J. Soils and Crops 34 (1) 85-88, June 2024

ISSN 0971-2836 (Print)
ISSN 2582-2756 (Online)

FLUORIDE CONTENT IN FOOD CROPS AND DIETARY INTAKE IN A FLUORIDE - ENDEMIC AREA OF PIJDURA VILLAGE OF WARORA TEHSIL, CHANDRAPUR DISTRICT, MAHARASHTRA

Varsha Dhurvey[1], Firdos Karim[2] and Rashmi Urkude[3]

ABSTRACT

The goal of this study was to determine the fluoride (F) content in the drinking water and crops grown in the Pijdura village in Warora tehsil, district Chandrapur of Maharashtra state and dietary F intake of selected adult individuals of residing area during the year 2018. Crop samples like Wheat, Sorghum, Soybean, Red gram, Bengal gram, Tomato and Brinjal cultivated in the village area were gathered and the crop's edible portion was weighed, dried and ashed. The fluoride content of food crop and drinking water was determined by the ion selective electrode method using the powered and ashed crop samples.Twenty adult males and females were chosen for the estimation of F intake from their food which was their self-cultivated crops (Wheat, Sorghum, Soybean, Red gram, Bengal gram, Tomato and Brinjal)watered by local fluoridated ground water. Result exhibited that the F content was determined to vary in the gathered crop samples and drinking water. An examination of the diets of twenty adults was chosen and drinking water was found to have 73.02%, cereals (Wheat and Sorghum) 15.27%, 4.66% pulses (Soybean, Red gram and Bengal gram) and vegetables(Tomato and Brinjal)5.74% to the overall mean intake of F.Upon analyzing current data of this study it was concluded that F not merely enter via drinking water however with food crops cultivated in endemic area which might be responsible for these verity of fluorosis. Thus, recent techniques for water defluoridation should be implemented properly in the research area with continuous checking.

(Key words : Fluoride, crop, drinking water, pijdura, chandrapur, Maharashtra)

INTRODUCTION

Fluoride (F) is the 13th most abundant element existing in the natural environment (Tian *et al*., 2021) and one of the 12th most hazardous elements in the biosphere (Kimambo *et al*., 2019; Toolabi *et al*., 2020). Fluoride overexposure leading to endemic fluorosis is an issue with public health in India due to chronic intoxication of F (Yang *et al.,* 2000; Choubisa, 2001; Srikanth *et al.,* 2002; Binbin *et al.,* 2004). People in around 22,400 villages spread across 196 districts and 19 states in India are consuming F-contaminated water, which is more than the WHO-recommended maximum permissible value 1.5 ppm (Goswami, 2004). Approximately 62 million individuals in India are at risk, six million of them are children for endemic dental, non-skeletal and skeletal fluorosis (Carton, 2006). Water of poor quality, such as sewage and other waste water, is used to supplement irrigation demands, especially in peri-urban regions, as excellent quality water becomes increasingly rare for agriculture (Raut *et al.,* 2018). Drinking water with high fluoride content is undoubtedly the primary cause of fluorosis development (Batra *et al.,* 1995), although exposure does not come from this source alone. In addition to drinking water, food crops cultivated in F endemic area also become a source of F. Although, F absorption from food generally less than drinking water, by limiting one of the F sources, it is invalid to assume that a person's daily intake of F won't exceed a particular limit (Kewei, 1999). To estimate the retention of F in humans, it is necessary and valuable to find dietary F consumption. Many researchers have documented the pattern and pathways of F excretion related with varying F intake (Tomori *et al.,* 2004; 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 tehsil Warora in Chandrapur district of Maharashtra (Dhurvey and Dhawas, 2014). Pijdura village been chosen as a suitable area for this study because the residents of this village drink water polluted with fluoride which contain 0.66 to 5 mg l^{-1} fluoride (Dhawas *et al.,* 2013). Moreover, it was noted that fluorosis

1. Professor and Head, Dept. of Zoology, RTM Nagpur University, Nagpur
2. Asstt. Professor, Dept. of Zoology, Kamla Nehru Mahavidyalaya, Nagpur
3. Professor, Dept. of Chemistry, Shivaji Science College, Nagpur

has been recognized to be common in some Warora tehsil areas due to the nutritional quality and way of life in those areas (Dev *et al.,* 1995). The total population of Pijdura village is about 1082. Other than this study, no other research on F accumulation in vegetables and crops grown in the study area has been published. The goal of this study is to create a database for F in food crops in Pijdura village of Chandrapur district, Maharashtra, India. The current study was carried out to determine F content in food crops that are cultivated in the research area and dietary F intake among chosen individuals residing in the research area.

MATERIALS AND METHODS

Sampling of food crop: The crop samples like Wheat, Sorghum, Soybean, Red gram, Bengal gram, Tomato and Brinjal cultivated in the research area were collected during year 2018 directly from the farmers cultivating them, packed in pre-labeled airtight bags and stored. The samples were transported to the laboratory within 24 hrs.

Preparation of ashed crop sample: A sufficient quantity of the crop sample was taken, properly cleaned from any stones and contaminated material and dried without the use of lime suspension in order to determine F content. The drying and ashing of the samples were done as follows:

The edible part of the food crop sample was weighed and dried in an oven at 60^o C and dry weight was measured. The process was carried out till two constant successive weights were obtained. The dried samples were powdered. For estimation of F content sufficient quantity of the powered samples had taken into a porcelain crucible that has been cooled after being heated to 600 degrees Celsius. After placing the crucible on a clay pipe triangle, it was heated on low flame until all the materials were totally burnt, heated in a Muffle furnace for about 5 hrs at 600^o C, cooled in a desiccator then weighed. Reheat the crucible in the muffle furnace for one hour and then let it cool and weigh it to confirm that the ashing has been completed. Repeat the process till two successive weights were similar and the ash almost grayish white in color.

Fluoride estimation: The F content of the crop samples was determined by the ion selective electrode method using the powered and ashed crop samples (Model No. SA 720) (Raghuramulu *et al.,* 2004).

Dietary F intake estimation: Ten families in total, whose food crops were self-cultivated and supplied with local ground water containing F, were chosen for this study in order to estimate their dietary F intake. Only the adults in the age range between 25-35 years, twenty males and females, were chosen from a total of 52 family members to estimate their F intake through food.

RESULTS AND DISCUSSION

Fluoride content in food crops: The data regarding F content in crops and drinking water are presented in Table 1. F content was found different for different food crops. The maximum 15.96 ± 0.3221 mg kg^{-1} mean values of fluoride content was observed from food crop red gram followed by sorghum (09.10 ± 0.1960 mg kg^{-1}), wheat (07.30 ± 0.0595 mg kg^{-1}), soybean (07.20 ± 0.0634 mg kg^{-1}), brinjal (05.90 ± 0.0382 mg kg^{-1}), tomato (05.50 ± 0.0299 mg kg^{-1}) and bengal gram (02.70 ± 0.0596 mg kg^{-1}) respectively. Fluoride rich soil and water are the responsible elements for increased level of fluoride content in food and previous studies found higher F content in foods from fluoride-endemic regions (Gupta and Banerjee, 2009, Gautam *et al.,* 2010; Ghosh, 2010).

Dietary intake of fluoride: More than 90% of individuals suffering with fluorosis belong to financially weaker section and have general nutritional deficits. In the study area people are mostly illiterate and socio-economically backward and poor, most of the people involves in farming are either farmers or manual workers and usually consume more water, thus maximizing their F intake than conventional intake. It was found that all chosen adult male and female needed approximately 5 liters of water, 500 g of vegetable food and 1000 g of meal ingredients (roti, rice and dal) every day. In addition, the study area experiences a significant intake of F from food and drinking water because to its tropical climate. Owing to their low socioeconomic status, the residents of the area of study consumed locally grown vegetables like tomato and brinjal as well as locally cultivated cereals like wheat and sorghum as gruel/roti. The meal ingredient is of mixed type which content rice, gruel, roti and dal with a total F content of 7.30 to15.96 mg kg^{-1}. The average F found in vegetables (tomato and brinjal) was 2.28 mg kg^{-1} and F content in the drinking water was 19.6 mg l^{-1}. Table 2 illustrates the calculated results for each of the entities mentioned above.

The total quantity of F consumed via cereals, vegetables, pulses and drinking water was calculated as 26.84 mg day^{-1} which account for cereals (Wheat/Sorghum) 4.1 mg day^{-1} (15.27%), Pulses (Soybean/ Red gram/ Bengal gram) 0.86 mg day^{-1} (3.2%) and Vegetables (Tomato/ Brinjal) 2.28 mg day^{-1} (8.49%) of the total F content (Table 3).Thus, fluoridated drinking water was not the single source of F intake, but some amount of F come from foodstuff. The total percentage added up from the crop was 26.96% (15.27%+3.2%+8.49%), which was approximately one third of 73.02% intake from the water. The food crop irrigated with fluoridated water increased level of fluoride. Above results suggest that food crops cultivated in fluoridated areas mostly have increased level of fluoride than foods cultivated in ordinary areas are in agreement with the results of De *et al*. (2021) .

Table 1. F content in food crops and drinking water

Crops	Crops/ drinking water	F(mg kg^{-1})
Cereals	Sorghum	09.10±0.1960
	Wheat	07.30±0.0595
Pulses	Soybean	07.20±0.0634
	Red gram	15.96±0.3221
	Bengal gram	02.70 ±0.0596
Vegetables	Tomato	05.50±0.0299
	Brinjal	05.90±0.0382
	Drinking water	03.92±0.0382 (mg l^{-1})

Table 2. F content and intake in food crops and drinking water of Pijdura village

Crops	Crop/drinking water	food intake (g day^{-1})	Fcontent (mg kg^{-1})	Fintake (mg day^{-1})
Cereals	Sorghum	500	9.10±0.1960	4.55
	Wheat	500	7.30±0.0595	3.65
Pulses	Soybean	100	7.20±0.0634	0.72
	Red gram	100	15.96±0.3221	1.59
	Bengalgram	100	2.7 ±0.0596	0.27
Vegetables	Tomato	100	5.50±0.0299	0.55
	Brinjal	300	5.90±0.0382	1.77
	Drinking water	5 ℓ	3.92±0.0382 (mg l^{-1})	19.6

Table 3. Fintake (%) in individuals of Pijdura village

Attribute	Cereals (Wheat/ Sorghum)	Pulses (Soybean/ Red gram/ Bengal gram)	Vegetables (Tomato/ Brinjal)	Water	Total F intake (mg day^{-1})
Uptake amount	500 g	100 g	400 g	5l	
Fcontent (mg kg^{-1})	8.2	8.62	5.70	3.92	
Fintake (mg day^{-1})	4.1	0.86	2.28	19.6	26.84
Percentage of F Intake	15.27	3.20	8.49	73.02	

Upon analyzing current data of this study it was noticed that F not merely enter via drinking water however with food crops cultivated in endemic area which might be responsible for the severity of fluorosis. The presently available techniques for water defluoridation should be implemented properly in the research area with continuous checking. Defluoridation of drinking water is an urgent need of this area and if possible, not to irrigate crops with F-contaminated water.

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Rec. on 15.11.2023 & Acc. on 30.11.2023