water to the extent as indicated above. Mucus is not seen on the mucosal surface. The mucosa reveals "cracked clay appearance" possibly due to lack of mucus.





2

4

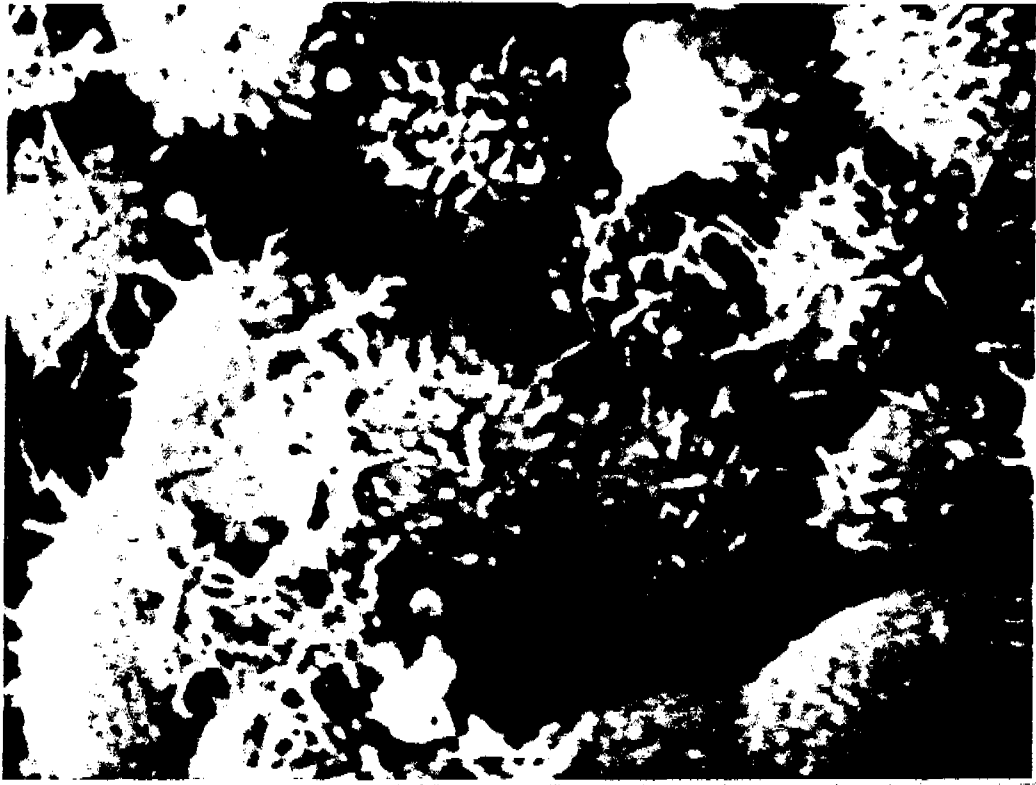


3



5

6



7