

FLUORIDE CONTENT OF IRANIAN BLACK TEA AND TEA LIQUOR

Amir Hussein Mahvi,^a Mohammad Ali Zazoli,^b Masoud Younecian,^a Yahya Esfandiari^b

Tehran, Iran

SUMMARY: The objectives of this study were to investigate the fluoride (F) content of various commercial brands of tea (*Camellia sinensis* L) marketed in Iran and to compare the release of F from them by infusion. The minimum and maximum F content was 35 ± 6 mg/kg and 182 ± 20 mg/kg in Sedaghat and Sharzad tea, respectively. The F content of tea liquor prepared by customary infusion from these teas ranged from 0.53 ± 0.07 to 2.60 ± 0.18 mg/L. The percentage of total F released into the tea liquor by infusion from the dried tea ranged from $67.7\pm 8\%$ for Golestan tea to $91.0\pm 4\%$ for Ahamad tea.

Keywords: *Camellia sinensis*; Fluoride in tea; Iranian tea; Tea infusion.

INTRODUCTION

Tea, whether black or green, is naturally rich in fluoride (F). Worldwide, black tea is one of the major teas used to prepare infusions for drinking.¹ The tea plant (*Camellia sinensis* L) takes up F from the soil and accumulates it in the leaves. Tea therefore can be a major source of human F intake.² The F content of tea plants is reported to range between 3.2 and 260 mg/kg, mostly between 100 and 200 mg/kg. In some publications, the F content is reported to be as high as 400 mg/kg.³ A substantial amount of F present in tea leaves is released during tea infusion, and nearly all (about 94.9%) of the released F is estimated to be absorbed by the body from tea infusions.^{4,5}

A perennial crop, the tea plant matures after 7 years of growth and, with careful field maintenance and regular pruning, can be plucked at a steady yield for up to 100 years. Favorable conditions for tea cultivation include a suitable temperature (15–25°C), high relative humidity (80–90%), and high annual rainfall (1500–2000 mm).⁵ Tea plantations in Iran are found in northern Iran in Gilan and Mazandaran provinces, where mist and high humidity ensure that the leaves grow slowly and remain tender. Most of the tea consumed in Iran is grown in these northern regions, but some tea is purchased from other countries, especially from India.

The main objectives of the present study were to determine the F content of various Iranian black teas and to compare the release of F from them by customary infusion.

MATERIALS AND METHODS

Sampling and analytical methods: Ten of the most widely consumed brands of Iranian black tea were purchased from local bazaar markets. Four to eight samples (60 altogether) of each brand were collected and analyzed. F concentrations in the tea and tea infusions were determined by the method of Duckworth and Duckworth with a F ion selective electrode (ISE) calibrated against a standard sodium fluoride solution in deionized water.⁴

Preparation of dried tea samples: For determining F content in tea, a weighed 0.1-g sample of tea dried at 60°C for 5 hr was mixed with 3 mL of 0.1 N NaOH in a nickel crucible which was placed in an oven at 150°C for 2.5 hr. After the water was vaporized, the crucible was heated in a muffle furnace at

^aFor correspondence: Amir Hossein Mahvi, School of Public Health, Center for Environmental Research, Tehran University of Medical Sciences, Tehran, Iran; E-mail: ahmahvi@yahoo.com;

^bEnvironmental Health Research Center and Department of Environmental Engineering, School of Health, Mazandaran University of Medical Sciences, Sari, Iran.

300°C and then 600°C for 30 min. The sample was allowed to cool and 5 mL of distilled water was added. Then 3 mL of 37% HCl was added to adjust the pH to 8–9, and the sample was transferred to a 100-mL volumetric flask to which an equal volume of total ionic strength adjustment buffer (TISAB) was added. The solution was diluted to the mark with distilled water and filtered through Whatman No. 40 filter paper.⁵ The TISAB solution was prepared by dissolving 22.05 g of sodium citrate dehydrate and 0.8 g of sodium hydroxide in deionized water and diluting to 100 mL. Afterward the pH was adjusted to 5.3 with perchloric acid.⁶

Tea infusion procedure: To each 2.0-g sample of tea dried as above, the Iranian manner of tea infusion was performed by addition of 50-mL of boiling deionized water and the mixture kept at 80°C on a water bath for 5–20 min (usually 10 min). At the end of the infusion period, the tea extract was diluted to 100 mL with deionized water,⁶ and the F concentration was determined by the ISE method.⁴

RESULTS

Table 1 shows that the total F content determined by alkaline extraction in 10 brands of dried Iranian tea ranged from 35±6 to 182±20 mg/kg.

Table 2 indicates that the water-soluble F extracted from the dried tea samples into the tea liquor by infusion varied between 0.57 mg/L from Sedaghat tea and 2.6 mg/L from Sharzad tea. As can be readily calculated from the data in tables, the percentage of the total F content of the dried tea released into the tea liquor ranged from about 67.7% for Golestan tea to 91% for Ahamad tea.

The results of a questionnaire showed that 66% of those who responded (from 1300 replies) consumed Sedaghat tea. Another 13.5%, 10.5%, and 5% of respondents consumed Sharzad, Kousar, and Ahamad tea, respectively. The questionnaire also revealed that 85% of respondents drank tea at meals three times a day and that each person consumed an average of 4 glasses of tea per day totaling about 400 mL.

DISCUSSION

This study revealed a wide range of F content in 10 brands of Iranian dried black tea with F concentrations in tea liquor prepared by infusion varying from 0.53 to 2.6 mg/L. About 68% to 91% of the total F in the dried tea was released into the tea liquor. Iranian tea, therefore, can provide substantial amounts of F in the daily diet.

A recent study in Turkey showed that F concentrations in tea infusions of 9 different brands of Turkish and imported black teas were somewhat higher than found here, ranging from 0.64 to 3.55 mg/L.³ Cao et al.,⁷ reported that among black, green, and Oolong packed teas, the F content ranged from 41.5 to 212.4 mg/kg tea, and they found that bottled and canned tea beverages had F concentrations ranging from 0.19 to 1.85 mg F/L, with the highest in Oolong tea beverages. Chronic toxic levels of F consumption from some of these newer tea commodities are possible. Another Chinese study revealed that the F content in fallen tea leaves (0.6–2.8 mg/g) was higher than that in young leaves (0.3–1.0 mg/g).⁵ In that work 24 to 83% of the total F content of the original tea leaf samples was extracted in preparing infusions. Brick tea was found to release an extremely high amount of F into customary infusions (7.34 mg/L) compared with that released from black tea (1.89 mg/L) or green tea (1.60 mg/L).⁵

Table 1. Total F content of ten brands of dried Iranian black tea

Tea brand name	No. of samples	Total F content (mg/kg)	
		Range	Mean±SD
Ahamad	5	78 – 118	99 ± 24
Dow Ghazal	8	95 – 13	104 ± 11
Golestan	6	159 – 193	182 ± 20
Jahan	6	40 – 49	49 ± 11
Khojasteh	5	12 –165	143 ± 29
Kousar	6	73 – 87	80 ± 9
Mahmoud	7	108 –135	121± 16
Rounas	4	35 – 62	50 ± 16
Sedaghat	7	30 – 38	35 ± 6
Sharzad	6	165 –195	182 ± 20

Table 2. Percent of F infused from ten brands of dried Iranian black tea and concentration of F in resulting tea liquor

Tea brand name	% of F infused		F concentration (mg/L)
	Range	Mean±SD	Mean±SD
Ahamad	85 – 93	91.0 ± 4	1.80 ± 0.10
Dow Ghazal	73 – 84.5	79.6 ± 7	1.65 ± 0.08
Golestan	60 – 76	67.7 ± 8	2.40 ± 0.27
Jahan	73 – 93	84.7 ± 10	0.82 ± 0.09
Khojasteh	69 – 86	77.0 ± 13	2.22 ± 0.24
Kousar	76 – 95	85.0 ± 11	1.36 ± 0.16
Mahmoud	81– 92	87.0 ± 6	2.10 ± 0.19
Rounas	75 – 87	80.6 ± 8	0.80 ± 0.10
Sedaghat	72.5 – 80	75.5 ± 5	0.53 ± 0.07
Sharzad	65 – 81	74.0 ± 9	2.60 ± 0.18

In our study, assuming the consumption of four normal-size (100 mL) servings of tea liquor per day, with each serving containing a 1:1 dilution of the original infusion, we calculate the daily F intake from black teas in Iran to be in the range of 1.06 to 5.2 mg/day. Thus, drinking black tea can make a significant contribution to the daily dietary intake of F in Iran.

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