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DEVELOPMENT OF THE FOOD PRODUCT FOR SPECIAL DIETARY USES – CHEESE WITH PHYTO-INGREDIENTS

Actuality. *The creation of new recipes of cheeses with a combined composition is relevant, it is based on reducing caloric content, increasing the content of nitrogenous and biologically active substances, and improving the amino acid and carbohydrate composition with improved taste indicators that are close to traditional ones.*

The aim of the study is *to improve the quality of low-fat cheese domashnii from cow's milk, enriched with a whey decoction of a mixture of burdock roots and licorice.*

The object of research is the technology of low-fat cheese domashnii enriched with a decoction of plant ingredients.

Material and methods*. Made three parts of homemade homemade product with rose ingredients. Research methods are standard generally accepted and special physico-chemical, organoleptic, microbiological, and mathematical-statistical processing of experimental data using modern computer programs.*

Research results. *The work describes the milk raw materials for the production of a milk product. For the production of domashnii cheese, the skim milk from the separation of cow's milk has been used. The protein content in the skim milk enriched with whey broth was higher, compared to the similar indicator in the skim milk (without its use) - by 0.4%. The dosage of the bacterial preparation Iprovit-SCM in the production of domashnii cheese has been determined based on the indicators of lactic coagulation activity and the acidity of the formed curd, and it has been proved that the dose of the drug is 15 g/t, which ensures the production of a product with an acidity of 98^{0}T, with a delicate consistency and release of transparent serum.*

Enrichment with a whey decoction from a mixture of two burdock roots and licorice in a ratio of 1:1 in the amount of 0.4 wt.,% helps to increase the yield of the finished product by 17.3% compared to the control batch of cheese from whole unskim milk and to improve its organoleptic indicators, in particular, an increase in the hardness of the elastic grain, a sweetish taste and a yellowish color against the background of a pronounced sour-milk taste and smell.

Based on the study of organoleptic, physico-chemical, and microbiological parameters, the storage conditions and shelf life of domashnii cheese are substantiated, namely 5 days at a temperature of 8...10°C and a relative humidity of 75%.

***Conclusion.** The use of a biotechnological approach (enrichment of skim milk with a whey decoction from a mixture of burdock roots and licorice) contributed to the improvement of the organoleptic parameters of the product: an increase in the hardness of the elastic grain, the appearance of a sweetish taste and a yellowish color, an increase in the yield of the final product from 10 kg of milk raw materials.*

***Key words:** domashnii cheese, bacterial preparation, whey decoction of plant ingredients, product quality, shelf life, cheese technology.*

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РОЗРОБЛЕННЯ ХАРЧОВОГО ПРОДУКТУ ДЛЯ СПЕЦІАЛЬНОГО ДІЄТИЧНОГО СПОЖИВАННЯ – СИРУ З ФІТОІНГРЕДІЄНТАМИ

***Актуальність.** Створення нових рецептур сирів із комбінованим складом базується на зниженні калорійності, підвищенні вмісту азотистих і біологічно активних речовин та покращенні амінокислотного та вуглеводного складу з покращеними смаковими показниками, що наближаються до традиційних.*

***Мета дослідження.** Покращання якості домашнього нежирного сиру з коров'ячого молока, збагаченого сироватковим відваром суміші з коренів лопуха та солодки.*

Об'єкт дослідження – технологія домашнього нежирного сиру, збагаченого відваром рослинних інгредієнтів.

Матеріал і методи. *Виготовлено три партії сиру домашнього з рослинними інгредієнтами. Використовували стандартні загальноприйняті та спеціальні фізико-хімічні, органолептичні, мікробіологічні та математично-статистичні обробки експериментальних даних із використанням сучасних комп'ютерних програм.*

Результати дослідження. *У роботі охарактеризовано молочну сировину для виготовлення молочного продукту. Для виробництва домашнього сиру використовували відвійки від сепарування коров'ячого молока. Уміст білку у відвійках, збагачених сироватковим відваром, був вищим порівняно з аналогічним показником у відвійках (без його використання) на 0,4%. Визначено дозу внесення бактеріального препарату Інровіт-СКМ у виробництві сиру домашнього за показниками молокозгортальної активності та кислотності утвореного згустку, та доведено, що економічно ефективною є доза застосування препарату 15 г/т, яка забезпечує одержання продукту кислотністю 98^{0}Т, ніжної консистенції з виділенням прозорої сироватки.*

Збагачення сироватковим відваром із суміші двох коренів лопуха та солодки у співвідношенні 1:1 в кількості 0,4 мас., % сприяє збільшенню виходу готового продукту на 17,3% порівняно з контрольною партією сиру із цільного незбираного молока та покращанню його органолептичних показників, зокрема підвищення твердості пружного зерна, солодкуватий смак і жовтуватий колір на тлі вираженого кисломолочного смаку і запаху.

На підставі дослідження органолептичних, фізико-хімічних та мікробіологічних показників обґрунтовано умови та термін зберігання домашнього сиру, а саме 5 діб за температури 8…10°С та відносній вологості повітря 75%.

Висновок. *Застосування біотехнологічного підходу (збагачення відвійок сироватковим відваром із суміші коренів лопуха та солодки) сприяло поліпшенню органолептичних показників продукту: підвищенню твердості пружного зерна, появі солодкуватого смаку і жовтуватого кольору, збільшенню виходу кінцевого продукту з 10 кг молочної сировини*

Ключові слова: *домашній сир, бактеріальний препарат, сироватковий відвар рослинних інгредієнтів, якість продукту, термін зберігання, технологія сиру.*

Introduction. One of the promising directions in cheesemaking is the production of combined soft cheeses. Soft cheeses belong to protein products with high biological value. The inclusion of various non-dairy components in their composition is aimed at enhancing the positive properties of the product. Some of the most well-known and widely consumed dairy products are different types of cheeses, particularly hard and soft ones (Danylenko, 2023).

Starter cultures play a significant role in the production of cottage cheese, as they form the organoleptic, physicochemical, and microbiological characteristics of the product.

An essential element of the technology for producing cottage cheese is the addition of the starter culture and the fermentation of the milk to form a firm curd within a specified time to achieve the desired acidity. For cottage cheese production, starter cultures containing strains of lactococci (*Lactococcus lactis subsp. cremoris*, *Lactococcus lactis subsp. lactis*, *Lactococcus lactis subsp. diacetylactis*), with or without thermophilic streptococcus (*Streptococcus thermophilus*), are used.

The use of starter cultures significantly increases the yield of the final product, greatly reduces the risk of contamination by foreign microbiota during the production process (especially important when manual labor is involved), and improves the organoleptic characteristics through the formation of lactic acid, alcohols, carbon dioxide, and volatile acids (Mohr, 1997). The starter culture acts as a biological means of protecting the cheese from spoilage.

The technological process of soft cheese production allows for the creation of combined dairy products with therapeutic and preventive purposes.

There are recommendations for using fruit and berry, vegetable, and wild raw materials, as well as marine products, beekeeping products, and others in the production of soft cheeses. Thus, domestic cheesemaking has a solid foundation for the broad development of soft cheese production in several directions, which will expand the product range, improve its quality, and increase the economic efficiency of production through more rational use of raw materials (Ostroumov, 2015).

The closest product to the improved technology of domashnii cheese we have developed is Kotedzh cheese made from pasteurized cow's milk. It is an unripened product with a soft, granular texture, delicate in taste, and very similar to rennet cheese. Kotedzh cheese is an excellent source of protein, but at the same time, it is very low in calories. It also contains vitamin B, calcium, phosphorus, and selenium. It is an essential part of the diet for those following a weight-loss regimen. Its high protein content keeps the feeling of fullness for a long time, while the consumer receives a minimal amount of calories from this dairy product (Tratnik 2001).

The main principles in creating new cheeses with a combined composition include reducing calorie content, increasing the amount of nitrogenous and biologically active substances, and balancing the fatty acid, amino acid, and carbohydrate composition. These products should have high taste qualities, comparable to traditional ones. An example of such a biotechnological approach is the production of soft acid-rennet cheese with rye bran, which allows for the directed regulation and improvement of the process of obtaining a new, balanced, and nutrient-enriched product (Semko, 2016).

There is evidence that plant extracts from cinnamon and oregano spices, pomegranate peel, grapevine, and especially clove have antimicrobial potential when added to food products (Shan,2011). Organic carboxylic acids demonstrate sufficiently high antimicrobial

activity and inhibit the growth of bacteria which are the most common causative agents of food-borne infections (Fomina, 2024).

The authors (Granato. 2018) confirm that the development of dairy products with the addition of herbal extracts and other natural extracts helps reduce the use of synthetic additives, providing a natural appeal to these food products while also imparting flavor and color.

A technology for producing sour cream butter from goat milk has been developed, based on the use of an activated bacterial preparation in whey decoctions of medicinal herbs. This technology significantly reduces the taste and smell of goat fat and prolongs the shelf life of the final product (Danylenko, 2020).

Fresh cheese treated with cranberry extract, as well as the stored product, contained significantly fewer psychrotrophic, enterococcal, proteolytic, and lipolytic bacteria, as well as lower amounts of yeast and mold, compared to the control cheese sample. However, a drawback of this method is the increased titratable acidity of the cheese, the appearance of cranberry flavor, and color tints in the experimental batches of the product (Khalifa, 2015).

The authors (Caleja, 2016) proved that plant decoctions and aqueous extracts of *Foeniculum vulgare* and *Matricaria chamomilla* help preserve the nutritional properties and improve the antioxidant activity of cottage cheese. However, this effect was limited to 7 days. It was found that the method involving the microencapsulation of functional additives provides antioxidant activity over a longer period compared to the use of plant decoctions.

A rational amount of linden flower decoction at a 0.025% concentration, introduced into the production process of experimental batches of cottage cheese from goat milk in an amount of 10-20%, instead of the portion removed during cheese grain processing, contributed to: increasing the density of the cheese grain, reducing the loss of its components with whey, increasing the yield of the product from 100 kg of goat milk by 0.6-0.8%, and increasing the population of starter culture microbiota by 2.5-2.8 times compared to the control. This improved the organoleptic properties of the experimental batches of homemade goat cheese, particularly by neutralizing the goat fat flavor and smell. However, one of the inventors' tasks remained unresolved: improving the color of the cheese mass, as the typical white color of the goat cottage cheese remained unchanged (Ryzhkova, 2018).

For the production of Portuguese cheese "Serra da Estrela", sheep's milk, salt, and thistle (*Cynara cardunculus L.*) are used for milk protein coagulation. Carocho, Barreira, et al., add other types of plants to this cheese, specifically chestnut flowers (*Castanea sativa Mill.*) and lemon balm (*Melissa officinalis L.*), to extend shelf life, enhance functional properties, and preserve sensory characteristics (Carocho, 2015). It has also been proven that adding basil leaves provided "Serra da Estrela" cheese with antioxidant properties, reduced moisture content, and preserved unsaturated fatty acids and proteins. Basil was introduced into the cheese in the form of decoctions and in a dehydrated form. Comparing both types of addition, decoctions had a higher functionalizing and preservative effect (Carocho, 2016, Carocho, 2016).

The addition of grape juice, skin, and grape seed extract to the recipe of Petit Suisse cheese enhances its functional properties. Grape processing products have antioxidant properties. The resulting cheese exhibits angiotensin-converting enzyme inhibitory properties and contains natural phenolic compounds (Pasini Deolindo, 2019).

It has been shown that the use of plant cultures, particularly spices, in soft cheese technology improves and diversifies the taste and aromatic properties of goat's milk cheeses, enriches them with a complex of biologically active substances, increases the yield of finished products, and enhances their shelf life stability (Kochubei-Lytvynenko, 2019).

The addition of grape extract, green tea, and dehydrated cranberry powder to the cheese product enriches it with catechin, epigallocatechin gallate, tannic acid, homovanillic acid, hesperetin, and flavones. These compounds exhibit proven antioxidant activity (Han, 2011).

The analysis indicates that the application of plant ingredients to dairy products improves quality and enhances the functionality of the products.

The aim of the research is to improve the quality of low-fat domashnii cheese made from cow's milk, enriched with a whey decoction of a mixture of burdock and licorice roots, which enhances the organoleptic properties of the product (taste, smell, color, consistency) and increases the product yield from a unit of dairy raw material.

To achieve this goal, the following tasks were set:

– to characterize the dairy raw material for the production of the dairy product;

– to select the dose of the starter culture composition;

– to evaluate the experimental samples of the fermented milk product with the filler based on quality indicators of the product;

– to improve the organoleptic properties of domashnii cheese, in particular, to enhance the fermented milk taste and smell, and increase the density of the curd;

– to reduce the loss of components of skim milk in the whey, thereby increasing the yield of the final product;

– to determine the shelf life based on microbiological indicators.

Materials and methods. For the production of domashnii cheese, milk and skim milk (obtained from the separation of cow's milk) were used. The milk came from black-and-white dairy and red-and-white dairy breed cows kept at the "Educational and Research Complex" of the State Biotechnological University.

According to the aim and the tasks set, one control batch (C) and two experimental batches (E1 and E2) of domashnii cheese were produced.

Preparation of plant ingredients (burdock and licorice roots)

The roots were washed under running water, peeled, and chopped using a meat grinder and blender. It was found that the positive result aimed at improving the quality of the low-fat homemade cheese (hereinafter referred to as "cheese") was achieved by using a whey decoction made from a mixture consisting of 0.4% by weight of burdock and licorice roots in a 1:1 ratio (0.2% by weight of each).

Characteristics of bacterial and enzymatic preparations

- The enzyme "Meito" for milk coagulation, produced by Meito Sangyo (Japan), is of plant origin. 1 g of the preparation is designed for 100 liters of milk. Activity: 300,000 units, milk coagulation time: 30 min.

The bacterial preparation Iprovit-SKM contains mesophilic lactococci (*Lactococcus cremoris + L. lactis + L. diacetilactis*) and thermophilic streptococcus (*Streptococcus thermophilus*). The number of lactic acid microorganisms in 1 g of the preparation is 5.8×10^{10} CFU. In terms of microbiological safety indicators, the sample complies with the requirements of TU U 15.5-00419880-100:2010. Starter cultures are available in dry and liquid forms.

Technological process of cheese production using whey decoction from burdock and licorice roots and without them.

The main stages of curd production corresponded to the requirements of the technological instruction DSTU 4554:2006 soar milk cheese.

The whey was pasteurized at (72±2) °C for 18-20 seconds and then cooled to (34±2) °C. The whey was divided into two portions of 10 kg each and placed into separate containers.

One control batch (C) of the product was made from 10 kg of whole unskim milk, which was prepared for inoculation and coagulation in the same way as the whey.

The normalized base was fermented with the Iprovit-SKM starter culture. The milk-coagulating enzyme was used at 1.0 g per 100 kg of milk as a 10% solution in whey, and milk coagulation was carried out for 4.5-5.0 hours until the curd pH reached 5.1-5.3. Coagulation was performed at a temperature of (32±1)°C.

After obtaining the curd, it was subjected to mechanical processing to form curd grains. The curd was processed for 30-60 minutes after whey removal. For the experimental batch of cheese (E2), the prepared whey was treated with a whey decoction mixture of burdock root to achieve a concentration of 0.4 mass%. The additional operation involved only the preparation of burdock and licorice roots for use.

Methods of analysis for milk and cheese produced from it:

– dry matter content – in accordance with DSTU 8552:2015 Milk and dairy products. Methods for determining moisture and dry matter content, and DSTU ISO 5534:2005 Cheese and processed cheese. Determination of total dry matter content (reference method) (ISO 5534:2004, IDF 4:2004, IDT);

– total protein content by the Kjeldahl method, in accordance with DSTU EN ISO 8968-1:2022 Milk and dairy products. Determination of nitrogen content. Part 1. Kjeldahl principle and calculation of crude protein (EN ISO 8968-1:2014, IDT; ISO 8968-1:2014, IDT);

– density – in accordance with DSTU 6082:2009 Milk and dairy products. Methods for determining density;

– mass fraction of fat – in accordance with DSTU ISO 1211:2002 Milk. Gravimetric method for determining fat content (reference method) and DSTU ISO 11870:2007 Milk and dairy products. Determination of fat mass fraction. General guidelines for the use of methods with the application of butyrometers (ISO 11870:2000, IDT);

– non-fat dry milk solids content is determined by the following formulas:

DSMR=(F/5+D/4)+0.76 (1)

DSMR=TS-F where: (2)

TS — total solids content in milk, %; 4.9; 4; 0.5; 1.31; 26.5; 0.1; 5; 0.76 — constant coefficients; F — fat content in milk, %; D — milk density, °A; G — milk density, kg/m3; DSMR — dry skim milk residue, %;

– active acidity (pH) – measured potentiometrically according to DSTU 8550:2015 Milk and dairy products. Measurement of pH by potentiometric method;

– titratable acidity – according to DSTU ISO 6091:2007 dried milk. Determination of titratable acidity (reference method) (ISO 6091:1980, IDT);

– organoleptic properties – according to DSTU 4554:2006 cottage cheese. General technical conditions;

– count of lactic acid bacteria according to DSTU 7999:2015 food products. Methods for determining lactic acid bacteria;

– coliform bacteria (E. coli group) according to DSTU 7357:2013 milk and dairy products. Methods of microbiological control;

– count of yeast and molds according to DSTU 8447:2015 food products. Method for determining yeast and molds.

– the results of the experimental research were subjected to statistical analysis using the least squares method to determine the margin of error in the obtained data. The results and graphical representation of the experimental data were processed using standard statistics in Microsoft Excel 2010. All experiments were repeated five times. The Student's t-test was used to calculate the reliability of the obtained results.

Results and their discussion. It is known that the microbiota of curd cheese depends on the species composition of the starter culture microbiota, its quantity, the initial microbial contamination of the milk, and the temperature and duration of the technological process. One of the most challenging aspects is determining the appropriate amount of bacterial starters for curd cheese production. According to the manufacturer's recommendations, the dosage of bascterial starter is from 10 to 20 g/t. The dosage of the bacterial preparation Iprovit-SKM for the production of Domashnii cheese was determined based on milk coagulation activity and the acidity of the resulting curd (table 1).

Table 1

Determination of the dosage of bacterial culture for curdling milk base at (34±1)°C

Dose of bacterial preparation	Duration of milk fermentation, hours	Acidity after 3 hours, °T	Acidity after 24 hours, °T
10 g/t	11,0±0,5	18±2	90±2
15 g/t	8,5±0,5	30±3	98±2
20 g/t	7,5±0,5	34±2	110±2

As the obtained data show, when 10 g/t of the preparation was added to the milk base, the curdling process lasted 11 hours, and the milk acidity after 3 hours was only 18°T. The use of the starter culture in amounts of 15 and 20 g/t ensures the formation of curd after 8.5 and 7.5 hours, respectively. Thus, the economically efficient dose of the preparation is 15 g/t, which guarantees the production of high-quality product. The curds formed had an acidity of 98°T, a delicate texture with whey separation, and a pleasant taste and aroma. Increasing the total amount of bacterial culture led to an increase in curd acidity.

Studies were conducted on the physicochemical properties of the daily average milk sample, sourced from the farm, and the skim milk obtained from separating part of the whole milk. The yield of the finished product was also determined from the raw material processing for the control (C) and two experimental batches of domashnii cheese (E1 and E2). The results of the research are presented in table 2.

As seen from the data in table 2, the protein content in the skim milk enriched with whey decoction, when processed into the experimental batch of product (E2), increased by 0.4% compared to the same indicator in the skim milk (without its use). The titrated acidity of the two experimental batches of cheese, E1 and E2, was higher by 10°T and 20°T, respectively, compared to the control. However, it remained within the normative limits according to the standard, which should not exceed 150°T. The yield of the control batch (C) from whole milk was lower by 54 grams or 5.84% compared to the product made from skim milk. This indicates the feasibility of milk separation and the separate processing

Table 2

Physico-chemical composition of dairy and yield of product from control (C) and two experimental batches (E1 and E2) of cheese (n=5, P≤0.05)

Indicators	Name of the dairy raw material		
	Control batch (C) of cheese	Experimental E1	Experimental E2
	Whole unskim milk	Skim milk	Skim milk*
M. f. of dry matter, %	12,1	-	-
M. f. of protein, %	2,9	3,0	3,4
DSMR	8,5	8,6	8,9
M. f. of fat, %	3,6	0,05	0,2±0,02
Titrated acidity, °T	17	18	19
Density	27,5	30	34
SC count, thousand/cm^3	450	350±0,14	-
Consumption rate (skim milk) kg/1 ton of cheese with 8.5% DSMR content, kg	11377	10818	9429
Yield of the product from 10 kg of whole milk and from skim milk, in grams	870	924	1060

Note: 1) *M. f. – mass fraction. SC – somatic cell count.;* 2) During the production of the experimental batch of cheese E2, the filtered whey decoction from a mixture of two roots (burdock and licorice) in a 1:1 ratio was added to the prepared skim milk in the amount of 0.4 mass %.

of skim milk into low-fat cottage cheese. Cream is added to low-fat cheese Domashnii, as is provided for the production of full-fat versions of the product.

Enriching the skim milk with a whey decoction of roots and processing it into Domashnii cheese in the experimental batches of the product (E1 and E2) contributed to an increase in the dry skim milk residue (DSMR) by 0.3% compared to the control. This factor influences the milk consumption rate and, accordingly, the yield of the final product. In this case, the yield was calculated from 10 kg of whole milk and, correspondingly, from skim milk.

It was established that the yield of the final product from the experimental batch of cheese (E2) was 17.3% and 12.8% higher, respectively, compared to the control batch of cheese (C) made from whole milk. The difference in product yield from 10 kg of skim milk between the experimental batch (E2), enriched with plant ingredients, and batch E1 (without them) was 136 grams, or 5.85% higher.

According to the requirements of the regulatory technical documentation, Domashnii cheese must meet the following standards for physicochemical properties: titratable acidity should not exceed 150 °T; fat content is not standardized; moisture content should range from 65% to 75%, and protein content should be at least 14%. In terms of organoleptic properties, Domashnii cheese should meet the following characteristics: taste and smell - clean, lactic acid without off-flavors or odors; appearance - curd mass in the form of grains; color - ranging from white to slightly yellowish.

A comparative analysis of the organoleptic properties of the control batch (C) of full-fat cheese and two batches of low-fat Domashnii cheese (E1 and E2) was conducted (table 3).

From the data in table 3, it can be seen that in the experimental (E2) batch of cheese, made from whole unskim milk and influenced by plant-based ingredients, a sweet taste and soft curd grain with a yellowish tint are present, which are absent in the experimental batch (E1) made from skim milk. Both the control (C) and experimental (E1) batches exhibit uniform, grainy, springy soft curd. This characteristic meets the quality standards for cheese. However, it is known that increased curd density usually leads to reduced loss of milk components in the whey. Therefore, the presence of grainy, springy hard curd, as well as the emergence of a sweet taste and yellowish tint in the experimental batch (E2), indicates an improvement in product quality and explains the increased yield from the milk raw material compared to the experimental batch E1, made without the use of plant-based ingredients.

During the development of a new product, it is important to justify the storage conditions and shelf life, as well as determine the patterns of change in microbiological indicators. The samples were stored in consumer packaging at a temperature of 8…10°C, with a shelf life of 7 days and humidity of 75%.

The produced domashnii cheese meets the microbiological requirements that characterize its quality – based on the number of lactic acid microorganisms – and safety, determined by the presence of coliform bacteria. The results of the studies on cottage cheese according to these indicators are presented in table 4.

From the analysis of Table 4, it can be seen that the number of lactic acid bacteria in all samples after production ranged from $(3.0\text{-}5.5)\cdot10^7$ CFU/g. Coliform bacteria were absent in 0.01 g after 5 days of storage. The microorganisms that exhibit the most resistance during the storage of cottage cheese are yeasts and molds. At the time of production, neither yeasts nor molds were detected. By the 5th day, yeasts were detected in the experimental sample, and by the 7th day, they were present in both experimental samples. Therefore, it can be concluded that the samples of cottage cheese meet microbiological standards and can be stored for up to 5 days under refrigerated conditions.

During storage, no changes in texture or taste were observed in any of the product variations, and only a slight increase in titratable acidity was noted.

Table 3

Comparative organoleptic characteristics of the control batch (C) and two experimental batches (E1, E2) of Domashnii cheese

Indicator name	Batch names of cheese		
	Control (C) full-fat product	Experimental (E1) low-fat	Experimental (E1) low-fat
Appearance and consistency	Uniform grainy elastic soft curd	Uniform grainy elastic soft curd	Uniform grainy elastic firm curd
Taste and smell	Clean, sour-milk taste. Flavor without foreign tastes or odors. A slightly sweet taste is present.	Clean, sour-milk taste. Flavor without foreign tastes or odors.	Clean, sour-milk taste. Flavor without foreign tastes or odors. A slightly sweet taste is present.
Color	Milky-white, uniform throughout the entire mass.	Milky-white with a bluish tint.	Milky-white with a yellowish tint.

Table 4

Microbiological indicators of the control (C) batch and two experimental batches (E1, E2) of types of domashnii cheese

Sample	The number of microorganisms, CFU/g											
	After production				During storage							
					After 5 days				After 7 days			
	Total number of lactic acid bacteria	Enteric bacteria (coliforms)	Mold fungi	Yeasts	Total number of lactic acid bacteria	Enteric bacteria (coliforms)	Mold fungi	Yeasts	Total number of lactic acid bacteria	Enteric bacteria (coliforms)	Mold fungi	Yeasts
C	$(3,0\text{-}5,3)\cdot10^7$	Not detected in 0.01 g	Absent	Absent	$(4,2\text{-}6,6)\cdot10^7$	Not detected in 0.01 g	0	<10	$(2,6\text{-}3,2)\cdot10^7$	Detected in 0.01 g	0	50
E1	$(5,4\text{-}6,1)\cdot10^7$	Not detected in 0.01 g	Absent	Absent	$(7,2\text{-}8,7)\cdot10^7$	Not detected in 0.01 g	0	Absent	$(5,0\text{-}7,2)\cdot10^7$	Detected in 0.01 g	0	<10
E2	$(5,5\text{-}5,9)\cdot10^7$	Not detected in 0.01 g	Absent	Absent	$(9,9\text{-}11,5)\cdot10^7$	Not detected in 0.01 g	0	Absent	$(7,7\text{-}9,1)\cdot10^7$	Detected in 0.01 g	0	<10

In recent years, there has been a growing interest in healthy food, particularly in the development and consumption of products with functional properties that have a positive impact on the human body. Bone diseases are quite common among the population of Ukraine and occur in most children with leukemia. Drugs are being developed for the treatment of bone lesions of various genesis, including hemoblastosis. The drug Korectin increases the density of bone tissue, purifies the blood, reduces psycho-emotional stress, accelerates alcohol detoxification, and may be used to treat bone, liver, and oncohematological pathologies (Volodina, 2017). It is known that the use of sour milk cheese helps to strengthen bones due to the calcium content, which is necessary for the health of the skeleton and the proper functioning of the heart and muscles.

Due to the balanced ratio of essential nutritional components, fermented dairy products possess dietary properties, making the combination of dairy and plant-based raw materials in a single product particularly appealing. The skillful combination of plant ingredients and a dairy base holds great potential, both in technological and social terms. It is the natural plant bioadditives, with their inherent properties, that give dairy products functional characteristics (Hachak, 2019).

Root vegetables also have significant nutritional value, as they are rich in carbohydrates, nitrogenous substances, essential oils, and vitamin C (Gutyj, 2017).

Burdock root is widely used as a traditional herbal remedy for treating inflammatory diseases in Eastern countries (Shin, 2015). In scientific medicine, it is utilized as a diuretic, cholagogue, antipyretic, anti-inflammatory, antibacterial, antifungal, desensitizing, immunostimulating, antioxidant, and metabolism-improving agent. It contains water-soluble inulin-like polysaccharides, inulin itself, essential oils, fatty oils, tannins, stigmasterol, sitosterol, bitters, proteins, and fatty acids such as stearic and palmitic acids (Oproshanska, 2014).

Extracts from licorice root possess biologically active properties (amino acids, sugars, pectins, resins, trace elements) and are used as novel food additives. Licorice root contains more than 20% of the triterpene saponin glycyrrhizin, phenolic compounds – flavonoids (up to 4.0%), carbohydrates – polysaccharides (up to 20%), minerals, vitamins, and more (Ammosov, 2004, Rukhmakova, 2014).

To improve the quality of low-fat cheese Domashnii, a whey decoction of a mixture of burdock root and licorice in a 1:1 ratio (0.2% by mass of each) was used, resulting in a total concentration of 0.4% by mass. This concentration did not affect the taste or color of the final product.

The authors (Samilyk, 2017) proposed the technology for the production of "Lyubomyr" cheese, enriched with vitamins, microelements, free amino acids, and dietary fibers. The high biological value of the cheese produced using this method is due to the chemical composition of its main components, namely white grape raisins, walnuts, and chicken eggs. These components are sources of structural, energetic, and protective nutrients.

The research (Gachak, 2019) demonstrated the potential of using "Buryak" cryopowder in the composition of therapeutic and preventive curd desserts. Adding "Buryak" cryopowder to cheese allows for an increase in the nutritional and biological value of the protein component. Specifically, there was a 1.73% increase in the total amount of amino acids, a 1.16% increase in essential amino acids, and a 2.17% increase in non-essential amino acids. The proposed product expands the domestic range of functional dairy products.

We have proposed a new recipe and production technology for cottage cheese domashnii with enhanced biological activity, enriched with a whey decoction of a mixture of two roots, burdock and licorice, in a 1:1 ratio, at 0.4% by mass.

In cheese production, the starter culture plays a crucial role in ensuring the controlled and predictable conversion of lactose into lactic acid. Controlling acid formation during cheese production is key to managing the cheese's pH, moisture, and lactose levels. These factors significantly influence the microbial, chemical, and biochemical environment during cheese maturation. The metabolism of starter cultures and the enzymes they produce contribute to the development of cheese flavor (Muthukumarappan, 2017).

To determine the optimal starter dosage for yogurt made from zebu milk, the authors of (Lorunnisomo, 2014) studied the effects of 5, 10, 15, 20, and 25 g/L of freeze-dried starter culture on milk fermentation activity. They demonstrated that curd formation occurred after 4 hours of incubation for the 25 g/L dosage and 10 hours for the 5 g/L dosage. The pH level of the yogurt decreased over time and with increased starter culture concentration. An increase in starter culture dosage improved the yogurt's physicochemical properties and reduced the fermentation time of the milk.

We proposed using a dosage of the bacterial preparation Iprovit-SKM at 15 g/ton for producing domashnii cheese. This dosage ensures a curd with acidity not exceeding 980°T, a delicate texture with whey release, and a pleasant milky taste and aroma. Increasing the dosage of the bacterial preparation led to higher curd acidity.

The quality of curd cheese with candied fruit and dried licorice root was studied during storage. When determining the titratable acidity of curd cheese with candied fruit (without licorice root) during the storage period at 4±2°C, the acidity increased from 200°T to 230°T. In curd cheese with candied fruit and dried licorice root, the titratable acidity on the first day of storage was 220°T, and on the fifth day, it reached 230°T. The use of dried licorice root in the production of curd cheese with candied fruit does not negatively affect the microbiological properties of this type of curd cheese (Nagovska, 2023).

Based on the study of organoleptic, physicochemical, and microbiological indicators, the storage conditions and shelf life of domashnii cheese have been determined: 5 days at a temperature of 8…10°C and a relative humidity of 75%. The number of lactic acid bacteria in all samples after production ranged from $(3.0\text{-}5.5)\cdot10^7$ CFU/g and by the end of the storage period reached $(4.2\text{-}11.5)\cdot10^7$ CFU/g, complying with regulatory requirements. Coliform bacteria were absent in 0.01 g after 5 days of storage. Yeasts were detected in the experimental sample on day 5 and in both experimental samples on day 7.

The effectiveness of the biopreparations "Megasvit" and "Biosvit," used for dissolving the enzyme "Fromaza", was proven for improving the quality and biological value of low-fat curd cheese. It was established that the use of "Biosvit" increases the total protein content by 0.4%, while "Megasvit" reduces it by 0.5%, compared to the control. The yield of cheese from every 100 kg of processed raw milk increased by 2.8% and 4.5%, respectively, when using the "Biosvit" and "Megasvit" preparations, compared to the control (Ryzhkova, 2023).

The enrichment of whey with a decoction of burdock and licorice roots and its use in the production of Domashnii cheese in experimental batches E1 and E2 led to an increase in the level of dry skimmed milk residue (DSMR) by 0.3% compared to the control. This residue affects the milk consumption rate and, consequently, the yield of the final product. The yield of the experimental cheese batch E2 was 17.3% and 12.8% higher compared to the control batch (C) made from whole unskim milk. Thus, the use of whey broth from a mixture of burdock and licorice roots at a concentration of 0.4% improves the organoleptic characteristics of domashnii cheese, specifically enhancing the firmness of the cheese curds, providing a slightly sweet taste, and a yellowish color against a background of pronounced sour milk flavor and aroma.

Conclusions

As a result of the conducted research, it was established that an effective dose of the bacterial preparation Iprovit-SKM is 15 g/ton. Increasing the overall amount of bacterial starter culture leads to an increase in the acidity of the curd.

It was proven that under the influence of whey broth from a mixture of burdock and licorice roots at a concentration of 0.4%, the organoleptic characteristics of the experimental cheese batch E2 improved, particularly with increased firmness of the cheese curds, a slightly sweet taste, and a yellowish color against a pronounced sour milk flavor and aroma in both cheese batches involved in our experiments.

The increase in the density of the firm cheese curds in the experimental cheese batch E2 contributed to a 5.85% increase in product yield from 10 kg of whey compared to the same indicator in the experimental batch (E1) of cheese (without whey).

Based on the research of organoleptic, physicochemical, and microbiological indicators, the storage conditions and shelf life of the domashnii cheese were substantiated, specifically 5 days at a temperature of 8…10°C and a relative humidity of 75%.

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