Development of the technology of production of cheese ‘Suluguni’ for farms

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Abstract. The aim of the research is the development of a technology for the production of ‘Suluguni’ cheese for farms from milk of cows. Investigations of the chemical composition and physicochemical properties of cows’ milk were carried out using ultrasonic method. It was found that the mass fraction of protein in milk is 3.19±0.02%, fat is from 4.32±0.06% to 5.07±0.08%. For the production of cheese, milk was standardized. The protein content in normalized milk is 3.37±0.02%, fat – 2.84±0.03%. The ratio of the mass fraction of protein and fat in normalized milk was 1.00:1.19. It was found that the milk of cows meets the requirements for raw materials for the production of cheese. We have developed a technology for the production of brine cheese ‘Suluguni’, which consists of the following operations: receiving milk, preparing milk for making cheese, fermenting, curdling and processing the curd, setting grain, drying, cheddaring, melting, forming a cheese head, salting, storing, transportation and sale of products. Cheese meets the requirements for organoleptic, physicochemical and microbiological indicators. The research results make it possible to recommend to farms the technology for the production of ‘Suluguni’ cheese with cheddaring and thermomechanical processing of the cheese mass.

1. Introduction

In Russia, the main raw material for cheese production is cow's milk. The quality of milk affects the commercial properties of the product. The organoleptic, physicochemical, microbiological and technological properties of milk are influenced by various factors. Chilled milk from one cow retains its original properties for a longer time than milk from a herd of cows [1]. The storage temperature of raw milk affects the changes in milk properties during processing [2]. Estonian scientists evaluated the influence of breed, offspring, lactation stage, period of the year and somatic cell count on the freezing point of milk from individual cows [3]. The quality of cheese is mainly related to the quality of raw milk used in its production [4]. The duration of lactation significantly affects the organoleptic, physicochemical properties and indicators of milk cheese suitability [5, 6].

In recent years, Russian farmers have started to open small cheese dairies. In this regard, the development of technologies for the production of certain types of cheeses in small farms from cow's milk is actual. Cheeses made from raw milk on a farm are not inferior in quality to cheeses produced by an industrial method [7]. There is a close relationship between the quality of raw milk and the quality of cheese [8, 9]. The quality of the cheese is influenced by milk fat [10, 11].

In cheese production, compliance with technological regimes is a mandatory requirement [12].
Various factors affect the quality of the cheese [13, 14] including milk processing temperature [15, 16]. The prevalence of *S. aureus* and other microorganisms is cause for concern about food safety in cheese production [17-19]. Various starter cultures are used for the production of cheeses [20-23]. Italian researchers have found that due to long-term use, cheese brines are gradually enriched with organic matter, which increase the number of microorganisms in brine. They assessed the possibility of using gaseous ozone to reduce microbial contamination of used brines [24]. The influence of the season of production and the ripening time of the cheese is known [25]. It is known that the chemical composition of cheese affects its organoleptic properties [26].

Consequently, the technology of cheese production depends on the quality of milk and other raw materials, the type of cheese, the equipment of the cheese dairy with the necessary equipment and many other factors.

The aim of the research is to develop a technology for the production of ‘Suluguni’ cheese from the milk of locally produced cows with cheddaring and thermomechanical processing of cheese mass. The novelty of the work is in fact at research has been carried out to develop a technology for the production of brine cheese with cheddaring from cow's milk.

2. Materials and methods

Studies of the chemical composition of cow’s milk of the Student Scientific Production Centre of the Chuvash State Agrarian University and organoleptic, physicochemical and microbiological parameters of ‘Suluguni’ cheese were carried out on the basis of the testing laboratory centre and the laboratory of milk technology and dairy products.

In the testing laboratory centre the mass fraction of protein was determined by the Kjeldahl method [27]. The mass fraction of fat was determined by the acid method [28]. The mass fraction of dry matter and dry skimmed milk residue – by the arbitration method [29].

In the laboratory of the technology of milk and dairy products, the physical properties and chemical composition of milk were investigated by the express method. On ‘Klever-2M’ analyzer, the ultrasonic method was used to determine the mass fractions of milk fat, protein, lactose, dry milk residue, dry skimmed milk residue, mineral salts, the amount of added water, density, freezing point, degree of homogenization, temperature in milk. The analyzer ‘Nitron-pH’ was used to determine the active acidity (pH), titratable acidity (°T), redox potential (mV), temperature (°C). We have developed a technology for the production of brine cheese ‘Suluguni’ (figure 1).

The organoleptic and physicochemical characteristics of ‘Suluguni’ cheese were determined via thermomechanical processing of cheese curd [30]. The microbiological safety of cheese was determined in accordance with the requirements of 033/2013 Technical Regulations of the Customs Union ‘On the safety of milk and dairy products’ [31].
Beginning of figure 1

- **Raw milk according to GOST R 52054-2013**

  - Cooling, ripening
t\( t=10\pm2^\circ C, \tau=14\pm2 \text{ h} \)

  - Sorting, cleaning

  - Heating
t\( t=38\pm2^\circ C \)

  - Normalization

  - Pasteurization
  at \( t=69\pm1^\circ C \), exposure 20-25 s, at \( t=64\pm1^\circ C \)
  exposure 20-30 min.

  - Calcium chloride
  25±15 g per 100 kg mix

  - Water
  pasteurized

  - Preparation of a solution at the rate of 1 dm\(^3\) per 150±50 g of salt, filtration

  - Leaven
  lactic acid bacteria 0.7-2.0%

  - Cooling
  up to ripening temperature
t\( t=38\pm2^\circ C \)

  - Component introduction

  - Preparation of the solution
  20-25 minutes before use,
t\( t=34\pm2^\circ C \)

  - Milk-clotting enzyme

  - Pasteurized water

  - Clotting
  at \( t=38\pm2^\circ C, \tau=30-35 \text{ min}, 21-25^\circ T \)

  - Cutting the clot and setting the grain
  cutting 5-7 min.,
grain size 6-15 mm

  - Second heating
  t\( =37\pm1^\circ C, \tau=10-15 \text{ min} \)

  - Removing serum
  70-80%

  - Separation
Continuation of figure 1

3. Results

It was found that ‘Suluguni’ cheese in appearance (table 1), taste and smell, consistency, pattern, color, mass fraction of moisture, fat, protein and salt complies with the requirements of the regulatory document.

The quality, nutritional and energy value of cheese depends on the chemical composition and physicochemical properties of milk. It was revealed that the mass fraction of protein in the milk of cows of morning and evening milking is 3.19±0.02% at a rate of at least 2.8%, in normalized milk 3.37±0.020% (table 2). The fat mass fraction in the milk of the morning milking exceeded the fat content of the milk of the evening milking by 1.17 times and amounted to 5.07±0.079% and 4.32±0.055%, respectively, with a norm of at least 2.8%. The fat mass fraction in normalized milk 2.84±0.031%.
ratio of protein and fat in normalized milk was 1.0:1.19, while the norm for cheese production was 1.0:1.2. The mass fraction of lactose in milk of morning and evening milking, as well as in normalized milk, was the same and amounted to 4.6±0.01%. The mass fraction of dry skimmed milk residue in the milk of morning and evening milking did not differ significantly and amounted to 8.58±0.02% and 8.55±0.01%, respectively, in normalized milk 8.71±0.01%. Mass fraction of dry milk residue in morning milk is 13.68±0.07%. The content of dry milk residue in evening milk is 0.74% less and amounted to 12.94±0.02% (table 2), which is caused by a decrease of the amount of fat. In normalized milk, the amount of dry milk residue is 11.61±0.01%. Mass fraction of salts in milk of morning milking is 0.73±0.01%, evening milking 0.74±0.01%, in normalized milk 0.75±0.01%.

| Indicator          | Characteristic                                                                 |
|--------------------|-------------------------------------------------------------------------------|
| Appearance         | Cheese without smoking has no crust. On the surface there is light lamination and the presence of small depressions. |
| Taste and smell    | The taste is slightly cheesy, clean, fermented, moderately salty.             |
| Consistency        | Layered, elastic, slightly dense.                                             |
| Drawing            | No drawing.                                                                   |
| Color              | White to light yellow.                                                        |

**Table 1. Organoleptic properties of ‘Suluguni’ cheese.**

| Parameter                      | Findings     | GOST 34356-2017 [30] |
|-------------------------------|--------------|----------------------|
| Mass fraction of moisture, %  | 40.4±0.5     | not exceeding 53     |
| Fat, %                        | 46.0±0.8     | 45.0±1.6             |
| Mass fraction of protein, %   | 22.2±0.2     | -                    |
| Mass fraction of sodium chloride, % | 2.1±0.5     | 1.0-3.0              |

It was revealed that the cheese does not contain bacteria of the *E. coli* group, pathogenic microorganisms, staphylococci, yeast and mold. The number of mesophilic aerobic facultative anaerobic microorganisms is $1.8\times10^4$ CFU/g (table 3).

**Table 3. Microbiological parameters of ‘Suluguni’ cheese.**

| Parameter                                      | Findings     | TR CU 033/2013 [31] |
|-----------------------------------------------|--------------|---------------------|
| QMAFAnM, CFU/g                                | 1.8×10⁴      | -                   |
| CGB (coli-forms) in 0.001 cm³ product         | not detected | not allowed         |
| Pathogens including salmonella in 25 cm³ product | not detected | not allowed         |
| Staphylococci aureus in 0.001 g product       | not detected | not allowed         |
| Listeria monocitogenes in 125 g product       | not detected | not allowed         |
| Yeast, mold, CFU/g                            | not detected | not allowed         |

We studied the physical and chemical properties of milk. It was found that the pH of milk of the morning milking was 6.69±0.006, the evening milking was 6.67±0.003, and that in normalized milk was 6.64±0.003. The titrated acidity is characteristic for fresh milk and amounted to 16.64±0.01°T, 16.99±0.09°T and 17.65±0.14°T, respectively, for morning, evening and normalized milk. The density of morning milk is 28.03±0.14°A, evening milk 28.59±0.14°A, normalized 30.56±0.05°A with a norm of at least 27.0°A. The freezing temperature of morning, evening and normalized milk was
–0.546±0.001°C, –0.541±0.001°C, –0.540±0.002°C, respectively, with a norm not higher than –0.520°C. Thus, the milk supplied to the laboratory by its chemical composition and physicochemical properties is suitable for the production of brine cheese ‘Suluguni’.

4. Discussion

The production technology of ‘Suluguni’ cheese begins with the acceptance and preparation of raw materials. Milk enters the laboratory in milk flasks. When receiving milk, milk flasks were washed outside with water, samples were taken and the quality of milk was determined [32, 33].

After receiving the milk was filtered and sent to a long-term pasteurization bath. The milk was heated to the temperature of 36-40°C for separation on a separator ‘Motor SICH STsM – 100’. This separator not only separates the milk into skim milk and cream, but also cleans more thoroughly due to centrifugal force. Skim milk was used to prepare a normalized protein/fat mixture. For the production of ‘Suluguni’ cheese, it is important that the ratio of protein to fat is 1.0:1.2. An increase in the fat content of the mixture or a decrease in it affects the plasticity of the cheese and its quality.

Normalized milk was pasteurized at a temperature of 68-70 °C, held for 25-35 sec and cooled to a ripening temperature of 38-39°C. For fermentation, a direct addition starter culture LC D27 was used. The working temperature for this starter culture is 35-43 °C. The starter culture was dissolved in 100 ml of warm water and mixed gently. The starter solution was poured into milk, mixed for 60 min. A solution of calcium chloride was added to the fermented mixture.

The rennet was used to coagulate the milk. The rennet solution was introduced in a thin stream into the fermented mixture. To evenly distribute the rennet solution, the mixture was stirred for 2 min, the stirrer was turned off and the milk was stopped rotating and left to coagulate. The time for clotting is on average 30 to 60 min and depends on the enzyme and the maturity of the milk. The bunch should be even with a smooth surface without delamination. It shouldn’t be too soft or too hard. The curd should easily come off the walls of the bath without sticking to them. The readiness of the clot was determined visually for fracture. The curd was then cut open with lyre and left to isolate the serum. Then we proceeded to staging the grain. It is important to work carefully and not to break the grain, as it has not yet matured. At the end of the curd treatment, the curd grains were the same size 8-10 mm. After setting the curd, it was dried. During drying with constant stirring, the curd actively releases whey. This process is called syneresis. At the same time, the grain gradually becomes denser, decreases in size and becomes more elastic, dense. For further pre-pressing and ripening of the cheese dough, 70-80% of the whey was separated. In the remainder of the whey, the curd was left to cheddaring.

Cheddaring of the cheese mass is a feature in the preparation of ‘Suluguni’ cheese, implying a change in the structure under the influence of lactic acid. The purpose of cheddaring is to obtain a fibrous-layered structure as a result of the intensification of the lactic acid process.

After separating the whey, the curd was left in the long-term pasteurization bath for self-pressing and ripening, maintaining the temperature at 38-39 °C. The ripening of the curd mass takes 2 to 3 h, while the pH of the curd mass should reach 5.3-5.0 units. An important indicator of the readiness of the cheese mass is that when heated in hot water, it will begin to stretch. To check, we took 20-30 g of cheese mass and immersed them in hot water at a temperature of 75-80 °C. After heating, the finished cheese mass should become plastic and easily stretch without breaking. This means that you can start cutting the cheese mass, and then melting. The cheese mass was cut into cubes 10×10 mm high and wide, 80-100 mm long, weighed on a scale of 800 g and placed in a wide, shallow pan and poured with hot water. The cheese mass was warmed up, the water was drained and a new portion of hot water was poured and stirred. In this case, the curd mass begins to stretch and join into a lump. We drained the water again, leaving some water so that the mass would not cool down. We connected the edges with an envelope from edge to center and formed a homogeneous mass – cheese dough. After getting a homogeneous plastic mass, a round cheese head was formed and transferred to the table for cooling. After cooling, the cheese was salted in an aqueous sodium chloride brine with a concentration of 20%. Stored in a refrigerator at a temperature of 4±2 °C.

Thus, the technological operations of cheese production in the laboratory are carried out manually.
This technology is recommended for the production of ‘Suluguni’ cheese in farms.

5. Conclusion
The quality of milk in terms of physical and chemical indicators meets the requirements for milk for cheese making. Raw cow milk, bacterial starter cultures, rennet enzyme, drinking water, salt are used in the technology of production of ‘Suluguni’ cheese.

The technology of the production of ‘Suluguni’ cheese consists of the following sequential operations: acceptance and preparation of milk for cheese production (cleaning, storage and reservation, maturation, heat treatment, normalization) preparation of milk and adding components to the cheese mixture (pasteurization, cooling, adding calcium chloride ), fermentation, curdling of the mixture, processing of the curd, drying of curd grains, cheddaring of the curd mass, melting, formation of a cheese head, cooling, salting, storage, transportation and sale of products.

The technology of the production of ‘Suluguni’ cheese with cheddaring and thermochemical processing of the cheese mass is recommended for production on farms. It is promising the further study of the characteristics of the composition and properties of milk from cows of farms and the development of technologies for the production of other types of cheeses.

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