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ARAŞTIRMA MAKALESİ **RESEARCH ARTICLE**

Effect of Almond Pulp Addition on Physical, Chemical and Functional Properties of Tarhana*

Badem Pulpu İlavesinin Tarhananın Fiziksel, Kimyasal ve Fonksiyonel Özelliklerine Etkisi

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Abstract

In this study, almond pulp was added to tarhana to increase its nutritional value. For this purpose, after grinding the almonds, the oil was reduced and almond pulp was added to the tarhana mix at the rates of 0% (control), 5%, 10%, 15%, 20%, 25% and 30%. According to the research data, pH and titration acidity values of tarhana increased significantly with the increase of almond pulp addition ($p<0.05$). It was observed that protein, ash and fat ratios increased significantly with the increase of almond ratio in tarhana ($p<0.05$). While increasing the almond ratio significantly decreased the whiteness (L*) values of tarhana ($p<0.05$), it was determined that the redness (a*) and yellowness (b*) values increased significantly ($p<0.05$). While there was no significant change in water holding capacity with increasing almond content in tarhana ($p>0.05$), it was determined that the almond additive increased the foaming capacity and foam stability statistically ($p<0.05$). It was determined that the viscosity of tarhana decreased statistically significantly as the almond content increased ($p<0.05$). It was determined that the almond pulp added to the tarhana mix increased the total phenolic substance and antioxidant activity values significantly ($p<0.05$). It was determined that almond pulp added tarhana samples had a positive effect on sensory parameters. Tarhana samples with 25% and 30% almond pulp added were found to be the most popular soups in terms of taste and aroma. Tarhana soups containing 15% almond pulp are the most preferred in terms of fragrance; Tarhanas containing 5% pulp were preferred in terms of color and consistency. As a result, it was determined that the addition of almond pulp positively affected the physical, chemical and rheological properties of tarhana. It has been determined that the best rate of almond pulp to be used in tarhana production is 30%.

Keywords: Tarhana, Almond pulp, Antioxidant activity, Total phenolic, Functional properties

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Öz

Bu çalışmada, besin değerini artırmak için tarhanaya badem posası ilave edilmiştir. Bu amaçla bademler öğütüldükten sonra yağı azaltılmış ve tarhana miksine % 0 (kontrol), % 5, % 10, % 15, % 20, % 25 ve % 30 oranlarında badem pulpu olarak ilave edilmiştir. Araştırma verilerine göre, badem pulpu ilavesinin artmasıyla tarhananın pH ve titrasyon asitliği değerleri önemli derecede yükselmiştir ($p<0.05$). Tarhanada badem oranının artmasıyla protein, kül ve yağ oranlarının önemli ölçüde arttığı gözlenmiştir ($p<0.05$). Badem oranının arttırılması tarhananın beyazlık (L*) renk değerlerini önemli derecede düşürürken ($p<0.05$), kızarıklık renk (a*) ve sarılık (b*) renk değerlerin anlamlı olarak arttığı belirlenmiştir ($p<0.05$). Tarhana örneklerinde artan badem pulpu içeriği ile su tutma kapasitesinde önemli bir değişiklik olmazken ($p>0.05$), badem posası ilavesinin tarhana çorbalarında köpürme kapasitesini ve köpük stabilitesini istatistiki olarak önemli derecede arttırdığı belirlenmiştir ($p<0.05$). Badem pulpu içeriği arttıkça tarhana örneklerinin viskozitesini istatistiksel olarak önemli ölçüde azaldığı tespit edilmiştir ($p<0.05$). Tarhana miksine ilave edilen badem pulpu çorba örneklerinin toplam fenolik madde ve antioksidan aktivite değerlerini önemli derecede ($p<0.05$) arttırdığı istatiksel olarak tespit edilmiştir. Badem posası katkılı tarhana örneklerinin duyusal parametreler üzerinde olumlu etkisi olduğu belirlenmiştir. % 25 ve % 30 badem pulpu katkılı tarhana örneklerinin tat ve aroma açısından en popüler çorbalar olduğu görülmüştür. %15 badem posası içeren tarhana çorbaları ise koku açısından en çok tercih edilenlerdir; renk ve kıvam açısından ise %5 posa içeren tarhana çorba örnekleri tercih edilmiştir. Sonuç olarak badem posası ilavesinin tarhananın fiziksel, kimyasal ve reolojik özelliklerini olumlu yönde etkilediği belirlenmiştir. Tarhana üretiminde kullanılacak en iyi badem pulpu oranının %30 olduğu tespit edilmiştir.

Anahtar Kelimeler: Tarhana, Badem pulp, Antioksidan aktivite, Toplam fenolik, Fonksiyonel özellik

1. Introduction

Recently, as consumer awareness has grown, it has become necessary to experiment with alternative methods of food processing and preservation in order to meet consumer demand for natural products. These methods, which include fermentation, are extremely important in biotechnological production and conservation (Erbaş et al., 2006). Fermented foods are reliable products; taste and aroma constitute another factor to be consumed (Daglioglu et al., 2002). Fermented foods produced in comparison with the ingredients in their compositions are nutrients that had a long shelf life with their nutritional and sensory properties (Tamime and O'Connor, 1995; Gotcheva et al., 2001). Tarhana is a highly nutritious food that is characterized by the lactic acid fermentation process (Temiz and Pirkul, 1991). Tarhana is thought to have originated with Turks and Mongols who migrated from Central Asia and were brought to Anatolia, the Middle East, Hungary, and Finland, where they became known and consumed. Tarhana is referred to as kish in Arab countries, 'tahonya' in Hungary, 'talkuna' in Finland 'turkhana' in Bulgaria, and 'turkhana' in Serbia (Yıldırım and Ercan, 2004). Tarhana regulates the intestinal system with fibrous components and provides weight control. Tarhana contains probiotic bacteria and beneficial yeasts that help to strengthen the immune system (Yıldırım and Güzeler, 2016). A lot of research has been done on Tarhana. Some of these include the formulation of tarhana was found to be a product suitable for enrichment with various foods. In this study, tarhana was enriched for nutritional, sensory, and structural enrichment (Tarakçı et al., 2013). As fruit additions, cranberry (Koca et al., 2006), quince (Gökmen, 2009), and carob (Herken and Aydin, 2015) have been used. In this study, almond fruit pulp, a rich source of phytosterols (Tasan et al., 2006), was used as a contribution to tarhana production. Almond is the most produced tree nut globally (Sahin et al., 2022) and used in many fields as a side component in the food sector thanks to its rich nutritional potential and sensory flavour. The objective of this study was to incorporate the almond pulp into traditional tarhana formula and to compare some physical, chemical, functional, structure and sensory properties of the products.

2. Materials and Methods

Wheat flour, working yogurt, tomato paste, fresh yeast, mint, nectarine, red pepper, salt, and almond pulp (dry matter: 95.58%, protein: 23.92%, fat: 45.99%, ash: 3.36%, total phenolic content: 3.16 mg GAE/g, and antioxidant capacity: 0.46 mg TE/g) were the ingredients used to make Tarhana samples. Physical, chemical, and sensory analyses were performed in Ordu University Faculty of Agriculture Food Engineering Laboratories.

2.1 Tarhana Production

In the study, 0% (K), 5% (B5), 10% (B10), 15% (B15), 20% (B20), 25% (B25), 30% (B30) almond pulps were added to Tarhana samples. The formulation specified in *Table 1* refers to the control group (0%). Tarhana varieties are produced in 21 samples, 3 replicates.

2.2 Preparation of Almond (Grinding)

Unsalted, raw almonds obtained from the Ordu province market were first broken down and divided into smaller pieces in a food processor. In the cold press oil machine, the oil amount of almond was reduced. After being ground in a food processor to separate them into smaller particles, the oil-reduced almonds were prepared for use as additions.

2.3 Preparation of Tarhana Samples

The raw material samples and quantities used in tarhana production are shown in *Table 1*. While the almond ratio increased in the product formulations, the other input ratios remained constant. Before chopping the onions in the food processor, tomato paste, dried mint, red pepper, and salt were mixed. After prebaking the mixture, water was added and it was cooked for a while. When the temperature of the obtained mortar decreased to 20°C, flour, yoghurt, yeast and almonds were added. Kneaded for 10 minutes to ensure homogeneous dough structure. The prepared tarhana doughs were allowed to ferment for 30 hours at 30°C. Fermented tarhana doughs were brought into almond-sized pieces on the drying tray. The fermented tarhana doughs were dried in a fan oven (Nucleon, NST-120, Ankara) at 52°C until the moisture content reached 12%, before being ground and pulverized.

Table 1. Standard Tarhana formulation

Material	Portion (%)	Quantity
Wheat Flour	50	500
Yoghurt	25	250
Onion	12	120
Tomato paste	6	60
Salt	4	40
Fresh yeast	1	10
Red pepper	1	10
Powdered mint	1	10

2.4 Chemical Analyses of Tarhana

Dry matter analyses; In the analysis, the method of James (1995) was modified and the drying oven was previously brought to a constant weight at 105℃ (Nucleon, NST-120, Ankara) and 5 g of sample was weighed into it. Ash analyses; in the analysis, James (1995) method was modified and 3-5 g of sample weighed into porcelain crucibles at 550±5℃ temperature until the formation of white color. Color analyses; Color analysis of Tarhana samples was performed with a color measurement device (Minolta, CR-400, and Osaka, Japan). (L*; 100 = white, 0 = black), redness; (a*; + red and -green) and jaundice; (b*; +yellow and -blue) measurements were taken in prepared tarhana soup samples (Zhu et al., 2008). Total Fat analysis; Soxhelet extraction method was used to determine the fat content of the samples (James, 1995). The tarhana samples were boiled by distillation in the extraction apparatus (Velp Scientifica, SER 148, and Usmate, Italy). The pH analysis; to determine the pH of the 5 g tarhana pulp sample was weighed into a beaker and the pH was measured with a digital pH meter (Mettler Toledo, Seven Compact S210) at 25°C (Ibanoglu et al., 1995). Titratable Acidity Analysis: Titration was continued with 1-2 drops of 1% phenolphthalein and 0.1 NaOH solution until the mixture became pink (İbanoğlu et al., 1999). Protein Analysis; The Kjeldahl method was used to determine the protein content (James, 1995).

2.5 Functional Properties Analyses

Viscosity Analysis; 10 g of dry tarhana sample was weighed into a glass beaker and 150 ml of distilled water was added. The sample was cooked by stirring for 10 minutes, thereby gelatinizing the starch. The samples were poured into the sample cup of the viscometer (AND, SV-10, Tokyo, Japan) while hot. Measurements were performed at 30°C, 45°C and 60°C (Tarakçı et al., 2013). Water Retention Capacity Analysis; 3 g tarhana sample was weighed into centrifuge tubes and 15 ml of distilled water was added. The solution was stirred in a shaking incubator (Infors Ht Ecotron) for 1 minute at 120 rpm, earth 15 minutes for 60 minutes. It was then centrifuged at 4,000 rpm for 20 minutes (2-6 Sigma, 3K30 and Steinheim, Germany). The weight of the liquid fractions was determined at the end of the process. The value in grams of water absorbed by 1 g tarhana is called water-holding capacity (Tarakçı *et al.*, 2013). Foaming Capacity and Foam Stability Analysis; Following the placement of the centrifuge tubes, 20 ml of distilled water was added to 4 g of tarhana. The mixture was homogenized at 120rpm for 20 minutes in a shaking incubator (Infors Ht Ecotron), then placed in a centrifuge and centrifuged at 4000 rpm for 20 minutes (2-6 Sigma, 3K30, Steinheim, Germany). After this process, tarhana samples were removed from the centrifuge and filtered using filter paper (Whatman No. 1). The filtered samples were whipped at high speed with the Waring Blender (Torrington, CT, USA) for 2 min. The foam level of the samples transferred slowly and carefully to the measuring cylinder was recorded after 10 seconds. The ratio of the resulting foam volume (ml) to the solution volume (ml) was defined as the foam capacity (Tarakçı et al., 2013). Total Phenolic Analysis of Tarhana Samples; the method used by Xu and Chang (2007) for the total phenolic content analysis was modified. After 3 g of tarhana sample was homogenized with 10 ml of water, it was kept in a water bath of 25°C for 30 minutes. Samples were centrifuged at 4000 rpm for 10 min and filtered (Whatman no. 1). After taking 300µl of the filtrate into the tubes, 4300µl of water and 100µl of Folin Ciocalteu reagent were added and left for 2 minutes. Then 300µl 7.5% (w/v) Na_2CO_3 solution was added to the samples. The samples were vortexed and kept in the dark for 2 hours. At the end of the time, the absorbance of the spectrophotometer was read at 760 nm (UV-VIS Shamadzu UV mini-1240). Antioxidant Analysis of Tarhana Samples: For the antioxidant activity analysis of Tarhana samples, the method used by Demirkol and Tarakçı (2018) was modified. The 3g of tarhana samples were homogenized with 10ml of methanol and then placed in a water bath of 25°C for 30 minutes. After centrifuging the samples at 4000 rpm for 20 minutes, they were filtered through Whatman No.1 filter paper.50µl of the obtained filtrate was taken and 1000µl of DPPH (1, 1-Diphenyl-2-picrylhydrazyl radical) reagent was added. At the end of the period, absorbance values of the samples were read on the spectrophotometer at 515nm wavelength.

2.6 Sensory Analysis of Tarhana Samples

Sensory analysis performed according to 100 g tarhana sample, 1.5 L distilled water, 40 g oil, and 10 g salt were mixed and the mixture is cooked in the steel pot at medium heat for 5 minutes while stirring. The cooked samples were kept in an oven at 60°C and presented to the panelists in porcelain bowls. Tarhana soups were served by faculty members and students (5 males, 5 females) in the Faculty of Agriculture who were between 20-40 years old and had no obstacles to sensory testing; color, odor, consistency, taste-aroma, and general acceptability characteristics were evaluated using the sensory form over 10 points (Anil *et al.*, 2020).

2.7 Statistical Analysis

For statistical analysis, the one-way ANOVA method was used with the Minitab 18 package program. as a result of variance analysis. The results are presented in tables.

3. Results and Discussion

3.1 The pH change was caused by the addition of almond pulp to Tarhana

The relationship between lactic acid bacteria and yeasts plays an important role in the production of Tarhana dough. Lactic acid bacteria are responsible for the increase of acidity; yeasts are responsible for the production of CO_2 and alcohol, the swelling of the dough, and its aromatic development. Although a variety of microorganisms are available at the beginning of fermentation, acid-producing lactic acid bacteria and acid-tolerant yeasts become dominant in later stages of fermentation (Şimşek et al., 2017). *Table 2* shows the pH analysis results for Tarhana. The highest pH value was determined as 5.32 in the group containing 30% almond pulp. The lowest pH value was found in the control group with a pH value of 4.65. During the fermentation period, it was determined that the pH value of Tarhana samples decreased because Tarhana dough, particularly yogurt bacteria and fermentable sugars, increased the amount of acid in the environment and thus reduced the pH value as a result of the effect of fermentable sugars on metabolites, particularly organic acids (Erbas et al., 2006). The effect of almond rate on pH was found to be statistically significant. ($p < 0.05$). During the fermentation of Tarhana, the production of acid occurs as a result of the activity of lactic acid bacteria and yeasts in the content of yogurt (Özdestan and Üren, 2013). Addition of yoghurt in the Tarhana formulation, the number of lactic acid bacteria increases, results in more lactic acid in the final product (İbanoğlu et al., 1999). Lactic acid fermentation protects Tarhana against mold growth and creates microbial safety (Leroy and De Vuyst, 2004).

When the Tarhana groups were compared, a statistically significant difference was found between the samples in terms of titratable acidity ($p<0.05$). As a result, it was discovered that adding almond pulp to Tarhana increased its acidity value. It is estimated that the free fatty acids released by hydrolysis and the high oil content in almond pomade increase the titratable acidity in Tarhana dough (Koca and Tarakçı, 1997).

3. 2 The color change was caused by addition of almond pulp to Tarhana

The L* values of Tarhana soups are shown in Table 2. The lowest L* value for the Tarhana sample was 47.68 for 30% almond pulp, and the highest L* value was determined as 59.52 for the control Tarhana sample. The effect of almond pulp additive on the L* value in Tarhana was found to be statistically significant ($p<0.05$). It was found that L* values decreased as the almond rate increased. Accordingly, it was concluded that the color of the soup darkened with the increase of almond pulp in due to the dark brownish color of the skins of almonds included in the pulp.

Table 2 displays a* values of Tarhana samples together with the variance analysis results. When the results are examined, it is understood that the effect of almond ratio on the a* value of tarhana is statistically significant ($p<0.05$). Tarhana soups a* values increase as the almond ratio increases. Accordingly, it was concluded that with the increase of almond pulp in tarhana, the redness of the soup color increased. Also, the effect of almond pulp on b* value of tarhana was statistically significant ($p<0.05$). The 10% almond pulp added tarhana has been found to increase the b* value whereas Tarhana with 5% almond pulp has been found to decrease b* value. In general, the almond ratio used in tarhana samples reduces the L* value while increasing a* and b* values. L*, a* and b* values were found generally compatible with the studies on tarhana (Erkan et al., 2006; Koca et al., 2006). However, the difference in L*, a* and b * values compared to some tarhana studies is thought to be due to their different tarhana formulations and additives utilized in tarhana formulations (Aktaş et al., 2015; Bilgiçli et al., 2014; Ozboy-Ozbas, et al., 2010).

Table 2. The pH, titratable acidity and color values of Tarhana samples

Almond Ratio (%)	**pH**	**Titratable acidy (%)**	***L****	***a****	***b****
K	4.76±0.12g	0.58±0.09f	59.52±0.23a	-1.27±0.23e	29.93±0.43de
B5	4.85±0.12f	0.67±0.09e	58.73±0.13b	1.72±0.15d	28.92±0.45e
B10	4.93±0.11e	0.70±0.09d	56.78±0.24c	2.60±0.45c	30.24±0.57d
B15	4.97±0.11d	0.73±0.10c	54.17±0.39d	3.27±0.37c	32.30±0.41c
B20	5.02±0.11c	0.76±0.09b	50.80±0.30e	4.57±0.21b	40.05±0.03b
B25	5.08±0.13b	0.78±0.09a	49.98±0.07f	5.06±0.20ab	40.60±0.48b
B30	5.12±0.14a	0.79±0.09a	47.68±0.30g	5.63±0.24a	42.16±0.18a
MSE	0.000	0.000	0.067	0.079	0.163

MSE: mean squared error, Results were expressed as mean±standard deviation. These data are the average of three replicates. There is no statistically significant difference between the means marked with the same lower-case letters in the same column ($p>0.05$).

3.3 Functional properties change caused by addition of almond pulp to Tarhana

Viscosity is known as an important quality criterion (Erkan et al., 2006). Viscosity can be expressed as the resistance of fluid foods to flow (*Table 3*). It was reported that tarhana soup shows pseudoplastic behavior (Erbaş et al., 2005). It was determined that viscosity statistically decreases as almond additive increases in Tarhana ($p<0.05$). Decreasing concentration of polysaccharides has been reported to reduce aggregation (Ikegwu et al., 2009). It is possible to say that the amount of starch in the total mass decreases with the increase of almond pulp in Tarhana formulation. Based on this information, it is estimated that the mass reduction of starch, a type of polysaccharide, in the formulation results in reduced aggregation, which leads to a decrease in viscosity.

Water holding capacity is an important functional feature in viscous foods (Ertaş et al., 2015). The factors that determine the water retention capacity of tarhana are structural proteins and starch (Hayta et al., 2002). The effect of the almond ratio added to tarhana on water holding capacity was not statistically significant ($p>0.05$). The addition of almonds to the Tarhana formulation had no significant effect on the water holding capacity values. The reason for this is thought to be due to the almond's low starch content, which may affect the water holding capacity value.

Tarhana samples with the highest foaming capacity were found to have 0.970±02ml/ml in Tarhana samples containing 30% almond pulp (*Table 3*). Control tarhana samples had the lowest foaming capacity value of 0.01±0.01ml/ml. According to the results, as the almond pulp contribution increased in tarhana, the foaming capacity increased and the samples containing 30% almond pulp had the highest foaming capacity of any tarhana variety tested. There are significant differences between the control samples and almond added samples ($p<0.05$).

According to the results of the analysis, the effect of the almond pulp ratio on foam stability was found to be statistically significant ($p<0.05$). As the almond pulp ratio increases in tarhana, the foaming stability increases. Among these values, the tarhana variety with maximum foam stability value was for the 30% almond pulp samples and its value was calculated as 2.63 ± 0.15 min (*Table 4*). Tarhana variety with minimum foaming capacity is the control sample and its value is determined as 0.02±0.01 min. Anil et al. (2021) stated that the foam stability value of tarhana samples prepared with unbaked corn flour was about 2 times higher than the tarhana samples prepared with baked corn flour. In the study performed by Tarakçı et al. (2013), the foam stability value of wheat flour tarhana was determined as 10.00 min. The quince added tarhana produced by Gökmen (2009); control, raw, baked, and dried quince foam stability values were 0.35 min, 0.45 min, 1.28 min, and 1.41 min respectively.

Table 3. Viscosity, water retention capacity, foaming capacity and foam stability values of Tarhana samples

Almond Ratio (%)	Viscosity (cp)	Water Retention Capacity (ml/g)	Foaming capacity (ml/ml)	Foam stability (ml)
K	106.48±25.45a	0.73±0.01	0.01±0.01f	0.02±0.01g
B5	93.72±19.02ab	0.69±0.04	0.27±0.04e	0.42±0.03f
B10	80.45±16.04bc	0.71±0.03	0.59±0.05d	0.82±0.03e
B15	64.43±13.95cd	0.66±0.03	0.72±0.02c	1.30±0.08d
B20	56.75±14.18de	0.63±0.05	0.77±0.03c	1.68±0.05c
B25	40.31±10.86ef	0.63±0.06	0.88±0.04b	1.93±0.06b
B30	27.60±7.00.88f	0.72±0.11	0.97±0.02a	2.63±0.15a
MSE	11.300	0.003	0.001	0.005

MSE: mean squared error, Results were expressed as mean±standard deviation. These data are the average of three replicates. There is no statistically significant difference between the means marked with the same lower-case letters in the same column ($p>0.05$).

3. 4 Ash, fat, protein, total phenolic and antioxidant capacity values of Tarhana

Proteins are used in the production of foam in the food industry. It is known that wheat and soy proteins, which have different foam-forming properties, are among the proteins with the highest foaming property (Kurek et al., 2022). Many factors, such as protein type, protein content, fat content, controlling power, and pH, play a critical role in foaming capacity and stability. Multiple comparison test results of protein amount according to almond pulp ratio are given in Table 4. Among these values, tarhana varieties having maximum protein amount of tarhana samples containing 30% almond pulp and mean value 16.11±0.03 g was harvested as sample. The tarhana variety with the minimum amount of protein is control tarhana and its value is 12.28±0.12g. It is seen that the amount of protein increases significantly as the almond pulp ratio increases in Tarhana groups. It is understood that the high protein content of almond fruit is reflected in tarhana samples with almond pulp additives.

Phenolic compounds contribute to the aroma and taste of many foods of plant origin. The contribution of the compounds to the aroma is mainly due to the presence of volatile phenols (Rodriguez et al., 2009). Total phenolic substance determination results are given in *Table 4*. In result of the measurements, the lowest amount of phenolic substance is 1598 mg GAE/kg. The highest phenolic content was found as 2376 mg GAE/kg sample for 30% almond pulp tarhana samples.

Table 4. Ash, fat, protein, total fenolic and antioxidant capacity values of Tarhana samples

Almond Ratio (%)	Ash (%)	Fat (%)	Protein (%)	TFMM (mgGAE/100g)	Antioxidant (mgTroloxE/kg)
K	1.21±0.01e	2.19±0.10g	12.28±0.12g	1640±0.01g	150±0.00f
B5	1.41±0.02d	4.28±0.27f	13.02±0.02f	1850±0.01f	240±0.00e
B10	1.49±0.01c	5.97±0.11e	13.85±0.02e	2020±0.01e	290±0.01d
B15	1.54±0.01c	7.75±0.10d	14.61±0.04d	2160±0.02d	350±0.00c
B20	1.59±0.01b	9.02±0.16c	15.17±0.08c	2240±0.01c	390±0.01b
B25	1.63±0.03a	10.29±0.11b	15.61±0.05b	2330±0.01b	420±0.01a
B30	1.65±0.01a	11.52±0.08a	16.11±0.03a	2360±0.01a	430±0.00a
MSE	0.000	0.022	0.009	0.000	0.000

MSE: mean squared error, Results were expressed as mean±standard deviation. These data are the average of three replicates. There is no statistically significant difference between the means marked with the same lower-case letters in the same column ($p>0.05$).

Table 4 shows the results of multiple comparison tests on total phenolic substance based on almond pulp ratio. Tarhana variety with the highest phenolic content contains 30% almond pulp and its value is 2360±0.01mgGAE/kg sample. Tarhana sample with the lowest amount of phenolic substance was observed as a control sample (1640 mg GAE/kg). When the results were examined, it was found that almond fruit significantly increased the total phenolic content of tarhana ($p<0.05$). It is thought that almond kernels have a high total amount of phenol and tocopherol to achieve this result (Kornsteiner *et al.*, 2006). The results of the analysis of variance of antioxidant activity in Tarhana samples are shown in Table 4. When the results were examined, the effect of almond ratio on antioxidant activity was found to be statistically significant ($p<0.05$). Among the values, tarhana samples containing 30% almond pulp have the highest antioxidant activity; the value is 430±0.00 mg TroloxE/kg. Tarhana variety with the lowest antioxidant activity was the control group; the value is approximately 150mg TroloxE/kg sample. When the results were examined, it was understood that the antioxidant amount of the samples increased significantly due to the almond pulp contribution. The antioxidant content of the tarhana group, which had the highest almond pulp addition, was found to be approximately three times that of the control group ($p<0.05$).

3.5 Sensory properties of Tarhana samples

Panelists reported a significant color difference between the control and almond pulp tarhana samples, and they preferred the almond pulp tarhana samples to the control tarhana (*Table 5*). In the control tarhana samples without almonds, it is estimated that the pepper, tomato paste, and mint in the formulation do not contribute much to the color attractiveness. In this case, it is thought that the almond pulp added to the tarhana improves the soup's appeal by changing the color of the product. Tarhana soups with 5% almond pulp were the most appreciated in terms of color. This is thought to be related to the fact that it contains almond additive at the rate closest to the usual tarhana color. It is estimated that other tarhana soups with almond pulp additions are therefore less appreciated as the color darkens as the almond ratio increases.

Table 5. Sensory properties of Tarhana samples

Almond Ratio (%)	Color and appearance	Smell	Consistency	Taste and Flavor	General Acceptability
K	6.10±1.45b	6.70±1.25	7.90±1.10	6.80±1.81	6.70±1.34
B5	8.30±0.82a	7.60±1.51	8.30±1.06	7.80±1.55	7.80±1.32
B10	8.10±0.74a	7.60±1.51	8.10±0.32	7.70±1.34	7.70±1.06
B15	8.20±1.32a	7.90±1.10	7.90±1.29	7.80±1.14	8.00±0.94
B20	7.90±0.99a	7.60±1.27	7.90±1.10	7.70±1.57	7.70±1.16
B25	7.50±0.85ab	7.60±1.17	7.40±1.08	8.00±1.05	7.60±0.97
B30	8.00±1.05a	7.60±1.35	7.50±1.18	8.00±1.56	7.80±1.55
MSE	1.125	1.730	1.121	2.111	1.459

MSE: mean squared error, Results were expressed as mean±standard deviation. These data are the average of three replicates. There is no statistically significant difference between the means marked with the same lower-case letters in the same column ($p>0.05$).

Tarhana sample, which has the highest odor score, is a sample containing 15% almond pulp and its average value is; 7.9±1.10; and the lowest odor group was the tarhana control group with a mean value of 6.7±1.25. There was no statistically significant difference between soup types ($p>0.05$). The most popular soup in terms of smell was found to be tarhana with almond pulp added 15%.

The Tarhana sample with the highest consistency score is 5% almond pulp soup, with an average value of 8.30±1.06; the group with the lowest consistency score is 25% almond pulp soups and the average value is 7.40±1.08. There was no statistically significant difference between the soup types in terms of consistency ($p>0.05$). Tarhana soups with 5% almond pulp added have the most popular consistency. Considering that the cooking time of tarhana samples is 10 minutes, it is estimated that this time is the most appropriate time for soups with 5% almond pulp added among all groups.

In *Table 5*, values of taste-aroma analysis among tarhana samples are given. Among these values, tarhana sample with the highest taste-aroma score is a tarhana sample containing 30% almond pulp, with an average value of 8.00 ±1.56 the control group had the lowest taste-aroma score, with a mean value of 6.80±1.81. There was no significant difference in taste-aroma between soup types ($p>0.05$). When some studies were examined, various flours such as barley flour, quinoa flour, and corn flour were used instead of wheat flour, and these products were scored low in terms of general acceptability (Erkan et al., 2006; Üçok et al., 2019). However, wheat flour was used in this study and no other flour was substituted in the formulation. Therefore, it is estimated that the almond has a position effect on the increase of general acceptability.

4. Conclusion

It was determined that the amount of protein, inorganic matter, and fat increased significantly with the increase in the use of almond pulp in tarhana. It has been determined that the high amount of protein and fat content and inorganic substance composition of almond fruit are reflected in the tarhana samples, increasing the nutritional quality significantly.

It was determined that the total phenolic substance and antioxidant activity values increased with the increase in the amount of almond pulp additive in the tarhana samples, and it was determined that the strong antioxidant amount in the almond composition was reflected in the tarhana samples. Furthermore, it is estimated that spices such as red pepper, mint, and onion in the formulation have a positive effect on the antioxidant activity of tarhana.

When the sensory properties of tarhana soups were examined, the almond pulp-added tarhana samples were more appreciated than the control samples in terms of color and odor. It has been determined that tarhana with high almond content in terms of taste and aroma is preferred. It is thought that the aromatic compounds in almonds and the oil have a positive effect on the taste and aroma of soups. When the soups were evaluated overall, it was determined that the soups with almond pulp were preferred over the control group soups.

It is thought that the use of fruit or fruits with high nutritional power and antioxidant capacity as additives in the production of tarhana in the future, which can positively affect the taste and appearance, will enrich the tarhana. Thus, it is thought that tarhana will not only expand the domestic production volume but also make a significant contribution to our country's economy.

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