GIDA
THE JOURNAL OF FOOD
E-ISSN 1309-6273, ISSN 1300-3070

Research / Araştırma
GIDA (2020) 45(3) 421-432
doi: 10.15237/gida.GD19152

QUALITY CHARACTERISTICS OF TARHANA PRODUCED WITH DIFFERENT RATIOS OF WHOLE WHEAT AND BUCKWHEAT FLOUR

Oktay Tomar[1*], Abdullah Çağlar[1], Gökhan Akarca[2]
[1]Kocaeli University, Faculty of Agriculture and Natural Science, Arslanbey Campus, Kocaeli, Turkey
[2]Afyon Kocatepe University, Faculty of Engineering, Department of Food Engineering, Afyonkarahisar, Turkey

Received / Geliş: 21.11.2019; *Accepted* / Kabul: 10.04.2020 *Published online* / Online baskı: 17.04.2020

Tomar, O., Çağlar, A., Akarca, G. (2020). Quality characteristics of tarhana produced with different ratios of whole wheat and buckwheat flour. GIDA (2020) 45(3) 421-432 doi: 10.15237/gida.GD19152

Tomar, O., Çağlar, A., Akarca, G. (2020). Farklı oranlarda tam buğday ve kara buğday unu ile üretilen tarhanaların bazı kalite özellikleri. GIDA (2020) 45(3) 421-432 doi: 10.15237/gida.GD19152

ABSTRACT
This study aimed to investigate physical, chemical and sensory properties of tarhana, produced by adding buckwheat flour with different ratios. Lightness (*L**) value increased in wet samples according to the ratio of buckwheat flour increased, whereas it decreased in dry samples (P<0.05). Redness (*a**) values decreased in wet samples whereas increased in dry samples. Yellowness (*b**) values were higher in wet samples however it decreased with drying process (P<0.05). Buckwheat addition decreased viscosity values whereas protein and ash values increased significantly (P<0.05). The highest viscosity value was determined in dried control sample with 935cP, while the highest protein, ash, DPPH free radical scavenging activity and total phenolic content values were 15.83%, 3.56%, 161.82 (mg Teq/g) and 14.00 (mg GAE/g) respectively, detected in samples containing 100% buckwheat flour. The highest overall sensory evaluation scores were 5.00 and 7.55 determined in samples containing 25% whole wheat and 75% buckwheat flour (P<0.05), respectively.
Keywords: Whole wheat, buckwheat, tarhana, celiac, quality

FARKLI ORANLARDA TAM BUĞDAY VE KARA BUĞDAY UNU İLE ÜRETİLEN TARHANALARIN BAZI KALİTE ÖZELLİKLERİ

ÖZ
Bu çalışmada; karabuğday ununun değişik oranlarda tarhanaya ilavesi ile elde edilen ürünün fiziksel, kimyasal ve duyusal özelliklerinin incelenmesi amaçlanmıştır. Karabuğday un oranı arttıkça parlaklık (*L**) değerinin yaş tarhana örneklerinde arttığı, ancak kuru tarhana örneklerinde azaldığı (P <0.05), kırmızılık (*a**) değerlerinin yaş örneklerde azaldığı, kuru örneklerde arttığı, sarılık (*b**) değerlerin ise; yaş örneklerde daha yüksek iken kurutmayla birlikte azaldığı belirlenmiştir (P <0.05). Karabuğday ilavesi ile viskozite değerlerinin azalmasına karşın protein ve kül miktarının önemli derecede arttığı kaydedilmiştir (P <0.05). En yüksek viskozite değerine 935 cP ile kurutulmuş kontrol örneği sahipken, en yüksek protein, kül miktarı, DPPH serbest radikal giderme aktivitesi ve toplam fenolik madde miktarlarına sırasıyla %15.83, %3.56, 161.82 (mg Teq/g) ve 14.00 (mg GAE/g) ile %100 karabuğday unu kullanılmış örneklerde olduğu belirlenmiştir. Örnekler arasında en yüksek genel beğeni puanına 5.00 ve 7.55 ile sırasıyla %25 tam buğday ve %75 karabuğday unu ilavesi ile üretilen örneklerin aldığı belirlenmiştir (P <0.05).
Anahtar kelimeler: Tam buğday, karabuğday, tarhana, çölyak, kalite

* *Corresponding author* /Yazışmalardan sorumlu yazar;
✉ oktay.tomar@kocaeli.edu.tr ✆ (+90) 262 351 4053 🖷(+90) 262 351 4038

Oktay Tomar; ORCID no: 0000-0001-5761-7157
Abdullah Çağlar; ORCID no: 0000-0002-9716-8795
Gökhan Akarca; ORCID no: 0000-0002-5055-2722

INTRODUCTION

Tarhana, named differently in various countries, such as atolle in Scotland, talkuna in Finland, thanu in Hungary, kishk and kushuk in Syria, Palestine and Egypt and thrahana in Greece (Aktas et al., 2015), is a food prepared by mixing white wheat flour, yogurt, yeast, vegetables (tomatoes, onions, green peppers and red peppers), salt and spices (mint, oregano, dill, tarhana herb, etc.) and fermenting for 1-7 days (Caglar et al., 2013). Tarhana is a product with an old history produced and used by the Turks in Central Asia according to some sources and introduced to other parts of the world through historical migrations (Alcay et al., 2015).

Yoghurt and flour in tarhana are considered as high-quality protein sources since they complement each other in terms of essential amino acids. Both lactic acid and yeast fermentation occur simultaneously during tarhana production (Gocmen et al., 2004; Celik et al. 2005). Tarhana is a rich source of iron, calcium and zinc and has great nutritional importance (Coskun, 2003). Also, tarhana is suitable for the addition of additives in terms of insufficient nutrients in its composition and various grains and grain derivatives are used for enrichment in tarhana production (Koca et al., 2002; Erkan et al., 2006; Bilgicli and Ibanoglu, 2007; Işık and Yapar, 2017).

Although Tarhana is consumed by healthy individuals without problems, it cannot be consumed by people with metabolic disorders such as celiac. Celiac is a disease that occurs as a result of the abnormal response given by the body's immune system to gluten in cereals such as wheat, barley and rye (Kitan, 2017).

Buckwheat is an annual plant belonging to the *Polygonaceae* family and although it is not a grain, the seeds are usually classified among the cereal grains (Acar et al., 2011; Peng et al., 2012). Buckwheat, which is a plant different from over grained crops such as wheat, rice and barley, is included in the pseudo-cereal group (which is similar to grain) (Wijngaard and Arendt, 2006). The main structural difference that separates buckwheat from cereals is that it is not a monocotyledonous but a dicotyledonous plant (Dizlek et al., 2009) and it can adapt to grow at high altitudes in a short time (Kan, 2011).

Buckwheat is not cultivated in Turkey but many countries including China, Russia, Ukraine, Kazakhstan, Poland, Brazil, USA, Canada and France. It has economic value, its consumption is increasing every day and it has a versatile use area (Acar et al., 2011; Kan, 2011).

Buckwheat is a very important source for the completion of the lysine amino acid deficiency in wheat flour with its balanced amino acid composition (Wijngaard and Arendt, 2006). Unlike wheat, buckwheat does not contain gluten and is used with other gluten-free cereal flours or starches in the development of new dietary products for celiac patients (Atalay, 2009).

This study aimed to investigate the physical, chemical and sensory properties of a new tarhana product produced by adding buckwheat flour, which has a very rich nutritional value and health benefits, to conventional tarhana in different proportions.

MATERIALS AND METHODS

Tarhana production

Tarhana samples used in the study were produced according to the formula described by Erbas et al. (2004), with modifications (Table 1).

Table 1. Raw materials used in tarhana production and their quantities (g).

Raw Material	Amount (g)
Flour	100
Yogurt	40
Tomato paste	10
Onion	5
Ground red pepper	2
Salt	1
Yeast (*Saccharomyces cerevisiae*)	2.5

A certain amount of onion shells are peeled and chopped in a blender (Waring 8011, USA) and flour (whole wheat flour and/or buckwheat), yogurt, salt, ground red pepper and yeast (*Saccharomyces cerevisiae*, Pakmaya, Turkey) were added according to the formula and the ingredients were mixed. The mixture was kneaded manually approximately for 10 minutes until the mixture got a homogeneous appearance and then placed in a closed container. Then the mixture was allowed to fermentation process at 30 °C for 5 days. At the end of the fermentation period, it was divided into very small pieces with 3-4 cm thickness (wet tarhana) and dried at 22 ^{o}C for 7 days dry (dried tarhana). At the end of this period, the pieces were reduced to homogeneous sizes using a 1 mm sieve (Figure 1).

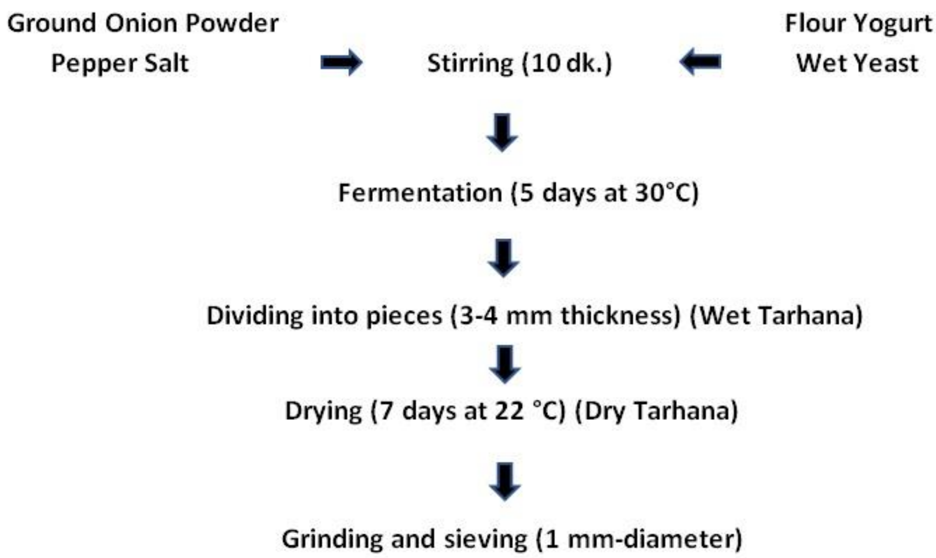

Figure 1. Tarhana production stages

The amount of whole wheat and buckwheat flours used in the production of samples and the codes of the samples are shown in Table 2.

Table 2. The amounts of whole and buckwheat flour added to the tarhana samples (g).

Sample	WWF (g)	BWF (g)
Control	100	-
TN1	-	100
TN2	50	50
TN3	25	75
TN4	75	25

WWF: Whole wheat flour, BWF: Buckwheat flour

Physical analyses

Color analysis

The color analyses of flours and tarhana samples used in production were carried out using a colorimeter (Konika Minolta Chroma Meter CR-400) and $L*$, $a*$ and $b*$ values were measured (Akarca et al., 2015).

Viscosity

20 g of tarhana sample was taken, added with 200 ml of distilled water (20 °C) and cooked for 5 min. Two-fold of samples were taken from the wet tarhana samples. Viscosity values of tarhana samples (souped) were determined using a Brookfield viscometer (Mod-RVDV ++, Brookfield Engineering Laboratories, Stoughton Mass., USA) with the spindle no: 4 at 25, 45 and 65 ^{o}C and at 5, 20, 30, 60 and 100 rpm rotational speeds (Hayta et al., 2006).

pH value

The pH values of tarhana samples were determined according to Ohaus pH meter manual (ST 5000, USA) and AOAC 981.12 (AOAC, 2016).

Chemical analyses

Titratable acidity

The titration acidity of Tarhana samples was determined in % lactic acid according to the method specified by TS 2282 (Anonymous, 2004) and Yorukoglu and Dayisoylu (2016) (Yorukoglu and Dayisoylu, 2016).

Determination of protein value

The protein values of flours and tarhana samples used in production were determined according to TS 1620 (Nitrogen was transformed into protein by the 6.25 factor, according to TS 2282) Protein value of tarhana samples was calculated on dry matter % (DM) (Anonymous, 2002; Anonymous, 2004).

Determination of dry matter value

The moisture content of tarhana samples and whole and buckwheat flours were determined according to TS 2282 (Anonymous, 2004).

Determination of ash value

Ash contents of samples with two different flour were determined according to the TS 1128 ISO 763 (Anonymous, 2000).

Determination of total phenolics

Total phenolic contents of flours and tarhana samples in mg GAE/g were determined according to Singleton and Rossi (1965) and Chu and Chen (2006), with modifications. Accordingly, 3 mL purified water and 0.25 mL Folin-Ciocalteu reagent was added to 0.1 mL samples extracted with methyl alcohol and diluted in appropriate ratios. Then 7.5% Na_2CO_3 and 0.9 mL pure water added and the samples were kept in a dark environment for half an hour. At the end of the period, the samples were read by spectrophotometer (Hitachi U-2000) at 760 nm wavelength and the total phenolic contents were calculated using the standard calibration curve drawn with pure gallic acid.

DPPH free radical scavenging activity (mg Teq/g)

DPPH free radical (2,2-diphenyl-1-picrilhydrazil) scavenging activity of flours and tarhana samples were performed according to Tural and Koca (2008).

Sensory evaluation

In the sensory evaluation of tarhana samples, the scoring system scale was adopted according to Akarca et al. (2016), with modifications. To determine the sensory characteristics, each tarhana sample was prepared as 100 g tarhana +1000 mL water +40 mL oil +10 g salt and cooked for 5 minutes with continuous stirring over medium heat. Wet tarhana samples were prepared with samples in double volume. Twenty panelists participated in sensory analysis and tarhana soup samples were presented to the panelists in numbered bowls of the same color and shape. Tarhana samples were scored from 1 to 9 for taste and aroma, color, odor, consistency and general evaluation. The scale adopted for sensory analyses were 1-3 (unacceptable), 4-5 (acceptable), 6-7 (good), 8-9 (very good) (Anonymous, 2012; Celik et al., 2010; Onogur and Elmaci, 2012).

Statistical evaluation

Statistical analysis of the results was performed using SPSS V 23.0.0 statistical package software (SPSS Inc., USA). The data obtained from the study were tested with one-way and two-way analysis of variance methods to test the significant differences between the samples, and the level of significance was set as $P < 0.05$. Also, when a difference was observed between the groups, Duncan test was applied to determine the different groups.

RESULTS AND DISCUSSION

The physical and chemical analysis results of the flours used in the production of tarhana samples (whole wheat and buckwheat) are shown in Table 3. It was determined that protein, ash, antioxidant and phenolic contents of buckwheat flour were higher than those of the whole wheat flour while L^* and a^* values were lower whereas b^* values were higher. Demir (2018) reported the L^*, a^* and *b** values of raw materials as 81.30, 2.01 and 13.88, respectively, while ash, moisture and protein contents have been reported as 1.81%, 12.04% and 13.79%, respectively. Kitan (2017) has reported the total phenolic contents as 17.92 and 10.64 mg/kg and the antioxidant values as 4.12 and 1.9 mmol/g. Although the differences between the studies and the findings of our study were not very substantial, it was thought that the type and composition of the raw materials used and process methods caused these differences.

Table 3. The results of chemical and physical analyses of flour used in tarhana production.

Analysis	WWF (g)	BWF (g)
Moisture (%)	12.06±0.56	12.15±0.14
Protein (%)	11.92±0.27	14.94±0.28
Ash (%)	1.202±0.01	1.855±0.01
Total Antioxidant Value (mg Teq/g)	15.91±0.13	131.36±6.46
Total Phenolics (mg GAE/g)	5.66±1.49	21.64±1.93
*L**	89.2±0.35	88.19±0.51
*a**	6.04±0.04	4.70±0.14
*b**	4.25±0.17	4.87±0.29

WWF: Whole wheat flour, BWF: Buckwheat flour, Protein value of flour samples was calculated on dry matter % (DM)

The lowest *L** (63.14), *a** (12.93) and *b** values (14.89) were found in dry tarhana samples containing 75% whole wheat +25% buckwheat (TN1) whereas the highest *L** (70.53), *a** (11.21) and *b** (21.03) values were determined in wet tarhana (Control) samples containing 100% buckwheat (P <0.05; Table 4). According to the analysis of variance, the effects of tarhana type, flour ratio and tarhana type-flour ratio interactions were found to be significant at P <0.01 (Table 5).

Table 4. Color, viscosity and pH values of wet and dried tarhana samples.

	Sample	*L**	*a**	*b**	Viscosity	pH
Wet	Control	66.23±1.03^{d}	15.79±0.40^{a}	24.09±0.59^{a}	480.00±28.28^{b}	4.84±0.05^{b}
	TN1	68.74±0.04^{c}	14.60±0.16^{b}	24.51±0.75^{a}	275.00±35.36^{e}	4.93±0.04^{a}
	TN2	68.96±0.17^{b}	13.96±1.08^{c}	21.98±3.80^{bc}	520.00±28.28^{a}	4.78±0.04^{c}
	TN3	70.36±0.28^{a}	13.82±0.88^{c}	23.16±3.37^{b}	437.50±17.68^{c}	4.43±0.04^{d}
	TN4	70.53±0.65^{a}	11.21±0.04^{d}	21.03±0.82^{c}	365.00±49.50^{d}	4.88±0.04^{b}
Dried	Control	67.80±1.55^{a}	12.03±0.21^{d}	17.81±0.73^{a}	935.00±21.21^{a}	4.87±0.02^{b}
	TN1	63.14±0.22^{c}	12.93±0.17^{c}	14.89±0.01^{d}	565.00±21.21^{e}	4.90±0.01^{a}
	TN2	63.43±0.54^{bc}	14.11±0.04^{a}	16.10±0.37^{b}	925.00±35.36^{b}	4.83±0.04^{c}
	TN3	64.60±0.25^{b}	13.43±0.16^{b}	15.20±0.64^{c}	697.50±38.89^{d}	4.53±0.04^{d}
	TN4	64.77±0.75^{b}	13.10±0.03^{bc}	17.44±1.39^{a}	725.00±35.26^{c}	4.87±0.05^{b}

$^{a-d\,(\downarrow)}$ Values with different letters in the same column differ significantly for each analysis (*P <0.05).

Table 5. The results of variance analyses for color, viscosity and pH values of tarhana samples.

Sample	*L**	*a**	*b**	Viscosity	pH
Tarhana	179.303**	12.633**	73.270**	595.325**	0,527
Flour	4.693*	10.453**	0.807	59.632**	188.798**
Tarhana x Flour	21.090**	19.832**	1.701	6.121**	2.372

: statistically significant (P <0.05), **: statistically very significant (*P <0.01), ***: statistically very highly significant (*P <0.0001)

Parallel to our results, Kitan (2017) has reported that the *L** value of the samples ranged between 71 and 76 while *a** value ranged between 1.25 and 5.45 and *b** value between ranged between 22.6 and 24.18. Tarakci et al. (2013), in tarhana samples prepared by adding different ratios of cherry laurel (*Prunus laurocerasus* L.), have reported the *L** value in the range of 48.52- 64.74, *a** value in the range of 7.73-9.99 and *b** value in the range of 18.62-29.9.

The lowest viscosity values of wet and dried tarhana samples were 275 cP and 565 cP, respectively. The highest viscosity value in tarhana samples produced with 100% buckwheat flour was 480 cP while the highest viscosity value in tarhana samples produced with 100% whole wheat flour was 935 cP (Table 4; P <0.05). It was determined that tarhana type, flour ratio and tarhana type-flour ratio interactions had significant effects on viscosity values (P <0.001) (Table 5).

Bilgicli (2009a) has reported that viscosity decreased with increasing buckwheat flour ratio in tarhana samples produced by adding buckwheat flour at different ratios. Tarakci et al. (2013) have reported that the viscosity values of tarhana samples produced by adding cherry laurel at different ratios varied between 1138 cP and 1827 cP at 25^{o}C, 728 cP and 1157 cP 45^{o}C at and 549 cP and 847 cP at 60 ^{o}C. The results obtained by the researchers were in line with the findings of our study.

In wet tarhana and dry tarhana samples, the lowest pH values were found to be 4.43 and 4.53, respectively. In the TN3 sample (containing 75% whole wheat and 25% buckwheat flour) (P <0.05) whereas the highest pH values were 4.93 and 4.90, respectively, in the TN1 sample (containing 100% buckwheat flour) (P<0.05). It was determined that tarhana type, flour ratios and tarhana type-flour ratio interactions had a significant effect on pH values (P <0.01) (Table 5). The findings obtained in our study were parallel to those reported by Kitan (2017) and Unlu (2017).

The titratable acidity (%) results of tarhana samples are shown in Table 6 and the variance analysis results are shown in Table 7. In both wet and dried tarhana samples, the lowest titratable acidity values were found to be 1.21% and 1.20%, respectively, in the samples containing 100% buckwheat while the highest titratable acidity values were determined to 1.52% and 1.47%, respectively, obtained in the samples containing 25% whole wheat and 75% buckwheat (P <0.05). According to the analysis of variance, the effects of tarhana type and flour ratio were found to be significant at P <0.01. The titratable acidity values of the samples were in line with those reported by Erkan et al. (2006) and Kitan (2017).

Tarhana type (P <0.0001) and flour type (P <0.0001) had an effects on the protein values (Table 7). The lowest protein values in wet and dried tarhana samples were found to be 16.88% and 14.74%, respectively, obtained in the tarhana samples containing 100% whole wheat flour whereas protein values in wet and dried tarhana samples were found to be 17.54% and 15.83%, respectively, obtained in the samples produced with 100% buckwheat flour (P <0.05).

Table 6. Results of the chemical analyses of wet and dried tarhana samples.

	Sample	Titratable Acidity (%)	Protein (%)	Dry Matter (%)	Ash (%)	DPPH (mg Teq/g)	Total Phenolics (mg GAE/g)
Wet	Control	1.22±0.01^{c}	16.88±0.65^{b}	51.58±0.28^{b}	1.83±0.01^{c}	17.28±0.64^{e}	1.40±0.32^{e}
	TN1	1.21±0.01^{c}	17.54±0.14^{ab}	53.60±0.11^{a}	2.02±0.02^{a}	139.70±0.64^{a}	3.59±0.11^{a}
	TN2	1.38±0.04^{b}	17.74±0.13^{a}	51.36±0.03^{b}	1.91±0.02^{b}	80.91±5.78^{c}	2.80±0.66^{c}
	TN3	1.52±0.01^{a}	17.23±0.11^{ab}	53.29±0.03^{a}	1.97±0.01^{ab}	107.43±1.72^{b}	3.15±0.44^{b}
	TN4	1.28±0.04^{bc}	17.07±0.16^{ab}	51.54±0.55^{b}	1.87±0.01^{bc}	52.58±6.00^{d}	1.78±0.52^{d}
Dried	Control	1.22±0.01^{c}	14.74±0.21^{b}	90.27±0.06^{b}	3.15±0.07^{d}	26.52±2.57^{e}	5.14±0.40^{e}
	TN1	1.20±0.01^{c}	15.83±0.25^{a}	90.61±0.07^{a}	3.56±0.01^{a}	161.82±0.21^{a}	14.00±1.84^{a}
	TN2	1.31±0.01^{b}	15.46±0.18^{a}	90.35±0.20^{b}	3.40±0.02^{b}	103.03±3.21^{c}	7.79±0.67^{c}
	TN3	1.47±0.01^{a}	15.69±0.35^{a}	89.71±0.08^{c}	3.48±0.07^{ab}	125.46±0.64^{b}	8.93±0.17^{b}
	TN4	1.24±0.01^{bc}	15.36±0.14^{a}	89.43±0.10^{c}	3.31±0.07^{c}	69.70±11.79^{d}	6.73±0.61^{d}

$^{a-e\ (\downarrow)}$ Values with different letters in the same column differ significantly for each analysis (*P <0.05).

Table 7. Variance analysis results of chemical analysis for the tarhana samples.

Sample	Titratable Acidity	Protein (%)	Dry Matter (%)	Ash (%)	DPPH	Total Phenolics
Tarhana	10.316**	56.572***	154812.483**	7084.102**	68.441**	330.491**
Flour	148.368**	29.757***	35.024**	26.295**	429.217**	32.822**
Tarhana x Flour	2.355	0.128	25.749**	11.164**	1.210	12.359**

: statistically significant (P <0.05), **: statistically very significant (*P <0.01), ***: statistically very highly significant (*P <0.0001)

Demir (2014) have reported that the crude protein content of the gluten-free tarhana samples varied between 16.26 and 16.99%. Cevik (2016) has reported that the protein values of tarhana samples ranged between 12.86% and 13.33%. The values reported by the researchers supported the data obtained in the present study.

The lowest dry matter content in wet tarhana samples was determined to be 51.36% in samples containing 50% whole wheat flour and 50% buckwheat flour whereas the highest dry matter content in wet tarhana samples was determined to be 53.60% in samples produced from 100% buckwheat flour (*P* <0.05). In dried tarhana samples, the lowest dry matter content was 89.43% in the sample containing 75% whole wheat and 25% buckwheat flour whereas the highest dry matter content was 90.61% in the sample containing 100% buckwheat (*P* <0.05).

It was determined that tarhana type, flour ratios and tarhana type-flour ratio interactions had a significant effect on dry matter values (*P* <0.01) (Table 7).

In tarhana standard (TS 2282), it is stated that the lowest dry matter amount of tarhana should be 90% (Anonymous, 2004). Tamer et al. (2007), in 21 tarhana samples, found the mean dry matter value as 88.32%. Unlu (2017) has reported the dry matter content of the samples between 87.8% and

90.8%. The results of researcher study conducted with the results of the present study are in line.

In both wet and dried tarhana samples, the lowest ash contents were found to be 1.83% and 3.15%, respectively, in the samples containing 100% whole wheat flour whereas the highest ash contents were found to be 2.02% and 3.56%, respectively, in the samples produced with 100% buckwheat flour (Table 6; P <0.05). According to the results of the analysis of variance, the effects of tarhana type, flour ratios and tarhana type-flour ratio interaction had a significant effect on ash content at P <0.01 (Table 7).

Demir (2014), in gluten-free quinoa tarhana trials, have reported that the amount of ash increased as the quinoa ratio increased. Cevik (2016) have reported that the ash contents of tarhana samples produced with different amounts of buckwheat, quinoa and lupine flour varied between 1.37% and 2.26%. These values were similar to the results obtained in the present study.

The lowest DPPH free radical scavenging activity values of wet and dried tarhana samples were 17.28 and 26.52 mg Teq/g, respectively, obtained in the samples containing 100% whole wheat flour whereas the highest DPPH free radical scavenging activity values of wet and dried tarhana samples were 139.70 and 161.82 mg Teq/g, respectively, obtained in the samples containing 100% buckwheat flour (P <0.05).

It was determined that tarhana type, flour ratio and tarhana type x flour ratio interactions had significant effects on DPPH values (P <0.01) (Table 5). Kitan (2017) has reported that the DPPH free radical scavenging activity was in the range of 6.16-10.41 mmol/g Tarakci et al. (2013) determined that this value was between 13.08 and 20.51% in tarhana samples prepared with cherry laurel pulp at different ratios. The values determined by Tarakci et al. (2013) were lower than those obtained in the present study. It was thought that this difference was due to the differences in formulations and raw materials used in productions.

Table 8. Sensory evaluation scores of the tarhana samples.

	Sample	Taste and Aroma	Color	Odor	Consistency	General Evaluation
Wet	Control	4.50±0.71^{d}	6.75±0.35^{b}	7.20±0.28^{a}	4.75±1.06^{a}	4.50±0.71^{b}
	TN1	4.85±0.92^{a}	6.00±1.41^{e}	6.00±1.41^{c}	4.10±0.71^{c}	4.28±1.06^{c}
	TN2	4.75±0.35^{b}	7.25±0.35^{a}	5.50±1.41^{d}	4.50±0.21^{b}	4.50±0.71^{b}
	TN3	4.60±0.57^{c}	6.50±0.71^{c}	6.50±0.71^{b}	4.50±0.71^{b}	5.00±0.01^{a}
	TN4	4.15±0.21^{e}	6.25±0.35^{d}	6.25±0.35^{bc}	4.20±0.71^{bc}	4.25±0.35^{c}
Dried	Control	6.75±0.35^{d}	6.75±0.35^{d}	7.25±0.35^{c}	7.25±0.35^{ab}	7.25±0.71^{b}
	TN1	7.01±0.14^{c}	7.40±0.42^{b}	7.65±0.49^{a}	6.75±0.35^{c}	7.04±0.35^{c}
	TN2	7.45±0.21^{a}	7.25±0.35^{c}	7.25±0.35^{c}	7.50±0.7^{a}	7.25±0.71^{b}
	TN3	7.15±0.21^{b}	7.75±0.35^{a}	7.50±0.71^{b}	7.05±0.35^{bc}	7.55±0.49^{a}
	TN4	6.40±0.57^{e}	6.25±0.35^{e}	6.75±0.35^{d}	7.15±0.21^{b}	6.75±0.35^{d}

$^{a-e}$ (↓) Values with different letters in the same column differ significantly for each analysis (*P <0.05). 1-3 (unacceptable), 4-5 (acceptable), 6-7 (good), 8-9 (very good).

Table 9. Variance analysis results of sensory evaluation for the tarhana samples.

Sample	Taste and Aroma	Color	Odor	Consistency	General Evaluation
Tarhana	128.669**	4.896	6.799*	113.485**	122.575**
Flour	2.320	1.703	0.576	0.509	1.113
Tarhana x Flour	0.207	1.907	0.677	0.243	0.913

: statistically significant (P <0.05), **: statistically very significant (*P <0.01), ***: statistically very highly significant (*P <0.0001)

In wet and dried tarhana samples, the lowest total phenolic contents were found to be 1.40 and 5.14 mg GAE/g, respectively, in sample produced from 100% whole wheat flour whereas the highest total phenolic contents were found to be 3.59 and 14 mg GAE/g, respectively, in sample produced from 100% buckwheat flour (Table 6; P <0.05). According to the results of the analysis of variance, the effects of tarhana type, flour ratio and the tarhana type- flour ratio interactions were found to be significant at P <0.01 (Table 7).

Parallel to the findings of the present study, Demir (2018) reported that the total phenolic content was 714-1521 mg GAE/100 g. Degirmencioglu et al. (2016) determined that the total phenolic content in the tarhana samples produced with the addition of oatmeal flour was in the range of 9.98-44.49 mg/g. The researchers stated that the increase in the amount of oatmeal increased the total phenolic content. The values determined in the study were higher than the findings obtained in the present study. It was thought that the differences were associated with the differences in formulations and raw materials used in productions.

Sensory analysis results of tarhana samples are shown in Table 8 while variance analysis results for the sensory analysis are shown in Table 9. The lowest taste and aroma scores of wet and dried samples were 4.15 and 6.40, obtained from the samples containing 75% whole wheat +25% buckwheat flour. The highest taste and aroma score obtained from wet samples were 4.85 obtained from samples containing 100% buckwheat flour while the highest taste and aroma score obtained from dried samples were 7.45 obtained from samples containing 50% whole wheat +50% buckwheat flour (P <0.05). The lowest color score in wet samples was obtained in the sample containing 100% buckwheat flour while the lowest color score in dried samples was obtained in the sample containing 75% whole wheat flour and 25% buckwheat flour (P <0.05) (Table 8). The highest odor scores in dried samples were 7.00 obtained in the control sample while the highest odor scores in wet samples were 7.65 obtain in the sample containing from 100% buckwheat flour (P <0.05). The highest consistency scores in both tarhana types were obtained from control samples with 4.75 and 7.25, respectively, while the panelists gave the lowest consistency scores to the TN1 sample containing buckwheat flour with 4.10 and 6.75, respectively, for both samples (P <0.05). The lowest overall evaluation scores for wet and dried tarhana samples were 4.25 and 6.75, respectively, obtained in the samples containing 75% whole wheat and 25% buckwheat flour. However, the highest overall evaluation scores for wet and dried tarhana samples were 5.00 and 7.55, respectively obtained in the samples containing and 25% whole wheat and 75% buckwheat flour (P <0.05). According to the analysis of variance, the effect of tarhana type on taste and aroma, consistency, and overall evaluation was statistically significant at P <0.01 while the effect of tarhana type on odor scores was statistically significant at P <0.05 (Table 9).

Bilgicli (2009b) found that the addition of buckwheat up to 40% increased taste and aroma scores, but added sourness to the product. It has been reported that the highest acceptable scores were also obtained in the 40% buckwheat formulation. The results reported by the researcher were parallel to those obtained in the present study.

CONCLUSION

This study aimed to use buckwheat flour at certain ratios as a replacement to wheat flour used in traditional tarhana production and to produce tarhana which can be consumed by celiac patients. Buckwheat has rich ash, protein and antioxidant content compared to whole wheat flour. This nutritional superiority was evident in the tarhana samples produced in the present study. In addition, the increase in the buckwheat flour ratio increased the total phenolic contents of the samples. In terms of sensory characteristics (color, taste, smell, consistency), it was determined that wet tarhana samples did not receive high scores however dry tarhana samples received high sensory scores. As a result of the study, it was determined that buckwheat flour substitution to whole wheat flour yields in a consumable product by both healthy individuals and individuals with celiac disease.

REFERENCES

Acar, R.A., Gunes, N., Gummadov, V., Topal, I. (2011). Effects of different plant densities on the yields and some yield components of buckwheat (*Fagopyrum esculentum* Moench). *Selcuk J Agric Food Sci,* 25: 47-51.

Akarca, G., Caglar, A., Tomar, O. (2016). The effects spicing on quality of mozzarella cheese. *Mljekarstvo,* 66(2): 112-121, doi: 10.15567/mljekarstvo.2016.0203.

Akarca, G., Tomar, O., Gok, V. (2015). Effect of different packaging methods on the quality of stuffed and sliced Mozzarella cheese during storage. *J. Food Proces Pres,* 39: 2912-2918, doi: 10.1111/jfpp.12542.

Aktas, K., Demirci, T., Akin, N. (2015). Chemical composition and microbiological properties of tarhana enriched with immature wheat grain. *J Food Process Pres,* 39: 3014-3021, doi: 10.1111/jfpp.12554.

Alcay, A., Yalcin, S., Bostan, K., Dincel, E. (2015). Dried foods from Middle Asia to Anatolia. *J of Anadolu Bil Vocational School of Higher Education*, 37: 83-93.

Anonymous (2000). Fruit and vegetable products determination of insoluble ash in hydrochloric acid (TS 1128 ISO 763:2003). Turkish Standards Institute. Ankara, Turkey.

Anonymous (2002). Macaroni Standard (TS 1620). Turkish Standards Institute. Ankara, Turkey.

Anonymous (2004). Tarhana Standard (TS 2282). Turkish Standards Institute. Ankara, Turkey.

Anonymous (2012). Food technology. Making sensory controls. Turkish Ministry of Education. Ankara, Turkey.

AOAC (2016). Official Methods of Analysis AOAC INTERNATIONAL. 20th Edition, Washington DC, the USA.

Atalay, M.H. (2009). Utilization possibilities of buckwheat (*Fagopyrum esculentum*) milling products in bread making. M.Sc. Thesis, Selcuk University, Graduate School of Natural and Applied Sciences, Konya, Turkey, 84 p.

Bilgicli, N. (2009a). Effect of buckwheat flour on chemical and functional properties of tarhana. *LWT-Food Sci Technol,* 42(2): 514-518, doi: 10.1016/j.lwt.2008.09.006.

Bilgicli, N. (2009b). Enrichment of gluten-free tarhana with buckwheat flour. *International J Food Sci Nutr,* 60(1): 1-8, doi: 10.1080/09637480802112546.

Bilgicli, N., Ibanoglu, S. (2007). Effect of wheat germ and wheat bran on the fermentation activity, phytic acid content and colour of tarhana, a wheat flour-yoghurt mixture. *J Food Eng,* 78: 681-686, doi: 10.1016/j.jfoodeng.2005.11.012.

Caglar, A., Erol, N., Elgün, M.S. (2013). Effect of carob flour substitution on chemical and functional properties of tarhana. *J Food Process Preserv,* 37: 670-675, doi: 10.1111/j.1745-4549.2012.00708.x.

Celik, I., Işık, F., Simsek, O., Gürsoy, O. (2005). The effects of the addition of baker's yeast on the functional properties and quality of tarhana, a traditional fermented food. *Czech J. Food Sci,* 23(5): 190-195.

Celik, I., Işık, F.,Yılmaz, Y.(2010). Chemical, rheological and sensory properties of tarhana with wheat bran as a functional constituent. *Academic Food Journal*, 8(3): 11-17.

Cevik, A. (2016). Utilization of quinoa, buckwheat and lupin flour in tarhana for nutritional enrichment. M.Sc. Thesis, Necmettin Erbakan University, Graduate School of Natural and Applied Sciences, Konya, Turkey, 113 p.

Chu, S.C., Chen, C. (2006). Effects of origins and fermentation time on the antioxidant activities of Kombucha. *Food Chem,* 98: 502-507, doi: 10.1016/j.foodchem.2005.05.080.

Coskun, F. (2003). The importance of tarhana in nutrition. *Journal of Food and Feed Science Technology,* 3: 46-49.

Degirmencioglu, N., Gurbuz, O., Herken, E.N., Yildiz, A.Y. (2016). The impact of drying techniques on the phenolic compound, total phenolic content and antioxidant capacity of oat flour tarhana. *Food Chem,* 194: 587-594, doi: 10.1016/j.foodchem.2015.08.065.

Demir, M.K. (2014). Use of quinoa flour in the production of gluten-free tarhana. *Food Sci Technol Res,* 20(5): 1087-1092, doi: 10.3136/fstr.20.1087.

Demir, M.K. (2018). Use of whole wheat flour in traditional tarhana production. *Academic Food Journal,* 16(2): 148-155, doi: 10.24323/akademik-gida.449606.

Dizlek, H., Ozer, M.S., Inanc, E., Gul, H. (2009). Composition of buckwheat (*Fagopyrum esculentum* Moench) and its possible uses in food industry. *The Journal of Food,* 34: 337-324.

Erbas, M., Certel, M., Uslu, M.K. (2004). Effect of fermentation time and storage of the sugars content of wet and dry tarhana. *The Journal of Food,* 29(4): 299-305.

Erkan, H., Celik, S., Bilgi, B., Koksel, H. (2006). A new approach for the utilization of barley in food products: Barley tarhana. *Food Chem,* 97: 12-18, doi: 10.1016/j.foodchem.2005.03.018.

Gocmen, D., Gurbuz, O., Roussef, R.L., Smoot, J.M., Dagdelen, A.F. (2004). Gas chromatographic-olfactometric characterization of aroma active compounds in sun-dried and vacuum dried tarhana. *Eur Food Res Technol,* 218: 573-578, doi: 10.1007/s00217-004-0913-6.

Hayta, M., Alpaslan, M., Baysar, A. (2016). Effect of drying methods on functional properties of tarhana: A wheat flour-yogurt mixture. *J Food Eng Physical Prop,* 67(2): 740-744, doi: 10.1111/j.1365-2621.2002.tb10669.x.

Kan, A. (2011). Investigation of some characteristic of buckwheat (*Fagopyrum esculentum* Moench) growing in Konya ecological conditions. *Selcuk J Agr Food Sci,* 25(4): 67-71.

Kitan, S. (2017). Utilization of quinoa (*Chenopodium quinoa*) in production of gluten-free tarhana. M.Sc. Thesis, Ondokuz Mayis University. Graduate School of Natural and Applied Sciences, Samsun, Turkey, 100 p.

Koca, A.F., Yazici, F., Anil, M. (2002). Utilization of soy yoghurt in tarhana production. *Eur Food Reseach Technol,* 215: 293-297.

Isık, F., Yapar, A. (2017). Effect of tomato seed supplementation on chemical and nutritional properties of tarhana. *J Food Meas Charact*, 11: 667-674.

Onogur, A.T., Elmaci, Y. (2012). Sensory Analysis of Food. Sidas Publishing, Izmir, Turkey, 148 p.

Peng, L., Wang, S., Zou, L., Zhao, J., Zhao, G. (2012). HPLC fingerprint of buckwheat from different habitats and varieties. *Phcog Journal,* 31: 5-10, doi: 10.5530/pj.2012.31.2.

Singleton, V.L., Rossi, J.A. (1965). Colorimetry of total phenolics with phosphomolybdic phosphotungstic acid reagents. *Am J Enol Vıtıcult,* 16: 144-158.

Tamer, C.E., Kumral, A., Asan, M., Sahin. I. (2007). Chemical compositions of traditional tarhana having different formulations. *J Food Proces Pres,* 31: 116-126, doi: 10.1111/j.1745-4549.2007.00113.x.

Tarakci, Z., Anil, M., Koca, I., Islam, A. (2013). Effects of adding cherry laurel (*Laurocerasus officinalis*) on some physicochemical and functional properties and sensorial quality of tarhana. *Qual Assur Saf Crop,* 5(4): 347-355, doi: 10.3920/QAS2012.0155.

Tural, S., Koca, I. (2008). Physico-chemical and antioxidant properties of cornelian cherry fruits (*Cornus mas* L.) grown in Turkey. *Science Horticulture,* 116: 362-366, doi: 10.1016/j.scienta.2008.02.003.

Unlu, U.M. (2017). Effect of carrot dietary fiber and sugar beet fiber on the quality of tarhana. M.Sc. Thesis, Aksaray University. Graduate School of Natural and Applied Sciences, Aksaray, Turkey, 60 p.

Wijngaard, H.H., Arendt, E.K. (2006). Buckwheat. *Cereal Chem,* 83(4): 391-401.

Yorukoglu, T., Dayisoylu, K.S. (2016). Some chemical and functional properties of Maras tarhana. *Atatürk Univ J of the Agricultural Faculty,* 47(1): 53-63.