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ASSESSMENT OF FLOURIDE CONTENT IN VARIOUS POPULAR INDIAN TEA BRANDS.

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ABSTRACT

Background: 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. **Objectives:** To estimate the fluoride content in various commercial brands of tea available in Indian market. **Methods:** A total of 15 tea brands among which five different popular brands of green tea and ten different popular brands of black tea was purchased from local supermarkets available in Nellore city. Tea infusions were prepared in a customary way at different brewing time i.e. 3 minutes, 5 minutes and7 minutes. Fluoride content of all samples was determined by SPADNS method using a spectrophotometer. The top 3 tea brands which release high fluoride content among 15 tea brands were again assessed to determine the effect of adding milk and sugar/honey on the fluoride release. The data was analysed using SPSS (statistical package for social sciences), version 22. Mean and standard deviations were calculated and ANOVA was used to compare the fluoride concentration in tea infusions prepared by different methods. **Results:** Mean concentration of fluoride in the black tea was 0.94±0.02 mg/lit without boiling, 1.04±0.09 mg/lit at 3 minutes, 2.07±0.14 mg/lit at 5 minutes and 2.81±0.18 mg/lit at 7 minutes. Corresponding concentrations in green tea were 1.25±0.07 mg/lit, 2.15±0.05 mg/lit, 2.96±0.07 mg/lit and 3.21±0.08 mg/lit respectively. Fluoride concentration was significantly higher in green tea in all four types of infusions. **Conclusion:** The study shows that tea contains significant amount of fluoride that should be taken into consideration. Currently, there is no strict regulations for the labeling of fluoride content on tea bags/packs in India and many other countries. So regulations concerning labeling should be issued.

INTRODUCTION

Fluoride (F) is a recognized substance used worldwide to control dental caries. Excessive amounts of fluoride in the form of different compounds can enter the human body by means of polluted air, water and the food chain. An additional source of fluoride for humans is toothpastes containing 0.1% fluoride in the form of NaF, SnF2 and Na2PO3F and water fluoridation. It is very characteristic that fluoride prevents tooth decay at about 1 mg/L but causes mottled teeth (dental fluorosis) and bone damage (skeletal fluorosis) at around 5 mg/L over prolonged periods of exposure. Fluorosis is an important public health problem in 24 countries, including India, which lies in the geographical fluoride belt that extends from Turkey to China and Japan through Iraq, Iran and Afghanistan. Of the 85 million tons of fluoride deposits on the earth's crust, 12 million are found in India. Hence it is natural that fluoride contamination is widespread, intensive and alarming in India.

Endemic fluorosis is prevalent in India since 1937. It has been estimated that the total population consuming drinking water containing higher levels of fluoride is over 66 million. Endemic fluorosis resulting from high fluoride concentration in groundwater is a public health problem in India.

Tea is a beverage made by steeping processed leaves from the plant, Camellia sinensis in hot water. Next to water, tea is the most widely consumed beverage inthe

world (Tea association of the USA, 2001). Tea or chai is probably the most popular drink in India. Our country is the largest consumer of tea in the world and we consume 25 per cent of the tea produced worldwide (as reported by The AssociatedChambers of Commerce of India in a December 2011 report). India is also the second largest producer of tea in the world. 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.

Several studies have shown correlation between tea intake and dental and skeletal fluorosis. In a country like India where dental fluorosis is endemic and where regular tea consumption is a cultural tradition, tea might play an important role in triggering undesirable effects on teeth and bone formation. The European Food Safety Authority (EFSA) reported that drinking just 2 cups of tea per day (with a fluoride content of 5 mg/L), combined with an average consumption of fluoridated drinking water and the use of fluoridated tap water in the preparation of food, but excluding all other sources (including solid foods, toothpaste and dental products), would provide a daily dietary intake of 6 mg fluoride per day. Small amounts of fluoride are vital for human in preventing dental carries, but it is toxic in larger amounts. Various tea companies are releasing tea products with no data of fluoride content on them. Thus monitoring of fluoride concentration in tea products is essential. So, the present study was conducted to estimate the fluoride content in various popular tea brands available in Nellore city, India.

AIM

- To estimate the fluoride content in various popular tea brands available in Nellore city.

OBJECTIVES

- To determine the fluoride release at three different brewing times i.e. 3min, 5 min and 10 min.
- To determine the effect of adding milk and sugar/honey on the fluoride release.

METHODOLOGY

A total of 15 tea brands among which five different popular brands of green tea and ten different popular brands of black tea will be purchased from local supermarkets available in Nellore city. Batch numbers and production date of all samples will be recorded.

PREPARATION OF TEA INFUSION SAMPLES

Infusions of tea samples will be prepared by employing customary way of tea preparation. In this procedure, distilled-deionized water will be boiled (95– 98 C) in 100 mL Teflon beaker; 2.5 g of tea leaves will be added to the beaker and allowed to infuse for 3 min. The tea was filtered using a plastic filter (mesh) and allowed to cool to room temperature. The infusion was filtered again using Whatman No. 42 filter paper. Finally the volume of the infusion was made 100 mL with distilled-deionized water again to compensate for the loss during boiling prior to storage in plastic bottles. With similar procedure, tea infusions were prepared by brewing for 5 and 10 min in triplicate for all tea brands.

FLUORIDE CONTENT ANALYSIS

This study will be done in Nellore district rural water supply department. Fluoride content of all samples will be determined by SPADNS method using a spectrophotometer. This method relies on the fact that when fluoride reacts with certain zirconium dyes, a colourless complex anion and a dye are formed. The complex, which is proportional to the fluoride concentration, tends to bleach the dye which therefore becomes progressively lighter as the fluoride concentration increases.

In the case of the fluoride ion reaction with Zr-SPADNS (sodium 2- (parasulphophenylazo-)-1,8-dihydroxy-3,6-naphthalene disulphonate), the resulting coloured complex is measured in a spectrophotometer at 570nm.

The fluoride content of 15 brands at different brewing times will be obtained. The top 3 tea brands which release high fluoride content among 15 tea brands will be sent for private food research lab(vimta lab, Nellore). Effect of adding milk/ honey on fluoride release of these 3 tea brands will be analysed there by repeating same procedure.

Ethical clearance

The ethical clearance for the study will be obtained by the Institutional review board of the Narayana dental college and hospital Nellore. The permission will be taken from chief supervisor of district rural water supply and sanitation department.

STATISTICAL ANALYSIS

The data will be analysed using SPSS (statistical package for social sciences), version 20. Mean and standard deviations will be calculated and ANOVA will be used to compare the fluoride concentration in tea infusions prepared by different methods. p value equal to or less than 0.05 will be considered to be statistically significant.

RESULTS

Fluoride concentration (Mean ±SD) in the tea infusions prepared at four different brewing times is shown in the table 1 for black tea. Among them, CTC tea and Arambh tea released high fluoride at different brewing times Fluoride concentration was increased with increase in brewing time which was statistically significant ($p<0.05$).

Fluoride concentration (Mean ±SD) in the tea infusions prepared at four different brewing times is shown in the table 2 for green tea. Among them, Eco valley and Twining released high fluoride levels. Fluoride concentration was increased with increase in brewing time which was statistically significant ($p<0.05$).

Fluoride concentration (Mean ±SD) was significantly higher ($p<0.05$) in green tea compared to black tea in all four methods (table 3).

Fluoride concentration (Mean ±SD) in the top four fluoride releasing tea brands prepared at four different brewing times after adding milk and sugar/honey is shown in table 4. Fluoride concentration was increased with increase in brewing time which was statistically significant ($p<0.05$).

Comparison of fluoride concentration (Mean ±SD) in top four tea brands before and adding after adding milk and sugar/honey (mg/lit) was shown in table 4. There was increase in fluoride concentration after the addition of milk and sugar/honey in all tea brands which was statistically significant.

Amount of fluoride ingested per day with 1 to 4 cups of tea and percentage of recommended fluoride intake through tea ingestion of black tea was shown in table 5. According to WHO, recommended daily intake of fluoride is 0.05 mg/kg/day, so for an adult with an average weight of 70 kg, the percentage of daily recommended fluoride from drinking four cups of black tea with a brewing time of 7 min is about 34- 40%.

Amount of fluoride ingested per day with 1 to 4 cups of tea and percentage of recommended fluoride intake through tea ingestions of green tea was shown in table 6. According to WHO, recommended daily intake of fluoride is 0.05 mg/kg/day, so for an adult with an average weight of 70 kg, the percentage of daily recommended fluoride from drinking four cups of green tea with a brewing time of 7 min is about 34- 44%.

Table 1: Fluoride concentration in black tea at different brewing times (mg/lit).

Brand name	N	Without boiling	At 3 minutes	At 5 minutes	At 7 minutes
Red label	4	0.91±0.03	1.02±0.03	2.10±0.09	3.00±0.04
CTC tea	4	0.93±0.04	1.92±0.02	2.63±0.04	3.42±0.02
3 roses	4	0.91±0.02	1.00±0.01	2.42±0.03	3.03±0.03
Five star	4	0.91 ±0.03	1.83±0.04	2.72±0.03	3.30±0.07
Gemini	4	0.90±0.02	1.00±0.02	2.00±0.02	3.04±0.03
Chakra gold	4	0.89±0.02	1.00±0.02	2.42±0.03	3.00±0.02
Taj mahal	4	0.90±0.02	1.05±0.02	2.28 ±0.02	3.05±0.01
Arambh tea	4	0.96±0.01	1.96±0.01	2.88±0.01	3.45±0.02
V fresh pure	4	0.95±0.01	1.05±0.02	2.23±0.03	3.05±0.01
Tata gold	4	0.93±0.01	1.23±0.02	2.30±0.03	3.03±0.02
Overall mean	4	0.92±0.02*	1.30±0.01*	2.39±0.02*	3.13±0.03*

ANOVA (with Post hoc test), *P<0.05 statistically significant.

Table 2: Fluoride concentration in Green tea at different brewing times (mg/lit).

Brand name	N	Without boiling	At 3 minutes	At 5 minutes	At 7 minutes
Eco valley	4	1.35±0.02	2.31±0.02	3.21±0.01	3.03±0.02
Tetley	4	1.33±0.03	2.24±0.03	3.21±0.01	3.33±0.02
Lipton	4	1.34±0.02	2.08±0.02	2.97±0.03	3.46±0.01
Gaia	4	1.33 ±0.01	2.32±0.02	3.13±0.01	3.45±0.03
Twining	4	1.41±0.01	2.92±0.02	3.18±0.03	3.91±0.01
Overall mean	4	1.35±0.02*	2.37±0.01*	3.16±0.02*	3.43±0.03*

ANOVA (with Post hoc test), *P<0.05 statistically significant.

Table 3: Fluoride concentration in Black tea and Green tea (mg/lit) (Mean ± SD).

Type of Tea	Without boiling	At 3 minutes	At 5 minutes	At 7 minutes	P value
Black tea	0.92±0.02	1.30±0.01	2.39±0.02	3.13±0.03	P<0.05*
Green tea	1.35±0.02	2.37±0.01	3.16±0.02	3.43±0.03	

Student t test, *P<0.05 statistically significant.

Table 4: Fluoride concentration in top four fluoride releasing tea brands after adding milk and sugar/honey (mg/lit).

Brand name	N	Without boiling	At 3 minutes	At 5 minutes	At 7 minutes
CTC tea	4	0.96±0.01	1.94±0.02	2.76±0.03	3.66±0.03
Arambh tea	4	0.97±0.02	1.98±0.01	2.94±0.02	3.76±0.02
Eco valley	4	1.39±0.01	2.43±0.01	3.35±0.02	3.64±0.01
Twining	4	1.43±0.02	2.99±0.02	3.24±0.02	3.97±0.02
Overall mean	4	1.18±0.02*	2.33±0.43*	3.07±0.24*	3.75±0.13*

ANOVA (with Post hoc test), *P<0.05 statistically significant.

Table 4: Fluoride concentration in top four tea brands before and adding after adding milk and sugar/honey (mg/lit).

Brand name	Method	Without boiling	At 3 minutes	At 5 minutes	At 7 minutes	p value
CTC tea (N=4)	Before adding milk	0.93±0.04	1.92±0.02	2.63±0.04	3.42±0.02	P<0.05*
	After adding milk	0.96±0.01	1.94±0.02	2.76±0.03	3.66±0.03	
Arambh tea (N=4)	Before adding milk	0.96±0.01	1.96±0.01	2.88±0.01	3.45±0.02	P<0.05*
	After adding milk	0.97±0.02	1.98±0.01	2.94±0.02	3.76±0.02	
Eco valley (N=4)	Before adding milk	1.35±0.02	2.31±0.02	3.21±0.01	3.03±0.02	P<0.05*
	After adding milk	1.39±0.01	2.43±0.01	3.35±0.02	3.64±0.01	
Twining (N=4)	Before adding milk	1.41±0.01	2.92±0.02	3.18±0.03	3.91±0.01	P<0.05*
	After adding milk	1.43±0.02	2.99±0.02	3.24±0.02	3.97±0.02	

Bonferroni post hoc test, *P<0.05 statistically significant.

Table 5: Expected fluoride (mg) intake through consumption of different amount of black tea and percentage of recommended daily fluoride intake*.

Brand name	mg/1cup /7min	mg/2cup/ 7min	mg/3cup/ 7min	mg/4cup/ 7min	Percentage of recommended fluoride intake/4 cup/day
Red label	0.30	0.60	0.90	1.20	34.2%
CTC tea	0.34	0.68	1.02	1.36	38.7%
3 roses	0.30	0.60	0.90	1.20	34.2%
Five star	0.33	0.66	0.99	1.32	37.6%
Gemini	0.30	0.60	0.90	1.20	34.2%
Chakra gold	0.30	0.60	0.90	1.20	34.2%
Taj mahal	0.35	0.70	1.05	1.40	39.9%
Arambh tea	0.34	0.68	1.02	1.36	38.7%
V fresh pure	0.30	0.60	0.90	1.20	34.2%
Tata gold	0.30	0.60	0.90	1.20	34.2%

*****recommended F intake =0.05 mg/kg/day. For adult with average weight of 70 kg, recommended fluoride intake=3.5 mg/day.

Table 5: Expected fluoride (mg) intake through consumption of different amount of green tea and percentage of recommended daily fluoride intake*.

Brand name	mg/1cup /7min	mg/2cup/ 7min	mg/3cup/ 7min	mg/4cup/ 7min	Percentage of recommended fluoride intake/4 cup/day
Eco valley	0.30	0.60	0.90	1.20	34.2%
Tetley	0.33	0.66	0.99	1.32	37.6%
Lipton	0.34	0.68	1.02	1.36	38.7%
Gaia	0.34	0.68	1.02	1.36	38.7%
Twining	0.39	0.78	1.17	1.56	44.4%

*****recommended F intake =0.05 mg/kg/day. For adult with average weight of 70 kg, recommended fluoride intake=3.5 mg/day.

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 treatment of osteoporosis, ischemia and other major diseases. But we should consider that these beneficial properties are true of normal range of 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.

In the present study, the fluoride concentration in black tea was ranged from 2.00 to 2.88 mg/lit (5 min brewing time) and fluoride content in the green tea was ranged from 2.97 to 3.21 mg/lit (5 min brewing time) which was similar to the study done by Gulati P et al and Jain et al. Fluoride content in the tea leaves depends on the fluoride

concentration of soil, ground water and types of tea leaves used (older leaves accumulate more fluoride compared to younger leaves).

In the present study we also found that concentration of fluoride increased with an increase in brewing time. This was in the line with other studies like Samuel Zerabruk et al, Jain et al and kalayci et al. This may be due to slow release in fluoride ions from tea infusions with increase in brewing time.

Amount of fluoride which gets released depends on the amount of dry tea used, concentration of fluoride in water used to make tea, brewing time and presence of milk etc. Since we used distilled water for the preparation of tea infusions, the actual amount of fluoride concentration in tea prepared by drinking water and milk may vary.

Since the region where the present study conducted was mostly a non-fluoridated one, the effect of fluoride levels in drinking water might have negligible effect on obtained fluoride levels. In the present study, there was an attempt made to find changes in the fluoride concentrations on addition of sugar/honey and milk to the top four fluoride releasing tea brands. We found that there was increase in fluoride concentration after the addition of milk and sugar/honey in all tea brands which was statistically significant ($p < 0.05$). This may be due to the fluoride levels presents in the milk used and these results were similar to the studies conducted by Gupta et al.

The results of the present study were used to estimate daily fluoride intake from drinking tea. According to WHO, recommended daily intake of fluoride is 0.05 mg/kg/day, so for an adult with an average weight of 70 kg, the percentage of daily recommended fluoride intake from drinking four cups of black tea with brewing time 7 minutes is about 34-40% and for the green tea with brewing time 7 minutes is about 34-44% i.e., almost half of the recommended daily intake of fluoride. This findings were similar to the studies conducted by Jain et al and M. Amanlou et al.

The results of this investigation indicated that tea samples consumed in India 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 India where tea is consumed daily irrespective of age, because the bioavailability of fluoride from tea is high and it is suggested that young children should consume less tea. We should take immediate action to protect our children's mental, physical and oral health from the increasing fluoride intake from various sources of fluoride, especially tea, which is the main source of fluoride intake of Indian 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. 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 India 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, which is effective for preventing caries as the previous epidemiological studies have demonstrated.

CONCLUSION

The study shows that tea contains significant amount of fluoride that should be taken into consideration. Currently, there is no strict regulations for the labeling of fluoride content on tea bags/packs in India and many other countries. So regulations concerning labeling should be issued. 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.

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