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MODERNIZATION OF THE FOOD INDUSTRY IN THE REPUBLIC OF KAZAKHSTAN, ON THE EXAMPLE OF COMBINED PRODUCTS FROM SHEEP MILK

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Abstract
In the article one of the ways to modernize the food industry in Kazakhstan, using the example of combined products from sheep milk is suggested. Despite the fact that the livestock industry, including sheep farming, in the Republic of Kazakhstan occupies about 43% of the total gross agricultural output, the main purpose of raising sheep in our country is to obtain meat and wool, and their milk is practically not used. Although world experience shows a steady increase in the volume of consumption of sheep milk and its processed products, due to its unique properties, both in the content of various vitamins, trace elements, and nutritional properties. According to its technological properties, sheep milk is most suitable for the production of combined products. For industrial development of production from sheep milk in order to increase the competitiveness of domestic dairy products, it is necessary to develop and implement technical regulations and standards for new types of combined dairy products, harmonized with international requirements, which requires research and development of technologies for combined dairy products.

Keywords: sheep milk, food products made from sheep milk.

INTRODUCTION

Historically, milk has occupied a special place among the most important human food products. It should be noted that the use of sheep milk for food and its processing into various products began much earlier than cow milk. The general concept of "milk" in the research literature is interpreted as a biological fluid secreted by the mammary gland of mammals and intended for feeding newborns [1, 2].

The deep roots of consuming sheep milk are also noted for the countries of the Middle East, Turkey, Greece, and Italy. In these countries, it is used not only in its pure form, but also prepared from it various fermented milk products, such as cheeses, cottage cheese, butter, and medicines. To increase productivity, special breeds of sheep were bred, which during the lactation period, lasting from 4 to 5 months, are able to give up to 150-200 kg of milk [3, 4].

By volume, the world's production of sheep milk is in third place after cow and goat [5, 6]. For Kazakhstan, sheep farming is the most ancient and developed branch of animal husbandry. By the beginning of the last century, there were 18.0 million sheep and goats on the territory of Kazakhstan. Sheep is a very economical and extremely unpretentious animal. For one kilogram of weight gain of growing young animals, 4 - 5 feed units are spent. The sheep has its own pasture area, which other herbivores cannot use, so it is not a competitor to any animal species [7, 8].

The main purpose of raising sheep in our country is to obtain meat and wool, and their milk is practically not used [9]. Thanks to milk, the human body, starting from the first minutes of life, receives all the necessary proteins, enzymes, vitamins, mineral salts, trace elements and a number of other biologically active substances [10, 11, 12, 13]. Long-term research on the study of the biological and physical properties of milk and dairy products has allowed us to establish medical and medical-preventive properties for a number of diseases and contribute to improving the immune system of the human body [14, 15]. Sheep milk differs in its organoleptic and biological properties from the milk of other domestic animals, in that it is fatter and more concentrated. The nutritional value of sheep milk due to its high protein and fat content is 1.5 times higher than cow milk, it has a delicate and slightly sweet taste. The color of sheep milk is white with a faint grayish tinge, which is due to the lack of carotene.

Compared with cow or goat milk, it contains several times more vitamins A, B15, B2, zinc and calcium. The calcium in sheep milk is easily digested, and the ratio of phosphorus and calcium in it is ideal. This product is classified as an antioxidant, thanks to which the human body synthesizes cholesterol, amino acids, as well as vitamins A and D. In those who regularly drink sheep milk, the brain works more actively, the body cells absorb more oxygen. It should also be noted that the protein of sheep milk has less allergenic properties than the proteins of goat or cow milk, so it is recommended to use it for people who are prone to allergic diseases. The use of sheep milk and its processed products is primarily recommended for pregnant women and children, teenagers, to strengthen the immune system after various diseases, bones and prevention of osteoporosis. However, it should be noted that sheep milk fat contains a significant amount of nicotinic and pantothenic fatty acids. They give sheep milk a specific smell and taste, which is a restriction for its use in food in its entirety.

In the technical regulation of the Customs Union TR CU 033/2013 "On the safety of milk and dairy products" in Annex No. 5, the identification indicators of raw milk of "other types of farm animals, including sheep", according to which the content of the components of sheep milk should be, in %: fat, not less than 6.2; protein, not less than 5.1; dry substances, on average 18.5. Density at a temperature of 20°C, not less than 1034; acidity, °T, not more than 25 [16].

In the national standard of the Republic of Kazakhstan ST RK 2117-2011 "National Kazakh dairy products. 12 Types. General specifications", in section 4 "Classification", depending on the type of milk–raw materials of agricultural animals, which is used in the production of national Kazakh dairy products, the subgroup ". from goat and sheep milk" is mentioned, but separate organoleptic and physicochemical indicators are not given. Also, in p. 5.3 Requirements for raw materials, mention is made of the use of sheep milk as raw materials in the production of national dairy products, references are given to ST RK 1760-2008, ST RK 166, ST RK 1005, which cover only such types as cow, camel, and mare milk [17, 18, 19].

Thus, the analysis of the sheep farming industry and the market of milk and dairy products in our country shows that there is no dairy sheep farming as a livestock industry, and therefore there is no industrial processing of sheep milk, which determines the relevance of our research on the composition and properties of milk of Kazakh sheep breeds, as well as the creation of food products from sheep milk.

METHODS AND RESULTS OF THE RESEARCH

Talking about the composition and properties of sheep milk, it should be noted that it is dominated by proteins - high-molecular compounds consisting of amino acids linked by a characteristic protein peptide bond and are the most valuable component of milk. The value of proteins consists in the presence of essential amino acids such as valine, lysine, leucine, isoleucine, methionine, tyrosine, tryptophan, and phenylalanine, which are not synthesized in the human body. According to the content of essential amino acids and the ratio between them, sheep milk proteins are classified as biologically complete proteins. The total protein content in sheep milk is 2 times higher than in cow milk, and 1.5 times higher than in goat milk. Among the protein components of sheep milk, casein and whey proteins are considered to be the main ones from a technological point of view. Casein is the main protein in milk. The main components are S1 -, S2 -, β- and caseins. The main mass of casein (about 95%) is found in milk in the form of relatively large colloidal particles – micelles, which are 22 associates of the main casein fractions. The mineral part of casein micelles is represented by calcium and phosphorus, in small amounts they contain citrate, magnesium, potassium, sodium, and carbohydrates. Casein micelles contain organic and inorganic calcium and phosphorus. A complex of organic calcium with casein, called calcium caseinate, forms a caseinatcalcium phosphate complex (CCPC) with colloidal calcium phosphate. The particle size of the caseinatcalcium phosphate complex is related to the amount of added calcium and phosphorus and decreases as their content decreases.

The group of whey proteins consists of milk protein components that remain in the serum after casein deposition at a pH 4.6. This group of proteins is also heterogeneous and includes globular proteins that differ in structure and properties. The main representatives of whey proteins are lactoglobulin (β-Lg) and lactalbumin (α-La). In addition to them, this group includes: serum albumin, immunoglobulins, microglobulin and some other minor components. Whey proteins, unlike casein, do not form associates and are not deposited at an isoelectric point. They are also subject to genetic polymorphism. The molecular weight of whey proteins varies in a wide range – from 14000 to 66000. Whey proteins are characterized by a large number of sulfur-containing amino acids and a low content of proline residues. They are not hydrolyzed by rennet, are less sensitive to calcium compared to casein, but are more sensitive to heat.

The ester of trivalent alcohol of glycerin and fatty acids are heterogeneous in composition and is a mixture of triglycerides (triacylglycerols), diglycerides (diacylglycerols) and monoglycerides (monoacylglycerols). Triglycerides predominate, up to 98%, with di- and monoglycerides accounting for 1.5% in total. Milk fat also contains phospholipids; substances that accompany fat (fat-soluble vitamins, sterols, carotenoids); free fatty acids. In milk, fat is found in the form of fat balls. The number and size of fat globules depend on the lactation period, the breed of livestock, the feeding diet, and the conditions of maintenance. Fat balls are covered with a protective protein-lecithin shell, which ensures the stability of the emulsion and allows to save it during the processing of milk.

The main carbohydrate of milk is lactose (milk sugar). It is a disaccharide, less sweet than sucrose, consisting of D-glucose and D-galactose residues. The lactose content in sheep milk is 4.5– 5.0%. Lactose is a good substrate for lactic acid bacteria and is fermented by them to lactic acid, under the action of which milk casein precipitates (production of fermented milk beverages and products).

Milk contains 0.6–0.8% (by weight of the dry residue) of mineral substances, which are divided into macronutrients and 23 microelements. The mineral substances of milk are represented by cations and anions that determine its salt composition. Milk is dominated by phosphates, citrates and chlorides of calcium, potassium, sodium and magnesium, which can be found in the form of true or colloidal solutions. They determine the nutritional value of milk and stabilize its colloidal system. The salt disbalance can lead to precipitation of milk proteins. The microelements of milk include copper, iron, zinc, cobalt, manganese, iodine, fluorine, molybdenum, chromium, aluminum, selenium, tin, lead, silicon, etc. They are associated with milk proteins (iodine, selenium, zinc, etc.) and the shells of fat balls (copper, iron), are part of many enzymes (iron, molybdenum, manganese, etc.) and vitamins (cobalt). Microelements make a certain contribution to the nutritional value of milk, however, excessive amounts of some of them can cause defects in the quality of raw materials and finished products. Milk contains almost all the essential vitamins, although in small amounts, as well as their provitamins. There are fat-soluble and water-soluble vitamins. Fat-soluble vitamins include vitamin A (retinol), vitamin D (calciferol), vitamin E (tocopherol), and vitamin K (phylloquinone) [20, 21].

The analysis of the composition and properties of sheep milk on a complex of organoleptic, physicochemical and technological indicators and determine the suitability of sheep milk for industrial processing to produce various combined dairy products. The organoleptic properties of products include such indicators as appearance, consistency, color, taste and smell, which are evaluated using visual, tactile, olfactory, taste and auditory sensations of a person and serve as one of the main criteria that determine the consumer's choice. The color of sheep milk is white with a faint grayish tinge, the consistency is a homogeneous liquid without sediment and flakes, the taste and smell are specific to sheep milk, without foreign tastes and smells [22, 23].

It should be noted that the specific taste of raw sheep milk, significantly different from the usual taste of cow milk, and a sharp smell that many consumers do not like and is its main disadvantage for direct consumption in food. The reasons for the sharp taste and sometimes unpleasant smell of whole sheep milk, as we have shown above, are both the presence of a high content of nicotinic and pantothenic fatty acids, and the use of strongly smelling kreoline used for processing sheep after shearing, the presence of odorous herbs in the feed, the maintenance of animals and traditional manual milking of sheep in improper sanitary conditions. To reduce the impact of these factors, it is necessary first of all to improve the animal feed base, housing conditions, and mechanize the milking of sheep.

Important indicators of freshness and quality of milk are titrated acidity and their density. The titrated acidity is expressed in degrees of Turner (°T). The Turner degree refers to the number of milliliters of 0.1 n sodium hydroxide solution required to neutralize 100 ml of milk. Titrated acidity is due to the presence of proteins in milk (they account for 4-5°T), acidic salts (about 9-13°T), dissolved carbon dioxide, acids and other compounds (in total 1-3°T). According to the authors [3, 23] the acidity of sheep milk depending on the breed, lactation period, etc. it lies in the range from 23 to 24^0T. The authors [22], who studied the milk of sheep farm "Yerbol" of the Republic of Kazakhstan, titrated acidity of sheep milk was 20±0.1ºT. There is data [1] on the acidity of sheep milk from 20.0 to 28.0ºT. Studies of sheep milk of the South Kazakhstan Merino breed on farms in Almaty region and South Kazakhstan region [24] showed results of titrated acidity from 10.5 to 25.75ºT. It should be noted that the technical regulation of the Customs Union 033/2013, which applies to the territory of the countries of the Customs Union, established in the identification indicators of raw sheep milk the acidity of no more than 25°T [16].

Active acidity, or hydrogen index (pH), characterizes the concentration of free hydrogen ions and is numerically equal to the negative decimal logarithm of the concentration of hydrogen ions, expressed in mol per 1 liter. In fresh milk, the pH changes within fairly narrow limits and is on average equal to 6.7 [22, 24]. The pH value determines the colloidal state of milk proteins, the development of useful and harmful microflora, the thermal stability of milk, and the activity of enzymes. Milk has buffering properties due to the presence of proteins, hydrophosphates, citrates and carbon dioxide. This is proved by the fact that the pH of milk does not change with a certain increase in titrated acidity. The buffer capacity of milk is understood as the amount of 0.1 n of acid or alkali required to change the pH of the medium by 1 unit. When lactic acid is formed, the balance between the individual buffer systems shifts and the pH decreases. Lactic acid also dissolves colloidal calcium phosphate, which leads to an increase in the content of titrated hydrophosphates and an increase in the effect of calcium on the titration result. The redox potential of milk is determined mainly by the concentration of oxygen dissolved in it. The average value of the potential is 0.2-0.3 V. Metals (copper, iron) and mixing contribute to an increase in the redox potential. The appearance in milk and dairy products of such taste defects as metallic, oxidized, salty taste is associated with an increase in the redox potential of the product. During the development of microorganisms, the amount of oxygen decreases, and enzymes are released that catalyze reduction reactions. This leads to a decrease in the redox potential.

The milk density shows the ratio of the mass of the substance to the volume occupied by it, i.e. the specific volume. The density depends on the temperature and chemical composition of the milk: it decreases with an increase in temperature and an increase in the mass fraction of fat and increases with an increase in the mass fraction of protein, lactose, and salts [22, p.20-23]. The density value is also affected by the lactation period, the breed of sheep, the state of health and conditions of their maintenance, etc. By the density of milk, such falsification as dilution with water can be determined. When adding water, it decreases, for example, when adding 10% of water, the density of milk decreases by about 3 kg/m^3, therefore, this indicator can be used to judge the naturalness of milk. Viscosity is the property of a medium to resist relative movement of its layers. The viscosity of milk is almost 2 times greater than the viscosity of water and at 20°C for different types of milk is (1,3-2,1) 10-3Pa*s., for sheep milk 2,1x10-3Pa•s, since the strongest influence on the viscosity index is the amount and dispersion of milk fat and the state of proteins. When heating milk to 40-45°C its viscosity decreases, at higher temperatures (starting from 65°C), the viscosity of milk increases, which is associated with irreversible coagulation of whey proteins.

In structured dairy products - fermented milk beverages, sour cream, etc., the viscosity is due to the formed structure and serves as an indicator that determines their consistency. The viscosity of such systems depends on the shear stress and velocity gradient and is called effective. Surface tension occurs at the milk-air interface. The surface tension of milk is much lower than that of water and is about 44*10-3N/m at 20°C (against 72.7•10-3N/m for water) [22, p.24-26]. This is due to the presence of such surfactants in milk as phospholipids, milk whey proteins, fatty acids, and proteins of fat globules. The surface tension decreases when heating milk, especially if there is a hydrolysis of fat, accompanied by the formation of surfactants that reduce the amount of surface energy (fatty acids, mono- and diacylglycols). The surface tension is associated with the formation of foam during pumping, transportation, separation of milk, as well as in some technological processes of its processing. All factors that decrease surface tension reduce foaming, and vice versa.

Osmotic pressure and freezing point are interrelated and depend mainly on the concentration of lactose and dissolved salts. The osmotic pressure of milk is close to the osmotic pressure of blood and is on average 0.66 MPa. Osmotic pressure changes when milk is adulterated, its acidity increases, and its chemical composition changes [24, p.54-56]. The average freezing point of milk of normal chemical composition is minus 0.54°C (with fluctuations from minus 0.505 to minus 0.575°C). Its value changes significantly when diluting milk with water (adding 1% of water increases the freezing point by about 0.006°C), adding soda to it, increasing the acidity, changing the chemical composition of milk in case of animal disease. The principle of measuring the freezing point of milk is the basis of a cryoscopic method for determining its naturalness. Therefore, the cryoscopic temperature can reliably judge the falsification of milk.

Electrical conductivity describes the ability of a substance or solution to conduct electricity. The unit of measurement of specific electrical conductivity in the SI system is adopted by Siemens per meter (Sm/m). The electrical conductivity of milk is due to its salt composition and is constant for normal milk [24, p.57]. Its value increases with the disease of the animal (for example, mastitis), with increasing acidity and decreases with the addition of water, with the concentration of milk. The lactation period also affects the amount of electrical conductivity - at the beginning of lactation, milk has a minimum electrical conductivity, at the end – the maximum. Optical properties are expressed by the refractive index, which for milk is 1.348. Dependence of the refractive index on the content of dry substances is used to control skim solids, protein and determine the iodine number by refractometric studies. The dielectric constant of milk and dairy products is determined by the amount and energy of the moisture bond. For water, the dielectric constant is 81, for milk fat 3.1-3.2. The dielectric constant is used to control the moisture content of butter and dry dairy products. The refractive index of milk at 20°C is 1.3340-1.3485. It is determined by the refractive index of water 1.3329 and the presence of skim solids, more precisely, lactose, casein and other proteins, mineral salts and other substances. In this

regard, the refractive index, which is measured by a refractometer, controls the mass fraction of skim solids, proteins and lactose.
The main technological properties controlled in the process of milk processing include thermal stability and rennet coagulability. The thermal stability of milk is mainly due to its acidity and salt balance and determines the suitability of milk for high-temperature processing. The main stability indicators of protein molecules are the presence of a surface charge and a hydrate shell [24, p.58]. It affects the thermal stability and the content of calcium and magnesium ions in milk. Fresh milk with an acidity of up to 18°T (pH 6.6–6.7) can withstand high-temperature processing without visible protein coagulation. It is especially important to consider this property when producing sterilized milk and canned milk, as well as baby food products. Rennet coagulability of milk (the ability of its proteins to coagulate under the action of rennet enzyme to form a dense clot) is a criterion that determines the suitability of milk for cheese production. The rate of coagulation of milk proteins and the density of the resulting clot depend primarily on the content of casein and calcium ions in milk. The higher it is, the faster the clot forms and the higher its density. The increased concentration of hydrogen ions and high content of somatic cells negatively affect the rennet coagulability of milk.
According to its technological properties, sheep milk is most suitable for the production of cheeses and yogurt. In the EU, the American, African and Australian continents, sheep milk cheeses are included in the category of elite cheeses. French Roquefort, Bulgarian brynza, Italian caciocavallo and Pecorino, Romanian halloumi, Spanish Manchego and Cabrales are world famous. With the addition of cow milk to sheep milk, many types of soft, brine, semi-hard, hard cheeses are produced in the world – brynza, feta, anevato, caciocavallo, azeitan, krupt, kurut, tanir, panir, skir, gaitost, gammelost. In Russia, traditionally, a certain amount of sheep milk is processed in the mountainous regions of Dagestan for Tarni-Tau, Erpelinsky, Dagestani, brynza and some other national cheeses, mainly brine type, or for cheese products with aromatic herbs. The high acidity and salinity of these cheeses, the taste and aroma of herbs to some extent muffle the specific taste and smell of sheep milk. Yogurt has long been popular in Bulgaria and other countries of the Balkan Peninsula. It was prepared from the milk of sheep and goats, which contains a higher amount of protein, fat and carbohydrates than cow. This is caused by such a basic indicator as the consistency of yogurt. It is thicker than many dairy products. The main starter culture for yogurt served as a lactic acid Streptococcus thermophilus and "Bulgarian Bacillus".
Thus, taking into account all the organoleptic, physicochemical and technological indicators of sheep milk and the world experience in the production of various dairy products from sheep milk, we consider it most appropriate for Kazakhstan to conduct in-depth studies of the composition and properties of milk of domestic sheep breeds, as well as their technological potential for industrial production of dairy products.
Research on the composition and properties of sheep milk was conducted by a number of scientists to develop the milk productivity of sheep of various breeds bred in the country. Such breeds as the tsigey, balbass, mazekh, Karakul, and tushin had fairly high milk productivity and were used as dairy animals. Here it is necessary to note one feature - Kazakhstan is characterized by a wide variety of natural, climatic, economic and ethnic factors that have a specific impact on the development of sheep farming in certain regions. Therefore, the restoration and development of this industry requires considering these conditions. At the same time, it is important to use both domestic and international experience in the development of sheep farming, in relation to local conditions. Milk productivity of sheep depends on such important factors as: conditions of keeping, feeding, breed and age. There is data on the average milk productivity of sheep of various breeds in Kazakhstan [25].
Based on the data provided it can be concluded that the composition of sheep milk varies widely during lactation. The lactation period in sheep lasts for 120-170 days. The largest amount of milk is obtained in the second decade after lambing. Until the fifth lactation, the milk yield increases, and then gradually decreases to 100-200 g of milk per day. Getting milk also depends on the duration of keeping lambs under the ewes. So, when weaning lambs for 3-4 days, ewes can be milked for 4-5 months. For the first 2 months, the sheep are milked both in the morning and in the evening, and then 1 time a day.
In addition, until now there was no data on the chemical composition and technological properties of milk obtained from Kazakhstani sheep breeds. As shown in scientific research by foreign scientists, sheep milk contains all the necessary nutrients for the human body in an easily digestible form, which allows to make combined products.
To identify differences in physicochemical composition for experimental research investigated the milk of sheep pasture-stalled housing in the southern region, in particular, of the farm "Tabys" in Almaty region, engaged in breeding of Kazakh coarse wool sheep that is well adapted to pasture conditions and pasture-stalled housing in the northern regions, in particular, in the Akmola region. For analyses, standard methods used for the study of cow milk were used.
The chemical composition of sheep milk in the considered regions of Kazakhstan differs slightly from each other. The content of sheep milk in the southern region exceeds the content of sheep milk in the northern region, and **the content of dry matter exceeds 4.5 times.** These indicators of sheep milk can allow the development of combined dairy products, which are especially of consumer value among the population.
The creation and research of combined products is a concept like food combinatorics. "Food combinatorics" is a scientific and technical process of creating new types of food products by forming specified organoleptic, physicochemical energy and medicinal properties, thanks to the application of food and biologically active additives [26, p.249].
When designing combined dairy products, for example, yogurt, it should be striven to create a product as a whole from separate elements that separately do not provide an optimal balance in terms of protein, fat, carbohydrates, vitamins and minerals. For example, the author [27] suggests Bio-yogurt, formed when fermenting sheep milk and fresh quince juice as a result of lactic acid fermentation. Adding quince juice to sheep milk improved the necessary qualitative and quantitative indicators of the food product and, accordingly, strengthened the therapeutic and dietary functions of the developed Bio-yogurt.
Other authors [28] have developed a yogurt made from sheep milk and pumpkin juice with starter culture, including lactobacilli and Bulgarian bacillus. Developed yogurt from sheep milk and pumpkin juice, had low calorie content (74.7 kcal). In comparison with sheep milk, there is a significant decrease in the amount of fat (from 10.53% to 3.6%) and an increase in the amount of carbohydrates (from 4.6% to 6.71%). In addition, yogurt made from sheep milk and pumpkin juice contained all eight essential amino acids. Therefore, the product is biologically complete and dietary.

CONCLUSION

Creation and industrial development of combined dairy products from sheep milk is possible on the basis of in-depth research of the composition and properties of sheep milk of Kazakhstani sheep breeds, and the subsequent development and implementation of technical regulations and standards for combined dairy products, harmonized with international requirements. For the development of the dairy and canning industry of the Republic of Kazakhstan, it is necessary to create specialized enterprises or workshops at the enterprises operating in the country for the production of milk and its processed products. For targeted re-equipment of such enterprises, it is necessary to solve the tasks of modernizing such production facilities or develop a set of measures aimed at ensuring the release of innovative products with the planned characteristics of technical level, quality, price, quantity, and release dates. The effectiveness of such modernization or introduction of a new technology into production depends on the consistency and quality of the so-called technological audit at enterprises, considering the specifics of the products.

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