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The effect of fermentation conditions on the nutrients and acceptability of tarhana

Senol Ibanoglu, Paul Ainsworth,* George Wilson & George D. Hayes

Department of Food and Consumer Technology, Hollings Faculty, The Manchester Metropolitan University, Old Hall Lane, Manchester M14 6HR, UK

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A laboratory method was evaluated for the production of tarhana, a popular Turkish fermented wheat–yogurt mixture. The changes in pH, the total titratable acidity and the vitamin content (thiamine, riboflavin and vitamin B12) of tarhana of different formulations (type of wheat flour, amount of yogurt and presence of salt) were monitored during fermentation. Chemical composition and acceptability of laboratory-produced tarhana were compared with those of authentic homemade and commercially produced tarhana. The pH and titratable acidity of tarhana samples did not change after the third day in the course of a 4-day fermentation. The final pH and acidity (expressed as percent lactic acid) of tarhana were found to be in the range of 4·3–4·8 and 1·8–2·3 (dry basis), respectively. The thiamine, riboflavin and vitamin B12 contents of tarhana did not change considerably during fermentation. The addition of salt to tarhana lowered the acid formation rate during fermentation, leading to a higher pH. The replacement of white wheat flour with wholemeal flour resulted in an expected increase in the protein and vitamin content of tarhana; however, a decrease in overall acceptability was observed.

INTRODUCTION

Fermented foods play an important role in the diets of many people in the Middle East. One such product, tarhana, is widely consumed in Turkey and forms a significant part of the diet, especially of infants and young children, as well as of the elderly (Siyamoglu, 1961). In general, tarhana is produced by mixing ½ or one part of yogurt with one part wheat flour and allowing the mixture to continue fermenting for several (1–7) days (Robinson & Cadena, 1978). Baker's yeast is also incorporated in the mixture. The resulting material is then air-dried and consumed as a soup, giving a product with high nutritional contents of protein and vitamins. Other ingredients such as paprika, salt, tomato and onions are often incorporated for flavouring (Campbell-Platt, 1987). Tarhana is not hygroscopic and can be kept for 1–2 years without any deterioration, due to its low pH and moisture content (Wang & Hesseltine, 1981). There are some other fermented milk–cereal mixtures similar to tarhana, such as kishk in Syria, Jordan and Egypt (Youssef, 1990) and kushuk in Iraq (Alnouri & Duitschaever, 1974).

The amount and type of ingredients used in tarhana production may effect its nutritional content and sensory attributes. The purpose of this study was to develop a laboratory method for the production of acceptable tarhana samples and investigate changes in total acidity, pH and vitamins (thiamine, riboflavin and vitamin B12) during tarhana fermentation when the type of wheat flour (wholemeal wheat flour, white wheat flour), the level of salt and the amount of yogurt used were varied. A comparison was also made of the composition and sensory properties of laboratory-produced tarhana samples with those of authentic homemade and commercially produced tarhana samples.

*To whom correspondence should be addressed.

MATERIALS AND METHODS

Materials

The ingredients used in tarhana preparation were purchased from local markets in Manchester, except tarhana otu (*Echinophora sibthorpiana*) (Kivanc, 1988), which was obtained from Turkey. The crude protein content of the wheat flours used were 12·4% (±0·3) and 13·9% (±0·4) for white and wholemeal flour, respectively. Yogurt was made of cow's milk and had a fat content of 3·6%. Tomato puree was double concentrated. Yeast was baker's yeast in active dry form. The spices used were in powder form. Homemade tarhana was obtained from a village in South East Turkey, and commercial tarhana was purchased from a supermarket in Gaziantep, Turkey.

Preparation of tarhana

Four different tarhana formulations were prepared: (1) tarhana with two parts white wheat flour, one part yogurt and salt (standard tarhana); (2) tarhana with two parts wholemeal flour, one part yogurt and salt; (3) tarhana with one part white wheat flour, one part yogurt and salt; and (4) tarhana with two parts white wheat flour, one part yogurt and without salt. Table 1 indicates the composition of standard tarhana and the formulation of the other tarhana samples under investigation.

To prepare tarhana samples, onions were chopped and blended with 50 ml of tap water by means of a food processor for 30 s. The ingredients other than wheat flour, yogurt and yeast were added to the onions and the resulting mixture was blended for an additional 30 s and simmered over a medium heat for 10 min. The mixture was left to cool to room temperature and then yogurt, wheat flour, yeast and 100 ml of tap water were added to the mixture. The final mixture was kneaded mechanically in a commercial food processor for 15 min (40 rpm). The resulting dough was then spread over a stainless-steel tray to a depth of approximately 1 cm and incubated at 30 ± 1°C for fermentation for 4 days. Samples were taken initially and then every 24 h during fermentation for the determination of acidity, pH and vitamin analysis. After fermentation, the tarhana was dried in an air oven at 50 ± 1°C for 48 h followed by grinding in a hammer mill and sieving to pass a 1-mm screen (Fig. 1).

Analytical methods

Determination of pH

A 5-g sample was blended using a laboratory blender with 100 ml of distilled water for 3 min, and the solution was filtered through Whatman 30 filter paper. The pH of the solution was then measured using a digital pH meter.

Table 1. Composition of standard tarhana

Ingredient	Quantity (g)
White wheat flour[a]	500
Yogurt	250[b]
Onions	60·0
Tomato puree	60·0
Yeast	10·0
Salt	40·0[c]
Paprika	10·0
Dill	1·0
Mint	1·0
Tarhana otu	6·0
Water	150

[a]Wholemeal flour in tarhana with wholemeal flour.
[b]500 g in tarhana with increased yogurt.
[c]Nil in tarhana without salt.

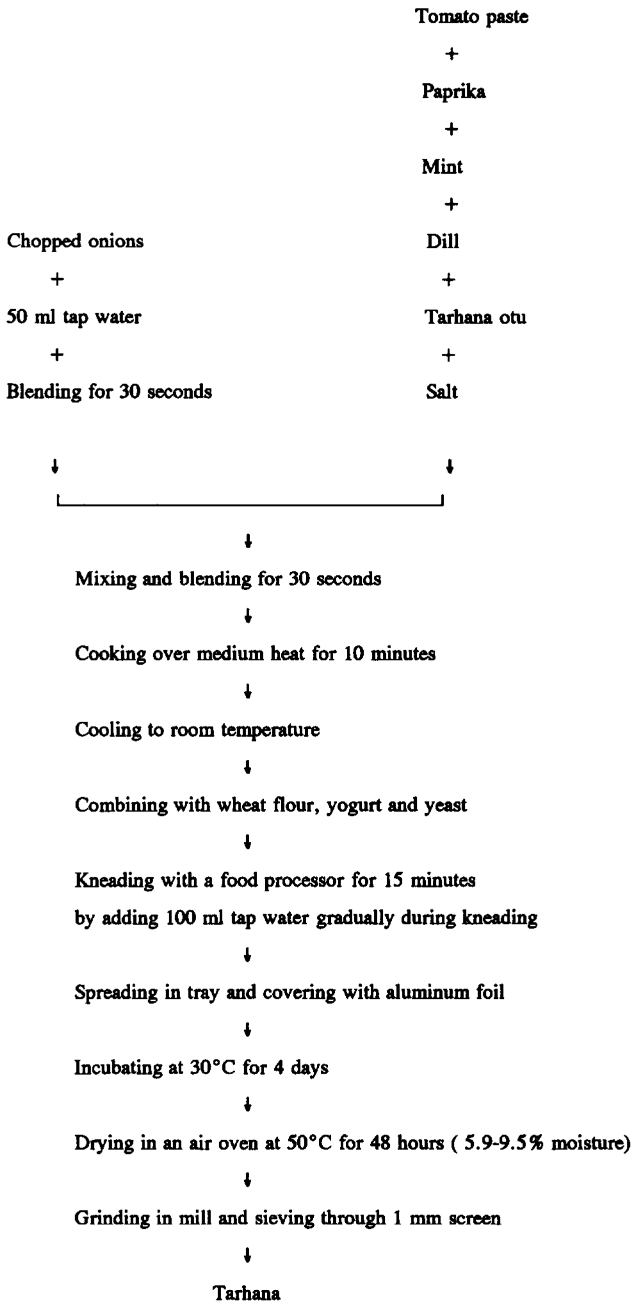

Fig. 1. Flow chart of laboratory produced tarhana.

Determination of acidity

Acid formation during fermentation was determined by titration using 0·1 M NaOH and expressed as percent lactic acid (Kirk & Sawyer, 1991).

Determination of vitamins

The thiamine, riboflavin and vitamin B12 contents of tarhana samples were determined by microbiological assays (AOAC, 1984). The test organisms were *Lactobacillus fermentum* NCIMB 6991, *Lactobacillus casei* NCIMB 6375 and *Lactobacillus leichmannii* NCIMB 8118 for thiamine, riboflavin and vitamin B12, respectively. Culture medium, inoculum broth and maintenance agar were of Difco Laboratories, Detroit, MI, USA. Thiamine and riboflavin were extracted from the samples as follows. A 5-g sample was mixed with 50 ml of 0·1 M H_2SO_4 and autoclaved for 30 min at 121°C. After cooling, the contents were adjusted to pH 4·5 with 2 M sodium acetate. To the solution were added 1 ml of 2% α-amylase (from *Aspergillus oryzae*, Sigma) and 5 ml of 10% papain (from papaya latex, Sigma). The solution was incubated for 12 h at 35 ± 1°C followed by filtration. Vitamin B12 was extracted from tarhana by using a cyanide-buffer solution as described by Truesdel *et al.* (1987).

Determination of protein content
The protein contents of the samples were estimated from the crude nitrogen content of the samples determined by the Kjeldahl method (AOAC, 1984).

Moisture determination
The moisture contents were determined by drying the samples at 130°C for 1 h in an air oven.

Ash determination
Samples were ashed at 550°C in a muffle furnace until a constant weight was obtained.

Fat determination
The total fat contents of the samples were determined by the Soxhlet method using a Soxtec HT system (Tecator, Sweden), with petroleum ether being the solvent.

Sensory analysis

Laboratory produced tarhana samples, one homemade tarhana sample and one commercially produced tarhana sample were subjected to sensory evaluation. Five Turkish students who were familiar with tarhana and living in the Leeds area were asked to score the tarhana soups in terms of colour, sourness, mouth feel, odour and overall acceptability using a nine-point hedonic scale, with 1 being 'dislike extremely' and 9 being 'like extremely'. Tarhana soups were prepared by mixing one part tarhana with 20 parts tap water and simmering for 10 min over medium heat with constant stirring. The samples were coded with letters and served to the panellists at random to guard against any bias. A Tukey HSD multiple comparison test was used to analyse the data (Stone & Sidel, 1985).

RESULTS AND DISCUSSION

A laboratory method was developed for the successful production of tarhana samples. From Fig. 2 it is seen that pH values showed the same trend for all tarhana samples, except tarhana with no salt. The pH decreased sharply on the first day of fermentation and then decreased gradually up to the third day, after which it remained constant. This was believed to be due to the buffering effect of NaCl (Etchells *et al.*, 1975). However, in the case of tarhana without salt, pH values showed a sharper decrease even up to the fourth day of fermentation (Fig. 2). The titratable acidity of the samples (on a dry basis) increased sharply during the first day of fermentation and became almost constant from the third (Fig. 3). Again, the tarhana sample prepared

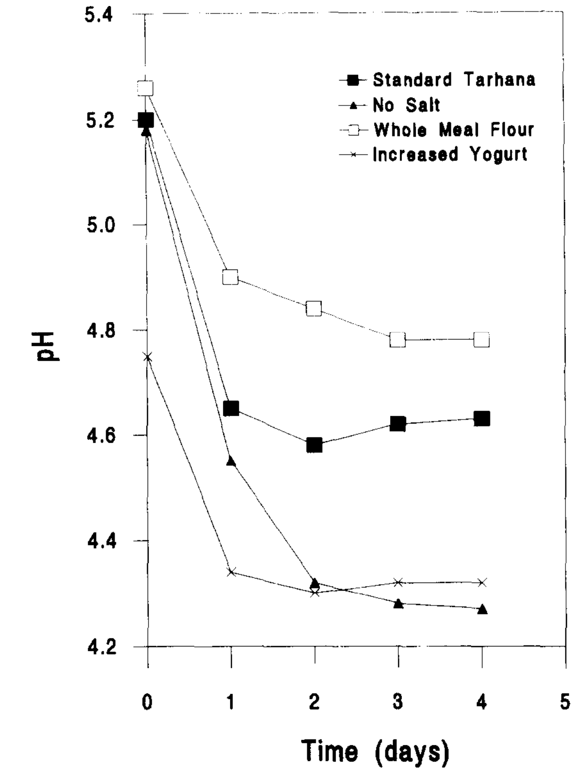

Fig. 2. Changes in pH during tarhana fermentation.

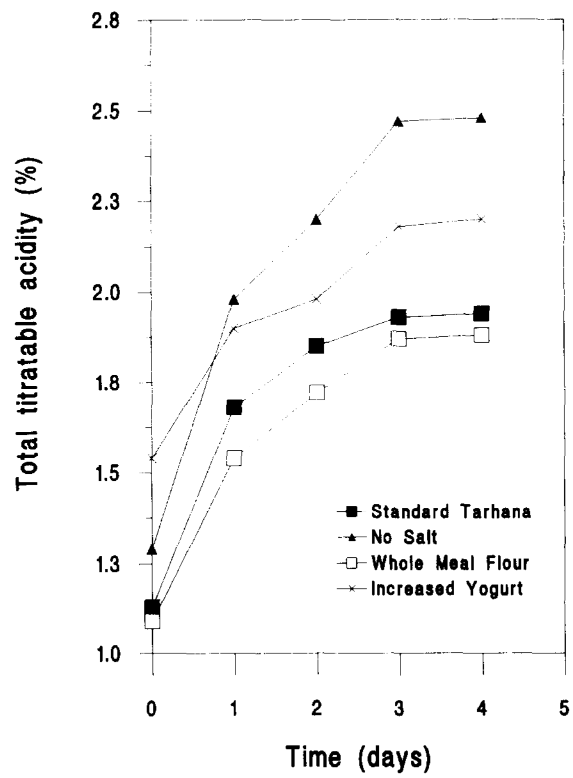

Fig. 3. Changes in titratable acidity during tarhana fermentation.

Table 2. Changes in vitamin content of tarhana sample during fermentation on dry basis (mean ± SD, n = 3)[a]

Days	S1	S2	S3	S4
		Thiamine (μg/g)		
0	1·9±0·2	1·9±0·1	1·8±0·3	3·5±0·3
1	1·9±0·1	2·0±0·2	1·9±0·2	3·6±0·2
2	2·0±0·2	2·0±0·1	1·9±0·2	3·6±0·3
3	2·0±0·1	2·0±0·1	1·9±0·1	3·6±0·2
4	2·1±0·1	2·0±0·3	1·9±0·2	3·6±0·2
		Riboflavin (μg/g)		
0	1·0±0·2	1·4±0·3	1·2±0·1	1·4±0·2
1	1·0±0·1	1·4±0·2	1·2±02	1·5±0·3
2	1·0±0·2	1·5±0·2	1·2±0·2	1·6±0·3
3	1·0±0·1	1·5±0·1	1·3±0·1	1·6±0·3
4	1·0±0·2	1·5±0·2	1·3±0·2	1·5±0·3
		Vitamin B12 (μg/kg)		
0	1·5±0·2	2·2±0·3	1·2±0·1	1·3±0·2
1	1·6±0·1	2·3±0·2	1·3±0·2	1·3±0·2
2	1·6±0·2	2·3±0·2	1·3±0·1	1·4±0·3
3	1·6±0·2	2·3±0·4	1·3±0·1	1·4±0·3
4	1·6±0·3	2·2±0·2	1·3±0·1	1·4±0·2

[a]S1, standard tarhana sample; S2, tarhana sample with increased yogurt; S3, tarhana sample without salt; S4, tarhana sample with wholemeal flour.

without salt showed a higher degree of acidity as compared with the other samples. Therefore, if salt is added before fermentation, the pH of tarhana does not decrease so much and the acidity is less when compared with tarhana fermented without addition of salt. The patterns of pH and acidity exhibited are in agreement with the findings of Ozbilgin (1983) for tarhana fermentation supplemented with lentils and chickpeas. It is reported that lactic acid bacteria are responsible for the production of lactic acid during tarhana fermentation (Ozbilgin, 1983).

The vitamin contents of tarhana samples showed variations before fermentation due to different formulations (Table 2). The thiamine content of tarhana with wholemeal flour (3·5 μg/g) was higher before fermentation than that of other tarhana samples, which ranged from 1·8 to 1·9 μg/g. This was expected, since wholemeal flour is richer in thiamine than white wheat flour (Combs, 1992). It was observed that the thiamine, riboflavin and vitamin B12 contents of tarhana samples did not change significantly during fermentation. Ozbilgin (1983) reported a 20% increase in the riboflavin content of tarhana supplemented with chickpeas and lentils during fermentation. Microorganisms can synthesise these vitamins by using substrates, while at the same time they can consume them for their growth requirements (McFeeters, 1988). Therefore, even though organisms involved in tarhana fermentation might be able to synthesise the vitamin, the rate of synthesis may be slow, and these organisms could utilise readily available vitamins for growth and/or other functions.

The compositions of laboratory-produced (after drying and grinding), homemade and commercial tarhana samples are given in Table 3. The moisture content of the commercial tarhana sample was higher (12·1%) than laboratory-produced tarhana samples, which ranged from 5·9 to 9·5%. The higher moisture content of tarhana with increased yogurt (9·5%) when compared with other laboratory produced tarhana samples can be explained by the incorporation of more yogurt, containing approximately 80% water, to the formulation. The crude protein content of the tarhana sample prepared with wholemeal flour was higher than other samples under examination (19·2%), while commercial tarhana had the lowest value (12·9%). However, the ash content of commercial tarhana was the lowest when compared to the rest of the samples, except for tarhana with no salt. The reason for the high ash content of homemade and laboratory tarhana samples could be the high concentrations of flavouring agents used, such as mint, paprika and tarhana otu, which are high in ash content. Oven drying of tarhana caused approximately 20% loss of thiamine and riboflavin content of the laboratory samples, while no significant change was observed for vitamin B12 (Tables 2 and 3). The thiamine and riboflavin content of commercial and homemade tarhana samples were found to be lower than in the laboratory samples. Although the drying method of commercially produced tarhana is unknown, homemade tarhana was sun-dried, which might destroy heat-labile thiamine and light-sensitive riboflavin. Platt (1964) reported a 50% thiamine loss during sun-drying of bulgur (parboiled, dehulled, cracked wheat) when processed traditionally.

Table 3. Proximate composition of tarhana samples on dry basis (mean ± SD, n = 3)[a]

	S1	S2	S3	S4	S5	S6
pH	4·8±0·1	4·4±0·1	4·3±0·1	4·8±0·1	4·5±0·1	4·5±0·1
Titratable acidity (%)	1·8±0·2	2·0±0·1	2·1±0·1	1·8±0·1	2·1±0·2	1·9±0·1
Moisture (%)	7·7±0·3	9·5±0·3	6·9±0·2	5·9±0·2	10·6±0·3	12·1±0·3
Crude protein (%) (N × 6·25)	16·2±0·4	16·7±0·3	16·0±0·2	19·2±0·4	15·6±0·3	12·9±0·4
Ash (%)	7·4±0·2	7·6±0·2	1·8±0·1	8·2±0·2	4·5±0·2	2·9±0·2
Crude fat (%)	3·8±0·1	4·5±0·1	3·3±0·2	5·7±0·3	3·6±0·2	5·3±0·3
Thiamine (μg/g)	1·5±0·1	1·5±0·2	1·6±0·1	2·9±0·2	0·6±0·1	0·5±0·1
Riboflavin (μg/g)	0·8±0·1	1·1±0·1	0·9±0·1	1·1±0·1	0·4±0·1	0·6±0·1
Vitamin B12 (μg/kg)	1·5±0·1	2·1±0·2	1·2±0·1	1·2±0·1	2·0±0·2	1·0±0·1

[a]S1, standard tarhana sample; S2, tarhana sample with increased yogurt; S3, tarhana sample without salt; S4, tarhana sample with wholemeal flour; S5, homemade tarhana; S6, commercially produced tarhana.

Table 4. Sensory evaluation of tarhana samples[a]

	Colour	Mouth feel	Sourness	Odour	Overall acceptability
S1	7·6	7·0	8·0	7·6	8·0
S2	7·6	7·2	7·8	7·6	7·8
S3	6·8	7·0	7·0[b]	7·2	7·0[b]
S4	6·2[b]	8·0[b]	6·0[b]	6·0[b]	6·2[b]
S5	5·8[b]	7·8	7·[b]	5·2[b]	5·4[b]
S6	8·2	8·8[b]	8·4	8·2	8·2

[a]S1, standard tarhana sample; S2, tarhana sample with increased yogurt; S3, tarhana sample without salt; S4, tarhana sample with wholemeal flour; S5, homemade tarhana; S6, commercially produced tarhana (1, dislike extremely; 5, neither like or dislike; 9, like extremely).
[b]Significantly different from standard tarhana sample ($P < 0·01$).

Sensory analysis of tarhana samples (Table 4) indicated that commercial tarhana was the most liked (8·2). No significant difference was found in the overall acceptability between this sample, the standard tarhana and the tarhana with increased yogurt. Homemade tarhana obtained the lowest score (5·4) for overall acceptability. One possible reason for the relatively low score for homemade tarhana could be the fact that this product was prepared to satisfy individual tastes. Although the overall acceptability of tarhana sample with wholemeal flour was scored lower (6·2) than the other laboratory tarhana samples, its score for mouth feel was found to be the highest (8·0) of the laboratory samples.

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