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Traditional Turkish Fermented Cereal Based Products: Tarhana, Boza and Chickpea Bread

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ABSTRACT

Fermented products are one of the important foodstuffs in many countries of the world. People have gradually recognized the nutritional, functional and therapeutic value of these products and this has made them even more popular. Today, almost all consumers have a significant portion of their nutritional requirements fulfilled through these products. Scientific and technological knowledge is quite well developed for some fermented products such as wine, beer, cheese, and bread. These products are produced universally. However, scientific knowledge for some traditional foods produced locally in Turkey is still poor and not thorough. Numerous traditional, cereal-based fermented foods are produced in Turkey. The aim of this paper is to provide knowledge regarding the characterization, raw materials used for production, production methods, fermentation conditions and microorganisms which are effective in the fermentation of traditional foods. The study will focus on Boza, Tarhana, and Chickpea bread which are foods widely produced in Turkey.

Introduction

Daily foods, which are essential for establishing a balanced human life, consist of various foods which have different origins and process types and reflect the taste of the region in which they were produced. Among them, products produced by fermentation have an important place (Tanguler et al., 2010). In general, fermentation is an inexpensive process involving the use of microorganisms to carry out enzyme catalysed transformations of wide range of agricultural materials (Erten et al., 2008). It is one of the oldest and economical methods of food processing and safety (Erbas et al., 2005). Although the primary purpose of fermentation was to achieve food safety, it plays at least five roles: (a) bettering the diet through a diversity of flavors, nutritional value and textures in food substrates; (b) preservation of food through lactic acid, acetic acid and ethyl alcohol; (c) biological enrichment of the substrates; (d) detoxification and destruction of undesirable substances present in raw foods such as cyanide, phytates, tannins and polyphenols during food fermentation processing; (e) lowering cooking times and fuel requirements (Aloys and Angeline, 2009; Liu et al., 2011).

Fermented products derived from plant and animal materials are made in different parts of the world. Some, such as beer, wine, pickles and cheeses are made in large-scale industrial production and therefore are of significant commercial importance worldwide (Waites et al., 2001). In contrast; some are minor products in global terms, although they are made commercially in some countries. Examples of these are shalgam (Erten and Tanguler, 2010), tarhana (Settanni et al., 2011), kefir (Kesmen and Kacmaz, 2011), koumiss (Kabak and Dobson, 2011), ayran, which is a yoghurt based drink, kanji (Erten et al., 2008) and boza (Yegin and Fernández-Lahore, 2012).

In many reviews and text books, authors have mentioned the diversity of traditional fermented foods produced in Asia, Africa, and in Western countries, their preparation methods, and the safety conditions thereof in the past two decades. However, in the literature, there are some reports (Daglıoglu, 2000; Zorba et al., 2003; Hatzikamari et al., 2007a; Cosansu, 2009; Ozer et al., 2010; Kabak and Dobson, 2011; Altay et al., 2013; Ozturk et al., 2013) on general composition, microbiological processes, and preparation methods of traditional Turkish foods and beverages. Therefore, this review aims to characterize some traditional Turkish cereal-based fermented products in their traditional production methods, fermentation conditions and microorganisms.

Fermented Cereal Based Foods and Beverages

Cereals have a noteworthy place among the dietary nutrients all over the world. Fermentation of cereal has a long history of preparing a variety of foods. And fermentation might be the most simple and inexpensive way of increasing their nutritional value, sensory properties, and functional qualities, even though they lack some basic components (e.g. essential aminoacids). Cereal-based fermented products contribute to about one-third of the diet world wide. Several types, which can be categorized by the raw materials used or the type of fermentation involved in the manufacturing process, are produced. Among the cereal based fermented foods, bread and beer are the most popular ones, but there are also many other indigenous cereal-based fermented foods prepared in other parts of the world (tempeh, pito, sekete, kwass and etc.) and in Turkey (boza, tarhana, kumru and etc.). Most cereal based food and beverages in Turkey are prepared using either wheat, maize, barley, oat, millet, rice or their flours (Blandio et al., 2003; Kabak and Dobson, 2011; Yegin and Fernández-Lahore, 2012).

Boza

Boza is a highly viscous and low-alcoholic traditional Turkish fermented cereal beverage (Yegin and Fernández-Lahore, 2012; Akpınar-Bayizit et al., 2010). It is also consumed widely in some Balkan (Albania, Bulgaria, the Republic of Macedonia and Romania), Middle East (Iran and Iraq), Asia (Turkestan) and African (Egypt and Kenya) countries (Arıcı and Dağlıoğlu, 2002). According to Turkish Standards Institution (TS 9778), boza is defined as "A product which is made by adding drinkable water to cereals such as millet, maize, wheat, and rice. The sugar is then added to allow alcohol and lactic acid fermentation. Boza can be classified as sweet or sour boza depending on its acid content" (Anonymous, 1992).

Boza is produced mainly in homes and also commercially. However, there is an increasing interest in the production of boza in a large scale. There may be some differences in the methods of production but cereals are always the major component (Akpınar-Bayizit et al., 2010). Boza is made of various kinds of cereals such as millet, maize, and wheat. Boza can also be produced by the combination of any of the mentioned cereals. But, the best quality and taste is made of millet flour (Arıcı ve Daglıoglu, 2002; Yegin and Fernández-Lahore, 2012).

The most important factors affecting the physicochemical properties of boza are the types and amounts of cereals and cereal products as a raw material used in boza production, fermentation time and temperature. Especially, extended fermentation time results in higher amounts of total acidity and lower pH (Altay et al., 2013). Akpinar-Bayizit et al. (2010) stated that raw materials such as rice, millet and wheat effected on the chemical composition of boza.

The production of boza is given in Figure 1. Preparation of boza includes processes, (a) breaking a selected and cleaned cereal, or a combination of two or more cereals into the size of semolina between 300-800μm, (b) cooking at 2-8 hours in an open or steam jacketed stainless steel boiler after the addition of drinkable water. During the boiling process, the mixture absorbs water and therefore hot water is added several times, until a homogenous pulp is obtained. Then, the cooked material is transferred into suitable vessels for cooling. For removing bran, hull and other foreign materials, the cooled pulp is strained. After sugar (15-20% sucrose) addition, the broth is fermented at 15-30ºC for 24 hours by adding previously fermented boza (2-3%), sourdough or yoghurt as a starter culture. The ratio of the starter culture depends on the season and temperature (Arıcı and Dağlıoğlu, 2002; Tamer and Copur, 2004).

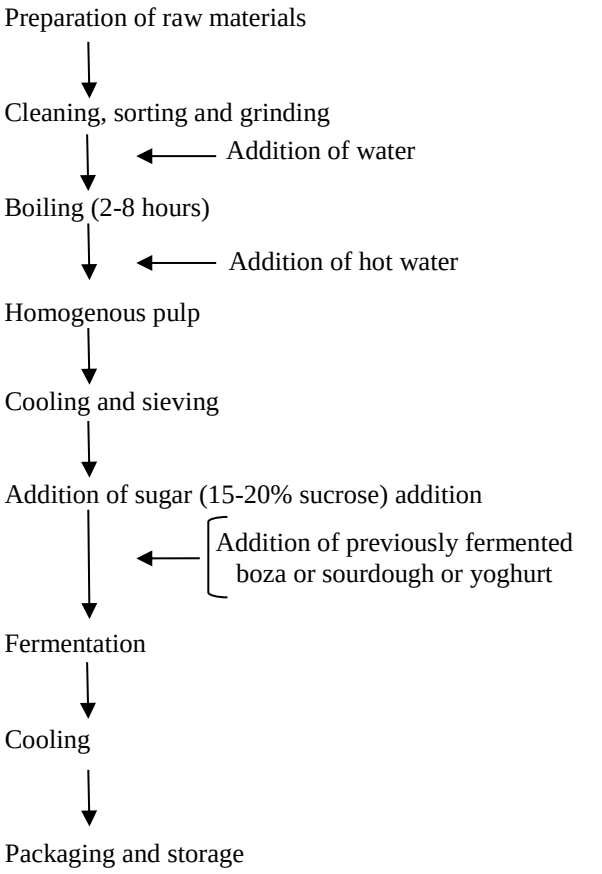

Figure 1 Production of boza (Adapted from Arıcı and Dağlıoğlu, 2002; Tamer and Copur, 2004).

During the fermentation, two different kinds of fermentation happen concurrently: Alcohol fermentation and lactic acid fermentation (Arıcı and Dağlıoğlu, 2002). Microorganisms responsible for alcohol fermentation in boza are yeasts (*S. cerevisiae, S. carlsbergensis, C. tropicalis, C. pararugosa, C. diversa, C. boidinii, C. lactiscondes, C. lambica, C. norvegica, C. inconspicua, Pi. fermentans, Pi. norvegensis, R. mucilaginosa, R. araucariae* and *T. delbrueckii)* and lactic acid bacteria, LAB, (*Lb. confusus, Lb.fermentum, Lb. plantarum, Lb. cryniformis, Lb. sanfrancisco, Lb. coprophilus, Lb. paracasei* subsp. *paracasei, Lb. brevis, Lb. acidophilus, Lb. rhamnosus, Leu. mesenteroides, Leu.oenos, Leu. raffinolactis, Lc. lactis, P. pentosaceus* or *Weissella* (*W.*) *confusa*) (Hancıoğlu and Karapınar, 1997; Tamer and Copur, 2004; Botes et al., 2007). Total counts of LAB and yeast found vary within the range of 2.94×10^5–4.6×10^8 cfu/mL and 2.24×10^5–8.40×10^7 cfu/mL in boza, respectively (Hancioglu and Karapinar, 1997).

Fermentation is not completely terminated during the boza production. After 24 hours of fermentation, partially fermented boza is cooled to refrigeration temperature and bottled in plastic containers. It should be consumed within 3-5 days (Arıcı and Dağlıoğlu, 2002). Usually, people consume boza during the winter season. On the other hand, boza is also preferred in summer. Generally served pure, it might also be served with cinnamon and/or unsalted roasted chickpeas sprinkled over the fermented cereal (Genc et al., 2002; Yegin and Fernández-Lahore, 2012). According to the Turkish Standard Institute, total dry matter and total sugar (as sucrose) content should be a minimum of 20% and 10%, respectively. Ethyl alcohol content should not exceed 2% by volume and total acidity as lactic acid should be 0.2–1.0% in boza (Anonymous, 1992).

Tarhana

Tarhana is an old and popular cereal-based traditional Turkish fermented product. It is produced by lactic acid and ethyl alcohol fermentation of a mixture of wheat flour, yoghurt, yeast, some vegetables and various spices, followed by drying and grinding. There are some other food products similar to tarhana such as kishk/kushuk, trahana/trahanas/kapostoes, trahana, tarana, goce, tahonya/thanu, talkuna and atole in the Middle East, Asia, Balkans and Europe (Maskan and İbanoglu, 2002; Erten and Tanguler, 2010).

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 (Daglioglu, 2000; Maskan and İbanoglu, 2002). However, there are four different types of tarhana, stated by Turkish Standardization Institute (TS-2282): flour tarhana, goce (cracked wheat) tarhana, semolina tarhana and mixed tarhana (Anonymous, 1981). The difference between them is the usage of the wheat flour, chopped wheat and semolina separately or as combinations in the recipe (Daglioglu, 2000; Maskan and İbanoglu, 2002). In the production of tarhana, cereal and legume flours other than wheat flour can also be used (Ozdemir et al., 2007). The contents and quantities used for tarhana preparation may differ, but the major ingredients are always cereals and stirred or set type yoghurt. The widely-known methods for tarhana production on a commercial scale are; (a) direct method (b) sour dough method (Daglioglu, 2000; Maskan and İbanoglu, 2002).

The production of tarhana by direct method is given in Figure 2. In the direct method, onion is chopped and blended in a blender. Then, it is mixed with wheat flour, durum wheat semolina, tomato paste, red pepper paste, lentil flour, vegetable oil, salt, bakers' yeast, yoghurt and citric acid. The mixture is kneaded for 15 minutes into dough with the addition of water, or yoghurt serum, if necessary. The obtained dough is spread over a stainless steel tray to a depth of 1-1.5 cm and then subjected to fermentation at 30-40ºC (generally at 35ºC) for 5 days. The characteristic taste, flavour and odour of tarhana develops during dough fermentation (Dağlıoğlu, 2000; Maskan ve İbanoglu, 2002; Erbaş et al., 2005; Özdemir et al., 2007).

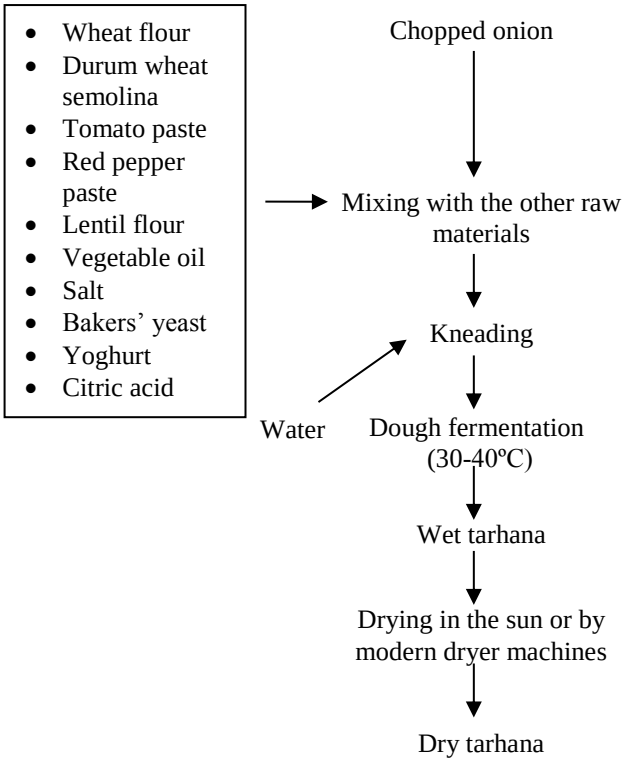

Figure 2 Tarhana production by direct method (Adapted from Dağlıoğlu, 2000; Erbaş et al., 2005; Özdemir et al., 2007).

In the sourdough method, there are three different production recipes. Each one has different amounts and type of ingredients. Baker's yeast is not used in sourdough method. Tarhana production by sourdough method is given in Figure 3. For each method, first all ingredients in the recipe are mixed, after which they are kneaded. The obtained dough is spread over a stainless steel tray and then fermented at 40-42ºC (Daglioglu, 2000). Fermentation time ranges from 1 - 7 days depending on the desired properties of tarhana (Tamer et al., 2007).

During fermentation, yogurt bacteria (*Lb. delbrueckii* subsp. *bulgaricus* and *Str. thermophilus*,) and baker's yeast (*S. cerevisiae*) are mainly responsible for the formation of lactic acid, ethanol, carbondioxide and some other fermentation products (Daglioglu, 2000). Partially digested and hydrolysed by LAB and yeast during fermentation, protein, carbohydrate, and lipid, result in a product with improved digestive properties (Ozdemir et al., 2007). Other LAB such as *Lb. plantarum, Lb. casei* subsp. *pseudoplantarum, Lb. helveticus, Lb. brevis, Lb. delbrueckii* subsp. *bulgaricus, Lb. acidophilus, Lb. casei, Lc. lactis, Lc. diacetylactis, Leu. cremoris, Leu. mesenteroides* subsp. *mesenteroides, S. thermophilus, P. pentosaceus* and *P. acidilactici* (Daglioglu, 2000; Erten and Tanguler, 2010; Settanni et al., 2011), and yeast (*Rhodotorula glutinis*) have also isolated in tarhana fermentation. The most important microbial group for tarhana fermentation is LAB, they have a key role in 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 (Settanni et al., 2011).

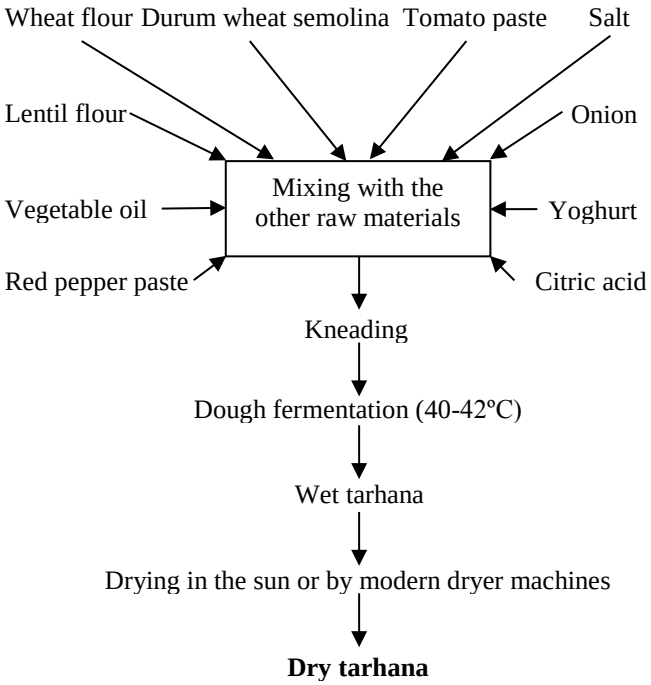

Figure 3 Tarhana production by sourdough method (Adapted from Dağlıoğlu, 2000; Özdemir et al., 2007).

At the end of the fermentation, dough has an acidic and sour taste and is called 'wet tarhana'. 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 (Maskan and İbanoglu, 2002; Tamer et al., 2007; Certel et al., 2007).

In the final product, low pH (3.3±5.0), low moisture (6–10%) and components (organic acids, bacteriosin, etc.) make tarhana a poor medium for pathogens and spoilage organisms during long term storage (Maskan and İbanoglu, 2002; Tamer et al., 2007). Because, it has been determined that the major food pathogenic microorganisms survive during production of tarhana, it is advised not to consume wet fresh tarhana within the first 7 days of production (Settanni et al., 2011). Its shelf life varies, but because of low moisture content and pH, generally it can be stored for 2-3 years without any sign of deterioration (Koca et al., 2002; Kose and Cagindi, 2002; Ozdemir et al., 2007; Certel et al., 2007). After drying and having a certain size (particle size <800µm), tarhana is sold as powders in the Turkish supermarkets in 70–100 g plastic bags or 500 g in cloth bags and stored at ambient temperatures (10–30°C) (Ozdemir et al., 2007)

People generally consume tarhana as a soup at lunch and dinner. In addition to its highly flavored, thick-creamy and high nutritive value, tarhana soup can be easily digested. It is also consumed as a snack when dried as thin layer or nugget after fermentation (Erbas et al., 2005; Ozdemir et al., 2007). It is a good source of proteins, vitamins (B_1 and B_2), minerals (calcium, iron, sodium, potassium, magnesium, zinc and copper) and so is usually fed to children and elderly people in the form of a thick soup (Maskan and İbanoglu, 2002; Daglioglu, 2000; Koca et al., 2002). The nutritional content and organoleptic properties of tarhana may be controlled by varying the type and quantity of ingredients (Kose and Cagindi, 2002).

The commercial interest in producing tarhana powder as an instant form in recent years increases. Tarhana powder in instant form would be very valuable in hospital and school canteens, as well as in the home. It can be produced by extrusion cooking, spray drying, and atmospheric boiling (Maskan and İbanoglu, 2002).

Chickpea bread

Production of bread is one of the most widespread and ancient foods consumed by humans known since ancient times. It is stated that the first bread was made in Egypt around 4000 B.C. (Tuncel et al., 2010). Bread is mainly produced from wheat in Turkey and plays an important role in Turkish culture. There are many different types of bread, but they are well described in the scientific literature. For this reason, a lesser known fermented product from chickpeas that is already produced and marketed, is being reviewed in this study.

In some Mediterranean countries such as Turkey, Macedonia and Greece, bread dough is also produced using "chickpea yeast" and the chickpea bread is made by that yeast in some places of Aegean, Thrace, Meditarrenean and Middle Anatolia regions in homes and commercially in some bakeries. Chickpea yeast as a leavening agent and for giving distinctive odour and taste is especially used to make some products such as galeta, simit, peksimet (Melba toast) and kumru (Hancıoğlu-Sıkılı, 2003; Ozer et al., 2010).

"Chickpea yeast" is a filtrate obtained by filtrating the mixture of coarsely grounded chickpea, salt and boiled water which has been fermented at 37-40°C for 16-18 hours. "Sweet chickpea yeast (dough)" is described as a sponge which is made by mixing the filtrate (fermented and filtrated liquid) with wheat flour and some salt and left to raise to the initial volume. Bread obtained from this mixture is known as "chickpea bread or bread with sweet ferment" (Ozer et al., 2010; Hatzikamari et al., 2007a).

National and international studies are limited on the microflora of chickpea fermentation and the properties of chickpea bread. While in a study done by Hancıoğlu-Sıkılı (2003) and Cebi (2009) in Turkey, only LAB such as *Lb. plantarum, Lb. pentosus, Lb. bifermantans, Str.thermophilus, Lc. ssp. lactis, Lb. brevis, Lb. plantarum, Lb. pentosus* and *Weisella confuse* and yeasts such as *S. cerevisiae* were identified. In a study performed in Greece (Hatzikamari et al., 2007b) *Bacillus* spp. (especially *B. cereus, B. thuringiensis* and *B. licheniformis*) and *Clostridium* spp. (especially *Cl. perfringens and Cl. beijerinckii*) were identified. Baykara (2006) and Hatzikamari et al. (2007b) stated that using cheackpea yeast to make bread is possible.

The carbohydrate amount found in Chickpea bread is 47.45%. In addition, it has 35% moisture, 1.75% ash and

13.60% protein content (Tuncel et al., 2010). Regarding chickpea dough and bread, research is lacking with respect to: (a) isolation, purification and identification of the predominant flora (LAB, *Bacillus* spp., *Clostridium* spp. and yeasts) during fermentation by phenotypic and genotypic methods; (b) selecting the most promising bacteria (especially LAB) for industrial usage as starter culture; (c) production chickpea bread using selected cultures; (d) identification of flavor active compounds. Therefore, there is a need for research to address these afore mentioned subjects.

Conclusions

Day by day there is increasing scientific findings that many fermented foods and beverages are good for health or contain ingredients that are good for our health. Particularly, the fermented products related to the group of microflora which has an effect of enhancing levels of protein, vitamins, essential amino acids and fatty acids. For this reason, fermented foods and beverages, especially because of increasing populations, consumer demands and, protein and vitamin deficiencies in second and third world countries, may become even more important in a daily diet and the maintenance of health. However, specific scientific information for some traditional Turkish fermented products such as chickpea bread, are still needed. For some fermented products, several subjects are not been well understood with respect to (1) isolation, purification and identification of the predominant flora during fermentation by phenotypic and genotypic methods; (2) selecting the most promising bacteria and/or yeast for industrial usage as starter culture; (3) production using selected cultures; (4) identification of flavor active compounds; and (5) nutritional, functional and therapeutic properties. This review about fermented food and beverages should encourage further research to evaluate those characteristics.

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