

**Traditional Fermented Foods from Turkey.** By M. Samli & S. (Tellioglu) Harsa. *Food Engineering Department, Izmir Institute of Technology, Gulbahce Kampus, 35430, Urla, Izmir, Turkey.*

• **Background & history**

The origin of Turkish nutrition culture- which is one of the richest cuisine cultures among the world- mainly belongs to Central Asia. The traditional Turkish cuisine culture has taken its final form *via* union of Anatolian and Ottoman cultures. The traditional production methods so far shape the scientific and technological bases of modern food industries. Fermentation is one of the most important techniques among all of production methods (1). There are several fermented food products belonging to Anatolian culture that have been traditionally produced for many centuries (Table 1) for their classification.

**Table 1.** Classification of Turkish fermented foods

Group	Products
Milk products	Yoghurt; Torba Yoghurt; Kurut; Ayran; Kefir; Koumiss; Buttermilk; Red Cheese
Meat Products	Sucuk; Pastırma; Bez Sucuk
Beverages	Rakı
Fruit & Vegetables	Turşu (Pickle); Shalgam juice; Hardaliye; Olive
Cereals	Tarhana; Boza; Sour Dough; Chickpea Bread; White Bread; Flat Bread; Millet Bread; Yufka; Mayalı; Bazlama; Simit

• **Which microbes are involved & Fermentation process**

Fermented foods and beverages are produced through the action of microorganisms (bacteria, yeast, and mycelia fungi; dominantly lactic acid bacteria ((LAB) and yeasts) and their enzymes. Lactic acid bacteria used in Turkish fermented foods are Gr (+), facultative anaerob, catalase (-), non-motile and non-spore forming bacteria (Table 2).

**Table 2.** Microorganisms used in Turkish fermented foods (1, 2, 3)

Products	Lactic acid bacteria (LAB)
Yoghurt	<i>Streptococcus thermophilus</i> and <i>Lactobacillus delbrueckii subsp. bulgaricus</i> , <i>Lactococcus lactis ssp. lactis</i> , <i>Enterococcus faecium</i> , <i>Enterococcus durans</i> , <i>Lactobacillus delbrueckii ssp. lactis</i>
Ayran	<i>Streptococcus thermophilus</i> and <i>L. delbrueckii subsp. bulgaricus</i>
Kefir	<i>Streptococcus lactis</i> , <i>S. durans</i> , <i>S. thermophilus</i> , <i>S. avium</i> , <i>S. cremoris</i> , <i>Lactobacillus kefir</i> , <i>L. bulgaricus</i> , <i>L. cellobiosus</i> , <i>L. kefiranofaciens</i> , <i>L. kefirgranum</i> , <i>L. parakefir</i> , <i>L. brevis</i> , <i>L. plantarum</i> , <i>L. helveticus</i> , <i>L. acidophilus</i> , <i>L. delbrueckii</i> , <i>L. hilgardi</i> , <i>L. casei</i> , <i>L.rhamnusus</i> , <i>L. paracasei</i> , <i>L. fructivorans</i> , <i>L. fermentum</i> , <i>L. viridescens</i> , <i>Lactococcus lactis subsp. cremoris</i> , <i>Leuconostoc mesenteroides</i>
Koumiss	<i>Lactobacillus bulgaricus</i> , <i>Lb. acidophilus</i>
Buttermilk	<i>Streptococcus salivarius ssp. thermophilus</i> , <i>Lactobacillus delbrueckii ssp. bulgaricus</i> , <i>L. casei ssp. casei</i> , <i>L. paracasei ssp. paracase</i> , <i>Enterococcus faecium</i> , <i>Leuconostoc</i>

	<i>pseudomesenteroides, L. gelidum, Weissella paramesenteroides</i>
Sucuk	<i>Lactobacillus plantarum, L. curvatus, L. pentosus, L. fermentum, L. brevis, L. sake, L. viridescens, L. agilis, L. carnis, L. casei subs. rhamnosus, Pediococcus pentosaceus, P. acidilactici, Lactococcus lactis subsp. lactis, Leuconostoc mesenteroides subsp. mesenteroides/dextranicum Lb. plantarum</i>
Pastırma	<i>Lactobacillus pentosus, L. sakei</i>
Pickle & Shalgam	<i>Lb. sanfranciscensis, Lb. pontis, Lb. brevis, L. plantarum, Lb. alimentarius, Lb. fructivorans, Lb. reuteri, Lb. fermentum, Leuconostoc mesenteroides, Pediococcus pentosaceus and Enterococcus faecalis</i>
Hardaliye	<i>Lactobacillus paracasei subsp. paracasei, L. casei subsp. pseudoplantarum, L. pontis, L. brevis, L. acetotolerans, L. sanfrancisco, L. vaccinostrercus</i>
Tarhana	<i>Streptococcus thermophilus, Lactobacillus bulgaricus, Lactococcus lactis, Lactococcus diacetylactis, Lb. acidophilus, Leuconostoc cremoris and Lb. casei</i>
Boza	<i>Leuconostoc paramesenteroides, Leu. mesenteroides subsp. mesenteroides, Leu. mesenteroides subsp. dextranicum, Leuc. raffinolactis, Leu. oenos, Lb. coryniformis, Lb. confusus, Lb. sanfrancisco, Lb. fermentum, Lb. paracasei subsp. paracasei, Lb. plantarum, Lb. brevis, L. rhamnosus, Lb. coprophilus, Lb. pentosus, Saccharomyces uvarum, S.cerevisiae Candida tropicalis, Candida glabrata, Geotrichium penicillatum, Geotrichium candidum, Candida diverca, Candida inconspicua, Candida pararugosa, Issatchenkia orientalis, Pichia fermentans</i>

Many traditional fermented foods and beverages in Anatolia are produced by natural spontaneous fermentations, or by employing the back-slopping method, while there is a very high degree of variability exists between each of these fermentations.

### Yoghurt

Yoghurt and similar types of fermented products have been made under household conditions, to meet the nutritional needs of villagers in some regions of Turkey and Middle Eastern countries for centuries. Yoghurt is produced by the “back-slopping method” and obtained through the lactic fermentation (2). Initially, *S. thermophilus* grows rapidly, ferments the lactose in the presence of the dissolved oxygen, and releases more lactic acid. This developing acidity, anaerobic condition, CO<sub>2</sub>, and formic acid provide an environment that is conducive to the growth and metabolism of *L. delbrueckii* subsp. *bulgaricus*. As a result of this cooperation, both bacteria actively metabolize lactose to lactic acid, aroma compounds, with exopolysaccharides sometimes being produced. Incubation is conducted at 42–45°C for 3–6 h. Many different types of yoghurt are available in Turkey e.g. *plain yoghurt, low-fat yoghurt, non-fat yoghurt, Turkish type creamy yoghurt, filtered yoghurt, sac yoghurt, Silivri yoghurt, winter yoghurt, and salted yoghurt.*

### Ayran

*Ayran*, a drinkable fermented milk product of Turkey is widely consumed especially in summer. *Ayran* has been manufactured for hundreds of years in homes in Anatolia, traditionally by mixing yoghurt with water and salt. Nowadays, however, it is produced on an industrial scale by milk fermentations with *S. thermophilus* and *L. delbrueckii* subsp. *bulgaricus* (2). *Ayran* is a very nutritious drink and also easily digestible. *Ayran* can be stored at refrigerated temperature for up to 15 days with acceptable sensory properties. Fermentation continues until a pH of 4.4–4.6 is obtained, the coagulum is then diluted by the addition of salty water. The finished product has a pH value of 4.2–4.3 (4).

### Kefir

*Kefir* is a viscous, effervescent, foamy and white coloured beverage which was originated from Caucasian region of Anatolia. Many types of milks (cow, goat, sheep, camel,

buffalo) and milk substitutes (soy, rice and coconut milk) are suitable for kefir production. Kefir grains incorporated into pasteurized milk and let to be ferment at ~25°C for 24 hours. Fermentation increases shelf life of milk product; kefir could be stored 20 days at refrigerated temperatures. Kefir is a potentially probiotic product since its microbiota consist of probiotic LAB and yeasts strains. *Kefir* differs from other fermented milk products in that it is produced as a result of a fermentation process involving a mixed microflora confined to a matrix of discrete “*kefir grains*” which are recovered for subsequent fermentation. *Kefir grains* are gelatinous, yellowish, irregular shaped, and vary in size, from 0.3 to 3.5 cm in diameter. *Kefir* contains a variety of up to approximately 40 aromatic compounds, including lactic acid, diacetyl and acetaldehyde, which give it a characteristic flavour and aroma (5, 2). Several health benefits have been attributed to kefir since it includes probiotics and antimicrobials:

- enhanced immune responses against tumors
- treatments of metabolic-gastrointestinal disorders, atherosclerosis, allergic disease, peptic ulcers biliary tract diseases, chronic enteritis, bronchitis, and pneumonia.

### **Boza**

Boza is generally produced from wheat, millet, maize or rice by fermentation. Boza is sweet-sour tasted, non-alcoholic, cold drink and suitable for consumption in winter season. Boza could be characterized as an acidic, pale coloured suspension. In production of boza, lactic acid and alcohol fermentation are applied by LAB and yeasts, respectively. Lactic acid produced by LAB, take a big role in maintaining the unique taste of boza. Metabolites of alcohol fermentation affect textural quality of boza. *Leuconostoc paramesenteroides* (25.6%), *L. sanfrancisco* (21.9%) and *L. mesenteroides subsp. mesenteroides* (18.6%) are dominant lactic acid bacteria; while is dominant yeast *Pichia fermentans* isolated from Turkish boza (2, 3).

### **Tarhana**

Tarhana is prepared by mixing and mixing and kneading wheat flour, yoghurt, salt, baker's yeast, various cooked vegetables (tomatoes, onions, salt, mint, and paprika) and spices. This mixture is left generally for 1-7 days, lactic and alcoholic fermentations play role. This dough, can be called as wet tarhana having acidic and sour taste, is dried under the sun or a dryer can be used to obtain dry tarhana. The nutritional properties, aroma and flavour of tarhana dough can be improved by homo/hetero fermentative lactic acid bacteria (LAB) and the metabolism of yeast fermentation; releasing lactic acid, ethanol, and carbon dioxide to the media. LAB are naturally occurring microorganism in tarhana and predominantly ferments cereal and milk.

*Lactobacillus bulgaricus* and *Streptococcus thermophiles* come from yoghurt, and *Saccharomyces cerevisiae* from yeast; *Lactococcus lactis*, *Lactococcus diacetylactis*, *Lactobacillus acidophilus*, *Leuconostoc cremoris*, *Lactobacillus casei* are naturally developed during the fermentation and give characteristic taste and flavour of *tarhana*. The reduction in the pH level (3.8–4.2) through the formation of organic acid during fermentation and the removal of excess water (6–10% moisture) by the drying process following fermentation make *tarhana* a poor medium for the growth of pathogens and spoilage microorganisms in general. Therefore tarhana has long shelf-life properties and highly nutritious (6, 7, 8, 9).

### **Tursu (Pickle)**

*Tursu* can be made from a wide variety of different vegetables and fruits such as cucumbers, cabbages, green tomatoes, green peppers, *acur*, melon, carrots, green beans, red beets, egg plants. Large quantities of *tursu* are produced in households throughout Anatolia,

especially in autumn months and it is one of the oldest fermented product. To prepare *tursu*, vegetables and/or fruits together with the flavouring agents (garlic, parsley, ginger, fresh dill, fresh mint, and bay leaves) are placed in either glass or plastic containers and pressed. Usually grape vinegar is added on top of fruits&vegetables and/or brine solution containing appr.10–15% NaCl; the pickles are left to ferment by their natural microflora at about 20°C for 4 weeks, but in some instances the “back-slopping method” is used in *tursu* production. *Tursu* fermentation process typically begins a few days after the vegetables/fruits have been placed in the brine. This traditional fermentation of vegetables and fruits most often involves lactic acid fermentation with many different species of lactic acid bacteria being active at different stages of the fermentation process which is then followed by yeast fermentation (2).

### **Shalgam Juice**

Shalgam juice is a cloudy, sour tasted beverage. Turnips, black carrot, bulgur flour mixture in water are fermented by lactic acid bacteria and salt is used as additive. Black carrots give the red colour of shalgam juice. In the Mediterranean region, it is widely consumed especially in lunch and dinner with kebab. Shalgam juice is very nutritious containing minerals, vitamins, amino acids and polyphenols at high amounts. Shalgam juice is traditionally produced by sourdough fermentation. Fermentation is performed in order to increase the numbers of LAB and yeasts. Sourdough is obtained from fermented baker's yeast. Water soluble part of mixture is separated after fermentation. Salt, sliced black carrot and turnip are added into water soluble extract for carrot (2nd) fermentation. The mixture is then fermented from 3 to 10 days inversely proportional to the temperature. After the second fermentation, shalgam juice takes its final form by filtration. In another method, chopped black carrots, salt, sliced turnip, bakers' yeast (*Saccharomyces cerevisiae*) or sourdough and adequate water are directly added into fermentation tank. Fermentation occurs at ambient temperatures in between 10 - 35 °C for 3–5 days (2, 3).

### **Sucuk**

Sucuk, a dry-fermented sausage, is a well-known traditional meat product in Turkey. It is prepared by kneading sheep and/or beef meat or goat meat or buffalo meat with a required amount of tail fat, sugar, salt, nitrite/nitrate, dry garlic, and various species such as black pepper, paprika, and cumin. The mixture (sucuk dough) is then stuffed into the small intestines of cattle that have been cleaned and allowed to ferment and dry for several weeks at ambient temperature. Traditionally, starter lactic cultures are not used in the production of sucuk and fermentation occurs spontaneously by sucuk microflora which predominantly consisted of lactic acid bacteria. This resulted in large variations in both the quality and stability of the end product. It was therefore necessary to use starter cultures to avoid these variations in the quality of the product. Also, there is no heat treatment in the traditional production of sucuk. In the past decade, heat processing has however been incorporated into the production stage resulting in shorter processing times and in a safer product. Sucuk is generally heated to an internal temperature of 45–70°C after a short fermentation period (2, 10, 11).

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