



Microbiological Quality and Sensory Properties of Tarhanas Produced by Addition *Saccharomyces cerevisiae* and Sourdough as Starter Culture after Different Fermentation Periods

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Author's contribution

The sole author designed, analysed, interpreted and prepared the manuscript.

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ABSTRACT

Aims: The aim of this study was to investigate some effects of different starter cultures (*Saccharomyces cerevisiae* and sourdough) and different fermentation times (7, 14 and 21 days) on tarhana.

Place and Duration of Study: Food Engineering Department, Namık Kemal University, Tekirdag, Turkey, October 2017.

Methodology: Wheat flour, full-fat commercial set-type yoghurt made from cow milk, starter culture (sourdough and dried baker's yeast as *Saccharomyces cerevisiae*), fresh red pepper, onion, tomato, dill, parsley, dry mint, table salt and ground black pepper were used as materials. Tarhana doughs prepared using these materials were fermented for 7, 14 and 21 days. Physicochemical and microbiological analyses of tarhana samples were performed using standard methods. Tarhana soups were evaluated by panelists in terms of sensory properties at the end of the 21st day.

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Results: pH values of baker's yeast added samples were lower than the others and their acidity were higher than the others during the fermentation period. Dry matter of samples increased with the prolongation of fermentation time. The dry matter of the sample produced using baker's yeast was slightly higher than that of the other sample at day 21. Total mesophilic aerobic bacteria and lactic acid bacteria (mesophilic rod) counts of tarhana samples with sourdough were always higher than the others during the fermentation. Yeast-mould counts of tarhana samples with baker's yeast decreased slightly during the fermentation period, but were higher than the others. The coliform group bacteria was not detected on the 7th day of fermentation. Samples were left to fermentation for 7 and 14 days were less favoured than those were left to fermentation for 21 days. On the 21st day of fermentation, the sample added dry baker's yeast was the most favoured sample.

Conclusion: As a result of the sensory analysis, considering the total score, although the difference between them is slight, baker's yeast added tarhana soups were more favoured than the others. Also, with the prolongation of the fermentation period, in terms of sensory properties, tarhanas were more favoured and microbiologically safer tarhanas were obtained.

Keywords: Tarhana; cereal-based traditional fermented product; kishk; kushuk; trahanas.

1. INTRODUCTION

Tarhana is an old and popular cereal-based traditional Turkish fermented product. There are similar products to tarhana in different countries. For example, kishk in Egypt, kushuk in Iraq, trahanas in Greece, tahonya in Hungary and talkuna in Finland [1]. Tarhana is prepared by mixing wheat flour, yoghurt, yeast and a variety of cooked vegetables (tomatoes, onions, green pepper), salt and spices (mint, paprika), followed by fermentation for one to seven days [2]. The fermentation time can be as long as 21 days depending on seasonal conditions. There are differences among tarhanas depending on the preparation and changes in the materials used in various regions in Turkey [1]. Tarhana is mainly produced at a home or at home-scale level. It is also made commercially on small and large scales. Production methods may vary from one region to another [2,3]. Tarhana can be produced dry (nugget, biscuit, and powder forms) or wet and can be stored for 1-2 years under proper storage conditions. The soup prepared from dry or wet tarhana has a sourish taste and is popular as a breakfast and soup prior to main meals in Turkey [4].

Yoghurt or sour milk is used as a starter for lactic acid fermentation. In addition to this classical application, sourdough or baker's yeast (*Saccharomyces cerevisiae*) can also be added in some regions. Both lactic acid bacteria and yeast fermentations occur simultaneously during tarhana production. Protein, carbohydrate and lipid components of tarhana mix are subjected to partial digestion and hydrolysis during fermentation, resulting in a product with improved digestive properties [5]. In one study, tarhana

samples were collected at different time fermentation from eight different regions of Turkey. *Pediococcus acidilactici* were found to constitute 27 % of the isolates, 19 % were identified as *Streptococcus thermophilus*, 19 % as *Lactobacillus fermentum*, 12 % as *Enterococcus faecium*, 7 % as *Ped. pentosaceus*, 5 % as *Leuconostoc pseudomesenteroides*, 4 % as *Wiesella cibaria*, 2 % as *L. plantarum*, 2 % as *L. delbrueckii* spp. *bulgaricus*, 2 % *Leu. citreum*, 1 % as *L. paraplantarum* and 0.5 % as *L. casei* [6]. Information on yeast diversity in tarhana fermentation is limited. However, it is stated that *Saccharomyces cerevisiae* dominates the flora. *Rhodotorula glutinis* was also isolated in tarhana fermentation. The most important microbial group for tarhana fermentation is LAB, they have a key role in the generation of the aromatic compounds, and moreover, they strongly have contributed to the stability of the product during storage by the inhibition of several unwanted microorganisms. Meanwhile, yeasts have further effects on the aromatic profile of tarhana [7]. The fermentation stage in the production of tarhana is very important for the quality of the product [2]. Lactic acid bacteria in the flora of yogurt added to the dough ferment the sugars and form lactic acid. Baker's yeast performs ethyl alcohol fermentation. Thus, the obtained tarhana has an acidic and sour taste [8]. The nutritional value of the product increases with fermentation, it is easy to digest. It is stated that the fermentation process is an important step in terms of the development of sensory properties in the production of tarhana, but some sensory properties are partially lost during drying in the production of traditional tarhana [9]. After fermentation, the dough is dried and then ground

to a particle size of <1 mm [10]. It is dried in the sun or by modern dryer machines as a lump, nugget or in thin layers, and subsequently called 'dry tarhana'. After drying, it has between 6–10 % of moisture content. One of the critical steps in tarhana production is the drying operation. As a result of incorrect drying procedures, many disadvantages, such as discolouration and poor rehydration performance may arise. For this reason, if the product is dried more rapidly, the better is its rehydration quality and the shorter residence time of drying [3,11-13]. Generally, tarhana soup has an acidic and sour taste with a strong yeasty flavour [10].

In this study, the effects of different starter cultures (sourdough and dried baker's yeast as *Saccharomyces cerevisiae*) and different fermentation times (7, 14 and 21 days) on microbiological quality and sensory properties of tarhana were investigated.

2. MATERIALS AND METHODS

2.1 Materials

Wheat flour (Type 550, moisture 14.5 %, protein 11% and ash 0.55 %), full-fat commercial set-type yoghurt made from cow milk (dry matter 16 %, fat 3.5 % and protein 4.5 %), starter culture (sourdough and dried baker's yeast as *Saccharomyces cerevisiae*), fresh red pepper, onion, tomato, dill, parsley, dry mint, table salt and ground black pepper were used as materials.

2.2 Methods

2.2.1 Production of tarhana

Stem and seeds of fresh red pepper were separated. Shells of onion and tomato were pared. They were cooked in steel pot with lid covered at a low heat up to 40 minutes until softened. Then, mixture of softened fresh red pepper, onion and tomato was blended using a blender. Dill, parsley and dry mint were infused and the obtained liquid was added to dough. Ground black pepper was directly added to the dough. Ingredients were used the same quantities for both types of tarhana. Then the starter culture was added. Recipe for tarhanas is as shown in Table 1.

All ingredients were mixed in a bowl. Different bowls were used for each dough. Tarhana

doughs were left in fermentation ($23^{\circ}\text{C}\pm 2$). In the early days of fermentation, dough fermented with baker's yeast leavened more than the other. The doughs were often kneaded for the first two days. The doughs were kneaded twice a day for the next 10 days, as morning and evening. Then, the doughs were kneaded once a day. The fermentation of 1/3 of the doughs was finished on the 7th day. The fermentation of 1/3 of the doughs was finished on the 14th day. The fermentation of remaining doughs was finished on the 21st day. The dough was in a fluid state with high viscosity. Tarhana dough with baker's yeast was more fluid than the other.

After the fermentation was completed, doughs were spread on the cloth in small pieces and dried in a place with shade and air flow. Doughs were divided into smaller pieces when the water content of doughs decreased. Before doughs completely dried, were grinded by hand rubbing until the size of the semolina (so dough should not stick to hand). After that its name was tarhana. In order that granule sizes of tarhanas are standard, sieving was carried out using a sieve. Then, they were spread again and drying was completed. Tarhana samples were packed in glass packages. Packages were wrapped in aluminium foil for not getting light. The colour of the tarhana could be changed if it is exposed to sunlight.

2.2.2 Analysis

The pH, acidity (%), dry matter (%), total mesophilic aerobic bacteria, lactic acid bacteria (mesophilic rod), coliform group bacteria, yeast and mould counts of samples were determined at the beginning, 7th, 14th and 21st days of the fermentation. At the end of the 21st day, soups were prepared from all the tarhana samples. The sensory evaluation of tarhana soups was made by the panelists.

2.2.2.1 Physicochemical analysis

The amounts of moisture of the tarhana samples were measured according to approved methods of the AACC [14]. The acidity degree (as lactic acid) was determined according to the reported method by the Tarhana Standard (TS 2282) of Turkish Standards Institute [15]. pH was determined using a pH meter (Hanna Instruments 211) after mixing a 5 g sample with 100 ml distilled water.

Table 1. The ingredients used for both types of tarhana and quantities of ingredients

Ingredients	Quantity used for tarhana with <i>Saccharomyces cerevisiae</i> *	Quantity used for tarhana with sourdough
Wheat flour	1 kg	1 kg
Dry Baker's yeast	20 g	-
Sourdough	-	45 g
Salt	10 g	10 g
Ground black pepper	2.7 g	2.7 g
Yoghurt	250 g	250 g
Sliced fresh red pepper, tomato and onion	250 g	250 g
Dill, parsley and dry pepper mint infused water	200 ml	200 ml

* In consideration quantity of the flour and water in the sour dough, 20 grams of flour and a quantity of tap water (5 ml) were added to the tarhana dough with *Saccharomyces cerevisiae*.

2.2.2.2 Microbiological analysis

For microbiological analysis, after homogenised with a stomacher, tarhana samples (10 g) were diluted and decimal dilutions were conducted in sterile physiological solution (90 g). Plating and incubation of microbial suspensions were conducted as the following: yeast and molds on Potato Dextrose Agar (PDA, Merc), incubated at 25°C for five day [16]; total mesophilic aerobic bacteria (TMAB) on Plate Count Agar (PCA, Merc), incubated at 30 °C for 72 h [17]; coliforms on Violet Red Bile Agar (VRBA, Merc), incubated at 37°C for 24 h [18]; mesophilic rod LAB on de Man Rogosa Sharpe Agar (MRS, Merc), incubated at 30°C for 72h [19]. Counts were carried out in duplicate and the results were expressed as log₁₀ cfu g⁻¹.

2.2.2.3 Sensory analysis

For sensory analysis, 100ml of water (tap water at 20 °C) was added into 45 grams of tarhana samples, mixed and dissolved for 10min. 500 ml of water was added to this mixes and placed in glass balloons to cook. A total of 600 ml of soups were simmered for 15 min over medium heat with constant stirring. The prepared soups were presented to the panelists at the same temperature (60°C) in transparent cups. Tarhana soups were evaluated separately by 8 panelists in terms of colour, odour, consistency, taste, general acceptability. Each characteristic was scored between 0-10. For each characteristic, 9 and 10, 7 and 8, 4-6, and 1-3 scores were evaluated as very good, good, medium, poor, respectively. While the tarhana soups with a total score of 35-42 were considered very good, the tarhana soups with 29-34 were good, the tarhana soups with 15-28 were medium and the tarhana soups with 4-14 were considered to be poor.

2.2.2.4 Statistical analysis

All statistical calculations were performed by IBM SPSS V 21.0. Analysis of variance (One-Way ANOVA) was performed to determine whether there is a difference among the effects of fermentation days. The degree of difference was determined by Duncan's Multiple Range Test. Post hoc tests required to determine differences between samples could not be performed because the number of samples is less than 3 when evaluating the results of the physicochemical and microbiological analysis.

3. RESULTS AND DISCUSSION

3.1 Physicochemical Analysis

The pH values of baker's yeast added tarhana samples were lower than pH values of sourdough added tarhana samples on the 7th, 14th and 21st days of fermentation. The pH values of tarhana samples decreased during fermentation. The pH value of tarhana sample produced using the baker's yeast showed a very slight increase on the 21st day of the fermentation. If pH value is less than 4.5 which provides a significant advantage in terms of preservation of the product. The tarhana produced with the dry baker's yeast became safe within the first week, the tarhana produced with the sourdough within the second week (Table 2). The limit of pH value is not specified in Turkish Tarhana Standard [15]. The reason for the decrease of pH in tarhana is the growth of lactic acid bacteria and yeasts during the fermentation period.

In the study of Sengün et al. [6], initially, on the 1st, 2nd, 4th, 6th, and 15th days of fermentation, the

pH values of a tarhana dough sample were 4.5, 4.2, 4.1, 3.9, 3.8 and 3.9, respectively. A slight increase was observed in the last day as in this study. In the same study, initially, on the 1st, 2nd, 4th, 6th, and 21st days of fermentation, the pH values of another tarhana dough sample were 4.50, 4.40, 4.10, 4.10, 4.11 and 4.00, respectively.

The titratable acidity (% LA) increased with the prolongation of the fermentation period in both samples. The acidity of the sample produced using the baker's yeast was higher than that of the other sample during the fermentation period (Table 2).

Dry matters of samples increased with the prolongation of fermentation time. The dry matter values of both samples were close to each other during the fermentation period. However, the dry matter of sample produced using baker's yeast was slightly higher than that of the other sample at day 21 (Table 2).

According to the results of statistical analysis, the difference among fermentation days in terms of pH, acidity and dry matter values were found significant ($P < 0.01$).

In the study of Şimşek et al. [20], homemade tarhana doughs were left to fermentation for 15 days. pH values of tarhana doughs decreased until 10th day of fermentation and then increased. The pH values determined in this study were higher than their determined pH values during the fermentation (reduced from 4.40 to 3.70 on average during fermentation). In their study, acidity values increased during fermentation (increased from 8.79 % to 18.45 % on average during fermentation) and were higher than those in this study. Although initially higher than those in this study, in their study, dry matter values

(increased from 53.08 % to 55.79 % on average during fermentation) were lower than those determined in this study. These may be due to the difference in raw materials used.

3.2 Microbiological Analysis

TMAB counts of tarhana samples increased until the 7th day of fermentation and then decreased. LAB counts of the samples increased until 14th day of fermentation and then decreased. TMAB and LAB counts of tarhanas with sourdough were always higher than the others during the fermentation. The reason for this may be bacteria in sour dough. The yeast and mold counts of tarhana samples with baker's yeast decreased slightly during the fermentation period, but was higher than the others. The coliform group bacteria was not detected in both samples on the 7th day of fermentation (Table 3).

According to the results of statistical analysis, the difference among fermentation days in terms of TMAB and LAB counts was significant ($P < 0.05$). The difference among fermentation days in terms of yeast and mold counts was not significant ($P > 0.05$).

In the study of Şimşek et al. [21], the TMAB (initially 7.12, 8.65 on the 3rd day and 5.46 log cfu g⁻¹ on the 15th day) and LAB (initially 7.65, 8.47 on the 3rd day and 6.52 log cfu g⁻¹ on the 15th day) counts of the samples increased until the 3rd day of fermentation and then decreased. Yeast mold counts fluctuated during the fermentation, as in this study, no significant change was observed.

In the study of Sengün et al. [6], initially, on the 1st, 2nd, 4th, 6th, and 15th days of fermentation, lactobacilli counts of a tarhana dough sample were 7.5, 7.3, 7.3, 7.0, 6.2 and 5.2 log cfu g⁻¹,

Table 2. The physicochemical properties of tarhana samples during fermentation

	Samples	At the beginning	7 th day	14 th day	21 st day
pH	1*	5.58 ^A	4.13 ^B	4.04 ^{BC}	4.08 ^C
	2**	5.55 ^A	4.84 ^B	4.45 ^{CB}	4.18 ^C
Acidity (%)	1	1.80 ^A	5.55 ^B	9.99 ^C	13 ^D
	2	1.83 ^A	4.00 ^B	8.41 ^C	11.5 ^D
Dry Matter(%)	1	51.40 ^A	55.34 ^B	58.55 ^C	60.66 ^D
	2	51.42 ^A	55.66 ^B	58.38 ^C	58.66 ^D

*Dry baker's yeast added sample

**Sour dough added sample

Different letters (A,B,C,...) in the same row indicate differences among values ($P < 0.01$).

Table 3. The microbiological quality of tarhana samples during fermentation

	Samples	At the beginning	7 th day	14 th day	21 st day
TMAB log cfu g ⁻¹	1*	5.89 _B	5.97 _A	5.18 _B	4.95 _B
	2**	7.04 _B	7.94 _A	6.64 _B	5.00 _B
Coliform group log cfu g ⁻¹	1	2.48	<1	<1	<1
	2	2.95	<1	<1	<1
LAB log cfu g ⁻¹	1	4.25 _B	5.34 _B	6.00 _A	5.48 _B
	2	4.40 _B	5.87 _B	6.78 _A	6.23 _B
Yeast-Mold log cfu g ⁻¹	1	6.90 _A	6.84 _A	6.00 _A	5.60 _A
	2	4.30 _A	4.00 _A	4.59 _A	4.46 _A

No statistical evaluation for coliform bacteria counts.

*Dry baker's yeast added sample **Sour dough added sample

TMAB: Total mesophilic aerobic bacteria, LAB: Lactic Acid Bacteria

Different letters (A,B,C,...) in the same row indicate differences among values ($P < 0.05$).

Table 4. Sensory analysis of tarhana soup samples

Samples	Colour (0-10)	Odour (0-10)	Consistency (0-10)	Taste (0-10)	GA** (0-10)	Total
1*	4 ^E	6 ^B	8 ^A	7 ^{AB}	7 ^{AB}	32
2	7 ^C	6 ^B	7 ^A	6 ^B	6 ^B	31
3	5 ^D	7 ^{AB}	7 ^A	7 ^{AB}	6 ^B	33
4	8 ^B	7 ^{AB}	7 ^A	6 ^B	7 ^{AB}	35
5	8 ^B	8 ^A	7 ^A	8 ^A	8 ^A	39
6	9 ^A	8 ^A	8 ^A	8 ^A	8 ^A	41

*1: with sour dough and fermentation time is 7 days

3: with sour dough and fermentation time is 14 days

5: with sour dough and fermentation time is 21 days

2: with baker's yeast and fermentation time is 7 days

4: with baker's yeast and fermentation time is 14 days

6: with baker's yeast and fermentation time is 21 days

**GA: General acceptability

Different letters (A,B,C,...) in the same column indicate differences among values ($P < 0.01$).

respectively. In the same study, initially, on the 1st, 2nd, 4th, 6th, and 21st days of fermentation, lactobacilli counts of another tarhana dough sample were 7.5, 7.4, 6.8, 7.0, 8.0 and 7.7 log cfu g⁻¹, respectively.

3.3 Sensory Analysis

Tarhana soups cooked according to instructions (Fig. 1) were evaluated by panelists in terms of sensory properties. As a result of the evaluation,

samples left to fermentation for 7 and 14 days were less favored than those left to fermentation for 21 days. On the 21st day of fermentation, the sample added dry baker's yeast was the most favored sample (Table 4).

The difference among samples in terms of colour, odour, taste and general acceptability was significant ($P < 0.01$). In terms of consistency, the difference among samples is negligible ($P > 0.01$).

**Fig. 1. Tarhana soups**

1: with sour dough and fermentation time is 7 days

3: with sour dough and fermentation time is 14 days

5: with sour dough and fermentation time is 21 days

2: with baker's yeast and fermentation time is 7 days

4: with baker's yeast and fermentation time is 14 days

6: with baker's yeast and fermentation time is 21 days

It is stated in the TS 2282 Tarhana Standard that tarhanas should have their own yellowish red colour. The composition of the tarhanas produced in this study is similar to the composition of the tarhanas produced in the province of Kırklareli studied by Coskun [21]. As a result of sensory evaluation performed in that study, the colour and appearance, consistency, sensation in the mouth (taste, odour and other) scores of soups made from tarhanas produced in Kırklareli province were 8, 7, 8, 8, respectively. The results are similar to the results obtained in this study. In that study, the taste and smell of baker's yeast-added tarhanas were better than tarhana, which has no baker's yeast added.

4. CONCLUSION

Tarhana is a semi-prepared food that can be safely consumed and high nutritional value. Beside the nutritional value of the raw materials used, fermentation also increases nutritional value. With the prolongation of the fermentation time, pH decreases more and the product becomes safer using dry baker's yeast. More durable products with lower pH can be obtained. The use of baker's yeast improves the taste colour and consistency in the tarhana soup. The fermentation period of commercially produced tarhana is usually 5-7 days. Application of different fermentation times may increase consumer liking. Longer fermentation times may have negative consequences if the air temperature is above 25°C.

COMPETING INTERESTS

Author has declared that no competing interests exist.

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