

Assessment of fluoride content and daily intake from different brands of tea bags in Iran

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Abstract

Tea is the second most commonly consumed beverage world wide. Tea (*Camellia sinensis*) is a naturally rich source of fluoride. The quantity of fluoride intake is important in optimizing its dental caries-preventive role. Intense concentration of fluoride in tea, can lead to excessive fluoride intake which may cause health problems in turn. The measurement of fluoride intake usually requires information on the fluoride concentration in food and beverages. The main objective of this study was to investigate the fluoride content of various commercial brands of tea bag available on the market in Iran. Furthermore, daily fluoride intake from these brands is assessed. The results of this study showed that among 15 brands of tea bag assessed in this study, Nemooneh™ had the highest fluoride concentration (0.41 ± 0.01 mg/100 ml/3 min), whereas Ahmad™ had the lowest level (0.10 ± 0.01 mg/100 ml/3 min). The average fluoride concentration was 0.23 ± 0.01 mg/100 ml/3 min. Thus, it seems that daily consumption of four cups of tea could provide up to 73% of recommended daily dose of fluoride in children 2-5 years old and up to 50% recommended daily dose for adults. It seems that existing tea bag in Iranian market contain proper amounts of fluoride and there is no toxicity with their regular consumption.

Keywords: Fluoride; Tea; *Camellia sinensis*; Ion selective electrode

INTRODUCTION

Fluoride (F) is a recognized substance used worldwide to control dental caries. However, ingestion of high levels of fluoride during tooth formation and mineralization is responsible for dental fluorosis. Prolonged ingestion of high levels of fluoride, leads to corroded, pitted rusty brown teeth. The upper limit for clinically acceptable dental fluorosis is not well known, but the value of 0.05-0.07 mg F/kg/day is generally accepted as a reference (1).

Tea, an infusion of *Camellia sinensis* leaves, is one of the most popular beverages in the world because of its favorable taste, aroma, and health-promoting effects. The tea plant is known as a fluorine (an ionic form of fluoride) accumulator. Leaves contain nearly 98% of total fluoride content of the whole plant. Old leaves, harvested in the Summer or Autumn, contain a higher level of fluoride compared to

young tender shoots harvested in the spring (2). The tea plant absorbs fluoride from acidic soil through passive diffusion, which is then accumulated in the leaves during the plant's life span (3,4). In the past, tea was grown in natural soil but nowadays fertilizers are used to boost production. It is also known that plants can take up more fluoride when the mineral fertilized soil is used (5).

Tea consumption has also spread all over the world through the industrialization of tea-based beverages. In countries where regular tea consumption is a cultural tradition, tea plays an important role in triggering fluoride's undesirable effects on tooth formation. Drinking tea after meals and during the day is a widespread cultural practice in Iran. In the cities of Iran where dental fluorosis is endemic, fluoride intake from tea has been strongly correlated to these effects (6-8).

However, these studies have primarily focused on black tea, while various types of

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Table 1. Estimated amount of fluoride (mean \pm SD; n=4) in one bag of black tea bag in Tehran market

No	Black Tea bags brand	Fluoride ^a content (mg/bag/cup _{100 ml} /3 min)	Fluoride ^b content (mg/bag/cup _{100 ml} /3 min)	Fluoride intake in consuming 4 cups of tea	Percent of recommended fluoride intake ^c (from tea in adults 70 kg)
1	Ahmad TM	0.10 \pm 0.01	0.13	0.51	14.7
2	Alcozy TM	0.23 \pm 0.01	0.26	1.04	29.7
3	Bartar TM	0.19 \pm 0.01	0.22	0.88	25.1
4	Debsh TM	0.17 \pm 0.01	0.20	0.80	22.8
5	Dogazal TM	0.14 \pm 0.01	0.17	0.68	19.4
6	Gelin TM	0.17 \pm 0.01	0.20	0.80	22.8
7	Golestan TM	0.21 \pm 0.01	0.24	0.96	27.4
8	Golkiss TM	0.24 \pm 0.01	0.27	1.08	30.8
9	Jahan TM	0.23 \pm 0.01	0.26	1.04	29.7
10	Keila TM	0.23 \pm 0.01	0.26	1.04	29.7
11	Lipton TM	0.25 \pm 0.01	0.28	1.12	33.1
12	Nemooneh TM	0.41 \pm 0.01	0.44	1.76	50.2
13	Oghab TM	0.23 \pm 0.01	0.26	1.04	29.7
14	Shahrzad TM	0.38 \pm 0.04	0.41	1.64	46.8
15	Tiba TM	0.32 \pm 0.02	0.35	1.40	40.0
-	Mean TM	0.23 \pm 0.01	0.26	1.04	29.7

^ainfused with distilled water, ^binfused with boiled tap water, ^c(0.05 mg/kg/day)

tea such as instant tea, tea bag and herbal tea are now available on the market, with no data on their fluoride contents. Furthermore, the amount of fluoride in Iranian children's diet is unknown. Hence, data on their level of fluoride intake is not available. Consequently, keeping the safe threshold for fluoride exposure to avoid probable dental fluorosis is an important issue in health care. The purpose of this study is to assess fluoride content of black tea bag brands available in Tehran, the capital of Iran, considering the risks that fluoride poses to oral and general health.

MATERIALS AND METHODS

Sampling

Fifteen different brands of tea bag, shown in Table 1, were available in Iranian market and four samples of each brand were purchased from various local supermarkets (Tehran, Iran, May 2008). Batch numbers and production date of all samples were recorded.

Chemicals

1,2-cyclohexanediaminetetracetic (CTDA), NaCl, NaF, sodium acetate and glacial acetic acid were of analytical reagent grade and were purchased from Merck (Germany). The total ionic strength adjustment buffer solution 2 (TISAB II) contained 58.5 g (1 M) of NaCl, 61.52 g of sodium acetate (0.75 M), 4.0 g (0.01 M) CTDA and 14.3 ml of glacial acetic acid (0.25 M) per liter.

Apparatus

A Metrohm 692 pH/Ion Meter with a Metrohm fluoride ion selective electrode (ISE 6.0502.150) coupled with Metrohm reference electrode (Ag/AgCl; 6.0729.100) was used for measurement of fluoride concentrations.

Preparation of tea bag infusions

Four tea bags were taken out randomly from each product and tea bag infusions were prepared in the laboratory using double distilled water. Ninety ml of double distilled

Table 2. Comparison of daily fluoride ingestion in children from studied tea bags with recommended total daily intake (0.05 mg/kg/day)

Age (average weight)*	Average F intake (mg/kg/day)	Percent of recommended intake (0.05 mg/kg/day)
2 (12.05 kg)	0.01 - 0.04	21.4 – 73.0%
3 (14.35 kg)	0.01 - 0.03	18.0 - 61.3%
4 (16.35 kg)	0.01 - 0.03	15.7 - 26.9%
5 (18.2 kg)	0.01 - 0.02	14.1 - 48.3%

*http://www.webhealthcentre.com/general/yc_hwchart.asp

water was brought to boil in teflon beakers to prevent fluoride absorption, then one tea bag was added into each beaker. After 3 min of infusion, the tea bags were taken out, the solutions were left to reach the room temperature, and the volumes were made to 100 ml with distilled water in a volumetric flask.

Fluoride determination

Fluoride content of all samples was determined potentiometrically using a fluoride ion selective electrode after buffering with the equal volume of TISAB II. The electrode was calibrated with six standard solutions. Fluoride concentration of each sample was calculated after 3 min of infusion (mg F/bag).

Statistical analysis

Statistical comparisons of various groups were carried out by Student's t-test using SPSS software at $P < 0.05$ for statistically significant differences. The results of fluoride determination of samples are presented as mean \pm SD.

RESULTS

The sensitivity limit for fluoride detection was 0.02 ppm using the mV value of the blank solution as reference. The amount of fluoride per cup (100 ml of solution per bag after 3 min of infusion) is shown in Table 1. The result of this study revealed that among of fifteen brands of tea bag, NemoonehTM has the highest fluoride concentration (0.41 ± 0.01 mg/100 ml/3 min), whereas AhmadTM has the lowest level (0.10 ± 0.01 mg/100 ml/3 min) with mean fluoride concentration of $0.23 \pm$

0.01 mg/100 ml/3 min. Water fluoridation increases the fluoride content. Assuming that the average amount of fluoride in fluorinated water of Tehran's water supply is 0.3 mg/l, the total fluoride content for one cup of tea (fluoride content in 100 ml) and the percent of recommended fluoride intake for adults is shown in Table 1. Our data showed that the fluoride ingestion from one cup of tea was about 21.4-73.0% and 18.0-61.3% of recommended daily fluoride intake for 2 and 3 year-old children, respectively (Table 2).

DISCUSSION

Fluoride is now widely regarded as the cornerstone of modern preventive dentistry. In addition to its prophylactic qualities, fluoride is investigated for its benefits in the treatment of osteoporosis, ischemia, and other major diseases (9) but we should consider that these beneficial properties are true of normal fluoride content. Another important factor to consider is the fluoride content of consumers' diet. Fluoride intake from diet, in addition to tea fluoride can increase the level of fluoride intake and consequently, the possibility of fluoride toxicity. Tea is the second most commonly consumed drink in the world. It is well known that the ionic fluoride composes more than 90% of total fluoride in tea.

As seen in Table 1, the fluoride content of the studied samples showed a range of variation from 0.10 to 0.41 mg F/cup/3min, which is in agreement with another report (10). High levels of fluoride in some tea bags may reflect the supposition that the raw material used to prepare these tea bags were not of high quality. However, little information has been

found concerning the relationship between fluoride level and tea quality. As reported by other research groups, currently the maturity degree of tea leaves is assessed through determination of the level of crude fiber, which is rather complicated and time-consuming. The results mentioned above suggest that the fluoride level can play the same role as the crude fiber. Furthermore, the analysis of fluoride content is much simpler and needs a smaller amount of tea per sample (2).

According to WHO (WHO, 1990), recommended daily concentration of fluoride intake is 0.05 mg/kg/day, so for an adult with an average weight of 70 kg, the amount of recommended fluoride intake from drinking four cups of tea is about 14.7% to 50.2% of the recommended daily dose of fluoride (Table 1). Thus daily consumption of four cups of black tea is safe for adults, provided that each cup of tea is prepared using one fresh black tea bag and fluorinated tap water. However, higher levels of water fluoridation in some regions (0.8 or 1.0 ppm), in addition to other possible sources of fluoride, such as fluoride-containing toothpaste, various beverages, fish, sea-food, fluorinated salt and fluoride-containing medicines increase the daily fluoride intake to a level higher than the recommended value.

The results of this investigation indicated that tea bag samples consumed in Iran are sufficient in fluoride content. Dentists and other health care providers should be aware of possible fluorosis in heavy tea drinkers who are exposed to other possible sources of fluoride or live in areas with a higher level of water fluoridation. This is a serious concern in Iran where tea is consumed daily irrespective of age, because the bioavailability of fluoride from tea is high (11) and it is suggested that young children should consume less tea. We should take immediate action to protect our children's mental and physical health from the increasing fluoride intake from various sources of fluoride, especially tea, which is the main source of fluoride intake of Iranian population.

It is also important to provide the consumers with accurate information on the quality of the tea that they drink. Fluoride concentration is the best commonly applicable parameter to

reflect the quality of tea (2). Having this information, consumers can choose the right brand of tea, containing an appropriate level of fluoride to avoid excessive consumption without changing their tea drinking habits. Currently, there is no strict regulation on the labeling of fluoride content of tea bags in Iran and many other countries, so regulations concerning labeling should be issued. Assuming that each individual consumes four cups of tea daily and each cup of tea is made as described in the methods' section using fluorinated water, the daily fluoride intake may vary from 0.52 to 1.76 mg (Table 1), which is effective for preventing caries as the previous epidemiological studies have demonstrated (12).

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