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A Traditional Fermented Product 'Kishk'

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Abstract

The preservation of food through fermentation dates back to ancient times. With the understanding of its positive effects on health, fermented foods have become commonly consumed today. Kishk, a traditional fermented product among fermented foods, is widely produced in different countries, especially in the Eastern Mediterranean, North Africa, and the Middle East. It is similar to tarhana and is made by fermenting and drying a mixture of milk or fermented milk products (yogurt, buttermilk, churned buttermilk "Shanina," or Labneh), along with bulgur or other cereals and salt. The production of kishk can vary from country to country and even within different regions of the same country. This variation makes it difficult to standardize kishk production worldwide. This study aims to provide general information about kishk, which is relatively unknown in Turkey but broadly produced and consumed with love worldwide, especially in Arab countries.

Anahtar Kelimeler: Fermentation, food, kishk, production, traditional

Geleneksel Bir Fermente Ürün 'Kişk'

Öz

Gıda maddelerinin fermantasyon yolu ile muhafazası tarihte çok eski yıllara kadar uzanmaktadır. Sağlık üzerindeki olumlu etkilerinin anlaşılmasıyla birlikte, fermente gıdalar günümüzde sıklıkla tüketilen gıdalar haline gelmişlerdir. Fermente gıdalar arasında yer alan kişk farklı ülkelerde; özellikle de Doğu Akdeniz, Kuzey Afrika ve Orta Doğu'da yaygın üretilen, tarhanaya benzeyen, süt veya fermente süt ürünleri (yoğurt, yayık ayranı "Shanina", veya Labne) ile bulgur gibi tahıl ürünleri ve tuz eklendikten sonra fermente edilip kurutularak elde edilen geleneksel bir fermente üründür. Kişk üretimi ülkeden ülkeye hatta aynı ülkenin farklı bölgelerine göre değişkenlik gösterebilmektedir. Bu durum dünyada standart bir kişk üretiminin yapılmasını zorlaştırmaktadır. Bu çalışmada; Türkiye'de az bilinen ancak dünya genelinde ve başta Orta Doğu ülkeleri olmak üzere birçok Arap ülkesinde geleneksel olarak üretilip sevilerek tüketilen kişk hakkında genel bilgilerin verilmesi amaçlanmıştır.

Key Words: Fermantasyon, gıda, geleneksel, kişk, üretim

INTRODUCTION

Fermentation is one of the most inexpensive techniques for manufacturing and preserving food (1,2). It has been used along with smoking, drying, and salting processes since ancient times to store food for later consumption, marking a significant step in the culinary history of humanity (3-7). Fermentation is a natural method that enhances the nutritional value of foods by preserving them from spoilage and providing essential amino acids, probiotics, postbiotics, and vitamins. Moreover, it increases the digestibility and absorption of some nutrients. It also detoxifies unwanted substances such as phytates, tannins, and polyphenols in raw foods or breaks down lactose sugar, thus helping lactose-intolerant individuals (8,9).

Fermented foods are defined as foods that undergo fermentation through controlled processes involving beneficial microorganisms, resulting in various enzymatic changes and health-promoting end products. With the appearance of microbiology as a branch of knowledge in the xixth century, the fermentation concept started to be understood, and dairy-based fermented products were considered inherently safe, acceptable, and highly nutritious and were being offered to the customers (1,2,10-13). Fermented foods and beverages are a fundamental component of the dietary culture of every society in the world, carrying the cultural history of ethnic communities (9,10,14-16). It is evaluated that more than

thirty-five hundred fermented foods and beverages are produced worldwide, including dairy-based (Kefir, Kumis, Kurut), grain-based (Boza, Mahewu, Idli, Dosa), and grain-dairy-based (Tarhana, Kishk) products (3,6-9,17). Fermented products have many biological functions, such as preserving perishable foods, enriching nutritional value, producing antioxidants and postbiotics, and having immunological benefits due to the functional microorganisms they contain. Besides being greatly nutritious, their organoleptic properties appeal to many taste buds, which makes them have high acceptability (11,18-21). This is the reason why the range of fermented dairy products and their variety is expanding day by day, such as Greek-style yogurt and yogurts containing probiotic microflora (e.g., *Lactobacillus acidophilus* and/or *Bifidobacterium* spp.) (5,7,9).

Kishk is a traditional fermented product based on grains and dairy, originated in the Pharonic period (3200-322 B.C.) in Upper Egypt where it's called 'Kishk Sa'eedi' and is made in various shapes and forms depending on the geographical region. The time when kishk began to be developed in Lebanon during the early 10th century, mainly in the Al-Bekaa' region, then started to be known in the nearby countries such as Jordanian and Syrian regions with some differences in the production process. In this review study, introducing the traditional production stages and the general characteristics of kishk based on compiled research have taken place (13,22-25). It's foreseen that this can be a great reference to produce more functional kishk products that can be high quality, safe with long-shelf-life, and at the same time super fortifying food. This would be a significant contribution to future generations and school students, the dairy food sector, and the kishk industry.

KISHK TYPES AND NOMENCLATURE

Kishk is a highly nutritious, fermented food widely consumed by rural populations, particularly in the Eastern Mediterranean, Middle East (including Egypt, Syria, Lebanon, Northern Jordan, and Iraq), and the Indian subcontinent. At the same time, similar products are widespread in Greece and Turkey. The different synonyms of the word 'Kishk = dried yogurt' vary according to the product's production region, the type of milk and grain used, the borrowed name, the country's convention, and the type of content material (13,15,17). For instance, the fermented product kishk, made from bulgur and yogurt (Laban Zeer), is called Sa'eedi (KS) in Egypt. The variation in naming is due to differences in the cereal base used when both the yogurt base and salt addition remain constant (Table 1).

Table 1. Synonyms for Kishk and related products in different countries[a]

Traditional Name	Ingredient/additive[b]	Country
Kishk, Kushuk, Keshkeh, or Kichk Sa'eedi	Bulgur, Burgul or Burghol[c]	Syria, Lebanon and Egypt
Hogut	Same as above	Qatar
Kishk Siyamy	Vegetables	Egypt
Zhum	Wheat flour, garlic and pepper	Yemen
Kushuk, Kushik	Wheat flour and herbs	Iraq
Kashk, Kaskg	Herbs	Iran
Chura	Wheat flour and tea	Nepal, Tibet, India
Tarhana, Kapestoes	Crushed wheat or flour	Greece and Türkiye
Kurut	None	Türkiye
Madeer, Oggt	None	Saudi Arabia
Tamar Oggt	Dates	Saudi Arabia
Klila	None	Algeria

a Data compiled from Tamime et al. (13).
b Major ingredients besides the salt added to yogurt.
c Parboiled cracked wheat

KISHK PRODUCTION

The traditional method of producing kishk has been inherited through generations and has shaped the food identity of Egyptian, Syrian, and Lebanese people. Involving two main components: cereal and fermented milk. Systematically, as grains, white and hard cracked wheat "bulgur," *Triticum vulgaris*, and as fermented milk, yogurt, are the most used ones (1,10,13,24). However, the types of ingredients (such as cow, goat, sheep, buffalo, or camel milk; white/brown bulgur, rice, etc.) and the preparation method (including the making processes, fermentation conditions and techniques, storage conditions, tools and utensils used) vary across different regions, countries, and ages. This is the reason why its chemical composition, physical, and sensory properties also differ (12,15-17). For example, while goat and buffalo milk are used in Lebanon and Egypt, camel milk products are more preferred to be used in North Africa. Thus, differences in the materials used and traditional methods during kishk production can factually affect the compositional, sensory, and nutritional properties of the final product (1,17,23,25). Kishk is typically made during the spring and summer months, specifically in August and July, when the sunlight and temperature are the most suitable for open-air fermenting and drying. The traditional kishk is prepared in 4 stages: 1. Cereal and

milk processing and mixing with salt, 2. Fermentation (conditioning), 3. Hand-shaping and drying, and 4. Packing or packaging (10,12-17).

Cereal and Milk Processing

White hard durum wheat, commonly referred to as "bulgur" in Turkish, is typically used in kishk production as cereal. Wheat grains are cleaned of dirt using a metallic sieve called 'Ghorbal' that was usually used to separate the fine particles of grains from the coarse ones. Then partially boiled until they become soft 'Belila' (1,12,15). The partially boiled wheat grains are washed and spread over fabric mats or trays to be sun-dried for 24-48 hrs. Thereafter, the dehydrated grains are crushed using a stone/wood hand mill, named Al-Jaroush or Rahaia, into various sizes. The hard bulgur grains are selected for production. Historically, the rotary hand mill, which is called Rahaia, was also used for grinding different cereals (e.g., millet, bulgur, rice, chickpeas, lentils, oats, and barley), turning them into powder or small pieces. Nowadays, these hand mills have been replaced by small mechanized manual or electric grinders and large rotary industrial grain mills (10,15). For making yogurt, 'Laban Rayeb,' 'Laban Zeer,' or 'Laban Khad,' sheep and cow milk are the most traditionally preferred among Arab countries. Full cream sour milk or sour buttermilk was sometimes utilized by the elite class. Generally, the milk used is full, med, low-fat cow milk, and it's initially pasteurized to eliminate microorganisms that could compete with the starter culture. Milk fermentation is carried out using a yogurt starter (The starter culture from a previous batch of yogurt) added at 45 ^{o}C (1,13,15,17). The name 'Laban Zeer' comes from the earthenware jars called 'Zeer' in which sour buttermilk was gathered and drained to be used in the making of kishk.

Fermentation (conditioning)

Yogurt is gradually and daily added to the bulgur at usually a 1:2, 1:4 or 1:5 ratio (w:w) over 2-8 days (at 30-35°C), mixed with (1-6% w/w) salt, and always covered with a thick fabric or metallic cover, resulting in hydrated bulgur indulged in a Kishk paste called 'Hamma' (13,15,16,23). Ambient temperature, relative humidity (RH), culture, and moisture content influence the fermentation rate and the absorption rate of the premix. Salameh et al. (24) studied the sorption isotherms of kishk samples when exposed to a progressive rehydration process with a gradually increasing relative humidity (RH) under a controlled atmosphere, temperature, and time. Prominent changes in the microstructure of the particles' surface were observed clearly at high water activities (a_w) (above 0.75 a_w). Concluding that water absorption, surface rehydration, and physical bonding between kishk particles are directly proportional to the biochemical interactions of starch and protein, resulting in the formation of more solid bridges and agglomerations. The purpose of the fermentation step is to enhance the product's safety, flavor, nutritional value, texture, and rheological quality (11,24-26).

Hand-Shaping and Drying

When fermentation ends, the paste 'Hamma' is modeled into tiny sphere shapes, placed over mats or trays on concrete roofs to be sun-dried for 2-8 days until reaching 6-12% moisture content. No specific temperature had been identified specifically for this step, but it's thought to be between 48 and 55 ^{o}C. Dried kishk is either ground into a fine powder using grain mills or food/grain processors or sold as small round balls. Nowadays, Kishk is produced with variations in traditional production basic lines and materials. It's being fermented under much more aseptic conditions and dried in an air oven and by freeze or roller-drying (13,15-17,23,27,28).

Packaging

Kishk is usually packed in cloth or plastic bags (80 grams or 10-12 balls in upright/flat bags) or in airtight glass jars. Meeting the common demand of urban European markets for individual-sized packaging. The package cover should provide a variety of recipes selected to suit the global consumer (16,24,29).

KISHK HEALTH BENEFITS

Each society has its own unique food culture and eating habits, and at the same time, every person in this society needs adequate and balanced nutrition for a sustainable, healthy life. Addressing dietary patterns, kishk can be consumed at every stage of production. Common ways for consumption are as follows: Hamma (paste) (a semi-solid puree consumed with vegetables or eggs); the dried kishk reconstituted by boiling in water as a hot soup with bread, spices, and vegetables; a school snack (sandwich); Meeykeh (a Kishk salad made with wild mint, onions, olive oil, and tomatoes); Mana'neeş (a kishk pie: as a filling on pita bread); Kebbeh b Kishk (a stuffed kibbeh with kishk filling); Shish Barak b Kishk (a kishk chicken dumplings with rice). The unique fermented product, kishk, holds great significance in nutritional and sensorial value (3,5). It possesses excellent high-quality nutrients, being a well-balanced food. It is richer in B vitamins, lactic acid, minerals, protein, and fiber than both milk and cereals. As cereals are known to have a decreased protein content, poor in some essential amino acids (e.g., lysine), and starch availability compared to milk and milk products, the art of gathering milk with cereals in kishk creates a complementary source of balanced essential amino acids and high protein availability (13%-23.5%) derived from fermentation and the combination of milk and wheat proteins. This also results in a low-sugar and nutritive high-fiber mixture. Additionally, the bioavailability of calcium, iron, magnesium, and zinc is super-enhanced in kishk. This fermented product is recognized as a significant source of fibers, complex carbs, antioxidants, polyunsaturated fatty acids (α-linolenic C18:3 (n-3) and α-linoleic C18:2 (n-6)), and therapeutic probiotic-prebiotic potential, with a low glycemic load (GL). Thus, it's believed to facilitate digestion and offer numerous health benefits, such as reducing cholesterol levels, blood sugar levels, the risk of colon cancer and heart diseases, along with strengthening immunity (30,31). It is also advancing in nutrition practices due to its content of minerals (Fe, Mg, Mn, Ca,

phosphorus, and selenium), vitamins (riboflavin, thiamine, niacin), and growth factors, aligning with current nutritional perspectives (15-19,27,32,33). In light of Yavuz E et al.'s (34) findings that investigated the possible health effects of tarhana on the impaired lipid profile criteria and serum glucose readings in male BALB/c mice fed a high-fat diet; fermented dairy products may affect positively in alleviating metabolic disorders such as diabetes, high cholesterol, and coronary heart disease by enhancing the total lipid profile, and blood sugar values. Similar findings have been reported by Altundağ ÖÖ et al. (35), emphasizing that the same health attributes are entirely dependent on the properties of the ingredients used in production and the storage conditions engaged in that area (10,23,25,27,30,36).

Globally recognized kishk manufacturing is one of the cheapest and simplest ways to preserve nutritious raw food materials. Although kishk is not widely recognized in some countries and among cosmopolitan consumers, it remains an indispensable staple in rural areas, among nomads, and desert dwellers due to its high nutritional value and effectiveness as a strategic food reserve (Mouneh) without losing its health benefits (3,10,14). Researchers have started using different flours (e.g., soybean, malt, chickpea, rice, carob, purslane, or corn flour) instead of the traditional "bulgur' or wheat flour" along with fermented milk products combinations to develop Kishk products in Middle Eastern countries (11,17-20,23,37). As the prevalence of malnutrition, colon diseases, and many foodborne infections increases, some researchers have attempted to produce functional, nutritious, and delicious kishk products by integrating rich foods or milks (such as buffalo or camel milk) or using plant-based milk and flour such as using soy milk instead of cow's milk and replacing bulgur with oat or quinoa flour to provide β-glucan, much more protein and fiber, and unsaturated fatty acids for individuals with weak immune systems or intestinal disorders (9,20,21,24,25,32,33,38).

KISHK PROPERTIES

The chemical and microbial content, as well as the physical, rheological, and sensory properties of kishk products from different countries, vary depending on the production method, duration, and materials used. However, all kishk producers share a common goal, which is to produce a fermented food product with a long shelf life that is well-textured, tasty, and functional (1,11,24,26).

Chemical Properties of Kishk

Due to its low pH and moisture contents of 3.5 – 4.42 and 6% -12%, respectively, along with high salt content, kishk is famous for its long shelf life (1-3 years). The chemical properties of Kishk are influenced by several factors, including the addition of other milk products (e.g., Labneh), the type of bulgur or grain added, the type of milk and fermented milk products used, the relative ratio of added salt, the compositional attributes of using strained yogurt (e.g., 26%-50% dry matter) or buttermilk (10% dry matter), the ratio of bulgur to the fermented milk product (1:4 w:w), and the different multiplying factors (such as 6.25 or 6.38) used in protein content calculations (1,10,17,24).

Kishk holds increased amounts of essential amino acids like phenylalanine, leucine, isoleucine, histidine, threonine, and L-2,6 Diaminohexanoic acid. However, small amounts of 2-amino-3-(1H-indol-3-yl) propanoic acid and sulfur-containing amino acids can be found. This is also the case for tryptophan (an important essential amino acid) content, which has been considered by the FAO and WHO (18) as one of the most important amino acids that are likely to be limiting and temporary. This is due to the loss of tryptophan and sulfur-containing amino acids, such as cysteine and methionine, associated with exposure to sunlight during drying and fermentation. However, the substitution of the sun drying method with more advanced technologies under controlled conditions has shown good levels of tryptophan within kishk products during and after manufacturing (8,18,28,30-33,38,40). Additionally, The sort and status of milk primarily affect the fat content. Kishk made from goat milk had significantly higher fat content. While the moisture content is influenced by both the type of milk and the drying technique, the ash content is associated with the salt added to the kishk mixture. Regarding protein content, it's dependent on the type of milk, the grains used, and their ratio to each other (16,24,26,32).

Physical Properties of Kishk

Significant physical properties of kishk, such as color and particle size, vary significantly depending on production-storage conditions and the materials used. Regardless of the type of milk, kishk is perceived as a composite system of macrocomponents (such as milk protein and wheat starch inside a thick fatty layer). The fattier the kishk formulation, the more agglomerates it produces and the more advanced its microstructure becomes (24). The color of kishk varies as well, this is dependent on the type of milk and grain used. For example, kishk made with goat milk does not contain carotene, giving more brightness (increased L* values) compared to the one prepared with cow's milk and brown bulgur (wheat grains) that gives lower L* and higher b* values. Moreover, the color of kishk darkens when exposed to sunlight for longer periods due to browning reactions from heat treatment and evaporation (10,16,24,38).

Microbiological and Antimicrobial Properties of Kishk

Lactic acid bacteria (LAB), like *L. Bulgaricus* and *S. thermophilus*, are the major flora for undergoing the conditioning process in kishk. So far, Kishk production remains traditional, and the diversity of LAB in kishk has not been fully studied. One of the current major goals is to enhance its production using selected cultures (16,21,30,32).

Lactobacillus genus has an extended history of harmless utilization, and plays a major role in the production of fermented milk products. During the last fifteen year, it has undergone evolution and currently comprises of more than 80 species found in raw milk and cheese, yogurt, and fermented milk products (41,42). *Lactobacilli* include huge and varied groups of gram-positive, non-spore-forming, cata-

lase-negative rod-shaped bacteria that has the ability to produce lactic acid as the final outcome from carbohydrate fermentation (40,43). They are generally recognized as safe (GRAS) organisms and can be safely used as probiotics for medical and veterinary applications. During recent decades, an amplified desire has been seen for segregating the novel *Lactobacillus* strains which are probiotic forms that have a favourable health effect when ingested by humans (14,40,43-45). As a result, hindrance of pathogenic microorganisms like *Shigella*, *Salmonella*, and *Helicobacter* was also noticed (40,43,46-49). Furthermore, a bacteriocin-like substance (BLS) obtained from a strain of *Streptococc*us *infantilum* spp. (CNCM I-841) was indicated by Gomez et al. (50) that it had shown an inhibitory effect on gram-positive foodborne pathogens including *Clostridium* ands *Listeria* species (40,48-51). The microbiological quality of kishk, both commercially and in industrial production, varies significantly. This variation serves as an indicator of the reliability of kishk and whether it is produced under hygienic conditions. Therefore, the decreased moisture, increased acidity, and the ratio of salt added during production serve as sources of microbiological safety and greatly reduce the likelihood of coliforms and *Staphylococcus aureus* being present in kishk. However, kishk can still be exposed to contamination by various organisms. It can be contaminated with coliforms, *Enterococcus* spp. and *Escherichia coli*. While both coliforms and *E. coli* are considered as hygiene indicators, no limits have been set for *Enterococci*, which have small-scale merit as hygiene marks in food industry (1,8,10,14,16,29,40,41). Particularly, milk gathered from mammals fed with feeds that contaminated with mycotoxins (aflatoxin B1) can also contain aflatoxin M1 which is a hepatocarcinogen (40,51-53).

In the last two decades, probiotic (health-promoting) microorganisms, especially lactic acid bacteria (LAB), such as *L. bulgaricus*, *B. animalis*, *B. Lactis*, *L. acidophilus*, and *S. thermophilus*, have been progressively embodied into different food products, particularly fermented dairy products (19,20,41). Probiotics, are live microorganisms, that advantageously influence the host's health by enhancing the intestinal microbial balance (21,26,51,54). Literally, great settlements of probiotic bacteria are required to conduct the beneficial outcomes and to prevent pathogenic microorganisms and food-borne illnesses. The professional implementation in the field of fermented dairy products points to integrating the prospective health benefits of probiotics with their ability to increase in milk, creating a highly nutritious and desirable product (41,42,46,47,49).

Functional foods are defined as foods that supply more than simple nutrition; they provide extra physiological benefits to the consumer (55). Nowadays, the world market is full of functional foods that have numerous positive health-promoting attributes. Traditional fermented products containing probiotics and an extended shelf life, such as kishk might be very promising (2,25,28,55).

CONCLUSION

Kishk, with a long history, is one of the nutritious and healthy grain-dairy-based fermented foods characterized by a tasty nature with an ideal shelf life. The variations in the characteristics of kishk referred to the ratio of grains to yogurt, chemical composition, production time, drying, and storage conditions. Thus, further analyzing for these characteristics helps to understand the reactions within the product during processing, storage, and consumption, leading to higher quality outcomes without losing the organoleptic properties.

Each food product reflects the identity of the society, the cultural dimensions, and the production and storage conditions it undergoes, just like "Kishk." Therefore, because of its nutritious nature and effectiveness in food security, kishk is still an essential dish globally. It is a fermented food product that appeals to a wide range of consumers through both traditional consumption methods and modern recipes. This characteristics enabled kishk to meet the growing demand in urban European markets and adapt to different cultural preferences through various consumption styles. Current thoughts and studies on improving kishk's nutritional and microbiological values in terms of high acceptability are growing day after day.

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