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EFFECTS OF BAKER'S YEAST ADDITION ON SOME PROPERTIES AND PHYTIC ACID CONTENT OF TARHANA PREPARED WITH DIFFERENT CEREAL AND LEGUME PRODUCTS

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Abstract:

Fermentation is an important process for improvement of functional properties of food product. It is also one of the most effective methods for reducing phytic acid content. Tarhana production contains 7 day fermentation by yoghurt bacteria with and without bakers' yeast. In this study, wheat flour used in tarhana preparation was replaced with different cereal flours (barley, rye and oat), legume flours (chickpea, common bean and lentil) and cereal bran (rye, oat and barley) at 50%, 50% and 25% levels, respectively. All types of flour and bran addition increased the ash and mineral content compared to the control, and the highest ash, calcium, iron, magnesium and zinc content was determined with rye flour addition. After fermentation process, the lowest phytic acid content was found with 50 % barley flour addition. The mean of phytic acid loss after fermentation changed between 90.91% and 94.31% and the lowest phytic acid losses were found with oat and rye bran addition. Tarhana samples produced with yeast had higher mean values for mineral matter, total phenolic content and antioxidant capacity on the other hand gave less appreciation by the panelists. According to general acceptability; the most popular tarhana samples after control was rye flour tarhana sample.

Keywords: Tarhana, Cereal, Legume, Flour, Bran, Phytic acid, Mineral

Introduction

Traditional food is gaining popularity in recent years, due to the depending on changes in consumers' lifestyles, new flavours, new products, safe food, less processed food and foods contain less additives that consumer demand at the national and international market. Tarhana is the traditional soup consumed in Turkey.

Tarhana is fermented cereal product that contains generally wheat flour, yoghurt, different vegetables and spices. Also, tarhana is a suitable product for enrichment, for this reason buckwheat (Bilgiçli, 2009), barley flour (Erkan et al., 2006), steel-cut oats and oat flour (Kilci and Goçmen, 2014a, 2014b, Değirmencioğlu et al., 2016), soy bean (Öner et al., 1993), chickpea and lentil (Özbilgin, 1983) rye, maize and soy bean flour (Köse and Çağındı, 2002), wheat germ/bran (Bilgiçli and Ibanoglu, 2007) oat bran and chelating agents (Ekholm et al., 2003), wheat bran (Çelik et al. 2010), ground tench flesh (Erdem et al., 2014), phytase sources (Bilgiçli et al., 2006), soy yoghurt (Koca et al., 2002), whey concentrates (Ertaş et al., 2009), lupin yoghurt (Ertaş et al., 2014), tomato seed (Işık and Yapar 2017), cherry laurel (Temiz and Tarakçı, 2017), baker's yeast (Çelik et al., 2005) and rose hip (Levent et al., 2013) have been used in tarhana production.

Phytic acid, commonly found in cereals and legumes forms insoluble complexes with many minerals which necessary for the body at physiological pH, and reduces their bioavailability. In reducing the amount of phytic acid; many physical, chemical and biochemical methods such as grinding, fermentation, cooking under pressure, germination, soaking and the addition of phytase enzyme can be used (Liang et al., 2008). A method or combination of several different methods may be possible for use depending on structure and manufacturing process of each product.

Fermentation develops the nutritional and sensory characteristics of the food and also it reduces the amount of phytic acid. In fermented cereal products, phytase enzyme from microorganisms in natural flora of flour and/or bakers' yeast provide the breakdown of phytic acid. Moreover decreasing the acidity of the medium increases phytic acid breakdown during fermentation (Lopez et al., 1983).

The aim of this study was to determine the effect of phytic acid rich materials and baker's yeast on some quality properties and phytic acid content of tarhana.

Materials and Methods

Materials

Commercial white wheat flour with a crude protein content of 12.52 % (Nx5.7, w/w, dry basis) was used in tarhana production. Commercial full-fat (8.43 %) strained yoghurt (with 7.87% protein) made of cow's milk was used to prepare tarhana. Bakers' yeast (*Saccharomyces cerevisiae*, press form), onions, tomato paste (22% total dry solids), red pepper (powder form) and salt were purchased from local markets in Konya, Turkey. Before use, onion was peeled and chopped finely. Cereal flours (barley, rye and oat), legume flours (chickpea, common bean and lentil) and cereal bran (rye, oat and barley) were obtained Saglık Agriculture Mill in Konya, Turkey.

Preparation of tarhana samples

Tarhana samples prepared at laboratory conditions with the formula contained; wheat flour (400g), yoghurt (160g), tomato paste (40g), chopped onions (20g), red pepper (8g), table salt (4g) and with and without bakers' yeast (10g). These ingredients were mixed with 100 ml distilled water using a KitchenAid mixer for 5 min at the highest speed. Twenty different tarhana formulations with two replication were prepared (Table 1). Flours of cereal (oat, rye and barley), and legume flours (chickpea, common bean and lentil) were replaced with wheat flour at the level of 50% (w/w), brans of cereals (oat, rye and barley) were replaced with wheat flour at the level of 25% (w/w). And also tarhana samples were prepared with (2.5%) and without bakers' yeast. After mixing, the tarhana dough was incubated at 30 ˚C for 72 h, and the fermented dough samples were dried at 55 ˚C for 48 h in drier (Nüve FN- 500). The dried tarhana dough samples were ground into granulated form in a hammer mill equipped with 1 mm opening screen.

Colour measurement

Dried and ground tarhana samples were used to determine to colour properties. Konica Minolta Chroma Meter (Model CR-400, Konica Minolta Sensing, Inc., Osaka, Japan) was used to measure colour properties. Colour of the samples was evaluated by measuring the L* a* and b* values with illuminate D63 as reference. From a* and b* values, the hue angle ($\tan^{-1} b^*/a^*$) and saturation index ($(a^{*2}+b^{*2})^{1/2}$) were calculated. Triplicate readings were taken from each tarhana sample.

Analytical methods

The moisture content (AACC method 44-12) and ash content (AACC method 08-01) were determined according to standart methods (AACC, 1990).

Nutritional analysis

Phytic acid content was measured by a colorimetric method according to Haugh and Lantzsch (1983) at 72 hours of tarhana fermentation. A standard curve was prepared using sodium phytate solution. Determinations were conducted in triplicate. The phytic acid loss as percentage during fermentation was calculated by the following formula.

$$\text{Phytic acid Loss (\%)} = \frac{(\text{Amount of phytic acid in tarhana dough initially} - \text{Amount of phytic acid in tarhana after fermentation})}{\text{Amount of phytic acid in tarhana dough initially}} x\ 100 \quad (1)$$

Table 1. Experimental design of tarhana samples

Bakers' Yeast (%)	Flour Blends
0	Wheat flour (Control)
	Oat flour (%50)
	Rye flour (%50)
	Barley flour (%50)
	Chickpea flour (%50)
	Common bean flour (%50)
	Lentil flour (%50)
	Oat bran (%25)
	Rye bran (%25)
	Barley bran (%25)
2.5	Wheat flour (Control)
	Oat flour (%50)
	Rye flour (%50)
	Barley flour (%50)
	Chickpea flour (%50)
	Common bean flour (%50)
	Lentil flour (%50)
	Oat bran (%25)
	Rye bran (%25)
	Barley bran (%25)

Results and Discussion

The statistical significance levels of factors in this study were given in Table 2. According to the table of variance analysis, while bakers' yeast came out to be significant for phytic acid content, phytic acid loss, total phenolic content, antioxidant capacity, all minerals, taste and overall acceptability scores, flour blend came out to be significant for all parameters except odor scores.

Colour properties

Colour properties of tarhana samples are given in Table 3. The L* value gives a measure of the lightness of the product colour. The redness and yellowness are denoted by a* and b* values, respectively. L*, a*, b* saturation index and hue angle values did not change according to bakers' yeast addition. The effect of different cereal and legume flours and brans on colour properties of tarhana were significantly different ($p<0.05$). The measured values of the colour parameters of tarhana samples varied in as ranged between 67.59 and 74.43 for lightness,4.57 to 9.82 for redness, 25.67 to 32.63 for yellowness, 26.08 to 33.81 for saturation index and 73.11 to 79.89 for hue angle. Rye flour addition in to the tarhana formulation gave the lowest redness, yellowness and saturation index and the highest hue angle values. Bilgiçli (2009) stated that L* and b* values of tarhana decreased and redness values increased with increasing buckwheat addition. Esimek (2010) reported colour values of which commercial tarhana and collected from different locations in Turkey were determined as ranging between 60.6 - 85.6 for L*, 0.0 - 19.2 for a*, and 7.3 - 30.4 for yellowness. Similar results have been reported by Erkan *et al.*. (2006) with wheat and barley flour tarhana. Also Bilgiçli and İbanoğlu (2007) determined the lightness values decreased and redness and yellowness values increased with wheat germ and wheat bran addition in tarhana according to control sample.

Chemical properties

Crude ash and mineral content of tarhana samples were given in Table 4. Addition of bakers' yeast in tarhana formulation did not significant effect (p>0.05) on the ash content of tarhana samples. The highest ash content was obtained with rye flour substituted tarhana, and the lowest ash content was found in control tarhana. Tarhana containing cereal bran had lower ash content than that of containing legume flour due to low level use of bran (25%) according to legume flour (50%).

Table 2. Statistical Significance level

	L *	a*	b*	Saturation index	Hue angle	Phytic acid content	Phytic acid loss	Total phenolic content	Antioxidant capacity (DPPH)
Bakers' yeast addition (A)	**ns**	**ns**	**ns**	**ns**	**Ns**	**	**	**	**
Flour blend (B)	**	**	**	**	**	**	**	**	**
AxB	**	**	**ns**	**ns**	**	**ns**	**ns**	**	**

	Crude ash	Calcium	Iron	Potassium	Magnesium	Phosphorus	Zinc
Bakers' yeast addition (A)	**Ns**	**	**	**	**	**	*
Flour blend (B)	**	**	**	**	**	**	**
AxB	**	**	**	**	**	**	**

	Taste	Odor	Colour	Grittiness	Sourness	Overall Acceptability
Bakers' yeast addition (A)	**	**ns**	**ns**	**ns**	**ns**	*
Flour blend (B)	**	**ns**	**	**	*	**
AxB	**Ns**	**ns**	**ns**	**ns**	**ns**	**ns**

ns: (p > 0.05), *: (p < 0.05), **: (p < 0.01)

Table 3. Colour values of tarhana samples substituted with phytic acid rich flours[1]

	Colour values				
	L*	a*	b*	Saturation index	Hue angle
Bakers' yeast (%0)	71.72 A	7.62 A	30.30 A	31.27 A	76.05 A
Bakers' yeast (%2.5)	71.28 A	7.92 A	30.29 A	31.32 A	75.46 A
Wheat flour	74.43 [a]	8.53 [bc]	32.63 [a]	33.73 [a]	75.34 [de]
Oat flour	70.60 [cd]	6.27 [d]	27.33 [d]	28.04 [e]	77.08 [bc]
Rye lour	70.92 [cd]	4.57 [e]	25.67 [e]	26.08 [f]	79.89 [a]
Barley flour	72.77 [abc]	6.30 [d]	27.63 [d]	28.34 [e]	77.17 [b]
Chickpea flour	70.32 [d]	9.08 [ab]	31.75 [ab]	33.02 [ab]	74.04 [ef]
Common bean flour	67.59 [e]	9.31 [ab]	32.13 [a]	33.46 [ab]	73.83 [f]
Lentil flour	70.29 [d]	9.82 [a]	32.35 [a]	33.81 [a]	73.11 f
Oat bran	71.86 [bcd]	7.90 [c]	30.72 [c]	31.72 [d]	75.62 [cd]
Rye bran	72.07 [abcd]	8.10 [c]	31.03 [bc]	32.07 [cd]	75.38 [de]
Barley bran	74.18 [ab]	7.84 [c]	31.73 [ab]	32.69 [bc]	76.12 [bcd]

[1] Means with different superscripts in the same column are significantly different.

Minerals play a pivotal role in many functions such as bone health, blood pressure, healthy teeth, cell protection, heart rate, muscle function in the body. Tarhana is rich in minerals with its ingredients used in production like as calcium from yogurt, iron from wheat flour, magnesium from tomato paste and chili, zinc from yeast, and potassium from tomato paste, red pepper, yeast and onion (Bilgiçli *et al.,* 2006).

In this research, addition of bakers' yeast had significant effect on the calcium, iron, potassium magnesium, phosphorus ($p<0.01$) and zinc contents ($p<0.05$) of the samples and different cereal and legume flours and brans had significant effect ($p<0.01$) on the calcium, iron, potassium, magnesium, phosphorus and zinc contents of the samples. Calcium, iron and potassium contents in tarhana samples were determined as mg/100 g; 58.98 - 214.09; 2.84 - 16.14; 399.82 - 940.79. Addition of yeast in tarhana formulation resulted an increase in calcium, iron and potassium contents in tarhana samples. The highest calcium, iron and potassium contents were found in tarhana samples containing 50% rye flour (214.09 mg/100g), 50% rye flour (16.14 mg/100g) and 50% common bean flour (940.79 mg/100g), respectively. As previously mentioned, partially lower mineral content of tarhana containing cereal bran than legume flours due mainly to low level use of bran (25%) according to legume flour (50%). Dry matter loss as carbohydrates during long fermentation process may cause this proportional increase in mineral content.

Similar results have been determined by some researchers (Yücecan *et al.,* 1988; Erbaş *et al.,* 2005; Bilgiçli *et al.,* 2006; Esimek, 2010). The Recommended Dietary Allowances (RDAs) are 130 mg of magnesium, 800 mg of calcium, 500 mg of phosphorus and 5 mg of zinc for 4-8 years old children. When 100g (dry matter) tarhana containing 50% rye flour were consumed 26.8 % of RDA for calcium, 125.9% of RDA for magnesium, 69.8 % of RDA for phosphorus, and 64.4 % of RDA for zinc were taken by the children.

Nutritional evaluation

Phytic acid or its salts, the phytate, are found in plants. Phytic acid has been considered to be an anti-nutritional factor due to its chelates with important minerals such as calcium, magnesium, iron, zinc, and protein (Rickard and Thompson, 1997). There are various studies in the literature for increment of phictic acid in raw material or end product. Soaking, autoclaving (Mubarak *et al.*, 2005; Shimelis and Rakshit, 2007), cooking (Attia *et al.,* 1994; Wang et al., 2008), dehulling, sprouting, extrusion (Alonso *et al.,* (2000), fermentation and heat treatment reduce the phytic acid content (Özkaya *et al.,* 2004).

In present study, phytic acid loss of tarhana after 72nd hours of fermentation was affected by yeast addition and cereal and legume flours and brans statistically ($p<0.01$). Phytic acid content of tarhana samples with (2.5%) and without (0 %) yeast were 28.18 and 35.45 after 72 hours, respectively (Table 5). Phytic acid loss of tarhana samples with and without yeast addition were 93.92 and 92.36%, respectively. Phytic acid losses of with and without yeast fermented tarhana sample by natural microbial flora are very close together. Fermentation process is a very important method to reduce the amount of phytic acid (Marfo *et al.*, 1990). In general, long fermentation time and yeast addition increases the degradation of phytate. However, the lactic acid fermentation of tarhana without yeast was provided very high rate of phytic acid loss (Lopez *et al.*, 1983). The environment pH is a very important factor for degradation phytic acid (Fretzdorff and Brümmer 1992). Due to the high pH drops during fermentation tarhana samples loss of phytic acid was observed. The highest phytic acid content at 72nd hours tarhana samples were determined with 25 % oat bran (39.80 mg/100g) and 25 % rye bran (42.16 mg/100g) addition. The lowest phytic acid loss was also obtained with same tarhana samples.

Phenolic compounds have antioxidant activity in many plants, grains and other cereal products. Phenolic compounds such as flavonoids, tannins and isoflavonoids are located in legumes (Pekşen and Artık, 2005), and particularly located the outer bran layer of the grain (Adom and Liu, 2002). Total phenolic content and antioxidant capacity of tarhana samples are given in Table 6. The amounts of total phenolic were determined ranged between 2661 and 4960 mg GAE /100g in tarhana samples. Addition of yeast to tarhana caused an increase in phenolic content. The highest amount of total phenolic was obtained with 50 % oat flour addition (4960 mg GAE/100g); and the lowest were obtained with 50 % common bean flour (2661 mg GAE/100g) addition in tarhana. It is known that the linear regressions were indicated between total phenolic content and antioxidant activity by a lot of researchers. Foods that phenolic contents are high have high antioxidant effects. Antioxidant activity values determined according to DPPH method of tarhana samples ranged between 20.81

and 28.06 %. Addition of yeast to tarhana caused an increase in antioxidant activity. The antioxidant activity of the bakers' yeast comes from bioactive compounds which can serve as antioxidants, for example glutathione, Maillard reaction products and sulfur-containing amino acids (Sommer, 1996; Stephen and Jamieson, 1996). 25 % barley bran (28.06%) and 50 % rye flour (27.86%) addition in tarhana showed the highest antioxidant activity.

Table 4. Crude ash (%) and mineral content (mg/100g) of tarhana samples substituted with phytic acid rich flours[1]

	Crude ash	Calcium	Iron	Potassium	Magnesium	Phosphorus	Zinc
Bakers' yeast (%0)	1,87 A	87,51 B	4,71 B	600,97 B	86,13 B	328,81 B	2,14 B
Bakers' yeast (%2.5)	1,92 A	90,52 A	5,18 A	654,91 A	88,70 A	352,91 A	2,50 A
Wheat flour	1,26 f	58,98 f	2,84 d	399,82 f	48,50 h	254,57 g	1,37 d
Oat flour	1,68 e	66,70 de	3,69 c	502,52 e	77,54 f	345,45 cde	2,92 ab
Rye flour	2,54 a	214,09 a	16,14 a	622,15 c	136,91 a	348,87 bcd	3,22 a
Barley flour	1,80 d	69,33 d	3,74 c	585,67 cd	82,31 e	331,02 def	1,81 d
Chickpea flour	2,01 c	96,48 c	4,12 b	821,20 b	97,13 c	367,41 abc	3,05 ab
Common bean flour	2,42 b	123,15 b	3,70 c	940,79 a	113,23 b	371,81 a	2,00 cd
Lentil flour	2,08 c	63,23 e	4,34 b	799,27 b	73,53 g	374,93 a	2,75 ab
Oat bran	1,81 d	65,91 de	3,64 c	559,78 d	87,49 d	369,85 ab	2,49 bc
Rye bran	1,65 e	69,08 d	3,70 c	543,54 de	85,09 de	321,22 f	1,79 d
Barley bran	1,68 e	63,21 e	3,53 c	504,66 e	48,50 g	254,57 ef	1,37 d

[1] Means with different superscripts in the same column are significantly different.

Table 5. Phytic acid content and phytic acid loss of tarhana samples substituted with phytic acid rich flours[1]

	Phytic acid content (mg/100g)	Phytic acid loss after fermentation (%)
Bakers' yeast (%0)	35,45 A	92,36 B
Bakers' yeast (%2.5)	28,18 B	93,92 A
Wheat flour	30,41 bcd	93,45 abc
Oat flour	30,75 bcd	93,37 abc
Rye flour	27,36 cd	94,10 ab
Barley flour	26,41 d	94,31 a
Chickpea flour	28,21 cd	93,92 ab
Common bean flour	31,42 bc	93,23 bc
Lentil flour	28,68 bcd	93,82 abc
Oat bran	39,80 a	91,42 d
Rye bran	42,16 a	90,91 d
Barley bran	32,94 b	92,90 c

[1] Means with different superscripts in the same column are significantly different.

Table 6. Total phenolic content and antioxidant capacity of tarhana samples substituted with phytic acid rich flours[1]

	Total phenolic content (mg GAE/100g)	Antioxidant capacity (DPPH) (%)
Bakers' yeast (%0)	2760 B	23.18 B
Bakers' yeast (%2.5)	4108 A	25.51 A
Wheat flour	2837 de	20.81 e
Oat flour	4960 a	24.52 c
Rye flour	4126 b	27.86 a
Barley flour	3531 bcd	26.45 b
Chickpea flour	3268 cde	22.59 d
Common bean flour	2661 e	22.67 d
Lentil flour	3072 cde	21.21 e
Oat bran	3252 cde	26.65 b
Rye bran	2853 de	22.59 d
Barley bran	3780 bc	28.06 a

[1] Means with different superscripts in the same column are significantly different.

Sensory properties

Sensory properties of tarhana samples are given in Table 7. Tarhana soups prepared from different legume and cereal flours and brans varied significantly ($p<0.01$) in terms of taste, colour, grittiness and overall acceptability. Range of scores regarding taste, colour and grittiness were 2.69-4.31; 3.40-4.68; and 3.00-4.43 respectively.

The most admired tarhana samples regarding to taste was control and 50% rye flour added tarhana, and the most dislike tarhana samples was chosen 50% chickpea flour added tarhana by the panelists. The sensory panel resulted in that tarhana soups with rye flour and rye bran substituting of flour in the formulation were most liked according to colour properties. Common bean flour addition caused a decrease in the scores for grittiness, while addition of oat flour did not affect this attribute and gave similar grittiness properties like control. Addition of lentil flour to tarhana formulation was found to improve sourness of tarhana and gave similar scores like control. The highest score for overall acceptability was observed with wheat flour (control tarhana), and the lentil flour added tarhana samples as shown in Table 6.

Conclusion

Different legume and cereal flours and brans were used to produce fortified tarhana samples. Flours of legumes and cereal and brans of cereal were phytic acid rich materials. For reduce the phytic acid content and increase the bioavailability of minerals, tarhana fermentation process with and without yeast addition to tarhana formula is aimed. Bakers' yeast addition gave higher phytic acids loss than tarhana without bakers' yeast. After 72 hours tarhana fermentation process, the highest phytic acid loss was determined with 50 % barley flour addition, and the lowest phytic acid content was also found with 50 % barley flour addition.

Some nutritional changes such as mineral elements, phenolic contents, occurred in tarhana samples with cereal and legume flour and cereal bran addition. Functional properties were affected with changed tarhana formulation. Addition of yeast into tarhana caused an increase in phenolic content and antioxidant activity. 25 % barley bran and 50 % rye flour addition in tarhana showed the highest antioxidant activity. According to sensorial properties; the most popular tarhana samples except the control, was rye flour tarhana sample with bakers' yeast. Further investigations are needed for the assessment of their fermentative microbial flora and fermentation conditions.

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Table 7. Sensorial properties of tarhana samples substituted with phytic acid rich flours[1]

	Taste	Odor	Colour	Grittiness	Sourness	Overall Acceptability
Bakers' yeast (%0)	3.85 A	3.99 A	4.09 A	3.76 A	3.78 A	3.89 A
Bakers' yeast (%2.5)	3.21 B	3.80 A	4.09 A	3.71 A	3.91 A	3.74 B
Wheat flour	4.31 [a]	4.43 [a]	4.43 [ab]	4,43 [a]	4.20 [a]	4.36 [a]
Oat flour	3.59 [cde]	3.93 [ab]	4.20 [ab]	4,40 [a]	4.00 [abcd]	4.02 [bc]
Rye flour	4.23 [ab]	4.25 [a]	4,68 [a]	3,83 [bcd]	3.60 [bcd]	4.12 [ab]
Barley flour	3.40 [cde]	4.20 [a]	3,95 [bc]	4,03 [ab]	3.55 [cd]	3.83 [cd]
Chickpea flour	2.69 [f]	3.45 [b]	3,53 [c]	3,55 [cde]	3.75 [abcd]	3.39 [f]
Common bean flour	3.00 [ef]	3.80 [ab]	3,53 [c]	3,00 [f]	4.08 [ab]	3.48 [ef]
Lentil flour	3.68 [bcd]	4.05 [ab]	3,40 [c]	3,90 [bc]	4.18 [a]	3.84 [cd]
Oat bran	3.83 [abc]	3.53 [b]	4,18 [ab]	3,43 [def]	4.05 [abc]	3.80 [cd]
Rye bran	3.38 [cde]	3.80 [ab]	4,58 [a]	3,38 [ef]	3.53 [d]	3.73 [de]
Barley bran	3.20 [def]	3.50 [b]	4,43 [ab]	3,41 [def]	3.50 [d]	3.61 [def]

[1] Means with different superscripts in the same column are significantly different.

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