

# Determination of fluoride levels after brewing in three Turkish black tea products

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## ABSTRACT

The aim of this study was to determine the fluoride levels at two different brewing times of 15 samples with different production dates belonging to each of the three different tea products, which were grown and served as commercial products in Turkey. In this study, 15 samples of each tea products (Filiz Çay, Rize Turist Çayı, Doğu Karadeniz Lüks Rize Çayı) with different production dates were steeped with double-distilled de-ionized water (1% m/V) at two different brewing times (5-10 min). The fluoride levels of all samples were measured with combined fluoride electrode. The average fluoride value after five minutes of brewing was found as 1.66 ppm in the Rize Turist Çayı group, 1.69 ppm in the Doğu Karadeniz Lüks Rize Çayı group, and 1.38 ppm in the Filiz Çay group. The average fluoride value after ten minutes of brewing of the Rize Turist Çayı group was 1.87 ppm. Doğu Karadeniz Lüks Rize Çayı group was 1.88 ppm, and the Filiz Çay group was 1.53 ppm. While there were no statistical differences between Rize Turist Çayı and Doğu Karadeniz Lüks Rize Çayı, the fluoride level of Filiz Çayı was found lower than the other products. Fluoride levels of tea samples suggested that tea consumption is an important source on daily fluoride intake.

**Key words:** Black tea, fluoride, Turkey

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## INTRODUCTION

Fluorine (F), which is the 9<sup>th</sup> element on the periodical table, is negatively charged and belongs to the halogens group. This element exists in water, soil, and air. It is the 17<sup>th</sup> most abundant element existing in soil.<sup>[1,2]</sup>

Understanding the fact that the dental enamel gains resistance against acids with the increase of fluoride concentration has brought a new dimension to dentistry; and a great many suggestions concerning fluoride applications have emerged.<sup>[3-5]</sup> These suggestions are categorized under two main headings; as topical fluoride applications and systematic applications. In topical applications, it is provided that the agent containing fluoride directly contacts the teeth. However, in systematic applications, the agent containing fluoride is swallowed and distributed throughout the body. That a substance, which is used only for the benefit of the dental system is being distributed throughout the body, has also involved some

discussions.<sup>[2]</sup> However, another topic, which is accepted as indisputable, is that the systematic applications have to be planned independent of the parameters such as the regional climate conditions, fluoride level in the water consumed, and the amount of fluoride taken by diet.<sup>[2,6,7]</sup>

Living creatures are directly or indirectly dependent on water and soil for the continuation of their growth and development. This relationship indicates that all the diet products contain more or less amounts of fluoride. It is known that, among the diet products, marine products contain high levels of fluoride. Another product, which also contains high fluoride, is tea.<sup>[8]</sup>

Homeland of the tea plant is India and China region. *Camellia Sinensis* is the type of tea most consumed in the world. The different processing methods of *Camellia Sinensis* cause the product to be called with names such as black tea, green tea, and oolong tea. Black tea constitutes nearly the 90% of the world tea production.<sup>[9]</sup>

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The fluoride element is accumulated in the texture of the tea plant in the course of time. Accordingly, old tea leaves contain more fluoride in comparison with young tea leaves. When brewed, 84% of the fluoride existing in the tea leaf can be transferred into the water. The amount of fluoride, which is transferred into the water, increases depending on the brewing time of the tea.<sup>[9-11]</sup>

Researchers have announced that tea, by means of its high fluoride content, strengthens the crystal structure of the enamel tissue against acid attacks, decreases the cryogenic effect of starch by inhibiting the amylase in the saliva, inhibits the development of some bacteria such as *Streptococcus Mutans*, and decreases the plaque formation. On the other hand, there are also researches stating that tea is responsible for certain cases of endemic fluorosis.<sup>[3,4,6,12,13]</sup>

The aim of this study was to determine the fluoride levels at two different brewing times of 15 samples with different production dates belonging to each of the three different tea products, which were grown and served as commercial products in Turkey.

## MATERIALS AND METHODS

In this study, the fluoride levels at two different brewing times of 15 samples with different production dates of three different types of tea produced and most consumed in Turkey were determined.

Filiz Çay (ÇAYKUR, Rize), Rize Turist Çayı (ÇAYKUR, Rize), and Doğu Karadeniz Lüks Rize Çayı (Doğu Gıda, Ordu) were used in this study. These brands were determined according to the information given of the four biggest retail shopping centers about the products most preferred by the consumers in Konya province. Each group was formed of 15 different samples with different production dates in order to guarantee that the products belong to different harvesting periods.

Preparation of samples for analysis the fluoride levels at two different brewing times of each of the three different tea products were planned. The samples of different brands of tea were prepared with bi-distilled, de-ionized water in a concentration of 1% m/V. The samples were brewed for five minutes and/or ten minutes for the determination of the transfer of fluoride from the tea leaves to the brew. A teapot made of porcelain was used during the brewing process. After brewing, the 90 samples were transferred to the plastic containers. The determination of the fluoride levels was performed by the combined fluoride electrode (Model 96-09, Orion

Research, Boston, MA, USA) connected to the ion analyzer (EA910, Orion Research, Boston, MA, USA). The slope value of the ion electrode was noted before starting the measurements, and the electrode was prepared for calibration with standard solutions. Then, the fluoride levels of the samples to which TISAB II (Cat.No. 940909, Orion Research, Boston, MA, USA) solution was added to mobilized fluoride elements to the samples were determined.

Samples were divided into two different brewing times of belonging to each of the three different tea products. The results of analyzing were entered into an Excel (Microsoft, Seattle, WA) spread sheet for calculation of descriptive statistics. For all groups, the average values and standard deviations (SD) were calculated. Statistical analysis was performed by using the Kruskal-Wallis analysis and Mann Whitney U-test (Statistical Package for Social Sciences Vers. 10.0, [Chicago, IL, USA]) for inter-group comparisons (each tea products and each brewing times) at the 0.05 level of significance.

## RESULTS

The sum of the results is seen in Table I accordingly; the average fluoride value after five minutes of brewing was found as 1.66 ppm in the Rize Turist Çayı group, 1.69 ppm in the Doğu Karadeniz Lüks Rize Çayı group, and 1.38 ppm in the Filiz Çay group. The average fluoride value after ten minutes of brewing of the Rize Turist Çayı group was 1.87 ppm, Doğu Karadeniz Lüks Rize Çayı group was 1.88 ppm, and the Filiz Çay group was 1.53 ppm [Table I].

The Kruskal-Wallis analysis was performed, which showed significant statistical difference between the tea samples brewed for five minutes and the tea samples brewed for ten minutes ( $P < 0.05$ ). Afterwards, binary comparisons of the groups were performed by using Mann Whitney U-test. While no statistical differences were observed within the Rize Turist Çayı and Doğu Çay groups with five minute and ten minute brewing times ( $P > 0.05$ ), significant statistical differences were observed between the Filiz Çay and the other two products ( $P < 0.05$ ) [Tables 2 and 3].

**Table 1: The average fluoride value (mean±standard deviation) of the groups (n=15)**

	Brewing time	
	5 min (ppm)	10 min (ppm)
Rize Turist Çayı	1.66±0.08	1.87±0.07
Doğu Çay	1.69±0.05	1.88±0.06
Filiz Çay	1.38±0.11	1.53±0.12

**Table 2: Mann Whitney U-test comparisons of the groups at 5 min brewing**

	Rize Turist Çayı	Doğuş Çay	Filiz Çay
Filiz Çay	*	*	
Doğuş Çay			

\*P&lt;0.05

**Table 3: Mann Whitney U-test comparisons of the groups at 10 min brewing \*P<0.05**

	Rize Turist Çayı	Doğuş Çay	Filiz Çay
Filiz Çay	*	*	
Doğuş Çay			

\*P&lt;0.05

## DISCUSSION

In this study the effect of different brewing times on fluoride levels of different black tea products in Konya (TURKEY) was evaluated. This situation is essential for dental care because of tea, which is highly rich fluoride source consumed in Turkey.

Wu and Wei<sup>[14]</sup> have pointed out that tea is a rich plant in terms of the fluoride level it contains, and between 40 mg and 400 mg of fluoride can be found in 1 kg of raw tea plant. Nabrzyski and Garjewska state that 1 kg of black tea contains an amount of fluoride in the range of 30-340 mg.<sup>[15]</sup>

In the studies conducted related to the fluoride content of brewed tea, it has been observed that the fluoride levels on the average varied between 0.5 ppm and 4 ppm. While Simpson *et al.*<sup>[8]</sup> determined a value of 3.5 ppm, Zerabruk *et al.*<sup>[13]</sup> announced a range of 117-682 mg/kg for two different types of tea. Duckworth and Duckworth, in the study which they conducted to observe the tea consumption of 50 families living in England in 15 days, observed that the fluoride values in tea were between 1.5 ppm and 3.6 ppm, and they found that the subjects took on the average 0.04 mg and 2.7 mg of fluoride a day.<sup>[10]</sup>

One of the studies, which investigated the fluoride levels in tea produced in Turkey, was implemented by Tiritoglu and Söylev, and fluoride levels of 0.7 ppm and 1.2 ppm were reported for the brands researched in the mentioned study.<sup>[11]</sup> Kacar determined a range of fluoride levels from 0.4 ppm to 2.4 ppm in brewed Turkish tea.<sup>[9]</sup> In a similar study, Kandemir determined that the fluoride values in four different types of tea were between 1.9 ppm and 3.5 ppm.<sup>[16]</sup> Koparal *et al.* measured the fluoride levels of certain types of black tea produced in Turkey in the range of 0.3-1.3 ppm.

It is seen that the mean fluoride values of the tea samples analyzed in our study are consistent with the studies mentioned above. Among the three brands of tea examined,

Filiz Çay is found to have statistically lower fluoride content than the other two brands. The fact that, although it is a product which belongs to the same region, Filiz Çay has a lower mean fluoride value, which can be explained by its being produced from the young leaves of the tea plant.<sup>[9]</sup>

For the fluoride measurements, certain methods of analysis such as ion-specific electrode, spectrophotometer, gas chromatography, capillary electrophoresis, and microdiffusion are defined.<sup>[17]</sup> Although these methods have advantages and disadvantages when compared with each other, ion-specific electrode method has found a wide application area because of being a simple and practical technique. This method determines the quantity of fluoride that can be ionized.<sup>[17]</sup> Also, in our studies, the measurements of fluoride was performed by the ion-specific electrode method.

The tea samples used in our study were brewed with bi-distilled water. Taking into consideration that network water is intensively used in individual tea consumption, the need for adding the fluoride value of the network water to the fluoride levels of the tea samples we analyzed will emerge. In conclusion, it is seen that brewed tea is a really rich source in terms of fluoride content.

This situation, which has also been observed by other researchers who are interested in the topic, has created the idea of encouraging the consumption of this drink in several researchers, but on the other hand, it has caused anxiety among several researchers who saw that the tea consumed is responsible for certain cases of endemic fluorosis.<sup>[5,8,10,11,16]</sup> That these worries are not groundless, ones can be exemplified by the high fluorosis prevalence, which is observed in the society living in the Gansu region of China; although the fluoride content of the water consumed by the people of the region is in the range of only 0.1-0.3 ppm, fluorosis cases in children living in the area are remarkably high.<sup>[18]</sup> Tea, which is a traditional and indispensable drink for the people in the region and which is frequently consumed also by children, is held responsible for this situation.<sup>[18]</sup> Beside the risk of fluorosis, when it is taken into consideration that children generally consume this drink with plenty of sugar, there are also concerns that a negative cariogenic effect will emerge with the encouragement of tea consumption.<sup>[19]</sup>

Dentists should be able to generate ideas about the daily fluoride intakes of their patients. This evaluation is highly essential, especially if the individual fluoride supplements will be planned. Under such a condition, taking only the fluoride level in drinking water as criteria may be misleading. Examination of the diet habits is another parameter, which should be significantly emphasized. Tea, which is highly consumed in Turkey, is one of the things

which should not be disregarded while researching the diet habits.

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