Development of the composition and technology of a probiotic fermented milk product with the addition of a plant ingredient

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Abstract. The research work reflects the problems of baby food at the present stage, arising from the low prevalence of high-grade specialized products. The expediency and possibilities of using microwave-drying vegetable powders for enriching fermented milk products for baby food with vitamins and dietary fiber are considered. A new fermented milk probiotic product with unique nutritional properties has been proposed, the optimal composition and features of its manufacture have been developed.

1. Introduction
In nature, there are no products that would contain all the components necessary for a person, only a combination of different products best provides the body with the delivery of necessary physiologically active components with food [16].

The need for the production of these products is due to an increase in the incidence of digestive system organs and disorders of general metabolism in young children. The main reason for these negative phenomena is the insufficient quality and lack of balance in baby food. Low nutritional value leads to the emergence of chronic diseases and irreversible deviations in the development of a child [3, 17, 18].

Conducting research on the development and implementation of new specialized functional products that provide nutritious healthy nutrition is the most important and necessary condition for improving children's health, determines the relevance and validity of the topic, its purpose and objectives. In accordance with the modern concept of balanced nutrition, the most extensive group of functional food products are dairy products, which occupy a significant place in the diet and prevent the development of existing nutritional nutrient deficiencies in children [4, 7].

The use of dairy products as the basis for obtaining a variety of combined products is explained by their high nutritional and biological value, the content of more than 100 different components, including macronutrients, micronutrients, biologically active substances that are balanced and easily digestible and prevent nutritional deficiencies in children [10]. The main role of maintaining the physiological processes of the intestine at an optimal level belongs to lactic acid bacteria [3].

Probiotics include those biological preparations that consist of microorganisms or their metabolic products that contribute to the improvement of the gastrointestinal tract. The colonization of the intestine with vital lactic acid bacteria supplied with probiotic products maintains the physiological
processes of the intestine at an optimal level. The role of fermented milk products as probiotics has now been studied in sufficient detail. The basis for their production is starter cultures, consisting of various strains of lactic acid bacteria of active probiotics.

Biolact can be classified as a product with the ability to normalize the intestinal microflora. Such a natural fermented milk product of a functional orientation is used in case of a lack of breast milk, and is produced at infant-feeding centers.

2. Materials and methods
The biological value of biolact and other fermented milk drinks recommended for baby food has been repeatedly proven in previous studies. A number of publications are devoted to this topic by the authors of this article. In addition, the authors took into account the materials of studies conducted in Russia and abroad and proving the biological value of functional food products, both for the nutrition of children and for the nutrition of adults. The results of these studies indicate that products with a pronounced multifunctionality are optimal for the nutrition of children.

Biolact is a product of animal origin, which, in addition to the indicated useful components, lacks dietary fiber and vitamins, which are found in plant products. The authors considered the possibility of balancing children's nutrition and enriching biolact with biologically valuable substances in carrot vegetable powder. Moreover, powders obtained using microwave heating, which weakened the chemical bonds of the extracted substances as much as possible and ensured their most complete transition into a fermented milk product.

Dried food suspensions from vegetable purees are powders with the highest degree of dispersion [14]. The greatest degree of dispersion is provided by microwave heating. The microwave method provides the highest degree of preservation of biologically active properties in the resulting product, and also preserves its vitamin composition, taste and aroma. In comparison with the traditional drying technology, the content of vitamins in the finished product increases: 1.9 times for B1, 1.76 times for B2, 2.1 times for vitamin C and 1.5 times for vitamin E. The absorbed microwave energy is quickly converted into heat inside the pieces of the product, as a result of which the pressure in the inner layers rises to such an extent that the particles not only do not decrease, but increase in volume and retain it during drying. The result is a porous dried product with improved recuperation [6].

Taking advantage of the exceptional value of carotene dissolved in a fatty medium, research institutes, together with manufacturing enterprises, develop and introduce into production multifunctional products enriched with carotene. Very good stability was recorded for carotene found in butter, margarine, whole milk powder, fortified flour products and potato chips stored at normal temperatures. Carotene has also shown good persistence in fortified lard, dried eggs, soft drinks, and canned juices [11].

In the course of the research, materials of publications were also used, proving the greatest efficiency of the transfer of fat-soluble substances from vegetable raw materials to a fatty medium from vegetable powders in comparison with vegetable purees. It has also been repeatedly proven that the most optimal is the powder obtained by microwave heating.

During the drying process, fat-soluble substances are concentrated in the dry residue and released from chemical bonds with other components, become "free agents" and easily dissolve in oils. As a result of the drying of raw materials and their grinding, the volumetric extraction surface increases, the chemical bonds of soluble substances with other organic substances and with water are disrupted. The low moisture content of the dried product is also important. In addition, it should be noted that physically bound moisture remains in the dried product, which cannot interfere with the extraction process. During the drying process, the product is partially deactinized. Microwave heating does not contribute to the formation of the surface framework of the dried particles during drying; therefore, the degree of availability of fat-soluble substances for extraction into an oil medium increases.

Less fat-soluble substances are transferred from vegetable raw materials in the form of mashed potatoes to oil. Despite the fact that when grinding the raw material, its capillary structure is disturbed, cell walls are ruptured, cell sap flows out, which increases the degree of availability of fat-soluble
substances for extraction, the extraction process itself is less intense. Most of all, this process is impeded by undestroyed pectin substances and chemically bound moisture [5].

Researchers from the Michurinsky State Agrarian University have repeatedly proved that natural vegetable products in the form of powders are not biologically active additives, but are raw materials used to make functional food products [15].

Based on the review of the analysis of the results of studies carried out in our country and abroad, it is possible to formulate the goal of this work: the enrichment of the fermented milk product biolact with biologically valuable substances of dried carrot powder of microwave heating and the development on this basis of the composition and technology elements of a specialized functional product for feeding children aged from eight months to three years.

To achieve this goal, the following tasks were solved:
- the fermented milk product biolact was chosen as a tasty, easily digestible and useful product and a medium for extracting soluble substances of vegetable powder;
- the choice of dried microwave-drying carrot powder as a "donor" of soluble nutrients for biolact was substantiated;
- the optimal composition of a functional product and a sequential scheme of technological operations for its production have been determined.

Biolact is a stable emulsion in which there is a significant amount of moisture and a sufficient amount of milk fat, which does not have dense fat globules, since it has been homogenized. That is, biolact is an ideal medium for the transition into it of both water-soluble and fat-soluble substances from vegetable powders. The powders themselves, obtained using microwave heating, are a material with destroyed chemical bonds, and therefore the transfer of vitamins, minerals, sugars and other soluble substances into the fermented milk product will proceed unhindered.

The choice of carrots as a raw material for the enrichment of a fermented milk product is quite justified. These roots are used for the production of vegetable-based canned foods for baby food. They are vegetables to which the organism of the inhabitants of Russia is genetically adapted.

The average composition of microwave-dried carrot powder for vitamins A, C, beta-carotene and dietary fiber is shown in Table 1.

| Name of substances         | Content in 100 g of product |
|---------------------------|-----------------------------|
| Dietary fiber, g          | 21.05                       |
| Vitamin A, mg             | 2.9                         |
| Beta-carotene, mg         | 27.49                       |
| Vitamin C, mg             | 17.81                       |

When feeding with biolact with powders from dried carrots, all the useful elements of the product are absorbed much better and contribute to the colonization of the intestines of children with a healthy microflora and also reduces the risk of developing intestinal infections, intestinal colic and allergic diathesis. Thus, the easily digestible delicate structure of the fermented milk product biolact with vegetable carrot powder for young children makes it possible to use it for feeding children from eight months. The possibility of introducing the powder into a fermented milk product will normalize the intestinal microflora, helping to improve the intestinal motility of the child, and helping to effectively fight constipation.

Despite the high biological value of biolact, the composition of the drink is not fully balanced for baby food. In particular, it does not contain dietary fiber that is so necessary for a child's body. The daily norm of dietary fiber for young children is 20-25 grams (Table 2) [12].

Dietary fiber has a significant impact on the textural and organoleptic properties of food products [2, 8]. Also, biolact contains quite a few vitamins A, C and some B vitamins.
Vitamins A and C play an important role in the processes of growth and reproduction, differentiation of epithelial and bone tissue, maintenance of immunity and vision. Deficiency of vitamin A leads to impaired dark adaptation (“night blindness” or hemeralopia), keratinization of the skin, and reduces resistance to infections [13].

The recommended physiological requirements for vitamins in children from one to three years of age for vitamin C is 45 mg, for vitamin A the figure is 0.45 mg (Table 2) [16].

**Table 2.** Recommended norms of physiological requirements for dietary fiber and vitamins A and C for children aged from one to three years

| Name of substances | Norms of physiological needs |
|--------------------|-----------------------------|
| Dietary fiber, g   | 20-25                       |
| Vitamin A, mg      | 0.45                        |
| Vitamin C, mg      | 45                          |

Taking into account the recommended norms of the physiological needs of children for dietary fiber and vitamins, technological features of the use of vegetable powders for enriching various food products, it was decided to investigate the effect of 1 g (1%), 3 g (3%), 5 g (5%) and 7 g (7%) of dried carrot powder for biological value of 100 g of biolact. To do this, the indicated doses of carrot powder were sequentially introduced into the control sample of biolact; the powder was dissolved in the biolact, and the content of dietary fiber, vitamins C, A, beta-carotene was measured and the organoleptic quality indicators were evaluated. At the same time, scientifically grounded measurement and assessment methods were used, as set out in technical regulations and national standards [1].

### 3. Results

As a result of the research, the dynamics of changes in the content of vitamins and dietary fiber in the enriched biolact was formed in comparison with the base sample (Table 3).

**Table 3.** Dynamics of changes in the quantitative indicators of dietary fiber and vitamins as a result of introducing carrot powder into biolact (per 100 g of product)

| Indicator name | Biolact produced according to the traditional technology TR CU 033/2013 | Biolact with the addition of carrot powder (taking into account dosing losses) |
|----------------|---------------------------------------------------------------------|------------------------------------------------------------------------------|
|                |                                                                     | 1 g (1%)                       | 3 g (3%)                       | 5 g (5%)                       | 7 g (7%)                       |
| Dietary fiber, g | -                                                                   | 0.207                         | 0.621                         | 1.035                         | 1.449                         |
| Vitamin A, mg   | 0.042                                                               | 0.072                         | 0.132                         | 0.192                         | 0.252                         |
| Beta-carotene, mg | 0.015                                                               | 0.286                         | 0.828                         | 1.37                          | 1.912                         |
| Vitamin A, taking into account the transformation of beta-carotene in the body | 0.045                                                               | 0.12                          | 0.27                          | 0.42                          | 0.57                          |
| Vitamin C, mg   | 0.69                                                                | 0.865                         | 1.215                         | 1.565                         | 1.915                         |

Comparative characteristics of the organoleptic quality indicators of biolact variants are shown in Table 4.
Table 4. Dynamics of changes in organoleptic quality indicators as a result of introducing carrot powder into biolact (per 100 g of product)

| Indicator name | Biolact produced according to the traditional technology TR CU 033/2013 | Biolact with the addition of carrot powder (taking into account dosing losses) |
|----------------|------------------------------------------------------------------|--------------------------------------------------------------------------------|
| Taste and smell | Clean, fermented milk smell. Sweetish taste                       | Predominantly fermented milk smell. In addition, there is a pronounced carrot aroma. Sweetish taste. Carrot flavor prevails over fermented milk, which is inharmonious. Sweetish taste |
| Color          | Milky white                                                      | White with a slight yellowish tinge                                                                                            |
|                |                                                                  | White with a faint yellow-orange tinge                                                                                         |
| Consistency    | Homogeneous, reminiscent of sour cream, with a pronounced clot, without gas formation | Homogeneous, reminiscent of sour cream, with a broken clot, without gas formation                                               |

Analyzing the data obtained, the following conclusions can be drawn.

1. The basic, unenriched version of biolact does not contain dietary fiber, which is so necessary for a child for the intestines to function. In this variant, there is also a deficiency of vital vitamins: vitamin A, which is essential for the growth and development of the body, and vitamin C, which forms and strengthens the immune system.

2. It is recommended to use microwave-heated (microwave dried) carrot powder as a fermented milk product enrichment product, which to the greatest extent gives soluble substances to a water-fat emulsion.

3. Analyzing the results of measuring the quantitative indicators of dietary fiber and vitamins in biolact variants enriched with biologically active substances, it is possible to distinguish the most balanced option in terms of the composition of substances—the third option (with the addition of carrot powder per 100 g of biolact in an amount of 5 g (5%)). It should be borne in mind that biolact is used in children's nutrition as complementary foods. The amount of biologically active substances should not exceed the daily intake of these substances by the child's body. In the fourth variant of biolact with carrot powder in the amount of 7 g (7%) per 100 g of the base product, the daily intake of vitamin A is exceeded. This should not be allowed, since hypervitaminosis can harm the health of children. The first and second versions of the samples of enriched biolact contain an insufficient amount of biologically active substances, therefore, it was decided not to consider them.

4. In terms of organoleptic quality indicators, the third variant of the considered sample of biolact can again be distinguished. The characteristics of the quality indicators of this sample of the product most fully reflects the compliance with the requirements for functional fermented milk products with plant supplements.
4. Conclusion
Thus, the best option for a specialized functional product for feeding young children is the third option (with the addition of carrot powder per 100 g of biolact in an amount of 5 g (5%)).

References
[1] Technical regulations of the Customs Union On the safety of milk and dairy products (TR CU 033/2013) Retrieved from: http://docs.cntd.ru/document/902320560
[2] Baranovsky A Yu, Kondrashin E A 2000 Dysbacteriosis and intestinal dysbiosis (St Petersburg: GIORD) 290 p
[3] Belmer S V, Malkoch A V 2006 Intestinal dysbiosis and the role of probiotics in its correction Attending physician 6 18–23
[4] Belmer S V 2015 Dairy products in the nutrition of children of the first years of life Questions of Pediatric Dietetics 1 50–53
[5] Bocharov V A, Terekhova A V, Stroilov A Yu 2015 Influence of the method of preparation of vegetable raw materials on the content of fat-soluble substances in the enriched oil extract Azimuth of scientific research: economics and management 1(10) 118-121
[6] Bocharov V A 2010 Improving the elements of technology for drying vegetables: candidate dissertation (Michurinsk) 218 p
[7] Bulatova E M, Volkova I S, Netrebenko O K 2008 The role of probiotics in the state of the intestinal microbiota of infants Pediatrics 5 87–92
[8] Gapparov M G, Kochetkova A A, Shubin O G 2006 Dietary fibers - a necessary “ballast” in the diet Food industry 6 56-58
[9] Dudkin M S, Cherno N K et al 1988 Dietary fibers (Kiev: Harvest) 152 p
[10] Kon I Ya 2007 Probiotic and fermented milk products in the nutrition of young children Attending physician 1 8–12
[11] Livinsky A A 2011 Different oils are important, different oils are needed Oil and fat industry 2 4-7
[12] Mogilny M P, Shlenskaya T V, Galyukova M K, Shaltumaev T Sh, Balasanyan A R 2013 Modern trends in the use of food fibers as functional ingredients New technologies 1 27 - 31
[13] 2009 Norms of physiological requirements for energy and nutrients for various groups of the population of the Russian Federation. Guidelines (Moscow: Federal Center for Hygiene and Epidemiology of Rospotrebnadzor) 36 p
[14] Palchikov A N, Nesterenko I A 2019 Food powders are a promising form of supply of functional nutrition ingredients between the states of the Euro-Asian community Functional nutrition is a common problem of a “healthy lifestyle” of the population of Eurasian states: scientific articles of the X Eurasian Scientific Forum: collection (St Petersburg: University at the IPA EurAsEC) pp 128–132
[15] Popova E I 2018 Technology of production of functional food products from fruits and leaves of viburnum vulgaris: candidate dissertation (Michurinsk) 151 p
[16] 2019 Program for optimization of nutrition for children aged 1 to 3 years in the Russian Federation: P 78 methodological recommendations (National Medical Research Center of Children's Health of the Ministry of Health of Russia) 36 p
[17] Tutelyan V A, Nechaev A P, Bagryantseva O V, Bessonov V V, Vorobieva V M et al 2013 Food ingredients in the creation of modern food products: a monograph (Moscow: DeLi plus) 520 p
[18] Tutelyan V A, Spirichev V B, Sukhanov B P, Kudasheva V A 2002 Micronutrients in the diet of a healthy and sick person (reference guide to vitamins and minerals) (Moscow: Kolos) 424 p