

# Fluoride Contents in Teas and Investigation of Children's Tea Consumption in Relation to Socioeconomic Status

## SUMMARY

*The aim of the study was to determine the fluoride content in teas and investigate the consumption frequency of tea by children with special reference to socioeconomic status. Tea infusions for herbal teas (n=6) and black tea - Camellia sinensis (n=7) were prepared according to the manufacture's instructions. 9 samples were prepared by inserting the tea bag to hot water and 4 kinds of tea were brewed for 2 hours. The fluoride contents of the infusions were measured by using ion specific fluoride electrode. Questionnaires were filled for 120 children from low and 80 children from high socioeconomic status. The amount of herbal and black tea consumed by children were recorded.*

*The findings of the study revealed that the fluoride contents of herbal teas were ranging among 0.12 to 0.17ppm. Fluoride levels of black tea increased by the brewing time and were measured between 0.62ppm to 1.17ppm. Questionnaire findings showed that children from low socioeconomic status consume black tea more frequently but, in general, children do not drink tea regularly. Although children do not prefer highly to drink black tea, the effect of high fluoride content of tea after brewing on dental caries and dental fluorosis should be evaluated by further studies.*

**Keywords:** Fluoride; Black Tea; Herbal Tea

**Ece Eden, Fahinur Ertugrul, Özant Oncag**

Ege University, School of Dentistry  
Department of Paedodontics  
Bornova-Izmir, Turkey

## ORIGINAL PAPER (OP)

**Balk J Stom, 2007; 11:171-174**

## Introduction

Tea is an infusion of dried leaves of the plant *Camellia sinensis* and is consumed as a very popular drink all around the world. Dried tea is produced each year mainly in India, China, Sri Lanka, Turkey, Russia and Japan<sup>1</sup>. Teas are classified into 3 major types according to the manufacturing process. These are non-fermented green tea, the semi-oxidized oolong tea and the fermented black tea. The manufacturing process can affect the properties of various teas. Green tea is the richest in the antioxidant constituents of pharmacological interest<sup>2</sup>.

Many studies have shown antimicrobial activity and oral health benefits of green tea or oolong tea<sup>3-7</sup>. Tea polyphenols, oxidized polyphenols called tannins, antioxidant nutrients such as carotenoids, tocopherols, ascorbic acids and fluoride have been accepted as important components of tea on dental health<sup>1,2,8</sup>.

Fluoride significantly reduces caries risk. Studies showed that children in communities with fluoridated water had fewer cavities than the children living in

communities with insufficient fluoride in early sixties<sup>9,10</sup>. In developed countries, risk of dental fluorosis lead researchers to re-evaluate the benefits of systemic fluoride<sup>11,12</sup>. Epidemiological evidence showed that ingestion of high concentrations of fluoride could cause severe fluorosis. With widespread usage of fluoride toothpaste and other fluoride sources such as processed foods and beverages, greater fluorosis risk prompted the investigators to suggest various educational efforts and controls of extraneous sources of fluoride<sup>9-12</sup>. High levels of fluoride in tea may have anti-caries potential, but the role on dental fluorosis should be taken into account especially for young consumers.

Studies have focused primarily on black tea since 80% of the tea consumed is this type, especially in Europe and North America<sup>1,2</sup>. However, there is a wide variety of tea and herbal tea available in the market, with no data on fluoride content. Therefore, the purpose of this study was to determine fluoride concentrations in black and herbal teas available in Turkey, and investigate the

children's tea preferences and frequency with reference to socioeconomic status (SES).

## Materials and Methods

### Preparation of Tea Infusions

A total of 13 commercial herbal and black tea samples were used (Tab. 1). 2 samples from each tea brand were purchased from the market and prepared. All the samples were prepared in plastic containers with lids.

Tea samples that were presented as tea bags were prepared by keeping a bag in 100ml boiled distilled water (100 °C) for 5 minutes. The infant tea, presented as a brewing bag, was prepared by adding 100 ml distilled water at 80°C and brewed in boiling tank for 2 hours. Dried tea leave samples were weighed and 1g of tealeaves was brewed in 100 ml of distilled water at 80°C for 2 hours in a boiling tank.

Table 1. Tea samples and their preparation techniques

Tea Type	Preparation
<b>Herbal teas</b>	
Apple	Tea bag
Linden	Tea bag
Daisy	Tea bag
Rosehip	Tea bag
Children's tea*	Tea bag
Infant tea**	Brewing bag
<b>Black teas</b>	
Lipton Yellow Label	Tea bag
Stassen Pure Ceylon Tea	Tea bag
Lipton (Strawberry)	Tea bag
Lipton Earl Grey (Bergami)	Tea bag
Lipton Yellow Label	Tea leaves
Caykur Rize	Tea leaves
Tomurcuk (Bergami)	Tea leaves

\* Content of children's tea: Fennel, anise, root of licorine plant, peppermint leaves, yellow daisy flower

\*\* Content of infant tea: Daisy, peppermint, anise)

### Measurement of Fluoride Content

Fluoride contents were measured by using a fluoride ion selective electrode (96-09 BN Orion Ionplus fluoride) attached to a digital pH-meter (Jenco 671P). The fluoride ion selective electrode was calibrated by standard solutions

of  $10^{-1}$ ,  $10^{-2}$ ,  $10^{-3}$ ,  $10^{-4}$ ,  $10^{-5}$ ,  $10^{-6}$  M NaF at the start of the measuring and repeated every 2 hours. Equal amounts of TISAB II buffer solution was added to the samples during fluoride measurements. The measured fluoride content was in milivolt, so a computer programme was used to change milivolt readings to ppm values.

2 ml of tea was taken from samples prepared by tea bags straight after the preparation and fluoride content was measured. This was repeated 3 times for each tea sample. Mean of 3 measurements was recorded.

Fluoride contents of the brewed samples were measured in 5 minutes, 10 minutes, 15 minutes, 30 minutes, 1 hour and 2 hour intervals. 2 samples for each time interval was taken and mean of both measurements were recorded.

### Questionnaire

A questionnaire consisting 10 questions on SES and tea drinking frequency was applied to 200 children at the age of 8-9 years. All children were living in Izmir, with fluoride concentration of 0.4ppm in drinking water. Children were categorized as none, medium (1-3 cups/day) and heavy (>4 cups/day) drinkers according to their tea consumption frequency per day. The findings were evaluated statistically by  $\chi^2$  test.

## Results

### Fluoride contents of teas

Fluoride contents that were measured after 5 minutes for teas prepared by tea bags are presented in table 2. Fluoride contents of teas prepared by brewing for 2 hours are presented in table 3.

Table 2. Fluoride contents of teas prepared by tea bags (ppm)

Herbal teas	Fluoride content (ppm) $\pm$ SE
Children's tea	0.12 $\pm$ 0.003
Linden	0.12 $\pm$ 0.006
Daisy	0.12 $\pm$ 0.005
Rosehip	0.14 $\pm$ 0.005
Apple tea	0.17 $\pm$ 0.003
<b>Black teas</b>	
Lipton yellow label	0.32 $\pm$ 0.006
Lipton – Strawberry flavour	0.92 $\pm$ 0.008
Stassen Pure Ceylon Tea	1.09 $\pm$ 0.002
Lipton Earl Grey	1.27 $\pm$ 0.005

Table 3. Fluoride contents of teas during brewing (ppm)

TEA	5'	10'	15'	30'	60'	120'
Infant tea	0.07	0.07	0.08	0.09	0.07	0.06
Lipton	0.83	0.87	1.01	1.06	1.01	1.01
Caykur Rize	0.62	0.68	0.75	0.83	0.79	0.79
Tomurcuk	0.83	0.92	1.01	1.06	1.06	1.17

### Questionnaire findings

Questionnaire findings revealed that 120 children were from low SES whereas 80 children were from high SES. The children who preferred to drink black tea were higher in low SESs (Fig. 1). Herbal tea drinking frequency was higher in high SES (Fig. 2). There was a statistically significant difference among SES and frequent black tea consumption ( $p < 0.01$ ). It was recorded that all children drink all kinds of tea with sugar.

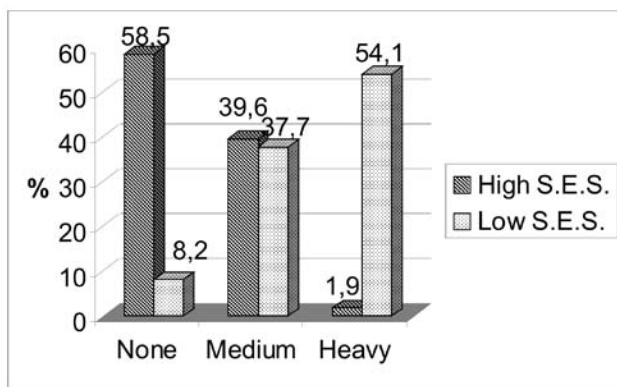


Figure 1. Black tea drinking frequency among children (%)

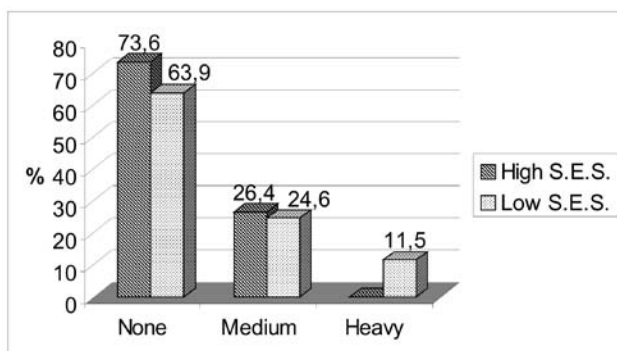


Figure 2. Herbal tea drinking frequency among children (%)

### Discussion

There are several studies on diet, nutrition or frequency of food consumption and dental caries that are showing the hazardous effect of sugar<sup>13</sup>. Diet may contain anti-cariogenic potential, as well as cariogenic effect. One of such snack drink is tea - in one hand there is a beneficial effect of fluoride, but with sugar content it is a cariogenic challenge.

However, the evidence of beneficial reduction in caries by systemic fluoride should be considered together with the increased prevalence of dental fluorosis<sup>9-11</sup>. Franco et al<sup>14</sup> recently reported that daily fluoride intake of young children was above the upper estimated threshold of 0.07 mg/kg/day. The 2 major sources of systemic ingested fluoride in the study by Franco et al<sup>14</sup> were fluoridated

salt and dentifrices. Systemic review of water fluoridation also reported increased prevalence of dental fluorosis and focused on reconsidering the sources of high fluoride<sup>10</sup>.

Tea is comparatively cheap and is readily available drink for consuming enjoyably. Fluoride is accumulated mainly in tea leaves and increased with age of the leaf. Lu et al<sup>15</sup> reported that fluoride could be regarded as a qualitatively important element in tea and that it could be used as a quality estimation of the product. Fluoride concentrations in tea infusions of green, oolong or black tea ranged from 0.6 to 1.9 mg/l, whereas brick tea liquors contain 4.8 to 7.3 mg/l<sup>16</sup>. The high fluoride contents in brick teas were due to the use of old leaves<sup>16,17</sup>. Chan and Koh<sup>18</sup> reported that de-cafeinated tea had higher fluoride content. In the present study, the fluoride amount released by brewing increased by time especially in half an hour and higher concentrations were measured with scented teas (bergami). On the other hand, similar to our findings, Hayacibara et al<sup>19</sup> also reported that fluoride levels in herbal teas were very low.

Simpson et al<sup>20</sup> demonstrated that tea can provide an effective vehicle for fluoride delivery to the oral cavity and this may lead to local topical as well as the systemic effects. Jamel et al<sup>21</sup> reported that beneficial effects of consuming tea due to its high fluoride content on dental caries were outweighed by the impact of the sugar levels in the tea consumed. In our study, it was found that all the children drink all kinds of tea with sugar.

Ramsey et al<sup>22</sup> evaluated the effect of tea drinking on dental caries in 12 years old children for 2 years and reported that children who drank 4-4.9 cups of tea had 1.5 more increase in the DMF-S index.

Duckworth<sup>23</sup> reported that tea consumption was showing an increase by age and that the children at the age of 7 were not usually drinking tea. However, Malde et al<sup>24</sup> reported that most children in rural areas in Ethiopia had been introduced to tea before the age of 12 months. Therefore, it seems that there is a cultural difference among tea consumption among young children and, similar to our findings, it is reported that children from lower SES were drinking tea more frequently<sup>25</sup>.

It is clear that there is a high fluoride concentration in black tea infusions and not a clear relationship is found among beneficial effects of this on dental caries or the effect on dental fluorosis. Therefore, there is a great need for further studies to evaluate the role of black tea drinking, especially for young children, as a preventive agent or a factor in dental fluorosis.

### References

1. Wu CD, Wei G-X. Tea as a functional food for oral health. *Nutrition*, 2002; 18:443-44.

2. Mitscher LA, Jung M, Shankel D, Dou J-H, Steele L, Pillai SP. Chemoprotection: a review of the potential therapeutic antioxidant properties of green tea (*Camella sinensis*) and certain of its constituents. *Medicinal Research Reviews*, 1997; 17:327-365.
3. Ooshima T, Minami T, Aono W, Tamura Y, Hamada S. Reduction of dental plaque deposition in humans by oolong tea extract. *Caries Res*, 1994; 28:146-149.
4. Matsumoto M, Minami T, Sasaki H, Sobue S, Hamada S, Ooshima T. Inhibitory effects of oolong tea extract on caries-inducing properties of Mutans Streptococci. *Caries Res*, 1999; 33:441-445.
5. Ooshima T, Minami T, Matsumoto M, Fujiwara T, Sobue S, Hamada S. Comparison of the cariostatic effects between regimens to administer oolong tea polyphenols in SPF rats. *Caries Res*, 1998; 32:75-80.
6. Matsumoto M, Hamada S, Ooshima T. Molecular analysis of the inhibitory effects of oolong tea polyphenols on glucan-binding domain of recombinant glucosyltransferases from *Streptococcus Mutans* MT8148. *FEMS Microbiology Letters*, 2003; 228:73-80.
7. Esimone CO, Adikwu MU, Nwafor SV, Okolo CO. Potential use of tea extract as a complementary mouthwash: comparative evaluation of two commercial samples. *The Journal of Alternative Complimentary Medicine*, 2001; 7:523-527.
8. Linke HAB, LeGeros RZ. Black tea extract and dental caries formation in hamsters. *International Journal of Food Sciences and Nutrition*, 2003; 54:89-95.
9. Horowitz HS. The future of water fluoridation and other systemic fluorides. *J Dent Res*, 1990; 69:760-764.
10. McDonagh, Whiting PF, Wilson PM, Sutton A, Chestnutt I, Cooper J, Misso K, Bradley M, Treasure E, Kleijnen J. Systemic review of water fluoridation. *Br Med J*, 2000; 321:855-859.
11. Villa AG, Guerrero S, Villalobos J, Anabalón M. Dental fluorosis in Chilean children: evaluation of risk factors. *Comm Dent Oral Epidemiol*, 1998; 26:310-315.
12. Cao J, Zhao Y, Liu J. Prevention of brick tea fluorosis in rats with low-fluoride brick tea on laboratory observation. *Food and Chemical Toxicology*, 2001; 39:615-619.
13. König KG. Diet and oral health. *Int Dent J*, 2000; 50:162-174.
14. Franco AM, Martignon S, Saldarriaga A, Gonzales MC, Arbelaez MI, Ocampo A, Luna LM, Martinez-Mier AE, Villa AE. Total fluoride intake in children aged 22-35 months in four Colombian cities. *Comm Dent Oral Epidemiol*, 2005; 33:1-8.
15. Lu YI, Guo Wen-Fei, Yang X-Q. Fluoride content in tea and its relationship with tea quality. *Journal of Agricultural and Food Chemistry*, 2004; 52:472-476.
16. Wong MH, Fung KF, Carr HP. Aluminium and fluoride contents of tea, with emphasis on brick tea and their health implications. *Toxicology Letters*, 2003; 137:111-120.
17. Shu WS, Zhang ZQ, Lan CY, Wong MH. Fluoride and aluminium concentrations of tea plants and tea products from Sichuan Province, PR China. *Chemosphere*, 2003; 52:1475-1482.
18. Chan, JT, Koh, SH. Fluoride content in caffeinated, decaffeinated and herbal teas. *Caries Res*, 1996; 30:88-92.
19. Hayacibara MF, Queirioz CS, Tabchoury CPM, Cury JA. Fluoride and aluminium in teas and tea-based beverages. *Revista de Saúde Pública*, 2004; 38:100-105.
20. Simpson A, Shaw L, Smith AJ. The bio-availability of fluoride from black tea. *J Dent*, 2001; 29:15-21.
21. Jamel HA, Sheiham A, Watt RG, Cowell CR. Sweet preference, consumption of sweet tea and dental caries; studies in urban and rural Iraqi populations. *Int Dent J*, 1997; 47:213-217.
22. Ramsey AC, Hardwick JL, Tamacas JC. Fluoride intakes and caries increments in relation to tea consumption by British children. *Caries Res*, 1975; 9:312. (Abstract)
23. Duckworth SC, Duckworth R. The ingestion of fluoride in tea. *Br Dent J*, 1978; 45:368-370.
24. Malde MK, Zerihun L, Julshamn K, Biorvatn K. Fluoride intake in children living in a high-fluoride area in Ethiopia-intake through beverages. *Int J Paediat Dent*, 2003; 13:27-34.
25. Sayegh A, Dini EL, Holt RD, Bedi R. Food and drink consumption, sociodemographic factors and dental caries in 4-5-year-old children in Amman, Jordan. *Br Dent J*, 2002; 192:37-42.

---

Correspondence and request for offprints to:

Ece Eden  
Ege University, School of Dentistry  
Department of Paedodontics  
35100, Bornova-Izmir  
Turkey  
E-mail: eceeden@yahoo.com