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Oxalate Content of Different Drinkable Dilutions of Tea Infusions after Different Brewing Times

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ABSTRACT

Background: The aims of this study were to determine the effect of different brewing times and diluting on oxalate content of loose-packed black teas consumed in Tabriz, Iran.
Methods: The oxalate content of black teas after brewing for 5, 10, 15, 30, 60 minutes was measured in triplicate by enzymatic assay. In order to attain the most acceptable dilution of tea infusions, tea samples which were brewed for 15, 30 and 60 minutes were diluted two (120 ml), three (80 ml) and four (60 ml) times respectively.
Results: There was a stepwise increase in oxalate concentrations associated with increased brewing times ($P< 0.001$) with oxalate contents ranging from 4.4 mg/240 ml for the 5 min to 6.3 mg/240 ml for 60 min brewing times, respectively. There were significant differences between the mean oxalate content of different dilutions after brewing for 15, 30 and 60 minutes ($P< 0.001$).
Conclusion: The oxalate content of Iranian consumed black tea after different brewing times and different dilution was below the recommended levels. Therefore, it seems that consumption of black tea several times per day would not pose significant health risk in kidney stone patients and susceptible individuals.
Keywords*:* Black tea, Oxalate, Kidney stones, Brewing times, Different dilutions

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Introduction

Nephrolithiasis, or the presence of kidney stones, is an increasingly significant health problem in the population and regarded as the main cause of major surgeries and kidney failures in patients [1, 2]. Kidney stones affect about 10% of men and 5% of women by the time they are 70 yr old [3]. The prevalence of urolithiasis within different populations has been estimated to range from 3.5 – 18.5% and Iran is a country with an estimated 5.7 % prevalence of urolithiasis [4, 5, 6-11]. Calcium stones are the most common: 60% of stones are calcium oxalate, 10% calcium oxalate and calcium phosphate, and 10% calcium phosphate [1]. Hyperoxaluria is a primary risk factor in calcium oxalate stone formation and a high oxalate uptake from the diet is also thought to play a role in hyperoxaluria [12, 13]. Furthermore, because of possessing negative charges; oxalate has high affinity for minerals, such as calcium, magnesium and zinc and affects their availability and metabolism [14]. Foodstuffs that contain high levels of oxalate and can elevate oxalate excretion include

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spinach, rhubarb, beetroot, cocoa powder, some nuts, and black tea [15, 16].

Coming from China, black tea and infusion of *Camellia sinensis*, is one of the most popular beverages in the world because of its favorable taste, aroma, and health-promoting effects [17]. Today, 3 billion of cups of tea are consumed every day by millions of people all over the world [18]. Drinking tea after meals and during the day is a widespread cultural practice in Iran [17], especially in Tabriz, a major city of the East Azerbaijan Province. Although tea consumption can lead to an increment in urinary oxalate levels in healthy individuals, few studies in western countries indicated that because of high fluid intake it is associated with a reduced risk of kidney stone formation [19, 1]. However, considering the importance of hyperoxaluria in stone formation, some experts continue to advise those prone to calcium oxalate stone formation to limit tea consumption [20]. Additionally, brewing times and techniques, differ greatly from region to region, and may affect the oxalate content of final extraction [21].

Since tea is drunk via a samovar in Iran and a small aliquot of tea infusion is diluted with hot water which changes the outcome of any drinking, the objectives of the present study were to determine the effect of different brewing times and diluting on oxalate content of loose-packed black teas consumed in Tabriz, Iran.

Material and Methods

Samples

Twenty-three samples of most popular commercial loose-packed black tea were purchased from various markets in Tabriz, Iran during December, 2010. Batch numbers and production date of all samples were recorded. One sample from each tea brand was purchased.

Brewing process, sample preparation and Enzymatic oxalate assay

Two grams of tea leaves were brewed in 240 ml of hot boiling tap water for 5, 10, 15, 30, and 60 min (which are standard brewing times in Iran) and then tea leaves were removed by filtering the solution through a tea strainer. In order to attain the most acceptable dilution of tea infusions, tea samples which were brewed for 15, 30 and 60 min were diluted from 10, 20, 30, up to 230 ml and then the volume was increased to 240 ml with boiling tap water from samovar. The most drinkable tea solutions were attained after two (120 ml), three (80 ml) and four (60 ml) times diluting for 15, 30 and 60 min respectively. The samples were left to reach the room temperature for analysis.

Oxalate from tea samples were measured in triplicate using an oxalate kit obtained from Trinity Biotech (Jamestown, NY, USA).The method is based on the oxidation of oxalate by oxalate oxidize followed by detection of H2O2 produced during the reaction [22]. The optical density value at a wavelength of 590 nm was then measured by spectrophotometer (Shimadzu, model 1650 PC).

Statistical analysis

The data are presented as the mean ± SEM of three determinations. The normality of variables was tested using a Kolmogorov Smirnov test All variables were normally distributed. A one-factor ANOVA was used to assess differences in oxalate associated with different brewing times. The Tukey post hoc test was used to determine statistically significant differences among the various brewing times. Differences between the oxalate content of different dilutions were calculated by independent *t*-test. *P*-values of less than 0.05 were considered statistically significant.

Results

The oxalate contents of loose-packed black teas with different brewing times are depicted in Fig. 1. There was a stepwise increase in oxalate concentrations associated with increased brewing times ($P< 0.001$) with oxalate contents ranging from 4.4 mg/240 ml for the 5 min and 6.3 mg/240

ml for 60 min brewing times, respectively. The post-hoc test further specified that there were significant differences between oxalate content of tea infusions with longer intervals of brewing times ($P< 0.001$) and no significant differences were observed in tea infusions with shorter intervals of brewing times.

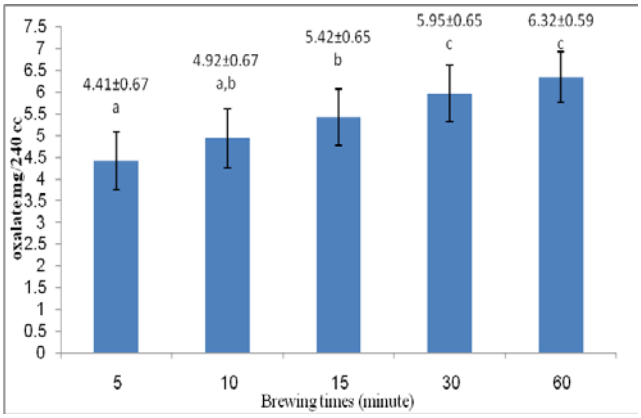

Fig. 1: Mean oxalate content of loose-packed black tea infusions after different brewing time (2g/240 ml)/ All analytical data are the mean of triplicate measurements of three independent samples ± SEM/ A one-factor ANOVA and the post hoc test showed that there were significant differences between the oxalate content of different brewing times ($P<0.001$), except the ones with same letters

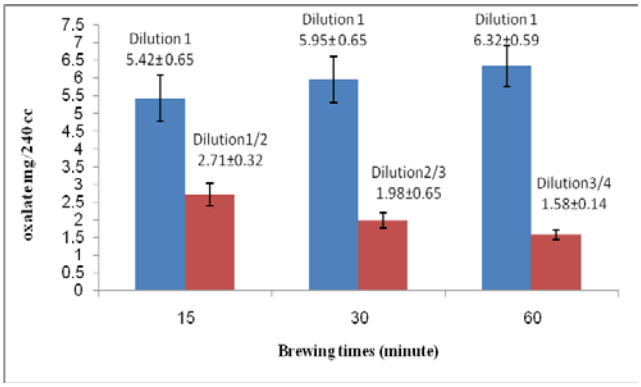

Fig. 2: Mean oxalate content of loose-packed black tea infusions after different dilutions (2g/240 ml)/ All analytical data are the mean of triplicate measurements of three independent samples ± SEM/The results of independent *t*-test showed that there were significant differences between the mean oxalate content of different dilutions ($P<0.001$)

Comparison of the soluble oxalate content of the different dilutions of tea samples is shown in Fig. 2. The results of independent *t*-test showed that there were significant differences between the mean oxalate content of different dilutions after brewing for 15, 30 and 60 min ($P< 0.001$). For example, for the 30 min brewing time, the mean oxalate content of two dilutions (1 and 2/3) was 5.95 and 1.98 mg/240 ml, respectively.

Discussion

Nutrition is main environmental risk factor in idiopathic calcium oxalate stone disease, since diet strongly influences urine composition [23]. Patients at risk for calcium oxalate stone formation are therefore advised to avoid foods and beverages rich in oxalate [24].

As shown in Fig. 1, the range of oxalate in Iranian consumed loose-packed black tea after different brewing times was from 4.4 to 6.3 mg/240 ml. The brewing of tea in hot water extracts that portion of total oxalate that is soluble, leaving the insoluble oxalate (mainly oxalate bound to calcium) in the tea leaves [25]. The oxalate contents of black tea samples from tea bags for 1 and 5 min infusions were 10.8 and 20.8 mg oxalate/250 ml, respectively, for one brand and 10.8 and 12.0 mg oxalate/250 ml for another brand [26]. By contrast, no significant increase in oxalate content of Chinese green teas was observed by longer brewing time (5 vs. 10 min) [27]. The results of present study revealed incremental increases in soluble oxalate with increased brewing times all the way up to 60 min although after the 15 min time point, there was a marked decrease in the magnitude of this increase per unit of time.

On the other hand, samovar is widely used in Iran, and a small aliquot of tea infusions is usually diluted with boiling tap water from samovar; therefore, it can be assumed that the level of oxalate in tea would be much less than non-diluted ones. As it can be seen from our results, the oxalate content

of diluted tea infusions was much less than non-diluted ones. Since to date, there appear to be no comprehensive information about the effect of diluting on oxalate content of tea infusions.

Tsai et al. analyzed oxalate contents of foods and beverages that are common in Taiwan. They showed that if green tea powder is diluted 100-fold, its oxalate content would be 0.6 mg/100 ml and for patients with calcium oxalate stones, it is hazardous to drink green tea powder without adequate dilution [24].

Although diluting caused a significant decrease in oxalate amounts of tea infusions, considering our results, consumption of four cup of tea (a moderate daily consumption for a tea drinker) [17] made from loose-packed black tea after different dilutions and different brewing times would result in an average intake of 6 to 25 mg oxalate/day. Since, kidney stone patients are usually recommended to limit their intake of foods which contain >10 mg oxalate per serving, with total oxalate intake not to exceed 50-60 mg/day [28], it can be concluded that that consumption of four cups of the teas especially diluted ones would only have marginal impact on daily oxalate intake and these infusions may be consumed several times per day by kidney stone patients and individuals who are susceptible with no harmful side effects from oxalate.

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