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Fluoride Distribution and Fluorosis in some Rural Areas of Udaipur, Rajashtan

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Abstract: The occurrence of fluoride in drinking water, ambient air and in certain vegetable crops were studied and releted with the prevalence of dental fluorosis in some rural areas of Udaipur district of Rajasthan. Although, most of the portable water samples, when analysed using fluoride electrode, showed fluoride levels below permissible limit (1.0ppm), the incidence of fluorosis was surprisingly high. The study revealed the prevalence of dental fluorosis in adults and also in school going children. Khemi was found to be the most affected village where the well water used by the villagers for drinking purposes contained highest fluoride level (2.0 ppm) observed in this study. The ambient air and the edible parts of certain crops also contained high concentrations of fluoride. This could be due to atmospheric emissions from phosphate fertilizer factories situated near these villages. The study suggests that in addition to drinking water, atmospheric deposition on crops followed by dietary intake could enhance total fluoride in body tissue and hence the cases of fluorosis.

Introduction

Recent scientific efforts, although yielded beuntiful return to our basic knowledge of water quality management, have raised many questions about the safety of drinking water supply. In countries, like ours where the majority of population live in villages with bare infrastructural facilities, poor sanitation and hygiene, the concept of safe drinking water assumes great significance. This has particular concern for arid and semi-arid regions. In states such as Rajasthan, where the quantity of freshwater demand itself has become a big problem due to persistent drought from last five years, per capita availability of safe drinking water is a matter of serious concern. Rajasthan is identified as one of the highly endemic states for fluorosis[1]. Fluoride, one of the abundant and widely distributed elements in nature, plays a vital role in water quality management due to its both, beneficial and adverse health effects[1,2]. Although fluoride helps preventing dental caries, its higher concentrations lead to mottled enamel. Excess intake of fluoride beyond the permissible limit (>1ppm) causes dental and skeletal fluorosis and neurological disorders. In India, Lakdawala and Punchar[3] made extensive study on the prevalence of fluorosis and total fluoride intake through drinking water and commonly consumed food. In our country, about 62 million people, including six million children, suffer from dental and skeletal fluorosis because of consuming fluoride contaminated water[1]. Fluoride, being ubiquitous in nature, is always present in plants, soils and waters. In surface waters, its concentration varies widely, some time achieving values as high as 18000 $\mu g\ L^{-1}$ in hot springs[4]. Fluoride enters in ground water mainly through leaching from the earth crust. various rock types contain fluoride ranging from 180mg $\mu g\ g^{-1}$ in sandstone and greywaeke to 800 $\mu g\ g^{-1}$ in granites[4].

Rock phosphate, phosphatic nodules and phosporites contain high concentrations of fluoride[5]. Industrial effluents, drugs, cosmetics and agricultural application of fertilizers coupled with pesticides also add sizeable amount of fluoride to the ground water, surface waters and to the terrestrial environment[6]. Thus, the fluoride content in different components of environment and its possible bearing on total fluoride intake in human beings have become a matter of great concern[7]. For instance, in addition to drinking water, dietary fluoride intake could significantly enhance total fluoride in our body[3,8]. In a preliminary study conducted at Udaipur district of Rajasthan, we observed that, in spite of low level of fluoride in drinking water, a number of persons including school going children suffer from fluorosis. Hence a systematic study was conducted to examine the cases of fluorosis in school going children and in adults in 10 villages of Udaipur district of Rajasthan. Attempts were made to relate the cases of fluorosis with fluoride in drinking water as well as in agricultural crops. Since the present study was conducted in an area receiving emissions from phosphate fertilizer factories, atmospheric depositions were likely to enhance fluoride levels in crops.

Materials and Methods

The present study was conducted in rural areas of NE Udaipur (Rajasthan). The climate of the region is tropical with three distinct seasons, a hot and dry summer (March to June), a warm and wet rainy (July to October) and a cool and dry winter (November to February), with annual average 24^0 temperature, 45% relative humidity and 800mm annual precipitation. The first half of the summer season experiences strong, hot an dry winds and high temperatures, while the second half is generally hot and humid. During the study period, the day time summer temperature ranged from 34^0 to 46^0C. During winter, temperature varied between 10 to 23^0C and the night temperature some time dropped below 4^0C. The annual rainfall averaged 595mm and relative humidity ranged between 12 and 95%. Wind direction shifted predominantly westerly and non-westerly in October to April and to easterly and south-westerly in the remaining months.

Ten villages were selected, and based on the population of each village, 50-218 cases of adults in the age group 21 to 65 (both men and women) were examined for dental fluorosis. Children of 10 schools (age group 5 to 13) were examined for dental caries and fluorosis. The food habits of the villagers were also enquired. Most of the villagers use well water and some use borewell water for drinking and cooking purposes. All the drinking water sources, including ground and surface sources, were tested for fluoride concentration. Drinking water samples were collected in pre-sterilized bottles from all the 10 villages and analysed for fluoride concentration using a fluoride electrode. Citrate was included in the total ionic strength adjustment buffer (TISAB) as a chelating agent in order to avoid interference by fluoride binding metal ions.

Since the area lies between two phosphate fertilizer units (Udaipur Phosphate Fertilizer Factory and Rama Phosphate Fertilizer Factory), it receives substantially high amount of fluoride through atmospheric depositions. In order to assess the possible dietary intake, samples of locally growing crops were also analyzed for fluoride concentration following bellack[10]. Fluoride concentrtion in ambient air was monitored using High Volume Samplers (Envirotech APM-415) following Narayan et.a.[11]

Results and Discussion

Fluoride concentrations in drinking water samples are presented in Table 1. For most of the water samples, fluoride concentration was well below the permissible limit. Water samples collected from Khemli village contained the highest level of fluoride (2.0 ppm) observed in the present study. Interestingly, fluoride concentrations in the ambient air as well as in crops were substantially high (Fig.1 and Table 2). This could be due to atmospheric emission of fluoride from phosphate fertilizer factories situated near these villages. The cases of dental fluorosis in school going children of some rural areas of Udaipur district of Rajasthan are presented in Table 3. In school going children (age 5 to 13) the cases of dental fluorosis ranged between 13.3% to 45.2%. The incidence of dental fluorosis in boys and girls did not differ significantly. The data on dental fluorosis in adults (both men and women) are presented in Table 4. Khemli was found to be the most severely affected among the 10 villages studied, where 58.3% of the adult population have shown the sign of dental fluorosis. Devali was the least affected village observed in the present study. Water samples (well water) collected from Khemli village contained fluoride above the permissible limit. This could account for the high percentage of fluorosis in Khemli, since well is the major source of drinking water supply in this area. Borewell water of Khemli village also contained fluoride above the permissible limit.

Table 1 : Concentration of fluoride in drinking waer samples collected from selected villages of Udaipur.

Village	Fluoride (ppm)
Khemli	
Well water	1.80-2.15 (x=2.00+0.21)
Borewell water	1.15-1.40 (x=1.27+0.13)
Asna	
Well water	0.03-0.09 (x=0.06+0.005)
Borewell water	0.07-0.15 (x=0.10+0.02)
Shangawa	
Borewell water	0.32-0.64 (x=0.48+0.05)
Gondoli	
Borewell water	0.07-0.15 (x=0.10+0.02)
Devali	
Well water	0.05-0.1 (x=0.07+0.006)
Chandesara	
Borewell water (South)	0.05-0.1 (x=0.07+0.006)
Borewell water (Primary School)	0.16-0.26 (x=0.20+0.04)
Bhagrio Ka Guda	
Well water	0.48-0.85 (x=0.59+0.07)
Gudali	
Borewell water	0.05-0.15 (x=0.09+0.006)
Well water	0.03-.009 (x=0.06+0.006)
Junawas	
Borewell water (East)	0.03-0.09 (x=0.06+0.005)
Borewell water (West)	0.56-0.66 (x=0.61+0.10)
Odwadia	
Borewell water	0.05-0.1 (x=0.07+0.005)
Borewell water Primary school	0.03-0.1 (x=0.06+0.005)

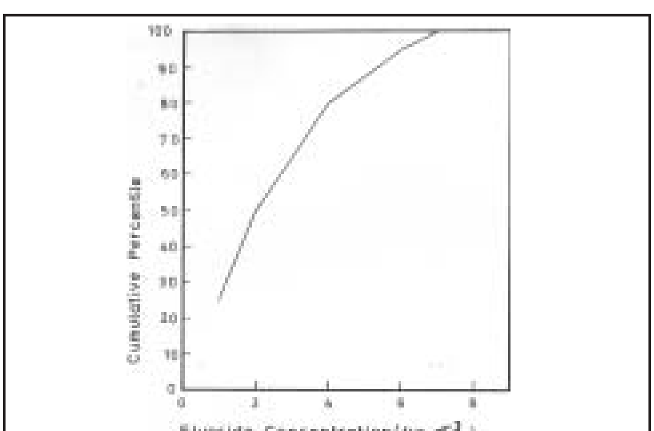

Fig. 1 : Cumulative percentile distribution of 2-h mean concentrations of fluoride in the ambient air of the study area.

Table 2 : Fluoride concentration in crops (ppm dry matter basis).

Component	Fluoride		
	Range	Mean	C.V.
Grains*	28.6 - 84.5	52.3	17.4
Vegetables**	46.1 - 136.4	86.3	16.2

C.V.: Coefficient of variation
** Include maize, wheat and pearl millet*
***Include tomato, brinjal, cauliflawer, lady's finger and beans*

Table 3 : Cases of dental fluorosis in school going children in rural areas of Udaipur.

Name of the School	Village	No. of Students examined	Affected Boys(%)	Affected Girls(%)
Primary School	Khera	96	21(52.5)	19(47.5)
Primary Girls School	Kanpur	300	22(55.0)	18(45.0)
Primary School	Umara	115	13(48.1)	14(51.9)
Primary School	Dedkia	74	12(60.0)	08(40.0)
Rajiv Gandhi Primary School	Jhapa	42	03(42.8)	04(57.2)
Primary School	Umara Khera	77	09(81.9)	02(18.2)
Primary School	Dhama Talai	120	15 (46.9)	17(53.1)
Primary School	Dharma Talai	100	09(37.5)	15(62.5)
Middle School	Kanpur	100	22(52.4)	20(47.6)
Middle School	Khera	31	6(42.9)	8(57.2)

Values in perentheses indicate per cent of the affected cases.

Table 4 : Cases of dental fluorosis in adults in rural areas of Udaipur.

Village	No. of person examined	Affected Men	Affected women
Khemli	218	69(54.3)	58(45.7)
Asna	150	35(51.5)	33(48.5)
Shangawa	142	32(62.7)	19(37.3)
Gandoli	110	10(55.6)	08(44.5)
Devali	116	07(53.8)	06(46.2)
Chandesara	170	27(50.9)	26(49.1)
Bhagrio Ka Guda	180	32(50.8)	31(49.2)
Gudali	160	26(59.1)	18(40.9)
Junawas	50	10(71.4)	4(28.6)
Odwadia	100	10(66.7)	05(33.3)

Values in percentheses indicate per cent of the affected cases.

In addition to the natural sources of fluoride in drinking water, this area also receives high amount of fluoride through atmospheric deposition from phosphate fertilizer factories. This was evidenced by high concentrations of fluoride in ambient air as well as in crops. Plans can accumulate fluoride in concentration many fold higher than that available in air environment[12]. This could account for enhanced total fluoride in body tissue through dietary intake.

Data on ambient air quality indicates high concentration of fluoride in the air environment. About 5% of 2-h hourly mean concentrations exceeded 6.0 μg m-3 a level sufficient to cause significantly fluoride acculati in plant parts[12].

The cases of fluorosis in villagers, particularly in school going children in SE Udaipur appeared alarming. Children with fast growing tissues could get affected more severely and quickly. Children have also shown such symptoms as pain in the stomach, intermittent diarrhoea, chronic constipation and gas formation caused due to intake of fluoride[13]. It has been shown that excess intake of fluoride leads to the accumulation of dermaten sulphate, which demineralize the area around both in teeth and bones[14]. Such demineralised areas in teeth get perforated and chipped beside being discoloured[15]. In most of the water samples, fluoride level was found below the permissible limit. However, since fluoride is an accumulating pollutant, it could induce adverse effects in due course, if taken continuously even at very low concentration[16]. Furthermore, atmospheric emissions from phosphate fertilizer factory could make an additional source of fluoride intake through inhalation and oral uptake through food. The area studied is exposed to the emission from phosphate fertilizer factories. This together with fluoride in drinking water could exacerbate the prevalence of fluorosis in villages having fluoride content in water even below the permissible limit. A number of adults in these villages (aged 45-61) showing dental fluorosis, also complained severe pain in their joints. These symptoms may be indicative of skeletal fluorosis followed by dental fluorosis[17]. In most of these villages the socio-economic status is very poor. The villagers can hardly afford to take clacium and vitamin-C rich diet. Therefore, the present study invites attention, of both scientists and policy makers, to develop and implement suitable control measures so that fluoride related health problems of this area can be minimized. Alternative approaches such as sufficient availability of calcium and vitamin-C rich diet can provide some relief to this problem. However unlike most part of Rajasthan, fluorosis did not appear endemic to this area. And therefore, alternative approaches would be least productive unless the local inhabitants are getting relief from atmospheric fluoride input from phosphate fertilizer factories. This has relevance if Fluorosis Management Programme need to get success in India.

Acknowledgement

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References

1. Susheela A K, Fluorosis management programme in India, Curr. Sci. 1999;77:1250-1256.
2. Pandey U Paandey J, Response of two strains of *Nostoc muscorum* to graded concentration of fluoride, in; Gyani K C, Vaish A K and Vaish P Eds. Proceedings of National Seminar on Environ and Health, Udaipur, India, 1999;31-33.
3. Lakdawala D R Punchar B D, Fluoride content of water and commonly consumed floods in Bombay and a study of dietary intake, Ind. J. Med. Res. 1973;16:1679-1687.
4. Madhavan N Subramanian V, Fluoride concentreation in river water of South Asia, Curr. Sci. 2001;80:1312-1319.
5. Ray S K, Prevalence of fluorosis in rural community near Varanasi, Fluoride 1981;14:86-90.
6. Samal U N, Dental fluorosis in school children in the vicinity of an aluminium factory in India, Fluoride 1988;21:137-141.
7. Adriano D C, Trace Elements in Terrestrial Environment, New-York, Springer - Verlag, p.533.
8. Lakshmaiah N and Srikantia S G, Fluoride retention in humans on sorghum and rice based diets, ind. J. Med. Res. 1977;65:543.
9. Pandey J Nagda G, Prevalence of fluorosis in ten villages of Udaipur district of Rajasthan, Ind. J. Environ. Sci. 2002;6:163-166.
10. Bellack E, Methods and materials for fluoride analysis, J. Am. Water Works Assoc. 1972;64:62-66.
11. Narayan D Agrawal M Pandey J Singh J, Changes in vegetation characteristics downwind of an aluminium factory in India, Ann. Bot. 1994;73:559-565.
12. Sidhu S S, Patterns of fluoride accumulation in boreal forest species under perennial exposure to emissions from a phosphorus plant, Atmos. Pollut. Stud. Environ. Sci. 1980;8:425-432.
13. Mutukumaran K, Balasubramanian B Ramakrishna T V, Removal of fluoride by chemically activated carbon, Ind. J. Env. Prot. 1995;15:54-57.
14. Kumar S, Studies on desorption of fluoride from activated alumina, Ind. J. Env. Prot. 1995;15:50-53.
15. Maithani PB Gujar R Banerjee et al. Anamalous fluoride in groundwater from western part of Sirodhi district, Rajasthan and its crippling effects on human health, Curr. Sci. 1998;74:773-777.
16. Susheela AK Das TK, Chronic fluoride toxicity: a scanning electron microscopic study of deuodonal mucosa, Clin. Toxi Col. 1988;26:467-476.
17. Apparao B V Karthikeyan G, Water in Indian Rural environment, Ind. J. Environ. Prot. 1986;6:172-175.

ETHICAL GUIDELINES FOR BIOMEDICAL RESEARCH

The need for uniform ethical guidelines for research on human subjects is universally recognised. It has acquired a new sense of urgency as the critical issues in the area of biogenetic research involving human subjects have become acute. Apart from the mandatory *clinical trails* on new drugs, a number of *diagnostic procedures, therapeutic interventions and prevention measures* including the use of vaccines, are being introduced which involve human subjects. Further the advent of *new medical devices* and *radio-active materials* and therapeutic benefits of *recombinant DNA products* have added a new dimension to the ethical issues that need to be considered before evaluating these for their efficacy, utility and safety.

Any research using the human beings as subjects shall bear in mind the following **principles** of : i) **essentiallity**, (ii) **voluntariness, informed consent**, (iii) **non exploitation**, (iv) **privacy** and **confidentially**, (v) **precaution** and **risk minimisation**, (vi) **professional competence**, (vii) **accountability & transparency**, (viii) **maximisation of public interest** and **distributive justice** (ix) **institutional arrangements** (x) **public domain** (xi) totality of **responsibility** and (xii) **compliance**.

Recent advances in the field of **Assisted Reproductive technologies, organ transplantation, Human genome analysis**,and **gene therapy** promise unquestionable benefits to mankind. At the same time, they raise many questions of law and ethics, stimulating public interest and concern.

(Source : ICMR Publication 2000)

NOBLE PRIZE IN MEDICINE

Dr. Barry J. Marshal and **Dr. Robin Warren** from Australia have won the 2005 **Nobel Prize in Physiology;** for discovering that bacteria (H. Pylori), not stress, was the main cause of ulcer (90% duodenal; 80% Gastric). The bacteria can be eradicated effectively, by a short course of antibiotics and acid secretion inhibitors.

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