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Research and Development of Production Technology for Ethnic Functional Product «Red Cottage Cheese»

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1. SUMMARY

The technology of "Red Cottage Cheese" production is deeply rooted in the past of the Turkic people. "Red Cottage Cheese", with its creamy caramel flavor, has long been considered a delicacy. The Turkic people cooked "Red Cottage Cheese" by a long-term simmering of the mixture of whole milk and a fermentation agent in order to obtain a curd clot, and then adding sugar and butter.

The aim of the research is to develop a new technology for the production of the ethnic functional product "Red Cottage Cheese". To develop this new cottage cheese product, we used skim milk, fermentation agent, and stevioside.

2. Introduction

The most suitable basis for functional protein foods are dairy products, in particular low-fat cottage cheese and cottage cheese products. The protein contained in cottage cheese possesses a complete amino acid composition and is easily digested **[1]**.

Production volumes and consumption of low-fat dairy products tends to increase both abroad and in our country. Leading foreign companies produce cheeses, cheese-like and gelled products from skim milk, buttermilk and whey, using various food flavorings. These products possess satisfactory organoleptic characteristics and a good combination of biologically valuable milk components: proteins, carbohydrates, essential amino acids, macro- and microelements. Biologically active substances in the composition make these products a good supplement in a balanced diet for people of different age groups **[2], [3]**.

Production of sweet fermented dairy products should involve the usage of natural sweeteners, which are safe for man. Having analysed the literature, we selected stevioside as a natural low-calorie sweetener, extracted from Stevia leaves (*Stevia rebaudiana Bertoni,* Compositae family) **[4]**.

An important factor when considering using sweeteners in cooking involving heat treatment is their heat resistance. The sweetness of an aqueous stevioside solution doesn't change when heated to 95 °C for 2 hours. When heated to 95 °C for 8 hours, the sweetness slightly drops. It is a well-known fact that stevia sweeteners do not decompose in practical use **[5]**.

Stevioside is stable in acidic and alkaline solutions. An acidic solution containing 0.02% stevioside in a pH> 3 at 95 °C for 1 hour does not show a significant deterioration, and a 12% stevioside solution at pH = 2 decomposes under these conditions **[6]**.

According to the results of studies by Japanese scientists Fujita and Edahiro (1979), stevioside is stable in the pH range of 3–9 at 100 °C for 1 hour. In a strongly alkaline solution, stevia extract decomposes into steviolbioside and Rebaudioside, thus, the sweetness intensity decreases **[7]**.

The aim of this work is to develop the technology of a low-fat and low-calorie ethnic product using functional ingredients of plant origin that meet the principles of good nutrition. Cottage cheese is the most suitable basis for protein foods. The use of stevioside in the formula of the new fermented dairy product „Red Cottage Cheese" will reduce the calorie content

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of the finished product and expand the functional dairy products range.

3. Materials and methods

3.1. Materials

The following served as the object of the research:

- skim milk separated from natural cow's milk;
- low-fat cottage cheese;
- model samples of cottage cheese products with different proportions of components;
- ready samples of the developed cottage cheese product "Red Cottage Cheese" (with stevioside, with sucrose).

3.2. Methods

The mass fraction of moisture and dry matter in the product was determined by drying a sample of the test product at a constant temperature.

Titratable acidity was determined by neutralizing acids contained in the product with sodium hydroxide solution in the presence of a phenolphthalein indicator.

The mass fraction of fat was determined by isolating fat from the product under the action of concentrated sulfuric acid and isoamyl alcohol, followed by centrifugation and measuring the volume of the released fat in the graduated part of the butyrometer.

The mass fraction of protein was determined by measuring the mass fraction of total nitrogen using the Kjeldahl method subsequently determining the mass fraction of protein.

The mass fraction of sugar was determined by oxidation of reductive sugars containing an aldehyde group, using iodine in an alkaline medium. The mass fraction of sucrose was determined by the difference between the amount of taken and unspent iodine, determined by titration with sodium thiosulphate.

The raw material was evaluated visually for such organoleptic characteristics as appearance, color, and consistency. The obtained fermented dairy products were evaluated for organoleptics using a 1 to 5 scale **[8]**.

All measurements were carried out in three replications. Statistical analysis was performed using Microsoft Excel XP and Statistica 8.0 software package. The statistical error of the data did not exceed 5% (at 95% confidence level).

4. Results and discussions

Low-fat cottage cheese was produced through an acidic process.

The choice of ***pasteurization modes*** was based on the modes generally accepted in the production of low-fat cottage cheese. We considered the following modes: (72±2), (78±2), (84±2) °C, 20-30 seconds holding time.

An increase in the heat treatment intensity was accompanied by an increase in the mass fraction of moisture in the curd clot, as well as the actual yield of the product. But at the same time the consistency of the finished product became crumbly.

The pasteurization mode of (72±2) °C with holding time of 20-30 seconds was set.

We also made choice of ***the type of milk fermentation agent*** and fermentation temperature. We studied the parameters of the clot processing and the effect on the quality of the cottage cheese product, namely active acidity when cutting the clot, speed and temperature of the clot heating **[9]**.

Direct starter cultures of two types were selected to produce the cottage cheese product: LAT CW LT Lactina (*Lac. lactis*, *Lac. cremoris*, *Str. termophilus*) and F-DVS CC-06 (*Lactococcus lactis subsp. cremoris* and *Lactococcus lactis subsp.*). The temperatures of (28±2), (32±2), (36±2) °C were chosen **[10]**.

The analysis of the results revealed the following:

- F-DVS CC-06 was more active in comparison with LAT CW LT Lactina, it accelerated the increase in acidity in the process of fermentation by 0.64%, but the organoleptic characteristics of the curd clot deteriorated;
- increasing the fermentation temperature from (28±2) to (32±2) °C led to an acceleration of the increase in acidity by 3.74%, an increase in the synergistic properties of clots by 1.2 times, a decrease in the mass fraction of moisture in the curd clot by 7.6%.
- increasing the fermentation temperature higher than (32±2) °C led to the deterioration of the organoleptic characteristics of the curd clot, and at the temperature lower than (32±2) °C the fermentation process slowed down by 1.5 hours. Thus, the recommended starter culture is LAT CW LT Lactina, fermentation temperature – (32±2) °C.

We studied ***the effect of the clot processing parameters on the quality of the cottage cheese product***. To state the end of the milk fermentation process and the value of active acidity when cut-

ting a clot, test samples were fermented to the following active acidity values: 4.86±0.2; 4.80±0.2; 4.74±0.2; 4.70±0.2; 4.64±0.2 pH units. The analysis of the results showed that when the cut clot had an active acidity of 4.86±0.2 and 4.80±0.2 pH units, it thickened poorly during heating, the taste and smell were not pronounced enough. At the active acidity of 4.64±0.2 pH units, the product acquired a pronounced rubbery texture and an overly sour taste. The optimum active acidity value of the clot during cutting was established to be 4.70-4.74 pH units.

To accelerate separation of whey, the clot was cut horizontally and vertically with knives into cubes with an edge size of 20 mm and then left for 30-60 minutes. The cut clot was heated to 36–38 °C during 15-20 minutes to accelerate the syneresis process.

The separated whey was drained from the bath through the connecting tube and collected in a separate container. The obtained clot in Mylar bags was put into a cooler drum for pressing and cooling.

The ***modes of simmering*** of the obtained low-fat cottage cheese in skim milk were also studied. Simmering gives the product a cream color, caramel taste and smell of baked milk, characteristic of "Red Cottage Cheese". Simmering was carried out at 90 °C, 95 °C, 99 °C. Simmering of cottage cheese at a temperature of 95 °C reduces the likelihood of burn-ins on the apparatus walls by 50%, while the time of heat treatment increases by 20-40% to 3.5-4.0 hours. The quality of red cottage cheese remains almost at the same level.

When simmering is carried out at the temperature of 90 °C and below, the duration of simmering increases to 6-8 hours. The finished product has a stiff, granular consistency, uneven color and high moisture content, which dramatically affects its sensorial characteristics. The likelihood of burn-ins in this case is reduced to minimum.

An important factor in simmering is removal of the moisture from the product surface, which allows to reduce the time of heat treatment to 10–15% and lower the boiling temperature by 1-2 °C.

Thus, in order to reduce the time of heat treatment and avoid burning the product to heat-exchange surfaces, we recommend the following mode of simmering:

- Maintain the temperature of 95 °C during first 1-2 hours, the mixer rotation frequency of 12-24 min^{-1} and a minimum exhaust hood capacity to obtain a characteristic taste, color and texture of the finished product;
- In the remaining time reduce the temperature to 92 °C, increase the mixer frequency to 36 min^{-1} and the capacity of the exhaust hood to the full, to ensure the removal of the remaining excess moisture from the product.

During simmering of the curd clot in skim milk at the temperature of 90–100 °C, there occurs isomerization of lactose (formation of lactulose) and its interaction with amino groups of proteins (melanoidin formation reaction, Maillard reaction). The final product of this interaction is brown pigments – melanoidins, which give the finished product a rich cream color **[11]**. There also takes place a complete precipitation of casein and whey proteins of skim milk, while the mass fraction of proteins in the finished product increases. Thus, the high-temperature coagulation of milk proteins during simmering of a curd clot increases the yield of the product and its biological value due to the maximum use of all protein components of the raw material.

Based on the conducted research, we developed the production technology of the fermented dairy product "Red Cottage Cheese" with the use of skim milk. A flowchart illustrating the production of cottage cheese products from skim milk is given in ***Figure 1***.

The following raw materials were used to obtain test samples of cottage cheese products: skim milk separated from natural cow's milk, with acidity not higher than 19 °T; dry starter cultures of direct application – LAT CW LT Lactina (*Lac. lactis, Lac. cremoris, Str. termophilus*), sucrose, stevioside.

A natural sweetener, stevioside, was used to give a sweet taste to the developed cottage cheese product and reduce its calorie content. Stevioside was introduced into the "Red Cottage Cheese" base in the amount of 0.01; 0.03; 0.05; 0.07; 0.1% by weight of the finished product. "Red Cottage Cheese" with sucrose (10% by weight of the finished product) was used as a control sample.

Profilograms of organoleptic characteristics of test samples of cottage cheese products with stevioside and sucrose are given in ***Figure 2***.

For the organoleptic evaluation of the samples under study a 1 to 5 rating scale was used, main organoleptic indicators had been determined through an expert evaluation.

The diagrams given above show that the test sample with 0.05% stevioside has the best organoleptic characteristics. The introduction of less than 0.05% stevioside does not give the product the desired taste, while the concentration greater than 0.05% negatively affects its organoleptic characteristics, giving the product an excessive sweetness with a touch of bitterness. The use of stevioside as a sweetener can improve the synergistic characteristics of the cottage cheese product.

The organoleptics of a product affect consumers' choice to a much greater extent than chemical composition and nutritional value, and ultimately create the demand for it **[12]**.

The organoleptic characteristics of "Red Cottage Cheese" samples with stevioside in different concentrations are given in ***Table 1***. The appearance of the product is shown in ***Figure 3***.

Considering the obtained data, we developed the formula of "Red Cottage Cheese" product with stevioside (***Table 2***).

Table 3 describes the physical and chemical indicators of the obtained cottage cheese product.

The developed samples of "Red Cottage Cheese" fully comply with the regulatory requirements of Technical Regulations of the Customs Union "On the safety of milk and dairy products" (TR CU 033/2013).

The "Red Cottage Cheese" product with stevioside has a high protein content of 22.9%, which is by 4.9% more compared to the cottage cheese product of the traditional technology. The energy value of 100 g of the "Red Cottage Cheese" with stevioside is 136 kcal (*569 MJ – The Editor*), i.e. 32 kcal (*134 MJ – The Editor*) less compared to the cottage cheese product with sucrose.

5. Conclusions

We were first to develop and test the new technology for production of the cottage cheese product "Red Cottage Cheese". To obtain the new cottage cheese product, we used skim milk, fermentation agent, and introduced stevioside instead of sugar. The described production technology of this ethnic product allows to obtain cottage cheese of low fat and calorie content.

We established the most suitable technological modes for the production of the cottage cheese product.

The cottage cheese products were subject to quality evaluation and physical and chemical study. The obtained low-calorie "Red Cottage Cheese" product is crumbly, with an uneven surface and distinct particles of milk protein. The product has a sour-milk, caramel taste and smell of baked milk. The obtained product has a high protein content of 22.9%, which is 4.9% more compared to the cottage cheese product of the traditional technology. The energy value of 100 g of cottage cheese product "Red Cottage Cheese" with stevioside is 136 kcal (569 MJ – The Editor).

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