Enriched confectionary dairy product

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Abstract. The article presents data on a developed recipe of a new vegetable milk product. A method of its production and its quality and chemical composition have been studied. Physical and chemical properties of the cakes and their biological value have been studied. Physicochemical properties and amino acid composition have been investigated. The nutritional value of the samples developed using vegetable oilcakes has been studied. So, in comparison with Control sample, Test samples were registered to have an increase in protein content by 3 and 3.4% and carbohydrates, including fiber, and a decrease in fat content by 7 and 8%, respectively. Moreover, alcoholic extract of beeswax being added in an amount of 0.5% has been revealed to increase the storage capacity of the confectionery spread samples developed. The data obtained showed that the method proposed allowed to obtain a confectionery spread with a high sensory qualities, improved nutritional value.

1. Introduction

One of the main tasks of the food industry in the world is to develop formulations and technologies for dairy products with plant material added to balance the nutritional value, expand the assortment and provide various groups of the population with affordable products. From this point of view, the priority areas include increasing the biological value of the product due to high-protein ingredients added into the formulation, modifying the amino acid and fatty acid compositions to enrich it with mono- and polyunsaturated fatty acids and their derivatives from plant materials [1, 2].

Against the background of a stable tendency to reduce the level of consumption of animal protein, protein-containing byproducts of processing plant materials have been recently considered as promising raw materials for the production of food products of various compositions. To date, with respect to these purposes, soybean processing byproducts have remained the world leader, but potential sources of protein, such as secondary products of processing sesame seeds [3], melon [4], amaranth [5], [6, 7], nuts and other non-traditional oilseeds [8-13] are also being studied as possible solutions to the raw material issue identified.

Confectionery products are referred to regular foods. However, their composition is mostly characterized by a pronounced excess of fats and simple carbohydrates, with other nutrients being absent or of low content. So are confectionery spreads noted for an imbalance in main food components in terms of a fairly high (506-567 kcal) energy value, i.e., they contain 2.4-9% of protein, 30-37% of fat and 45-60% of carbohydrates, mainly sucrose.
One of the promising types of plant raw materials is oilseed processing byproducts (pumpkin, watermelon and melon seeds) after extracting oil, namely, oilcake and meal \[14, 15\]. Vegetable oilcake is a seed processing byproduct \[16\]. Oilseed residues contain easily digestible proteins, unsaturated fatty acids and their derivatives, minerals and vitamins. The sorption properties of oilcakes are due to fiber (about 21.8%) that is a natural organic sorbent \[17\].

The purpose of this work was to create a new confectionery product of high biological value by using solid byproducts of low-temperature extraction of oilseed raw materials in the formulation, as well as study the safety of the product quality during storage. The development of a method for producing the new vegetable milk product is relevant and advisable in terms of rational use of secondary raw materials of the food industry.

2. Goals and objectives
The goal is to research prospects of application of secondary vegetable raw materials in the production of confectionery.

In connection with the goal, it is necessary to solve the following tasks: optimization of technology and formulation of experimental samples; analysis of the quantitative ratio of components in products; development of experimental samples, research (organoleptic, technological, physical and chemical indicators, indicators of nutritional value, storage capacity); assessment of the effectiveness of the developed production method and recipes.

3. Methods and materials
To analyze the efficiency of using vegetable meal in the confectionery spread production, we studied the effect of this raw material on the nutritional value, sensory, physicochemical characteristics and other quality indicators of the finished product.

3.1. Research methodology
Experimental studies were carried out on the basis of the diversified analytical laboratory of the Volga Region Research Institute of Manufacture and Processing of Meat-and-Milk Production and the laboratory of the Food Production Technology Department of Volgograd State Technical University (Volgograd, Russia). The experiment was conducted in accordance with the scheme shown in figure 1.

Objects of the research were the samples of vegetable milk spread; they were developed in accordance with formulations optimized and technology developed on literature and patent data using a cutter MSK 760-II and rollers for grinding food.

3.2. Sensory and physicochemical parameters
Sensory qualities were determined according to «Features of organoleptic quality assessment of certain types of mass-produced public catering products» (Method of sensory evaluation GOST 31986-2012). The weight fraction of total fat was determined according to GOST 32189. The weight fractions of moisture and volatile substances were determined according to GOST 3626. The contents of carbohydrates, organic acids and ash were found according to regulatory documentation.

The content of essential amino acids in the samples was defined on an Aracus amino acid analyzer in accordance with the instructions for the device.

3.3. The calculation of the nutritional value
The nutritional value (NV) was estimated in accordance with the following formula:

\[ NV, kcal/100g = 4 \cdot P + 9 \cdot F + 4 \cdot C \]  

where \( P \) – percentage of protein, %; 
\( F \) – percentage of fat, %; 
\( C \) – percentage of carbohydrates, %.
3.4. The dynamics of changes in indicators during storage and shelf life of product

Storage of confectionery spread at sales temperatures often leads to a considerable deterioration in its quality, therefore the product's storage capacity was studied at a temperature of 5±1°C (sales temperature).

The acid value was determined by titrating a fat sample with a potassium hydroxide solution in the presence of a phenolphthalein indicator according to the method for determining the acidity of the fat phase according to GOST 3624. The peroxide values of fat extracted from the spread by the iodometric method based on the interaction between active peroxide or hydroperoxide oxygen and hydroiodic acid was found according to the normative documentation.

The study of approximate shelf life of confectionery was carried out on the basis of methodological guidelines "Control methods. Biological and microbiological factors. sanitary and epidemiological assessment of the validity of shelf life and storage conditions of Food Products and the method of a single acceleration factor ASLT [18], as factors of acceleration of spoilage processes, temperature conditions were used, and as controlled indicators – indicators of oxidative spoilage and organoleptic quality indicators (color, smell, taste). The duration of the storage period was determined by the time from the beginning of the experiment to the moment when the product is considered unsuitable for one or more controlled indicators.

3.5 Statistical analysis

The research data were processed by the method of variation statistics using the Microsoft Office software package.

The difference between the samples was assessed using unpaired t-test. The pair correlation coefficient was calculated to establish the relation between the parameters. The significance of differences was determined by the Student's criterion (t). The level was considered significant at p≤0.05.
4. Results and discussion

4.1. Recipe optimization

Confectionery spread is a plastic confectionery based on sugar, oils, milk and products of its processing, with or without food additives, flavorings, with a weight fraction of fat of from 28% to 35% [19]. The vegetable milk food products are known to have a number of valuable biologically active components and properties and are recommended for consumption [20].

As a plant component, we proposed to use biologically active therapeutic and prophylactic additives, i.e. oilcake that is a solid product of low-temperature crushing pumpkin, watermelon and melon oilseed in the following ratio of components: pumpkin cake of 33-35%, watermelon cake of 33-34% and melon meal of 31-34%.

The technology for the production of oilcakes and meal from them is widely known [21-23]. After drying, oilseeds are pressed to produce edible oil. As a by-product (waste) is cake, containing fiber and a protein-carbohydrate component [24]. After drying at 60-65 °C, cake is crushed and mixed. The finished additive is a yellowish-green powder with a weight fraction of protein of 27.5-41% (figures 2 a and b). The physico-chemical properties of the oilcakes investigated are shown in table 1.

![Picture of oilcakes]

Figure 2. a – after pressing; b-finished mixture; c – confectionary dairy product.

The study found that pumpkin meal contained the largest amount of protein, i.e., more than melon by 0.77% and watermelon by 2.19%. The pumpkin meal was characterized by highest contents of fiber and crude fat, which in turn affected such indicators as free-running property, rancidity rate and others. However, values of the fat content of all samples did not exceed the standard, not more than 25%.

The biologically active additive proposed is a prophylactic for obesity and diabetes due to dietary fiber, for toxicosis with heavy metals due to fiber and a carbohydrate-protein complex with sorption properties (for example, in terms of copper and zinc up to 3-4 mg/g).

Of great importance is selenium trace element in cake that is an antioxidant, especially in combination with vitamin E and an important protection factor from some forms of oncological and heart diseases [7]. The content of selenium was 2.9 mg/kg in pumpkin cake, 1.3 mg/kg in watermelon cake and was not found in melon cake.

![Table 1](image)

**Table 1. Physico-chemical parameters of oilcakes of different types.**

| Parameter                  | Type of oilcake<sup>a</sup> | melon    | pumpkin |
|----------------------------|-----------------------------|----------|---------|
|                            | watermelon                  | melon    | pumpkin |
| Moisture, %                | 4.68±0.2                    | 4.8±0.4  | 5.34±0.15|
| Crude fat, %               | 7.32±0.3                    | 8.1±0.2  | 8.52±0.2 |
| Crude protein, %           | 22.38±0.5                   | 23.8±0.4 | 24.57±0.6|
| Fibre, %                   | 21.5±0.5                    | 20.58±0.8| 21.89±0.7|
| Ash, %                     | 3.75±0.02                   | 4.1±0.03 | 3.74±0.02|
| Amount of carbohydrates, % | 44.68±2.4                   | 43.42±2.1| 41.30±1.81|
| Peroxide value, mmol / kg  | 2.2±0.01                    | 3.4±0.02 | 2.5±0.01 |
| Acid value, mmol KOH / g   | 0.6±0.01                    | 1.2±0.2  | 1.1±0.01 |

<sup>a</sup> results are expressed as average ± standard deviation (n = 3).
Table 2 shows the cake’s amino acid composition that confirmed its high biological value and, as a consequence, its being appropriate for the inclusion into confectionery products, including confectionery spreads. According to the amino acid composition, the cakes of melons and gourds complemented each other.

In order to increase storage capacity, the method proposed for the production of vegetable milk product used an alcohol extract of beeswax as an antioxidant obtained by extraction with 95% ethanol at a ratio of 1:2 at a temperature of 24 °C for 5 days, in an amount of 0.5% by weight of product.

| Component     | Amount, kg /100 kg |
|---------------|--------------------|
| Spread        | 42.0               |
| Powder milk   | 32.0               |
| Granulated sugar | 26.0             |
| Vegetable cake | –                  |
| Beeswax Extract | –              |
| Total         | 100                |

Table 2. Amino acid composition of oilcake, % of oven-dry substance.

| Amino acid | Content in the cake watermelon | melon | pumpkin |
|------------|--------------------------------|-------|---------|
| Lysine     | 0.60±0.02                      | 1.02±0.01 | 3.28±0.02 |
| Histidine  | 0.64±0.01                      | 0.88±0.02 | 4.38±0.03 |
| Arginine   | 2.50±0.01                      | 3.52±0.03 | 10.40±0.5 |
| Aspartic acid | 1.70±0.02                  | 2.34±0.02 | 10.84±0.06 |
| Threonine  | 0.65±0.03                      | 0.94±0.02 | 2.43±0.01 |
| Serine     | 0.93±0.02                      | 1.36±0.02 | 7.21±0.02 |
| Glutamic acid | 3.42±0.01                   | 4.85±0.03 | 16.47±0.3 |
| Proline    | 0.92±0.01                      | 0.90±0.02 | 1.39±0.04 |
| Glycine    | 1.08±0.02                      | 1.75±0.01 | 8.98±0.4 |
| Alanine    | 0.93±0.02                      | 1.22±0.02 | 4.97±0.01 |
| Cystine    | 0.33±0.02                      | 0.37±0.02 | –       |
| Valine     | 0.91±0.03                      | 1.32±0.02 | 3.60±0.01 |
| Methionine | 0.63±0.01                      | 0.78±0.02 | 1.79±0.02 |
| Isoleucine | 0.77±0.04                      | 1.74±0.03 | 3.33±0.02 |
| Leucine    | 1.28±0.04                      | 2.02±0.04 | 8.09±0.02 |
| Tyrosine   | 0.55±0.01                      | 0.76±0.02 | 5.71±0.04 |
| Phenylalanine | 1.02±0.02                  | 1.46±0.01 | 5.49±0.05 |

Beeswax is a natural product secreted by a bee wax pocket. Its complex chemical composition is a mixture of more than 300 different compounds and minerals. Wax contains about 72% of esters of higher fatty acids and higher alcohols, up to 13.5% of free acids and 12-12.5% of hydrocarbons. The melting point is 62-70 °C. In addition, wax contains up to 0.3% of ash elements, up to 0.4% of water, a certain amount of pollen admixture of flower pollen, beta-carotene (8.1 mg/100 g), vitamin A and aromatic and coloring substances [25-27].

Thus, after a series of experiments conducted, appropriate recipe compositions of the finished products (samples) in a spread form were established (table 3). At the stage of optimization of the product formulation, the effect of the ratio between the components of the formulation on the consistency of the product was evaluated. There is a number of requirements to the consistency of confectionery spreads, i.e., to their plasticity, ability to hold the shape and being spread well.

Table 3. Recipes of the samples under study.
These properties are achieved by technologically sound dosage of components. The content of any of the claimed ingredients being increased or decreased in the formulation leads to a deterioration in the sensory qualities of the product.

### 4.2. Technology optimization

The experiments established that a new vegetable milk confectionery product (spread) can be obtained by successively grinding and mixing the components (spread with the addition of natural antioxidant, milk powder with sugar and vegetable cake) to a homogeneous fine grain mass after holding at a temperature of 20-30 °C for 2 hours according to the following formulation, weight parts: spread of 36, milk powder of 18, granulated sugar of 20, vegetable meal of 25.5 and alcoholic extract of beeswax of 0.5.

The production technology of the vegetable milk product involved the following stages:

- stage of raw materials inspection and preliminary preparation of components;
- mechanical mixing and crushing of all components according to the recipe on a cutter MSK 760-II in a certain sequence, mixing and crushing on the rollers; and
- molding, packaging and storage of the finished product.

Preliminary preparation of recipe components was as follows. Watermelon-pumpkin-melon meal was crushed in a ratio of 1:1:1 to particles with a maximum size of 0.3 mm and mixed in a container with other dry components (sugar and milk powder). The vegetable-creamy spread was held at a temperature of 25±2 °C until a plastic consistency was obtained and mixed thoroughly with filtered alcoholic extract of beeswax. After preliminary preparation of the raw materials, the components were stepwise mixed according to the recipe. After each stage, thorough mixing and grinding on the rollers was performed. At the final stage, the mixture should have a plastic homogenous consistency of light green colour with a slightly creamy odor and a pleasant aroma (figure 3c).

### 4.3. Sensory and physicochemical parameters

When using raw materials of the quality stated and according to the Test II recipe (table 4), a vegetable milk product – confectionery spread – was obtained with high quality indicators (tables 5) and with biological value improved, i.e., essential amino acids, g/100g of spread, not less than 0.80 of lysine, 0.50 of methionine+cystine and 0.30 of tryptophan.

Thus, a mixture of vegetable cake added significantly affected the chemical composition of the finished spread. So, the protein content increased by 3 and 3.4% in the Test samples compared with Control, carbohydrates, in particular fiber by 4.9 and 5%, respectively, while the fat content significantly decreased by 7 and 8%. In terms of the energy value, the Test samples were slightly below Control.

### Table 4. Sensory characteristics of the finished product.

| Indicator                          | Value                                                                 |
|------------------------------------|-----------------------------------------------------------------------|
| Appearance and consistency         | at a temperature of 12±2 °C, the consistency is plastic, fine-grained, the cut surface is slightly shiny, dry in appearance |
| Taste and smell                    | slightly creamy with a pronounced pleasant taste and aroma of watermelon-pumpkin-melon meal                             |
| Colour                             | yellow-green, typical of cake                                         |

### 4.4. The dynamics of changes in indicators during storage and shelf life of product

An important indicator, characterizing the safety of the product, is the change in the acidity of fat during the storage. The dynamics of changes in the acid number during the storage of the samples studied is shown in figure 3.

The product added with vegetable cake had a slightly higher acid number than the Control sample. However, during storage, the acid number was increasing much more slowly in an antioxidant product.
During the storage, the oxidation processes occurring in the milk product were monitored by measuring the peroxide value (figure 4). The analysis of the data obtained (figure 4) showed that the accumulation of primary oxidation products – peroxides in Test II with alcohol extract of beeswax was much slower than in Control sample and Test II.

Table 5. Physico-chemical indicators and energy value of the product.

| Indicator                      | Control   | Value\(^a\) |  |
|-------------------------------|-----------|-------------|---|
| Moisture, %                   | 17.7±0.5  | 12.4±0.2    | 12.7±0.5 |
| Proteins, %                   | 11.8±0.3  | 14.8±0.3    | 15.2±0.3 |
| Fat, %                        | 39.1±2.4  | 31.8±1.7    | 31.1±2.4 |
| incl. milk fat                | 4.9±0.02  | 4.6±0.02    | 4.6±0.01 |
| Carbohydrates, %              | 28.2±1.7  | 34.4±2.7    | 36.4±2.7 |
| incl. fiber                   | 0.3±0.01  | 5.2±0.02    | 5.3±0.02 |
| Organic acids, %              | 0.8±0.01  | 1.2±0.01    | 1.3±0.01 |
| Ash, %                        | 0.9±0.01  | 1.56±0.01   | 1.83±0.01 |
| Nutritional value, kcal/100 g | 512       | 478         | 481 |

\(^a\)results are expressed as average ± standard deviation (n = 3).

The study enabled us to come to the conclusions that the alcoholic extract of beeswax added in an amount of 0.5% increased the storage capacity of the confectionery spread samples developed. The dose of the wax added was due to the sensory characteristics, as well as the ability to slow down the oxidation processes in the product. Lower and higher doses of natural antioxidant did not allow achieving appropriate qualities of the finished product.
The finished product is recommended to be formed and packed at a temperature of 25±2 °C and stored at a temperature not exceeding 6 °C (table 6).

Based on the data obtained, the expiration date of the confectionery spread was determined, i.e., in cooling conditions (at 4±2 °C) no longer than for 1 month.

Table 6. Storage conditions and shelf life of the product.

| Temperature, °C | Expiration date, days |
|----------------|-----------------------|
| -20… -10       | 60                    |
| -10 … - 3       | 40                    |
| +2 … +6         | 30                    |

5. Conclusions
Thus, a method for producing a vegetable milk product – confectionery spread – was developed. The data obtained showed that the method proposed made it possible to obtain a confectionery spread with high sensory qualities, nutritional value improved and storage capacity increased.

The new vegetable milk product can be used as an independent product that can make up for the shortage of essential food components in the diet and be used in the production of combined food products, in particular, in the confectionery industry.

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