Akademik Gıda 8 (3) (2010) 11-17

Research Paper / Araştırma Makalesi

Chemical, Rheological and Sensory Properties of Tarhana with Wheat Bran as a Functional Constituent

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ABSTRACT

Tarhana is a fermented food widely consumed in Turkey and the Middle East. Addition of wheat bran as a source of dietary fiber to tarhana contributes to the development of value-added functional foods. In this study, wheat flour was partially (20 and 40%) substituted with wheat bran, and chemical, rheological and sensory properties of tarhana soups were determined. All tarhana dough samples had similar pH values (about 3.8) after six days of fermentation. The substitution of wheat flour with wheat bran in tarhana formulation at a 40% level significantly increased the crude fiber contents of tarhana powders from about 0.6 to 4.3% on dry basis. Flow behavior indices of tarhana samples ranged from 0.45 to 0.65, indicating that all tarhana soup samples exhibited pseudoplastic behavior over the temperatures studied. Lower flow behavior indices were found for tarhanas with wheat bran than control tarhanas. Panelists equally liked tarhana soups with wheat bran substituting 20% of flour and control tarhana soups, while disliking tarhana soups with wheat bran substituting 40% of flour in formulation. Results indicated that wheat bran can be added to tarhana as a source of dietary fiber to develop a functional food; however, consumer acceptability is a key factor restricting the amount of wheat bran in formulation.

Key Words: Tarhana, Wheat bran, Fiber, Functional food

Fonksiyonel Bir Bileşen Olarak Buğday Kepeği İçeren Tarhana'nın Kimyasal, Reolojik ve Duyusal Özellikleri

ÖZET

Tarhana Türkiye ve Orta Doğu'da yaygın olarak tüketilen fermente bir gıdadır. Buğday kepeğinin diyet lifi olarak tarhanaya ilavesi katma değeri yüksek fonksiyonel gıdaların geliştirilmesine katkıda bulunabilir. Bu çalışmada buğday unu kısmen buğday kepeği ile (%20 ve 40 oranında) ikame edilmiş ve tarhana çorbalarının kimyasal, reolojik ve duyusal özellikleri araştırılmıştır. Altı gün fermantasyonu sonrasında tarhana hamur örneklerinin pH değerleri benzer bulunmuştur (yaklaşık 3.8). Tarhana formülasyonundaki buğday ununun kepekle %40 oranında ikame edilmesi toz tarhana örneklerinin ham lif içeriğini kuru madde bazında %0.6'dan 4.3'e yükseltmiştir. Tarhana örneklerinin akış davranış indeks değerleri 0.45-0.65 aralığında bulunmuş olup, tarhana çorbalarının çalışılan sıcaklıklarda psödoplastik davranış gösterdiği anlamına gelmektedir. Kontrol örnekleriyle kıyaslandığında, buğday kepekli tarhanaların akış davranış indeksleri daha düşük bulunmuştur. Panelistler kontrol ve %20 buğday kepeği ikameli çorbaları eşit şekilde beğenmişler, ancak formülasyonda %40 kepek içeren tarhanayı beğenmemişlerdir. Çalışma sonuçları buğday kepeğinin fonksiyonel bir gıda geliştirmek amacıyla diyet kaynağı olarak tarhanaya ilave edilebileceğini, fakat tüketici kabul edilebilirliğinin formülasyondaki buğday kepeği miktarını sınırlandırmada önemli bir faktör olduğunu göstermiştir.

Anahtar Kelimeler: Tarhana, Buğday kepeği, Lif, Fonksiyonel gıda

INTRODUCTION

Tarhana is a traditional fermented food, and it is consumed by a wide range of population in Turkey. It is fermented for 1-7 days after yoghurt and wheat flour are mixed with yeast and a variety of raw vegetables such as tomatoes, onions, and paprika, and spices like salt and mint. Although tarhana preparation methods may vary from one region to another [1], flour and yoghurt are usually the two major components of tarhana. While the former plays a significant role in the texture formation of the soup, the latter is important mostly for the development of tarhana flavor during fermentation. Fermentation activity in early stages of tarhana fermentation is usually high, and excluding salt from the formulation increases fermentation activity [2]. Chemical [3] and rheological [4] properties of traditional tarhana soup have been previously reported in the literature, and these properties are important for both nutritional quality and commercial production of tarhana. The effect of barley flour, which is high in β-glucan content, on chemical and sensory properties of tarhana was studied by Erkan et al. [5].

Fiber is important for human digestive tract to maintain healthy bowel function. Dietary fiber is defined as "a class of compounds, mainly carbohydrate, polysaccharide in nature but also including lignin, which when ingested in the form of plant material, escapes hydrolysis, digestion and absorption in the small intestine of the human" [6]. Recommended daily fiber intake ranges from 20 to 35g/day for normal gastrointestinal activity, depending on the nutritional status of people, and should come from various sources such as leafy vegetables, legumes, cereals, and fruits [7, 8]. About 3g/day of soluble fiber from oat products may help to reduce the hearth disease mortality by lowering total plasma cholesterol level [9]. A diet high in fiber can also relieve or prevent some of the bowel disorders such as diverticulosis [10], constipation and hemorrhoids [11].

Wheat bran, a by-product of wheat milling industry, is a good source of dietary fiber. Wheat bran contents include 46% non-starch polysaccharides [12], 10-20% starch, 15-22% proteins, 4-8% lignin and some minor constituents [13]. In animals, wheat bran was shown to have protective activity against colon cancer induced by 1,2-dimethylhydrazine [14, 15] and azoxymethane [16], and against breast cancer [17, 18]. Cancer protective activity of wheat bran has been associated with its non-nutrient phytochemicals [19]. Colon cancer protective activity for wheat bran was reported to be higher than cellulose [20]. Wheat bran extracts were able to inhibit lipid peroxidation in low density lipoproteins by scavenging free radicals, and this property may reduce the risk of atherosclerosis for humans [21].

Flour tarhana is one of the four major tarhanas defined by Turkish Standardization Institute [22]. Although the fiber content of tarhana depends on the type of ingredients used in its formulation, average fiber content of various tarhanas from different regions of Turkey is 1.0% [3]. The reason is most likely that tarhana is traditionally and commercially produced with white, unenriched and bleached flour in Turkey, and this type of flour is usually low in dietary fiber. Addition of dietary fiber or a source of dietary fiber to tarhana, a soup consumed mostly throughout winter by a wide range of population in Turkey, will contribute to the development of value-added functional foods that currently are in high demand. Studying the rheological properties of this type of tarhanas is essential for determining equipment design parameters for the commercial production of tarhana. Therefore, the objectives of this present study were to enrich tarhana with wheat bran as a source of dietary fiber, and to determine chemical, rheological and sensory properties of tarhana soups with or without wheat bran.

MATERIALS and METHODS

Materials

White flour (unenriched and bleached) and wheat bran were obtained from Denizli Flour Company (Denizli). Non-fat yoghurt (SEK, Istanbul), bakery yeast (Ozmaya Yeast Company, Adana) and all other ingredients used in tarhana formulations were purchased from a local market in Denizli, Turkey.

Preparation of Tarhana Powder

Three different formulations were used to prepare tarhana: (1) control without any wheat bran (Control), (2) tarhana with wheat bran substituting 20% of flour (TF20) and (3) tarhana with wheat bran substituting 40% of flour in the formulation (TF40) (Table 1).

Table 1. Formulations for the production of traditional tarhana and tarhana with wheat bran as a dietary fiber source.

Soup Sample	Ingredient (% weight basis)		
	Control	TF20	TF40
Flour	59.7	47.8	35.8
Wheat Bran	-	11.9	23.9
Yoghurt	17.9	17.9	17.9
Fresh tomato puree	12.0	12.0	12.0
Fresh paprika puree	6.0	6.0	6.0
Fresh onion puree	1.4	1.4	1.4
Dry mint powder	1.2	1.2	1.2
Salt	1.2	1.2	1.2
Yeast	0.6	0.6	0.6

Prior to mixing the ingredients, fresh onions, tomatoes and paprika were chopped in a commercial blender (Arzum Ultima, Istanbul, Turkey) for 45s at a medium speed. Chopped tomatoes, paprika and onion were mixed with non-fat yoghurt, dried mint, salt, yeast and flour (one fifth of the initial weight in the formula). Then, the dough was transferred into plastic containers, and it was allowed to ferment at 30±2°C for a day. While two fifth of flour was added to dough on the 2nd and 3rd days of fermentation, the rest was added on the 4th day of fermentation. In tarhanas with wheat bran, flour was uniformly mixed with wheat bran, and then this flour-wheat bran mixture was added to the respective formulations. Wheat bran, like other dietary fiber sources, absorbs water easily; for example, wheat bran addition into bread dough increases water absorption rate of dough [23]. We observed that wheat bran together with flour absorbed most of the water in tarhana dough system, and tarhana mixtures with wheat bran were unable to form a dough structure. To alleviate this problem, 11.9% and 23.9% water (v/w) were incorporated into the TF20 and TF40 formulations, respectively. Half of total water was added to tarhana dough on the 2nd day, the other half on the 3rd day of fermentation. At the end of the 7th day of fermentation, tarhana dough (height≅0.5cm) was rolled into a sheet, and it was cut into small pieces (width≅0.5cm). Pieces of tarhana dough were open-air dried at 30±2°C for 72h. Then, samples were ground with a grinder (Toper TKS-16S, Izmir, Turkey) to a particle size of <400μm for further analysis. Three replications (n=3) were used for each tarhana powder sample.

Preparation of Tarhana Soup

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

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

Analytical Measurements

Dry matter, ash, and protein content of tarhana powders were determined according to AOAC [24] procedures. The micro-Kjeldahl method was used to determine nitrogen content of tarhana powders, and the results were multiplied by a factor (5.70) to determine crude protein content [24]. Crude fiber analysis was performed according to Elgun et al. [25].

Specific gravity of tarhana soups with different formulations was determined according to Lee and Hoseney [26] at room temperature. pH of tarhana-water mixtures were measured using a pH meter at about 50°C. Color values (Hunter *L*, *a* and *b*) were determined by the Hunter-Lab Mini Scan XE colorimeter (Reston, VA, USA) [27].

Consistency coefficients (K) and flow behavior indices (n) of tarhana soups with different ingredients were determined by a Brookfield Programmable DV-II+ viscometer (Brookfield Eng. Labs. Inc., Stoughton, MA, USA). Briefly, hot soup samples were poured into 600mL-insulated-beakers, and they were allowed to cool down at room temperature. Temperature measurements (±1) were taken by a thermocouple attached to the viscometer. Then, K and n values for each soup sample determined at 35, 40, 50, 60 and 70°C with a spindle number 2. In order to determine the flow behavior characteristics of tarhana soups, the power-law model $\delta = K(\dot{\gamma})^n$, where δ is the shear stress (Pa), $\dot{\gamma}$ is the shear rate (s^{-1}), K is the consistency coefficient ($Pa.s^n$) and n is the flow behavior index (dimensionless), was used [28].

Sensory Evaluation

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

Statistical Analyses

Data were analyzed using the Statistical Analysis System software [29]. PROC GLM with Duncan's multiple comparison test was performed to determine significant differences at α= 0.05.

RESULTS and DISCUSSION

The pH values of tarhana dough were monitored after first, second, third and sixth days of fermentation (Figure 1). One day fermentation reduced the pH values of all tarhana dough samples to about 4.4. After the sixth day of fermentation, pH of dough samples was about 3.8. Tarhana soup is made by fermented and dried tarhana dough, and it has acidic and sour taste with a yeasty flavor [4]. Production of acids by lactic acid bacteria of yoghurt and bakery yeast in the formulation during fermentation is the main reason of pH reduction in tarhana dough samples [2]. The use of yoghurt (source of lactic acid bacteria) together with yeast plays an important role in developing distinctive tarhana taste and flavor [1]. The pH of soups may be reduced with increasing the amount of yoghurt or excluding salt in formulations [2]. In our study, we found that pH values of tarhana dough samples with or without wheat bran were similar after the fermentation of dough for six days (p>0.05).

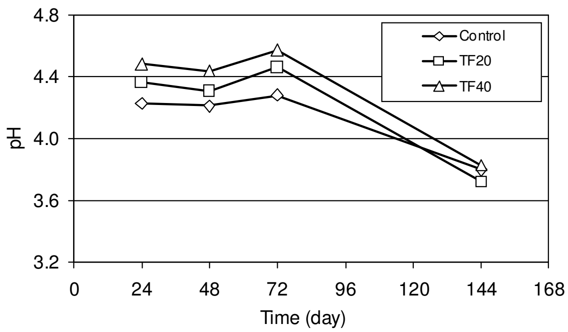

Figure 1. The effect of fermentation time on pH of tarhana dough samples prepared with or without wheat bran (means of three replicates for each time).

The analyses for fermented and dried tarhana powder samples showed that TF40 powder retained more moisture than control tarhana (Table 2) (p<0.05). Moisture content of tarhana powder samples ranged from 6.2 to 7.2%, and it was slightly lower that average moisture content (10%) of tarhanas from different regions of Turkey [3]. Water absorption rate can be increased by the addition of wheat bran into bread dough systems, and this rate is correlated with the bran particle size [23]. In our samples, we used wheat bran with a particle size higher than 0.6mm. Considering the fact that coarse bran (about 0.6mm in particle size) retains significantly more water than medium (about 0.4mm) or fine bran (0.3mm) [23], we can conclude that wheat bran in TF40 dough absorbed more water during fermentation than control and retained more after drying. Another reason for higher moisture content of TF40 can be the addition of water for the purpose of developing dough structure during six day fermentation period.

Significant differences in protein, ash and crude fiber contents were found among tarhana powder samples with or without wheat bran (Table 2). Ash content of tarhanas had a trend similar to crude fiber content because the amount of wheat bran in formulation contributes to the ash content of tarhanas. On dry basis, crude fiber contents of TF20 and TF40 were about 2.0 and 4.3%, respectively. Protein content of tarhana powder TF40 was about 17% (db), and it was higher than control tarhana powder (15%, db) (p<0.05). This is because wheat bran contains proteins as well as starch, moisture, ash and some phytochemicals [30, 31]. Average protein and ash contents of various tarhana samples from different regions of Turkey were 16.0% and 1.0%, respectively [3].

Table 2. The effect of wheat bran addition to tarhana formulations on some physical and compositional properties of tarhana powder and soup samples.

Tarhana	Moisture (%)	Ash (%)	Protein (%, db)	Crude Fiber (%, db)	Specific Gravity**	pH**	Hunter *Lab* Values**		
							L	*a*	*b*
Control	6.18±0.20b*	1.73±0.31c	15.08±0.08b	0.57±0.17c	1.05±0.01	4.37±0.1b	58.18±1.07a	4.44±0.60	14.22±0.59a
TF20	6.60±0.36ab	2.38±0.25b	16.20±0.31ab	1.99±0.48b	1.04±0.01	6.21±0.5a	46.74±2.86b	4.31±0.20	12.45±0.54b
TF40	7.17±0.53a	3.42±0.13a	16.96±1.22a	4.25±0.26a	1.05±0.01	6.74±0.1a	36.66±1.29c	4.06±0.05	10.74±0.10c

* Different letters within the column across the table show significant differences at α=0.05.
** These properties were measured in tarhana soups described in the text.

High dietary fiber intake can relieve or prevent some of the bowel disorders such as diverticulosis [10], constipation and hemorrhoids [11]. Harris and Ferguson [44] reported that wheat bran dietary fiber may be protective against colorectal cancer. The authors also indicated that studies on animals pointed out that "sources of insoluble dietary fibers, including wheat bran, appear more protective than soluble dietary fibers, and some dietary fibers appear to enhance carcinogenesis." On the other hand, dietary fiber intake higher than recommended levels may cause problems besides benefits. The stool becomes difficult to eliminate when diet is very high in fiber. If water is not enough, intestines can be blocked by high amounts of fiber [32]. Gas production due to the fermentation of high amounts of fiber in diet by intestinal microflora causes discomfort. Reduction in nutrient absorption can be another problem related to high fiber intake in diet [11] even though inhibition of mineral absorption by dietary fibers through chelating has lack of strong data [33]. In the present study, tarhana soup supplemented with wheat bran (TF20) cannot provide the majority of daily fiber intake but only contributes to the recommended daily fiber intake. The contribution of wheat bran to the daily fiber intake is expected to be about 10% of recommended daily intake.

Soup samples prepared with tarhana powder (TF20 or TF40) and water had a similar pH; however, pH of control tarhana soup was significantly lower than the others (p<0.05). Deionized water used to prepare tarhana soup had a pH around 6.8. Hydrogen bonding with water in starch molecules occurs among hydroxyl groups of neighboring sugar molecules or the ring oxygen atoms or the glycosidic oxygen atoms connecting one sugar ring to another [34]. In control tarhana samples, wheat flour consisting of mainly starch was the major ingredient. From the design of experiments, it should be inferred that starch contents of tarhana samples TF20 and TF40 were lower than control. The number of sugar units in a polysaccharide chain is positively correlated with the water holding capacity since hydration of polysaccharides occurs easily in the presence of water [34]. Hydrogen ions in deionized water, which were not able to be neutralized by starch molecules in tarhana samples with wheat bran, were most likely to be the reason for higher pH in tarhana soup samples than control.

In terms of soup color, addition of wheat bran into tarhana significantly effected the color of tarhana soup, especially lightness (*L*) and yellow-blue (*b*) values ($p<0.05$). Increasing the wheat bran amount added to formulation significantly reduced those two color values of tarhana soup samples, while the change in red-green (*a*) value was insignificant. When the amount of wheat bran in formulation was increased, the color of tarhana soup became darker, and lost its yellow color. The reason for a darker soup color is most likely from the lignin content of wheat bran. Lignin, which is responsible for the yellow-brown color of wood at 400- 700nm [35], constitutes to 4-8% of total wheat bran weight [13]. Pigments in carotenoid and flavone nature and other constituents are responsible for the yellow color of wheat flour. Reducing wheat flour in tarhana formulations with wheat bran significantly reduced the yellow color values of tarhana soups (*b*), causing the formation of darker soups ($p<0.05$).

Tarhana soup with or without wheat bran exhibited pseudoplastic behavior at a temperature range from 35° to 70℃ (Table 3). Flow behavior indices for tarhanas prepared with wheat bran were usually lower than those for control samples. Erbas et al. [36] reported that tarhana soup exhibited pseudoplastic behavior ($n=0.396$). Studying the effect of different drying methods on the functional properties of tarhana, Hayta et al. [37] found that drying methods such as microwave-, free- and tunnel-drying of tarhana dough influenced the K and n values of tarhana soups, and tarhana soups exhibited pseudoplastic behavior at different temperatures. Ibanoglu and Ibanoglu [4] reported that consistency coefficient and flow behavior index of tarhana soups were dependent on the type of flour in formulation and the particle size of tarhana powder. Flow behavior indices of tarhana soups prepared with white wheat flour were foundlower than those prepared with wholemeal flour. The authors also reported that n values were unaffected by temperature but increased as the particle size of tarhana powder increased. In our study, we found that K and n values for tarhana soups with or without wheat bran changed over the temperature studied. At high temperatures, especially at 70C°, K and n values for control and TF20 soup samples were significantly different than those at 35℃ ($p<0.05$). For those samples, low K values at high temperatures are the indicators of low apparent viscosities because, according to power-law equation, apparent viscosity is positively correlated with consistency coefficient [28]. In tarhana soups high in wheat bran, differences in apparent viscosities became less clear over the temperatures studied.

Table 3. Effect of temperature and wheat bran addition on consistency coefficients (*K*) and flow behavior indices (*n*) of tarhana soups.

Temperature (℃)	Control*		TF20		TF40	
	K (Pa.s^n)	*n*	*K* (Pa.s^n)	*n*	*K* (Pa.s^n)	*n*
35	11.99±1.19a**	0.51±0.03b	10.86±1.22a	0.47±0.02b	6.41±1.04ab	0.52±0.02ab
40	9.60±2.39a	0.55±0.04ab	10.93±0.35a	0.45±0.03b	6.19±0.26ab	0.49±0.01ab
50	9.01±2.68a	0.55±0.05ab	10.20±1.55a	0.45±0.01b	7.49±0.47a	0.45±0.01ab
60	8.48±0.65ab	0.52±0.03b	6.45±1.36b	0.50±0.02b	6.42±0.07a	0.46±0.04b
70	4.70±0.84b	0.65±0.07a	3.74±1.86b	0.62±0.10a	4.52±1.01b	0.51±0.07a

*Results are means of three replicates at each temperature (r^2 ranged from 0.96 to 0.99).
** Different letters within the column across the table show significant differences at $\alpha=0.05$.

Sensory evaluation results of tarhana soups indicated that differences in overall, smell, consistency, taste and aftertaste liking scores for control and TF20 tarhana soups were insignificant ($p>0.05$) (Table 4). The sensory panel resulted in that tarhana soups with wheat bran substituting 40% of flour in the formulation were not liked by the subjects. Liking scores for soup color reduced significantly from about 6 to 3 as the wheat bran concentration increased in tarhana dough formulation ($p<0.05$). A number of panelists reported that TF40 had a layer of vegetable oil on the top of soup samples served. This was most likely from the insufficient gel formation because starch content in those samples was lower than control or TF20 tarhanas. The layer of vegetable oil on soups might affect the color perception of judges for those tarhanas. Another reason of the low scores for TF40 color might be that wheat bran in formulation was more likely to constitute to the brown color of soups because of its lignin and lignin like constituents [13]. Addition of wheat bran to toast breads [38] and beef burgers [39] as a source of dietary fiber has been found to improve sensory and nutritional properties of these foods. In a study by Bilgiçli et al. [40], substitution ratios of 10, 25 and 50% for wheat germ or bran on the wheat flour basis were used to improve nutritional status of tarhana, and sensory evaluation of soup samples with seven subjects who are familiar with this type of traditional soup showed that 25% wheat bran substituted tarhana soup was the most liked by sensory panelists. In our study, we also found that wheat bran could be added to tarhana to produce a value-added food product which is both traditional and functional. However, the results of our study indicated that substituting more than 20% of wheat flour in formulation by wheat bran was ineffective for producing tarhanas with wheat bran that are acceptable by consumers.

Table 4. The results for the sensory evaluation of tarhana soups with or without wheat bran.

Tarhana Sample	Sensory Characteristic*					
	Smell	Color	Consistency	Taste	Aftertaste	Overall
Control	5.2a**	6.3a	6.3a	6.3a	6.2a	6.1a
TF20	4.7a	4.7b	5.6ab	5.1a	4.9ab	4.9ab
TF40	3.4b	3.3c	4.7b	3.6b	3.9b	3.7b

*Scale of 1 (dislike extremely) to 9 (like extremely).
** Different letters within the column across the table show significant differences at α=0.05.

Wheat bran is not a dietary fiber per se, but a good source of dietary fiber. Major components of dietary fiber include cellulose and lignin, and its minor components such as hemicelluloses, pectin, gums and other carbohydrates are not digestible by human digestive tract [41]. Wheat bran crude fiber content is about 10% (db), while wheat flour crude fiber content is usually less than 1% (db) [42]. Bran total dietary fiber content ranges from 3 to 7g/100g [43]. In our study, we demonstrated that crude fiber content of tarhana, thus its dietary fiber content, could be increased by the addition of wheat bran into formulation or by the substitution of wheat flour in formulation with wheat bran. However, consumer acceptability for tarhana with wheat bran restricts the amount of wheat bran added or the amount of wheat flour substituted in formulation.

CONCLUSION

Tarhana dough samples with or without wheat bran had pH values similar after the fermentation of dough for six days (p>0.05). Crude fiber contents of tarhana powders produced from fermented and dried dough samples increased by the substitution of wheat flour with wheat bran. The effects of wheat bran addition into tarhana formulation on *L* and *b* color values were significant. Reducing wheat flour in tarhana formulations with wheat bran significantly reduced the yellow color values of tarhana soups, causing the formation of darker soups. Tarhana soup with or without wheat bran exhibited pseudoplastic behavior over the temperatures studied. Flow behavior indices for tarhanas prepared with wheat bran were usually lower than those for control samples. The temperature significantly affected the K and n values of tarhana soups. Sensory evaluation results of tarhana soups indicated that control and TF20 tarhana soups were liked similarly; however, tarhana soups with wheat bran substituting 40% of flour in formulation were disliked by the subjects. The results indicated that consumer acceptability is a restricting factor for the amount of wheat bran added or the amount of wheat flour substituted in tarhana formulation.

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