

# Decision to fluoridate. 1. Fluoride levels in herbal teas used in Lebanese communities

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## Abstract

*This study assessed fluoride levels in herbal teas available in the Lebanese market, taking into consideration methods of preparation and time. The fluoride contents of two-minute decoctions prepared from 25 different brands of herbal teas were measured. Only tea and maté were prepared as infusions, and decoctions were prepared from tea, anise, mint, and mixed herbs (0.5, 1, 2, 3, 4, 5, and 10 minutes). For two-minute decoctions, fluoride concentrations ranged from 0.620 to 1.680 mg/L for tea (mean, 0.955 mg/L), 0.056 to 0.060 mg/L for anise (mean, 0.058), 0.030 to 0.037 mg/L for mint (mean, 0.033), 0.010 to 0.068 mg/L for mixed herbs (mean, 0.039), and 0.143 to 0.185 mg/L for maté (mean, 0.160). More fluoride was leached in tea decoctions than in infusions with the same preparation time. Leaching of fluoride reached a maximum after boiling for 10 minutes for tea, mint, and mixed herbs; boiling for 3 minutes for anise; and five runs for maté. Fluoride levels were highest in tea decoctions, followed by mixed herbs, anise, and mint. These findings point to the importance of considering fluoride levels from herbal teas in the overall determination of fluoride intake. In addition, such studies enrich databases required when considering fluoridation as a policy issue.*

## Introduction

The ingestion of herbal teas is a widespread cultural habit of rural and urban Lebanese communities. Studies have shown that herbal teas could account for a

sizeable proportion of total dietary fluoride [1, 2]. The anticariogenic effect of fluoride is well documented in the literature [3], and so are undesirable effects from excessive intake, such as enamel fluorosis [4]. Indeed, health professionals are concerned with the increase of fluoride ingestion from dentifrices, rinses, fluoridated water, and foods and beverages with high fluoride content. This study was set up to determine fluoride levels in herbal teas ingested in urban and rural Lebanese communities, taking into consideration local preparation methods. The findings of this study will constitute a basis for researchers interested in determining the fluoride intake of Lebanese families that consume these herbal teas. In addition, it will enrich the database required for considering policy issues relevant to fluoridation.

## Materials and methods

### Study population

A random sample of urban and rural families was selected to identify herbal teas used in Lebanese communities and their method of preparation. Urban families ( $n = 70$ ) in Beirut were selected at random from a list available at the Population Laboratory Project offices [5]. Rural families ( $n = 90$ ) in three villages of the Shouf area in Mount Lebanon were selected at random from lists obtained from their respective mayors. Data were collected by interview, and all families were responsive because of the non-personal nature of the questions.

### Herbal teas

The families were surveyed regarding types of herbal teas consumed and their mode of preparation. Based on this survey, the following herbs were identified for inclusion in this study: tea (*Camellia sinensis*, Family Theaceae), anise (*Pimpinella anisum*, Family Umbelliferae), mint (*Mentha piperita*, Family Labiatae), and

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maté (*Ilex parauariensis*, Family Aquifoliaceae). Mixed herbs were also used. These consisted of a combination of herbs, such as chamomile, cherry stalks, corn silk, hyssop, linden, mallow, rose, St. Joseph wort, senna, etc. None of the families reported drinking decaffeinated teas. A survey was also conducted in the areas of the selected families to identify the brands of herbal teas (packaged and unpackaged) available for their use. Unpackaged herbal tea brands were obtained from specialized shops known as Attars' shops.

### Methods of preparation of herbal tea

Maté was prepared as an infusion, tea as an infusion or a decoction, and other herbal teas as decoctions only. An infusion is made by pouring boiling water over the herb and letting it stand until the tea is sufficiently strong. A decoction is made by boiling the herb in water to bring out its fragrant oils [6]. Most of the study families prepared decoctions with an estimated boiling time of two minutes.

### Fluoride determination

Twenty-five brands of herbal tea were purchased from local supermarkets and Attars' shops, and the fluoride levels in two-minute decoctions of these brands were calculated. The decoctions were prepared by adding an amount of herbal tea leaves similar to the mean amount reported used by the study families (table 1) to 100 ml of boiling deionized water. Four sets of decoctions were made for every herbal tea brand and the mean values are reported. Assessment was also made of the total fluoride contents of the dry leaves. For the investigation of the effect of infusion and boiling times on herbal teas, the brands most commonly used by the study families were selected. Infusions were prepared by adding the amount of herbal tea used by the study families to 100 ml of deionized water preheated to 85°C. The flasks were placed in a water bath, and samples were taken at intervals of 0.5, 1, 2, 3, 4, 5, and 10 minutes. Four trials were run for tea infusions for each soaking time, and the mean fluoride levels were calculated. Decoctions were prepared as noted above, and samples were taken at intervals of 0.5, 1, 2, 3, 4, 5, and 10 minutes. Four trials were also

run for decoctions of herbal teas for each boiling time, and the mean fluoride values were calculated. Maté was prepared as a two-minute infusion and six runs were made for these infusions. A run is defined as pouring boiling water on the maté herbal tea and filtering it out after two minutes, with the initial amount of maté used throughout the six runs. Fluoride levels were calculated for all six runs, in addition to fluoride levels per dry weight of the herbal tea.

Fluoride determinations were assessed after preliminary distillation using an ionic selective meter (Model 407A, Orion Research) with a combination fluoride-selective electrode. Standard fluoride solutions and total ionic strength adjustment buffers (TISAB II) were prepared according to the Standard Methods for the Examination of Water and Waste Water [7].

## Results

### Amounts of herbs used

The quantity of herbs used per 100 ml of water varied with the type of herb used. The mean amount was  $1.00 \pm 0.05$  g for tea,  $2.00 \pm 1.30$  g for anise,  $0.50 \pm 0.00$  g for mint,  $1.00 \pm 0.5$  g for mixed herbs, and  $0.69 \pm 0.00$  g for maté (table 1). Similar amounts of maté and mint were used by the study families.

### Fluoride levels in different herbal tea brands

For two-minute decoctions, the fluoride concentrations ranged from 0.620 to 1.680 mg/L for tea (mean, 0.955), 0.056 to 0.060 mg/L for anise (mean, 0.058), 0.030 to 0.037 mg/L for mint (mean, 0.033), 0.010 to 0.068 mg/L for mixed herbs (mean, 0.039), and 0.143 to 0.185 mg/L for maté (mean, 0.160) (table 2).

### Fluoride levels in tea

Decoctions leached more fluoride from tea than infusions for the same preparation time. Fluoride levels ranged from 0.38 to 0.85 mg/L for soaking times of 0.5 to 10 minutes, and the maximum was reached after soaking for 10 minutes (table 3). Fluoride levels in tea decoctions ranged from 0.460 to 1.050 mg/L for boiling times that ranged from 0.5 to 10 minutes. Leaching of fluoride from tea reached a maximum after boiling for 10 minutes (table 4).

### Fluoride levels in other herbal teas

The fluoride levels in other herbal teas are presented in tables 4 and 5. Fluoride levels in anise decoctions ranged from 0.046 to 0.060 mg/L for boiling times that ranged from 0.5 to 10 minutes. Leaching of fluoride started to increase after 2 minutes and reached a maximum after boiling for 3 minutes. Fluoride levels in mint decoctions ranged from 0.030 to 0.083 mg/L

TABLE 1. Herbs used in the preparation of herbal teas

Herbal tea	Mean $\pm$ SD amount used (g/100 ml water)
Tea	$1.00 \pm 0.05$
Anise	$2.00 \pm 1.30$
Mint	$0.50 \pm 0.00$
Mixed herbs	$1.00 \pm 0.50$
Maté	$0.69 \pm 0.00$

TABLE 2. Fluoride levels in two-minute decoctions prepared from different brands of herbal tea

Brand	Mean $\pm$ SD <sup>a</sup> fluoride (mg/L)	Fluoride dry weight (mg/g)
<b>Teas</b>		
Lipton, English Breakfast	1.320 $\pm$ 0.050	0.130
Lipton, traditional	0.780 $\pm$ 0.050	0.080
Lyons	1.680 $\pm$ 0.120	0.170
Twinings, Ceylon Breakfast	0.720 $\pm$ 0.050	0.070
Twinings, China Black	0.780 $\pm$ 0.050	0.080
Twinings, Earl Grey	0.800 $\pm$ 0.080	0.080
Twinings, English Breakfast	1.080 $\pm$ 0.050	0.120
Twinings, Lapsang Souchong	0.780 $\pm$ 0.100	0.080
Twinings, Orange Pekoe	1.180 $\pm$ 0.050	0.120
Unpacked, brand 1	0.680 $\pm$ 0.050	0.070
Unpacked, brand 2	1.450 $\pm$ 0.060	0.140
Unpacked, brand 3	0.880 $\pm$ 0.100	0.090
Unpacked, brand 4	0.620 $\pm$ 0.000	0.060
Unpacked, brand 5	0.620 $\pm$ 0.050	0.060
Mean $\pm$ SEM ( <i>n</i> = 14)	0.955 $\pm$ 0.334	0.096
<b>Anise teas</b>		
Bruggen	0.056 $\pm$ 0.005	0.003
London	0.060 $\pm$ 0.003	0.003
Mean $\pm$ SEM ( <i>n</i> = 2)	0.058 $\pm$ 0.003	0.003
<b>Mint teas</b>		
London	0.030 $\pm$ 0.002	0.006
Menthe d'Anjou	0.032 $\pm$ 0.002	0.006
Unpacked, brand 1	0.037 $\pm$ 0.003	0.007
Unpacked, brand 2	0.031 $\pm$ 0.003	0.006
Mean $\pm$ SEM ( <i>n</i> = 4)	0.033 $\pm$ 0.003	0.006
<b>Mixed herb teas</b>		
London	0.068 $\pm$ 0.000	0.070
Yago	0.010 $\pm$ 0.000	0.001
Mean $\pm$ SEM ( <i>n</i> =2)	0.039 $\pm$ 0.041	0.036
<b>Maté teas</b>		
Campeon	0.143 $\pm$ 0.005	0.00009
Castiello	0.153 $\pm$ 0.021	0.00009
Cruz de Malta	0.185 $\pm$ 0.006	0.00001
Mean $\pm$ SEM ( <i>n</i> = 3)	0.160 $\pm$ 0.018	0.00006

a. Plus-minus values are means  $\pm$  SD except where noted as SEM.

TABLE 3. Distribution of fluoride levels in tea infusions according to soaking time

Soaking time (min)	Mean $\pm$ SD fluoride (mg/L)	Fluoride dry weight (mg/g)
0.5	0.38 $\pm$ 0.04	0.04
1	0.40 $\pm$ 0.04	0.04
2	0.53 $\pm$ 0.04	0.05
3	0.58 $\pm$ 0.05	0.06
4	0.70 $\pm$ 0.03	0.07
5	0.72 $\pm$ 0.02	0.07
10	0.85 $\pm$ 0.01	0.08

for boiling times that ranged from 0.5 to 10 minutes. Leaching of fluoride started to increase after 2 minutes and reached a maximum after boiling for 10 minutes. Fluoride levels in mixed herb decoctions ranged from 0.178 to 0.198 mg/L for boiling times that ranged from 0.5 to 10 minutes. Leaching of fluoride started to increase after 5 minutes and reached a maximum after boiling for 10 minutes. Fluoride levels in maté infusions ranged from 0.001 mg/L in the first run to 0.145 mg/L for the sixth run. Leaching of fluoride from maté reached a maximum after the fifth run. Comparison of fluoride levels in herbal teas and for the same boiling times (0.5–5 minutes) showed that fluoride levels were highest in tea decoctions, followed by mixed herbs, anise, and mint (fig. 1).

## Discussion

This study was designed to assess fluoride levels in herbal teas consumed in urban and rural communities in Lebanon, taking into consideration preparation methods and time. The results point to three main findings. First, there is the large variability in two-minute decoctions of available tea brands, a finding that is in agreement with those of other researchers [8–10]. This large variation was expected, because tea is a variable product that can be differentiated on the basis of variety, origin, time of packing, maturity of leaves, and methods of processing and grading

TABLE 4. Distribution of fluoride (F) levels in herbal teas according to boiling time

Boiling time (min)	Tea		Anise		Mint		Mixed herbs	
	Mean $\pm$ SD F (mg/L)	Dry wt F (mg/g)	Mean $\pm$ SD F (mg/L)	Dry wt F (mg/g)	Mean $\pm$ SD F (mg/L)	Dry wt F (mg/g)	Mean $\pm$ SD F (mg/L)	Dry wt F (mg/g)
0.5	0.460 $\pm$ 0.040	0.046	0.046 $\pm$ 0.003	0.094	0.030 $\pm$ 0.003	0.002	0.178 $\pm$ 0.335	0.018
1	0.540 $\pm$ 0.060	0.054	0.046 $\pm$ 0.005	0.092	0.030 $\pm$ 0.002	0.002	0.178 $\pm$ 0.335	0.018
2	0.650 $\pm$ 0.030	0.065	0.046 $\pm$ 0.005	0.092	0.030 $\pm$ 0.002	0.002	0.178 $\pm$ 0.335	0.018
3	0.740 $\pm$ 0.020	0.074	0.055 $\pm$ 0.002	0.010	0.031 $\pm$ 0.001	0.002	0.178 $\pm$ 0.335	0.018
4	0.740 $\pm$ 0.030	0.074	0.058 $\pm$ 0.006	0.011	0.048 $\pm$ 0.007	0.002	0.178 $\pm$ 0.335	0.018
5	0.840 $\pm$ 0.030	0.084	0.060 $\pm$ 0.010	0.012	0.058 $\pm$ 0.005	0.003	0.178 $\pm$ 0.335	0.018
10	1.050 $\pm$ 0.060	0.100	0.060 $\pm$ 0.003	0.012	0.083 $\pm$ 0.001	0.004	0.198 $\pm$ 0.375	0.019

TABLE 5. Distribution of fluoride levels in maté infusions according to the number of successive runs

Run	Mean $\pm$ SD fluoride (mg/L)	Fluoride dry weight (mg/g)
1	0.001 $\pm$ 0.005	0.00006
2	0.120 $\pm$ 0.008	0.00007
3	0.128 $\pm$ 0.010	0.00008
4	0.135 $\pm$ 0.013	0.00008
5	0.142 $\pm$ 0.005	0.00009
6	0.145 $\pm$ 0.006	0.00009

[11]. On the other hand, very low fluoride levels were observed for herbal teas in this study. This finding is similar to those of others who reported negligible fluoride levels in herbal teas, which they attributed to their ingredients [8, 10].

The second main finding was that tea decoctions leached more fluoride than tea infusions for similar preparation times, because maintaining higher temperatures helped leach fluorides in tea. The fluoride levels of tea infusions determined in this study are lower than fluoride levels reported in other studies that also used deionized water and after taking similar infusion times into consideration [1, 8–10]. These differences can be attributed to the brands used in these studies. The third main finding was an increase in fluoride concentration of tea infusions and decoctions with increased brewing and boiling times. This agrees with the findings of others who reported a comparable pattern of increase in fluoride concentrations of tea infusions with time [1, 9, 10]. The maximum fluoride leaching time for tea in this study was approximately 5 minutes.

In conclusion, in this study fluoride levels in herbal teas varied with the type of tea, brand, and method of preparation. The contribution of fluoride in tea to the total fluoride consumed by Lebanese families appears

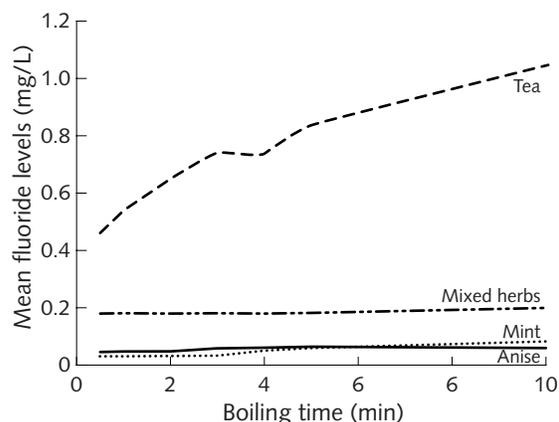


FIG. 1. Distribution of mean fluoride levels according to boiling time

to be substantial, particularly given that the results of this study do not take into consideration fluoride intake from sources such as dentifrices, rinses, foods and beverages in general, nonmilk fluids, and drinking water [12–14]. Information from this study and others should constitute a basis for policy considerations regarding water fluoridation in Lebanon.

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