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DEVELOPMENT OF TECHNOLOGY PRODUCTION OF SOFT CHEESE "MOZZARELLA" ON THE BASIS OF GOAT'S MILK

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Among variety of food products, cheeses occupy one of the leading places. It is a concentrated protein product that is easily absorbed by body and has good organoleptic properties. The purpose of research is to develop technology for the production of soft cheese "Mozzarella" based on the optimal ratio of dairy raw materials (cow's and goat's milk) and enriched by food additive - paprika. Soft cheese product "Mozzarella" made from 50% goat's milk: 50% cow's milk became the best example. Standard and generally accepted research methods were used in work in accordance with technological scheme and taking into account latest achievements of science and technology. Physico-chemical indicators of finished products are presented. An x-ray spectroscopic analysis of the composition of chemical elements of soft cheese "Mozzarella", made in ratio of goat and cow milk, with addition of paprika, was carried out. The results of research showed that soft cheese contains many macro- and microelements. The product is rich in valuable proteins, vitamins and minerals, such as calcium - 27.21%, phosphorus - 18.80%, and has high nutritional value. The implementation of the proposed technology in production allows to obtain products oriented to the domestic market. The developed cheese "Mozzarella" expands range of products, has increased nutritional and biological value, improves organoleptic and functional properties of product.

Keywords: soft cheese, goat milk, technology, enzyme, mozzarella, paprika.

РАЗРАБОТКА ТЕХНОЛОГИИ ПРОИЗВОДСТВА МЯГКОГО СЫРА «МОЦАРЕЛЛА» НА ОСНОВЕ КОЗЬЕГО МОЛОКА

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Среди разнообразия пищевых продуктов сыры занимают одно из ведущих мест. Это концентрированный белковый продукт, который легко усваивается организмом и имеет хорошие органолептические свойства. Цель исследования - разработка технологии производства мягкого сыра «Моцарелла» на основе оптимального соотношения молочного сырья (коровье и козье молоко) и обогащенный пищевой добавкой – паприка. Оптимальным образцом стал мягкий сырный продукт «Моцарелла», изготовленный из 50% козьего молока: 50% коровьего молока. В работе использовались стандартные и общепринятые методы исследования в соответствии с технологической схемой и с учетом последних достижений науки и техники. Представлены физико-химические показатели готовой продукции. Проведен рентгеноспектральный анализ состава химических элементов мягкого сыра «Моцарелла», изготовленного в соотношении козьего и коровьего молока, с добавлением паприки. Результаты исследований показали, что мягкий сыр содержит много макро- и микроэлементов. Продукт богат ценными белками, витаминами и минералами, такими как кальций – 27,21%, фосфор – 18,80%, имеет высокую пищевую ценность. Внедрение предлагаемой технологии в производство позволяет получать продукцию, ориентированную на внутренний рынок. Разработанный сыр «Моцарелла» расширяет ассортимент продукции, имеет повышенную пищевую и биологическую ценность, улучшает органолептические и функциональные свойства продукта.

Ключевые слова: мягкий сыр, козье молоко, технология, фермент.

ЕШКІ СҮТІ НЕГІЗІНДЕ «МОЦАРЕЛЛА» ЖҰМСАҚ ІРІМШІГІН ӨНДІРУ ТЕХНОЛОГИЯСЫН ӘЗІРЛЕУ

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Азық-түлік өнімдерінің алуан түрлілігі арасында ірімшіктер жетекші орындардың бірін алады. Бұл организмге оңай сіңетін және жақсы органолептикалық қасиеттері бар концентрлі ақуыз өнімі. Зерттеудің мақсаты сүт шикізатының (сыыр және ешкі сүті) оңтайлы арақатынасына негізделген және тағамдық қоспа – паприкамен байытылған «Моцарелла» жұмсақ ірімшік өндіру технологиясын жасау болып табылады. 50% ешкі сүті : 50% сыыр сүтінен жасалынған «Моцарелла» жұмсақ ірімшік өнімі оңтайлы үлгі болып табылады. Жұмыста технологиялық схемаға сәйкес және ғылым мен техниканың соңғы жетістіктерін ескере отырып, стандартты және жалпы қабылданған зерттеу әдістері қолданылды. Дайын өнімнің физикалық-химиялық көрсеткіштері көрсетілген. Ешкі сүті мен сыыр сүті қатынасында жасалған, тағамдық қоспа паприка қосылған «Моцарелла» жұмсақ ірімшігінің химиялық элементтерінің құрамына рентгендік-спектрлік талдау жүргізілді. Зерттеу нәтижелері жұмсақ ірімшік құрамында макро және микроэлементтер көп екенін көрсетті. Өнім құнды ақуыздарға, дәрумендер мен минералдарға бай, мысалы, кальций – 27,21%, фосфор – 18,80% сияқты элементтердің және тағамдық құндылығы жоғары болды. Ұсынылып отырған технологияны өндіріске енгізу отандық функционалдық бағыттағы өнім алуға мүмкіндік береді. Жасалған «Моцарелла» ірімшігі өнімнің ассортиментін кеңейтеді, тағамдық және биологиялық құндылығын арттырады, өнімнің органолептикалық және функционалдық қасиеттерін жақсартады.

Негізгі сөздер: жұмсақ ірімшік, ешкі сүті, технология, фермент.

Introduction

Today's consumer seriously thinks about quality of the products consumes and beneficial properties of food. This forces manufacturer to pay attention to the quality of raw materials, formula and production technology used. Production and consumption of dairy products are significantly affected by processes such as globalization, changes in social models of people's nutrition, trends and achievements of world science in this field, and growth of energy and environmental problems throughout the world. A combination of these factors requires research aimed at improving traditional and new technologies of dairy products.

Research and development of new recipes and technologies for production of soft cheese with various additives is relevant due to the interest in cheese production in dairy products.

Mozzarella soft cheese is one of the most popular varieties in the world. Due to its unique taste, it is used in all types of dishes from Italian cuisine. Italy started producing this delicious cheese for the first time. It is made in various shapes, but most often it is rolled into small balls, ready to eat, without pre-cutting.

Mozzarella - creamy white balls with a smooth, shiny surface. Mozzarella production technology has remained unchanged for several hundred years. The calorie content and composition of the dairy product in question mainly depends on the raw material from which cheese is made. The classic recipe uses black buffalo milk. Since this is very expensive product, it is replaced by cow's milk in our country and in other countries. Mozzarella cheese belongs to the category of dietary products, so it is often included in the diet of overweight people. One ball of Mozzarella prepared according to the classic recipe weighs about 30 grams. It contains about 7 grams of easily digestible protein, 4 grams of fat and only 1 gram of carbohydrates. Mozzarella cheese is an excellent source of protein, calcium, phosphorus, fat-soluble vitamins, it tastes good and is easily digestible. In addition, increase in the production of mozzarella cheese was due to its widespread use in baking pizza. At the same time, cheese must have special properties that meet following properties: capable of stretching, melting and grinding well, and having bright, pronounced taste and aroma characteristic of this product. A study was conducted on the preparation and evaluation of mozzarella cheese from cow and goat milk [1].

The use of goat's milk can be considered as an actual issue not only for the production of soft

mozzarella cheese with cow's milk, but also for the expansion of its assortment and for ensuring food safety of people suffering from allergies and intolerances to cow's milk. And in recent years, demand for soft cheeses with a bright, intense flavor from goat's milk has grown significantly.

The composition of the offered goat's milk is very similar to cow's milk, but it has its own differences in the high content of proteins, fats and calcium, also characteristic difference in technological properties. It contains biologically active substances that are not found in cow's milk. Due to these additives, goat's milk remains fresh for a long time. It does not sour for three days at room temperature, and can be stored in the refrigerator for more than a week. It has a high fat content, so it can be stored longer than other milks. Goat milk from the new milking has bactericidal characteristics. Due to the carotene content in it, its color is amber. The fat in goat milk consists of acids such as capric and linoleic. Due to the small size of fat globules, the result is better absorption for humans. It is similar in amino acid content to breast milk, differing only in size. Goat milk has fat content of 3.6% to 6% and more (depending on the breed). Goat milk is very useful for diseases such as stomach and intestinal diseases, tuberculosis, as well as for individuals working in toxic enterprises, for baby food and other diseases. It helps to treat diseases of the thyroid gland [2].

Therefore, it can be concluded can say that using goat's milk as a raw material, studying its useful properties, and producing food products with high biological value from it is appropriate and relevant.

As part of the research work, a patent search was conducted for various methods of obtaining soft cheeses. These methods help to improve the quality of the obtained food product, its organoleptic properties and increase its biological value.

In last five years, the demand for bright, intensely flavored cheeses, especially those made from goat's milk, has grown significantly. The popularity of soft cheeses is also increasing including Italian soft cheese "Mozzarella".

Recommendations for solving problems of sustainable development of the milk and milk products market in the region are based on study of its current situation and prospective directions.

The main factors that determined high level of development of the world cheese industry: high-quality raw materials, high density of its production and, on this basis, increasing the unit capacity of cheese-producing enterprises, minimum seasonal fluctuation of milk, purchases, effective technologies,

constant high quality of the finished product, technical level of technological equipment.

Scientists propose the following classification of cheeses: according to its type, characteristics, microbiotics used in production, technological modes, results, characteristics and structure of finished cheeses. Among all the cheeses offered, soft cheeses with high and low heating temperatures are widely used [3].

Several methods of producing soft cheese from goat's and cow's milk are known in patents. However, technology of their production requires a long time, in addition, functional properties of biologically active components and selection of yeast cultures, unfortunately, are not sufficiently justified. In this regard, reduction of kneading time indicators, use of traditional production doughs and production of soft cheese products "Mozzarella" - on the basis of goat and cow's milk - is an actual issue. The offered new soft cheese product "Mozzarella" is rich by micro and macro elements. In addition, soft cheese with curative and preventive effect complements range of products and very useful for people of all ages. Compared to the methods proposed by other authors, technical result of the invention is to increase yield of soft cheese, increase its biological value, improve quality characteristics of final product, and increase its shelf life.

The purpose of work is to develop technology for the production of soft Mozzarella cheese by partially replacing cow's milk with goat's milk, enriched by paprika.

Objects of the study - cow and goat milk and chemical composition of soft cheese with food additive - paprika.

Materials and research methods

Sampling and preparation of raw materials were carried out according to the unified methodology of research of domestic food products. Research was conducted in accordance with generally accepted and standard research methods.

- GOST 34356-2017 Cheese with cheddarization and thermomechanical processing of cheese mass. Technical conditions

- GOST 3626-73 Milk and dairy products. Method of determination of moisture and dry matter

- GOST 5867-90 Milk and dairy products. Definition of the method is simple

- GOST 233227-98. Milk and dairy products. Method of measuring mass fraction of total nitrogen by Kjeldahl and determining the mass fraction of protein

Density of soft cheese "Mozzarella" was determined on instrument Strukturometer ST-2

The pH value was determined with an electronic digital pH meter

The mineral composition of the mentioned raw materials was studied in the regional test laboratory of the engineering profile "Construction and biochemical materials" of the M. Auezov South Kazakhstan University.

Determining amount of mineral substances in the cheese product was carried out using scanning electron microscope (REM) and inductively coupled plasma mass spectrometry (ICP-MS) method.

Literature review

In recent years, interest in the production of soft cheeses has increased. From an economic point of view, it is very profitable and technologically fast [4-8].

The authors developed soft cheese, which prepared from pasteurized cow's milk, sour whey, with introduction of an enriching filler - milk thistle and its meal [9].

A known method of obtaining soft cheese. Involves adding prepared mashed potatoes to the curd mass at a temperature not lower than 75°C and stirred evenly until smooth. It is also possible to use milk-soy mixture. Then various aromatic spices such as dill, parsley, etc. are added, according to the recipe [10].

The authors have developed method of cheese production in which dietary beet fiber is added, amount is introduced according to the recipe [11].

A technology has also been developed for the production of feta cheese and cottage cheese using whey. Research was conducted on the physical and chemical parameters of cheese [12].

The following paper presents data on the results of theoretical and experimental research on the selection of raw materials and components for the recipe of new type of functional soft cheese based on mixture of milk from farm animals (goat, sheep) [13].

Scientists propose the following type of cheese made from goat's milk with the addition of nut flour. As a result, the optimal ratio is proposed according to the recipe [14].

The proposed next type of cheese, developed by scientists, involves production of a product from various types of milk, such as cow's, goat's and sheep's. As a result, comparative characteristics were obtained, according to which best indicators were dominated by a product made from sheep's milk compared to others [15].

Results and discussion

Currently, several methods of producing soft cheese from goat's and cow's milk are known, which are presented in patents. However, technology of their production requires a long time, in addition, functional properties of biologically active components and the selection of yeast cultures, unfortunately, are not sufficiently justified. In this regard, reduction of kneading time indicators, use of traditional production doughs and production of soft cheese products "Mozzarella" - on the basis of goat and cow's milk - is an actual issue.

The purpose of this stage of the work was to study coagulation ability of goat milk and its components mixed with cow's milk under the influence of coagulation enzymes used for the production of soft cheese "Mozzarella". The enzyme VIVO (Ukraine) and thermophilic yeast MicroMilk TT1 (Italy) were selected for cheese production.

Milk coagulation enzyme "VIVO" is prepared for standardized milk coagulation obtained from enzyme of microbial origin, enzymatically produced chymosin. It distinguishes it well from yellow enzymes of animal origin, which primarily affects taste of the product, and works perfectly on basis of goat's milk. The basis of VIVO milk coagulation enzyme includes: chymosin of microbial origin, food salt [16]. Milk coagulation activity of enzyme preparations was studied according to the requirements of ISO11815-2015.

The demineralization time of the cheese mass is reduced due to the presence of strains in the yeast that have high acid-forming activity. Different scientists and specialists in this industry offer different opinions on the content of the microbiota. Some of them suggest the inclusion of thermophilic streptococci [17].

MicroMilk TT1 thermophilic yeast is suitable for production of Mozzarella, Chechil, Suluguni, Kosichka, Cachotta cheeses. Bacterial composition: *Streptococcus thermophilus*. Type of yeast: thermophilic. Fermentation temperature: 30-35°C.

Research has shown that when goat milk coagulates, it creates coagulation that affects the whey.

In practice, in cheese production, temperature of 25-30°C ensures obtaining sufficiently dense curd in 30-40 minutes. An increase in temperature up to 50°C increases duration of coagulation (coagulation process does not take place at temperature of 60°C). At low coagulation temperature, soft lump appears, at high temperature - viscous (hard). At temperature lower than 10°C, small scales appear, milk is practically not coagulated by enzyme, but with further

increase in temperature, a lump appears. Fermentation of milk is often used in large scale production, i.e. keeping it with enzymes at low temperature.

Increasing enzyme dose accelerates process of milk coagulation - total duration of gel formation and its individual stages are shortened. The titratable acidity of milk affects both coagulation speed and structural and mechanical properties of curd. The higher acidity of milk, the faster coagulation of milk proteins and speed of syneresis.

Thus, with an increase in acidity of 1°T, duration of coagulation decreases on average by 8%,

but an increase in acidity from 18 to 19°T is especially important. With low acidity, loose, pale curd appears, excessively dense curd increases, from which cheese with poor consistency is obtained - crushing. Before coagulation, optimal acidity (ripening) of milk should be 19. At 20°T during production of hard cheeses and 22-25°T soft cheeses.

The innovation of this product was development of technology production of soft cheese "Mozzarella" from goat and cow milk with addition of paprika. The goal of creating composite products is not to replace traditional food products, but to expand assortment, taking into account requirements of nutritional science and demand of the population.

Paprika is one of the most popular spices in the world. It is added to various products and dishes to improve its taste, aroma, and color. Paprika powder is mildly flavored red spice made from dried and ground sweet red peppers of the bell pepper plant.

The nutritional value of paprika powder is really good because it is very low in calories and completely free of sodium and cholesterol. It is also free of saturated fat and has healing antioxidant properties that fight cell damage caused by free radicals. Rich in vitamins C, A, B6 and E, also important minerals such as calcium, magnesium, iron, potassium, magnesium, phosphorus and zinc.

Capsaicin in paprika can help treat diabetes. It affects genes involved in blood sugar control and affects enzymes in the body that break down sugar, and also improves insulin sensitivity. In addition, the health benefits of the vitamin E it contains include aiding the body in producing red blood cells and facilitating wound healing. It strengthens protective functions, stimulates digestion, and promotes skin healing and improvement. Furthermore, it contributes to improved blood circulation. [18].

The optimal sample that met standard requirements for study of the properties of soft

cheese "Mozzarella" was soft cheese "Mozzarella" made in ratio of 50% goat's milk: 50% cow's milk, with addition of paprika. Organoleptic indicators (GOST 28283-89) were carried out in the laboratory to determine its properties: appearance,

color, taste and smell, consistency. The finished product was evaluated according to a five-point system. Organoleptic indicators of "Mozzarella" soft cheese are shown in Table 1.

Table 1 – Organoleptic indicators of soft cheese "Mozzarella" with paprika

#	Name of organoleptic indicator	Descriptions	
		According to GOST 28283-89	"Mozzarella" soft cheese with paprika
1	Appearance	smooth, wrinkled surface crust and no sediment	spherical, clean, smooth, slightly wet, not dried out, not bruised
2	Color	yellow spots from white to light yellow are allowed	yellowish, slightly pale
3	Taste and smell	clean, without foreign taste and smell	fermented milk is delicious and tasty, taste of goat's milk was not felt
4	Consistency	delicate, dense, elastic	dense, elastic

When evaluating organoleptic indicators of soft cheese "Mozzarella" with addition of paprika, consistency of soft cheese "Mozzarella" was dense and elastic. "Mozzarella" soft cheese is yellowish, slightly pale in color. The resulting cheese had a clean, pleasant sour milk taste. The taste of goat's

milk was not felt. Appearance: clean, smooth, slightly wet, without sediment, not dried, not moldy.

The results of research on physico-chemical parameters of soft cheese "Mozzarella" are shown in table 2.

Table 2 – Analysis of physico-chemical parameters of "Mozzarella" soft cheese with paprika

#	Indicators	Normative documents for test methods	Control sample	Soft cheese "Mozzarella" with paprika
1	Humidity, % , not more	GOST 3626-73	60	54.5
2	Mass fraction of fat in dry matter %, not less	GOST 5867-90	45	52
3	Mass fraction of protein, %, not less	GOST23327-98	16	20
4	Density, kg/m ³ , not less	-	1029	1030
5	pH	-	5,7	5.8

As can be seen from the obtained data, the optimal ratio of dairy raw materials and food additive - paprika positively affects the physical and chemical indicators of the finished product.

Moisture did not exceed the standard set by the proportion of goat's milk in the combination. Thus, cheese yield is directly proportional to the total solids content of the milk used to make the cheese.

As proportion of added goat milk increased, fat content increased.

A high pH level leads to elongation and melting of Mozzarella cheese.

Tables 3, 4 show results of X-ray spectrum analysis of chemical elements of "Mozzarella" soft cheese, made in ratio of goat's milk and cow's milk, with addition of paprika (1-figure).

Table 3 – Chemical element composition of "Mozzarella" soft cheese with food additive paprika

Elements	Soft cheese "Mozzarella" made from goat's milk, %	Soft cheese "Mozzarella" made from cow's milk, %
C	5.9	5.43
O	40.1	40.54
Na	3.2	4.68
Mg	0.8	0.89
P	18.6	18.45
K	4.77	4.77
Ca	26.2	25.24

Table 4 – Chemical element composition of soft cheese "Mozzarella" with food additive paprika

Elements	Values %
C	6.13
O	40.13
Na	2.00
Mg	0.96
P	18.80
K	4.77
Ca	27.21

The composition of macro and microelements in finished product was studied using an electron microscope. An electron microscope is a device that allows to take an image of sample surface with high accuracy. The research

results showed that soft cheese contains lot of macro and microelements. The product is rich in valuable proteins, vitamins and minerals, such as calcium - 27.21%, phosphorus - 18.80%, and high nutritional value.

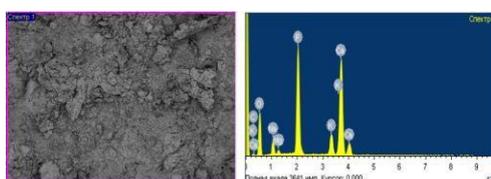


Figure 1 – Chemical element composition of "Mozzarella" soft cheese with food additive paprika

Conclusion

The product meets all quality and safety requirements regulated by applicable documents. During the study of coagulation ability of raw milk and its additive compositions, it was found that goat's milk forms less strong clot compared to cow's milk with greater transfer of milk components to serum. The composition of raw materials obtained from goat and cow's milk - 50:50 ratio has favorable technological properties. The enzyme VIVO (Ukraine) and thermophilic yeast MicroMilk TT1 (Italy) were selected to produce Mozzarella soft cheese.

The innovation of this product was development of technology production of soft cheese "Mozzarella" from goat and cow milk with addition of paprika. The goal of creating composite products is not to replace traditional food products, but to expand the assortment, taking into account the requirements of nutritional science and demand of the population.

An X-ray-spectral analysis of the composition of the chemical elements of "Mozzarella" soft cheese, made in the ratio of goat's milk and cow's milk, with addition of paprika, was carried out. The research results showed that soft cheese contains a lot of macro and microelements. The product is rich in valuable proteins, vitamins and minerals, such as calcium - 27.21%, phosphorus - 18.80%, and high nutritional value.

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ПЕРСПЕКТИВЫ ПРИМЕНЕНИЯ ТЕХНОЛОГИИ LAYER-BY-LAYER ДЛЯ РАЗРАБОТКИ ФЕРМЕНТНОГО БИОСЕНСОРА ИСПОЛЬЗУЕМОГО ДЛЯ КОНТРОЛЯ КАЧЕСТВА МОЛОКА

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В данной статье представлены результаты научных исследований по разработке биосенсорной системы для определения солей тяжелых металлов (кадмия и свинца) в молоке. При разработке биосенсорной системы уделяется большое внимание подбору биологического материала и методу их стабилизации с помощью физико-химических сил, а именно, иммобилизацией. В связи с этим проведены исследования по подбору фермента и способа его иммобилизации при разработке биосенсора для обнаружения солей тяжелых металлов в молоке. Разработка биосенсора для определения токсичных элементов в пищевых продуктах имеет научное и практическое значение. В мировой практике особое внимание уделяется загрязнению сырья и пищевых продуктов токсическими химическими веществами, в основном антропогенного происхождения, которые относятся к стойким органическим загрязнителям. Поэтому контроль качества сырья, пищевых продуктов имеет важное значение для потребителей и, соответственно, для пищевой промышленности. Экспериментальные исследования основаны на методах Филипповой А.М., Воробьевой О.В. для определения удельной активности фермента ацетилхолинэстеразы.