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Safety evaluation on fluoride content in black tea

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Abstract

Fluoride content in black tea in various commodities, packages, and preparation processess was assayed and its safety evaluated. A fluoride ion selective electrode method was used to determine the fluoride content in 20 tea samples, in various black tea commodities, namely stick-shaped, granular, and canned or bottled tea beverage, originally produced in India, Sri Lanka, China, Japan and UK, and milk–tea after addition of milk and sugar. The fluoride content of 5 stick-shaped black teas was 96.9–148 mg/kg, that of 8 granular black tea was 139–223 mg/kg, and that of 3 canned or bottled beverage black tea beverages was 0.70–0.96 mg/l, respectively. Neither the bagged black tea paper nor the addition of milk and sugar affected the ionic fluoride level within the tea. These results suggest that, for heavy black tea drinkers, the fluoride intake in areas with drinking water fluoridation, and also other probable sources of fluoride, may approach or reach the level of risk from chronic fluoride intoxication.

Keywords: Black tea; Fluoride; Water fluoridation; Safety evaluation

1. Introduction

Black tea prepared as stick-shaped, granular, paper bagged powder, and canned or bottled beverage forms, is one of the major tea commodities consumed by people worldwide. Another fermented tea commodity, brick tea, with extremely high fluoride content, was found to induce endemic fluorosis among many minorities inhabiting the west and north nomadic areas in China (Cao, Bai, & Zhao, 1996, 1997). The safety of fluoride levels in black tea commodities has been alerted and recognized by healthcare workers and food regulation agencies. However, fluoride level in various black tea commodities and the safety concomitant problem is largely ignored. The present study collected samples of various black tea commodities, from different production regions of different types, different packages and different consumption modalities for fluoride level assay, and safety evaluation was considered according the generally accepted international criteria.

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2. Materials and methods

2.1. Materials

Thirteen various black tea commodities were selected, including granular and stick-shaped that originated from India, Sri Lanka, China, and Japan, and six commodities of the Lipton and Twining Co. of UK (stating the origin of raw material); and three bottled black tea beverage commodities from China and Japan. Black tea filtrations treated with milk and/or sugar were prepared in our laboratory.

2.2. Methods

2.2.1. Preparation of tea filtration samples

2.2.1.1. Stick and granular black tea. Packages were removed, including the paper package of the tea in bags, tea was dried for 5 h in a stable 60 °C drying cabinet; each take 2.000 g sample was added to 150 ml 100 °C de-ionized water and kept in a 100 °C bath for 10 min. After filtration, the volume was determined.

2.2.1.2. Instant black tea powder. 2.000 g of sample was added to 200 ml 100 °C de-ionized water, filtered after 10 min, and the volume determined.

2.2.2. Preparation of the sample for examination of influence of the paper bag of packaged tea

The tea sample within the paper package after removal of the package was dried for 5 h in a stable 60 °C drying cabinet and the paper package replaced; a sample not replaced with the paper package was used as the control.

2.2.3. Preparation of the sample for examination of influence of addition of milk and sugar on the fluoride level in the tea filtrate

The stick black tea for the Lipton Co. was dried for 5 h in a 60 °C drying cabinet, a 2.000 g sample was added to 150 ml 100 °C de-ionized water and kept in a 100 °C bath for 10 min, filtered and the volume determined after addition of 50 ml milk and 30 g sucrose.

2.3. Fluoride ion selective electrode method for the assay of fluoride levels

Fluoride content was determined by using the standard F selective ion electrode method.

2.4. Analytic quality control

A reference water sample was prepared in our laboratory; the fluoride content was assayed six times, and the mean value and the coefficient of variance were calculated to be 49.95 ± 0.20 μg/ml in the 50 μg/ml fluoride solution of distilled water.

3. Results

The stick-shaped black tea commodities constitute unique raw material that maintains its specific features when examined. The results are presented in Table 1.

Among the trade black tea commodities, the paper-bagged granular black tea contributed 30%, of the total and offered raw material, of different origins (Editorial board of Chinese Agriculture Encyclopaedia, 1998). The results are presented in Table 2.

Whether the paper bag influenced the solubility of fluoride in the tea filtrate was tested by using the 4th and 8th samples of the above Table, the results indicated that the paper bag did not affect the fluoride levels within the filtrate (see Table 3).

The fluoride levels in black tea beverages are presented in Table 4.

Many areas consume black tea with added milk and sugar. The 2nd and 3rd stick tea samples of Table 2 were used to test whether they influenced the ionic

Table 1
Fluoride content in the stick-shaped black tea (mg/kg^{-1})

No.	Commodity name	The manufacturer	Raw material from	n	$\bar{x} \pm SD$
1		UK Lipton	Unknown	3	148 ± 11.6
2		UK Twinings	Darjeeling, India	3	96.9 ± 9.8
3	Qimeng black tea	Tea Institute of Qimeng, Anhui	Anhui, China	3	111 ± 11.3
4	Zhengshan small	Tongmu Tea Factory of Fujing	Fujing, China	3	148 ± 15.7
5	Yunnan black	Dadugang Tea Factory of Yunnan	Yunnan, China	3	124 ± 14.2

Table 2
Fluoride content in paper bag black tea commodity (mg/kg^{-1})

No.	Commodity name	The manufacturer nation	Raw material originating from	n	$\bar{x} \pm SD$
1	Lipton	UK	China	5	142 ± 12.5
2	Nitton	Japan	Japan	3	168 ± 11.9
3	Mlesna	Sri Lanka	Sri Lanka	3	139 ± 13.4
4	Twin	UK	Darjeeling, India	3	173 ± 14.2
5	Twin	UK	Darjeeling, India	3	171 ± 10.8
6	Twin	UK	Sri Lanka	3	152 ± 9.7
7	Twin	UK	Qimeng, China	3	223 ± 13.1
8	Qualtety	China	Guangdong, China	3	146 ± 10.3

Table 3
Influence of paper bag on fluoride in tea (mg/l)

No.	With paper bag		Without paper bag		P
	N	$\bar{x} \pm SD$	n	$\bar{x} \pm SD$	
#4 Twin	3	173 ± 8.9	3	174 ± 11.1	>0.5
#8 Qualtety	3	146 ± 15.1	3	146 ± 9.9	>0.5

Table 4
Fluoride levels in black tea beverage (mg/l)

Region of manufacturer	Package	Site of raw material production	*n*	x̄ ± SD
Japan	Al can	Japan	4	0.96 ± 0.11
Mainland, China	PVC bottle	Japan	5	0.70 ± 0.15
Taiwan, China	PVC bottle	Taiwan, China	5	0.82 ± 0.23

Table 5
Influence of milk and sugar on fluoride level in the tea filtrates (mg/l)

No.	With milk and sugar		Without milk and sugar		*P*
	N	x̄ ± SD	*n*	x̄ ± SD	
2 (Nitton)	3	96.8 ± 7.5	3	96.9 ± 7.6	>0.5
3 (Mlesna)	3	139 ± 9.8	3	139 ± 11.3	>0.5

fluoride level in tea filtrate and the results are presented in Table 5.

The results indicated that addition of milk and sugar does not affect the tea filtrate ionic fluoride level.

4. Discussion

Tea drinking is popular in America and Europe, especially black tea. Some regions use water fluoridation as a measure to prevent caries and fluoride-supplemented tooth products are prevalent as well. The safety of tea drinking has, however, been scarcely considered.

It is well known that the ionic fluoride composes more than 90% of total fluoride in tea (Cao, Zhou, & Liu, 1998). about 75–90% of the ionic fluoride ingested each day is absorbed from the alimentary tract. Only the water-soluble fluoride, the ionic fluoride, ingested is relevant to human health. The ionic fluoride is detectable by the fluoride ion-specific electrode (Institute of Medicine. Ed., 1999, Chap. 9).

Samples of black tea selected in this study are market commodities from famous tea trade companies. The market commodities were prepared by mixing raw black teas, originally produced in India, Sri Lanka, China, and Japan, by the tea trade companies, to favour the consumers' needs and cost consideration. Use of the market commodity for testing of samples can accurately illustrate the tea drinkers' fluoride intake.

The present study revealed that fluoride level of stick black tea was in the range of 96.9–148 mg/kg, and that of the granular black tea was 139–223 mg/kg. Assuming that one consumes 4 cups of tea every day, and each cup uses 2 g black tea, daily fluoride intake may be 0.78–1.18 or 1.11–1.78 mg, respectively, which is effective for preventing caries as the previous epidemiological studies have demonstrated (Cao, Chen, & Wu, 1987). According to the 1989 American RDA, the safe upper limit of daily fluoride intake is 1.5–4.0 mg for adults and 2.5 mg for children. Thus 4 cups of black tea daily in consumption is safe, assuming that each cup uses 2 g of black tea. The paper-packaged black tea weighs 2 g as well. Furthermore, daily consumption of 2000 ml canned or bottled black tea is also safe. However, water fluoridation, raises the question of whether this safety evaluation is valid. When the water after fluoridation reaches a level of 0.8 or 1.0 ppm, in addition to other possible fluoride sources, such as fluoride-containing toothpaste and other products, the daily fluoride intake might be excessive. There has been reports suggesting that, among heavy tea drinkers in a British fluoridated city, was exceeded the upper permitted safety level (Jenkins, 1991), which indicates that close surveillance is required. The result of the present study is that, among populations habitually consuming black tea, water fluoridation is not only unnecessary but also possibly harmful.

Systemic observation and evaluation of populations exposed to threshold level of fluoride and facing the risk of mild chronic fluoride intoxication are insufficient. The target organs of chronic fluoride intoxication are not only the teeth and skeleton, but also the liver, kidney, nervous and reproductive systems (Guan, 1986; Medvedeva, 1985; Zhavoronkov & Dubynin, 1971). These organ-systems should be focussed upon in design of epidemiological survey and safety evaluation. In addition, regions with fluoride exposures approximating the upper limit threshold should pay attention to other possible environmental fluoride sources, as any additional fluoride may exceed the threshold.

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