

Determination of Fluoride Content in Tea Infusions Sold in Karachi Using Fluoride Ion Selective Electrode

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ABSTRACT

Fluoride intake is recognized to be important for dental health. Potentiometric analysis of fluoride content ion (F^-) in solutions by using fluoride ion-selective electrode is simple, reliable and cheap. Very small concentrations of fluoride-ions ($10^{-6} \text{ mol.dm}^{-3}$) can be determined by fluoride selective electrode. The purpose of this study was to estimate the fluoride contents in various commercially available tea infusions with a specific focus on risk of dental caries and fluorosis. 100 mL of 44 different tea brands were kept at boiling temperature and fluoride concentrations were measured at 5, 10 and 15 min using ion selective electrode. In case of tea bags tea infusions were analyzed for fluoride at 5 min after introducing tea bag in boiling water with no further heating. After 5 min at boiling temperature, the mean fluoride concentration for black, green and herbal tea infusions were 1.51 – 7.97, 1.22 – 5.94 and 0.08 – 0.16 respectively.

Keywords: Fluoride, fluoride selective electrode, fluorosis, tea infusions.

1. INTRODUCTION

Fluoride (F^-) is a very important micronutrient present in food stuffs and in drinking water in different concentrations. It is a dual natured ion. A moderate amount of fluoride is considered beneficial for the prevention of dental caries as well as for the treatment of osteoporosis [1 – 4]. However, exposure to high levels of fluoride has adverse effects and may cause symptoms ranging from darkening of teeth in children to as severe as osteoarthritis in adults on prolonged consumption [1, 2, 5]. Furthermore its excessive intake also affects parathyroid gland [6], kidney and liver [7]. Fluoride intake is considered very important for dental health. The daily intake of fluoride from all sources is set to be 0.05 – 0.06 mg/kg body weight per day regardless of the sex and age [8 – 10]. While for adults its lethal dose is 0.2 – 0.35 gm/kg body weight [11].

Tea (*Camilla sinensis*) is a unique evergreen plant which can give yields up to 100 years if cured and regularly pruned [12, 13]. The favorable conditions for tea cultivation are high humidity (Up to 90%), high annual rainfall (1500 – 2000mm), moderate temperature (15 – 25) °C and low pH (4.5 – 6.5) [12 – 14]. Tea (*Camilla sinensis*) has some therapeutic effects against cancer [15 – 17], vascular diseases [15, 18], hypertension [19] and dental caries [20]. Tea contains some essential minerals like potassium, magnesium and manganese and its daily consumption may significantly contribute to the dietary requirements of these minerals [21 – 23]. Due to its attractive aroma and taste, tea has become the second largest consumed beverage in the world after water [2, 25, 26]. In Asia, tea has been drunk for more than 4000 years [2, 26]. Pakistani people are fond of consuming tea. They drink tea all day long especially at breakfast and in evening.

Along with beneficial effects, the consumption of tea in large quantity may have adverse effects as it is one of potentially dangerous source of fluoride [1]. It selectively absorbs fluoride from the soil and environment and accumulates most of it (98%) in its leaves [27] which on brewing release most of the fluoride in infusion that is available for consumer. so, consumption of tea may contribute significantly to a person's fluoride dietary requirement [28].

According to the degree of fermentation process tea is classified into mainly three types i.e. green (unfermented), oolong (semi fermented 10 – 70 %) and black (fully fermented 80 – 100 %) [25, 29]. Tea with herbal supplements is also available in the markets. These herbal teas do not contain traditional black tea leaves, rather only composed of dried food products and dried fruit leaves together with fillers and flavoring agents. Traditionally green and black teas are most popular in south Asian countries whereas black tea is very popular in western countries [24]. The aim of the present study was to estimate the fluoride contents in tea infusions commercially available in Karachi and to relate this to the risk of fluorosis.

2. MATERIALS AND METHODS

Forty four different brands of tea were purchased from commercial outlets in different areas of Karachi. 2.00 gm of dry tea leaves were weighted with digital balance. These tea leaves were each placed in beaker containing 100 mL of pre – heated distilled water at 100 °C [21, 29]. As soon as tea leaves were put into the beakers the time was noted. The samples

of different tea infusions were taken at 5, 10 and 15 minutes with continuous heating. In case of tea bags, the samples were put into 100 mL of boiling water and their infusions were taken only at 5 minutes with no further heating which is the traditional procedure. Each infusion was then poured into 100 mL volumetric flask and make up to compensate the evaporation loss. Each sample was then cooled to ambient temperature and fluoride concentration was determined by means of ion specific electrode for fluoride. Each sample was thoroughly mixed at 1:1 total ionic strength adjustment (TISAB II) prior to analysis [26].

3. RESULTS

The fluoride concentrations of tested black, green, herbal tea and tea bags are listed in table 1 – 3.

Table 1: Fluoride concentration (mg/L) in black tea infusions

Type of Tea/Brand	Time of Brewing (min)		
	5	10	15
International (loose)	3.446±0.035	3.473±0.031	3.78±0.025
International (loose)	3.686±0.053	3.763±0.006	3.84±0.031
Local (loose)	3.763±0.086	3.75±0.01	3.61±0.025
Local (loose)	2.92±0.025	2.923±0.015	3.03±0.022
Local (loose)	5.046±0.045	5.157±0.012	5.16±0.025
Local (loose)	6.847±0.035	7.03±0.045	7.08±0.052
Local (loose)	3.856±0.015	3.92±0.025	3.93±0.045
Local (loose)	7.967±0.025	8.07±0.05	8.24±0.425
Local (loose)	6.39±0.05	6.4±0.031	6.44±0.05
Local (loose)	5.143±0.025	5.5±0.015	5.52±0.072
Local (loose)	5.237±0.025	5.51±0.025	5.53±0.052
Local (loose)	7.063±0.050	7.15±0.022	7.16±0.075
Local (loose)	5.247±0.025	5.28±0.032	5.31±0.031
Local (loose)	5.057±0.015	5.29±0.031	5.31±0.012
Local (loose)	6.343±0.031	6.44±0.031	6.47±0.025
Local (loose)	6.553±0.031	6.93±0.045	6.92±0.025
Local (loose)	4.767±0.351	5±0.012	4.93±0.05
Local (loose)	3.26±0.025	3.26±0.05	3.24±0.023
Local (loose)	5.74±0.045	5.93±0.023	5.94±0.022
Local (loose)	2.88±0.035	2.89±0.031	2.92±0.031
Local (loose)	4.35±0.045	4.36±0.015	4.61±0.015
Local (loose)	2.66±0.025	2.67±0.012	2.63±0.025
Local (loose)	3.99±0.022	4.27±0.025	4.33±0.025
Local (loose)	2.69±0.025	2.76±0.012	2.75±0.015
International (bag)	4.03±0.05	N/A	N/A
International (bag)	8.62±0.075	N/A	N/A
International (bag)	1.51±0.005	N/A	N/A
Local (bag)	3.68±0.031	N/A	N/A
Local (bag)	2.89±0.05	N/A	N/A
Local (bag)	2.48±0.025	N/A	N/A

Table 2: Fluoride concentration (*mg/L*) in green tea infusions

Type of Tea/ Brand	Time of Brewing (<i>min</i>)		
	5	10	15
International (loose)	2.16±0.022	2.13±0.025	2.13±0.022
International (loose)	2.96±0.025	3.32±0.015	3.34±0.023
Local (loose)	2.89±0.015	2.74±0.05	2.77±0.025
Local (loose)	2.89±0.023	3.19±0.052	3.14±0.015
Local (loose)	1.22±0.005	1.29±0.023	1.42±0.05
Local (loose)	1.32±0.023	1.51±0.015	1.45±0.005
Local (bag)	5.94±0.025	N/A	N/A
Local (bag)	4.85±0.022	N/A	N/A

Table 3: Fluoride concentration (*mg/L*) in herbal tea infusions

Type of Tea/Brand	Time of Brewing (<i>min</i>)		
	5	10	15
International (bag)	0.13±0.002	N/A	N/A
International (bag)	0.16±0.002	N/A	N/A
International (bag)	0.08±0.005	N/A	N/A
Local (loose)	0.16±0.015	0.13±0.002	0.11±0.002
Local (loose)	0.1±0.001	0.09±0.002	0.08±0.001
Local (bag)	0.08±0.001	N/A	N/A

4. DISCUSSION

In the present study, fluoride has been analyzed in black, green and herbal tea infusions using ion selective electrode. The concentrations of fluoride ion in black tea infusion were found to be highest among all the three tea types and were found to be (1.51 to 7.97) while it was lowest in herbal tea infusions and was found to be (0.08 to 0.16). About 98 % of the total stored fluoride in tea plant accumulated in its leaves most of which is available for the consumer.

The results from the present study support the data reported previously in other regional tea fluoride analysis. In general, tea infusions tend to contain relatively high concentrations of fluoride [1, 30–34]. As previous studies reveal [1, 2, 21, 30, 32, 35], black tea infusions demonstrated the highest concentration of fluoride while herbal tea infusion have the lowest concentration with a mean value of (0.12 ppm).

As mentioned earlier, fluoride consumption in small amount is beneficial for health. Fluoride in oral environment ensures the reduction of dental caries [36]. So, it has been recommended that community drinking water should be fluoridated at a concentration between 0.7 – 1.2 ppm to fight against dental caries [37].

Almost all black teas analyzed in this study met or exceed the optimal fluoride concentration for the prevention of dental caries. Thus a person consuming excessive black tea is not at a risk of catching caries.

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