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Comparative Characteristics of the Amino Acids Composition of Sheep Milk from Breeds of Northern Kazakhstan

AKNUR MULDASHEVA[1], GULMIRA ZHAKUPOVA[1]*, DULAT IBRAYEV[1], AIGUL OMARALIEVA[2] and ZHULDYZ SATAYEVA[1]

[1]Department of Technology of Food and Processing Industries, S. Seifullin Kazakh Agrotechnical University, Nur-Sultan, Republic of Kazakhstan.

[2]Technical Faculty, Kazakh University of Technology and Business, Nur-Sultan, Republic of Kazakhstan.

Abstract

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. The production of dairy products from sheep is limited due to the low productivity of animals and the seasonality of milk production throughout the year, as well as the short lactation period. Also, one of the problems is manual milking of sheep, which does not allow obtaining sheep milk on an industrial scale. The market of dairy products, currently in the Republic of Kazakhstan is represented only by-products made from cow's milk, and at the same time, most of them are products made from cow's milk powder, so the development of products made from sheep's milk is an urgent task. In addition, sheep's milk is a national product, and one of the tasks is to revive the traditional products of the Kazakh people. The analysis of literature studies shows that in-depth studies of the chemical composition of sheep's milk have not been conducted in Kazakhstan. The chemical composition data obtained during the Soviet period only give an idea of the primary chemical parameters obtained by generally accepted basic methods and do not provide reliable information about the deep chemical composition of the milk of local ewes. According to the results of studies, the content of the essential amino acid valine in cow's milk (0.21 g/100g) is also lower than in sheep's milk (9.69-3.79 g/100g). Sheep's milk protein is digested in the human body by 99.1%, and cow's milk protein by 91.9%. According to world experts, one of the advantages of Kazakhstan's domestic milk products is its naturalness, a low share of the use of genetically modified organisms, and environmentally friendly pastures, due to which they receive high-quality and safe products. Therefore, the designated research topic and its analysis are appropriate and relevant.

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CONTACT Gulmira Zhakupova researchkz@mail.ru Department of Technology of Food and Processing Industries, S. Seifullin Kazakh Agrotechnical University, Nur-Sultan, Republic of Kazakhstan.

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Introduction

Sheep's milk, produced all over the world, is mainly used in the production of dairy products, especially cheese. In the European Union, although sheep account for only 8.4% of the world's livestock, milk production reaches approximately 27.1% of the world market.[1]

Sheep's milk is an unconventional type of raw milk, its properties resemble goat's milk. Sheep's milk, which differs from cow's milk by a higher (by 30-50%) dry matter content, is more preferable in the production of solid dairy products. The energy content in sheep's milk is also about 50% higher than in cow's or goat's milk.[2,3,4]

Sheep's milk differs in its organoleptic and biological properties from the milk of other domestic animals, in that it is more fat and concentrated. The nutritional value of sheep's milk due to its high protein and fat content is 1.5 times higher than cow's milk. Sheep's milk has a delicate and slightly sweet taste. The color of sheep's milk is white with a faint grayish tinge.[5,6,7]

Sheep's milk is an important source of bioactive substances that have health-promoting functions for the body. The valuable composition of sheep's milk is due to the high content of fatty acids, immunoglobulins, proteins, hormones, vitamins and minerals. Many biopeptides found in milk have antibacterial, antiviral and anti-inflammatory properties. The bioactive substances of sheep's milk also show anticancer properties. Sheep's milk, thanks to its content of CLA and orotic acid, prevents the occurrence of type 2 diabetes, Alzheimer's disease and cancer. Sheep's milk, as a product rich in bioactive substances, can be used as a medical aid to support the body in the fight against neurological and cancer diseases.[8]

Sheep breeding for the Republic of Kazakhstan is an industry that goes back centuries, traditional for our country and our people, and is one of the most promising areas for the development of agriculture. The harsh climatic conditions and the quality of pastures determined the choice of our ancestors to engage in sheep farming. At the moment, the sheep breeding of the republic, which counts almost 20 million heads of sheep, is focused only on obtaining products: meat, wool, fur, and fur sheepskins. However, sheep's milk, rich in vitamins, trace elements, amino acids, minerals, and products made from sheep's milk remainsunexplored.[9,10]

Sheep farming in Kazakhstan is a traditional, historically developed branch of animal husbandry, the development of which is facilitated by the availability of wide natural pastures. Currently, fine-wool,semi-fine, coarse-wool, and semi-wool directions represent the sheep breeding of the republic.[11]

Studies on the composition and properties of sheep's milk in Kazakhstan were conducted by a number of scientists back in the Soviet Union to develop the milk productivity of sheep of various breeds. Such breeds as Pigeyskaya, Balbasskaya, Mazekhskaya, Karakulskaya, Tushinskaya, etc., had fairly high milk productivity and were used as dairy animals replaced by recent ones.[12]

Although sheep's milk does not have the same economic importance and long-standing traditions as in other European countries (for example, in particular in the Mediterranean region), in recent years it has become increasingly important in Kazakhstan. This is probably since sheep's milk is a traditional food for the indigenous population, and can also provide a profitable alternative to cow's dairy products to expand the product range.[12]

Commercial milking of sheep is a new agricultural industry in the United States starting approximately 30 yr ago. The industry is still small, but it is growing. The majority of the sheep milk is used in the production of specialty cheeses. The United States is the major importer of sheep milk cheeses with 50 to 60% of annual world exports coming to the United States during the past 20 yr. Therefore, there is considerable growth potential for the industry in the United States.[13,14]

To make full use of sheep's milk, scientists of the Institute of Meat and Dairy Industry in Minsk (Republic of Belarus) examined samples of sheep's milk of the Lakayune breed. It was established that sheep's milk is characterized by a high content of dry substances, proteins, fat, has high acidity and density. It was also found that the production of yogurt with good consistency of sheep's milk is achieved at a pasteurization temperature of raw milk 90±2°C and determined that the maximum

degree of use of dry substances in the manufacture of cottage cheese from sheep's milkis observed at the pasteurization temperature of raw milk 80°C.[15]

In order to create a biologically complete and dietary product, Ayazbekova M. A., Baigozhina G. T., Suleimenova M. Sh., designed yogurt from sheep's milk and vegetable filler in the form of pumpkin juice.[16]

However, in Kazakhstan, there is currently no processing of sheep's milk, and traditional technologies of national products from sheep's milk, such as Kurt, cheeses are almost lost. In addition, there is almost no information about the chemical, biochemical composition, and physical properties of sheep's milk. Therefore, a deep study of the properties and composition of sheep's milk, to revive traditional recipes, along with the creation of new technologies, is advisable.

The consumption of sheep's milk products is widespread in the Mediterranean countries and the Caucasus. World-famous elite cheeses such as Roquefort (France), Pecorino (Italy), Cabrales (Spain), Cecil (Caucasus) are traditionally made from sheep's milk. The traditional technology of cooking Kazakh Kurt also provided for the use of sheep's milk, since our ancestors did not breed cows. It is established that 1 kg of sheep's milk meets the daily human need for protein, vitamins, and minerals.[17]

To date, enough research has been conducted on the technology of various products made from sheep's milk. However, there are no studies to determine the amino acid composition of the milk of Kazakh sheep breeds "Kazakh short-tailed rough-haired" and "Kazakh short-tailed semi-rough-haired". Taking into account that the studied type of milk will be used for the production of dairy products, thework aims to study in-depth the amino acid composition of sheep milk taken from two different breeds of sheep in Northern Kazakhstan.

Materials and Methods

Samples

Raw sheep's milk was chosen as the object of study. Experimental samples of sheep's milk were taken from the sheep of the farm "Tabys "(Akmola region, Republic of Kazakhstan) of the Kazakh short-tailed rough-haired breed and" Otkanzhar" LLP (Karaganda region, Nurinsky district, Izendy village) of the Kazakh short-tailed semi-rough-haired breed. Milk samples were taken during the lactation period of sheep in the spring. Lactation in sheep lasted 120-170 days. The greatest amount of milk was obtained in the second decade after lambing. Until the fifth lactation, milk yield increased, and then gradually decreased to 100-200g of milk per day.

Laboratory studies of sheep's milk prototypes were conducted in the laboratory of the Department "Technology of Food Production and Processing industries" of the Kazakh Agrotechnical University named after S. Seifullin (Nur-Sultan, Republic of Kazakhstan).

Studies of the quantitative amino acid composition of sheep's milk were carried out based on the laboratory of "Nutritest" LLP (Almaty), by the method of high-performance liquid chromatography with a spectrophotometric detector (Agilent Technologies 1200, USA; MVI.MN 1363-2000).
Statistical data processing was performed using the MicrosoftExcel program(Two-factor analysis of variance, 2019).

Organoleptic and Physicochemical Composition

Standard tests were used to determine the physicochemical composition of sheep's milk.

To characterize sheep's milk, a descriptive method based on the determination of organoleptic parameters was used. Also, along with this, generally accepted methods were used to determine the physical, chemical, and biochemical parameters. Research methods used in the work: to determine the titratable acidity - titrimetric method (GOST 3624-92), to determine the mass fraction of protein - the method of formol titration (GOST 25179-2014); the mass fraction of dry matter was determined by the method of drying to a constant mass (GOST 3626-73), milk lactose was determined by the refractometric method (GOST R 51259-99); titrated acidity in the control and test object was determined according to GOST 3624-92; organoleptic parameters in the control and test object were determined according to GOST R ISO 22935-1-2011; density was checked by the hydrometric method using an AMT-type hydrometer (Eximlab, Russia)with a density scale and a thermometer for

determining the temperature of milk(GOST 54758-2011); the fat content of the product was determined according to GOST 5867-90.[18,19,20,21,22,23]

Determination of the Amino Acid Composition of Sheep's Milk

The method for determining the content of amino acids in milkis based on the initial removal of lipids and fat-free substances by extracting them with a mixture of organic solvents, acid hydrolysis of proteins, obtaining DUBS-produced amino acids, and their chromatography.

Sheep's milk is taken in an amount of 10 g with an error of ±0.01 g. A sample weight of 1 ±0.001 g is weighed on a weighted paper filter and 40 cm3 of the chloroform mixture is washed:methanol in a 2:1 ratio to remove fat. Then the paper filter is dried in a drying cabinet at a temperature of 1000C for 1 hour, and after the filter cools down in the desiccator (Borosil Glass Works Limited, India), it is weighed again with an error of ±0.001 g. From the dried sample, a weight of 0.00130 g is taken with an error of ±0.00005 g and taken in vials with a volume of 2 cm2 for hydrolysis.

The treated sample samples are filled with 1 cm3 6 M of hydrochloric acid solution(ECOS-1, Russia). Vials are placed in a hydrolysis tank, which is purged with nitrogen to remove traces of oxygen. Then, using a vacuum pump, the nitrogen is pumped out at a dilution of no more than 1.35 kPa for 5 minutes and the hydrolysis vessel is hermetically sealed. Hydrolysis is carried out at a temperature of 150°C for 24 hours. After hydrolysis, hydrochloric acid is removed from the test tubes; it is blown off with nitrogen when the test tube is weakly heated in a sand bath. The evaporation temperature should not exceed 1500C.

Alkaline hydrolysis is carried out for the subsequent determination of the amino acid tryptophan. To do this, from the prepared product samples, a sample of 0.0100 g is taken into a 2 cm3 vial with an error of ±0.00005 g, 0.2 g+0.01 barium hydroxide(Agrochemical Engineering, Russia) is added and 1 cm3 of bi-distilled water is poured. The vial is placed in a hydrolysis vessel, which is purged with nitrogen to remove traces of oxygen. Then, using a vacuum pump, the nitrogen is pumped out at a dilution of no more than 1.35 kPa for 5 minutes and the hydrolysis vessel is hermetically sealed. Alkaline hydrolysis is carried out at a temperature of 105°C for 16 hours. After hydrolysis, the contents of the vial are poured into test tubes with a volume of 5 cm3, the vial is thoroughly washed and the volume is brought to 5 cm3 with bi-distilled water. To precipitate barium hydroxide, the aqueous solution is purged with carbon dioxide(Agrochemical Engineering, Russia) for 5 minutes. Check the pH value with the indicator paper, the medium should be neutral. If the medium is alkaline, the sample is once again purged with carbon dioxide for 5 minutes and proceed to obtain the DUBS derivative (GOST 25179-2014 Milk and dairy products. Methods for determining the mass fraction of protein).

Results

The results of the experimental studies are shown in Table 1.

Table 1: Chemical composition of sheep's milk of the experimental sample

Indicators	Chemical composition of milk, %	
	Sheep's milk of a prototype of the Kazakh short-tailed rough-haired breed	Sheep's milk of a prototype of the Kazakh short-tailed semi-rough-haired breed
Proteins, g	3,30	3,84
Fat, g	8,39	9,13
Lactose, g	4,59	4,62
Dry skimmed milk residue, g	9,56	11,14
Acidity, 0T	22	22
Density, kg / m3	1030,15	1032,63

According to the chemical analysis data, we can say that the experimental samples of milk meet the requirements for sheep's milk, have a pleasant, somewhat sweet taste and some specific smell of skin fumes. The strength of this smell largely depends on the conditions of keeping the sheep. According to the tabular data, it can be seen that the milk of the experimental sample of the Kazakh short-tailed semi-rough-haired breed has higher indicators than that of the other breed. Table 2 shows the indicators of the organoleptic evaluation of sheep's milk.According to the data indicated in Table 2, we see that sheep's milk is comparable to traditional cow's milk, and is suitable for food.

Table 2: Results of organoleptic parameters of sheep's milk

Indicators	Sheep's milk
Appearance and consistency	Opaque homogeneous liquid, without sediment, flakes of protein, slightly viscous, non-viscous
Colour	White, with a very faint cream tint, uniform
Taste and smell	Practical odorless and pronounced taste; the taste is slightly sweet

Table 3: Comparative table of amino acids of sheep's milk

Name of indicators	Sheep's milk of the Kazakh short-tailed coarse-haired breed, g/100g	Sheep's milk of the Kazakh short-tailed semi-coarse breed, g/100g
Asparagine	2,89	2,77
Glutamine	13,4	11,92
Serin	9,02	3,27
Glycine	2,57	6,14
Threonine	5,37	2,37
Arginine	8,45	2,11
Alanine	4,34	1,57
Tyrosine	8,71	1,96
Cysteine	3,38	0,61
Valine	9,69	3,79
Methionine	2,91	1,37
Phenylalanine	4,98	2,74
Isoleucine	3,03	2,84
Leucine	11,59	5,3
Lysine	3,30	5,85
Histidine	1,90	1,76
Proline	3,70	5,48
Tryptophan	0,77	0,71

For a more in-depth study of the chemical composition of sheep's milk, an analysis of the amino acid composition of milk of two breeds was carried out.

The results of the chromatographic analysis show that the amino acid composition of milk contains a significant amount of essential amino acids. The analysis data is shown in Table 3.

Discussion

Data analysis shows (table 3) that the milk of the Kazakh short-tailed rough-haired breed is dominated by such amino acids as: glutamine (13.4 g/100g), leucine (11.59 g/100g), valine (9.69 g/100g), serine (9.02 g / 100g), tyrosine (8.71 g / 100g), arginine (8.45 g / 100g). Also, following the data of the table, it can be seen that the milk of the Kazakh short-

tailed semi-rough-haired breed has the highest content of these: glycine (6.14 g/100g), lysine (5.85 g/100g), proline (5.48 g/100g). When summing up all the unminimated acids of the milk of sheep of the Kazakh short-tailed coarse-haired breed, their amount (99.0 g) is greater than in the milk of the Kazakh short-tailed semi-coarse-haired breed (70.0 g).From this, we conclude that the greatest value in terms of amino acid content is sheep's milk of the Kazakh short-tailed coarse-haired breed.

As shown in table 3 that the high nutritional value of sheep's milk is due to the high content of such amino acids as asparagine, glutamine, serine, glycine, threonine, arginine, alanine, tyrosine, cysteine, valine, methionine, phenylalanine, isoleucine, leucine, lysine, histidine, proline, and tryptophan.

Lysine is an essential amino acid that actively participates in the production of antibodies, hormones, and enzymes. Lack of it in the body can be expressed in the development of fatigue, inability to concentrate, irritability, damage to the blood vessels of the eyes, hair loss, anemia,and problems in the reproductive sphere. Lysine is one of the most important essential amino acids in providing a healthy diet. In the studied sheep's milk, its content is (3.30-5.85 g/100g), this value is much higher than in cow's milk (2.7 g/100g).

The content of the essential amino acid valine in cow's milk (0.21 g/100g)is also lower than in sheep's milk (9.69-3.79 g/100g). Valine plays a key role in manycomponents involved in the growth and synthesis of body tissues.

In the absence of the conditionally essential amino acids L-arginine and L-histidine, the processes of protein synthesis are significantly reduced. The body can synthesize them, but in some pathological conditions and young children, they can be synthesized in insufficient quantities.

Thus, sheep's milk has a huge energy potential, because it contains a significant amount of essential amino acids such as valine, isoleucine, leucine, lysine, histidine, methionine, threonine, tryptophan, and phenylalanine. The consequence of this is that the protein of sheep's milk is more complete than the milk proteins of other farm animals, in addition, sheep's milk contains an increased amount of casein (at the end of lactationup to 6.17%). Sheep's milk protein is digested in the human body by 99.1%, and cow's milk protein by 91.9%.

Conclusion

According to the results of the study, it was found that the sheep's milk of both breeds of sheep in Northern Kazakhstan has a rich amino acid composition, has a high biological value. It has a pleasant taste, moderate smell, during a thorough technological operation, in particular filtration, the smell is removed, and in pasteurized milk, the specific smell of sheep's milk is muted.

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In general, the amino acid composition of the milk of both breeds is almost identical, but the number of sheep of the "Kazakh short-tailed semi-rough-haired" breed exceeds the number of "Kazakh short-tailed coarse-haired", so it is advisable to conduct further research with the milk of sheep of the "Kazakh short-tailed semi-rough-haired"breed.

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Conflict of Interest

The authors do not have any conflict of interest.

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