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Effects of adding cherry laurel (*Laurocerasus officinalis*) on some physicochemical and functional properties and sensorial quality of tarhana

Z. Tarakci[1], M. Anil[2], I. Koca[2] and A. Islam[3]

[1]Ordu University, Faculty of Agriculture, Department of Food Engineering, 52100 Ordu, Turkey; [2]Ondokuz Mayis University, Faculty of Engineering, Department of Food Engineering, 55580 Samsun, Turkey;[3]Ordu University, Faculty of Agriculture, Department of Horticulture, 52100 Ordu, Turkey; munira@omu.edu.tr

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Abstract

Tarhana, a traditional fermented food produced from a mixture of wheat flour and yoghurt, is widely consumed in Turkey. The aim of this study was to investigate the effect of cherry laurel pulp on the physico-chemical, functional and sensorial characteristics of tarhana. Tarhana samples with 0, 5, 10, 15 and 20% cherry laurel pulp were manufactured. The statistical analysis showed that addition of pulp affected titratable acidity, pH, total phenolic, antioxidant capacity, foaming capacity, foam stability, viscosity, colour and sensorial scores significantly. Pulp addition decreased dry matter, titratable acidity, water absorption capacity, foaming capacity, foam stability and L* (lightness), a* (redness) and b* (yellowness) colour values significantly ($P<0.05$). There were significant differences ($P<0.05$) in viscosity values between the control tarhana and the samples made with cherry pulp. However, increasing pulp increased significantly ($P<0.05$) pH, total phenolic, ferric reducing antioxidant power, radical scavenging activity. The most acceptable sensory scores were obtained with 5.0 and 10.0% added pulp. In the production of flavoured tarhana sample, samples with these cherry laurel pulp levels are recommended.

Keywords: antioxidant, cherry laurel fruit, colour, sensorial properties, tarhana, viscosity

1. Introduction

Tarhana is one the oldest traditional Turkish soup material, which is made by fermenting cereals, and is widely consumed by people of all ages. It is prepared by mixing tarhana, cereal flours and a variety of cooked vegetables, including red and green peppers, onions and tomatoes flavouring agents are also added, including salt, mint, paprika and various herbs (Bilgicli, 2009). The mixture is then fermented for 1-7 days. Tarhana is one of the most widely consumed fermented foods in the Middle East and Turkey (Tarakci *et al.*, 2004). Production method and recipe of tarhana might differ from region to other region.

The amount and type of ingredients, as well as the processing techniques, might vary from place to place in Turkey. The ratio of tarhana to wheat flour is usually 1:1. In some regions, the level of tarhana may be reduced or replaced with milk. In different parts of the country, one or more of the following ingredients can be used in the formulation of the food: milk, soybean, maize, barley and rye flour, chick bean, lentils, cornelian cherry and baker's yeast. Cornelian cherry has been used for the medical treatment of gastrointestinal disorders and diarrhoea among people in Turkey. The fruits are not only consumed fresh but also used to produce jam, marmalade, pekmez, pestil (a locally dried fruit pulp product), syrup and several types of soft drinks. They are also used to produce tarhana (Koca, 2008; Sengun and Karapinar, 2012).

Cherry laurel (*Laurocerasus officinalis* Roem.) belongs to the *Rosaceae* family and is a popular fruit (dark purple or black when mature), mainly distributed in the coasts of the Black Sea region of Turkey and is locally called 'Karayemis' (Alasalvar *et al.*, 2005). In Turkey, approximately 5,000 tons of cherry laurel fruit is produced per annum. The composition of cherry laurel pulp is: 80.32% moisture, 15.31% soluble solids, 112.6 g/kg total sugar, 108.7 g/kg invert sugar, 3.7 g/kg sucrose, 0.47% crude fibre, 0. 23% pectin, 2139.6 mg/kg total phenolic matter, 0.53% ash, 90.19 mg/100 g potassium and has a pH of 4.69 (Ustun and Tosun, 2003). The plant-derived edible and non-edible products contain a wide range of phenolic compounds such as phenolic acids, flavonoids, anthocyanins, tannins, lignans, and catechin that possess antioxidant activities. These phenolics provide protection against harmful free-radicals and have been known to reduce the risk of certain types of cancer, coronary heart disease, cardiovascular disease, stroke, atherosclerosis, and other degenerative diseases associated with oxidative stress. The antioxidant activity of these phenolics is mainly due to their redox properties, which allow them to act as reducing agents or hydrogen-atom donors. Thus, natural antioxidants function as free-radical scavengers and chain breakers, complexers of prooxidant metal ions and quenchers of singlet-oxygen formation (Liyana-Pathirana *et al*., 2006). It is mostly consumed as fresh fruit in local markets although it may also be dried, pickled, and processed into pekmez, jam, marmalade, and fruit juice products (Islam, 2002). Besides its use for food, both fruit and seeds of cherry laurel are well known as traditional medicines in Turkey and have been used for many years for the treatment of stomach ulcers, digestive system complaints, bronchitis, eczemas, hemorrhoids, and as a diuretic agent, among others (Liyana-Pathirana *et al*., 2006). The objective of this study was to develop a new type of tarhana by adding cherry laurel pulp and to determine the effect of cherry laurel pulp on the physicochemical and sensorial properties of the tarhana.

Table 1. Properties of cherry laurel pulp used in tarhana production.

Properties	Content
Dry matter (%)	16.0
pH	3.90
Titratable acidity (as malic acid) (%)	0.63
Total phenol (mg/kg)	1,052.73
FRAP (μmol/g)	7,673.33
%DPPH reducing power (%)	30.91
L*	17.40
a*	4.17
b*	2.58

a* = redness; b* = yellowness; DPPH = 2,2-dipheynl-1-picrylhydrazyl; FRAP = ferric reducing antioxidant power; L* = lightness.

2. Material and methods

Materials

White commercial wheat flour with the protein content of 12% on dry basis was used. Tomato paste was double concentrated to a content of 30%. Cow milk with a fat content of 3% was added to the tarhana. Compressed baker's yeast in wet form, yoghurt, wheat flour, onion, tomato, green peppers and were purchased from local markets in Ordu, Turkey. The cherry laurel fruit was collected from the coasts of the Black Sea region of Turkey. The cherry laurel's properties is shown in the Table 1.

Production of the experimental tarhana

The tarhana samples were composed of 300 g flour, 300 g yoghurt, 30 g tomato paste, 60 g green pepper, 75 g onion, 3 g yeast. Tomato, green pepper and onion were chopped into pieces prior addition to the tarhana mixture. All ingredients except flour and yeast were first mixed, and the mixture was left under the room conditions for a day to become sour. At the end of that day, wheat flour was added and mixed. The tarhana mixture was divided into 5 aliquots. The cherry laurel pulp concentrations (0% (control), 5%, 10%, 15% and 20%) were added to the tarhana, and samples were coded as TC, T1, T2, T3 and T4, respectively. The resulting dough was fermented at 30 °C for 24 h. At the end of fermentation, the dough was dried in an air oven at 55±2 °C. The dough was divided into pieces of 1-2 cm thickness for drying; and small pieces were sometimes broken into smaller pieces during drying to make the drying easier. The drying process was continued until the moisture content of 10% was reached. The samples were milled in a hammer mill up to the particle size of 1 mm to standardise the sizes and then were stored in glass jars at 22±2 °C in a dark cupboard.

Sample analyses

Physical and chemical analyses

Dry matter content was determined by oven-drying 5 g samples at 105 °C until a constant weight was obtained. The pH was measured with a digital pH meter (Hanna Instruments, Centralino, Italy). Titratable acidity was determined by titration up to pH 8.1 with 0.1 N NaOH solution and results were expressed as grams of malic acid (in cherry laurel pulp) and lactic acid (in tarhana) per 100 g of sample (AOAC, 2000).

Total phenolic analyses

Extraction of samples: cherry pulp and 80% methyl alcohol 12 h tarhana samples kept in refrigerator temperature, 10 °C for 10 min and then centrifuged at 15,000×*g*, solid parts were removed. Total phenolic content was done according to the method of Thaipong *et al*. (2006) with some modification. The 20 μl of extract, 1,580 μl of pure water, and 100 μl of 0.25 N Folin-Ciocalteu reagents were combined in a plastic vial and then mixed well using a Vortex. The mixture was allowed to react for 3 min then 300 µl of 1.0 N Na_2CO_3 solution was added and mixed well. The solution was incubated at room temperature in the dark for 2 h. The absorbance was measured at 760 nm using a spectrophotometer. Results were expressed as milligrams of gallic acid equivalents per kilogram.

Antioxidant activity analyses

Antioxidant activity was measured by two methods: ferric reducing antioxidant power (FRAP) method and the free radical 2,2-dipheynl-1-picrylhydrazyl (DPPH) method. To measure antioxidant activity, an aliquot of the acetone/methanol/water/formic acid (40:40:20:0.1, v/v/v/v) extracts of cherry laurel pulp and tarhana samples were dried at 30 °C vacuum using rotary evaporator (Buchi, Newcastle, DE, USA) and redissolved in the same volume of water (Kalt *et al.*, 2000). Aqueous samples were mixed with 0.95 ml of ferric-TPTZ (2,4,6-tripyridyl-s-triazine) reagent (prepared by mixing 300 mM acetate buffer, pH 3.6, 10 mM TPTZ (Acros Organics, Fair Lawn, NJ, USA) in 40 mM HCl, and 20 mM $FeCl_3$ in the ratio of 10:1:1) and measured at 593 nm. $FeSO_4$ was used as a standard. Antioxidant power was expressed as micromole per gram FRAP (Gao *et al.*, 2000).

For the determination of free radical scavenging activity, the samples were extracted with methanol by using a homogeniser (Controls, Milano, Italy) at ambient temperature for 30 min. Then, they were centrifuged (Sigma 3K30; Osterode am Harz, Germany) at 15,000×*g* for 10 min. The supernatants were concentrated under reduced pressure at 40 °C. The dried extracts were dissolved in methanol. Free radical scavenging activity was measured according to the principle of Nakajima *et al.* (2004) with some modifications reported by Chiou *et al.* (2007). Fifty microliters of the diluted extracts were added to 1.0 ml of 6×10^{-5} mol/l DPPH (free radical, 95%, Sigma-Aldrich Chemie GmbH, Steinheim, Germany) in methanol. The mixture was shaken and left at room temperature for 30 min; the absorbance was measured with spectrophotometer at 515 nm. Methanol was used as the experimental control. The percentage of reduction of DPPH was calculated according to the following equation:

$$\% \text{ DPPH reduction} = (A_c\text{-}A_s/A_c) \times 100$$

Where A_c is the absorbance of control and A_s is the absorbance of added sample (Tural and Koca, 2008).

Water absorption capacity analyses

The 5 g of tarhana was thoroughly mixed with distilled water (25 ml) in a 50 ml centrifuge tube. The dispersion was stirred at 15 min intervals over a 60 min period and then centrifuged at 4,000×*g* for 20 min. The water absorption capacity values were expressed as grams of water absorbed per gram of tarhana (Hayta *et al.*, 2002).

Foaming capacity and foam stability analyses

Ten g of tarhana was dispersed in distilled water and stirred for 20 min. The mixture was centrifuged at 4,000×*g* for 20 min. The supernatant obtained was filtered (Whatman No. 1; Whatman, Piscataway, NJ, USA) and transferred to a Waring blender (Waring, Torrington, CT, USA) and whipped for 2 min at high-speed setting. The solution was slowly poured into a cylinder, and the volume of the foam was recorded after 10 sec. The foaming capacity was expressed as the volume (ml) of gas incorporated into 1 ml of solution. The foam stability was recorded in the course of time until a half of the original foam volume had disappeared (Hayta *et al.*, 2002).

Viscosity analyses

Ten g of tarhana was dispersed in distilled 150 ml water, stirred for 10 min, and then cooked for 10 min to permit complete starch gelatinisation. Viscosity was measured at 30, 45, and 60 °C using the Brookfield rotational viscometer (Model DV-1; Brookfield Engineering Laboratories, Inc., Stoughton, MA, USA) using No. 4 spindle at 20 rpm. Samples were stirred for 40 sec before measurement (ASTM, 1991; Koca *et al.*, 2002).

Colour characteristics analyses

The colour of tarhana samples was measured using the CIELAB system with a colorimeter (Minolta CR 400; Minolta Camera Co. Ltd, Osako, Japan) calibrated with a white tile (Minolta calibration plate, No. 21733001, Y = 92.6x = 0.3136y =0.3196) at 2° observation angle with a C illuminant source. L* (lightness; 100 = white, 0 = black), a* (redness; + = red, - = green) and b* (yellowness; + = yellow, - = blue) values were recorded. The tarhana samples were put into an optically flat glass dish for measurements.

Sensorial characteristics analyses

Tarhana soup was prepared by dissolving one part of tarhana sample in seven parts of warm water and boiling this mixture. Sixteen panelists from the Department of Food Engineering evaluated the sensory properties of the cooked tarhana samples (tarhana soup) using a hedonic scale. The panel consisted of the staff of the department (three females, five males) who enjoyed eating tarhana soup. The panelists were in the age range of 23-40 years. The samples were tempered to approximately 60 °C and labeled with randomly selected three-digit numerical codes. The samples were presented in a randomised balanced block design. The panelists evaluated each treatment in duplicates. In performing the test, the panelists rinsed their mouths with water and ate bread without salt between the samples. The assessments were made in partitioned booths equipped with daylight. The panelists gave scores on a nine-point scale from 1 (dislike extremely) to 10 (like extremely) for taste, odour, texture, colour, and acceptance of the prepared soups. The replication was achieved with five different tarhana samples evaluated by panelists.

Statistical analysis

The study was designed on 5 tarhana samples. Square root transformation was applied to the sensory data and the effects of the addition of cherry laurel pulp on each chemical, physical and sensory parameter of the experimental tarhana were estimated by one way ANOVA using the SSPS® (2000) statistical software (SPSS Inc., Chicago, IL, USA). Duncan's multiple range test was used for the determination of statistically different groups.

3. Results and discussion

The effect of different cherry laurel pulp levels on the chemical composition of tarhana is shown in Table 2. The dry matter contents of tarhana samples did not change by cherry laurel pulp addition significantly ($P<0.05$), except for 20% concentration. The highest average titration acidity value was found for the control sample. Increasing fruit pulp ration in tarhana samples decreased significantly titratable acidity and lowest value was found in T4 sample ($P<0.05$). Titratable acidity of the samples ranged from 0.63 and 0.81%. Titratable acidity values were lower than the values reported by Oner *et al.* (1993), Tarakci *et al.* (2004) and Erbas *et al.* (2005). It is expected that tarhana with cherry laurel has lower level of acidity compared to the some previous studies. The lowest average pH value was found in the control sample ($P<0.05$). In contrast to titration acidity, pH value of tarhana increased with cherry laurel addition. The differences in acidity values among tarhana samples were probably due to the concentration of cherry fruit used. Our results are in good agreement with the findings of Koca (2008), whereas our values were higher than those of Degirmencioglu *et al.* (2005) who used tarhana to which a herb (*Echinophora sibthorpiana)* was added.

Tarhana has a sour and acidic taste with a yeasty flavour. Lactic acid bacteria are usually responsible for the acid formation during fermentation. Baker's yeast (*Saccharomyces cerevisiae*) can be used to increase the characteristic flavour of tarhana because they, along with many other microorganisms, are responsible for the formation of carbon dioxide, alcohol, organic acids, aldehydes, ketones and other fermentation products which are all responsible for the flavour of tarhana (Campbell-Platt, 1987; Erbas *et al.*, 2005). Organic acids, formed throughout lactic acid fermentation, lower the pH to 3.8-4.2 and tarhana thus becomes a poor growth medium for pathogens and spoilage microorganisms. After drying, the non-hygroscopic nature and low moisture content (6-9%) of tarhana makes it stable for 1-2 years without deterioration (Ibanoglu and Ibanoglu, 1997). The amount and type of ingredients, as well as the processing techniques, may vary from place to place in Turkey (Daglioglu, 2000; Siyamoglu, 1961).

Fruits and vegetables account for a small part of our daily caloric intake; however their benefits to health surpass their caloric contribution. The contributory factors are due to the presence of vitamins and provitamins, such as ascorbic acid, tocopherols, carotenoids and a wide variety of phenolic substances (Loliger, 1991). As shown in Table 2, with increase cherry laurel fruit concentration in tarhana, total phenolic content raised ($P<0.05$) from 902.73 mg/kg (control tarhana) to 1,339.09 mg/kg (20% cherry laurel sample). The highest level of phenolic content of samples was found in T4, while the lowest content was found in control sample. However, these results are higher than those observed by Koca (2008) for tarhana samples with cornelian cherry, but lower than those found by Karakaya *et*

Table 2. Chemical properties of tarhana samples.

Properties	TC	T1	T2	T3	T4
Dry matter (%)	89.01±0.22a	88.91±0.21a	89.02±0.18a	88.89±0.17a	87.84±0.21b
Titratable acidy (% LA)	0.81±0.02a	0.74±0.03b	0.69±0.01bc	0.65±0.02c	0.63±0.03c
pH	3.51±0.03d	3.61±0.04c	3.68±0.03bc	3.75±0.02ab	3.78±0.02a
Total phenolic (mg/ kg)	902.73±70.7d	971.82±10.3cd	1,086.82±9.6bc	1,197.41±88.9b	1,339.09±45.0a
FRAP (µmol/g)	4,673.33±794c	6,280±644b	7,424.45±188ab	7,835.56±329a	8,504.17±216a
DPPH reducing power (%)	13.08±0.28d	14.41±0.09cd	15.27±0.56c	16.79±0.65b	20.51±0.86a

DPPH = 2,2-dipheynl-1-picrylhydrazyl; FRAP = ferric reducing antioxidant power; LA = lactic acid; TC = control tarhana, with no fruit pulp; T1 = tarhana with 5% fruit pulp; T2 = tarhana with 10% fruit pulp; T3= tarhana with 15% fruit pulp; T4 = tarhana with 20% fruit pulp.
Different letters within a column indicate significant differences among tarhana samples with added fruit pulp ($P<0.05$).

al. (2001) in traditional tarhana (3,717 mg/kg). As seen, total phenolics in cherry laurel pulp contribute total phenolic contents of the tarhana. These results indicated that the total phenolic content of cherry laurel could increase the total phenolic content of tarhana. This increase should be due to cherry laurel addition, has been considerable contribution to the antioxidant content of tarhana. It is well-known that phenolic compounds contribute to fruit quality and nutritional value by modifying colour, taste, aroma, and flavour, and also by providing beneficial health effects. These compounds also play a role in plant defensive mechanisms by counteracting reactive oxygen species, thus minimizing molecular damage due to microorganisms, insects, and herbivores (Kamiloglu *et al.*, 2009; Vaya and Aviram, 1997).

The fruit contains significant amounts of anthocyanins and other phenolics. Therefore, food industry is interested in fruits and vegetables with high content of bioactive anthocyanins with the aim of producing supplements which have preventative and therapeutic effects (Mazza *et al.*, 2002). DPPH is a free radical compound that has been widely used to determine the free radical scavenging capacity of various samples because of its stability (in radical form), simplicity and fast assay (Seah *et al.*, 2010). Ferric reducing antioxidant power is shown Table 1. DPPH ration raised significantly from 13.08% in control tarhana to 20.51% in T4 sample with increasing cherry fruit concentration in tarhana ($P<0.05$). The results showed that the highest free radical scavenging activity was in T4 sample that show agreement with the total phenolic content, while the lowest value was in control tarhana without fruit. The antioxidant activities of phenolic compounds are mainly of redox properties, including free radical scavenging, hydrogen donating and singlet oxygen quenching (Mayachiew and Devahastin, 2008). Pulido *et al.* (2000) reported the reducing capacity of polyphenols, as determined by the FRAP assay. This seems to depend on the degree of hydroxylation and extent of conjugation of the phenolic compounds (Seah *et al.*, 2010).

The DPPH radical scavenging assay is commonly employed to evaluate the ability of antioxidants to scavenge free radicals. The use of the DPPH free radical is advantageous in evaluating antioxidant effectiveness because it is more stable than the hydroxyl and super oxide radicals (Liyana-Pathirana *et al.*, 2006; Tural and Koca, 2008). Radical scavenging activity of tarhana was increased significantly with added cherry laurel pulp ($P<0.05$). Higher DPPH radical scavenging activity value indicates greater antioxidant activity. A general consensus has been reached during the last few years that diet has a major role in development of chronic diseases, such as cancer, coronary heart, obesity, diabetes type 2, hypertension and cataract. This consensus suggests that a predominantly plant-based diet rich in fruits and vegetables, pulses and minimally processed starchy staple foods reduces the risk for development of these diseases significantly. Fruits and vegetables contain many different antioxidant components. The antioxidant activity is most significantly correlated with the contents of total phenolics (Koca, 2008).

Effect of cherry fruit on functional values of tarhana

Water absorption capacity

The water absorption capacity (WAC) is considered as an important functional property in viscous foods, such as sauces dough and baked products (Hayta *et al.*, 2002). The cherry laurel additions on WAC of the tarhana samples are given in Table 3. In our study, it was found that the addition of cherry pulp to the samples decreased WAC values, but these decreases are not significant statistically ($P>0.05$). The decrease in WAC values can be explained by structural changes in starch and proteins present in tarhana ingredients (Celik *et al.*, 2005). Tarhana contains milk proteins, mainly casein, and wheat proteins (for example glutenin and gliadins) originating from yoghurt and flour used in tarhana preparation. Milk protein (casein) functionality is related to changes in structural composition and conformation. These changes may lead to the exposure of hydrophobic side chains on the proteins (Hayta *et al.*, 2002; Jahaniaval *et al.*, 2000).

Table 3. Functional properties changes of experimental tarhana samples.

Properties	TC	T1	T2	T3	T4
WAC (g/ml)	0.65±0.09a	0.64±0.03a	0.64±0.03a	0.64±0.05a	0.62±0.06a
FC (ml/ml)	2.55±0.01a	2.49±0.06a	2.35±0.01b	2.33±0.04b	2.32±0.04b
FS (min)	10.0±0.71a	9.87±0.89a	8.33±0.25ab	8.21±1.22ab	7.49±0.26b

FC = foaming capacity; FS = foam stability; TC = control tarhana, with no fruit pulp; T1 = tarhana with 5% fruit pulp; T2 = tarhana with 10% fruit pulp; T3= tarhana with 15% fruit pulp; T4 = tarhana with 20% fruit pulp; WAC = aater absorption capacity.
Different letters within a column indicate significant differences among tarhana samples with added fruit pulp ($P<0.05$).

Foaming capacity and foam stability

The foaming capacity (FC) and foam stability (FS) of the tarhana samples are given in Table 3. The cherry laurel addition reduced FC and FS continuously (P<0.05) as compared to the control tarhana samples. Decreases among from control and to added tarhana samples have reflect protein portion with increased cherry laurel concentration in tarhana. Some food proteins are capable of forming good foams, and their capacity to form and keep stable foams depends on the type of protein, degree of denaturation, pH, temperature, and processing methods.

Tarhana contains milk proteins (casein, globulin, and albumin) and wheat proteins (glutenin and gliadin) originating from yoghurt and flour used for the tarhana preparation (Celik *et al*., 2005; Daglioglu, 2000). Some food proteins are capable of forming good foams and their capacity to form and keep stable foams depends on the type and concentration of proteins, the degree of coagulation, pH, ions, temperature, and processing methods (Celik *et al*., 2005; Daglioglu, 2000). Differences in FC and FS between the samples may reflect decreases of proteins ration in tarhana samples. The decrease in FC and FS can be explained by the proteolytic activity of yeast, which leads to the weakness in the gas absorption property of proteins present in the tarhana formula.

Effect of cherry pulp on viscosity values of tarhana

The viscosity is one of the typical major parameters for semi liquid for food. The effects of the addition of cherry laurel pulp on the viscosity of tarhana soups are shown in Table 4. There were significant differences (P<0.05) in viscosity values between the control tarhana and the tarhana samples made with cherry laurel pulp. Viscosity values decreased to the level of 15% cherry laurel pulp in tarhana and viscosity in the next level (with 20% sample) showed increases. From Table 4, it was observed that viscosity decreased in flour concentration. The observed decrease could be attributed to solubility and swelling properties of the decrease flour ratios. A possible explanation is that the polysaccharide has a strong tendency to self-association with the extent of aggregation decreasing with decreasing concentration (Ikegwu *et al.*, 2009).

These changes might be due to water-holding capacity of the fruit pulp. In all the samples, viscosity decreased with the increase in temperature. Heating may rupture the molecular entanglement and bonds, stabilizing the molecular structure and resulting in a decrease in viscosity. As the temperature increases, destabilisation of protein-protein and protein-water interactions occur, which leads to a decrease in viscosity (Hayta *et al*., 2002). It was also found that the addition of cherry laurel pulp to the formulas caused an increase in viscosity, except for with 20% sample.

Effect of cherry laurel pulp on colour values of tarhana

L* value is an estimation of food whiteness. The colour characteristics of tarhana samples with and without cherry laurel pulp are shown in Table 5. As shown in Table 2, L* values of tarhana samples chanced by fruit pulp addition significantly (P<0.05). When compared with cherry laurel pulp added samples, higher L* values were determined in the control. This is probably because of tone of fruit colour. The difference in the colour between the control tarhana and the T1, T2, T3 and T4 tarhana samples increased with the increase in the level of cherry laurel pulp in the samples (P<0.05). The T4 tarhana added 20.0% cherry laurel pulp showed the lowest difference in colour. The increasing fruit ratios in tarhana had a darker colour with a higher degree of luminosity than that of control tarhana. L* values of tarhana found in the studies of Kose and Cagindi (2002), Erkan *et al*. (2006) and Bilgicli (2009) are higher compared to our values. Our values are generally higher than the values reported for tarhana by Kose and Cagindi (2002), Erkan *et al*., (2006) and Bilgicli (2009), while b* values are lower. This result is expected because anthocyanins in cherry laurel pulp contribute to the red colour. These results are in good agreement with the findings of Koca (2008) for properties of tarhana with cornelian cherry and Calvo *et al*. (2001) for colour intensity. This situation was acceptable in the industrial production of fruit added tarhana for

Table 4. Viscosity (cP) properties of tarhana samples.

Temperature	TC	T1	T2	T3	T4
25 °C	1,138±32.0b	1,377±55b	1,242±35.2b	1,827±4.24a	1,201±68.3b
45 °C	728±26.9b	868±14.9b	805±22.9b	1,157±31.1a	828±10.3b
60 °C	572±53.0a	721±170.7a	649±32.2a	847±32.5a	549±19.1a

TC = control tarhana, with no fruit pulp; T1 = tarhana with 5% fruit pulp; T2 = tarhana with 10% fruit pulp; T3= tarhana with 15% fruit pulp; T4 = tarhana with 20% fruit pulp.
Different letters within a column indicate significant differences among tarhana samples with added fruit pulp (P<0.05).

which colour intensity of the product needs to meet the consumers' demands. The appearance of foodstuffs is the only permitted way to evaluate food products. In that respect, colour is a clue for many qualities of food such as flavour, naturalness or maturity, and drives consumers' choices. An attractive aspect is, therefore, a key for food marketing, and this has led the food industry to devote much effort in offering pleasant and suggestively coloured products (Dufosse *et al*., 2005).

Effect of cherry laurel pulp on tarhana sensorial properties

The first impression for a food is usually visual, and a major part of the consumer's willingness to accept a food depends on its appearance. Often if the appearance is unattractive, a potential consumer may never take other attributes such as flavour and texture into consideration. Colour is one of the most important visual attributes in foods. Quality assessment of this attribute may include analytical or sensory measures (Gambaro *et al*., 2001).

Natural tarhana available on the market present a wide range of sensory properties. Consumers may not detect the particular sensory attributes as trained assessors, and results obtained from an analytical panel are usually more precise and repeatable than those from consumers (Amaya-Lialo *et al*., 2008). Tarhana texture characterisation is important for product and process development, and also for quality control to ensure consumer acceptability (Benezech and Maingonnat, 1994). This characterisation can be done using either instrumental or sensory measurements (Ares *et al*., 2007). A food product is accepted or rejected in accordance with the impression that it produces on all the senses (Calvo *et al*., 2001). The sensorial evaluation results of the fruit-flavoured tarhana are illustrated in Table 6. Results of sensorial evaluation showed that significant differences were observed among tarhana samples (P<0.05). The addition of cherry laurel pulp to tarhana in different rates affected the scores for appearance and colour, flavour and overall acceptability significantly (P<0.05), whereas no significant effect (P>0.05) was observed for body and texture, and small by addition of fruit pulp. The appearance and colour values of T3 were lower than the control group and other treatments. The lowest overall acceptability scores from 20.0% cherry laurel pulp-added tarhana were detected for T4 sample, while the higher overall acceptability scores were detected for T1 (with 5.0% pulp sample) and T2 (with 10.0% pulp sample). It can be concluded that the addition of 5.0 and 10.0% fruit would be recommended in the production of cherry laurel pulp tarhana.

Table 5. Colour properties in tarhana samples.

Colour	TC	T1	T2	T3	T4
L*	64.74±0.06a	60.38±2.03a	59.53±0.15a	53.92±0.91b	48.52±4.31b
a*	9.99±0.12a	9.68±0.13ab	7.73±0.51c	7.94±1.19c	8.39±0.21bc
b*	29.9±0.13a	27.94±0.98b	22.39±0.56c	19.66±0.19d	18.62±0.42d

a* = redness; b* = yellowness; L* = lightness; TC = control tarhana, with no fruit pulp; T1 = tarhana with 5% fruit pulp; T2 = tarhana with 10% fruit pulp; T3= tarhana with 15% fruit pulp; T4 = tarhana with 20% fruit pulp.
Different letters within a column indicate significant differences among tarhana samples with added fruit pulp (P<0.05).

Table 6. Sensorial evaluation of experimental tarhana samples.

Properties	TC	T1	T2	T3	T4
Appearance and colour	8.47±1.18ab	8.84±1.39a	8.63±1.25ab	7.78±1.35bc	7.13±1.46c
Body and texture	8.72±1.32a	8.84±1.39a	8.78±1.25a	8.75±1.06a	8.31±1.19a
Small	8.38±1.19a	8.47±1.18a	8.031±1.22a	8.41±1.02a	7.75±1.18a
Flavour	8.47±1.27ab	8.75±1.05a	7.97±1.31ab	8.19±1.12ab	7.69±1.49b
Overall acceptability	8.34±1.35ab	8.72±1.03a	8.47±0.99ab	8.13±0.88ab	7.75±0.98b

TC = control tarhana, with no fruit pulp; T1 = tarhana with 5% fruit pulp; T2 = tarhana with 10% fruit pulp; T3= tarhana with 15% fruit pulp; T4 = tarhana with 20% fruit pulp.
Different letters within a column indicate significant differences among tarhana samples with added fruit pulp (P<0.05).

4. Conclusions

Effects of cherry laurel pulp on physico-chemical and sensorial properties of tarhana were investigated. Fruit pulp addition affected the properties of tarhana depending on concentration. L*, a* and b* values of the tarhana decreased with the addition of cherry laurel pulp, but total phenolic, ferric reducing antioxidant power, DPPH-radical scavenging values, absorption capacity, foaming capacity, foam stability and viscosity contents increased. Flavoured tarhana with cherry laurel is possible that they could contribute to dietary antioxidant intake. Sensory evaluations showed that appearance and colour, body and texture were affected significantly by pulp concentration. In the sensorial evaluations, tarhana samples containing 5.0 and 10.0% cherry laurel pulp was preferred over other. It can be concluded that the addition of 5.0 and 10.0% fruit pulp would be recommended for the production of cherry laurel tarhana. The results revealed that cherry laurel fruit can be used in production of tarhana for increasing consumption, but further investigations are needed to achieve the best physico-chemical and sensory characteristics of the final product, and in particular, the effect of different stabilizing agents should be investigated for fruit-flavoured tarhana production.

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