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

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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

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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 produced 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 microorganisms”.

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						
	Neo-prolact U (1)	Promilk Kappa Opti-mum 85	Ingredia Prodiet S25	Promilk 852 FB1	Promilk 802 FB	Promilk Kappa Optimum	Promilk 870
Whey proteins,% of total protein content	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 fractions. The rest of the milk-protein concentrates contain whey proteins.

It has been experimentally revealed that it is advisable to use milk-protein concentrates 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.

Table 2: Biological value of sour milk

Name of essential amino acid	Sour milk (control), mg content per 100 g of product	Sour milk (experiment), mg content in 100 g of product	Amino acid rate (control),%	Amino acid rate (experience),%
Isoleucine	45.5	47.1	113.8	117.9
Leucine	80.0	85.0	114.3	121.4
Lysine	65.1	68.5	118.3	124.5
Methionine	36.4	38.1	104.1	108.8
Phenylalanine	67.5	69.3	112.5	115.5
Threonine	48.7	49.9	121.8	124.7
Tryptophan	11.1	11.6	111.4	115.6
Valine	57.5	59.1	115.0	118.3

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.

Table 3: Biological value of 15% fat content sour cream

Name of essential amino acid	Sour cream (control), mg content per 100 g of product	Sour cream (experiment), mg content in 100 g of product	Amino acid rate (control),%	Amino acid rate (experience),%
Isoleucine	41.0	42.0	102.5	105.0
Leucine	77.1	79.0	110.2	112.9
Lysine	60.7	62.0	110.4	112.7
Methionine	36.0	38.0	102.9	108.6
Phenylalanine	62.1	64.0	103.6	106.7
Threonine	42.3	44.1	105.7	110.3
Tryptophan	11.4	11.9	114.3	119.0
Valine	52.6	54.0	105.1	108.0

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.

Table 4: Biological value of 5% fat content cottage cheese

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

Duration of fermentationhour	The number of lactic acid microorganisms, CFU / g							
	Control	Experiment						
		Promilk 870	Ingredia Prodiet S25	Neo-prolact U (1)	Promilk Kappa Opti-mum 85	Promillk Kappa Otimum	Promilk 852 FB1	Promilk 802 FB
0	1.3×10^{7}	1.3×10^{7}	1.3×10^{7}	1.3×10^{7}	1.3×10^{7}	1.3×10^{7}	1.3×10^{7}	1.3×10^{7}
1	1.7×10^{7}	1.4×10^{7}	1.5×10^{7}	1.6×10^{7}	1.6×10^{7}	1.5×10^{7}	1.7×10^{7}	1.9×10^{7}
2	1.9×10^{7}	1.6×10^{7}	1.7×10^{7}	1.9x107	2.3×10^{7}	1.7×10^{7}	1.9×10^{7}	2.1×10^{7}
3	5.4×10^{8}	5.4×10^{8}	3.7×10^{8}	4.8×10^{8}	2.1×10^{8}	2.1×10^{8}	2.3×10^{8}	2.5×10^{8}
4	6.3×10^{8}	5.8×10^{9}	2.3×10^{9}	5.5×10^{9}	2.5×10^{9}	3.1×10^{9}	3.3×10^{9}	3.5×10^{9}
5	9.02×10^{9}	1.3×10^{10}	2.6×10^{10}	2.4×10^{10}	2.8×10^{10}	3.3×10^{10}	3.5×10^{10}	3.7×10^{10}
6	2.5×10^{10}	1.8×10^{11}	2.8×10^{11}	2.6×10^{11}	3.2×10^{11}	3.5×10^{11}	3.7×10^{11}	3.9×10^{11}
7	3.01×10^{10}	2.3×10^{12}	3.2×10^{12}	3.1×10^{12}	3.5×10^{12}	3.7×10^{12}	3.9×10^{12}	4.1×10^{12}
8	4.5×10^{11}	2.6×10^{13}	3.6×10^{13}	3.3×10^{13}	3.7×10^{13}	3.9×10^{13}	4.1×10^{13}	4.3×10^{13}

Table 6: Dynamics of the total number of cells of lactic acid microorganisms during fermentation of 15% fat content sour cream

Duration of fermentation, hour	**The number of lactic acid microorganisms, CFU / g**	The number of lactic acid microorganisms, CFU / g						
	Control	Experiment						
		Promilk 870	Ingredia Prodiet S25	Neo-prolact U (1)	Promilk Kappa Opti-mum 85	Promillk Kappa Otimum	Promilk 852 FB1	Promilk 802 FB
0	1.3×10^{7}	1.3×10^{7}	1.3×10^{7}	1.3×10^{7}	1.3×10^{7}	1.3×10^{7}	1.3×10^{7}	1.3×10^{7}
1	1.8×10^{7}	1.5×10^{7}	1.7×10^{7}	1.8×10^{7}	1.6×10^{7}	1.7×10^{7}	1.9×10^{7}	2.2×10^{7}
2	1.9×10^{7}	1.7×10^{7}	1.9×10^{7}	2.1x107	2.3×10^{7}	1.9×10^{7}	2.1×10^{7}	2.5×10^{7}
3	5.6×10^{8}	5.6×10^{8}	3.9×10^{8}	5.1×10^{8}	2.1×10^{8}	2.3×10^{8}	2.6×10^{8}	2.9×10^{8}
4	6.5×10^{8}	5.9×10^{9}	2.5×10^{9}	5.6×10^{9}	2.5×10^{9}	3.3×10^{9}	3.5×10^{9}	3.8×10^{9}
5	9.06×10^{9}	1.6×10^{10}	$2.7.5\times10^{10}$	2.6×10^{10}	2.8×10^{10}	3.5×10^{10}	3.7×10^{10}	4.1×10^{10}
6	2.7×10^{10}	2.1×10^{11}	2.9×10^{11}	2.8×10^{11}	3.2×10^{11}	3.7×10^{11}	3.9×10^{11}	4.2×10^{11}
7	3.11×10^{10}	2.4×10^{12}	3.5×10^{12}	3.3×10^{12}	3.5×10^{12}	3.9×10^{12}	4.1×10^{12}	4.4×10^{12}
8	4.65×10^{11}	2.8×10^{13}	3.8×10^{13}	3.5×10^{13}	3.9×10^{13}	4.4×10^{13}	4.3×10^{13}	4.6×10^{13}

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	The number of lactic acid microorganisms, CFU / g							
	Control	Experiment						
		Promilk 870	Ingredia Prodiet S25	Neo-prolact U (1)	Promilk Kappa Opti-mum 85	Promillk Kappa Otimum	Promilk 852 FB1	Promilk 802 FB
0	1.3×10^{7}	1.3×10^{7}	1.3×10^{7}	1.3×10^{7}	1.3×10^{7}	1.3×10^{7}	1.3×10^{7}	1.3×10^{7}
1	1.8×10^{7}	1.5×10^{7}	1.7×10^{7}	1.8×10^{7}	1.6×10^{7}	1.7×10^{7}	1.9×10^{7}	2.2×10^{7}
2	1.9×10^{7}	1.7×10^{7}	1.9×10^{7}	2.1x107	2.3×10^{7}	1.9×10^{7}	2.1×10^{7}	2.5×10^{7}
3	5.6×10^{8}	5.6×10^{8}	3.9×10^{8}	5.1×10^{8}	2.1×10^{8}	2.3×10^{8}	2.6×10^{8}	2.9×10^{8}
4	6.5×10^{8}	6.1×10^{9}	2.8×10^{9}	5.8×10^{9}	2.5×10^{9}	3.3×10^{9}	3.5×10^{9}	3.8×10^{9}
5	9.06×10^{9}	1.6×10^{10}	2.9×10^{10}	2.8×10^{10}	2.8×10^{10}	3.5×10^{10}	3.7×10^{10}	4.1×10^{10}
6	2.7×10^{10}	2.1×10^{11}	2.9×10^{11}	2.9×10^{11}	3.2×10^{11}	3.7×10^{11}	3.9×10^{11}	4.2×10^{11}
7	3.11×10^{10}	2.4×10^{12}	3.7×10^{12}	3.3×10^{12}	3.5×10^{12}	3.9×10^{12}	4.1×10^{12}	4.4×10^{12}
8	4.65×10^{11}	2.8×10^{13}	4.1×10^{13}	3.9×10^{13}	4.1×10^{13}	4.4×10^{13}	4.3×10^{13}	4.6×10^{13}

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.

References

[1] Patil, A. T., *et al*. (2018). *Production and Characterization of Milk Protein Concentrates 60 (MPC60) Amsterdam, Food Science and Technology,* vol. 91*, pp. 368-374*.

[2] Minorova, A., *et al*. (2017). Protein Composition and Technological Properties of Milk Whey Concentrates. *Agricultural Science and Practice,* vol. 4, issue 2 *pp.52-58*

[3] Fan, F., *et al*. (2018). Protein Cross-Linking and the Maillard Reaction Decrease the Solubility of Milk Protein Concentrates. *Food Science & Nutrition,* vol. 6*, pp.1196-1203*

[4] Kieferle, I., *et al*. (2019). Rheological Properties of Fresh and Reconstituted Milk Protein Concentrates under Standard and Processing Conditions. *Journal of Colloid and Interface Science,* vol. 537*, pp. 458-464*

[5] Stanislavskaya, E. B. (2018) Application of Whey Protein Microparticulates in Kefir Technology. *Dairy Industry*, vol. 8, pp. 49-51.

[6] Mironenko, I. M. (2017). Functional Features of Milk Whey Proteins. *Cheese and Butter Making*, vol. 4, pp. 44-48.

[7] Donskaya, G. A. (2017). Fermented Milk Drinks Enriched with Whey Proteins. *Dairy Industry*, vol 6, pp. 68-70.

[8] Torres-Hernandez, M., Howell, K. and Bennett, L. E. (2018). Addition of Proline-Rich Whey Peptides during Dehydration Increases Solubility of Rehydrated Milk Protein Concentrates *International Dairy Journal,* vol. 85*, pp. 137-143*

[9] Volodin, D. N., *et al*. (2015). Processing of Whey: An Understandable Strategy, Real Technologies, Adequate Investments, Products in Demand. *Dairy Industry*, vol 5, pp. 111-116.

[10] Mazeeva, I. A., Korotkiy, I. A. and Plotnikov, I. B. (2018). Modern Packaging Solutions for Whey Protein Concentrate. *Food Processing: Techniques and Technology*, vol. 4, issue 48, pp. 48-58.

[11] Korotkiy, I. A., Plotnikov, I. B. and Mazeeva, I. A. (2019). Modern Trends in the Processing of Milk Whey. *Food Processing: Techniques and Technology*, vol. 2, issue 49, pp. 227-234.