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COMPARISON OF PHYSICOCHEMICAL AND FUNCTIONAL PROPERTIES OF DOMESTIC AND COMMERCIAL TARHANA IN TURKEY

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Abstract

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Tarhana, cereal-based fermented product, is made domestically or commercially with different ingredients and recipes. Nutritional properties depend on ingredients and their ratios in recipe. In this research, some quality properties of 22 domestic and 14 commercial samples collected from 25 different locations of Turkey were analysed. Moisture, ash, salt, protein, crude fat, acidity degree, pH, $a_{w,}$ viscosity, *L** (lightness), *a** (redness), *b** (yellowness) values, total antioxidant activity (AOA) and total phenolic content of domestic and commercial samples were determined and compared. Domestic samples had higher fat content and varied in salt content, while commercial samples had more uniform physicochemical properties.

Key words: commercial tarhana, fermented cereal, functional properties, quality, traditional domestic tarhana, Turkey
List of abbreviations: GAE*:* gallic acid equivalent

Introduction

Tarhana is a traditional Turkish cereal based fermented food product that is produced domestically or commercially in Turkey (Dağlioğlu, 2000). There are fermented products similar to tarhana such as kishk in Syria, Jordan and Egypt (Yousse, 1990), kushuk in Iraq (Alnouri and Duitschaever, 1974), tahonya/talkuna in Hungary and Finland (Hafez and Hamada, 1984), trahana in Greece and atole in Scotland (Tamime et al., 2000).

It is prepared by mixing wheat flour, yoghurt, bakers' yeast (*Saccharomyces cerevisiae*), tomato, onion, paprika, salt, spices and herbs (tarhana herb, mint, thyme) into dough, followed by fermentation at 30–35°C for 1–5 days, drying and grinding (Temiz and Pirkul, 1990; Temiz and Pirkul, 1991; Ibanoğlu et al., 1995). Domestic tarhana production constitutes the major part of total tarhana production in Turkey and is not recorded. Since there is no optimization in tarhana production, ingredients and recipes for tarhana have some differences from region to region.

Due to its nutritious content, tarhana is good source of B vitamins, minerals, organic acids and free amino acids. It is healthy for children, adults and patients (Dağlioğlu, 2000). Moreover, it has low moisture (6–9%) and low pH (3.8–4.4) which make it a poor medium for pathogens and spoilage microorganisms. It can be stored for 2–3 years without deterioration (Salama et al., 1992).

Studies on tarhana have increased in recent years. Some of them include rheological behaviour of tarhana (Ibanoğlu et al., 1999; Ibanoğlu and Ibanoğlu 1999; Yilmaz et al., 2010) and chemical composition of tarhana (Temiz and Pirkul 1991; Dayisoğlu et al., 2004; Koca et al., 2006; Tamer et al., 2007; Funda and Kivanç, 2009). Moreover, effects of different ingredients such as corn flour and whey (Tarakçi et al., 2004), soy yoghurt (Koca et al., 2002), different flours (Köse and Çağindi, 2002), barley (Erkan et al., 2006), wheat germ and wheat bran (Bilgiçli and Ibanoğlu, 2007), whey concentrate (Ertaş et al., 2009), buckwheat flour (Bilgiçli, 2009), grapes (Kaya et al., 2009), bilberry fruit (Bayrakçi and Konak, 2011), cherry laurel (Tarakçi et al., 2011), lupin flour (Etgü et al., 2011) and effects of different applications

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such as precooking (Ibanoğlu and Maskan, 2001), production method and fermentation (Çopur et al., 2001), fermentation and drying (Ekinci, 2005), fermentation and storage (Erbaş et al., 2006; Certel et al., 2007), yeast, fermentation time and preservation method (Gurbuz et al., 2010) on physical, chemical, microbiological, nutritional and organoleptic properties of tarhana were extensively studied.

Most of these studies were applied on laboratory scale produced tarhana samples, while few of them (Yücecan et al., 1988; Koca et al., 2006; Tamer et al., 2007; Funda and Kivanç, 2009; Sengün et al., 2009) were applied on samples supplied from the local market or domestic producers. However, there is no study on comparison of domestic and commercial tarhana in the literature. Most of the tarhana consumed in Turkey is domestically produced. On the other hand, tarhana demand is increasing year by year. Due to increasing demand, tarhana is also produced at the industrial level (Ekinci, 2005). This study differs from the previous researches by comparing domestic and commercial tarhana in terms of physicochemical and functional properties and contributes to the insufficient literature. The main objective of this study was to determine and compare physicochemical and functional properties of domestic and commercial tarhana.

Materials and Methods

Materials

Domestic tarhana samples collected from 19 and commercial samples collected from 8 different locations were used in the study.

Table 1

The locations and the ingredients of domestic tarhana samples

Sample Code	Location	Ingredients	Status
DT1	Bursa	Wheat flour, yoghurt, tomato paste, red pepper paste, onion, black pepper, red pepper, red pepper powder, salt, baker's yeast	Dried/ground
DT2	Adapazarı	Wheat flour, yoghurt, tomato, red pepper paste, red hot pepper, salt, baker's yeast, sugar	Dried/ground
DT3	Çanakkale	Cracked and hulled wheat, milk, salt, black pepper	Dried/ground
DT4	Çanakkale	Wheat flour, yoghurt, tomato, onion, red pepper, tomato paste, salt	Dried/ground
DT5	Denizli	Wheat flour, yoghurt, tomato, red pepper, salt	Dried/ground
DT6	Muğla	Wheat flour, strained yoghurt, tomato, cracked and hulled wheat, onion, milk, salt, butter	Dried
DT7	Manisa	Wheat flour, yoghurt, tomato, onion, chickpea, red pepper, salt, peppermint, nigella seeds, baker's yeast	Dried/ground
DT8	Uşak	Wheat flour, yoghurt, tomato, onion, red pepper, red hot pepper, salt, chickpea, peppermint, bean	Dried/ground
DT9	İzmir	Wheat flour, yoghurt, tomato, onion, red pepper paste, red pepper, olive oil, chickpea, tarhana herb	Dried/ground
DT10	Malatya	Cracked and hulled wheat, water, wheat flour, yoghurt, yeast, salt, peppermint	Dried
DT11	Gaziantep	Wheat, strained yoghurt, wheat flour, salt	Dried
DT12	Antalya	Wheat flour, strained yoghurt, tomato, onion, red pepper, red pepper paste, salt, dried peppermint, nigella seeds	Dried/ground
DT13	Antalya	Wheat flour, strained yoghurt, tomato, onion, red pepper, red pepper paste, salt, dried peppermint, nigella seeds	Dried/ground
DT14	Burdur	Wholemeal wheat flour, wheat flour, chickpea, strained yoghurt, tomato, onion, red pepper, salt, milk	Dried/ground
DT15	Isparta	Ground wheat, dill, yoghurt, salt, peppermint	Dried
DT16	Alanya	Wheat flour, yoghurt, milk, tomato, onion, red pepper, red hot pepper, salt, peppermint, dill	Dried/ground
DT17	Bolu	Wheat flour, strained yoghurt, tomato, onion, red pepper, salt, peppermint	Dried/ground
DT18	Tokat	Cracked and hulled wheat, milk, strained yoghurt, salt	Dried
DT19	Bolu	Cornelian cherry, wheat flour, yoghurt, salt	Dried/ground
DT20	Düzce	Wheat flour, yoghurt, tomato, red pepper, onion	Dried/ground
DT21	Kastamonu	Wheat flour, strained yoghurt, tomato, chickpea, lentil, onion, green pepper, red pepper, fresh peppermint, parsley, garlic, half of bread dough	Dried/ground
DT22	Ankara	Wheat flour, yoghurt, tomato, onion, green pepper, red pepper, salt, tarhana herb	Dried/ground

Table 2
The locations and the ingredients of commercial tarhana samples

Sample Code	Location	Ingredients	Status
CT1	Edirne	Wheat flour, yoghurt, tomato, onion, red pepper, semolina, salt, baker's yeast	Dried/ground
CT2	Balıkesir	Wheat flour, water, yoghurt, tomato paste, salt, baker's yeast, spices	Dried/ground
CT3	Balıkesir	Wheat flour, yoghurt, tomato paste, onion, red pepper paste, semolina, salt, baker's yeast	Dried/ground
CT4	Balıkesir	Wheat flour, yoghurt, tomato paste, onion, red pepper paste, semolina, salt, baker's yeast, peppermint	Dried/ground
CT5	İzmir	Wheat flour, tomato paste, red pepper paste, yoghurt, onion, tarhana herb	Dried/ground
CT6	Kütahya	Wheat flour, red pepper, yoghurt, tomato, onion, baker's yeast, peppermint	Dried
CT7	Uşak	Wheat flour, yoghurt, tomato, red pepper, onion, pepper, salt, peppermint, sour dough	Dried/ground
CT8	Kütahya	Wheat flour, yoghurt, red pepper, onion, salt, tomato, peppermint, sour dough	Dried/ground
CT9	Erzurum	Semolina, wheat flour, yoghurt, tomato, onion, red pepper, green pepper, red pepper paste, dill, salt, peppermint	Dried/ground
CT10	Kahramanmaraş	Cracked and hulled wheat, goat yoghurt, salt, oregano	Dried/ flake
CT11	Kahramanmaraş	Cracked and hulled wheat, goat yoghurt, salt, oregano	Dried/ flake
CT12	Kahramanmaraş	Cracked and hulled wheat, goat yoghurt, salt, oregano	Dried/ flake
CT13	Kahramanmaraş	Cracked and hulled wheat, goat yogurt, salt, oregano, hot pepper	Dried/ flake
CT14	Beypazarı	Wheat flour, ayran, yoghurt, dill, onion, chickpea, pepper, hot pepper, tomato, salt, bread dough	Dried/ground

Fig. 1 (*a*) Dried and ground tarhana (*b*) Dried tarhana balls (*c*) Tarhana flakes

Tarhana samples were in different forms and had different particle sizes as they were prepared by different production procedures in different regions of Turkey. Most of them were ground after drying, which is the accustomed consumption style of tarhana (Figure 1a) Some of them were prepared with cracked wheat and left as dried dough balls without grinding (Figure 1b). Another form was tarhana flakes that are consumed raw as tarhana chips (Figure 1c). The origins and the ingredients of the samples were given in Table 1 and Table 2.

Methods

Physicochemical and Functional Analyses

The colour of tarhana samples was measured by using Minolta Chroma Meter CR-310 (Minolta, Japan). The *L**, *a** and *b** colour measurements were determined according to the CIE Lab colour space system.

Moisture, ash, and crude fat contents of tarhana samples were determined according to AACC Methods (AACC, 1990). The nitrogen content of the samples was determined by the Kjeldahl method (AACC, 1990) and converted to protein content by multiplying 6.25. 10 g tarhana sample was blended with distilled water in 100 mL volumetric flask and pH values were measured using Hanna HI 2211 pH/ORP-meter (USA). The acidity degree of tarhana samples was measured according to TS 2282 (Anon., 1981), the official method of Turkish Tarhana Standard. Results were expressed as % of total lactic acid. In this standard, the acidity degree of tarhana is explained as the volume of 0.1N NaOH solution consumed to neutralize the free acids in 100 g of tarhana. The salt content of samples was determined by the

Mohr method according to TS 2282 (ANON., 1981). Water activity was measured with Testo 400, the Multi-function meter/logger (Germany). Total phenolic contents of samples were determined by using Folin-Ciocalteu method that was developed by Singleton and Rossi (1965) and modified by Li et al. (2006). Total antioxidant activity was determined by using DPPH-radical scavenging method (Brand-Williams et al., 1995; Singh et al., 2002).

Statistical Analysis

The study was planned as Completely Randomized Design. All analyses were done in three parallels on 2 replications. Data were subjected to one-way analysis of variance (ANOVA) followed by Fisher's LSD Test using PASW Statistics 18.0 software package (2009). Values of $p < 0.05$ were considered significant. Independent *t* test was used to compare commercial and domestic tarhana sample means.

Results and Discussion

Colour values of domestic and commercial samples were presented in Table 3. There was not significant difference ($p > 0.05$) between means of domestic and commercial samples in terms of *L*, a** and *b** values. It was observed that as lightness decreased, redness or yellowness of the samples increased. It was concluded that *+a** values of samples were higher due to higher amounts of red pepper, tomatoes and tomato/pepper paste in recipes of the samples. In addition, these samples had higher antioxidant activity and total phenolic content. Similarly, the same relation was stated by Esimek (2010). Köse and Çağındı (2002) and Gül (2010) reported *L*, a*, b** values between 52.71 – 63.03, 14.41 – 18.72, 33.41 – 44.14 and 44.03 – 59.22, 19.4 – 20.7, 29.71 – 35.29 respectively. Results in the present study were comparable with the previous studies.

Chemical properties of domestic and commercial samples were given in Table 4. Means of moisture contents of domestic and commercial samples did not differ from each other significantly ($p > 0.05$). Variations in the moisture content of tarhana samples, especially in domestic tarhana, arise from ingredients and drying method (Temiz and Pirkul, 1991; Erkan et al., 2006). As expected, tarhana samples from different regions having different raw materials and drying methods had different moisture contents.

Table 3

Colour values of domestic and commercial tarhana

	Domestic			Commercial		
	*L**	*a**	*b**	*L**	*a**	*b**
Minimum	54.61	-0.14	1.43	60.01	0.14	20.43
Maximum	88.57	28.10	52.88	85.71	25.57	45.24
Average	73.40	11.21	30.45	70.09	12.07	35.14
St. deviation	9.99	8.81	12.26	8.03	7.84	8.59
LSD	3.02	0.70	2.19	2.74	0.68	1.70
p value	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

Table 4

Chemical properties of domestic and commercial tarhana

		Moisture (%)	Ash (% dm)	Protein (% dm)	Fat (% dm)	Salt (% dm)	Acidity (%)	pH	a_w
Domestic	Minimum	7.94	1.41	3.31	0.25	2.55	7.00	3.76	0.28
	Maximum	17.01	7.93	6.61	4.12	8.79	28.13	4.57	0.63
	Average	10.96	3.27	5.32	3.47	4.63	14.05	4.17	0.49
	St.deviation	1.95	12.36	2.22	1.76	2.96	7.91	0.37	0.07
	LSD	0.89	1.42	1.84	1.22	0.44	2.27	0.17	0.05
	p value	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Commercial	Minimum	7.31	1.03	2.26	0.21	0.95	5.00	3.60	0.31
	Maximum	18.28	8.79	9.74	7.00	12.23	36.10	5.09	0.64
	Average	10.94	3.85	5.09	1.82	4.45	18.18	4.09	0.48
	St.deviation	2.96	1.91	1.32	1.05	1.71	6.51	0.25	0.11
	LSD	0.58	2.16	0.89	0.15	0.51	2.91	0.10	0.06
	p value	<.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

Ash content increases depending on the increase in the amount of salt content in recipe (Tamer et al., 2007). There was no significant difference ($p > 0.05$) between means of ash content of domestic and commercial samples. Gül (2010) reported that ash content of samples ranged between 4.48–6.09%. As seen in Table 4, samples containing higher amount of salt also contained higher amount of ash. Köse and Çağındı (2002) stated that ash content of salt-free tarhana samples varied between 1.10 – 2.39%.

There was no significant difference between means of protein content of domestic and commercial samples ($p > 0.05$). Erkan et al. (2006) stated that variations in the protein content in different tarhana samples depended on amount and type of yoghurt and properties of cereal or legume flours. Tamer et al. (2007) reported that protein content of 21 tarhana samples having different recipes varied between 6.77–28.55% and the mean was 14.93%. In that study, protein content was found to be over 20% in some samples. The reason for this could be the amount and type of yoghurt in tarhana recipe. Köse and Çağındı (2002) and Gül (2010) found that protein content of tarhana samples varied between 8.8–22.5% and 11.8–12.02%, respectively. Yücecan et al. (1988) reported that protein content ranged between 12.5–18.6% in 15 tarhana samples collected from different regions in Turkey. Samples in this research were considerably lower in protein content in contrast to findings of similar studies. This could be attributed to variations in the types and ratios of ingredients in the tarhana recipes.

Means of crude fat content of domestic and commercial samples were significantly different ($p < 0.05$). Fat content of domestic samples that do not have standardized recipe changed in a wider range. Higher fat levels were observed in these samples than commercial ones. The reason of this could be amount and type of yoghurt (fat-free, full-fat, strained) in recipe. Some researchers determined that the fat content of tarhana samples ranged between 4.0–7.02% (Yücecan et al., 1988), 3.5–4.5% (Ibanoğlu et al., 1999), 1.80–9.01% (Göçmen et al., 2003), 0.43–15.78% (Tamer et al., 2007) and 4.35–5.75% (Gül, 2010), respectively. The results obtained in this research showed considerable similarity with previous findings.

As seen from Table 4 and Figure 2, salt content of commercial samples changed in a wider range while more standardized salt content was obtained in domestic samples. On the other hand, there was not significant difference between commercial and domestic tarhana ($p > 0.05$) in terms of average salt content. Tamer et al. (2007) reported that salt contents of 21 traditional tarhana samples ranged between 0.62–9.01%. The findings of the present study were in accordance with the results of Tamer et al. (2007).

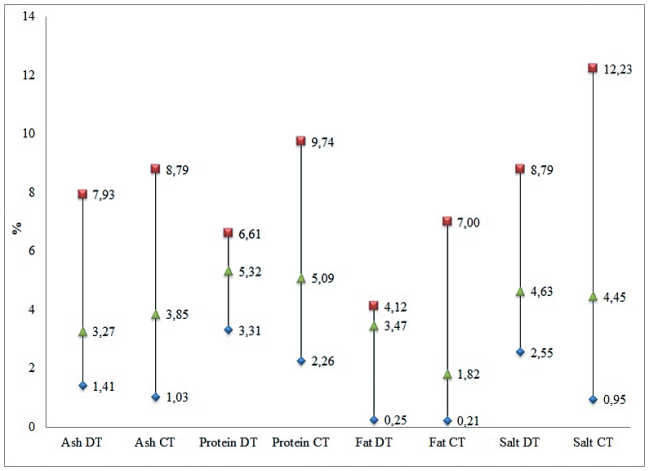

Fig. 2 Distribution of chemical compositions of domestic and commercial tarhana

Means of acidity degree of domestic and commercial samples did not differ significantly ($p > 0.05$). Temiz and Pirkul (1990) stated that acidity degree of tarhana samples increased as the fermentation period increased. Besides, it was determined by different studies that pH and acidity in tarhana varied due to yoghurt and flour type, use of whey instead of yoghurt, use of baker's yeast or salt and fermentation time (Esimek, 2010). Göçmen et al. (2003) reported acidity degree values between 9.65–28.0%.

There was not a significant difference ($p > 0.05$) between commercial and domestic samples in terms of mean pH values. The results were in accordance with Temiz and Pirkul (1990), Bilgiçli and Ibanoglu (2007) and Esimek (2010), which reported pH values between 3.99–4.33, 4.17–4.41 and 3.62–4.75, respectively.

Mean water activity of domestic and commercial tarhana samples did not differ significantly ($p > 0.05$). Erbaş et al. (2005) investigated the effect of storage type on chemical and microbiological properties and reported a_w value of 0.63 for sun – dried tarhana. Gül (2010) reported a_w values of samples between 0.45–0.55.

Total phenolic content of domestic and commercial samples were presented in Figure 3. Phenolic content of domestic tarhana changed between 0.55–42.67 µg GAE/g tarhana with an average of 12.62 µg GAE/g tarhana, while minimum, maximum and average phenolic content for commercial tarhana samples were 1.27, 28.18 and 7.36 µg GAE/g tarhana, respectively. There was not significant difference ($p > 0.05$) between means of phenolic content of domestic and commercial samples. AOA and phenolic content are closely related with the ingredients in the recipe. DT13 contained

black cumin in the recipe as seen in Table 1, which was reported to have superior antioxidant activity and phenolic content (Mariod et al., 2009). On the other hand, samples between DT1 – DT9 had lower phenolic content and were not different from each other statistically ($p > 0.05$). Esimek (2010) reported that phenolic content of tarhana samples ranged between 572.47–1851.83 µg GAE/g tarhana. Sample DT19 (which contained cornelian cherry) differed from other samples in terms of recipe and had the second highest antioxidant activity. Popović et al. (2012) also reported that cornelian cherry possessed high antioxidant activity.

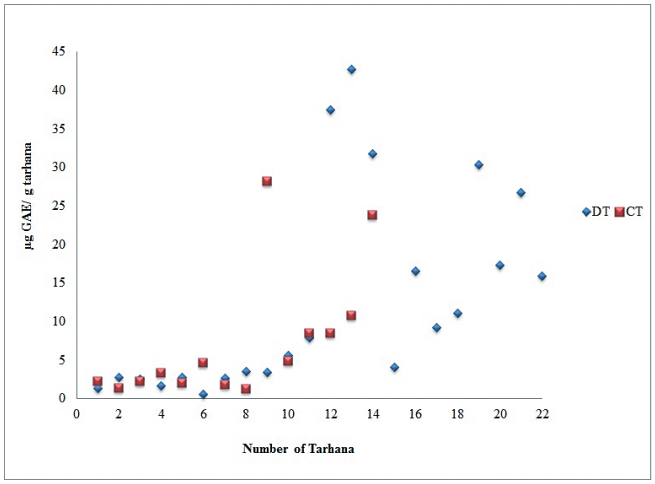

Fig. 3 Phenolic content of domestic and commercial tarhana

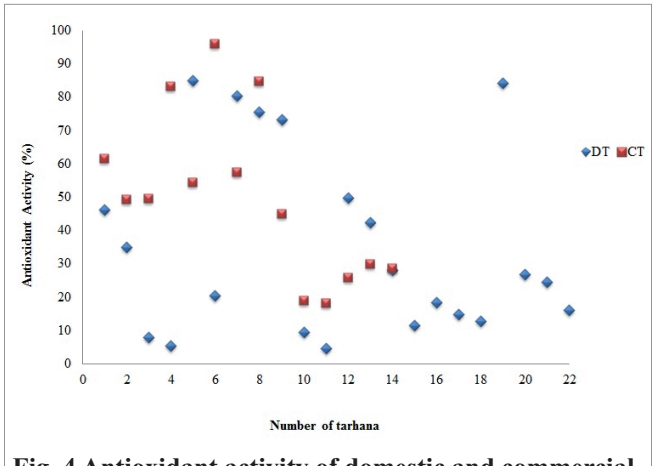

Fig. 4 Antioxidant activity of domestic and commercial tarhana

AOA of domestic and commercial tarhana samples were presented in Figure 4. AOA changed between 4.44 – 84.83% and 18.15 – 95.76% for domestic and commercial tarhana, respectively. AOA mean values for domestic and commercial tarhana were 35.06% and 50.07%. Similar to phenolic content, there was no significant difference ($p>0.05$) between means of AOA of domestic and commercial samples.

Conclusions

Tarhana is an important food product in Turkish diet. It is either produced domestically or commercially. In both cases, percentages of ingredients in the formulation are unclear. Variations in raw materials, production, drying and grinding procedures, regional preferences lead to physical, chemical and functional differences in end product. Domestic and commercial tarhana samples investigated in the current research differed in terms of fat content ($p<0.05$). Domestic tarhana samples had higher fat content, while commercial tarhana samples were more uniform in terms of chemical properties and had lower fat content in order to reduce cost value. As a result, it is concluded that optimization of production method is quite difficult for traditional food products like tarhana. On the other hand, statistical analysis showed that means of domestic and commercial tarhana did not differ except fat content.

References

AACC, 1990. Approved Methods, 8th ed. *American Association of Cereal Chemists*, MN, USA.

Alnourih, F. F. and C. L. Duitschaever, 1974. The use of pure cultures for the preparation of kushuk. *Journal of Institution of Canadian Science and Technology Alimentary*, **7**: 228.

Anonymous, 1981. TS 2282 Tarhana Standardı. *The Institute of Turkish Standards*, Ankara, Turkey.

Bayrakçı, H. A. and Ç. Konak, 2011. The effect of *bilberry fruit* (*Vaccinium myrtillus* L.) on some chemical and sensory properties of tarhana. International Food Congress-Novel Approaches in Food Industry, Izmir, Turkey, May 26-29, pp. 423.

Bilgiçli, N., 2009. Effect of buckwheat flour on chemical and functional properties of tarhana. *Food Sci. Technol-LEB*, **42**: 514.

Bilgiçli, N. and S. Ibanoglu, 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.

Brand-Williams, W., M. E. Cuvelier and C. Berset, 1995. Use of a free radical method to evaluate antioxidant activity. *Food Sci. Technol-LEB*, **28**: 25.

Certel, M., M. Erbaş, M. K. Uslu and M. O. Erbaş, 2007. Effects of fermentation time and storage on the water soluble vitamin contents of tarhana. *J. Sci. Food Agr.*, **87**: 1215.

Çopur, Ö. U., D. Göçmen, C. E. Tamer and Ö. Gürbüz, 2001. Effect of different applications to product quality in tarhana production. *Gıda*, **26** (5): 339.

Daglioğlu, O., 2000. Tarhana as a traditional Turkish fermented cereal food, its recipe, production and composition. *Nahrung*, **44** (2): 85.

Dayısoğlu, K. S., Y. Gezginç, A. D. Duman and M. Didin, 2004.

Some properties of traditional Kahramanmaraş tarhana and functional importance in nutrition. Geleneksel Gıdalar Sempozyumu, Van, Turkey, September 23-24.

Ekinci, R., 2005. The effect of fermentation and drying on the water soluble vitamin content of tarhana, a traditional Turkish cereal food. *Food Chem.,* **90**: 127.

Erbaş, M., M. M. Certel and M. K. Uslu, 2005. Microbiological and chemical properties of tarhana during fermentation and storage as wet—sensorial properties of tarhana soup. *Food Sci. Technol-LEB*, **38**: 409.

Erbaş, M., M. K. Uslu, M. O. Erbaş and M. Certel, 2006. Effects of fermentation and storage on the organic and fatty acid contents of tarhana, a Turkish fermented cereal food. *J. Food Comp. Anal.*, **19**: 294.

Erkan, H., S. Çelik, B. Bilgi and H. Köksel, 2006. A new approach for the utilization of barley in food products: Barley tarhana. *Food Chem.*, **97**: 12.

Ertaş, N., D. Sert, M. K. Demir and A. Elgün, 2009. Effect of whey concentrate addition on the chemical, nutritional and sensory properties of tarhana (a Turkish fermented cereal-based food). *Food Sci. Technol.*, **15**: 51.

Esimek, H., 2010. Determination of dietary fiber and antioxidant properties of tarhana. MSc Thesis, *İnönü University, Malatya*, Turkey.

Etgü, H., B. Uçar, G. Özugur, S. Sivrioglu and M. Hayta, 2011. Effect of lupin flour addition on physical, chemical and sensory properties of gluten free tarhana. International Food Congress-Novel Approaches in Food Industry, Izmir, Turkey, May 26–29, p. 670.

Funda, E. G. and M. Kıvanc, 2009. Investigation of some chemical and microbiological properties of tarhana produced in our country. 2.Geleneksel Gıdalar Sempozyumu, May 27–29, Van, Turkey, 630.

Göçmen, D., O. Gürbüz and İ. Şahin, 2003. An investigation on ready to eat tarhana soup. *Gıda*, **28** (1): 13.

Gül, T., 2010. Evaluation of stale bread in tarhana production. MSc Thesis, *Erciyes University*, Kayseri, Turkey.

Gürbüz, O., D. Goçmen, N. Ozmen and F. Dağdelen, 2010. Effects of yeast, fermentation time and preservation methods on tarhana. *Prep. Biochem. Biotechn.,* **40**: 263.

Hafez, Y. S. and A. S. Hamada, 1984. Laboratory preparation of a new soy-based kishk. *J. Food Sci.*, **49**: 197.

Ibanoğlu, E., S. Ibanoğlu and P. Ainsworth, 1999. Effect of different ingredients on the fermentation activity in tarhana. *Food Chem.*, **64**: 103.

Ibanoğlu, S. and E. Ibanoğlu, 1999. Rheological properties of cooked tarhana, a cereal-based soup. *Food Res. Int.*, **32**: 29.

Ibanoğlu, S. and M. Maskan, 2001. Effect of cooking on drying characteristics of tarhana dough. *Gıda*, **26** (4): 271.

Ibanoğlu, S., P. Ainsworth, G. Wilson and G. D. Hayes, 1995. The effect of fermentation condition on the nutrients and acceptability of Tarhana. *Food Chem*., **53**: 143.

Kaya, C., R. Cangi, M. Yıldız and O. Saraçoğlu, 2009 Tokat grape tarhana. 2. Geleneksel Gıdalar Sempozyumu, Van, Turkey, May 27-29, p. 72.

Koca, A. F., F. Yazici and M. Anil, 2002. Utilization of soy yoghurt in tarhana production. *Eur. Food Res. Technol.*, **215**: 293.

Koca A.F., Koca İ., M. Anıl and B. Karadeniz, 2006. Physical, chemical and sensory properties of cranberry tarhana. Türkiye 9. Gıda Kongresi, Bolu, Turkey, May 24-26, 377.

Köse, E. and Ö. S. Çağındı, 2002. An investigation into the use of different flours in tarhana. *Int. J. Food Sci.Tech.*, **37**: 219.

Li, Y., C. Guo, J. Yang, J. Wei, J. Xu and S. Cheng, 2006. Evaluation of antioxidant properties of pomegranate peel extract in comparison with pomegranate pulp extract. *Food Chem.*, **96**: 254.

Mariod, A. A., R. M. Ibrahim, M. Ismail and N. Ismail, 2009. Antioxidant activity and phenolic content of phenolic rich fractions obtained from black cumin (*Nigella sativa*) seedcake. *Food Chem.*, **116**: 306.

PASW Statistics, 2009. PASW Statistics, 18. 2009. *SPSS Inc.*, Chicago, USA.

Popović, B. M., D. Štajner, K. Slavko and S. Sandra, 2012. Antioxidant capacity of cornelian cherry (*Cornus mas* L.) – Comparison between permanganate reducing antioxidant capacity and other antioxidant methods. *Food Chem.*, **134**: 734.

Salama, A. A., A. A. Damir and M. S. Mohamed, 1992. Effect of cooking on nutrients, microbial and sensory properties skimmed milk and rayeb kishk. *Acta Aliment. Hung*, **21** (1): 67.

Sengun, I. Y., D. S. Nielsen, M. Karapinar and M. Jakobsen, 2009. Identification of lactic acid bacteria isolated from Tarhana, a traditional Turkish fermented food. *Int. J. Food Microbiol.,* **135**: 105.

Singh, R. P., K. N. C. Murthy and G. K. Jayaprakasha, 2002. Studies on the antioxidant activity of pomegranate peel and seed extracts using in vitro models. *J. Agr. Food Chem.*, **50**: 81.

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

Tamer, C. E., A. Kumral, M. Aşan and İ. Şahin, 2007. Chemical compositions of traditional tarhana having different formulations. *J. Food Process. Pres.*, **31**: 116.

Tamime, A. Y., D. D. Muir, M. Khaskheli and M. N. I. Barclay, 2000. Effect of processing conditions and raw materials on the properties of khishk. I. Compositional and microbiological qualities. *Food Sci. Technol-LEB*, **33**: 444.

Tarakci, Z., I. S. Doğan and A. F. Koca, 2004. A traditional fermented Turkish soup, tarhana, formulated with corn flour and whey. *Int. J. Food Sci. Tech.*, 39: 455.

Tarakci, Z., M. Anil, I. Koca and A. Islam, 2011. 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.

Temiz, A. and T. Pirkul, 1990. Chemical and microbiological changes in tarhana fermentation. *Gıda*, **15** (2): 119.

Temiz, A. and T. Pirkul, 1991. Chemical and sensory properties of tarhana produced with different compositions. *Gıda*, **16** (1): 7.

Yılmaz, M. T., D. Sert and M. K. Demir, 2010. Rheological properties of tarhana soup enriched with whey concentrate as a function of concentration and temperature. *J. Texture Stud.,* **41**: 863.

Youssef, M. M., 1990. Instantization and evaluation of some traditional Egyptian foods. *Food Chem.*, **38**: 247.

Yücecan, S., K. Kayakırılmaz, S. Başoğlu and M. Tayfur, 1988. An investigation on nutritional value of tarhana *Turk Hij. Deney. Biyol. Derg.*, **45**: 47.

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