Use of Milk-Protein Concentrates in the Production of Fermented Milk Products

Nikolay Gutov and Irina Maseeva

Technological Institute of Food Industry, Kemerovo State University, 6, Krasnaya St., Kemerovo, 650043, Russian Federation

ORCID:
Nikolay Gutov: http://orcid.org/0000-0002-4429-9919

Abstract
There are an increasing number of products containing milk-protein concentrates. Their use helps to reduce the duration of the fermentation process; increases the concentration of viable cells of lactic acid microorganisms; creates the desired consistency of finished products with required structural and mechanical properties; improves the taste; expands the range of fermented milk products; increases the content of essential amino acids and regulates the amino acid composition; increases the product yield; and improves the manufacturability, including the turnover of the main technological equipment and production areas. This article presents the results of the use of milk-protein concentrates in the production of sour milk, cream and cottage cheese. The acidity of test samples, their biological value, and the total amount of lactic acid microorganisms were determined. The research results show that the use of milk-protein concentrates in the production of dairy products contributes to the intensification of the technological processes and improves the quality of the finished products.

Keywords: casein, milk protein, milk protein concentrate, whey proteins, lactic acid microorganisms, biological value

1. Introduction
The problem of protein deficiency is important. Proteins (from the Greek protos - the first) are an irreplaceable component related to high-molecular compounds consisting of amino acids. They consist of 53% carbon, 7% hydrogen, 22% oxygen, 15-17% nitrogen, and 0.3-3% sulfur. Phosphorus, iron and other elements are present only in some proteins. By their structure, proteins are divided into two groups: simple and complex. Simple proteins (globulins, albumins) consist only of amino acids. Complex proteins contain non-protein compounds. For example, lipoproteins contain lipids, phosphoproteins - phosphoric acid, c glycoproteins - carbohydrates, etc.
Proteins are not capable of accumulating in the human body, and they lack the ability to synthesize from other food substances. As a result, proteins are an indispensable component in human nutrition. Serious problems in the activity of endocrine glands, changes in the blood composition, a decrease in human intellectual activity, slow development of children, and a decrease in resistance to various infections occur due to a deficiency of proteins in the body [1].

There are complete proteins (containing all 8 essential amino acids) and defective ones. Dairy products, meat, fish, poultry, and eggs are a source of complete proteins. Vegetable food belongs to the source of defective proteins. It is necessary to take into account that in the intestine more than 90% of amino acids are absorbed from the proteins of animal products, and 60-80% - from vegetables. Proteins of dairy products, fish, meat, bread and cereals are rapidly digested. This aspect is of great importance for therapeutic diets and nutrition of a healthy person. For a rational diet, it is necessary to combine animal and plant products, thereby improving the balance of amino acids. One of the ways to resolve this issue is the market of dairy products enriched with milk-protein concentrates (MPC) [2].

Milk-protein concentrates are obtained from skim milk, buttermilk and milk serum or their mixtures by removing water and ballast substances - lactose, mineral salts and biologically active substances with a simultaneous concentration of protein at the level of 15-85%. Depending on the mass fraction of dry substances, milk-protein concentrates are sub-divided into liquid (pasty) and dry. Liquid and dry MPC have different types of protein (casein, whey milk-protein concentrates, coprecipitates) and solubility in water (soluble and insoluble) [3].

Along with concentrates, products containing protein concentrates as a basic ingredient for existing and developed technologies of innovative dairy products are popular [4].

2. Purpose

The purpose of this article is to study the possibility of using milk-protein concentrates in the production of sour milk and cream and cottage cheese and their influence on the intensification of technological processes and quality of dairy products.
3. Research Object and Methods

The objects of research were samples of sour milk and cream and cottage cheese pro-
duced with the addition of milk-protein concentrates in the laboratory of the Department
of Technology of Animal Food Products, Kemerovo State University.

When determining the acidity of sour milk, sour cream and cottage cheese samples
during fermentation, a method based on the neutralization of free acids, acid salts and
free acid groups was used in accordance with GOST R 54669-2011 “Milk and milk
processing products. Acidity determination methods”.

The biological value of the prototypes was determined by the amino acid scoring
method.

The total number of lactic acid microorganisms was determined in accordance with
GOST 10444.11-89 “Food products. Methods for the determination of lactic acid microor-
ganisms”.

4. Results and Discussion

At the first stage, the composition of milk-protein concentrates in sour milk and cream
and cottage cheese was studied: the content of whey proteins and casein proteins. The
results are shown in Table 1.

| Table 1: Content of whey and casein proteins in milk-protein concentrates |
|---------------------------------------------------------------|
| Name of protein fractions | Name of milk-protein concentrate |
|---------------------------|---------------------------------|
| Whey proteins,% of total protein content | Neo-prolact U (l) | Promilk Kappa Optimum | Ingredia Prodiet \( S25 \) | Promilk 852 FB1 | Promilk 802 FB | Promilk Kappa Optimum | Promilk 870 |
| 43.75 | 27.87 | - | - | 75.31 | 9.59 | 12.37 |
| Proteins-caseins,% of total protein content | 56.25 | 72.13 | 100.00 | 100.00 | 24.69 | 90.41 | 87.63 |

Table 1 shows that two types of milk-protein concentrates contain only casein frac-
tions. The rest of the milk-protein concentrates contain whey proteins.

It has been experimentally revealed that it is advisable to use milk-protein concen-
trates containing whey proteins in the production of sour milk and cream, since they
help to reduce the syneresis of the milk-protein clot, whey sediment, which makes it
possible to improve the consistency and appearance of finished products.
The biological value of the samples of sour milk and sour cream is presented in Tables 2 and 3. The sample of a dairy product produced according to the classical technology from a mixture normalized milk and cream was used as a control sample.

The tables demonstrate that the use of milk-protein concentrates increases the content of essential amino acids by 4.5%. In addition, the presence of casein and whey proteins in milk-protein concentrates increases the biological value of finished products.

It was found that in the production of cottage cheese with a 5% fat content, it is recommended to use milk-protein concentrates containing only casein proteins. The absence of a whey protein fraction contributes to an increase in syneresis and good dehydration of sour milk produced during coagulation, excluding the smear consistency and a large amount of free whey. As a result, cottage cheese produced with the use of milk-protein concentrates has a crumbly consistency and a rather dense curd grain.
The biological value of the cottage cheese samples is presented in Table 4. The sample of a dairy product produced according to the classical technology from a normalized mixture by the acid-rennet method was used as a control sample. Table 4 shows that the use of milk-protein concentrates increases the content of essential amino acids by 7.0%. The biological value of the finished product increases.

| Name of essential amino acid | Cottage cheese (control), mg content per 100 g of product | Cottage cheese (experiment), mg content in 100 g of product | Amino acid rate (control),% | Amino acid rate (experience),% |
|------------------------------|----------------------------------------------------------|----------------------------------------------------------|-----------------------------|-------------------------------|
| Isoleucine                   | 42.3                                                     | 46.4                                                     | 105.8                       | 116.1                         |
| Leucine                      | 75.0                                                     | 79.9                                                     | 107.1                       | 114.2                         |
| Lysine                       | 0.0                                                      | 57.8                                                     | 0.0                         | 105.0                         |
| Methionine                   | 37.7                                                     | 39.1                                                     | 107.7                       | 111.6                         |
| Phenylalanine                | 61.6                                                     | 64.8                                                     | 102.6                       | 107.9                         |
| Threonine                    | 43.3                                                     | 45.1                                                     | 108.3                       | 112.8                         |
| Tryptophan                   | 11.0                                                     | 11.5                                                     | 110.2                       | 115.0                         |
| Valine                       | 53.9                                                     | 55.4                                                     | 107.7                       | 110.8                         |

In addition, the sample contains “lysine”. The use of milk protein concentrates eliminates lysine deficiency whose absence can lead to fatigue, weakness, poor appetite, growth retardation, inability to concentrate, irritability, bleeding in the eyeball, hair loss, anemia and reproductive problems.

The human gastrointestinal tract is home to many probiotic lactic acid microorganisms, lacto- and bifidobacteria. The product of their metabolism - lactic acid - has a number of positive aspects (stimulates intestinal motility; reduces gas formation; stimulates the secretion of digestive juices; improves the absorption of calcium, phosphorus and iron). In addition, lactobacilli can resist to various pathogenic microbes. Due to the production of biologically active substances (organic acids, hydrogen peroxide, antibiotics and bacteriocins), microorganisms which are dangerous for the intestinal activity are displaced. If the concentration of lactic acid bacteria in the content of the chyme is reduced, pathogenic microflora develops. The use of milk-protein concentrates contributes to an increase in the total number of lactic acid microorganisms. Regular consumption of such dairy products can improve the human intestinal microflora.

We studied the effect of milk-protein concentrates on the dynamics of the total number of cells of microorganisms during fermentation of test samples of fermented milk products. The data obtained are shown in Tables 5-7.

The research results demonstrate an increase in the biomass of cells of lactic acid microorganisms in the experimental samples of fermented milk products containing...
TABLE 5: Dynamics of the total number of cells of lactic acid microorganisms during fermentation of sour milk-protein concentrates, which leads to the intensification of acid formation and efficiency of the fermentation process [5].

An increase in the concentration of viable cells of lactic acid microorganisms in the test samples is associated with an increased content of protein and other nutrients [6, 7].
TABLE 7: Dynamics of the total number of cells of lactic acid microorganisms during fermentation of 5% fat content cottage cheese

| Duration of fermentation, hour | Control | Promilk 870 | Ingredia Prodiet S25 | Neoprolact U (l) | Promilk Kappa Optimum 85 | Promilk Kappa Optimum | Promilk 852 FB1 | Promilk 802 FB |
|------------------------------|---------|-------------|----------------------|-----------------|--------------------------|-----------------------|----------------|--------------|
| 0                            | 1.3x10⁷ | 1.3x10⁷    | 1.3x10⁷              | 1.3x10⁷         | 1.3x10⁷                  | 1.3x10⁷              | 1.3x10⁷         | 1.3x10⁷      |
| 1                            | 1.8x10⁷ | 1.5x10⁷    | 1.7x10⁷              | 1.8x10⁷         | 1.6x10⁷                  | 1.7x10⁷              | 1.9x10⁷         | 2.2x10⁷      |
| 2                            | 1.9x10⁷ | 1.7x10⁷    | 1.9x10⁷              | 2.1x10⁷         | 2.3x10⁷                  | 1.9x10⁷              | 2.1x10⁷         | 2.5x10⁷      |
| 3                            | 5.6x10⁸ | 5.6x10⁸    | 3.9x10⁸              | 5.1x10⁸         | 2.1x10⁸                  | 2.3x10⁸              | 2.6x10⁸         | 2.9x10⁸      |
| 4                            | 6.5x10⁹ | 6.1x10⁹    | 2.8x10⁹              | 5.8x10⁹         | 2.5x10⁹                  | 3.3x10⁹              | 3.5x10⁹         | 3.8x10⁹      |
| 5                            | 9.06x10⁹ | 1.6x10¹⁰  | 2.9x10¹⁰             | 2.8x10¹⁰        | 2.8x10¹⁰                 | 3.5x10¹⁰             | 3.7x10¹⁰        | 4.1x10¹⁰     |
| 6                            | 2.7x10¹⁰ | 2.1x10¹¹  | 2.9x10¹¹             | 2.9x10¹¹        | 3.2x10¹¹                 | 3.7x10¹¹             | 3.9x10¹¹        | 4.2x10¹¹     |
| 7                            | 3.1x10¹⁰ | 2.4x10¹¹  | 3.7x10¹²             | 3.3x10¹²        | 3.5x10¹²                 | 3.9x10¹²             | 4.1x10¹²        | 4.4x10¹²     |
| 8                            | 4.65x10¹¹ | 2.8x10¹³  | 4.1x10¹³             | 3.9x10¹³        | 4.1x10¹³                 | 4.4x10¹³             | 4.3x10¹³        | 4.6x10¹³     |

The research results indicate that a rather sharp increase in the number of lactic acid microorganisms in experimental samples 3 hours after the fermentation is associated with the rapid adaptation of microorganisms to the milk environment [8].

5. Conclusion

Currently, protein concentrates used in the production of dairy products have gained popularity. This is due to good anabolic properties and bioavailability of concentrates, increased awareness of the Russian population about benefits of dairy products and ingredients, an increase in purchasing power, trends towards healthy eating and healthy lifestyle [9-11].

The studies confirmed that the use of milk-protein concentrates in the production of fermented milk products increases the content of essential amino acids, reduces duration of the fermentation process due to active acidification, increases the concentration of viable cells of microorganisms, creates the desired consistency of finished products with required structural and mechanical properties (due to the increased content of the protein fractions); improves taste; expands the range of fermented milk products; increases the product yield; improves the manufacturability of production, including the turnover of the main technological equipment and production areas.
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