ROLE OF TEA DRINKING AND CALCIUM RICH FOOD ON DENTAL FLUOROTIC PATIENTS: A CASE STUDY

Abstract

Habitual consumption of large volume of poor quality tea for 4/5 times is very common among the rural population of Assam. This region lies within the geographical fluoride belt and fluoride occurs as minor constituent of ground water in all categories of hydro-geological settings. Tea plants absorb higher amount of fluoride from soil and therefore chronic toxic levels of fluoride consumption from tea beverages are possible. A study was carried out to find out the relationship between prevalence of fluorosis among the populations of tea garden belt villages of Assam and fluoride ion concentration in drinking water as well as in tea beverages. Calcium tablets and calcium rich food (banana) was supplied to five severely affected fluorotic patients for one month daily in the morning. Fluoride ion in urine (morning) was estimated before and after treatment with calcium foods. Pre-treatment urine fluoride content was recorded higher for adults than children and the controlled samples. Whereas, post-treatment was found higher in child patient than the adults. High positive correlation ($p < 0.001$) was found between fluoride concentration in water and urine, and tea drinks and urine. Study revealed that continuous intake of calcium rich food can help in minimum incorporation of fluoride.

Keywords: Tea, dental fluorosis, urine fluoride, calcium food

Author

Bhupen Kumar Baruah
Assistant Professor
Department of Chemistry
JB College
Jorhat, Assam, India
b.k.baruah2000@gmail.com

I. INTRODUCTION

Fluorosis becomes an important public health related problem in many parts of the world including Assam. Fluorosis is an endemic disease resulting from excess intake of fluoride ion either through drinking water or food at concentration of 1.5 mg/L or above (**Yadawe et al., 2010).** It is characterized by dental mottling and skeletal manifestations such as crippling deformities and osteoporosis. Fluoride ion in groundwater is governed by the climate, fluoride bearing rocks and hydrogeology of the region (Gupta et al., 2006). The fluoride content in groundwater is a function of many factors such as availability and solubility of fluoride minerals, velocity of flowing water, temperature, pH, concentration of calcium and bicarbonate ions in water etc. (**Meenakshi et al., 2004**). The primary etiological factors for dental and skeletal fluorosis are consumption of large amount of fluoride containing drinking water, ingestion of food exposed to coal smoke and phosphate fertilizers (**Bilbessi, 1988; Karthikeyan et al., 1994)**. However, it has been seldom reported that continuous consumption of certain items such as tea, betel nut, tobacco etc. leads to fluorosis (**Liang, 1993; Cao et al., 2005; Kubakaddi et al., 2005; Yi and Cao, 2008**).

Tea as a beverage is an infusion of the leaves of the tea plant Camellia sinensis var. assamica belong to genus Camellia and family Theaceae. Now a days, tea is the most widely consumed beverage in the world for its health benefits, particularly with respect to its potential for preventing and treating cancer, cardiovascular diseases etc. (**Li and Ni, 2009, Zhang et al., 2009).**

Recent reports of dental and skeletal fluorosis are available in China, USA, UK, Pakistan and India who had drank tea for a long periods and never lived where water contained by fluoride. **Cao et al., (1996a)** reported after large epidemiological observations in Tibet, Mongolia and western part of China that long term consumption of brick-tea initially affects the developing teeth, leading to dental fluorosis. Bilbessi reported that the severity of dental fluorosis in Jordanian children might be associated with the excessive tea drinking (**Bilbessi, 1988**). Spinal osteosclerosis and cortical elephantiasis also reported due to long-term intake of large quantities of instant tea (**Whyte et al., 2008**). Studies also reported that fluorosis patients become normal after stopping drinking tea and regular intake of calcium rich foods (**Cao et al., 2005; Yi and Cao, 2008**). Poor nutrition and diet deficient in their content of calcium, magnesium and vitamin-C intensify fluoride toxicity in India (**Mishra et al., 1992; Gupta et al., 1997**). Consumption of calcium rich dietary products is one of the most important entities to combat the ill effects of fluoride poisoning in our body (**Gupta et al., 1994).** For proper growth, average daily intake range of calcium around 230-430 mg for adults and 800-1000 mg for growing children. High intake of calcium reduces the amount of fluoride absorbed into the bones (**WHO, 1984**).

It is well established fact that tea plant selectively absorbed aluminium and fluoride ions from acidic soil and transformed it to AlF_x compounds and accumulated in tea leaves (**Yi and Cao, 2008**). The amount of accumulation of Al and F increases with the increase in age of the tea bush.

Tea is one of the oldest well organized and self regulated industries in Assam, still the premier producing state in India. It is estimates that 40% of tea bushes are over 50 years of

age and 10% are of between 40-50 years. Although fluoride occurs as a minor constituent in all categories of hydro chemical settings of Assam, out break of fluorosis due to tea beverages is not diagnosed properly till now. Their effects on human physiology are poorly understood and few reports are available regarding this aspect of fluoride toxicity. **Baruah et al., (2011)** reported higher prevalence of dental fluorosis among school children in tea garden belts of Golaghat district of Assam even at low content of fluoride ion in drinking water. Therefore, the possibility of fluorine toxicity due to long term consumption of tea cannot be ignored as acidic soil and age old bushes are congenial condition for maximum adsorption of fluoride by tea plants. An attempt was made to study the role of calcium on fluorine toxicity among the fluorotic patients of Assam.

II. MATERIALS AND METHODS

1. **Survey on prevalence of dental fluorosis:** Two hundred individuals (112 male, 88 female) between 8-65 years of age from ten tea garden belts villages in Darrang district of Assam were initially examined. A specially designed standard questionnaire was used for this purpose. From each village 2-3% of the total households were selected. Sample was selected by stratified sampling method. Individual proforma sheets recorded name, age, sex, address, source of drinking water (tube well or ring well), depth of the well, duration of staying in the village, brushing pattern (with toothbrush or without toothbrush), frequency of brushing (once daily or more), type of toothpaste (commercial paste or indigenous household materials), amount of water consumed per day (0-2 litre, 2-4 litre or more than 4 litre), food habits (vegetarian, non-vegetarian or mixed), habit of drinking tea (regular or irregular) and amount of tea per day (0-2 times, 2-4 times or more than 4 times), awareness about fluorosis (known or unknown), habit of tobacco and betel nut chewing, socio-economic status of the family and their lifestyle. The presence and severity of dental fluorosis along with any other dental anomalies observed and recorded. The Dean Index was used to determine the grade of dental fluorosis (**Dean, 1934; Dean and Elvolve, 1935**).

2. **Estimation of fluoride concentration in tea drinks:** For determination of fluoride in tea drinks, tea samples were collected from five households of the study area. Fluoride ion concentration were measured with an ion-selective electrode system.

3. **Estimation of fluoride concentration in urine:** After completion of the survey, severely affected three children and two adult fluorotic individuals (8-45 years of age) were selected for urine sample. Urine samples were collected in the early morning before breakfast during 6:00-8:00 AM. Urine samples from two non flurotic patients were also collected as control. Fluoride ion concentration in urine samples were measured with an ion-selective electrode.

4. **Estimation of fluoride concentration in water:** Water samples were also collected from the same households and fluoride ion estimated as per APHA guideline.

5. **Treatment of calcium rich food to fluorotic patients:** A 500 mg of calcium tablet (Shelcal-500; Elder Pharmaceuticals Ltd. Dheradun, India) and one banana was supplied to all patients and the controlled samples in the morning daily for one month. After one

month, urine samples were collected again from the patients as well as from the controlled and analysed.

III. RESULTS

1. **Characteristics of survey samples:** Out of 200 samples selected for the study, 112 were male and 88 female, including 95 children and 105 adults. All the participants were belonged to socio-economically backward strata and 65% were illiterate and unaware of the importance of good nutrition and balanced diet. Majority of the respondents were tea garden worker and main occupation of the rest was agriculture. All of the respondents had a habit of drinking tea, 86.17% of adults had habit of tobacco and betel nut chewing.

   Majority of the respondents had a habit of taking mixed diet, more than four times tea consumed in a day and unknown about fluorosis. Respondents having no toothbrush were recorded 42.67% and they use indigenous materials like charcoal, neem stick, jatrofa stick etc. as toothpaste.

2. **Prevalence of dental fluorosis:** Survey on dental fluorosis showed that out of 200 samples 58.5% (117) were free from dental fluorosis and 41.5% (83) were suffering from clinical sign of fluorosis from questionable to severe range. Using Six Points Scale Deans Fluorosis Index (Dean, 1934) prevalence of dental fluorosis was recorded as questionable - 24.09% (20), very mild - 31.32% (26), mild - 13.25% (11), moderate - 19.3% (16) and severe -12.04% (10) (Fig. 6.1). Out of 72 fluorotic patients 45 were male (child-28; adult-17) and 27 (child- 19; adult-8) female.

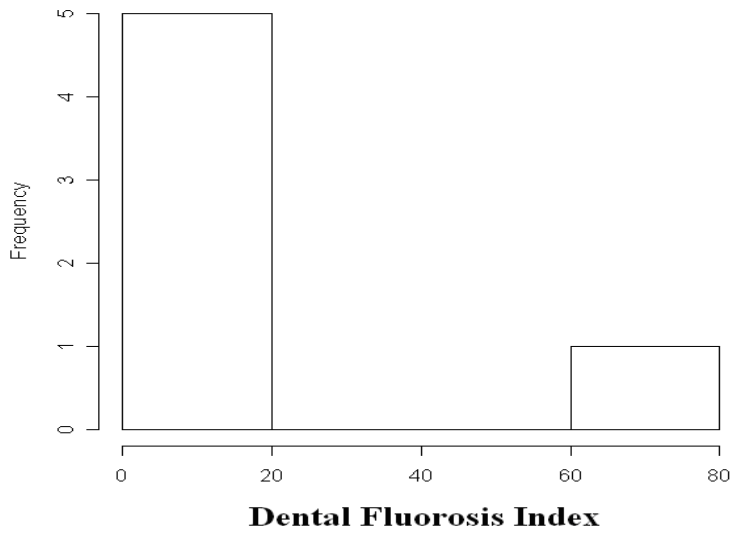

Figure 1: Prevalence of dental fluorosis among the population during the study

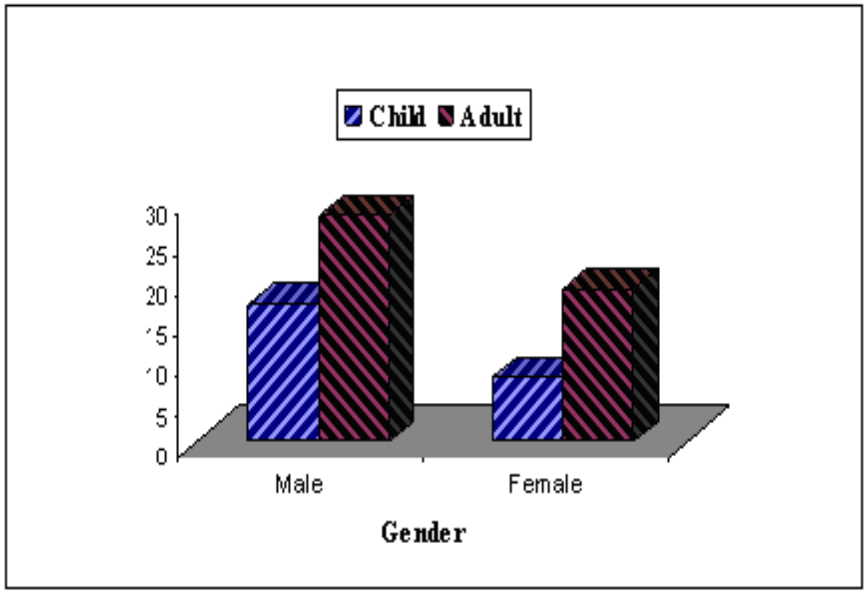

Figure 2: Gender wise distribution of fluoritic patients during the study

3. **Fluoride concentration in tea drinks:** Fluoride content in drinking water samples (N=10) collected from the domestic sources of that patients' household were estimated and found in the range of 0.97-2.13 mg/L (Table 1). Fluoride content reported in the present study was found to be much higher than the WHO permissible limit. Calculated mean value of water fluoride (2.19 □ 0.94) was almost two fold higher than the tea drink fluoride (1.17 □ 0.46).

Tea Fluoride (N=10)		**Water Fluoride (N=10)**	
Range	Mean ± SD	Range	Mean ± SD
0.97-2.13	1.69 ± 0.46	0.96 - 3.38	2.19 ± 0.94

Table 1: Fluoride level in water and tea samples (mg/L)

4. **Fluoride concentration in urine samples:** The concentration of urinary fluorine of adults and children were significantly different. The range of fluoride content in urine before dietary calcium food treatment and after treatment on adults and children were reported in Table 2 and Table 3.

Parameter	**Urine volume (ml)**	**Range**	**Mean ± SD**
Child (N=9)	117 ± 8	1.09 - 1.29	1.19 ± 0.26
Adult (N=6)	176 ± 16	1.07 - 1.94	1.53 ± 0.41
Control(N=6)	121 ± 13	0.76 - 1.07	0.84 ± 0.18

Table 2: Pre-treatment descriptive statistics of urinary fluoride (mg/L) of the study samples

Parameter	Urine volume (ml)	Range	Mean ± SD
Child (N=9)	117 ± 8	1.17 - 2.13	1.90 ± 0.91
Adult (N=6)	176 ± 16	1.12 - 2.08	1.54 ± 0.12
Controlled (N=6)	121 ± 13	0.78 - 1.09	0.56 ± 0.24

Table 3: Post-treatment descriptive statistics of urinary fluoride (mg/L) of the study samples

Results revealed that fluoride ion excretion rate was higher in adults than the children. Urine fluorides in controlled samples were below the range of the both type of fluorotic patients. Urinary fluoride after the treatment of calcium rich foods showed a good improvement in fluoride ion concentration. Study revealed that urine fluoride content for both adult and children after the treatment of calcium food was found to be higher than the pre-treatment amount. On the other hand, urinary fluoride concentrations for controlled samples before and after treatment of calcium food were found to be almost equal.

The highest positive correlation ($r = 0.773$, $p < 0.001$) was found between the fluoride levels in drinking water and urine. Also, there was a high positive correlation ($r = 0.681$, $p < 0.001$) between the fluoride levels in tea drinks and urine of the fluorotic patients investigated. The results of this study seemed to indicate that increased fluoride intake through either water or tea drinks increases the fluoride levels in urine.

Comparison	r	p
Water / Urine	0.773	0.007
Tea / Urine	0.681	0.006

Table 4: Correlation analysis of urine fluoride content with water and tea fluoride

IV. DISCUSSION AND CONCLUSIONS

Results of the present study suggested that fluoridating water pushes the majority of inhabitants of the study area into excessive fluoride intake. The experimental data on fluoride content in drinking water as well as tea drink strongly suggests that the extent and danger of public exposure to fluoride have been seriously underestimated by the inhabitants of the study area. Urinary fluorine is considered as a fluorine load in human body (Mansfield, 2010). In the present study urine fluoride content after treatment of calcium reach food in both adult and the children was found to be higher than the pre-treatment. It may be attributed that after treatment of calcium food fluorotic patients obtained the balance calcium diet and excess fluoride through water and tea automatically eliminated by the kidney as urine fluoride. Due to presence of optimum amount of calcium through diet reduced the rate of adsorption of fluoride ion from alimentary tract resulting low deposition of fluoride on bone and teeth (WHO, 1984; National Research Council, 1993).

The manifestation of fluorosis in the study area might not only due to high fluoride containing water and the habitual consumption of tea but also low calcium rich diet.

Although tea is the main drink in Assam, fluorine standard in tea commodities is lacking here and contribution to prevalence of fluorosis might be significant. A surveillance program should begin urgently in the study area to relate the total fluoride consumption of individuals to their health experience.

REFERENCES

[1] APHA, AWWA and WEF. Clesceri LS, Greenberg AE, Eaton AD. (Eds.), **(1998)**. Standard Methods for the Examination of Water and Waste Water, 20th Ed., American Public Health Association, Washington DC.

[2] Baruah BK, Haque A, Das B, Misra K, Medhi C and Misra AK. **(2011)**. Fluoride ion in drinking water and prevalence of dental fluorosis among the population in some tea garden belt villages in Golaghat district of Assam, India. Archives of Applied Science Research, **3(1)**: 175-179.

[3] Bilbessi MW. **(1988).** Dental fluorosis in relation to tea drinking in Jordan. Fluoride, **3**: 120-122.

[4] Cao J, Bai X, Zhao Y, Liu J, Zhou D, Fang S, Jia M and Wu J. **(1996a)**. The relationship of fluorosis and brick tea drinking in Chinese Tibetans, Environmental Health Perspectives**,** 104(12): 1340-1343.

[5] Cao J, Bai X, Zhao Y, Liu J, Zhou D, Fang S, Jia M and Wu J. **(1996b)**. Fluorosis induced by drinking brick tea. Fluoride, **29(3)**: 139-143.

[6] Cao J, Zhao Y and Liu J. **(1997)**. Brick tea consumption as the cause of dental fluorosis among children from Mongol, Kazak and Yugu Populations in China. Food Chem. Toxicol., **35(8)**: 827-833.

[7] Cao J, Liu J, Tang T, Sangbu D, Yu S, Zhou S, Yu Y and Que H. **(2005).** Dental and early stage skeletal fluorosis in children's induced by fluoride in break-tea. Fluoride**, 38(1)**: 44- 47.

[8] Dean HT. **(1934)**. Classifications of mottled enamel diagnosis. J. American Dental Association, **21**: 1421-1427.

[9] Dean TH and Elvolve E. **(1935)**. Studies on minimal threshold of the dental sign of chronic endemic fluorosis (mottled enamel). Public Health Rep., **50**: 1719-1729.

[10] Gupta SK, Gupta RC, Seth AK and Gupta A. **(1994)**. Reversal of clinical and dental fluorosis. Indian Pediatrics, **31**: 439-443.

[11] Gupta SK, Gupta RC, Seth AK and Gupta A. **(1997)**. Reversal of fluorosis in children. Fluoride, **30(1)**: 68-69.

[12] Karthikeyan G., Pius A, Apparao BV. **(1994)**. Levels of fluoride and several other parameters in drinking water sources of certain fluorotic and non fluorotic areas of Taminadu, South India. In: Proceedings of the XX th Conference of the International Society for Fluoride Research, Beijing, China. Beijing: Ministry of Public Health of People's Republic of China, 109-110.

[13] Kubakaddi A, Bharati P and Kasturiba B. **(2005)**. Effect of fluoride rich food adjuncts and prevalence of fluorosis. J. Hum. Ecol., **17(1)**: 43-45.

[14] Li C and Ni D. **(2009)**. Effect of fluoride on chemical constituents of tea leaves. Fluoride, **42(3)**: 237-243.

[15] Liang CK. **(1993)**. Total intake of fluorine and the dose-response relationship of fluorosis in coal-fluorosis area. Hygienic Research, **3**: 7-12.

[16] Meenakshi, Garg VK, Kavita, Renuka and Malik A. **(2004)**. Groundwater quality in some villages of Haryana, India: Focus on fluoride and fluorosis. J. Hazard. Mater., **106B**: 85-97.

[17] Mishra UK, Gujral RB, Sharma VP and Bhargava SK, **(1992)**. Association of vitamin D

deficiency with endemic fluorosis in India. Fluoride, **25**: 65-70.

[18] Report of the Subcommittee on the 10th Edition of the RDAs Food and Nutrition Board Commission on Life Sciences, National Research Council. RDAs: Fluoride. Washington: National Academy Press, **1993**; 235-240.

[19] Whyte MP, Totty WG, Lim VT and Whitford GM. **(2008)**. Skeletal Fluorosis from instant tea: Case report. J. Bone and Mineral Research, **23(5)**: 759-769.

[20] WHO, **(1984)**. Fluorine and Fluoride, World Health Organization, Geneva, Switzerland (Environmental Health Criteria Bulletin-36), 93.

[21] Yadawe MS, Hiremath DM and Patil SA. **(2010)**. Assessment of fluoride content in ground and surface water and its environmental impacts at Basavan-Bagewadi and Muddebihal Taluka of Bijapur district, Karnataka, India. E-Journal of Chemistry, **7(2)**: 641-647.

[22] Yi J and Cao J. **(2008).** Tea and fluorosis. J. Fluorine Chemistry, **129**: 76-81.

[23] Zhang M, Huang J, Xie X, Holman C. **(2009)**. Dietary intakes of mushrooms and green tea combine to reduce the risk of breast cancer in Chinese women. Int J. Cancer, **124(6)**:1404-1408.

