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DEVELOPMENT OF SOFT CHEESE TECHNOLOGY FROM BLENDED MILK WITH OPTIMIZATION OF COAGULATION PARAMETERS

Abstract: *The rational use of mixed dairy raw materials is a promising direction in soft cheese technology, as it allows to increase the cheese suitability and improve the quality of the finished product. The study investigated the effect of the ratio of cow's, goat's and camel's milk on the coagulation processes and the quality of soft cheese. The temperature regimes of coagulation, duration of coagulation, organoleptic, physic-chemical and textural parameters of the product were studied.*

It has been established that optimal coagulation conditions for combined dairy raw materials are achieved at a temperature of 40 ° C and a duration of 40 minutes. The best results were shown by a sample *with a ratio of 60% cow's milk, 20% goat's milk and 20% camel's milk, which provided an increase in the yield of cheese mass by 3.3% compared with the control, stable coagulation and formation of a homogeneous structure of the product and a decrease in titrated acidity to 106 °T versus 116°T in the control sample from cow's milk.*

The increased cheese yield and coagulation stability in 1-sample are due to the balanced ratio of proteins and fats in the combined dairy raw materials.

The results obtained confirm the prospects of using combined dairy raw materials in soft cheese technology and can be used in the development of products with improved organoleptic and structural-mechanical properties.

***Key words**: soft cheese, combined milk raw materials, milk coagulation, goat milk, camel milk, textural properties of cheese, cheese suitability of milk.*

Introduction

In the diet of modern humans, cheese occupies one of the leading positions. Among the wide variety of cheeses, the group of soft cheeses – those with a short ripening period or produced without ripening – appears particularly promising from the standpoint of high nutritional and biological value, efficient utilization of raw material components, and the feasibility of organizing their production at existing dairy processing facilities, among other advantages. An additional attractive feature is that the production of soft cheeses allows the incorporation of a broad range of functional food ingredients and various flavor additives. This capability significantly expands the assortment of cheeses produced, enabling them to be targeted at different population groups and to be endowed with specific functional properties [1].

Increasing the production of soft cheeses by utilizing not only cow's milk but also milk from other animal species – particularly goat and camel milk – can serve as one of the most accessible approaches to partially addressing the problem of insufficient high-quality protein in the modern human diet. This is especially relevant given that goat farming is currently a rapidly developing branch of animal husbandry. The hypoallergenic properties and unique biological characteristics of both goat and camel milk are also highly attractive features [2].

In this context, expanding the product range through the development and production of soft cheeses made from mixtures of cow's and goat's milk with the addition of plant-derived components represents a relevant and promising direction in modern cheese-making technology.

The purpose of the study is to substantiate the rational composition of a mixed raw material formulation for cheese production, as well as to select and justify the optimal coagulation (renneting) regimes that ensure stable progression of coagulation processes, the formation of a high-quality curd, and the production of a product with predetermined physicochemical and technological characteristics.

The scientific novelty of the study is a comprehensive assessment of the effect of a three-component dairy system consisting of cow, goat and camel milk on the kinetics of rennet coagulation, as well as on the physico-chemical, textural and organoleptic properties of soft cheese. Unlike previously published studies that focused on two-component milk mixtures, this paper shows how different ratios of three types of milk affect the formation of the cheese structure and the overall quality of the final product.

In the present work, cow, goat, and camel milk were selected for further investigation.

Cow milk contains a sufficient amount of casein – the main milk protein responsible for curd formation and cheese structure. Casein accounts for approximately 80% of the total protein in cow milk, making it particularly suitable for coagulation and the production of firm and semi-firm cheeses. This property enables the manufacture of a wide range of cheese varieties, such as Cheddar, Gouda, Parmesan, and many others [3].

The fat and protein content in cow milk is present in an optimal ratio for cheese production, which ensures the desired consistency and flavor profile of the final product. Milk fat plays a critical role in the texture and flavor richness of cheese [4].

Camel milk is characterized by a lower casein content and a distinct protein structure compared to cow milk. Nevertheless, under rationally selected technological coagulation conditions, it is capable of forming a stable soft curd with high water-holding capacity [5].

Taking into account the specific technological properties of each type of milk, it is considered technologically and economically justified to develop a combined mixture based on cow, goat, and camel milk.

This approach allows for the creation of a balanced raw material base that combines the strong coagulating ability and structural-forming potential of cow milk with the unique biological and functional properties of goat and camel milk, thereby expanding the possibilities for producing soft cheeses with enhanced nutritional and consumer characteristics.

It has been found that using milk from several species of animals can produce a product with a unique combination of fats, proteins and vitamins, since cow's milk provides the basis for a product with a high casein content, necessary for coagulation and texture formation [6]. And goat milk adds lightness and improves digestibility thanks to its small fat globules and special fatty acids. Camel milk adds probiotic and antibacterial properties to the product, and also increases the content of vitamins C and B, which makes snacks healthier. Due to camel milk, the product can have a probiotic effect, helping to improve digestion [7].

Previously, research was carried out on the creation of cheeses from mixed components of dairy raw materials. For example, Gemechu et al. found that 100% camel milk is characterized by low cheese yield and delayed coagulation, while its mixture with cow's milk, especially 25:75, provides intensive coagulation, higher yield and improved physicochemical properties, confirming the feasibility of combined raw materials [8].

Abdugamitova A.E. et al. investigated the technology for the production of brine cheese from combined milk raw materials (a mixture of cow and goat milk), showing that the use of a combined composition allows us to obtain a product with an improved consistency, a more pronounced flavor profile and stable organoleptic characteristics compared to cheese from single-species cow's milk, and cheese from a combined mixture gave a higher yield (12.5%) than cow's milk (11%) [9]. In a study by S. Saremnezhad et al. studied the effect of different ratios of sheep and goat milk on the functional properties of Lighvan white cheese cheese during 90 days of ripening and showed that the use of a milk mixture with a higher proportion of goat milk increased antioxidant activity and angiotensin converting enzyme (ACE) inhibitory activity, and also increased α-glucosidase inhibition, while a higher proportion of sheep milk increased the content esters, terpenes, alcohols and saturated/unsaturated fatty acids, which indicates positive changes in the functional and aromatic profile of the product when using formula [10]. In the works of O. Boukria et al. Cheeses based on mixtures of milk from different animal species are studied and it is shown that such cheeses demonstrate improved chemical, physicochemical, structural and organoleptic properties. Such as a change in fat and protein profile, increased free fatty acid content and improved sensory characteristics - compared to cheeses made from milk of the same type [6].

Modern cheese making actively uses combined milk, which is a specially developed mixture of milk from different animals (cattle and small livestock). This approach allows for precise control of casein, whey proteins, fat and minerals, which are critical to achieving the desired curdling and ripening properties of the cheese. Mixing different types of milk (for example, cow's milk with goat's or camel's milk) provides a number of advantages, such as accelerated curd formation, increased cheese yield, improved moisture and texture, as well as enrichment with fatty acids and minerals [11, 12].

Materials and methods

To conduct experimental studies on the comparative assessment of milk from various farm animals as raw materials for cheese production, the following were used: milk from Simmental cows from «Moya Ferma» LLP, camel milk from the Bacterian breed from personal farms, and milk from Saanen goats from «Arka-Zerenda» LLP.

The technology of soft cheese commences with the reception of milk, which undergoes initial purification to remove any foreign particles. Following this, the milk is homogenized to achieve an ideal distribution of its protein, fat, and mineral components. This prepared blend is then subjected to pasteurization at 72°C for a brief period of 15-20 seconds, before being cooled to the appropriate temperature for fermentation. At this stage, specific starter cultures, namely Lactococcus lactis subsp. lactis and Lactococcus lactis subsp. cremoris, along with rennet, are introduced. The interplay of lactic acid fermentation and enzymatic action leads to the formation of a firm, uniform curd.

The curd is cut to accelerate the separation of the whey. This is followed by a process of self-pressing and mechanical pressing to consolidate its structure. Salting is achieved by immersing the cheese in a 10% sodium chloride solution for 10-15 minutes. Finally, the cheese undergoes a ripening phase at 10-12 °C with approximately 80% relative humidity, allowing it to develop its distinctive sensory attributes. Figure 1 shows the appearance of soft cheese produced from the combined milk mixture.

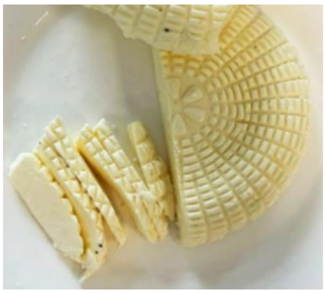

Figure 1 – The appearance of soft cheese made from a combined milk mixture (60-20-20)

Studies of the chemical composition of milk from camels, goats and cows, and the study of their comparative characteristics were carried out in the scientific laboratory of the Institute of Engineering and Food Technologies in accordance with regulatory documents using generally accepted research methods.

The coagulation processes of a combined milk mixture in the production of soft cheese were studied in laboratory conditions.

To select the optimal temperature regime for coagulation during production, the most important factors are temperature and duration of heat treatment. These factors affect milk coagulability, cheese yield, consistency and moisture content.

The mass fraction of proteins and fats (%) was determined using a Tango-R FT-NIR near-infrared spectrometer. This method is an express, non-destructive and high-precision analytical method that ensures prompt receipt of reliable results.

Titratable acidity (°T) was determined by the acid-base titration method in accordance with GOST 3624-92 «Milk and dairy products. Method for determining titratable acidity». This method allows an integral assessment of the total content of all titratable acids present in the product.

The density of milk mixtures was determined in accordance with the GOST R 54758-2011 standard «Milk and milk processing products. Methods for determining density» [13].

The mass fraction of dry substances (%) was determined by the refractometric method in accordance with the requirements of GOST 3626-73 «Milk and dairy products. Method for determining the content of dry substances». This method is based on the dependence of the refractive index of a sample on the concentration of dissolved solids in its composition [14].

Active acidity (pH) was determined in accordance with the requirements of GOST 26188-84 «Food Products. Methods for determining pH». The study used an Atago pH meter, which provides a reliable and accurate estimate of the hydrogen ion concentration in the samples [15].

Organoleptic evaluation was carried out in accordance with GOST R ISO 22935-2-2011 «Milk and dairy products. Organoleptic analysis. Part 2. Recommended methods for organoleptic evaluation». The tasting assessment was carried out in a specially prepared room under standard conditions: air temperature 20-22 °C, uniform natural and artificial lighting, absence of foreign odors and noise. 10 tasters (teachers and students) took part in the organoleptic analysis. Processing and systematization of the obtained data was carried out using the Microsoft Excel software application [16].

The determination of texture characteristics was carried out on a TX-700 Lamy Rheology SARL texture analyzer, the operation of which is based on measuring the resistance force of a sample during its mechanical deformation. During the analysis, the sample was subjected to controlled compression by a probe at a given speed and depth, and the device recorded the dependence of force on deformation. Based on the curves obtained, the main textural parameters characterizing the structural and mechanical properties of the product were calculated.

Statistical data processing was performed using Minitab software, while graphical visualization of the results was carried out in Microsoft Excel.

Results

Proper combination of different types of milk is an effective way to control the processes of curd formation and formation of the cheese structure. In the context of the conducted research, special attention was paid to the effect of mixing milk of different animal species on the parameters of coagulation and structure formation during the cheese-making process.

Compositions were made from cow, goat and camel milk and work was carried out in the laboratory to study changes in the content of fat, protein and density and acidity in raw milk.

The combined mixture consists of a composition of milk: cow/goat/camel in the following ratios (%):

Option-1: 60:20:20
Option-2: 40:30:30
Option-3: 20:40:40

Cow's milk 100/0 was taken as a control sample. Analysis data are shown in Table 1.

Table 1 – Chemical composition and properties of mixed compositions of dairy raw materials

Samples	Indicators			
	Mass fraction of protein, %	Mass fraction of fat, %	Density, kg/m^3	Acidity, °T
n=5				
Control	3.11±0,06	3,32±0,08	1028,87±0,17	17±0.78
60/20/20	3,07±0,08	4,03±0,07	1027,80±0,21	18±0.15
40/30/30	3,04±0,07	3,76±0,06	1028,13±0,19	18±1.25
20/40/40	3,01±0,06	4,04±0,08	1027,81±0,13	18±0.65

In the original cow's milk, the mass fraction of protein was 3.11%, while in all variants of mixed milk (60/20/20, 40/30/30 and 20/40/40) it was slightly lower (3.07-3.01%), that is, the difference did not exceed approximately 1-3% compared to the control sample. The mass fraction of fat, on the contrary, increased from 3.32% in cow's milk to 3.76-4.04% in mixtures, which corresponds to an increase of approximately 13-22% relative to the control and reflects the contribution of fattier components (goat and camel milk) in the formation of the mixture composition. The density in all samples remained comparable (1027.80-1028.87 kg/m³), the titratable acidity value changed slightly.

To study the coagulation processes of the combined milk formula, 3 variants of technological modes were selected – temperature and duration of heat treatment.

1st mode – temperature 30 °C: duration 40 minutes;
2nd mode – temperature 40 °C: duration 40 minutes;
3rd mode – temperature 50 °C: duration 40 minutes.

It should be noted that when using the 1st mode, i.e. at 30°C, the coagulation process of the combined milk formula did not occur due to the low temperature. A study of the 2nd and 3rd coagulation modes at coagulation temperatures of 40 °C and 50 °C showed positive results.

The Table 2 provides data on the effect of temperature conditions on the yield of cheese and whey.

Table 2 – Influence of technological regimes (temperature 40 °C and 50 °C, duration 40 minutes) on the coagulation process of the combined milk mixture during the self-pressing stage

Indicators	Control	1-sample	2-sample	3-sample
	100/0	60/20/20	40/30/30	20/40/40
At 40°C				
Cheese mass yield, g	600	620	550	The clot did not form
Cheese whey yield, ml	400	380	450	The serum did not stand out
At 50°C				
Cheese mass yield, g	560	610	530	An unstable clot has formed
Cheese whey yield, ml	440	990	470	Most of the protein went into the whey

At 40°C, the control sample (100/0) produced 600 g of cheese mass and 400 ml of whey. The highest cheese yield was observed in the 1-sample (60/20/20), reaching 620 g, while the whey yield decreased to 380 ml. In the 2-sample (40/30/30), the cheese mass yield decreased to 550 g, accompanied by an increase in whey separation to 450 ml. In the 3-sample (20/40/40), stable clot formation was not observed, and whey separation did not occur.

At 50°C, a decrease in cheese mass yield was observed in most samples. The control sample produced 560 g of cheese mass and 440 ml of whey, while the 1-sample showed a yield of 610 g. However, in the 1-sample, whey separation increased substantially to 990 ml. The 2-sample demonstrated lower cheese yield (530 g) and 470 ml of whey. In the 3-sample, only an unstable clot was formed, indicating impaired coagulation properties at elevated temperature.

Also, analyzes were carried out on the obtained cheese samples to determine physicochemical parameters. The data is given below on Figure 2.

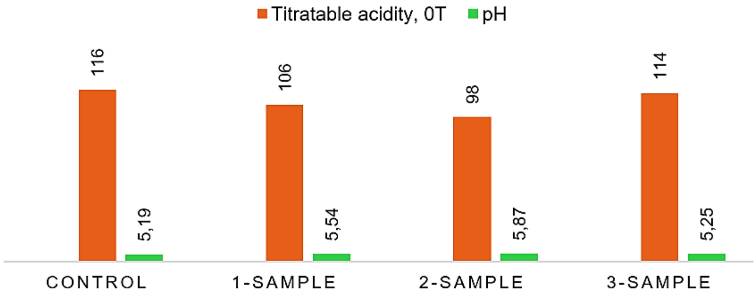

Figure 2 – pH and titratable acidity of cheese from a combined milk mixture

The results showed that the addition of goat and camel milk to cow's milk affected the physicochemical properties of the samples, particularly titratable acidity and pH. Compared to the control, titratable acidity decreased from 116°T to 106°T and 98°T in the 1-sample and 2-sample, while pH increased from 5.19 to 5.54 and 5.87, indicating a decrease in overall acidity.

However, in the 3-sample, titratable acidity increased to 114 °T and pH decreased to 5.25, approaching the control values.

Subsequently, an examination of the protein, fat, and solids mass fractions presented in Figure 3 was conducted.

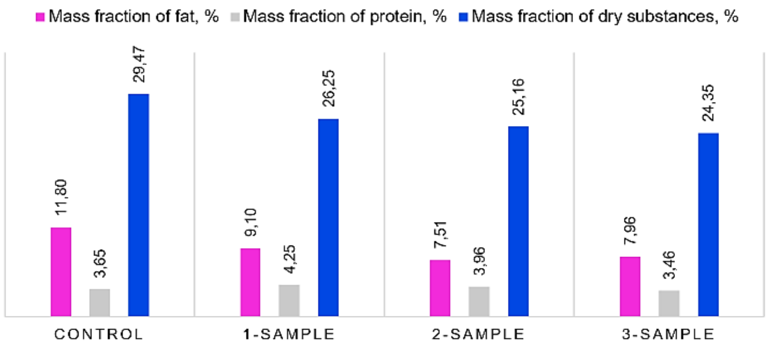

Figure 3 – Physic-chemical characteristics of cheese from a combined milk mixture

The substitution of cow's milk with goat's and camel milk significantly affected the physicochemical properties of the samples. As the proportion of goat and camel milk increased from 60/20/20 to 20/40/40 (cow/goat/camel milk), the fat content gradually decreased from 11,8±1,63% in the control sample to 9,1±1,06%, 7,51±0,02%, and 7,96±1,05% in the 1-, 2-, and 3-samples, respectively. Protein content varied within a relatively narrow range; however, the 1-sample showed the highest value (4,25±1,41%). A gradual decrease in dry substances was also observed, from 29,47±0,86% in the control to 26,25±1,05%, 25,16±1,45%, and 24,35±0,56% in the experimental samples.

It is crucial to study the texture characteristics of cheeses in order to assess their quality and technological suitability. Modern scientific studies emphasize the importance of texture analysis in the development and comparison of cheeses with different compositions. Changes in the composition and ripening stage of cheeses significantly impact their rheological and textural properties, which directly affect the functionality and quality of the final product [17]. Texture indicators such as hardness, elasticity, and cohesion allow for objective differentiation between different types of cheeses and correlate with their structural integrity and organoleptic properties [18]. The Table 3 shows data on texture indicators.

Table 3 – Texture indicators of cheese from a combined milk mixture

Indicator	Control	60/20/20	40/30/30	20/40/40
n=5				
Hardness	8,90±1.02	7,50±1.02	6,70±0.12	3,80±0.12
Gumminess	6,80±0.56	8,90±1.86	5,10±1.52	2,90±0.75
Chewiness	6,90±0.75	9,10±0.15	5,20±0.12	3,00±0.75
Cohesiveness	0,76±0.45	0,79±0.85	0,74±0.85	0,68±0.15
Springiness	0,95±0.95	1,02±0.95	0,96±0.75	0,90±0.25
Resilience	0,28±0.12	0,32±0.15	0,27±0.96	0,22±0.87

According to the research, the sample with a ratio of 60:20:20 demonstrated the highest hardness values (7.50 N), significantly superior to the other tested samples (40:30:30 – 6.70 N; 20:40:40 – 3.80 N). Similarly, this sample had the highest values of stickiness (8.90 N) and chewiness (9.10 N), indicating the formation of a denser and more elastic protein structure. It also showed the best results in cohesion (0.79), elasticity (1.02) and elasticity (0.32), indicating strong internal bonds and good recovery after deformation.

Organoleptic analysis allows you to comprehensively assess the consumer properties of cheese – taste, aroma, consistency, appearance and color, reflecting its quality, degree of maturity and compliance with technological requirements. Figure 4 shows the organoleptic characteristics of ready-made cheeses.

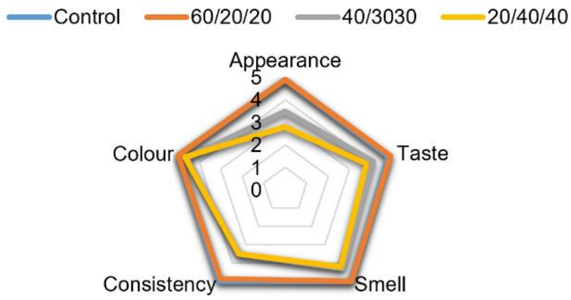

Figure 4 – Diagram of organoleptic characteristics of cheese samples

Organoleptic evaluation showed that the control sample and the sample with a 60/20/20 ratio received the highest scores (4.8-5.0), characterized by harmonious taste, aroma, uniform consistency, attractive appearance and uniform color. Sample 40/30/30 was rated as satisfactory (3.5-4.6 points) with slight deterioration in taste, smell and consistency. The worst results (2.8-4.7 points) were shown by sample 20/40/40, which had noticeably reduced indicators of appearance, taste and consistency. In general, an increase in the proportion of some components in the recipe led to a deterioration in the organoleptic characteristics of the product.

Discussion

The incorporation of goat and camel milk noticeably influenced the physicochemical and technological behavior of the mixed dairy systems. These effects are primarily related to differences in protein structure, fat globule size, mineral composition, and buffering properties of the non-cow milk components [19]. Goat milk, characterized by lower αs1-casein content and smaller fat globules, contributed to the formation of a softer protein matrix, whereas camel milk affected coagulation behavior due to its specific casein profile and reduced coagulation ability [20].

Changes in acidity parameters confirmed the impact of milk composition on the acid-base equilibrium of the system [21]. The decrease in titratable acidity and increase in pH observed in the 1- and 2-samples may be associated with the higher buffering capacity and altered mineral balance of goat and camel milk. However, at higher replacement levels (20/40/40), the acidity profile shifted closer to the control values, suggesting destabilization of the mineral-protein equilibrium and changes in acid formation during coagulation [22].

Coagulation temperature also played a critical role in curd formation and whey separation. The absence of stable coagulation at 30°C indicates insufficient enzymatic activity and slower aggregation of casein micelles in combined milk systems. In contrast, increasing the temperature to

50 °C intensified syneresis and weakened the protein matrix, resulting in higher whey losses and reduced curd stability. These effects were especially pronounced in samples with elevated proportions of goat and camel milk. The most stable coagulation behavior and the highest technological suitability were observed at 40°C, particularly for the 60/20/20 formulation.

The ratio of milk components additionally influenced fat retention, dry matter content, and textural characteristics of the cheeses. Increasing the proportion of goat and camel milk led to a gradual reduction in hardness, cohesiveness, and chewiness, indicating the formation of a softer and less compact structure [23]. This is consistent with literature data describing weaker gel formation and higher moisture retention in cheese systems containing goat and camel milk [24]. Samples with higher levels of camel milk also demonstrated increased whey separation and a more curd-like consistency, reflecting weaker protein network formation.

Sensory evaluation supported the physicochemical and textural findings. The control sample demonstrated organoleptic properties typical of soft cheese, while the 60/20/20 sample combined a mild creamy flavor, uniform consistency, and acceptable structural stability. Further increase in goat and camel milk content negatively affected texture and appearance, resulting in softer, less cohesive products with visible whey release.

Overall, the results indicate that moderate incorporation of goat and camel milk can improve certain nutritional and sensory characteristics of soft cheese while preserving technological stability. Among the studied formulations, the 60/20/20 ratio provided the most balanced combination of coagulation properties, texture, physicochemical characteristics, and sensory quality.

Conclusion

Currently, the use of mixed milk raw materials is of particular importance, as it enables more efficient resource utilization, compensates for the limitations inherent to individual milk types, and provides precise control over the coagulation and structure-forming processes during cheese production.

Blending different types of milk represents an effective technological approach that enhances production stability and facilitates the development of novel cheese varieties with tailored functional and sensory characteristics.

The conducted research demonstrated that the optimal coagulation conditions are a temperature of 40°C and a coagulation time of 40 minutes. These parameters ensure a stable and reproducible coagulation process, resulting in the formation of a high-quality curd.

It was established that the proportions of cow, goat, and camel milk in the mixture significantly influence the quality attributes and overall characteristics of the resulting soft cheese. The best results in terms of taste, aroma, appearance, chemical composition, and texture parameters (hardness, chewiness, elasticity, and cohesiveness) were obtained with the formulation containing 60% cow milk, 20% goat milk, and 20% camel milk. The sensory and textural properties of this variant fully comply with the quality requirements for soft cheeses.

This particular blend also contributed to an increased cheese yield, efficient whey separation, and the achievement of optimal physicochemical properties in the final product.

Thus, the selected coagulation parameters and the composition of the milk mixture have been scientifically substantiated and are recommended for practical application in cheese-making technology.

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РАЗРАБОТКА ТЕХНОЛОГИИ МЯГКОГО СЫРА НА ОСНОВЕ СМЕСИ КОРОВЬЕГО, КОЗЬЕГО И ВЕРБЛЮЖЬЕГО МОЛОКА С ОПТИМИЗАЦИЕЙ ПАРАМЕТРОВ КОАГУЛЯЦИИ

Рациональное использование смешанного молочного сырья является перспективным направлением в технологии мягких сыров, поскольку позволяет повысить сыропригодность и улучшить качество готового продукта. В работе исследовали влияние соотношения коровьего, козьего и верблюжьего молока на процессы коагуляции и качество мягкого сыра. Изучались температурные режимы свертывания, продолжительность коагуляции, органолептические, физико-химические и текстурные показатели продукта.

Установлено, что оптимальные условия коагуляции комбинированного молочного сырья достигаются при температуре 40 °С и продолжительности 40 минут. Наилучшие результаты показал образец с соотношением 60 % коровьего, 20 % козьего и 20 % верблюжьего молока, обеспечивший повышение выхода сырной массы на 3,3 % по сравнению с контролем, стабильное свертывание и формирование однородной структуры продукта и снижение титруемой кислотности до 106 °Т против 116 °Т у контрольного образца из коровьего молока.

Повышенный выход сыра и стабильность коагуляции в образце 1 обусловлены сбалансированным соотношением белков и жиров в комбинированном молочном сырье.

Полученные результаты подтверждают перспективность использования комбинированного молочного сырья в технологии мягких сыров и могут быть использованы при разработке продуктов с улучшенными органолептическими и структурно-механическими свойствами.

***Ключевые слова**: мягкий сыр, комбинированное молочное сырье, свертывание молока, козье молоко, верблюжье молоко, текстурные свойства сыра, сырная пригодность молока.*

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СИЫР, ЕШКІ ЖӘНЕ ТҮЙЕ СҮТІНІҢ ҚОСПАСЫ НЕГІЗІНДЕ ҰЙЫТУ ПАРАМЕТРЛЕРІН ОҢТАЙЛАНДЫРУ АРҚЫЛЫ ЖҰМСАҚ ІРІМШІК ТЕХНОЛОГИЯСЫН ӘЗІРЛЕУ

Комбинирленген сүт шикізатын ұтымды пайдалану жұмсақ ірімшік технологиясының перспективалы бағыты болып табылады, өйткені ол ірімшікке жарамдылықты арттыруға және дайын өнімнің сапасын жақсартуға мүмкіндік береді. Бұл зерттеуде сиыр, ешкі және түйе сүтінің арақатынасының коагуляция процестеріне және жұмсақ ірімшіктің сапасына әсері зерттелді. Ұйытудың температуралық режимдері, ұйыту ұзақтығы, өнімнің органолептикалық, физика-химиялық және текстуралық көрсеткіштері зерттелді.

Комбинирленген сүт шикізатының коагуляциясының оңтайлы шарттарына 40 °С температурада және ұзақтығы 40 минутта қол жеткізілетіні анықталды. Оңтайлы нәтиже 60% сиыр, 20% ешкі және 20% түйе сүтінің арақатынасы бар үлгі көрсетті, бұл бақылаумен салыстырғанда ірімшік массасының 3,3% жоғарылауын, өнімнің біркелкі құрылымының тұрақты ұюы мен қалыптасуын және титрленетін қышқылдықтың 106 °Т дейін төмендеуін қамтамасыз етті.

1-үлгідегі ірімшік өнімділігі мен коагуляция тұрақтылығының жоғарылауы аралас сүт шикізатындағы ақуыздар мен майлардың теңдестірілген қатынасына байланысты болуы мүмкін.

Нәтижелер жұмсақ ірімшік технологиясында комбинирленген сүт шикізатын пайдалану амалын растайды және органолептикалық және құрылымдық-механикалық қасиеттері жақсартылған өнімдерді әзірлеу кезінде пайдаланылуы мүмкін.

Түйін сөздер: *жұмсақ ірімшік, аралас сүт шикізаты, сүттің ұюы, ешкі сүті, түйе сүті, ірімшіктің құрылымдық қасиеттері, сүттің ірімшікке жарамдылығы.*

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ИССЛЕДОВАНИЕ АНТИОКСИДАНТНОГО СЫРЬЯ И РЕОЛОГИЧЕСКИХ СВОЙСТВ ПЛОДОВО-ЯГОДНО-ОВОЩНОГО КИЁМА

Аннотация: *В статье представлены результаты исследования физико-химических показателей, антиоксидантных и реологических свойств растительного сырья и десертного продукта «киёма» на его основе. В качестве объектов исследования использованы шафран, куркума и имбирь, а также образцы киёмов, разработанные с применением различных рецептурных решений.*

Целью настоящего исследования является обоснование целесообразности использования растительных ингредиентов с высокой антиоксидантной активностью при разработке функционального плодово-овощного-ягодного десерта «киёма», а также оценка их влияния на структурно-механические характеристики готового продукта. Развитие ассортимента натуральных десертов на основе фруктов, овощей и пряно-ароматического сырья способствует формированию рационального питания за счёт замещения традиционных сахаросодержащих сладких изделий продуктами с повышенной пищевой и биологической ценностью.

В ходе экспериментальных исследований определены показатели влажности, зольности, pH, содержания биологически активных соединений и антиоксидантной активности растительного сырья. Установлено, что шафран характеризуется наибольшей антиоксидантной активностью, обусловленной высоким содержанием кроцина и флавоноидов, тогда как куркума и имбирь дополняют композицию за счёт куркумина.

Реологические свойства киёма оценивали по показателям вязкости, крутящего момента, текучести, липкости и адгезии. Показано, что исследуемые образцы относятся к вязко-пластичным системам с псевдо пластическим характером течения, а рецептурные различия