Development of a technology for a new dairy-grain product

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Abstract. The usage of different grain crops in fermented milk products has acquired ever-greater popularity lately. The studies of the formulation and technology development of a fermented dairy-grain product of functional use have been carried out. The objects of the study were defatted milk, raw buttermilk, flax meal, flax oil, chitosan. The quality attributes of a ready product and the process of its storage were the subjects of the study. The standard methods of analysis were applied to the study of the properties of the raw material, milk basis, normalized composition, clots and ready products. Taking into account the planned amount of the added flax oil and flax meal, the developed fermented dairy-grain product is related to functional products according to the content of polyunsaturated fatty acids (PUFA).

1. Introduction
The most actively developing directions of the contemporary market of food products are the development and introduction of functional products, which allow customers to follow a healthy lifestyle. It can be explained by popularization of a healthy lifestyle in general and healthy eating in particular. The customer becomes more and more experienced in nutrition issues and constantly looks for its optimization [1].

Usage of different grain crops in fermented milk products acquires ever-greater popularity currently that allows increasing their biological value by means of introducing additional proteins, increasing the content of food fibers, which dairy products are poor in. Thereby, it will help making the product healthier for digestion [2].

The purpose of the study is the development of the formulation and production technology of a fermented dairy-grain product of functional use.

2. Materials and methods
The studies were carried out in the laboratory of technology of milk and dairy products of FSBEI HE Vologda State Dairy Farming Academy named after N.V. Vereshchagin.

The objects of the study were defatted milk according to the GOST (government standard) 31658-2012 [3]; raw buttermilk according to the GOST 34354-2017 [4]; flax meal according to TU (technical requirements) 9293-010-89751414-10; flax oil according to TU 9141-001-92001421-04 [5]; chitosan.

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Goal setting of an organoleptic testing, the general principal approach to carrying out of the organoleptic analysis of experimental samples of the products and preparation of test persons was...
performed in accordance with described in GOST ISO 6658-16 “Organoleptic analysis. Methodology. General guide.” Testing results were then interpreted in accordance with the same GOST [6]. The active acidity of dairy raw material, sample composition and ready products were studied by the methods stipulated in GOST 32892-2014 [7], titrated acidity – by titration-based method according to GOST R 54669-2011 [8]. To determine the weight content of fat, protein and dry matters the method of spectroscopy was applied with the use of Fourier spectrometer of the near-infra-red region produced by Bruker Corporation (Germany) [9]. Energy value calculated as per [10].

The product shelf life was defined according to the Methodical Guidelines MUK 4.2.1847-04 “Sanitary and epidemiological evaluation of the rationale for expiry dates and conditions of storage of food products” [11].

As the milk base for production of a fermented product, a composition of defatted milk and buttermilk was chosen. Such choice was conditioned by the following advantages: reprocessing of secondary raw materials (rational use), low fat (dietary characteristics), and economic efficiency [12].

Taking into consideration the policy of import substitution, being widely implemented in the country, it was necessary to choose the raw material produced in the territory of our country as the functional components [13].

The Vologda region is a historical center of flax growing, here the centuries-old traditions of the branch are kept, the full complex of enterprises of deep flax processing – “from a field to a counter” [14].

The composition of the product includes flax meal and flax oil as the functional additives of vegetable origin.

Flax meal is a product of milling of linseeds after oil separation [14]. This is the most valuable source of protein, fat, vitamins and minerals. Food fibers of flax meal are cell membranes of seeds, consist of polysaccharides, starches and lignins. The proportion of soluble and insoluble fibers varies within the limits of 1:4…2:3 that corresponds to human needs [15]. The insoluble fraction of fibers consists of cellulose and complex polymeric compounds (lignans). The soluble fraction of fibers is mucilaginous material [16].

Lignans, the same as pectin matters, are the natural polymers. Having bonding properties, they can hold toxins, pathogenic bacteria and metal ions on their surface, thus removing them from the human organism.

Flax oil is characterized by a high content of desaturated fatty acids (in %): 44—61 % of linolenoic acid (Omega-3), 13—29 % of linolic acid (Omega-6), 13—29 % of oleic acid (Omega-9) that allows using it as their source. Flax oil contains a considerable amount of tocopherols (Vitamins E), folic acid and estrogen-like phytohormones [17].

The content of the most important nutrients of flax meal and oil and also the percentage of the daily need (DN, %) are shown in the Table 1.

Table 1. The content of polyunsaturated fatty acids (PUFA) in 100 g. of the product and the percent of meeting a daily need in them

| Nutrient  | Daily need, g. | Flax oil                  | Flax meal                  | Total DN, % |
|-----------|---------------|---------------------------|---------------------------|-------------|
|           |               | Content in 100 g. of the  | Content in 100 g. of the  |             |
|           |               | product, g.               | product, g.               |             |
|           |               | DN, %                     | DN, %                     |             |
| PUFA      | 11            | 67.7                      | 0.8                       | 7.2         | 697.2       |
| Food fibers | 30           | 0.5                       | 26.3                      | 87.6        | 89.2        |

Chitosan was used as a stabilizer during the production of the dairy-grain product. Being an active natural polysaccharide, chitosan can form a firm gel, also in the dairy raw material. This feature of chitosan was taken as a basis into the production of pudding, mousse, and jelly with different natural or nature-identical fillers [18].
An unquestionable advantage is the safety of chitosan. It is environmentally safe and can be used in all its applications for a long time. Under natural conditions, this polysaccharide disintegrates completely [19]. Besides that, lately intensive researches have been made to evaluate the possibilities of chitosan usage by the production of functional food products due to the biological characteristics of this biopolymer. It is biocompatible and biodegradable up to the matters common for an organism (N-acetylglucosamine and glucosamine). It has immunomodulating, antimicrobial, fungistatic, antitumorigenic, radioprotective, antiphlogistic, vulnerary, anticholinergic, hemostatic actions and moreover it is low-toxic [19, 20].

Choosing the dose of flax meal priory information was taken into account, based on which the interval of adding was decided on from 1 to 5 % of the product mass [21].

Weight content of flax oil made 5 % of the mass of normalized composition.

The production process included the following stages: making of a dairy basis, adding of flax meal, flax oil, stabilizer, and dispersion of the received composition. Pasteurization was carried out at the temperature of $(92\pm 2)^\circ C$ with the timing of 10 minutes, after that it was cooled off up to $40^\circ C$.

The process of souring and fermentation was made by the bulk starter consisted of *Streptococcus thermophilus* and *Lactobacillus bulgaricus* taken on a 4:1 ratio [22]. The starter was added in the amount of 5 % of the composition mass by the temperature of $38–40^\circ C$, the process of fermentation was carried out up to the clot acidity of 75–80 °T.

The received clots were estimated organoleptically. It was determined that by adding 1–3 % of flax meal, the product had medium-viscous consistency, syneresis was not observed, the clot restored after the destruction very well. In the case of adding 4 and 5 % of meal, the product was received with the viscous, slow-flowing consistency; the clot was not destroy by shaking.

### 3. Formulation and grounding of the expiry dates of the fermented dairy-grain product.

Based on the received results the dose of flax meal was chosen within the range from 1 to 3 %, taking into account the FAO and WHO recommendations in connection with the minimal necessary amount of food fibers, entering a human organism daily, a decision was made to choose the dose of meal in the product equal to 3 %.

As a result of the rheogoniometries the dose of the stabilizer, for which chitosan was used, reached 0.7 %. The formulation of the product is shown in the Table 2.

| Component      | Mass, kg |
|---------------|---------|
| Buttermilk    | 619.2   |
| Defatted milk | 305.0   |
| Flax oil      | 46.2    |
| Flax meal     | 27.7    |
| Stabilizer    | 1.9     |
| Starter DVS   | -       |
| **Total**     | **1000**|

In the laboratory conditions, the samples of the product were received and their organoleptic, physical-chemical and microbial attributes of quality were studied. Organoleptic and physical-chemical attributes of quality were defined in the conditions of FSBEI HE Vologda S DFA at the department of technology of milk and dairy products, and the study of microbial attributes was made in an accredited laboratory of FSBI Vologda State Center of Agro-chemical Service”.

Organoleptic quality attributes of the fermented dairy-grain product are introduced in the Table 3. Physical-chemical characteristics are shown in the Table 4.
Table 3. Organoleptic attributes of the fermented dairy-grain product

| Attribute name | Characteristic |
|----------------|----------------|
| External appearance and consistency | Smooth, with particles of flax meal. Light sediment is available by storage |
| Taste and smell | Clean, fermented-milk. Taste is mild, refreshing, lightly sweetish |
| Color | Cream-colored, smooth all over the mass |

Table 4. Physical-chemical attributes of the fermented dairy-grain product

| Attribute name | Norm |
|----------------|------|
| Fat weight content, %, no more than | 5.5 |
| Including milk fat, %, no more than | 0.5 |
| Protein weight content, %, no less than | 3.5 |
| Dry matter by weight, %, no less than | 11.5 |
| Acidity, °T | 85 |
| Phosphatase or peroxydase | none |

For determining the expiry dates of the product, its microbial quality and safety attributes were studied.

The designed product was related to short-life ones (shelf life – up to 7 days), based on this fact the reserve ratio was accepted to be equal to 1.5. The storage life of the product in a vacuum packing by the temperature (4±2) °C made 8 days.

The quality and safety evaluation of the product was carried out in accordance with the plan of the work program of testing by the determining the expiry dates of the product introduced in the Table 5.

Table 5. The plan of the testing program for determining the expiry dates of the fermented dairy-grain product

| Attribute name | Monitoring frequency, storage days | Study method |
|----------------|-----------------------------------|--------------|
| Organoleptic attributes (External appearance, taste, smell, color) | Basic sample | 5 | 8 |
| Fat weight content | + | - | + | GOST R ISO 22935-2-2011, GOST R ISO 22935-3-2011 |
| Weight content of dry matters | + | - | + | Methods of VNIMI (All-Russian Research Institute of Dairy Industry), GOST R 54668-2011 |
| Acidity | + | - | + | GOST R 54669-2011 |
| Peroxide number | + | - | + | GOST R 51487-99 |
| Amount of fermented milk microorganisms | + | + | + | GOST 33951-2016 |
| Coliform bacteria | + | - | + | GOST 32901-2014 |
| Pathogenic bacteria, including Salmonella | + | - | + | GOST 31659-2012 |
| S. aureus | + | - | + | GOST 30347-2016 |
| L. monocytogenes | + | - | + | GOST 32031-2012 |
| Proteus | + | - | + | GOST 28560-90 |
| Yeast | + | - | + | GOST 10444.12-2013 |
| Moulds | + | - | + | GOST 10444.12-2013 |
The results of microbial studies of the fermented dairy-grain product complied with the requirements of TR TS 033 “On safety of milk and dairy products”.

The organoleptical and physical-chemical quality attributes complied with the requirements specified for the fermented dairy-grain product throughout the shelf life.

The microbial safety attributes of the product complied with the requirements of TR TS 033 throughout the shelf life.

Based on the received results, the shelf life of the fermented dairy-grain product in a vacuum packing by the temperature (4±2) °C was defined as 5 days.

4. Conclusion

Following the FAO and WHO recommendations in relation to daily need of an organism in polyunsaturated fatty acids (PUFA) [10], a calculation was made to determine what percentage of the human daily need is covered by taking in 100 g. of the fermented dairy-grain product.

Taking into account the planned amount of flax oil and flax meal, a 100 g serving of the fermented dairy-grain product covers 34.5 % of demand in PUFA and 8.8 % of demand in food fibers. The received data allow referring the developed fermented dairy-grain product to functional products according to the PUFA content.

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