FLUORIDE IN FOOD AND WATER CONSUMED IN KOOHBANAN (KUH-E BANAN), IRAN

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SUMMARY: Fluoride (F) levels in samples of grains, protein products, fruits, vegetables, and also in drinking and agricultural waters consumed in Koohbanan (Kuh-e Banan), Kerman Province, Iran, were determined. For food items the hexamethyldisiloxane-facilitated diffusion method was used, followed by analysis with a F ion selective electrode. In foods, the F content varied from a very low level of 0.02 mg/kg to a relatively high level of 8.85 mg/kg, and in water sources it ranged from 2.36 to 3.10 mg/L.

Keywords: Dental fluorosis; Fluoride in food; Koohbanan (Kuh-e Banan), Iran; Waterborne fluoride.

INTRODUCTION

Although fluoride (F) is widely promoted for the prevention of dental caries, its overconsumption in infancy may lead to dental fluorosis and other adverse effects.[1,2] According to the US Centers for Disease Control and Prevention, in order to avoid overexposure, careful monitoring and control of F intake levels is necessary.[3]

The small city of Koohbanan (Kuh-e Banan, population ca. 20,000), located 160 km north of Kerman, the capital of Kerman Province in SE Iran, is situated in a cold mountainous region 2000 m above sea level. The highest part of Koohbanan is the mountain top at 3660 m. Most mountains and hills around the city have coal mines. In this region, vegetables and fruits are grown by the inhabitants, and drinking water and agricultural water are provided from separate sources. In a survey of secondary school students in Koohbanan, the prevalence of dental fluorosis was found to be 93% with a mean intensity of grade 3, based on the Tooth Surface Index of Dental Fluorosis.[4] In view of this report, we decided to undertake an accurate measurement of the F concentration in the drinking water, agricultural water, and various foods consumed in this region. Since a relationship between high altitude and the occurrence of dental fluorosis has been documented,[5-7] it seems likely that living in Koohbanan at an altitude of 2000 m may be a factor in the observed severity of dental fluorosis.

MATERIALS AND METHODS

The F content of food products in Koohbanan was determined by the hexamethyldisiloxane-facilitated diffusion method followed by analysis with a fluoride ion selective electrode (Metrohm Co., Switzerland, which was also used

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for the water analyses.[8,9] Samples of drinking water and agricultural water as well as samples of 11 different grains, fruits, and vegetables and also five different food products sold in Koohbanan were collected. Grains, fruits, and vegetables were collected during the harvest season, dried, blended separately, and prepared for the analyses. In order to do the analyses blind, samples were codified. Samples of drinking and agricultural waters were collected in separate bottles and also codified.

For the F food determinations, the procedure of Jackson et al.[8] was essentially followed. Dried 300-mg samples were weighed in 7-mL polystyrene test tubes, followed by addition of 1 mL of ice-cold 70% perchloric acid. The cap of a 1.5-mL polypropylene microcentrifuge tube was used as a boat containing 50 µL of 2.5 M NaOH and floated in the test tube. HMDS (hexamethyldisiloxane) reagent (5%) was added to the sample in the tube, and the tube was capped tightly. After diffusion at room temperature for 20 hr, the contents of the boat containing the F trapped by the NaOH were transferred and rinsed with deionized water to another tube containing 50 µL of 2.5 M perchloric acid and then mixed with an equal volume of TISAB II (Total Ionic Strength Adjusting Buffer solution [JENEWAY, England]). After calibration of the F ion selective electrode against an Ag/AgCl reference electrode with standards prepared with exact amounts of F, the potentials of the samples were read directly. For the water samples, 50 mL portions were used.[8] The determinations were repeated three times for each sample, and means were reported as the final results. Data were analyzed by the SPSS 11.5 software package and presented as mean ±SD.

RESULTS AND DISCUSSION

F concentrations obtained for the food and water samples are presented in Tables 1 and 2. In vegetables grown in Koohbanan, the F concentrations were high (3.93–8.85 mg/kg). In an earlier report on F in vegetables in Fars Province of Iran, more F was found in stem parts than in roots and that the use of pesticides and herbicides increased F levels.[9] According to that study, in the meat and fish group, meat had the least amount of F (0.09 mg/kg).[9] In our study we found 0.07 and 0.23 mg F/kg in lamb and beef, respectively, which is essentially the same as in Fars study just cited. In our study, the F content of chicken was lower (0.13–0.25 mg/kg), which may be due to the fact that we used raw chicken without the skin. Among agricultural products, we found that the fruit group had relatively low F levels, in agreement with the results of the earlier study.[9] Another similar finding is the lower F concentration in fruits compared to vegetables.

It has been reported that the prevalence of dental fluorosis is higher in children living at an altitude of 2800 m (with 2.5 mg F/L in the drinking water) compared to children living at an altitude of 1750 m (with the same level of F in the drinking water).[5] It would appear, therefore, that in Koohbanan at 2000 m above sea level and 2.38 mg F/L in the drinking water, altitude is an influencing factor on the prevalence and severity of dental fluorosis.

Table 1. Fluoride concentration of dried samples (mg/kg) of grain, fruit, and vegetable from Koohbanan

Food product	Number of Samples	Number of experiments on each sample	Sample 1 Range (average ±SD)	Sample 2 Range (average ±SD)
Wheat	2	3	0.08–0.11(0.09±0.02)	0.08–0.16(0.11±0.04)
Pea	2	3	0.02–0.06(0.04±0.02)	0.03–0.06(0.05±0.01)
Almond	2	3	0.24–0.39(0.33±0.08)	0.23–0.38(0.29±0.08)
Apricot	2	3	0.43–0.54(0.46±0.06)	0.43–0.54(0.50±0.06)
Peach	2	3	0.31–0.40(0.37±0.05)	0.30–0.40(0.33±0.05)
Grape	2	3	0.08–0.14(0.12±0.03)	0.07–0.14(0.10±0.03)
Leek	2	3	3.93–4.14(4.01±0.11)	3.95–4.15(4.08±0.11)
Chervil	2	3	6.13–6.96(6.48±0.43)	6.33–7.00(6.75±0.37)
Mint	2	3	8.60–8.83(8.71±0.11)	8.61–8.85(8.76±0.13)
Cucumber	2	3	0.10–0.23(0.17±0.07)	0.09–0.20(0.13±0.06)
Cooked potato	2	3	4.88–5.54(5.12±0.36)	4.90–5.54(5.32±0.37)

Table 2. Fluoride concentration of dried samples (mg/kg) of bread and protein products and water samples (mg/L) from Koohbanan

Food product	Number of samples	Number of experiments on each sample	Sample 1 Range (Average ±SD)	Sample 2 Range (Average ±SD)
Bread	2	3	6.99–7.49(7.31±0.28)	6.94–7.49(7.18±0.28)
Egg	2	3	0.07–0.12(0.10±0.02)	0.06–0.12(0.09±0.03)
Lamb	2	3	0.05–0.09(0.07±0.02)	0.06–0.10(0.08±0.02)
Beef	2	3	0.20–0.26(0.22±0.03)	0.21–0.28(0.24±0.03)
Chicken	2	3	0.14–0.25(0.21±0.05)	0.13–0.24(0.18±0.05)
Drinking water	2	3	2.38–2.39(2.38±0.01)	2.36–2.39(2.38±0.01)
Agricultural water	2	3	2.86–2.99(2.90±0.07)	2.86–3.10(2.98±0.12)

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