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Tsvetanka Teneva-Angelova[1]
Tatyana Balabanova[2]
Petya Boyanova[2]
Dora Beshkova[1]

[1] Laboratory of Applied Biotechnologies, Department Applied Microbiology, The Stephan Angeloff Institute of Microbiology, Bulgarian Academy of Sciences, Plovdiv, Bulgaria

[2] Department of Technology of Milk and Milk Products, University of Food Technologies, Plovdiv, Bulgaria

Review

Traditional Balkan fermented milk products

Traditional fermented milk products have been prepared since ancient time by various civilizations. Despite their long history, popularity, and nutritive and healthy value, the acceleration and industrialization of food production leads to increase of the diversity of fermented milk products in the Balkan Peninsula. As a result of the multitude of food-microbe combinations, there are thousands of different types of fermented milk products — yoghurts, yogurt-like products, and various types of cheeses with proven health benefits. Among those products is the domestic Bulgarian yoghurt "kiselo mlyako", whose anti-aging effect has been scientifically studied yet at the beginning of 20th century. The current review summerizes the wide range of traditional fermented milk products at the Balkan countries, which are the primary source for their production.

Keywords: Balkan peninsula / Fermented milk products / Lactic acid bacteria / Traditional foods

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1 Introduction

The Balkan Peninsula is located in the southeastern part of Europe. It covers the entire territories of the following countries Albania, Greece, Bulgaria, Former Yugoslav Republic of Macedonia, Bosnia and Herzegovina, Kosovo and Montenegro, most of the territory of Serbia, Croatia, and Slovenia, small parts of Romania and Turkey and a very minor part of Italy. The Balkan peninsula was named after the most centrally located mountain range therein–Balkan mountain range (in Bulgarian–"*Стара планина*"–read *Stara Planina*). Since the Balkan Peninsula is located on the main route between Asia and Central and Western Europe, it has been a center of different ethnicities and cultures for millennia. These territories are descendants of ancient civilizations–Hellenic, Thracian, Roman, and Byzantine, which has left its mark over the traditional cuisine of the local peoples. Much of the food is unique and traditional for this part of the world and brings the peculiarities of life, culture, climatic conditions etc.

The term "traditional foods" has been extensively discussed in recent decades, as the concept includes on one side origin, composition, processing, and the usage of food, but on the other side also its mode of consumption. The European Food Information Resource (EuroFIR) and Traditional United Europe Food (TRUEFOOD) (projects funded by The European Commission Framework Programme 6) have been exploiting the traditional foods concept. According to EuroFIR traditional food is "*a food with a specific feature or features, which distinguish it clearly from other similar products of the same category in terms of the use of 'traditional ingredients' (raw materials of primary products) or 'traditional composition' or 'traditional type of production and/or processing method*" [1]. The opinions of consumers is not necessarily connected to the traditional food definitions. In six European countries (Italy, Spain, Norway, Belgium, France, and Poland) was carried out a survey of TRUEFOOD, which has examined how consumers perceive the traditional foods [2, 3]. The TRUEFOOD definition is on the base of local production, commercial availability, authenticity, and gastronomic heritage and it sounds "*... a product frequently consumed or associated to specific celebrations and/or seasons, normally transmitted from one generation to another, made with care in a specific way according to the gastronomic heritage, with little or no processing/manipulation, that is distinguished and known because of its sensory properties and associated to a certain local area, region or country*" [3].

The climate and geography of the Balkan peninsula favor the development of typical agriculture and food industry. The dairy industry in these regions, in particular, is known worldwide for the unique quality of the produced traditional dairy products. Their specific characteristics are directly related to the typical microflora used, as well as to the milk, produced by the typical breeds of animals there, the way these animals are fed, the climatic conditions of the area, etc. Milk and traditional dairy products originating from this region are valued and sought at the markets around the world, given their specific taste characteristics and beneficial effects on human health.

Correspondence: Prof. Dora Beshkova (beshkova@yahoo.com), Laboratory of Applied Biotechnologies, Department Applied Microbiology, The Stephan Angeloff Institute of Microbiology, Bulgarian Academy of Sciences, 139 Ruski Blvd., 4000 Plovdiv, Bulgaria

Abbreviations: LAB, lactic acid bacteria; **WBC**, white brined cheese; **WC**, water content; **Wff**, water in fat-free matter

Since ancient times, milk and dairy products are well-known for their benefits to human health. The beneficial effects of dairy products are due to biologically active compounds in milk, as well as because of the action and metabolites of lactic acid bacteria (LAB) in the fermented milk products.

Milk contains many health-promoting components, including bioactive peptides and fatty acids, immunoglobulins. Many milk peptides exhibit multifunctional properties – the specific peptide sequence may exhibit two or more different biological activities. Milk biologically active peptides are considered to be highly expressed health-promoting ingredients of functional foods. Moreover, LAB, used in the manufacturing of these products, synthesize many metabolites (lactic acid, γ-aminobutyric acid, bacteriocin, reuterin and reutericycline, conjugated linoleic acid, exopolysaccharides), which have beneficial effect on human health. The LAB metabolites and the biologically active components of milk have a number of activities such as: immunomodulatory activity [4–8], antihypertensive [9–13], antitumor or anticancer activity [14–18], antioxidant activity [5,12,14,17,19–21], antimicrobial activity [22–24], mineral-binding activity [25–27], opioid [28] etc.

2 Traditional fermented milks

Since ancient times people have produced fermented milks using traditional methods. Hundreds of such products are known worldwide.

Fermented milks classification could be done based on the fermentation type they undergo, such as lactic, yeast-lactic, and mould-lactic. Products produced by lactic fermentation could be classified depending on the features of LAB, such as mesophilic, thermophilic, and therapeutic (probiotic) [29]. Mesophilic-fermented products include traditional buttermilk, cultured buttermilk, cultured cream etc. obtained by *Lactococcus* and *Leuconostoc* fermentation. To thermophilic-fermented products belong yoghurt, acidophilus milk, and other products obtained by mesophilic LAB (*Streptococcus* and *Lactobacillus*). The therapeutic products group includes probiotic microorganisms. Likewise various kinds of fermented milks could be devided based on the raw milk (cow, sheep, goat, buffalo).

Balkan region is historically and traditionally important for production of various fermented milks. Nowadays fermented milks are manufactured in many countries and manufacture stages are a mixture of ancient receipts and science and modern dairy technologies. Main Balkan tradidional fermented milk is yogurt, known under various names, as well as: Bulgarian kiselo mlyako (Bulgaria), kiselo mleko (FYR Macedonia, Serbia), kislo mleko (Slovenia), kiselo mlijeko (Bosnia and Herzegovina), yoğurt (Turkey), and giaurti (Greece), also ayran (Turkey).

In the everyday life and traditions of the different ethnic groups have been established various technologies for fermentation of milk. The dairy products produced through these technologies directly reflect the geographic and ethno-cultural peculiarities in the historical development of the nations.

In the beginning of 20th century, the famous Russian scientist Ilya Mechnikov (1845–1916), Nobel Prize winner, began to deal with the problems of aging people. He assumed that during feeding, proteinaceous substances from food brake down by the action of putrefactive bacteria in the large intestine, yielding toxic amines, which causes poisoning of the human body and early death. He proved that the food, which is able to restrict the growth of putrefactive bacteria in the gut, is Bulgarian yogurt ("kiselo mlyako"), in particular the presence of suitable lactobacilli. Thus Mechnikov explained the fact, that Bulgaria had the highest number of centenarians and concluded that this fact was due to the consumption of Bulgarian yogurt [30].

The first Bulgarian, who studied the microflora of Bulgarian yoghurt, was Stamen Grigorov (1878–1945)–microbiologist and physician. In 1905, he proved that it consisted of one rod-shaped and one as he described it globular-shaped (coccus-shaped) lactic acid bacteria, and the announcement of his discovery was published in"Revue Médicale de la Suisse Romande," 1905, Genève. In 1907 the rod-shaped bacteria was called *Lactobacillus bulgaricus*. In 1917, Orla Jensen proved that during the production of yoghurt participated also cocci, called *Streptococcus thermophilus* [31].

Basic principles of the classification of fermented milks at the Balkan Peninsula are based on:

- The type of the raw material — cow, sheep, goat, buffalo's milk or a mixture of some of these types of milk;
- The fat content of the final product — skimmed, low-fat content, full-fat content, and high-fat content;
- Microorganisms involved in the milk fermentation;
- The consistency of the final product — with a dense coagulum or with a broken coagulum;
- Fermented milk, with the addition of different ingredients.

The yogurt's production is a millennial technique, and the knowledge has been transferred from generations. Yoghurt is a fermented milk product, which is well-known worldwide. *Lactobacillus delbrueckii* subsp. *bulgaricus* and *Streptococcus thermophilus* are LAB used in the production of yoghurt [32]. The most usual types of yogurts are set-style, stirred, and drinking forms. The set-style is prepared by incubation and cooling in the final package and it is with a stable and gel-like structure, while in other two forms, the final coagulum is broken — stirred form (by stirring) or drinking form by homogenization to a low-viscosity beverage and then cooling and packaging [33].

Traditional Bulgarian yoghurt (set-style) accounts for the largest share (about 80%) of the produced fermented dairy products in Bulgaria. It is characterized by a presence of a dense coagulum and a pronounced sour flavor and aroma. Bulgarian yogurt can be produced from fresh sheep, cow, goat, buffalo's milk, or from a mixture of these types of milk in a ratio of 1:1. It is known three ways for obtaining this product–home-made, artisanal, and industrial production. When comparing the three ways of producing yogurt, it should be emphasized that they differ not so much by the nature of the processes, rather than by the tools used for their realization. Therefore, traditional Bulgarian yoghurt with the necessary nutritional and biological properties can be prepared in all the three above-mentioned ways.

Typical traditional set-type yoghurt in Turkey is called "yogurt" in Turkish language. As raw material for the production

of Turkish yogurt is used mainly sheep's milk and cow's milk. The technology of production of the traditional Turkish yoghurt is rather simple and it is very similar, in regard to the technology used, to the one used for the production of the traditional Bulgarian yoghurt [34].

Traditional Greek yoghurt is known also as Mediterranean-style fermented milk, which is characterized by increased dry substance content. A main point in yoghurt's production technology is the standartization process, which can be accomplished in several ways: (1) by adding dry milk components to the milk (skimmed milk powder, milk concentrate, whey, or milk protein); (2) by thickening of the milk (membrane filtration methods) [35, 36]. The most common way of concentrating the milk ingredients is by applying ultrafiltration of the feedstock. The product, produced in this way is characterized by a high protein content (Greek yogurts typically have protein contents ranging from 6 to 12%, or about 1.5 to 4 times more in comparison to the traditional set-yogurt) and a lower lactose content compared to the traditional set-yogurt [37]. There are two methods of thickening the product, the first being before the fermentation process and the second—after the coagulation and cooling of the acidic gel.

Drinkable yogurts belong to the group of fermented milk products, having broken coagulum. Traditionally, these products are produced in Bulgaria and Turkey under the designation "ayran." In these countries, the product can be produced in two technological schemes, depending on the chosen method for standardization and coagulation. Ayran is a fermented beverage, which is traditionally prepared by blending yoghurt with water (30–50%) and salt (0.5–1.0%) [38, 39]. The ayran can be produced in two methods, either by adding some water to yoghurt or by adding some water to the milk at first, after which a subsequent fermentation of diluted milk takes place [40, 41].

3 Traditional cheeses

Cheeses are a group of fermented milk products. They are a part of high-nutritional value and healthy foods, because of various essential substances, such as proteins, calcium, phosphorus, minerals, and vitamins (B group), which are contained in them. Cheese is one of the most sophisticated and diverse food, we are pleased to have today.

Traditional cheeses have been considered natural, homemade, and artisanal dairy products that have been produced from ancient times from various animals' raw milk, by using traditional technologies. The uniqueness of traditional artisanal products is a result of the climate conditions, vegetation, and the activities of milk microflora. The unique organoleptic features of these products are a result of properties of milk, fermentation, and processes of ripening. Nowadays various traditional cheeses are produced, combining ancient domestic production steps and modern food industry practices.

The enormous diversity of cheese types is determined by the type of milk used, the composition and activity of autochtonous and added microflora, by the peculiarities of the processing methods and by a number of physical, biochemical, and mechanical factors. There are numerous classifications of cheese groups—according to coagulation method, the type of draining, and the type of ripening of the cheese (fresh, soft, pressed, hard without cooking) [42]; according to the Food and Agriculture Organization of the United Nations (FAO)/World Health Organization (WHO) Codex Alimentarius Comission, the classification of cheeses is based on the water in fat-free matter (Wff) (soft, semi-soft, semi-hard, hard, extra-hard); fat content in the dry matter (skimmed, low-fat, semi-skimmed, full-fat, high-fat); ripening (with and without ripening).

At the Balkan peninsula are mainly manufactured fresh cheeses, types of ripened cheeses and white brined cheeses (WBC). Some of the Balkan traditional cheeses nowadays are still produced only as home-made and artisinal (Lisnati, Katak/krutmatch, Kajmak, Skorup, Kashkaval from Stara planina, Curd, Urda etc.), while other cheeses are on one side homemade and artisinal, as well as industrially produced (Feta, Byalo salamureno, Kashkaval etc.).

3.1 Fresh cheeses

Production of fresh cheeses includes the addition of lactic acid microflora to the milk as a starter culture or the use of autochthonous milk microflora, without or with adding of a small amount of rennet, during lactic acid coagulation, when the coagulum is self-drained and without ripening, producing cheeses with dry matter 25–30% [42]. The technology of fresh cheese is aimed at obtaining a highly humid, sour, and slightly mineralized low-strength cheese. Fresh cheeses could be classified in terms of parameters–fat in dry matter and protein content in the final product [43, 44], as follows: structured cheeses, whey cheeses, and cream cheeses (butter type cheeses). Types of these cheeses are known as artisanal cheeses and are also manufactured at the Balkan Peninsula (Table 1).

Traditional structured fresh cheeses on the Balkan Peninsula are Anevato, Galotyri, Xinotyri, Katak/krutmatch, Škripavac [43, 45–52], which are mainly produced from raw sheep's or goat's milk or a mixture of them and are formed after draining the curd to the desired water content. The following cheeses (Xinotyri, Anevato, and Škripavac) are produced based on a mixed coagulation type (spontaneous fermentation of the milk from the autochthonous microflora and subsequent curding), periodic stirring, draining, and adding salt. They are characterized by a soft and tender, easy to spread consistency, as well as a pleasant lactic acid taste and aroma. Katak/krutmatch and Galotyri are cheeses produced mainly from sheep's milk at the end of the lactation period [39, 53, 54]. The technology of obtaining these types of cheese differs in the following technological steps of production: for the cheese Galotyri — biological ripening of the milk, adding salt, and leaving the mixture, after which the salted and biologically matured curd is stored in textile or leather bags or in wooden barrels at temperatures lower than 8°C for 2 months; for Katak/krutmatch–the milk is heat-treated at a low temperature, for several hours, to reach a certain density, adding salt and left at room temperature to develop the fermentation process. The final dairy product has a salty-sour taste and a shelf life of up to several months [47].

Whey cheeses are a group of cheeses produced by acid-thermal precipitation of the whey, separation after the

Table 1. Diversity of cheeses in Balkan countries

Country	Fresh cheeses	Types of ripened cheeses	Brined cheese	Referance
Albania	—	Kashar	—	[62, 107]
Bosnia and Herzegovina	Skorup	Livanjski sir (Livno cheese)	Travnicki/Vlasicki sir (Travnik cheese)	[60, 114]
Bulgaria	Katak /krutmatch, Curd	Kashkaval	Byalo salamureno sirenje (Byalo salamureno cheese)	[47, 53, 63, 64]
Croatia	Škripavac, Skuta	Paški Sir (Pag cheese), Trappist, Tounjski sir (Tounj cheese), Krčki sir (Krk cheese)	Prevelog sira (Preveli cheese)	[101, 132]
Greece	Anevato, Galotyri, Xinotyri, Myzithra, Xinomyzithra, Manouri	Graviera, Kefalotyri, Ladotyri, Manuri, Kasseri	Feta, Batzos, Telemes	[48, 50, 57, 65, 67, 79, 100, 103, 104, 119, 124, 125, 130, 133]
Kosovo	—	Kaçkaval	Sharri, Rugova	[106, 129]
Macedonia	Urda	Galichki kashkaval	Bieno sirenje (Beaten cheese)	[58, 121, 122]
Montenegro	Urdă, Skorup	Njeguški sir (Njegusi cheese), Lisnati	Pljevaljski sir (Pljevlja cheese), Polimsko-Vasojevaski, Ulcinjski	[55, 60, 111, 128]
Serbia	Kajmak	Kashkaval from Stara Planina	Beli sir u kriskama, Zlatar, Sjenicki, Homoljski sir (Homolje cheese), Svrljiški sir (Svrljig cheese)	[65, 80, 81, 110, 131, 134]
Slovenia	Skuta	Bohinjski sir (Bohinj cheese), Tolminc, Nanos, Dolenjski, Bovec, Karst	Mohant	[102]
Romania	Urda	–	Telemea	[135]
Turkey	Lor	Kašar	Beyaz peynir, Edirne peyniri	[56, 66, 123]

production of hard and semi-hard types of cheese. The whey cheeses, traditional for the Balkan Peninsula, are: Myzithra, Xinomyzithra, Manouri, Urda, Curd, Skuta, and Lor [55–58].

They are produced either only from whey (Urda, Skuta, Xinomyzithra, and Manouri) or from a mixture of whey and milk in an amount of 5 to 30% [59]. The main factors affecting this type of cheese are: initial acidity of the whey, temperature, and duration of heating. Depending on composition of the raw material, the whey cheeses have different fat content: skimmed or low-fat cheeses (Urda, Skuta, Curd), semi-skimmed cheeses (Lor, Myzithra, Xinomyzithra, Urda). The produced cheeses have a high nutritional and energy value, also they are characterized by a pure, lactic acid taste (slightly acidic and milky taste), with a homogeneous and gentle or crumbly texture, fresh odour, white, and uniform color.

Traditional Balkan cream cheeses are Kajmak and Skorup. They are produced from cow's milk (Kajmak) or from mixture of cow's and sheep's milk (Skorup) [60, 61]. Their production is mainly home-made type. These cheeses could be consumed fresh or ripened. According to the traditional technology, these types of cheeses could be consumed fresh, characterized by a short shelf life or ripen, having a shelf-life up to a year. They are known for their soft buttery texture, a specific pleasant taste and a slight odor.

The different technologies used, the stages of obtaining the different types of cheeses and the autochthonous microflora lead to production of cheese products with different physicochemical parameters, summarized in Table 2.

3.2 Types of ripened cheeses

In recent years, it is considered that the classification of the cheese should be based on parameters, determining its organoleptic characteristics and nutritional value. From this point of view, four principles of cheese classification can be formulated: milk type, coagulation mode, type of microflora used, chemical characteristics of the cheese (fat and water content (WC)). On the basis of the four principles listed, the following classification of traditional hard cheeses can be presented:

- —High temperature of cooking (>50°C) (WC 35–40%, Wff 51–57%) – Bohinj, Graviera;
- —Average temperature of cooking (43–50°C) (WC 36–42%, Wff 57–61%) – Tolminc, Nanos, Dolenjski ewe, Kefalotyri, Ladotyri, Pag, Livno;
- —Low temperature of cooking (36–42°C), cheddarization and scalding of the curd (WC 42–46%, Wff 52–56%) – Kasseri, Kašar, Kashar, Kashkaval, Galichki kashkaval, Kashkaval from Stara Planina, Kaçkaval;
- —Low temperature of cooking (36–42°C), cheddarization without scalding of the curd (WC 42–43%, Wff 59–60%)–Bovec, Karst, Trappist, Lisnati, Njeguški.

Some of the most famous Balkan ripened cheeses are presented on Table 1.

The group of hard cheeses is characterized by a specific technological process, aiming at obtaining a product with a low water content and higher solids contents, respectively, which also

Table 2. Physicochemical parameters of traditional Balkan cheeses

Type of cheese	Moisture (%)	FDM[a)] (%)	Proteins (%)	Salt (%)	References
FRESH CHEESES					
Anevato	60.0–62.0	42.0–45.0	12.0–15.0	1.0–1.5	[48, 100]
Galotyri	75.0	40.0	10.0–12.0	3.0–4.0	[50, 51]
Xinotyri	73.0–75.0	40.0–50.0	9.0–11.0	0.2–1.1	[50]
Manouri	50.0–53.0	70.0–72.0	10.0–13.0	2.2–2.4	[57]
Myzithra	67.0–69.0	15.0–17.0	20.0–22.0	0.0	[57]
Lor	60.0–73.0	7.0–21.0	14.0–21.0	1.2–2.2	[56]
Urda (FYRMacedonia)	75.0–80	0.5–1.5	20.0–25.0	2.0–2.5	[58]
Urdă (Montenegro)	60.0–62.0	50.0	18.0–21.0	—	[55]
Kajmak (Serbia)	31.0–40.0	65.0–80.0	5.0–10.0	3.0–3.1	[61]
Skorup	63.0–65.0	82.0–87.0	5.0–8.0	—	[60]
Škripavac	60.0–61.0	50.0	12.0–14.0	1.0–1.2	[101]
Skuta (Croatia)	53.0–57.0	41.0–50.0	8.0–14.0	0.2-0.4	[101]
Sour skuta (Slovenia)	77.0	21.0	13.0–15.0	—	[102]
Sweet skuta (Slovenia)	77.0	43.0	12.0–15.0	—	[102]
TYPES OF RIPENED CHEESES					
Graviera, Kefalotyri, Ladotyri	24.0–38.0	35.0–57.0	30.0–46.0	2.5–7.0	[103, 104]
Kasar,Kashkaval, Kasseri	42.0–48.0	42.0–50.0	25.0–27.0	2.0–3.0	[63, 65–67]
Kaçkaval	45.0–50.0	43.0–48.0	24.0–29.0	1.8–3.1	[105, 106]
Kashar	48.0–50.0	42.0–50.0	25.0–27.0	2.1–3.0	[107]
Kashkaval from Stara Planina	32.0–39.0	48.0–50.0	25.0–27.0	3.8	[65,108,109]
Galichki kashkaval	27.0–39.0	39.0–41.0	21.0–28.0	1.5–2.9	[110]
Njegusi	41.0–54.0	46.0–51.0	21.0–25.0	1.9–2.3	[111, 112]
Lisnati	42.0–57.0	35.0–47.0	20.0–25.0	1.5–2.5	[113]
Livno	33.0–35.0	49.0–54.0	25.0–30.0	2.0–3.5	[114, 115]
Trappist	40.0	47.0–48.0	25.0–28.0	2.5–3.0	[116, 117]
Pag	32.0–40.0	39.4–45.0	22.0–29.0	1.5–4.0	[118]
Bohinj, Nanos, Tolminc, Karst ewe, Bovec, Dolenjski ewe	32.0–40.0	45.0–57.0	21.0–29.0	1.5–2.5	[102]
BRINED CHEESES					
Batzos	43.4	34.6	23.2	4.0–4.8	[119, 120]
Beaten cheese	31.5–38.6	42.2–43.8	26.5–27.4	5.2–6.9	[58,121,122]
Beyaz peynir	45.0–50.0	52.0–55.0	17.0–20.0	4.5–5.0	[123]
Byalo salamureno	≤ 42.0	≤ 48.0	16.0–19.0	3.0–4.0	[64]
Feta	51.3–57.4	44.1–55.3	16.2–18.5	3.5–4.5	[124–127]
Pljevlja	–	46.4–60.5	12.5–19.0	2.1–4.3	[128]
Sharri	34.0–36.2	44.2–46.0	23.1–23.9	5.2–9.2	[129]
Telemes	52.5	–	17.7	–	[130]
Zlatar	50.0	54.0	17.0	2.4	[131]

[a)] FDM, fat in dry matter.

determines the longer ripening period. The specific textural and organoleptic characteristics of this group of cheeses are determined by the intensive processes of acidification, proteolysis, and lipolysis, that occur during the ripening process. Ripened cheeses have a uniform texture without eyes and yellowish to yellowish-amber color.

In the production of hard cheese Graviera, raw sheep's milk or a mixture of sheep's milk and goat's milk up to 30% is used, whereas in the case of Bohinj cheese, partly skimmed cow's milk is used. The milk is cured at a temperature of 32–35°C for 30 minutes. The coagulum is crushed on the curd grains. An important moment during cheesemaking is the high temperature during second heating (>50°C), where the curd grains are processed for 20–60 minutes. Formation and pressing of the cheese follows. Salting the cheese is done with a saturated brine solution, and the salting process lasts 2–4 days. Ripening in cheese Graviera lasts minimum two months at 14–17°C, while ripening in cheese Bohinj is carried out in several stages (15–18°C for 15 days; 22–24°C for 40 days and 12–14°C up to 60 days), thereby forming large pores and cracks of the cut surface and a slightly sweet flavor of the cheese.

Hard cheeses with average temperature of cooking (43–50°C) are characterized by a solid and grainy texture, a specific cut surface with/without presence of medium-sized pore and cracks, dense taste, and aroma, depending on the duration of ripening. The main raw material for production of hard cheese is

raw sheep's milk (Kefalotyri, Ladotyri, Pag, Livno, and Dolenjski ewe), partially decreamed cow's milk (Tolminc and Nanos) or a mixture of sheep's, cow's, and goat's milk (Liburski). It is cut and cooked at a temperature of 42–45°C for sheep's milk cheeses and 45–50°C for cows' milk cheeses. Formation is after the precipitation of the curd grains. The pressing of the cheese is gradual, with a gradual increase in pressure and a duration of 6–14 hours. The method of water salting is used (18–24% NaCl) for a period of 2 to 7 days at 14–16°C. The cheese ripening is at 12–16°C and duration of two or more months, depending on the desired sharpness of taste.

To hard cheeses belong cheeses with low temperature of cooking (36–42°C), cheddaring, and scalding curd (called "Pasta-Filata" or Kashkaval type cheese). These cheeses are characterized by a semi-hard and elastic consistency, a yellow color of the cutting surface and a water content of over 46% [62–66]. There are two specific operations in the production of "Pasta-filata" type of cheese, which determine the microbiological and biochemical processes, during the ripening: (1) cheddaring (curd acidification)–active fermentation process under the actions of LAB from raw milk or thermophilic starter culture up to pH 5.2–5.4; (2) scalding and kneading in hot water or brine (up to 13% NaCl and temperature from 68 to 85°C) [63]. Technology for production of these types of cheeses is based on use of raw sheep's milk or a mixture of sheep's and cow's milk. Fresh milk stays overnight to increase its acidity from the autochthonous microflora in the milk. This is followed by heating the milk and curding, coagulation for 35–45 minutes and cutting the curd. Slighter cooking at a low temperature of 38–42°C, and the pressing of the curd, is to preserve the greater part of the whey, contained in the curd, and an increase in acidity during cheddaring (for 1.5–2.5 hours, reaching pH 5.2–5.4). It is followed by scalding, kneading, and salting in a hot salt solution at a temperature of 68–82°C. During this process, the curd gets a smooth and shiny surface, the consistency becomes elastic, draws on a thread and is molded into a desired shape. Then, the formed cheese is cooled, stabilized, air-blown, and it ripens at a temperature of 8–12°C, not less than 45 days.

Technological process of cheeses Kaşar and Kasseri is similar to the one, used for production of Kashkaval. The major difference in manufacturing of Kaşar is the slower process of cheddaring of the crud, scalding with hot water at temperature of 65–75°C and dry-salting. Cheese ripens at a low temperature (2–3°C) for a longer period of time (3–10 months) [63, 66–68].

Types of cheeses with low temperature of cooking (36–42°C), cheddarization without scalding of the curd, are characterized by different physico-chemical composition and organoleptic characteristics. During the production of Bovec, Karst, and Njeguški cheeses are used raw ewe milk, in Trappist cheese — fresh cow's milk, and in Lisnati cheese — fresh and acidified milk in amount 50:50. Coagulation has a predominant enzyme character, as a result of higher doses of rennet. The initial coagulation time is short and the phase during which the curd is sealing is shortened, in order to reduce the degree of demineralization of the curd and to preserve its ability to drain. Cheese draining is faster, the major part of the whey being separated during the treatment in the vats by applying a certain physical intervention such as slicing and stirring and, in certain cases, cooking at a temperature of 38–42°C for Lisnati cheese, 40–45°C in Bovec, Karst, and Njeguški cheeses, and for Trappist cheese, the greater quantity of whey is drained during the processing of curd in the vats, replacing it with hot water with a temperature of 50–60°C. The end formating of the cheese is during the pressing period, which takes place at 14–16°C for 2–12 hours. Slating is in brine (Trappist, Bovec, and Karts cheese) for 24–48 hours and dry salting (Lisnati and Njeguški cheese) for 48 hours. Cheese ripens at 14–19°C for a period of 60 days (Bovec, Karts, and Njeguški cheese) and 8–15°C for 30 days (Trappist cheese).

The physicochemical composition of the examined hard cheeses is presented in Table 2.

3.3 Cheeses in brine

The cheeses of this group are known under the designation "White Brined Cheeses" (WBC), produced mainly from sheep, goat, and buffalo's milk. The lack of carotenoids in milk fat, by aforementioned milks, gives the white color of the cheese [67, 69]. WBC appeared at the area of the East-Mediterranean around 6000–7000 BC. According to Alichanidis and Polychromadou [62] the group of brined cheeses is the most popular in this geographical area. The cheeses of this group can be very similar, but at the same time very different. The common among them is that they ripen and are stored till consumption under anaerobic conditions in a saline solution.

Brined cheeses, produced from different types of milk, with enzymatic type of coagulation, are characterized by specific organoleptic, physicochemical, and microbiological features [70, 71]. The WBC production method can generally be represented by a mixed type of coagulation (enzyme-acid) of whole or standardized milk, with the participation of a milk-coagulating enzyme and lactic acid microflora, followed by draining the formed coagulum to increase the curd's acidity. They have a smooth cut surface, without or with single eyes, dense, and compact texture and a relatively high salt content 3–8%. The color varies from snow white to pale yellow, depending on the type of milk used [72], the taste is milky, sour, and salty [62, 71, 73].

Brined cheeses are produced in all countries of the Balkans (Table 1).

Technologically, this group of cheeses is characterized by very similar technological stages. The main raw material for the production of WBC is sheep, goat, cow, buffalo milk, or mixture of them. The traditional technology involves heating milk to a coagulation temperature (32–36°C), and the industrial technology requires a mandatory temperature treatment of the raw material at a temperature of 67–74°C (depending on the type of raw milk). Cooling and adding starter cultures of thermophilic and mesophilic microflora (*L. lactis* subsp. *lactis* and *Lb. delbrueckii* subsp. *bulgaricus* or *L. lactis* subsp. *lactis* and *L. lactis* subsp. *cremoris*), $CaCl_2$ and rennet. The formed coagulum is cut and the curd is formed. The differences in the technologies for production of WBC in the different Balkan countries are in the way of formating, the mode of pressing and salting, which results in differences of the physico-chemical parameters of the end products (Table 2). The formating of the cheese is made as follows: (1) shaping a block of cheese by Beli sir, Byalo salamureno, Telemea, Beyaz peynir, Pljevlja, and Sharri; (2) filling the curd

grains into perforated bottom molds, resulting in the formating of small, almond-shaped holes (technical pores and cracks) in the curd mass (Feta, Batzos, and Beaten cheese). Different pressing modes are applied, depending on the mode of salting. The already formed cheese is left at rest for self-pressing, then weights are placed, as the load on the block of cheese must be gradually increased (Beli sir, Bjalo salamureno, Telemea, Beyaz peynir, Pljevlja) or for self-pressing (Feta, Sharri, Batzos, and Beaten cheese). The process of salting the cheese can be done in three ways: water-salting in brine, water-salting in brine with dry additional salting during the packaging and dry salting. In most types of brine cheeses, the most common way is the one with combined salting.

From the group of Balkan brine cheeses, the technology of Beaten and Batzos cheeses is distinguished. A characteristic quality parameter for these cheeses is the presence of bacterial pores and cracks on the cutting surface, formed a few days after their production. A special feature in their technology is the crushing of the curd gel in curd grains. In Bieno cheese, after separation of the whey, the curd is poured with hot water (90–92°C) until the temperature of the curd reaches 41–42°C. The curd is self-pressing, put in strainers, hanging out. Thereafter, the curd is placed in perforated bottom molds, then the curd is removed from the molds, cut in pieces and salted with dry-salt. In Batzos cheese the processing of the curd grains is by heating to a temperature 43°C with continuous stirring, followed by precipitation and formating of the curd block. The formed curd is cut and salted using dry-salt. Ripening is a two-step process: the first stage (10 days) at 15°C and the second stage (2–3 months) at temperature under 7°C [71, 74]. These cheeses are characterized by moderately rigid to firm consistency.

4 Lactic acid bacteria for Balkan fermented milk products

For centuries, different LAB species have been used in various foods fermentation processes and are the foundation of the oldest methods known for food preservation. The LAB are Gram positive, catalase negative, nonmotile, do not form spore, anaerobic to aerotolerant bacteria, with coccus or rod shape, they produce lactic acid that is the main final product of carbohydrate fermentation.

Two main LAB species used for manufacturing of yoghurt are *Lactobacillus delbrueckii* ssp *bulgaricus* and *Streptococcus thermophilus*. There is a symbiotic relationship between both of them, resulting in a shortened fermentation time and a product with characteristics, which are different than the one obtained by milk fermented with a single species [75]. By obtaining yoghurts could be added also another bacterial species. LAB synthesize different metabolites lead to specific taste, flavor, and aroma of the final products [76].

Natural microflora of raw milk is significat for production of most traditional cheeses, since it takes a part in forming of taste and aroma of the end product. On the other hand it is a phageresistant and manifests diverse metabolic activity, which take a part during ripening of cheese. Raw milk is a source of diverse microflora, which imparts to the cheese unique organoleptic and sensory qualities.

The traditional cheeses are produced from raw milk with natural rennet and microflora, with or without starter culture (LAB). In cheese manufacturing, starter cultures are generally used for lactose fermention, as well as for production of flavor and aroma components or CO_2. Bacteria, used as starter cultures, mesophilic, and thermophilic LAB, belong to the genera *Streptococcus*, *Lactobacillus*, *Lactococcus*, and *Leuconostoc*, *Enterococcus*.

The main starter cultures, used in production of Balkan types of cheeses (Byalo Salamureno, Feta, Beyaz Peynir, Batzos, Kashkaval, Kašar, Greek cheese, Pljevaljski, Njeguši cheese etc.), include mesophilic LAB — *Lactococcus lactis* ssp. *lactis* and *Lactococcus lactis* ssp. *cremoris*, and thermophilic LAB — *Lactobacillus delbrueckii* ssp. *bulgaricus*, *Lactobacillus helveticus*, *Streptococcus thermophilus*, etc. In production of hard cheeses are involved also flavor and gas forming LAB species like *Leuconostoc mesenteroides*, *Lactococcus lactis* ssp. *lactis* biovar. *diacetylactis*, *Enterococcus* species etc. [74, 77, 78].

Representatives of the genera *Lactobacillus*, *Lactococcus*, *Streptococcus*, *Enterococcus*, *Leuconostoc*, and *Pediococcus* have been isolated from many traditional home-made, artisinal, and industrial-made dairy products, which LAB are typical for different products [79–87].

We are witnesses of a continuous searching for diversified foods from consumers by using new food substances and starter cultures, isolated from natural niches, carrying health benefits, and new organoleptic characteristics [88]. In recent years, in order to increase dairy products value, the interest in alternative sources for isolation of LAB is raising up, because they are carriers of greater metabolic activities and a variety of flavor-forming substances [89]. There are evidences that LAB, isolated from nondairy products have better biochemical and physiological characteristics (production of lactic acid, temperature and pH growth range, and halotolerance) compared with the LAB of milk origin [90–96]. This is a prerequisite for including them in the future in starter communities or as adjunct cultures for the production of new fermented dairy products, with improved nutrition and health effects.

5 Monitoring of technological process during cheesemaking

Cheesemanufacturing is of significant economic importance to food processing industry. Various types of cheeses are produced on the Balkan Peninsula, characterized by differences in the technological stages of their production. The industrialization of the dairy industry requires new technological approaches to quality control of the raw materials used, the stages of their transformation into the end fermented product. The development of science contributes to the use of new, modern on-line methods for control during the fermentation process and introduction of the HCCP control system [97–99]. The main controlled parameters in the technological operations during production of the different types of Balkan cheeses are presented in Table 3.

Table 3. Monitoring of the technological stages in the production of different types of cheeses

Technological operations	Control parameters	Type of the milk product
Raw materials	−Quantitative ratios of raw materials; −Physicochemical composition of milk type; −pH; −Presence of inhibitors and suppressants;	All types of cheeses fermented milk products
Normalization	−Fat content; −Casein/fat ratio;	Fresh and whey cheeses;Fermented milk products Hard and extra hard cheeses, semi-hard cheeses, WBC
Pasteurization	−Temperature; −Retention time (sec or min);	All types of cheeses Fermented milk products
Coagulation Fermentation	−Temperature of curding; −Composition and amount of starter culture; −Quantity of added CaCl2; −Dose of rennet enzyme; −Duration of coagulation; −Density and elasticity of the coagulum; −Fermentation temperature; −Amount of starter culture; −Duration of fermentation; −Density of the acidic gel;	All types of cheeses except Fresh and Whey cheeses, where the composition and the amount of starter cultures and temperature of protein precipitation are controlled; Fermented milk products
Processing of the coagulum	−Degree of slicing of the curd; −Type and duration of the processing of the curd grains (stirring and cooking); −Dynamics in the development of the added starter culture;	Hard and extra hard cheeses, semi-hard cheeses, WBC
Formation	−Type; −Shape dimensions; −Stability of the form;	All types of cheeses
Pressing	−Degree and strength of the pressing; −Duration of the pressing; −Water content of the pressed cheese; −pH of the cheese at the end of the pressing process; −Formation by filling in molds (bags of filter material) and self-pressing;	Hard and extra hard cheeses, semi-hard cheeses, WBC Fresh and whey cheeses;
Salting	−Type of salting; −Parameters of the saline solution; −Quantity of NaCl in the cheese;	All types of cheeses Hard and extra hard cheeses, semi-hard cheeses, WBC
Final product	−Consistency; −Sectional surface; −Taste and aroma; −Dry substance; −Fat in dry matter; −Acidity (pH); −Degree of maturity of the cheese; −% NaCl; −Microbiological characteristic of the finished product, according to the valid normative documents of the country, producer of the cheese.	All types of cheeses Fermented milk products

6 Conclusions and future prospects

Every nation has its specified unique and traditional foods, reflecting the peculiarities of life, culture, climatic conditions, and geographic location. The milk and traditional dairy products at the Balkans are valued and sought on the global markets, due to their specific flavor features and their beneficial actions over humans health. The diversity of dairy products is a result of specific LAB, whose activities are essential for the health effects in these beneficial foods.

Nowadays more and more people are looking back for natural and domestic foods, which are a result of millennial traditions and knowledge. Fermented dairy products are one of the main directions in modern healthy diet. The domestic traditional fermented dairy products in the Balkan region are going to play a major role in future modern healthy way of eating, due to enormous, scientifically proved, nutritional, and health effects, which they have. The rich variety of different types of fermented dairy products and the diversity of production ways, allow creation of specific products, responding the needs of special groups of

consumers. The development of new fermented dairy products by the incorporation of alternatives LAB (isolated from nondairy sources) will lead to manufacturing of "enhanced" traditional foods.

Practical Application

The summarized information may lead to the conclusion, that at the Balkans there is a wide variety of traditional fermented foods, with proven health and nutritional benefits for consumers. The use of new combinations of different types lactic acid bacteria, isolated from nondairy products with specific physiological properties, such as starter cultures, would result in a variety of fermented foods with increased nutritional benefits.

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