FLUORIDE ACCUMULATION IN FOODSTUFF AND DIETARY INTAKE IN A FLUORIDE-ENDEMIC AREA OF CHANDRAPUR DISTRICT, MAHARASHTRA

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ABSTRACT

The present research was conducted to estimate fluoride (F) accumulation in foodstuff grown in the study area, Dongergaon village of Chandrapur district, Maharashtra, India and dietary intake of F among selected people living in this study area. Food samples like cereals and pulses grown in the study area were collected, the edible portion of the food sample was weighed, dried and ashed. The powered and ashed food samples were used for analysis of fluoride content of food samples by Ion selective electrode method. Ten males and female adults were selected for the estimation of F intake through their diet whose food source was their own cultivated cereals, pulses and vegetables irrigated by local F-contaminated ground. Result showed that the F accumulation is found to be variable in collected food samples (Wheat, Sorghum, Red gram, Soybean, Bengal gram, Red chilly, Brinjal, and Tomato). Analysis of diet of selected 20 adults revealed that drinking water contributed 72.92%, cereals 16.67%, 4.66% pulses and vegetables 5.74%to the total mean F intake.

***Keywords**: Fluoride, Cereals, Pulses, Vegetables, Chandrapur district, Maharashtra*

Introduction

Chronic F intoxication (Fluorosis) is a worldwide health problem (Choubisa, 2011; Yang et al, 2000; Srikanth et al, 2002; Chen et al, 1997; Binbin et al, 2004; Teotia et al, 1984). Endemic fluorosis has been identified in 20 states of India (Teotia et al, 1984; Choubisa, 2001). In India, people of nearly 22,400 villages of 196 districts of 19 states are drinking F contaminated water which is above the maximum allowed concentration (MAC) of 1.5 ppm recommended by WHO (Goswami, 2004). About 62 million people, including 6 million children are at risk in India from dental, skeletal, and non-skeletal endemic fluorosis (Carton, 2006). Although the primary etiological factor for causing fluorosis is undoubtedly consumption of water containing large amount of fluoride (Das and Wahabs 1995; Batra et al, 1995) it is not only source of exposure. Apart from drinking water, food grown in endemic regions also serves as source of F. Consequently, even though F absorption from food isgenerally less than from water, it is not valid to assume the daily F intake of aperson will not exceed a certain standard by controlling only one of the F sources (Zhi and Jinsheng 1989; Kewei, 1999). Determining dietary F intake is therefore useful and important for estimating the retention of F in man. Pathways and patterns of F excretion associated with different intakes of F have been described by various researchers (Kalayc and Somer 2003; Tomori et al, 2004; Siebert and Trautner 1985; De et al, 2008).

As our previous report on physico-chemical analysis of ground water special emphasis on F concentration (Kodate et al, 2016), dental fluorosis (Dhurvey and Marganwar 2013; Marganwar et al, 2013) skeletal fluorosis (Dhawas et al, 2013) and nutritional status and living habit on some villages of Warora tehsil of Chandrapur district of Maharashtra (Dhurvey and Dhawas 2014). Dongergaon village (20^{o} 19’ 40” N and 78^{o} 57’35.7” E) was selected as an appropriate area for conducting this research because people of this village are consuming fluoride contaminated water which content 0.66 to 5mg/l fluoride (Dhawas et al, 2013) and in some areas of Warora tehsil the nutritional status and living habit (Dhurvey and Dhawas 2014) where the fluorosis has been known to be prevalent for some years (Deshmukh et al, 1995; Dev et al, 1995). The total population of Dongergaon is about 1574 with 258 households. Apart from that study, no study of F accumulation in cereals, pulses and vegetables cultivated in the study area have been reported. This research is with the view of

generating a database for F in foodstuff in Dongergaon village of Chandrapur district, Maharashtra, India. The present research was conducted to estimate i)F accumulation in foodstuff grown in the study area, and ii) dietary intake of F among selected people living in the study area.

Materials and Methods

Sampling of Foodstuff: The Chandrapur district of Maharashtra is endemic for fluorosis showing high F levels in drinking water and selection of Dongergaon village was made on the basis of available information from our earlier ground water analysis which shows the high F content in drinking water.

The food samples like cereals and pulses grown in the study area were collected directly from the farmers cultivating them, packed in pre-labeled airtight bags and stored. The samples of vegetables were collected from the field itself, where they were cultivated. Vegetables which were not smeared with wet soil or surface insecticides were taken. These samples were wrapped in tissue paper, labeled and stored in cardboard containers with holes for ventilation. The samples were transported to the laboratory within 24 hrs.

Preparation of Foodstuff: Sufficient quantity of the sample was taken, cleaned thoroughly from stones and infected material, dried without lime suspension for F determinations. The drying and ashing of the samples were done as follows:

The edible portion of the food sample was weighed and dried in an oven at 60^{o} C and dry weight was taken. The procedure was repeated till two constant consecutive weights were obtained. The dried samples were powdered. For estimation of F sufficient quantity of the powered samples had taken into a porcelain crucible which had previously been heated at 600^{o} C and cooled. Placed the crucible on a clay pipe triangle and heated first over a low flame until all the materials were completely charred, heated in a Muffle furnace for about 5 hrs at 600^{o} C, cooled in a desiccator and weighed. To ensure completion of ashing, heat the crucible again and heat in the Muffle furnace for 1 hr, cooled and weighed. Repeat the process until two consecutive weights were the same and the ash almost grayish white in colour.

Estimation of fluoride: The powered and ashed food samples were used for analysis of F content of food samples by Ion selective electrode method (Model No. SA 720) (Raghuramulu et al, 2004).

Estimation of dietary intake: For the estimation of dietary intake of F, total ten families, whose food source was their own cultivated cereals, pulses and vegetables irrigated by local F-contaminated ground, were included for study. Out of a total of 52 family members, only the couple of adults consisting of ten males and ten female in the age group of 25-30 years and 30-45 years respectively, were selected for the estimation of F intake through their diet.

Results and Discussion

Fluoride accumulation in foodstuff: F values in cereals, pulses and vegetables are presented in Table 1. A F content was found different for foodstuffs. The maximum 16.60 ± 0.3633 mg/kg mean values of fluoride observed from food sample of red chilly followed byred gram dal (16.10 mg/kg), sorghum (9.20 mg/kg), wheat (7.40 mg/kg), soybean (7.10 mg/kg), tomato (5.80 mg/kg), brinjal (5.70 mg/kg), and Bengal gram (2.5 mg/kg) respectively. Fluoride rich soil and water are the responsible factors for elevated level of fluoride in food and earlier investigations also found increased F enrichment in food items of fluoride endemic areas (Gupta and Banerjee 2009; Gautam et al, 2010; Ghosh, 2010).

Dietary intake of fluoride: Over 90% of the people affected with severe fluorosis belong to the low socio-economic status and they have generalized nutritional deficiencies.[29] In the study area villagers are mostly illiterate and socio-economically backward and poor in the society, majority of the adults involves in agriculture are either farmers or manual laborers and generally drink more water, thereby maximizing their F intake than conventional intake. Here it was found that each of the selected adult family members required an average of 1000 g of meal ingredient (roti+rice+dal), 500 g of vegetable food, and, 5 L of water per day.Moreover, the study area has a tropical climate, which contributes to high intake of F from water as

well as food.The substance like black tea and tobacco contain elevated level of F that are additional sources of F which would enhance the body burden F in already affected people (Teotia, 2011; Bilbeissi et al, 1988; Singh et al, 1993; Michael et al, 1996; Kubakaddi et al, 2005; Malde et al, 2006). The common beverage consumed in the study area is black tea and some has also involved in chewing of tobacco.The proportion of F from such pathways, to the total daily intake of F is very small, so these sources can be neglected in the calculation of the total daily F intake.

Due to poor socio-economic condition people of the study area used locally grown food grains like wheat, sorghum in the form of roti and sorghum gruel with either chilly chutney or locally grown vegetables like brinjal and tomato. The meal ingredient is of mixed type which content rice/gruel, roti and dalwith a total F content of 7.40 to 16.10mg/kg. The average F concentration in vegetables (tomato and brinjal) is 5.75mg/kg, and the average level of F in the drinking water, asnoted earlier, is 3.63 mg/L. The calculated results for the above entities are shown in Table 2.

The total intake of F through cereals, pulses, vegetables, and drinking water is estimated to be24.89 mg/day which account for 4.15 (16.67%),1.16(4.66%) and1.43 (5.74%) of the total F amount, respectively(Table 3).Therefore, F indrinking water was not the only source of F intake, but some amount of F came from foodstuff. The sum of the total percentage from the latter is 27.07%(16.67%+4.66%+5.74%), which is approximately one third of 72.92% intake from the water. The food grown in fluoridated water contained higher fluoride content. Our finding that, in general, the foods grown in fluorotic areas have higher F than those grown in normal area are in agreement with the observation (Anerman, 1973).

Table 1. Total F content in cereals, pulses and vegetables[a](n=10[b]) in Dongergaon

Cereals/pulses/vegetables	F (mg/kg)
Wheat	7.40 ± 0.0605
Sorghum	9.20 ± 0.2160
Red gram	16.10 ± 0.3122
Soybean	7.10 ± 0.0684
Bengal gram	2.5 ± 0.0656
Red chilly	16.60 ± 0.3633
Brinjal	5.70 ± 0.0464
Tomato	5.80 ± 0.0380

[a]Data are mean±SD. [b]n=10 meaning each sample was analyzed in parallel 10 times. The average value and standard deviation were calculated in terms of the dry mass of foodstuff.

Table 2. F content in and estimate intake from cereals, pulses, vegetables and drinking water in Dongergaon

Food stuff	Cereals/pulses/ vegetables	Estimated intake (g/day)	F concentration (mg/kg)	F intake (mg/ day)
Cereals	Wheat	500	7.40	3.7
	Sorghum	500	9.20	4.6
`Pulses	Red gram	100	16.10	1.61
	Soybean	100	7.10	0.71
Vegetables	Brinjal	400	5.70	2.28
	Tomato	100	5.80	0.58
Water		5 L	3.63(mg/L)	18.15

Table 3. F intake (%) among 20 adults in Dongergaon

Attribute	Cereals[a]	Pulses[a]	Vegetables[a]	Water	Sum
Uptake amount	500g	100g	500g	5L	
F concentration (mg/kg)	8.3	11.6	5.75	3.63	
F intake (mg/day)	4.15	1.16	1.43	18.15	24.89
Percentage of F intake	16.67	4.66	5.74	72.92	

[a]Average F content of the foodstuff (Table 2) commonly consumed in the diet.

Conclusion

After evaluating the data of the present study it was observed that F not only enters through water but also with foodstuff grown in endemic area which is might be responsible for the severity of fluorosis. The currently available techniques for defluoridation of water should be effectively applied in study area with constant monitoring, there is an urgent need for defluoridation of water used for drinking and it is therefore veryimportant, if possible, not to irrigate crops with F-contaminated irrigation water.

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References

1. Anerman, E. (1973). Fluoride uptake in humans. Fluoride, 6:78-83.
2. Batra, J., Vispute, J.B., Deshmukh, A.N., Vali, S. (1995). Contribution from rock, soil and ground water to fluoride content of foodstuffs grown in some selected villages of Bhadrawati Tehsil, Chandrapur District (M.S.). Gond Goel Mag, 9:81-90.
3. Bilbeissi, M.W., Fraysee, C., Mitre, D., Kerebel, M., Kerebel, B. (1988). Dental fluorosis in relation to tea drinking in Jordan. Fluoride, 21:121-126.
4. Binbin, W., Baoshan, Z., Cheng, Z., Xiaojing, L., Ning, A. (2004). Research on relationship between fluoride in tap water and that in urine of Chinese residents. Chinese J Geochem, 23:373-9.
5. Carton, R.J. (2006). Review of the 2006 United States National Research Council Report: Fluoride in drinking water. Fluoride, 39:163-72.
6. Chen, Y.X., Lin, M.Q., Xiao, Y.D., Gan, W.M., Min, D, Chen, C. (1997). Nutrition survey in dental fluorosis afflicted areas. Fluoride, 30:77-80.
7. Choubisa, S.L. (2001). Endemic Fluorosis in Southern Rajasthan, India. Fluoride, 34:61-70.
8. Choubisa, S.L. (2001). Endemic fluorosis in southern Rajasthan, India. Fluoride, 34:61-70.
9. Das, P.K., Wahabs, S.N. (1995). A study of prevalence and some epidemiological factor related to fluorosis in two villages in Chandrapur city. Gond Geol Mag, 9:113-137.
10. De, L., Daishe, W.U., Ping, L., Tengsheng, W., Chengguang, C., Wuyi, W., et al. (2008). Influence of high fluorine environmental background on crops and human health in hot spring-type fluorosisdiseased areas. Chinese J Geochem, 27:335-41.
11. Deshmukh, A.N., Wadaskar, P.M., Malpe, D.B. (1995). Fluorine in environment: A review. Gond Geo Mag, 9:1-20.
12. Dev Burman, G.K., Singh, B., Khatri, P. (1995). Fluoride in environment: Hydrogeochemical studies of groundwater having high fluoride contents in Chandrapur district. Gond Geol Mag, 9:71-80.
13. Dhawas, S., Dhurvey, V., Kodate, J., Urkude, R. (2013). An epidemiological study of skeletal fluorosis in some villages of Chandrapur district, Maharashtra, India. JERAD, 7:1679-1683.
14. Dhurvey, V., Dhawas, S. (2014). Skeletal Fluorosis in relation to drinking water, nutritional status and living habits in rural areas of Maharashtra, India. IOSR-JESTFT, 8(1): 63-67.
15. Dhurvey, V., Marganwar, R. (2013). Prevalence and severity of dental fluorosis among school students in Dongargaon of Chandrapur district, Maharashtra, India. J Environ Res Develop, 8(2):309-314.
16. Gautam, R., Bhardwaj, N., Saini, Y. (2010). Fluoride accumulation by vegetables and crops grown in Nawa tehsil of Nagpur district (Rajasthan, India). J phytol, 2(2):80-85.
17. Ghosh, D. (2010). Study of fluoride geochemistry and its exposure assessment among the villagers of Junitpur, Birbhum [dissertation]. Bardhaman, West Bengal, India: The University of Burdwan..

18. Goswami, S. (2004). Studies on removal of fluoride by hydrated zirconium oxide (HZO). Chem Env Res, 13(1-2):117-126.
19. Gupta, S., Banerjee, S. (2009). Fluoride accumulation in paddy (Oryzasativa) irrigated with fluoride contaminated groundwater in an endemic area of the Birbhum district, West Bengal. Fluoride, 42:224-7.
20. Kalayc, S., Somer, G. (2003). Factors affecting the extraction of fluoride from tea: application to three tea samples. Fluoride, 36:267-70.
21. Kewei, F. (1999). The progress of quantitative epidemiologic study of endemic fluorosis. Chinese J ContEndem Dis, 14:353-56.
22. Kodate, J., Marganwar, R., Dhurvey, V., Dhawas, S., Urkude, R. (2016). Assessment of groundwater quality with special emphasis on fluoride contamination in some villages of Chandrapur district of Maharashtra, India. IOSR-JESTFT, 10(3):15-26.
23. Kubakaddi, A., Bharati, P., Kasturiba, B. (2005). Effect of fluoride rich food adjuncts and prevalence of fluorosis. J Hum Ecol, 5(17):43-45.
24. Malde, M.K., Greiner-Simonsen, R., Jalshamn, K., Bjorvatn, K. (2006). Tea leaves may release or absorb fluoride depending on the fluoride content of water. Sci total environ, 366:915-917.
25. Marganwar, R., Dhurvey, V., Kodate, J., Urkude, R. (2013). Fluoride distribution in drinking water and dental fluorosis in children residing in Chandrapur District of Maharashtra. Int J of Life Sciences, 1(3): 202-206.
26. Michael, M., Barot, V.V., Chinoy, N.J. (1996). Investigations of soft tissue functions in fluorotic individuals of north Gujarat. Fluoride, 29(2):63-71.
27. Raghuramulu, R., Nair, K.M., Kalyanasundaram, S. (2004). A manual of laboratory techniques. National Institute of Nutrition, 136-146.
28. Siebert, G., Trautner, K. (1985). Fluoride content of selected human food, pet food and related materials. Z Ernahrungswiss (Eur J Nutr), 24:54-66.
29. Singh, V., Gupta, M.K., Rajwanshi P., Srivastava, S., Das, S. (1993). Studies on ingestion of fluoride through tobacco, pan masala and tooth paste. Ind J Environ Health, 35:215-220.
30. Srikanth, R., Vishwanath, K.S., Khasai, F., Fitsahatsion, A., Asmallash, M. (2002). Fluoride in groundwater in selected villages in Eritrea. Environ Monit Assess, 75:169-77.
31. Teotia, S.P.S. (2011). Environmental fluoride and metabolic bone disease, an epidemiological study (Fluoride and nutrient interaction). Fluoride, 17:37-41.
32. Teotia, S.P.S., Teotia, M. (1984). Endemic fluorosis in India: a challenging national health problem. J Assoc Physicians of India, 32:347-52.
33. Tomori, T., Koga, H., Maki,Y., Takaesu, Y. (2004). Fluoride analysis of foods for infant and estimation of daily fluoride intake. Bull Tokyo Dental College, 45:19-32.
34. Yang, C.Y., Cheng, M.F., Tsai, S.S., Hung, C.F. (2000). Fluoride in drinking water and cancer mortality in Taiwan. Environ Res, 82(3):189-93.
35. Zhi, C., Jinsheng, S. (1989). The quantitative epidemiologic study of endemic fluorosis. Chinese J Cont Endem Dis, 4:18-21.