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Effect of Cornelian Cherry Use on Physical and Chemical Properties of Tarhana

Fatma Işık[1, ✉], İlyas Çelik[1], Yusuf Yılmaz[2]

[1] Pamukkale University, Faculty of Engineering, Department of Food Engineering, Kınıklı, Denizli, Turkey
[2] Mehmet Akif Ersoy University, Faculty of Engineering and Architecture, Department of Food Engineering, Burdur, Turkey

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✉ *Corresponding author (Yazışmalardan Sorumlu Yazar): fisik@pau.edu.tr (F. Işık)*
✆ +90 258 296 3111 🖷 +90 258 296 32 62

ABSTRACT

In Turkey, regional tarhana recipes may contain cornelian cherry puree as a substitute for fresh tomato and paprika puree. In this study, the effect of cornelian cherry puree on some properties of tarhanas was determined. Tarhana dough with cornelian cherry had significantly lower pH value (3.6) than traditional tarhana (4.4). While both tarhana samples shared similar chemical properties, addition of cornelian cherry made the color of soups lighter, less red and yellow. The difference in antioxidant activities of traditional tarhanas and tarhanas with cornelian cherry was statistically insignificant ($p > 0.05$). Tarhana soup samples exhibited pseudoplastic behavior ($n < 1$) at 35, 40, 50, 60, and 70°C. The effect of temperature on flow behavior indices and consistency coefficients of tarhana soups with cornelian cherry was insignificant ($p > 0.05$). Panelists equally liked traditional tarhana soup and tarhana soup with cornelian cherry. Results indicated that cornelian cherry has a good potential in tarhana production.

Key Words: Cornelian cherry, Tarhana, Mineral, Antioxidant, Phenolic

Tarhananın Fiziksel ve Kimyasal Özellikleri Üzerine Kızılcık Kullanımının Etkisi

ÖZET

Türkiye'de tarhana üretiminde bazı bölgelerde domates ve biber püresi yerine kızılcık püresi kullanılmaktadır. Bu çalışmada kızılcık püresinin tarhananın bazı özellikleri üzerine etkisi araştırılmıştır. Kızılcık ilaveli tarhana hamurunun pH değerinin (3.6) geleneksel tarhana hamurundan (4.4) önemli derecede düşük olduğu bulunmuştur. Her iki tarhana örneğinin de benzer kimyasal özellikler göstermelerine rağmen tarhana formülasyonuna kızılcık ilave etmenin çorba rengini açtığı, kırmızılık ve sarılık değerlerini de azalttığı saptanmıştır. Çalışmada ayrıca tarhanaların antioksidan aktivitelerinin benzer olduğu ve tarhana çorbalarının 35, 40, 50, 60 and 70°C'de pseudoplastik akış davranışı ($n < 1$) gösterdikleri de tespit edilmiştir. Sıcaklığın kızılcık ilaveli tarhana çorbalarının akış davranış indisi ve kıvam katsayısı üzerine etkisi önemsizdir ($p > 0.05$). Geleneksel tarhana ve kızılcık ilaveli tarhana, duyusal analizlerde benzer puanlar almışlardır. Çalışma, kızılcığın tarhana üretiminde kullanım açısından iyi bir potansiyel teşkil edebileceğini göstermiştir.

Anahtar Kelimeler: Kızılcık, Tarhana, Mineral, Antioksidan, Fenolik

INTRODUCTION

Fermented foods play an important role in the diets of many people in Asia, the Near East and parts of Africa [1]. Tarhana is a fermented food consumed widely in the Middle East [2], and it is prepared by mixing wheat flour, yoghurt, yeast and spices followed by fermentation for several days and drying after fermentation. As a good source of protein and vitamins, tarhana has been used largely by children and elderly people in a form of a thick soup [3, 4].

Cornelian cherry (*Cornus mas* L.) has been cultivated in Caucasus and Central Asia for centuries as food or medicine. Cornelian cherry has been widely grown in different regions of Turkey. Although it is naturally grown in orchards or mountains, there are some exclusive orchards of this fruit in some regions. Cornelian cherry is mostly grown in Northern Anatolia. In Turkey, there are about 1.6 million cornelian cherry trees with a total yield of approximately 14,000 tons per year [5-7]. Cornelian cherry fruits can be dark red, cherry redish pink or yellow. The form of fruits can be oval, pear-shaped or bottle-shaped. Average fruit weight ranges from 5.0 to 8.0 g, and the stone makes up 7.5 to 11.0% of the total fruit weight [8]. The fruits of cornelian cherry have sour and sweetish taste. Total sugar content ranges from 6.7 to 11.0%, and titratable acidity in terms of malic acid is 2.0% [5]. Ascorbic acid content is approximately 83 mg per 100 g on average but it could be as high as 193 mg, and anthocyanin content ranges from 670 to 850 mg/ 100 g in skin and approximately 95 mg/ 100 g on average in pulp [5, 8, 9]. Fruits of cornelian cherry are not only consumed fresh but also used in the production of jam, jelly, stewed fruit, marmalade, pestil (a locally dried fruit-pulp product), syrup and several types of soft drinks. It is also used for medicinal purposes due to the properties of leaves and fruits [7, 10]. The fruits may be used as a treatment for certain bowel disorders and fevers. In traditional medicine cornelian cherry fruits has been used to treat diarrhea, hemorrhoids, diabetes and several diseases including sore throat, digestion problems, measles, chickenpox, anemia, rickets, liver and kidney diseases [11].

Tarhana with cornelian cherry is locally produced and consumed in the regions of Turkey where the plant is cultivated or naturally grown. Although this type of tarhana is produced widespread from Kütahya to Kastamonu in Turkey, there is no study about the chemical, physical and sensory properties of tarhana with cornelian cherry. The aim of this present study is to determine these properties of tarhana with cornelian cherry and to compare its properties with traditional tarhana's.

MATERIALS and METHODS

Materials

Commercial wheat flour (Type 550) with the moisture content of 12%, protein content of 11% and ash content of 0.52%, on dry basis, was used. White flour (unenriched and bleached, İnceoğlu Flour Company Denizli), yoghurt (SEK, Istanbul), bakery yeast (Özmaya, Adana), cornelian cherry and other ingredients were purchased from a local market in Denizli, Turkey.

Preparation of Tarhana Powder

Two different formulations were used to prepare tarhana: (1) traditional tarhana with fresh tomato and fresh paprika (*Capsicum annum*) puree and (2) tarhana with cornelian cherry substituting fresh tomato puree and fresh paprika puree (Table 1).

Table 1. Formulations used for the production of tarhana doughs

Soup Sample	Ingredient (weight basis, %)[1]	
	Traditional Tarhana	Tarhana with Cornelian Cherry
Flour	58.5	58.5
Yoghurt	18.5	18.5
Fresh tomato puree	12.3	-
Fresh paprika puree	6.3	-
Fresh cornelian cherry puree	-	18.6

[1]Each tarhana recipe contains 1.4% fresh onion puree, 1.2% dry mint powder, 1.2% salt and 0.6% bakery yeast.

Prior to mixing the ingredients, fresh onions and cornelian cherry (or fresh tomato and paprika, depending on the formulation) were chopped into puree in a commercial blender (Arzum Ultima, Turkey) for 45 s at medium speed. Chopped ingredients were mixed with yoghurt, dried mint, salt, yeast and flour (one fifth of the initial weight in the formula). Then, the dough was transferred into plastic containers, and it was allowed to ferment at 30 ± 2°C for seven days. While two fifth of flour was added to dough on the 2nd and 3rd days of fermentation, the rest was added on the 4th day of fermentation. At the end of the 7th day of fermentation, tarhana dough (height≅ 0.5 cm) was rolled into a sheet, and it was cut into small pieces (width≅ 0.5 cm). Pieces of tarhana dough were open-air dried at 30 ± 2°C for 72 h. Then, samples were ground with a grinder (Toper TKS-16S, Izmir, Turkey) to a particle size of < 400 µm for further analysis. Three replications (n = 3) were used for each tarhana sample.

Preparation of Tarhana Soup

Two sets of tarhana soups were prepared in this study. While the first was used to study the physical and rheological properties of tarhana soups, the second was used to simulate commercial tarhana soups in order to determine the sensory properties of these soups. In the first set, tarhana-water mixtures (7: 100 w/v) were blended in a Warring blender at high speed for 2 minutes. Then, the mixture was poured into a round bottom flask attached to a condenser to prevent water loss. Flask was heated in an electro-mantle. After the appearance of first bubbles formed, the mixture was boiled for 5 minutes. This mixture was used to determine physical and rheological properties of two different tarhana soups.

Recipes containing tarhana powder (4.9%), deionized water (87.1%), corn oil (5.2%), tomato paste (2.4%) and salt (0.4%) were used to simulate commercial tarhana soups. Tarhana powder was mixed with 40% of initial water, and it was stirred continually until dissolved. Corn oil was heated to about 150°C in a saucepan, and tomato paste was fried for 2 minutes until the tomato paste blended in well. Then, stirred tarhana and water mixture, salt and remaining water were added into the saucepan and this mixture was mixed with hand until boiling. After the tarhana soups were allowed to boil for 15 minutes, they were cooled down to 70°C for sensory analysis.

Analytical Measurements

Dry matter, ash, and protein content of tarhana powders were determined according to AOAC procedures [12]. The micro-Kjeldahl method was used to determine nitrogen content of tarhana powders, and the results were multiplied by a factor (5.70) to determine crude protein content [12]. Crude fiber analysis was performed according to Elgun et al. [13].

Specific gravity of tarhana soups was determined at room temperature according to Lee and Hoseney [14]. pH of tarhana-water mixtures were measured at about 50°C. Color values (Hunter *Lab*) were determined by the Hunter-Lab Mini Scan XE colorimeter (Reston, VA, USA) [15].

A portion of tarhana samples (1 g) was mixed with 10 mL of aqueous methanol (70 : 30, v/v). The mixture was sonicated for 10 min in an ultrasonic bath (E 60 H Model, Elma Co., Germany), followed by mechanical shaking (WiseShake SHO-1D Model, Daihan Co., Korea) for 15 min at room temperature. After the centrifugation of the mixture (Universal 30 RF, Hettich Co., Germany) at 26000 *g* at 4°C for 20 min, clear supernatants were collected into amber vials. Total phenolic content and antioxidant capacity of these extracts were performed in duplicates.

Total phenolic contents of tarhana extracts were determined with the Folin- Ciocalteu reagent according to the method of Singleton et al. [16] using gallic acid as a standard. Extracts (1 mL) were pipetted into test tubes, and then 5 mL of diluted Folin-Ciocalteu's reagent and 4 mL of Na_2CO_3 (7.5%) were added. The absorbance values of all mixtures were measured at 760 nm using a spectrophotometer (PG-80 UV-Vis Spectrometer, PG Instruments, England) after incubating at 30 °C for 2.0 h in dark. Results were expressed as milligrams of gallic acid equivalent (GAE) per 100 gram of dry weight.

DPPH assay was used to determine the antioxidant activity of tarhana extracts according to the method of Thaipong et al. [17]. The stock solution was prepared by dissolving DPPH (24 mg) in methanol (100 mL) and then stored at -20°C until use. The working solution was obtained by mixing stock solution (10 mL) with methanol (45 mL) to obtain an absorbance value of about 1.10±0.02 units at a wavelength of 515 nm. Tarhana extracts (150 µL) were allowed to react with the working solution (2850 µL) for 24 h in dark. Then absorbances were taken at 515 nm. The standard calibration curve was linear between 25 and 800 µM Trolox. Results were expressed in µmol Trolox equivalent (TE)/ 100 g dry weight.

Inductively coupled plasma with optical emission spectrometer (ICP-OES), (Perkin Elmer Optima 2100 DV, Shalton, CT, USA) was used to determine mineral elements (K, Na, Ca, Mg, Mn, Cu, Zn, Fe, and P) in tarhana samples according to Barnes [18]. Operating conditions of the instrument were as follows: RF power, 1,450 W; coolant gas flow, 15 L/min; auxiliary gas flow, 0.2 L/min; nebulizer 0.8 L/min; heater, 30°C; delay time, 60 s; plasma view, axial; sample flow rate, 1.5 mL/min. Sensitive wavelengths for mineral identification were obtained from the tables provided by the manufacturer [19]. Signal changes over time were corrected using an external drift monitor. Averages of readings from all replicates were reported.

Consistency coefficients (K) and flow behavior indices (n) of tarhana soups with different ingredients were determined by a Brookfield Programmable DV-II+ Viscometer (Brookfield Eng. Labs. Inc., Stoughton, MA, USA). Briefly, hot soup samples (12 mL) were poured into a chamber located in a water-jacketed small sample adaptor SC4 (Brookfield). A circulating water bath was used to determine K and n values for each soup sample at different temperatures (in the order of 70, 60, 50, 40 and 35°C (±1.0°C)). In order to determine the flow behavior characteristics of tarhana soups, the power-law model $\delta = K(\dot{\gamma})^n$, where δ is the shear stress (Pa), $\dot{\gamma}$ is the shear rate (s-1), K is the consistency coefficient (Pa.s^n) and n is the flow behavior index (dimensionless), was used [20].

Sensory Evaluation

A panel of 30 subjects in the Department of Food Engineering (Pamukkale University, Denizli, Turkey) evaluated the sensory properties of tarhana soups, and gave scores for smell, color, consistency, flavor, aftertaste and overall acceptance on a hedonic scale from 1 (dislike extremely) to 9 (like extremely) [21]. Approximately 80 mL of tarhana soup at about 60°C were presented to each subject. The panel consisted of students, staff and faculty members (21 males, 9 females), and 20% of the subjects were between 18 and 25, 63% between 26 to 40 years old, and 17% older than 40 years. The samples were labeled randomly with three-digit numerical codes. During the panel, subjects were instructed to rinse their mouths with water, and eat unsalted crackers before tasting each sample. The panel was performed in partitioned boots equipped with daylight.

Statistical Analyses

Data were analyzed using the Statistical Analysis System software [22]. The PROC TTEST (Student's t-test) procedure was performed to determine significant differences at $p < 0.05$.

RESULTS and DISCUSSION

Chemical and Physical Properties of Tarhana Powders

One-day fermentation at room temperature reduced the pH value of tarhana dough samples with cornelian cherry to about 3.6 ± 0.04 while it was 4.39 ± 0.05 for traditional tarhana. Tarhana soup is traditionally made by fermented and dried tarhana dough, and it has acidic and sour taste with a yeasty flavor [23]. Production of acids by lactic acid bacteria of yoghurt and bakery yeast in the formulation during fermentation is the main reason of pH reduction in tarhana dough samples [24]. The use of yoghurt (source of lactic acid bacteria) together with yeast plays an important role in developing distinctive tarhana taste and flavor [2]. The pH of soups may be reduced with increasing the amount of yoghurt or excluding salt in formulations [24]. In our study, we found that the use of cornelian cherry in the tarhana formulation lowered the pH value of the dough to a desired level in a very short time.

Chemical analyses of tarhana powder samples with cornelian cherry were similar to those of traditional tarhana; however, Hunter L value (lightness) was significantly higher for tarhana with cornelian cherry than traditional tarhana powder sample ($p < 0.05$) (Table 2). Protein and ash contents of both tarhana samples were about 14.0% (dry weight) and 1.6%, respectively. Tamer et al. (2007) reported that the ranges of protein and ash contents of various tarhana samples collected from different regions of Turkey were 6.77 - 28.55% and 1.36 - 9.40%, respectively, and our results were in good agreement with these ranges [25].

Table 2. Some chemical and physical properties of tarhana powders

Tarhana Sample	Traditional Tarhana[1,2]	Tarhana with Cornelian Cherry
Moisture (%)	4.80 ± 0.26a	4.58 ± 0.13a
Ash (%)	1.57 ± 0.16a	1.85 ± 0.18a
Protein (%, dw)	14.40 ± 0.76a	13.31 ± 0.27a
Crude Fiber (%, dw)	0.11 ± 0.01a	0.17 ± 0.12a
Antioxidant activity (µmol TE/ 100 g dw)	50.54 ± 5.29a	40.03 ± 4.36a
Total phenolic content (mg GAE/ 100 g dw)	598.65 ± 30.00a	557.89 ± 25.01a
Hunter *Lab* Values		
L	60.36 ± 0.60b	63.44 ± 0.26a
a	5.49 ± 0.65a	1.06 ± 0.21b
b	16.34 ± 0.57a	11.01 ± 0.11b

[1]Different letters within a row across the table show significant differences at $\alpha = 0.05$. [2]Results are the averages of duplicates ± standard deviation.

The differences in the total phenolic content and antioxidant activity of two tarhana samples were statistically insignificant ($p > 0.05$) (Table 2). Traditional tarhana contains tomato puree, which is a good source of lycopene, β-carotene and flavonols [26-28] and paprika puree, which is rich in capsanthin, β-cryptoxanthin, β-carotene, lutein, zeaxanthin and quercetin [27, 29, 30]. On the other hand, cornelian cherry significantly contains a variety of antioxidative constituents especially phenolic compounds and anthocyanins [31-33]. Results indicated that the substitution of fresh tomato and paprika puree with cornelian cherry puree in tarhana formulation had an insignificant effect on the antioxidant activity and total phenolic content of final products.

Hunter a and b values of traditional tarhana powder samples were about 5.5 and 16.3, respectively (Table 2). They were significantly higher than those of tarhana powder samples with cornelian cherry ($p < 0.05$), meaning that cornelian cherry puree in formulation made tarhana less reddish and yellowish in color.

Mineral Composition of Tarhana Powders

In terms of mineral composition of tarhana powders, both samples exhibited very similar mineral composition with the exception of phosphorous (Table 3). Phosphorus content of traditional tarhana was significantly higher than tarhana with cornelian cherry ($p < 0.05$). Phosphorus content of fresh tomato ranges from 209 to 336 mg/kg wet base [34] and it is from 254 to 355 mg/kg for paprika [35]. On the other hand, phosphorus content of cornelian cherry is lower than tomato and paprika and ranges from 152 to 261 mg/kg wet base [36]. Therefore, the difference in phosphorus contents of tarhana powders is most likely to be attributed to the type of ingredients used in formulation.

Chemical and Physical Properties of Tarhana

Soup samples prepared with tarhana powder with cornelian cherry and water had significantly a lower pH value than traditional tarhana soup ($p < 0.05$) (Table 4). This low pH arisen from the low pH of tarhana dough. Cornelian cherry fruits have sour and sweetish taste [5, 7]. While total sugar content of cornelian cherry fruits ranges from 6.7 to 11.0%, average titration acidity in terms of malic acid and pH of cornelian cherry fruits are

2.04% and 2.75, respectively [5]. Deionized water used to prepare tarhana soup had a pH around 6.8. Hydrogen bonding with water in starch molecules occurs among hydroxyl groups of neighboring sugar molecules or the ring oxygen atoms or the glycosidic oxygen atoms connecting one sugar ring to another [37]. Cornelian cherry puree in the tarhana dough formulation significantly decreased the red-green (a) and yellow-blue (b) color values of soups while increasing the lightness (L) of soups (p< 0.05). Cornelian cherry puree made the color of soups lighter, less red and yellow in color. Pigments in carotenoid and flavone nature and other constituents are responsible for the yellow color of wheat flour [38]. Higher Hunter a and b values of traditional tarhana soups are attributed to fresh paprika and tomato puree, which are replaced with fresh cornelian cherry puree in tarhana with cornelian cherry formulations

Table 3. Mineral composition of tarhana powders

Mineral	Tarhana Sample (mg/kg wet basis) [1,2]	
	Traditional Tarhana	Tarhana with Cornelian Cherry
Phosphorous	1683.1 ± 44.0a	1410.9 ± 75.5b
Copper	3.2 ± 0.9a	2.8 ± 0.2a
Zinc	9.4 ± 0.9a	8.0 ± 0.2a
Iron	58.7 ± 36.0a	29.7 ± 1.3a
Manganese	6.9 ± 0.8a	5.4 ± 0.1a
Calcium	1154.2 ± 121.6a	1023.9 ± 75.6a
Magnesium	558.0 ± 35.8a	555.1 ± 105.5a
Potassium	3982.4 ± 14.1a	4770.6 ± 131.8a
Sodium	10460.6 ± 233.9a	9211.8 ± 95.1a

[1]Different letters within a row across the table show significant differences at α= 0.05.
[2]Results are the averages of duplicates ± standard deviation.

Table 4. Some chemical and physical properties of tarhana-water mixtures (7: 100 w/v)

Property	Tarhana Sample[1,2]	
	Traditional Tarhana	Tarhana with Cornelian Cherry
Specific Gravity	1.06 ± 0.01a	1.06 ± 0.02a
pH	4.17 ± 0.16a	3.84 ± 0.01b
Hunter *Lab* Values		
L	36.46 ± 0.96b	39.04 ± 1.13a
a	2.78 ± 1.18a	0.04 ± 0.03b
b	12.25 ± 0.74a	6.76 ± 0.15b

[1]Different letters within a row across the table show significant differences at α= 0.05.
[2]Results are the averages of duplicates ± standard deviation.

Rheological Properties of Tarhana Soups

Traditional tarhana soups and tarhana soups with cornelian cherry exhibited pseudoplastic behavior (n< 1) at a temperature range from 35°C to 70°C, and this behavior was independent from the temperature range used in this study (Table 5). Consistency coefficients of traditional tarhana soups reduced significantly as the temperature increased (p< 0.05) while K values for tarhana soups with cornelian cherry remained unchanged over the temperature studied. Low K values at high temperatures are the indicators of low apparent viscosities because, according to the power-law equation, apparent viscosity is positively correlated with consistency coefficient [20]. Erbas et al. [39] reported that tarhana soup exhibited pseudoplastic behavior (n= 0.396). Studying the effect of different drying methods on the functional properties of tarhana, Hayta et al. [40] found that drying methods such as microwave-, free- and tunnel-drying of tarhana dough influenced the K and n values of tarhana soups, and tarhana soups exhibited pseudoplastic behavior at different temperatures. Ibanoglu and Ibanoglu [23] reported that consistency coefficient and flow behavior index of tarhana soups were dependent on the type of flour in formulation and the particle size of tarhana powder. Flow behavior indices of tarhana soups with white wheat flour were lower than those with wholemeal flour. The authors also reported that n values were unaffected by temperature but increased as the particle size of tarhana powder increased. In this present study, the effect of temperature on the flow behavior indices of both tarhana soups was insignificant (p> 0.05).

Sensory Properties of Tarhana Soups

Sensory evaluation results of tarhana soups indicated that differences in overall, smell, consistency, taste and aftertaste liking scores for traditional tarhana and tarhana soups with cornelian cherry were insignificant (p> 0.05) (Table 6). Results indicated that both types of tarhana soups were equally liked by the panelists.

Table 5. Effect of temperature and cornelian cherry addition on consistency coefficients (K) and flow behavior indices (n) of tarhana soups

Temperature (°C)	K (Pa.s^n) [1,2]		n [1,2]	
	Traditional Tarhana	Tarhana with Cornelian Cherry	Traditional Tarhana	Tarhana with Cornelian Cherry
35	7.25 ± 1.38a	8.45 ± 0.96a	0.62 ± 0.13a	0.57 ± 0.01a
40	6.08 ± 1.28a	9.35 ± 2.79a	0.66 ± 0.11a	0.56 ± 0.04a
50	5.25 ± 2.30a	8.13 ± 2.53a	0.67 ± 0.13a	0.55 ± 0.05a
60	3.45 ± 0.61b	6.38 ± 0.82a	0.77 ± 0.13a	0.59 ± 0.03a
70	1.96 ± 0.94b	6.35 ± 1.27a	0.73 ± 0.39a	0.54 ± 0.03a

[1]Different letters within a row across the table show significant differences at α= 0.05. [2]Results are the averages of duplicates ± standard deviation.

Table 6. Sensory evaluation results for traditional tarhana soups and tarhana soups with cornelian cherry (1: dislike extremely, 9: like extremely)

Sensory Characteristic*	Tarhana Sample[1,2]	
	Traditional Tarhana	Tarhana with Cornelian Cherry
Smell	5.7 ± 1.5a	6.4 ± 1.6a
Color	7.1 ± 1.5a	6.5 ± 1.5a
Consistency	7.1 ± 1.8a	6.5 ± 2.2a
Taste	6.7 ± 1.7a	6.6 ± 1.8a
Aftertaste	6.5 ± 1.7a	6.6 ± 1.8a
Overall	6.7 ± 1.8a	6.3 ± 1.4a

[1]Different letters within a row across the table show significant differences at α= 0.05.
[2]Results are the averages of duplicates ± standard deviation.

CONCLUSION

Tarhana dough samples with cornelian cherry had a pH value around 3.6, which is significantly lower than traditional tarhana after one day fermentation ($p< 0.05$). This high acidity is mostly arisen from the organic acid content of cornelian cherry [5, 8, 9] in tarhana formulation. Substitution of fresh tomato and paprika puree with cornelian cherry in tarhana mixture resulted in tarhana soups with lighter reddish and yellowish color. Both traditional tarhana soup and tarhana with cornelian cherry exhibited similar chemical composition. They also exhibited pseudoplastic behavior over the temperatures studied (i.e. $n< 1$). The effect of temperature on flow behavior indices of tarhana soups was insignificant. Sensory evaluation results indicated that both soups equally liked by the subjects. As a result, cornelian cherry, which has been used locally in the production of homemade tarhana soups in certain regions of Turkey, can be successfully used as an ingredient in commercial production of tarhana.

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