

The pH and Neutralisable Acidity of the Most-Consumed Turkish Fruit and Herbal Teas

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Abstract

Aim: Tea is a traditional beverage. There are different types of tea, such as black, green, oolong, herbal and fruit teas. In recent years, there has been increased interest in herbal and fruit teas among new generations. The aim of this study was to assess the erosive potential of some herbal and fruit teas on the Turkish market. **Methods:** The erosive potential of five fruit and six herbal teas was assessed in the laboratory by measuring their pH and neutralisable acidity at different infusion times (0, 2, 5, 10 minutes). **Results:** The pH of the fruit and herbal teas ranged from 2.72 to 3.62 and 6.47 to 7.24, respectively ($P < 0.001$). The neutralisable acidity (ml NaOH/20 ml) of the fruit teas and herbal teas was 0.30-2.70 and 0.00-0.20, respectively ($P < 0.001$). **Conclusion:** The pHs of the fruit teas were lower than those of herbal teas. The most acidic fruit tea measured was blackberry tea (pH 2.7). Consuming acidic fruit teas in large quantities may lead to dental erosion.

Key Words: Herbal Tea, Fruit Tea, pH, Neutralisable Acidity

Introduction

Tea is one of the most widely consumed beverages in Turkey. Turkish people drink a great deal of tea throughout the day, especially at breakfast and in the evening, and drinking tea following a meal is a traditional practice [1]. Turkey holds a significant place among the world's largest tea-producing countries, with a share of more than 5% of the market. According to Food and Agriculture Organization of the United States (FAO) statistics, Turkey ranks sixth in world production of tea after China, India, Sri Lanka, Kenya, and Indonesia [2].

There are different types of tea, such as black tea, green tea, oolong tea, herbal and fruit tea. Because they are regarded as a healthy drink, herbal and fruit teas are increasingly popular among young people. Tea is considered to be a healthy alternative to caffeine-based beverages because of its antioxidant properties [3]. However, tea is known to have an erosive effect on enamel [4-8].

Secondary to caries, dental erosion is considered to be the most threatening problem for dental health. Dental erosion, which is defined as irre-

versible loss of dental hard tissues because of a chemical process without the involvement of microorganisms, seems to be a growing problem. In some countries, an increase in tooth erosion is associated with an increase in the consumption of beverages containing acids. The literature indicates the considerable erosive potential of some types of teas such as fruit teas [5,6,9-11].

Dietary factors also play major role in aetiology of dental erosion. The erosive potential of fruit teas and soft drinks is related to the pH and the buffering effect of the drink [11-13]. The pH value (acidity) of a food or drink has been considered to be an accurate indicator for the erosive potential of that food or drink. Recently, total neutralisable acidity is widely accepted to be a more accurate measure of the total acid content of a drink; therefore it might be a better process for predicting erosive potential [4,14].

Aim

The aim of this study was to compare the erosive potential of five fruit and six herbal teas that are produced and widely consumed in Turkey. The

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hypothesis used in this study was that the fruit teas would not be more erosive than the herbal teas.

Materials and Methods

The pH and erosive potential were analysed in five fruit and six herbal “bag-based” teas available in Turkey. They were chosen for inclusion in this study because all are popular and are widely consumed in Turkey. Details about the type of tea, name, geographic origin or brand, shape (presentation in bags) and additives are given in *Table 1*.

Preparation of tea samples

Tea samples were prepared in the laboratory using eight bags from each box. Simulating home tea preparation, each tea bag sample was added separately to 250 ml of freshly boiled water and stirred. The tea bags were taken out immediately (0 min) and after 2, 5, and 10 minutes of infusion and cooled to 37°C. Two tea bags were separately used for each infusion.

pH and erosive potential determination

The pH of each tea infusion was determined using an electronic pH meter (Model 701A, Orion Research Inc., Cambridge MA, U.S.A.) at 37°C [9]. Prior to the measurements, the pH meter was calibrated via test solutions of known pH (pH=4) [7].

The neutralisable acidity of each tea infusion was determined by placing 20 ml aliquots of tea infusion in a glass beaker. The beaker was then placed in a thermostatically controlled water bath at 37°C. Next, a 0.1 M sodium hydroxide solution was gradually added to the tea sample and the pH rise was continuously monitored until it reached neutrality. Each tea infusion was stirred continuously while sodium hydroxide solution was added. The volume of sodium hydroxide required to increase the pH of the sample to neutral pH (pH=7) was then noted. This procedure was repeated twice for each tea infusion.

Statistical evaluation of the data

Statistical analysis of the results for pH and neutralisable acidity was carried out using the Student's t-test. The threshold for statistical significance was set at $P < 0.05$.

Results

The pH and neutralisable acidity values of fruit and herbal teas at 0, 2, 5, and 10 minutes are shown in *Table 2*. The pH of the fruit teas at 0, 2, 5, and 10 minutes ranged from 3.00-3.41, 2.73-3.59, 2.72-3.62, and 2.73-3.59, respectively. The pH of the herbal teas at the same intervals ranged from 7.00-7.24, 6.61-6.88, 6.48-6.89, and 6.47-6.95, respectively. The

Table 1. Tea Contents According to Manufacturers' Information

Fruit tea			
Type of tea, brand	Origin	Shape	Additives
Mandarin orange, Dogadan	Turkey	Bags	Rosehip, apple, orange peel (15%), hibiscus, blackberry leaves, orange flavour, lemon peel, mandarin peel (3%), echinacea herb, echinacea root
Lemon, Dogadan	Turkey	Bags	Lemon grass, lemon verbana, lemon peel, lemon flavour, chicory root
Rosehip, Dia	Turkey	Bags	Rosehip, hibiscus flowers
Apple, Dogadan	Turkey	Bags	Apple, hibiscus, blackberry leaves, apple flavour, lemon peel, cinnamon
Blackberry, Dia	Turkey	Bags	Hibiscus, apple, blackberry leaves, rosehip, blackberry flavour, orange peel, elderberry, blackberry pieces, cinnamon
Herbal tea			
Type of tea, brand	Origin	Shape	Additives
Linden, Carrefour	Turkey	Bags	Linden
Sage, Dia	Turkey	Bags	Sage leaves
Chamomile, Dogadan	Turkey	Bags	Chamomile, mint
Fennel, Dogadan	Turkey	Bags	Fennel, anise
Peppermint, Dogadan	Turkey	Bags	Peppermint
Nettle, Dogadan	Turkey	Bags	Nettle leaves, lemon grass

Table 2. pH and Neutralisable Acidity Values of the Teas at 0, 2, 5, and 10 Minutes

Fruit tea	pH				Neutralisable acidity (ml)			
	0 min	2 min	5 min	10 min	0 min	2 min	5 min	10 min
Mandarin	3.13±0.04	3.18±0.01	3.18±0.01	3.23±0.02	0.65±0.07	1.03±0.09	1.29±0.05	1.23±0.04
Lemon	3.41±0.01	3.59±0.17	3.62±0.05	3.59±0.01	0.69±0.05	0.99±0.20	1.23±0.10	1.48±0.17
Rosehip	3.14±0.05	2.88±0.05	2.88±0.04	2.87±0.05	0.40±0.00	1.85±0.00	2.15±0.00	2.30±0.00
Apple	3.35±0.08	2.98±0.09	2.93±0.07	2.93±0.05	0.30±0.00	1.25±0.00	1.35±0.00	1.35±0.00
Blackberry	3.00±0.01	2.73±0.01	2.72±0.00	2.73±0.03	0.57±0.00	2.33±0.00	2.47±0.00	2.70±0.00
Herbal tea	pH				Neutralisable acidity (ml)			
	0 min	2 min	5 min	10 min	0 min	2 min	5 min	10 min
Linden	7.23±0.00	6.75±0.07	6.84±0.22	6.78±0.21	0.0±0.00	0.01±0.00	0.0±0.00	0.0±0.00
Sage	7.21±0.00	6.61±0.14	6.48±0.12	6.47±0.19	0.0±0.00	0.02±0.00	0.03±0.00	0.03±0.00
Chamomile	7.00±0.00	6.77±0.06	6.60±0.09	6.55±0.01	0.0±0.00	0.01±0.00	0.02±0.00	0.03±0.00
Fennel	7.13±0.00	6.80±0.09	6.69±0.04	6.72±0.14	0.0±0.00	0.01±0.00	0.01±0.00	0.01±0.00
Mint	7.24±0.00	6.71±0.06	6.60±0.03	6.60±0.03	0.0±0.00	0.02±0.00	0.04±0.00	0.03±0.00
Nettle	7.24±0.00	6.88±0.04	6.89±0.07	6.95±0.07	0.0±0.00	0.01±0.00	0.01±0.00	0.00±0.00

Values are given as mean±SD

decrease in pH was observed in 2-, 5-, and 10-minute intervals for both fruit and herbal teas.

The neutralisable acidity (ml NaOH/20 ml) of the fruit teas was 0.30-0.69, 0.99-2.33, 1.23-2.47, and 1.23-2.70, respectively. The neutralisable acidity of the herbal teas at 0, 2, 5, and 10 minutes ranged from 0-0, 0.01-0.13, 0.015-0.150, and 0.005-0.200, respectively. The statistical results of the comparisons of fruit and herbal teas are given in *Tables 3 and 4*. The pH and neutralisable acidity of fruit teas were significantly different from those of herbal teas ($P<0.001$).

Table 3. Mean pH Values of Fruit and Herbal Teas

Infusion time (min)	Groups	
	Fruit tea	Herbal tea
0	3.21 ± 0.17	7.17 ± 0.09*
2	3.07 ± 0.33	6.75 ± 0.09*
5	3.07 ± 0.35	6.68 ± 0.16*
10	3.07 ± 0.34	6.67 ± 0.17*

Values are given as mean±SD

* $P<0.001$: significantly different from fruit teas

Table 4. Mean Neutralisable Acidity of Fruit and Herbal Teas

Infusion time (min)	Groups	
	Fruit tea	Herbal tea
0	0.52±0.16	0.00±0.00*
2	1.50± 0.58	0.01±0.01*
5	1.70±0.57	0.02±0.01*
10	1.81±0.65	1.75±0.01*

Values are given as mean±SD

* $P<0.001$: significantly different from fruit teas

Discussion

As a traditional beverage, tea has long been an important fluid component of the diet [6]. Nowadays, herbal and fruit teas, both of which have been introduced as a low-caffeine alternative to conventional black tea, are very popular. The erosive potential of agents such as acidic drinks or foodstuffs depends on chemical factors (e.g., pH, titratable acidity, mineral content, clearance on tooth surface) and on its calcium-chelation properties [15]. In this study, we compared the potential erosive effects of the most-consumed herbal and fruit teas found on Turkish market. This was assessed by determining the pH and neutralisable acidity. The results demonstrate that fruit teas are highly acidic. In this study, the pH of herbal teas was found to be near to neutral.

Brunton and Hussain (2001) [10] reported that both conventional black tea and herbal tea eroded dental enamel. They also stated that the pH of conventional black tea and herbal tea had been measured to be lower than the critical pH (5.5) that is necessary for the demineralisation of enamel. According to their results, the erosive effect of herbal tea was found to be five times greater than that of conventional black tea. Van Nieuw *et al.* (2004) [16] investigated the erosive potential of a number of teas with fruit aroma and ice teas. They stated that at their drinking temperature (45°C), teas with a fruit taste typically had a pH value of between 6.2 and 7.4. They found that the most acidic tea tested was mango-peach tea, which contains no buffer system. The baseline acidity is a major factor for the determination of erosive potential, but titratable acidity is generally accepted to be a

better indicator than pH value [4,8]. Generally, the lower the pH, the more sodium hydroxide was necessary to bring the pH to neutrality [14]. Rees *et al.* (2006) [17] measured the pH and neutralisable acidity of different fruit teas and suggested that the pH of the teas ranged from 2.98 to 3.95 and the neutralisable acidity from 10.63 to 33.0 ml of 0.1 M sodium hydroxide. They also concluded that all fruit teas were able to remove the smear layer. These values (pH 2.9-3.9) are similar to our results for fruit teas (pH 2.7-3.6). Our results are higher (pH 6.4-7.2) than the results of Brunton and Hussain (2001) [10] (pH 3.2) and Phelan and Rees (2003) [9] (pH 3.1 to 7.1) for herbal teas. Fruit teas contain organic acids, such as citric, malic, and oxalic acid. Naturally, these teas are acidic once brewed. Although the erosive potential of various teas can be compared, it is not possible to define the degree to which tea damages teeth; however, some

people are more susceptible to dental erosion than others. There are a number of risk factors such as salivary flow rate, pH, neutralisable acidity, and pellicle formation [4].

Conclusion

Based on the data obtained in this study, it was concluded that consuming some tea infusions that are available on the Turkish market (especially those prepared using fruit tea bags) in large amount quantities may lead to enamel erosion. The critical pH value below which enamel erosion takes place is 5.5. The pH of fruit teas tested in this study were measured to be lower than this critical pH value. The most acidic fruit tea measured in this study was blackberry tea (pH 2.7). After consuming fruit teas, water drinking can be recommended to increase oral pH.

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