Consumer properties and environmental safety of a functional curd product

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Abstract. The authors studied the composition and properties of sesame seeds and whey proteins. It was found that they have medicinal properties, high nutritional and biological value, contain a complex of essential minerals and vitamins necessary for the normal functioning of the body. The dose, method and technological stage of introducing sesame seeds and whey proteins in the production of curd products were studied, on the basis of which the technology of a functional curd product was developed and its consumer properties were determined. It was found that the introduction of sesame seeds and whey proteins increases the organoleptic characteristics, nutritional and physiological value of the curd product.

1. Introduction
Nutrition is practically the only means that prolongs the species life expectancy of a person by 25-40%. The diet of each person should include about 600 nutrients, 95% of which have therapeutic and prophylactic properties, but the imbalance and inadequacy of modern diets, as a rule, leads to disruption of metabolic processes in the body and, as a result, to the occurrence of diseases. An increase in the proportion of the population with various nutritional-related diseases, demographic and environmental problems, and a high epidemiological load have necessitated the development and implementation of a new nutraceutical direction - functional nutrition, which is based on functional foods (FP) [1, 2, 3]. In connection with the above, the development of new FP formulations from traditional raw materials is the main task facing the food industry and the scientific community.

In accordance with the requirements of State Standard R 52349 - functional food products are any modified food product intended for systematic use in the diet of all age groups of the healthy population, reducing the risk of developing diseases associated with nutrition, maintaining and improving health due to the presence in it composition of physiologically functional ingredients that can have beneficial effects on human health, in addition to the effects of the traditional nutrients they contain. Functional food ingredients include physiologically active, valuable and healthy ingredients with known physicochemical characteristics, for which beneficial properties have been identified and scientifically substantiated, and the daily physiological need has been established. As a rule, these are components of
animal, plant, microbiological, mineral origin or identical to natural ones, which are part of a functional food product in an amount of at least 15% of the daily physiological requirement, per serving of the product [4].

The main principle of creating a new type of FP is to achieve the highest possible level of usefulness and guaranteed safety. This requires a deep study of the chemical composition and nutritional value of the components of the planned product and the identification of the biological effects of the main functional ingredients.

Currently, functional products are usually created on the basis of traditional technologies, using modifications that provide an increase in the content of useful ingredients to a level comparable to the physiological norms of their consumption (10-50% of the average daily requirement) [5]. The basis of the developed FP was cottage cheese, functional ingredients - white sesame seeds and whey protein concentrate.

One of the most widely demanded fermented milk products is cottage cheese. It is a national Russian protein product with a high biological and nutritional value. Cottage cheese proteins contain all essential amino acids (lysine, histidine, methionine, isoleucine, arginine, threonine, valine, leucine, phenylalanine, tryptophan), in the optimal amount and ratio, the bioavailability of these proteins is 95-97%. The curd contains a small amount of lactose (milk sugar). Compared to fats and proteins, milk lactose passes into cottage cheese to the least extent, since it is in the state of a true solution in milk and remains in the whey during protein coagulation [6, 7]. Among the minerals, a special role belongs to calcium and phosphorus, which are in the curd in a balanced ratio, which determines their high assimilation by the body. Ca and P are the main irreplaceable minerals that make up the bone tissue (98% Ca and 85% are found in bones). Calcium and phosphorus play an important role in the regulation of hemostasis (approximately 1% of calcium ensures the normal functioning of the blood coagulation system, the generation and transmission of nerve impulses, the contraction of muscle fibers, the activation of certain enzymatic systems and the release of certain hormones). Ca and P provide the regulation of cellular functions (if the amount and ratio of these ions in the cell is disturbed, muscle weakness, tetany, coma may occur). The optimal ratio of calcium to phosphorus intake is 2: 1. In addition to the high content of amino acids, the curd contains vitamins A, E, B, group B [7, 8]. Cottage cheese is necessary for the body for the normal functioning of all internal organs, especially bone tissue.

One of the herbal additives used in the enriched curd product technology under development is white sesame seeds. Sesame contains a large amount of oil, consisting of organic acids, saturated and polyunsaturated fatty acids, triglycerides and glycerol esters. The useful composition of sesame seeds includes carbohydrates, amino acids, proteins and vitamins A, B, E, C, PP. They are also rich in calcium, phosphorus, iron, potassium, magnesium and other mineral compounds [9]. The main biologically active components of sesame are sesamin and sesamol. These components have a pronounced antiproliferative and antioxidant effect. In this connection, they have an anticancer effect against many lines of cancer cells [10]. Sesame and its lignins reduce the risk of cardiovascular disease by lowering total serum cholesterol and low-density lipoprotein levels [11]. Sesame improves the condition of nails, human hair, has a positive effect on blood composition, normalizes metabolism and improves the functioning of the nervous system. The high content of calcium makes it indispensable for maintaining the health of bones and joints, as well as in the prevention of arthritis and osteoporosis [12, 13].

Another functional ingredient in the development of a functional curd product technology is whey proteins obtained from the processing of whey obtained in the production of curd. The main serum proteins are albumin and globulin. Albumin is a simple protein and is highly soluble in water. Under the action of rennet and acids, albumin does not coagulate, and when heated to 70 °C, it precipitates. Globulin is present in milk in a dissolved state; it is the carrier of immune bodies. Globulin also refers to simple proteins, coagulates when heated in a weakly acidic environment to a temperature of 72 °C. Albumin and globulin are blood plasma proteins [14]. The concentration of amino acids and peptides in the blood rises sharply within the first hour after taking a diet based on whey proteins. At the same time, the acid-forming function of the stomach does not change, which eliminates the disruption of its work and the formation of gases. The digestibility of whey proteins is extremely high - 96-98%. The use of
whey proteins in nutrition leads to the normalization of blood coagulation and helps to reduce the formation of blood clots [15]. In addition, serum proteins are a source of biologically active peptides that can be used in the treatment of pathological processes such as cancer, HIV infection, hepatitis B, cardiovascular and neurodegenerative diseases, and osteoporosis [16, 17, 18].

Thus, the use of sesame seeds and whey proteins in the production of a curd product intended for all groups of consumers, as factors shaping consumer properties and quality, is relevant and appropriate.

Taking into account the above, the purpose of the work is to study the composition and properties of sesame seeds and whey proteins, to establish the dose, method and technological stage of their introduction, as factors that form new quality indicators of a curd product and affect its consumer properties.

2. Materials and methods
The objects of research are: raw milk in accordance with State Standard R 52054-2003; sesame seeds; whey proteins; samples of curd products, developed with the addition of functional ingredients, using various methods of introduction; control sample - curd product produced in accordance with State Standard 31453-2013 Curd. Technical conditions.

When organizing and conducting research, a complex of generally accepted, standard and modified research methods was used: determination of the mass fraction of fat - State Standard R ISO 2446-2011; protein determination - by the Kjeldahl method in accordance with State Standard 34454-2018; thermogravimetric method for determining the mass fraction of dry substances in curd products in accordance with State Standard 28561-90; vitamin C content by titrometric method according to State Standard 22935-2 and State Standard 33630-2015; microbiological indicators were determined according to State Standard 32901-2014. Statistical processing of the obtained data and construction of mathematical models was carried out using the Statistica 6.0 software package.

3. Results and discussion
As a result of the study, the organoleptic characteristics and nutritional value of the functional components were established. Organoleptic characteristics: sesame seeds used for food production are not heated, in a healthy state, have the color, taste and smell characteristic of normal sesame seeds - without musty, moldy and foreign taste and smell. Whey protein concentrate has a soft, spreadable, slightly crumbly consistency with the presence of perceptible particles of milk protein; pure fermented milk taste and smell with a pronounced taste of pasteurized milk; cream color, uniform throughout the mass.

It has been established that the nutritional value of functional ingredients is quite high, since fats (49.7%) and carbohydrates (23.6%) predominate in sesame seeds, incl. dietary fiber - 5.6%, and whey proteins - protein (25.8%) (Table 1).

Table 1. Nutritional information for sesame seeds and whey proteins.

| №  | Indicators                  | Indicator value     |
|----|-----------------------------|---------------------|
| 1  | Mass fraction of fat, g     | 49.7±0.19           |
| 2  | Mass fraction of protein, g | 17.7±0.13           |
| 3  | Mass fraction of carbohydrates, g | 23.6±0.18 |
|   | including mass fraction of dietary fiber, g | 5.6±0.10 |
| 4  | Mass fraction of moisture, g | 9.0±0.11           |
| 5  | Mass fraction of moisture, g | 100.0              |
|    | Whey proteins               | 1.8±0.02            |
|    | 25.2±0.18                   |
|    | 73.0±0.14                   |

The results of studying the amino acid composition of sesame seeds, casein and whey proteins are presented in Table 2.
Table 2. Amino acid content in sesame seeds, whey proteins and casein (g/100g protein).

| Amino acids    | The standard is chicken protein | Whey proteins | SV deviations from the standard, +/- | Casein | K deviation from the standard, +/- | Sesame seeds | SC deviation from the standard, +/- |
|----------------|---------------------------------|---------------|-------------------------------------|--------|----------------------------------|--------------|-----------------------------------|
| Arginine       | 4.4±0.002                       | 1.8±0.002     | -1.4                                | 3.3±0.002 | -1.1                             | 10.7±0.002   | +6.3                              |
| Valine         | 5.2±0.003                       | 5.1±0.002     | -0.1                                | 5.4±0.003 | +0.2                             | 5.0±0.003    | -0.2                              |
| Histidine      | 1.8±0.002                       | 2.0±0.002     | +0.2                                | 2.4±0.002 | +0.6                             | 2.7±0.002    | +0.9                              |
| Isoleucine     | 4.6±0.003                       | 6.2±0.002     | +1.6                                | 5.0±0.003 | +0.4                             | 4.4±0.002    | -0.2                              |
| Leucine        | 6.9±0.003                       | 12.8±0.002    | +5.9                                | 9.1±0.003 | +2.2                             | 7.6±0.003    | +0.7                              |
| Lysine         | 5.5±0.003                       | 10.3±0.002    | +4.8                                | 8.5±0.003 | +3.0                             | 3.1±0.003    | -2.4                              |
| Methionine     | 2.8±0.002                       | 2.0±0.002     | -0.8                                | 2.6±0.002 | -0.2                             | 3.2±0.002    | +0.4                              |
| Threonine      | 3.7±0.002                       | 4.2±0.002     | +0.5                                | 4.5±0.003 | +0.8                             | 4.3±0.002    | +0.6                              |
| Phenylalanine  | 4.8±0.003                       | 3.8±0.002     | -1.0                                | 4.4±0.003 | -0.4                             | 5.0±0.003    | +0.2                              |
| Tryptophan     | 1.0±0.002                       | 2.5±0.002     | +1.5                                | 1.8±0.002 | +0.8                             | 1.8±0.002    | +0.8                              |
| Σ essential amino acids | 40.7                             | 50.7          | +10.0                               | 47.0    | +6.3                             | 47.8         | +7.1                              |
| Substitutable amino acids | 4.7±0.002                      | 5.0±0.002     | +0.3                                | 3.4±0.002 | -0.7                             | 4.4±0.002    | -0.3                              |
| Aspartic acid  | 8.3±0.003                       | 10.2±0.002    | +1.9                                | 7.6±0.003 | -0.7                             | 9.4±0.003    | +1.1                              |
| Glycine        | 2.9±0.002                       | 1.9±0.002     | -1.0                                | 1.8±0.002 | -1.1                             | 7.8±0.002    | +4.9                              |
| Proline        | 3.2±0.002                       | 4.1±0.002     | +0.9                                | 9.7±0.003 | +6.5                             | 4.2±0.002    | +1.0                              |
| Serine         | 5.6±0.003                       | 3.9±0.002     | -1.7                                | 5.3±0.003 | -0.3                             | 5.3±0.003    | -0.3                              |
| Tyrosine       | 3.6±0.002                       | 3.4±0.002     | -0.2                                | 4.7±0.003 | +1.1                             | 4.0±0.002    | +0.4                              |
| Cystine        | 2.1±0.002                       | 3.7±0.002     | +1.6                                | 0.9±0.002 | -1.2                             | 1.8±0.002    | -                                  |
| Σ substitutable amino acids | 30.4                             | 32.2          | +1.8                                | 33.4    | +3.0                             | 36.9         | +6.5                              |
| Σ all amino acids | 71.1                            | 82.9          | +11.8                               | 80.4    | +9.3                             | 84.7         | +13.6                             |

It was revealed that the content of all amino acids in whey proteins is 16.6% higher than in the standard, in casein - by 13.1%, in sesame seeds - by 19.1%, incl. there are more essential amino acids in whey proteins than in the standard - by 24.6%, in casein - by 15.5%, in sesame seeds - by 17.4%; Substitutable amino acids - by 6.0% more than in the standard, in casein - by 10.0% and sesame seeds - by 21.4%. The amino acid tryptophan is very important, in whey proteins it is 2.5 times more than in the standard, 1.8 times more than in sesame seeds and 39% more than in casein.

Sesame seeds in large quantities contain both essential and substitutable amino acids (in 100 g the daily allowance is 37.0% and 27.4%, respectively), while the content of all amino acids found in the seeds (in 100 g) exceeds 10% of the daily value. Sesame is especially rich in essential amino acids:
tryptophan (1.8 g), valine (1.1 g) and isoleucine (0.9 g); among the Substitutable amino acids, arginine (3.1 g), glutamic acid (4.7 g) and glycine (1.4 g) are dominant.

The amount of essential amino acids in whey proteins is 12.0% higher than in casein, including arginine and leucine by 3.7 g, lysine by 1.8 g and isoleucine by 1.2 g, which is very important for curd products which are very important in nutrition for children, pregnant women, the elderly and athletes.

Sesame seeds contain 23.4 g of carbohydrates per 100 g of the product, of which dietary fiber accounts for 5.6 g. The content of dietary fiber in sesame covers 22.4% of the body's daily requirement, which is very important for a functional product (Table 3).

**Table 3.** The content of carbohydrates and fatty acids in sesame seeds.

| Name                        | Carbohydrates | Fatty acid          |
|-----------------------------|---------------|---------------------|
|                             | Content, mg per 100 g of product | % of the daily value | Name | Content, g per 100 g of product |
| Mono- and disaccharides     | 2.0           | 4.0                 | Oleic 18: 1 (omega-9) | 18.52 |
| Glucose                     | 0.10          | 1.0                 | Linoleic 18:2 (omega-6) | 21.37 |
| Fructose                    | 0.07          | 0.2                 | Linolenic 18:3 (omega-3) | 0.38 |
| Sucrose                     | 0.3           | –                   | Palmitoleic 16:1 (omega-7) | 0.15 |
| Starch                      | 10.20         | –                   | Gadoleic 20:1 (omega-11) | 0.070 |
| Alimentary fiber            | 5.6           | 22.4                | Total unsaturated      | 40.49 |
| Pectin                      | 0.4           | 8.0                 | Myristic 14:0          | 0.13 |
|                             |               |                     | Palmitic 16:0          | 4.44 |
|                             |               |                     | Stearic 18:0           | 2.09 |
|                             |               |                     | Total saturated        | 6.66 |
|                             |               |                     | Total                 | 47.15 |

Sesame seeds are also characterized by a high content of unsaturated fatty acids (99%), especially linoleic acid (omega-6), which contains 213.7% of the daily value per 100 g. The ratio of omega-6 and omega-3 fatty acids is 5.7: 1, which is optimal for the human body. There are quite a lot of sesame seeds and oleic acid - a monounsaturated (omega-9) fatty acid (18.52 g), which protects blood vessels from the formation of cholesterol plaques and is a good prevention of atherosclerosis.

The vitamin and mineral composition of sesame seeds has been determined. The results are shown in Table 4.

The basis of the mineral composition of sesame seeds is made up of such minerals as: silicon - 663.3% of the daily value, copper - 410.0%, vanadium - 136.8%, nickel - 126.7%, manganese - 123.0%, calcium - 113.6%, iron - 96.7%, magnesium - 87.8%, phosphorus - 67.5%, zinc - 64.6%, boron - 52.9%, zirconium - 50.0%, selenium - 37.5%, molybdenum - 21.4%, cobalt - 20.0%, potassium - 19.2%, iodine - 8.9%, etc.

Analysis of the table showed that vitamins such as vitamin B1 predominate in sesame seeds - in 100 g 46.8% of the daily value; vitamin B6 - 39.5%, folic acid - 24.3%, vitamin PP - 22.6%, gammatocopherol - 16.3%, vitamin B2 (riboflavin) - 12.5%.

Thus, the conducted studies of the qualitative characteristics of sesame seeds and whey proteins allow us to conclude that they have high consumer properties, physicochemical indicators, the amount of essential amino acids in whey proteins exceeds the number of essential amino acids in all essential amino acids, except for valine and phenylalanine. It follows from this that the introduction of whey proteins
and sesame seeds into the formulation of a curd product will lead to an improvement in the consumer and functional properties of the fortified product.

Table 4. Vitamin and mineral composition of sesame seeds.

| Name             | Content, mg per 100 g of product | % of the daily value | Name             | Content, mg per 100 g of product | % of the daily value |
|------------------|----------------------------------|----------------------|------------------|----------------------------------|----------------------|
| Macronutrients   |                                  |                      | Vitamins         |                                  |                      |
| Potassium, mg    | 478.0 ± 0.003                    | 19.2                 | Vitamin B1 (thiamine), mg | 0.79 ± 0.002 | 46.8                |
| Calcium, mg      | 1274.0 ± 0.003                   | 113.6                | Vitamin B2 (riboflavin), mg | 0.25 ± 0.003 | 12.5               |
| Silicon, mg      | 192.0 ± 0.002                    | 663.3                | Vitamin B3 (pantothenic acid) | 0.05 ± 0.002 | 1.0                 |
| Magnesium, mg    | 348.0 ± 0.003                    | 87.8                 | Vitamin B6 (pyridoxine), mg | 0.79 ± 0.003 | 39.5               |
| Sodium, mg       | 11.0 ± 0.002                     | 0.8                  | Vitamin B9 (folic acid), mcg | 97.0 ± 0.003 | 24.3               |
| Sulfur, mg       | 16.0 ± 0.001                     | 1.6                  | Vitamin E (alpha-tocopherol), mg | 0.25 ± 0.002 | 1.7                 |
| Phosphorus, mg   | 483.0 ± 0.003                    | 67.5                 | Vitamin PP (nicotine acid), mg | 4.52 ± 0.003 | 22.6               |
| Chlorine, mg     | 21.0 ± 0.002                     | 0.9                  | Vitamin K (phylloquinone), mg | 0.3 ± 0.002 | 0.3                 |
| Micro- and ultra-microelements |             |                      | Biotin, mcg     | 1.9 ± 0.002                     | 3.8                 |
| Boron, mcg       | 36.0 ± 0.002                     | 52.9                 | Beta-carotene, mcg | 5.0 ± 0.003 | 0.1                 |
| Vanadium, mcg    | 54.7 ± 0.003                     | 136.8                | Beta-cryptoxanthin, mcg | 2.0 ± 0.002 | 0.04                |
| Iron, mg         | 14.5 ± 0.002                     | 96.7                 | Lycopene, mcg    | 16.0 ± 0.003 | 3.2                 |
| Iodine, mcg      | 13.0 ± 0.003                     | 8.9                  | Choline, mcg     | 25.6 ± 0.003 | 5.1                 |
| Cobalt, mcg      | 2.0 ± 0.002                      | 20.0                 | Betaine trimethylglycine, mg | 0.4 ± 0.002 | 0.04                |
| Manganese, mcg   | 2380.0 ± 0.003                   | 123.0                |                   |                    |                     |
| Copper, mcg      | 4040.0 ± 0.003                   | 404.0                |                   |                    |                     |

In addition to the composition and properties of functional ingredients in the production of fortified dairy products, the dose, method and technological stage of their introduction into the curd base after heat treatment is of great importance [19].

When using herbal ingredients in the production of dairy products, their thermal treatment is mandatory, which has several goals: to destroy foreign microorganisms, to almost completely inactivate enzymes and, if possible, to completely preserve the presence of vitamins and biologically active substances [20].

The mode of heat treatment of sesame seeds was established experimentally using different temperatures: 65 ± 2 °C, 75 ± 2 °C and 85 ± 2 °C with an exposure time of 25-30 minutes. It was found that when using the second mode of processing sesame seeds with hot milk at a temperature of 75 ± 2 °C and holding for 25-30 minutes, the microbiological indicators are quite high, so pathogenic microorganisms such as salmonella, Listeria monocytogenes, Enterobacter sakazakii, bacteria of the genus Yersinia have not been identified, the number of molds and yeasts is significantly lower than the regulated values, so at a rate of 50 CFU/g, 15 CFU/g of yeast and 12 CFU/g of mold were detected. Extraneous microflora was not identified. In addition, sesame seeds become softer and acquire a pleasant pronounced taste of pasteurized milk, harmoniously combined with the fermented milk taste of the curd base.
For the production of whey proteins, we used cottage cheese whey obtained in the production of fat-free cottage cheese, containing 0.6% of albumin and globulin, which amounted to 3.0% of whey proteins from the mass of processed milk to obtain the required fat-free cottage cheese. Thus, in the future, when developing an enriched curd product, we will use exactly this amount of whey proteins.

To establish the dose of sesame seeds introduced in laboratory conditions, curd products were developed with different doses of sesame seeds. The results are shown in Table 5.

**Table 5. Quality indicators of the curd product, depending on the dose of introduced sesame seeds.**

| Dose of sesame seeds | Appearance, consistency | Taste and smell | Color |
|----------------------|-------------------------|----------------|-------|
| 0.5%                 | Soft, spreadable, slightly crumbly texture with single sesame seeds | Pure, fermented milk with a mild flavor of sesame seeds | Milky white, with occasional blotches of sesame seeds, evenly distributed throughout the mass |
| 1.0%                 | Soft, spreadable, slightly crumbly texture with single sesame seeds | Pure, fermented milk with a pronounced flavor of sesame seeds, harmoniously combined with the curd base | Milky white, with occasional blotches of sesame seeds, evenly distributed throughout the mass |
| 1.5%                 | Soft, smudging, slightly crumbly consistency with the presence of sesame seeds | Pure, fermented milk with a pronounced taste of sesame seeds | Milky white, interspersed with sesame seeds, unevenly distributed throughout the mass |

As can be seen from the Table 5, the second sample has the best organoleptic properties, where the dose of sesame seeds was used - 1.0%. Therefore, in further research, this dose will be used - 1.0% of sesame seeds. Considering the above presented research results, it is advisable to introduce prepared sesame seeds and whey proteins at the technological stage - making up a batch, which, according to the developed recipe, includes low-fat cottage cheese, whey proteins, prepared sesame seeds, pasteurized and chilled cream to normalize fat, everything is thoroughly mixed and is sent for packing in consumer containers, after which the obtained samples of the curd product were subjected to an assessment of its consumer properties. The results are shown in Table 6 and Table 7.

As can be seen from the table, due to the introduction of whey proteins and sesame seeds into its composition, the fat content increases by 0.5%, proteins - by 1.0%, incl. 0.8% whey proteins, carbohydrates appeared (1.0%), incl. dietary fiber (0.1%), which indicates the increased nutritional value of the fortified curd product and characterizes it as a functional food product.

Microbiological indicators characterize curd products as living products due to the presence of lactic acid bacteria in the amount of $2.2 \times 10^6$ CFU/g and safe due to the absence of pathogenic and opportunistic microorganisms, such as bacteria of the Escherichia coli group, staphylococcus S. aureus and bacteria of the genus Salmonella, which meet the requirements of TR CU 033/2013 for this group of fermented milk products.

It was found that the enriched curd product has higher organoleptic characteristics than the control sample, does not have a pronounced taste and smell, which will allow them to be used by different groups of the population, both children and the elderly.

From the results obtained, it can be seen that the developed curd products have a high nutritional value and safety, which confirms their physiological value.
Table 6. Physicochemical and microbiological indicators of curd products.

| No. | Indicator name                                      | Control sample       | Experimental sample  |
|-----|----------------------------------------------------|----------------------|----------------------|
|     | **Physical and chemical indicators**               |                      |                      |
| 1   | Mass fraction of fat, not less %                   | 18.0 ± 0.3           | 18.5 ± 0.9           |
| 2   | Protein mass fraction, not less %                  | 9.0 ± 0.2            | 10.0 ± 0.3           |
| 3   | Mass fraction of moisture, not more %              | 75.0 ± 1.5           | 70.5 ± 1.2           |
| 4   | Mass fraction of carbohydrates, % incl. mass fraction of dietary fiber, % | -                    | 1.0 ± 0.01           |
|     |                                                    |                      | 0.1                  |
| 5   | Titratable acidity, °T                             | 162 ± 0.2            | 160 ± 0.1            |
| 6   | Phosphatase                                        | not found            |                      |
| 7   | Temperature when leaving the factory, °C           | 4 ± 2                |                      |
|     | **Microbiological indicators**                     |                      |                      |
| 1   | The number of lactic acid bacteria at the end of the shelf life, CFU/g | 1 × 10⁶              | 2.2 × 10⁶            |
| 2   | Pathogenic microorganisms, including salmonella in 25 g of product | Not allowed          | Not found            |
|     | Weight (g) in which it is not allowed              |                      |                      |
| 3   | Product weight (g) in which it is not allowed      |                      |                      |
|     | E. coli group bacteria is not allowed in 0.1 g of the product | Not allowed          | Not found            |
|     | Staphylococcus aureus in 1 cm³ of product          | Not allowed          | Not found            |
| 4   | The number of molds in 1 cm³ of the product        | 50                   | 20                   |
| 5   | Yeast, at the end of the shelf life, CFU/g         | 50                   | 16                   |

Table 7. Organoleptic characteristics of curd products.

| Indicator name          | Curd products                        | Control sample | Experimental sample |
|-------------------------|--------------------------------------|---------------|---------------------|
| Appearance, consistency | Soft, smudging, slightly crumbly consistency |               | Soft, spreadable, slightly crumbly texture with single sesame seeds |
| Taste and smell         | Clean, fermented milk, without foreign tastes and odors |               | Pure, fermented milk with a pronounced aftertaste of harmoniously combined pasteurized milk and sesame seeds |
| Color                   | Milky white, evenly throughout the mass |               | Light cream, with sporadic splashes of sesame seeds and whey proteins, evenly distributed throughout the mass |

The biological value of the developed curd product was calculated (Table 8). Analysis of the Table 8 showed that the limiting amino acid in the enriched curd product is methionine, its amino acid rate was 95.8%. The enriched curd product contains 26.5% more essential amino acids than the reference protein, including higher levels of six essential amino acids, such as: valine (by 9.6%), lysine (by 60.0%), threonine (by 29.7%), isoleucine (by 17.4%), leucine (by 40.6%) and tryptophan - almost twice the values in the standard. The calculation of the biological value (BV) of the enriched curd product was 65.3%, which characterizes it as a product with a high biological value. The calculation of the utilitarian coefficient of the amino acid composition (U) indicates that the enriched product had a value of 0.77, and the higher the utility coefficient, the better-balanced amino acids in the protein and the more rationally they can be used by the body. This proves the balance of the amino acid composition of the enriched curd product.
Table 8. Biological value of the developed curd product.

| Name    | FAO standard, (g/100 g protein) | Curd product (g/100 g protein), (p≤0.05) | Indicator values |
|---------|---------------------------------|----------------------------------------|------------------|
|         |                                 | Amino acid score, %                    | Difference of the amino acid scoring of an amino acid | Coefficient of difference of amino acid score | BV  | K<sub>i</sub> | U    |
| Valine  | 5.2                             | 5.7                                    | 109.6            | 13.8            | 0.87            |
| Lysine  | 5.5                             | 8.8                                    | 160.0            | 64.2            | 0.60            |
| Methionine | 2.8                          | 2.7                                    | 96.4             | 0.6             | 0.99            |
| Phenylalanine | 4.8                         | 4.6                                    | 95.8             | 0               | 1.0             |
| Threonine | 3.7                          | 4.8                                    | 129.7            | 33.9            | 34.7            | 65.3          | 0.74 | 0.77 |
| Isoleucine | 4.6                          | 5.4                                    | 117.4            | 21.6            | 0.82            |
| Tryptophan | 1.0                          | 1.95                                   | 195.0            | 99.2            | 0.49            |
| Leucine  | 6.9                             | 9.7                                    | 140.6            | 44.7            | 0.68            |
| Total   | 34.5                            | 43.65                                  | 277.9            |                 | 6.20            |

4. Conclusion
The authors studied the composition and properties of sesame seeds and milk whey protein, established their high nutritional and biological value. High functional activity is shown. The method of obtaining whey proteins from whey obtained in the production of curd, preliminary preparation of functional ingredients, the dose of adding whey proteins and sesame seeds and the technological stage of their introduction into the prepared curd base - at the kneading stage, on the basis of which the technology of the enriched curd product was developed. It was found that the organoleptic and physicochemical indicators of the enriched curd product are significantly higher than the control sample - the curd product without additives. Enrichment of a curd product with whey proteins and sesame seeds contributes to an increase in its consumer properties: nutritional, physiological and biological value. The number of essential amino acids exceeds the value of the reference protein by 26.5% for six amino acids, the biological value was 65.3%, and the utility coefficient was 0.77, which proves the balance of the amino acid composition of the protein of the enriched curd product and the more rationally they can be used by the body.

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