The use of acidophilus bacterium for cheese cheddaring

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Abstract. One of the promising technologies for cheese making is cheddaring of cheese mass; it is desirable that the cheddaring takes place as soon as possible. The article considers the possibility of using acidophilus bacillus to intensify the cheddaring process. As starter cultures, the bacterial concentrate AiBi LcLS 30.11 and sourdough of acidophilus bacillus with inviscid BK-Uglich-ANV in a ratio of 5:1 were used. The cheddarization of cheese mass using a starter culture with acidophilus bacillus took 3 hours, while the cheddarization time was reduced by 2–4 hours. The optimum acidity of the serum is 65–70 ° T (pH 5.45–5.50), the thermomechanical processing requires water. Cheese produced using acidophilus bacterium meets the organoleptic and physico-chemical parameters.

1 Introduction

Cheese is a unique product. It "absorbs" all the most useful components of milk and contains them in a concentrated form.

Nowadays, in the cheese production, cheese cheddarization is one of the most promising technologies. Such cheeses include: "Cheddar", "Cheshire", "Derby", "Mozzarella", "Provolone", "Kachkaval", "Chechil", "Suluguni", "Halumi" and others. As a result of cheddarization, cheese becomes viscous, milk protein is transformed and becomes more easily digestible, the aging time is reduced. Despite the very short ripening time, cheese has a pronounced cheese flavor.

During cheddarization, lactic fermentation is active. The resulting lactic acid causes calcium to escape from the paracasein complex, and the cheese mass acquires a layered fibrous structure. The classic starter culture for cheddarization is Lactococcus lactis and Lactococcus cremoris. To intensify the process of acid formation, Lactococcus thermopfilus, Lactobacillus bulgarikum, Lactobacillus helveticum, Lactobacillus plantarum, Lactobacillus casei and others [1, 2] are introduced into the starter composition, while there is no data on the use of Lactobacillus acid.

What is the effect of acidophilus bacillus?

Firstly, it is the strongest acidifier. The maximum acidity of individual strains reaches 300–400 ºT, which corresponds to 3–3.5 % of lactic acid. Acidophilus bacillus ferments milk for 3–4 hours. Of all the microorganisms used to intensify the cheddarization process, only Lactobacillus bulgarikum is the most effective; the acid-forming effect of Lactococcus thermopfilus, Lactobacillus plantarum and Lactobacillus casei is less pronounced compared to acidophilus bacilli. [3–6]. Thus, we can expect that the cheddarization when using starter cultures with acidophilus bacillus will be much faster than when using classic starter cultures.

Secondly, the usefulness of acidophilus bacillus products is undeniable. This microorganism is a probiotic culture, that is, it is able to live in the intestine and have a beneficial effect on human health [7]. An important factor in the probiotic action of L. acidophilus is the ability to produce lactic acid (more than 90 % of all products of carbohydrate metabolism) and antibacterial substances (bacteriocins). These substances have a high antagonistic effect and suppress a wide range of pathogenic and opportunistic bacteria, including staphylococci (including Staphylococcus aureus) [8].

In our country, of all cheeses produced using the cheddarization technology, the most popular ones are Suluguni, Kachkaval, Kosichka, Chechil, etc.

The article deals with types of cheese. Thermomechanical processing is carried out by melting the cheese mass in hot water at a temperature of 75–85 °C, while the cheese mass warms up to 58–60 °C [2]. There is a starter microflora in the finished product. It is known that acidophilus bacilli bacteriocins are characterized by a thermal stability and an ability to be active over a wide pH range [8]. Therefore, these products even after heat treatment contain substances that will contribute to the normalization of intestinal microflora, that is, these products can be attributed to functional products. The bacteriocins present in the product will inhibit spoilage microorganisms acting as natural preservatives.

The purpose of the article is to describe a technology for the production of cheese of high biological value using acidophilus bacillus to accelerate the cheese mass cheddarization.

To achieve this purpose, the following tasks were set: to analyze the quality of raw materials for cheese production, to determine the main parameters for using acidophilus bacillus for cheddarization of cheese mass,

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to choose the optimal method for forming the cheese mass and evaluate the quality of the finished product.

2 Results and discussion

The following types of raw materials were used for the production of cheese: milk (GOST R 52054); fermentation (GOST 34372); milk-clotting enzyme preparation of animal origin (GOST 34353); calcium chloride (GOST R 55973) and food salt (GOST 13830).

Milk has to be of high quality, so the quality of raw milk was evaluated.

The tested milk corresponded to the requirements TR TS 033/2013 Technical Regulation of the Customs Union "On Safety of Milk and Dairy Products" (Tables 1, 2). According to GOST R 52054, milk is classified as premium. This quality is characteristic of milk produced in the Udmurt Republic [9].

Table 1. Organoleptic properties of milk

Parameter	Requirements TR TS 033/2013	Actual
Color	white, light creamy	meets
Consistence	Homogeneous liquid without sediment and flakes. Freezing is not allowed.	meets
Taste and flavor	clear taste and flavor, without extraneous odor and taste not characteristic of fresh milk	meets

Table 2. Physico-chemical properties of milk

Parameter	Requirements TR TS 033/2013	Actual
Mass fraction of fat, %, not less than	2.80	3.82±0.03
Mass fraction of protein, %, not less than	2.80	3.01±0.02
Mass fraction of dry skim milk substances (SOMO), %, not less than	8.2	8.41±0.4
Acidity, °T	16.0–21.0	17.0±0,5
Density, kg / m^3, not less than	1027.0	1028.0±0,04
The number of somatic cells, thousand / cm^3 no more than	$5 \cdot 10^5$ (when used in cheese production)	180±20
The number of bacteria (KMAFAnM), thousand / cm^3, no more than	$5 \cdot 10^5$	250±40
The presence of inhibitory substances	no	no

The starter cultures were the AiBi bacterial concentrate LcLS 30.11 (produced by Zelenye Lini LLC, Moscow) and the acidophilic acid starter culture of the inviscid BK-Uglich-ANV (produced by the Experimental Biofactory Federal State Budget Scientific Institution, Uglich).

Both starter cultures are active acidifiers. Latococcus lactis ssp lactis and Streptococcus thermophilus included in LcLS 30.11, as the main acid-forming agents, contribute to an intensive lactic acid process, the aroma-forming streptococcus Leuconostoc mesenteroide gives the product a pronounced pleasant aroma, Lactobacillus casei have a high biological activity. They can be used as immunostimulants. In addition, the casey bacillus has a moderate proteolytic effect, which contributes to the formation of a more pronounced creamy taste.

Before concentrating into milk, the concentrates were activated according to the technology provided for by the instructions for the preparation of starter cultures.

Organoleptic indicators, souring time, acidity, bacterial purity and the microflora composition were checked. For all indicators, the starter culture met regulatory and technical requirements [10].

Rennet was used as a milk-clotting preparation, which has good technological and safety characteristics [11], and it is suitable for the cheddarization of cheese mass. Calcium chloride is used to optimize rennet and produce a good quality clot. Salt is a preservative. It infleucnes the taste of cheese.

When developing a technology for the production of new cheese using acidophilus bacteria, the time and temperature of coagulation and cheddarization, the value of serum acidity at the end of cheddarization, and the external signs of the cheese mass ready for further thermomechanical processing, were determined. We also tested two methods of molding the cheese mass: processing in water and in serum.

The technological process begins with the evaluation of quality of raw materials. For the production of cheese of high biological value, raw materials with a high content of protein and SOMO are used to ensure a high yield and product quality and increase the activity of starter microorganisms. Milk should contain a small number of somatic cells and bacteria, which ensures a high yield and quality of the product, increases its safety for the consumer.

Next, they filter milk and send it for temporary reservation and ripening at 8–12 °C, until the acidity increases to 20–21 °T. Then the milk is heated to 35–40 °C, cleaned by milk separators, normalized by the fat

content taking into account the mass fraction of protein and pasteurized.

Milk is pasteurized at 70–72 °C with for 15 seconds. Then it is cooled to a temperature of 34 + 2 °C, 0.7–1.5 % the starter culture is introduced (bacterial concentrates LcLS 30.11 and BK-Uglich-ANV in a ratio of 5:1), calcium chloride in the form of a 40 % solution (from 10-40 g of anhydrous salt per 100 kg of milk) and rennet in the form of a 1 % solution.

Coagulation is carried out at 34 + 2 °C for 30–35 minutes. Then the clot is cut into cubes with an edge of 10–15 mm. Cheese grain formation lasts for 10–20 minutes, while the grain is gently kneaded.

The second heating is carried out at 36–38 °C for 8–10 minutes. Then the grain is dried for 15–20 minutes. The second heating can be carried out by heating part of the serum taken from the bath. The grain size should be 6–10 mm.

For the cheddarization of cheese mass, part of the serum is removed (70–80 %), a layer is formed and pressed in a bath or press trolley under a layer of serum at 36–38 °C for 3 + 0.5 hours. When using the traditional starter cultures, the cheddarization time is 5–7 hours, that is, Lactobacillus acidophilum and Lactobacillus casei contribute to the reduction of cheese production time.

The readiness of the cheese mass is determined by melting the cheese mass: a piece of cheese of 10x1x1 cm is placed in hot water at 90–95 °C for 1–2 minutes. When stretched, the finished cheese should form long threads. An external sign of maturity is the presence of eyes formed in the mass during ripening. Serum acidity should be 65–70 °T (pH 5.45–5.50).

After cheddarization, the cheese mass is cut into pieces 2–3 cm in size and put into a pot with water or serum heated to 75–80 °C. The mass is kneaded until a homogeneous pasty consistence is obtained and then molded.

The peculiarity of these cheeses is that they can have different shapes. It is necessary to mold cheese in the form of small cheese heads weighing 50–100 g (in the form of horses, cows, pigs, etc.). It can attract buyers, including children.

The cheese mass is salted in brine with a concentration of 18–20 % for 5–10 minutes. At a longer exposure, the products are very salty. The temperature is 8–12 °C.

3 Assessment of the quality of finished products

When assessing the quality of cheese, its organoleptic, physico-chemical and microbiological indicators are determined; they have to meet the requirements of technical regulations and standards.

4 Storage

Cheese is stored at 0–6 °C, with a relative humidity of 80–85 %. The recommended shelf life is 10 days.

Having produced cheese using this technology, we evaluated its quality in accordance with GOST 34356-2017 “Cheese produced by cheddaring and thermomechanical processing of cheese mass. Technical conditions” and determined its consumer properties. We produced two types of cheese: processing the cheese mass in water and serum. After a comparative analysis, we have chosen the best option for molding the cheese mass.

The organoleptic analysis of cheese showed that it fully meets the requirements of the standard cheese produced by processing the cheese mass in water (Table 3). This cheese was evaluated as the best. In total, it received 24.9 out of 25.0 points (Table 4).

Cheese processed in serum had a rough surface, a loose, grained consistence, and an unexpressed sour taste. The total score was 23.1 points.

According to the physicochemical properties, we evaluated only cheese produced by melting the cheese mass in water.

All standardized indicators corresponded to the requirements.

Thus, cheese made using acidophilus bacillus complies with the standard.

Table 3. Organoleptic characteristics of cheese

Parameter	Standard requirements	Cheese produced	
		by processing the cheese mass in serum	by processing the cheese mass in water
Appearance	Cheese has no crust. Light layering and small recesses are allowed.	Cheese has no crust. Rough surface	Cheese has no crust. Smooth surface
Taste and smell	Mild cheesy, pure, sour-milk, moderately salty	Weak smell. Sour taste	Mild cheesy, pure, sour-milk, moderately salty
Consistence	Laminated, elastic, slightly dense. Reduced layering after storing for 30 days	Loose, granular consistence	Layered, elastic, slightly dense
Pattern	No pattern. Small holes of round, oval or angular shape are allowed.	No pattern	No pattern
Color	White, light yellow	light yellow	white

Table 4. Tasting evaluation of cheese

Parameter	Appearance	Color	Consistence	Flavor	Taste	Total
Cheese mass processed in serum	4.5	4.8	4.5	4.5	4.8	23.1±0.1
Cheese mass processed in water	4.9	5.0	5.0	5.0	5.0	24.9±0.1

Table 5. Physico-chemical properties of cheese

Parameter	Standard requirements	Cheese
Mass fraction of fat in the dry matter, %	45.0±1.6	45.3±0.1
Mass fraction of moisture, no more than, %	53.0	52.0±0.1
Mass fraction of sodium chloride, %	1.0–3.0	2.2±0.1

5 Conclusion

Summarizing the results obtained, we can conclude that the acidophilus bacillus has reduced the cheddarization time by 2–4 hours. At the same time, the product did not distort, despite the fact that the acidophilus bacillus is an active acidifier. The optimal acidity of the serum is 65–70 °T (pH 5.45–5.50).

The most appropriate way is melting cheese in water, since this cheese has the best organoleptic characteristics.

Cheese produced using acidophilus bacilli meets the requirements. In addition, the use of Lactobacillus acidophilum and Lactobacillus increases its biological value, and it can be recommended as a functional food product.

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