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Study of Fluoride concentration in food items and milk samples of selected places of Haryana state

KEYWORDS

Fluoride, crops, vegetables, milk

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ABSTRACT Rural population of India is largely depending on groundwater as a major and preferred source of drinking water. Due to the various ecological, nature and anthropogenic factors, the groundwater is getting increasingly polluted. Fluoride is a major inorganic pollutant of natural origin found is groundwater. Besides, drinking water, crops grown in endemic regions also serve as source of fluoride. Extensive study was carried out in the study area focusing on the fluoride content in crops, vegetables and milk samples. The samples of crops, vegetables and milk were collected from villages having high fluoride content. Fluoride uptake and accumulation studies were also conducted on them in the laboratory. Leafy vegetables like onion and mustard leaves were found to have high fluoride content. In milk, fluoride content was low in all the samples. However, highest concentration was recorded in cow's milk (8.25 g/ml) of Garhi village and lowest concentration in goat's milk (1.23 µg/ml) of Dharan village.

Introduction

Fluorine is an important element for human beings, as it helps in growth and prevents the enamel of the teeth from dissolving under acidic conditions. Various dietary components influence the absorption of fluoride from gastrointestinal tract and the absorbed fluoride is distributed throughout the body.

Drinking water and sea food are good sources of fluoride. Fluoride is beneficial to health if the concentration (CF) of the fluoride ion (F-) in drinking water is less than 1.5 mg/L (WHO, 1994). A higher concentration causes serious health hazards.

Milk typically contains low levels of fluoride, e.g. 0.02 mg/l in human breast milk and 0.02–0.05 mg/l in cow's milk (Murray, 1986). Thus, milk is usually responsible for only a small fraction of total fluoride exposure. Tea leaves contain high levels of fluoride (up to 400 mg/kg dry weight). Fluoride exposure due to the ingestion of tea has been reported to range from 0.04 mg to 2.7 mg per person per day (Murray, 1986 and WHO, 2006). However, some Tibetans have been observed to ingest large amounts of fluoride (e.g. 14 mg per day) due to the consumption of brick tea as a beverage (Cao et al., 1997 and WHO, 2006).

Haryana is one of the fluorosis states in India. Assessment of fluoride in spent wash of the distilleries of Haryana. The spent wash samples were collected from distilleries areas of Haryana. The samples were having fluoride concentration in the range of 1.95 to 2.32 mg/l (Kumari and Kumar, 2013). Fluoride concentration was found to be more than permissible limits at seven locations.

Review of literature

Etesin et al., (2013) conducted surveys of fluoride contents of certain fodder plants like cassava,at aluminium smelting company in IkotAbasi , Nigeria in July , October and November 2010 and July, October and November, 2011 .The fluoride contents of the vegetation obtained in this studywere compared with the back ground fluoride content in vegetation determined elsewhere around the aluminium smelting plant before the commissioning of the plant. Results of this study, revealed that the fluoride contents in vegetation considered were far higher than the background fluoride contents of less than 2 mg/kg. Fluoride content in cassava increased by 200% and in bitter leaf it was increased by 300 % in 2010.Fluoride content in cassava increased by more than 1000%, wire grass increased by 200% in 2011. It was concluded that daily fluoride intake should not exceed 10 mg per person and there is a need to set up biomonitoring of fluoride emissions and control around the smelting plants.

India has been included in list of 20 countries suffering from fluoride and other heavy metal contamination in milk and causing diseases like fluorosis at a large scale (WHO 1991 and WHO 2006). Specially in the rural areas where residual are largely depending on wells for drinking water which is affected by high fluoride concentration (Hussain et al., 2012).

Study area

Rewari district comprises of 2 divisions (Rewari and Kosli), three Tehsils (Rewari, Bawal and Kosli) and one subtehsil (Dharuhera Rewari). Rewari also comprises of one Municipal council, one Municipal committee, Two market committees (Rewari and Kosli) and five development Blocks namely Bawal ,Jautusana , Khol, Nahar and Rewari.

The number of villages are 398 as against 348 gram panchayats, it is about 85 kms far from the nation capital. The district is splitted into two parts namely South East and North West .The North West is attacehd to Rohtak parliamentary consituency while South East part is included into Gurgaon parliamentary constituency. There are 3 assembly constituencies – Rewari, Bawal and Kosli.

Objectives

Therefore, In view of this, the present study is an attempt to assess fluoride contamination on plants and milk sample in the affected area of Rewari district of Haryana with following objectives:

1. To estimate the fluoride content in vegatbles, cereals etc. of fluorosis endemic regions of Bawal.
2. Estimate of fluoride in milk samples of Cattle in the fluoride prone area of the study area.

Sample

Besides, drinking water, crops grown in endemic regions also serve as source of fluoride. Extensive study was carried out in the study area focusing on the fluoride content in crops, vegetables and milk samples. The onset of fluorosis and the severity of the symptoms are governed by chronic fluoride ingestion, the most important being quantity of fluoride ingested and the duration of exposure (Viswanadham and Murty, 1977). The samples of crops, vegetables and milk were collected from villages having high fluoride content. Fluoride uptake and accumulation studies were also conducted on them in the laboratory.

Results

Leafy vegetables like onion and mustard leaves were found to have high fluoride content. Highest fluoride concentration was recorded in onion leaves (14.66-15.55 g/g) of Bolni village; irrigated with groundwater having 4.45 mg/L fluoride concentration (Table 1). In other vegetables also like chilli, potato, spinach and cabbage, Fluoride content was estimated. High content was also recorded in Spinach (12.78 g/g) from Kathuwas village irrigated with water

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having 3.91 mg/L fluoride. In cereals, fluoride content was estimated in wheat and chana. Fluoride content was lower in cereals even irrigated with high fluoride water and highest being in chana (20.55 g/g) samples collected from Nangal ugra village and irrigated with water having 3.76 mg/L fluoride concentration.

Milk of cows, buffaloes and goats were collected from villages where fluoride in water sources was high. In milk, fluoride content was low in all the samples. However, highest concentration was recorded in cow's milk (8.25 g/ml) of Garhi village and lowest concentration in goat's milk (1.23 g/ml) of Dharan village (Table 2).

From the study, it would be inferred that fluoride content in food items varied from place to place, depending on fluoride concentration in irrigation water and soil. It also depended on the fluoride tolerance and accumulation capacity of plant. The main excess fluoride exposure through food to the population is higher in winter season. This is because of more dependence of people on groundwater for irrigation of crops and vegetables, due to lack of sufficient rains.

Table 1: Fluoride Concentration in Raw Food Items in The Study Area

S. No.	Name of Block	No. of Samples Studied	Raw Food Item (s)	Fluoride Content (µg/g) in Food
1.	Rewari	13	Wheat	7.05
			Spinach	12.78
			Cabbage	10.67
			Cauliflower	8.54
2.	Bawal	19	Wheat	7.75
			Lady finger	8.90
			Chana	23.97
			Barley	15.0
3.	Khol At Rewari	15	Chana	20.50
			Onion	14.66
			Mustard leaves	17.55
4.	Jatusana	10	Wheat	8.90
			Fodder	13.33
			Chilli	10.45
			Potato	11.25
5.	Nahar	11	Raddish keaves	6.75
			Onion	15.25
			Wheat	8.45
			Mustard leaves	16.55

Table 2: Fluoride Concentration in Milk Samples in The Study Area

S.No.	Name of Block	No. of Samples Studied	Fluoride in Buffalo Milk (µg/ml)	Fluoride in Cow Milk (µg/ml)	Fluoride in Goat Milk (µg/ml)
1.	REWARI	11	3.33	4.66	1.23
2.	BAWAL	9	3.76	5.05	4.55

Discussion

The migration of Fluoride from localized fluoride rich sources to adjoining top soil layers followed by its uptake by the plants, is a complicated but crucial process of high biological significance as it may decide the ultimate level of dietary intake of fluoride by animals and human populations in the area. Major part of fluoride ingested in areas endemic to fluorosis is through water although some food materials contribute considerable amounts to total intake (Waldbott, 1963; Singh and Ophague, 1979, Nawlakhe, 1981; Gulati *et al.,* 1993 and Singh *et al.,* 1993). The transfer of fluoride from irrigation water and soils to plants depends on the tolerance levels of plants and their bio-accumulative capacities.

Some plants, however, exhibit higher bioaccumulation capacities than the others. Leafy vegetables grown in fluoride endemic areas contain high fluoride content. Jangid (2008) observed fluoride content of 27.22 g/g and 23.10 g/g respectively in spinach (*Spinacea oleracea*) and raddish leaves (*Rephanus sativus*). Gautam (2009) reported that fluoride concentration in spinach (*Spinacea oleracea*) was 25.70 g/g and in Sarso leaves (*Brassica campestris*) was 24.86 g/g, which were irrigated with high fluoride water.

In the present study, highest concentration of fluoride was recorded in leafy vegetables viz. spinach (*Spinacea oleracea*) (29.15 g/g), cabbage (*Brassica Oleracca*) (11.30 g/g) and raddish leaves (*Raphanus sativus*) (12.66 g/g). In general fluoride content of vegetables, cereals and pulses is not high in comparison to some others like tea leaves (Waldbott, 1963).

Some other vegetables also contained high fluoride viz. lady's finger (*Abelmorchus exculentus*) (22.19 g/g), red Chilli (*Capasicum annum*) (7.92 g/g), and in carrot (*Daucus carota*) (1075 g/g).

Cereals viz. wheat, barley and gram irrigated with high fluoride (up to 11.82 mg/L) water, contained low fluoride content. Highest was recorded in wheat (5.98 g/g) irrigated with 3.86 mg/L fluoride water (Brijlalpura, Northern zone). Thus, the percentage contribution of fluoride through cereals was lower in high fluoride Zones of Bawal. In other epidemiological studies, prevalence of *genu valugum* in areas with fluorosis was higher in subjects whose staple food was sorghum (4%) as compared to those whose staple food was rice (1%) (Krishnamachari, 1976).

The fluoride content in the fodder from fluoride endemic regions was found to be quite low. Highest was 2.16 g/g in the fodder from Jagatpura village of North-Western Zone irrigated with 6.00 mg/L fluoride water. Most pasture species do not accumulate large amount of fluoride and absorb only very limited from the soil. However, in studies conducted by Singh (2008), fluoride content in wheat fodder was found to be quite high (11.70 g/g) irrigated with water containing 1.24 mg/L fluoride concentration in groundwater.

Milk is a richest source of calcium which interacts negatively with fluoride. Studies have shown that calcium decrease intestinal absorption of fluoride. Fluoride does not readily pass the mammary barrier and milk products contain less fluoride than soft tissue (Underwood, 1981 and Miller *et al.,* 1991). In the present study, milk samples of cattle from fluoride endemic villages were taken and analyzed in laboratory. The maximum concentration of fluoride was reported in cow's milk (8.25 g/ml) from Garhi village (with sample water F concentration 4.66 – 8.25 mg/L). The present study revealed that the goat's milk showed lowest fluoride concentration. Also, a positive correlation was found between fluoride content in cattle milk and fluoride concentration in drinking water. The results of study conducted by Jain (2006), Singh (2008), Gautam (2009) and Saini (2009) supported the findings of the present investigation.

Conclusion

Fluoride analysis in milk samples of domestic cattle showed that cow milk contained highest fluoride content (8.25 g/ml). It was obtained from Garhi village where fluoride concentration in water was in the range of 3.71-3.91 mg/L. Goat milk was found to contain minimum fluoride (1.23 g/ml). It was obtained from Dharan village with 0.48 mg/L fluoride in drinking water. In general, milk samples from both high and low fluoride areas, accumulated less fluoride.

Samples of cereals, vegetables and fodder were collected from fluorotic belt and analyzed for fluoride content. These crops (mainly Rabi crops) were irrigated with groundwater containing high fluoride. Mustard leaves accumulated highest quality of fluoride (20.50 g/g). It was obtained from Bolni village and was irrigated with groundwater having 4.45 mg/L fluoride concentration. Cereals were found to accumulate less fluoride. Highest fluoride content in cereals was recorded in chana grains of Chanduwas village containing 20.50 g/g fluoride content. It was irrigated with water having 3.91 mg/L fluoride concentration.