Development and research of a product for gerodietic nutrition

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Abstract. This article presents material on the development and research of gerodietic nutrition. The composition of the developed product, including ingredients of animal and plant origin, is given, and the choice of raw materials and components used in the development of formulas is explained. A flowchart of the production stages is presented, according to which, in the experimental shop of the Research Institute of Children's Nutrition - a branch of FGBUN "FITS Nutrition and Biotechnology" a development type was produced. Based on the data obtained in the study of the nutritional value of the product, established the acceptability of its practical use in the diet of the elderly and old age.

1. Introduction

In connection with modern demographic trends - the increase in the number of elderly and senile people in the overall structure of the population, the elderly are becoming a separate social group, the number of which is on average more than 25% of the total number of Russian citizens and continues to grow steadily. Analyzing literary sources of information, and revealing the issue of demographic state of our country, we can confidently say that today the problem of expanding the range of gerodietic dairy products, is relevant and appropriate. Development of new types of functional dairy products is carried out in several directions: development of probiotic, prebiotic and symbiotic dairy products; products enriched with biologically active substances, vegetable proteins, minerals, vitamins, dietary fiber, vegetable oils [1].

To the basic principles of nutrition for practically healthy elderly and old people refer to: strict correspondence of the energy content of the food ration to the actual energy expenditure; an anti-sclerotic orientation of the diet by changing the chemical composition of the ration and enriching it with foods that are sources of anti-sclerotic substances; variety and use of foods that are easy enough to digest and moderately stimulate secretory functions of the digestive organs [2].

Protein deficiency is the cause of decreased muscle strength, rapid physical fatigue and other disorders. The optimal daily protein intake is 1.0-1.2 g per 1 kg of body weight. Of animal proteins, proteins of fish and dairy products are more preferable for the nutrition of older people. It is known that actual rations are deficient in such amino acids as: methionine, cystine, valine, arginine, glycine, asparagic acid.
It is necessary to limit the consumption of foods high in animal fat. The optimal rate of fat in the ration is 0.8-1.0 g per 1 kg of body weight. The daily requirement for fats is set at 76 to 85 g. Milk fat rich in vitamin A is considered the preferred animal fat.

The need for carbohydrates should be satisfied mainly by polysaccharides. It is also desirable to eat foods containing prebiotics (indigestible carbohydrates), which are a source of nutrition for normal intestinal microflora.

Micronutrient deficiencies in old age, resulting from both decreased bioavailability and increased consumption, require a constant supply of vitamins, minerals, bioflavonoids, organic acids. Various intestinal and other infections, long-term medications, chronic diseases of the gastrointestinal tract play a role in the formation of intestinal microflora of the elderly. Normalization of intestinal microflora is promoted by dairy products, dietary fiber, bifidofactor.

The development of gerodietic food products technologies has been a promising trend for many years. When developing them, it is necessary to take into account that in old age, quite often there are chronic diseases, including those related to nutrition. Therefore, when creating gerodietic nutrition products it is necessary to follow general approaches aimed at using ingredients that improve protein content, prevent joint diseases, correct mineral and vitamin composition, have prebiotic and probiotic properties.

2. Materials and methods
Experimental batches of two types of sour-milk product for gerodietic nutrition: with baobab fruit pulp powder and rosehip fruit powder were produced in the conditions of the experimental shop of the Research Institute of Child Nutrition - a branch of FGBUN "Research Center of Nutrition and Biotechnology. Used raw materials and materials had appropriate approvals for use in food products.

Mass fraction of protein, fat, carbohydrates (including lactose, fructose, galactose, sucrose) was examined according to GOST 30648.2-99; GOST 30648.1-99; GOST R 54760-2011. The content of dietary fiber - computational method.

Vitamin content: A - by GOST 30627.1-98, D3 - by GOST EN 12821-2014, E - by GOST 30627.3-98, B1 - by GOST 30627.5-98, B2 - by GOST 30627.6-98, B5 - by GOST 31483-2012, B6 - by GOST 31483.2012, PP - by GOST EN 15652-2015, Bc (folic acid) - by GOST 31483-2012, B12 - by GOST ISO 20634-2018, C - by GOST 30627.2-98.

Mineral content: calcium - by GOST EN 15505-2013, phosphorus - by GOST 31980-2012, potassium - by ISO 8070:2007, sodium - by GOST EN 15505-2013, magnesium - by GOST EN 15505-2013, copper - by GOST 30178-96, manganese - by GOST 26573. 2-2014, iron - by GOST 30178-96, zinc - by GOST 30178-96, selenium - by GOST 31707-2012 (EN 14627:2005), iodine - by GOST 31660-2012.

Organic acids - HPLC method.

Lactic acid microorganisms content - according to GOST 33951-2014.

3. Discussion and results
The selection of raw materials and product components for the gerodietics nutrition was based on modern scientific research and corresponded to the latest trends in the composition of products for the category of people in question (60 years and older).

This is a sufficient amount of high-quality protein containing essential amino acids [3-5]. Low-fat cow's milk was chosen as a source of complete proteins. The combination of milk proteins with hydrolyzed beef protein, which has good digestibility as a result of protein breakdown into fragments of different molecular weight [6], improves the amino acid composition. Hydrolyzed beef protein contains collagen, which has a positive influencing on the condition of joints, muscles and bones [7, 8].

The choice of plant ingredients, baobab pulp powder and rosehip fruit powder, is justified by data indicating the presence in them of natural forms of vitamins, minerals, dietary fiber, organic acids [9-14].
The use of carbohydrates that have a sweet taste and natural flavorings can adjust the organoleptic characteristics of the product if its composition includes ingredients with a specific taste and smell. Such an ingredient, in our case, is beef protein hydrolysate.

The use of probiotic cultures in the product formulation will contribute to easy digestion of the product, the normalization of microflora, the prevention of gastrointestinal diseases.

The study of raw materials, used components, additives and their various combinations, made it possible to create a formulation of sour milk product for gerodietic nutrition and to develop the technology of its production.

The product formulation included the following raw materials and components: cow’s milk, hydrolyzed beef protein, baobab fruit pulp powder or rosehip fruit powder, starch, sucrose, natural flavoring, starter culture (Streptococcus thermophilus, Lactobacillus delbrueckii subsp. Bulgaricus).

The use of baobab fruit pulp powder in one case and rosehip fruit powder in the other indicated the possibility of developing two types of product.

The stages of the technological process of producing fermented milk product for gerodietic nutrition are shown in figure 1.

![Figure 1. Block diagram of the technological process of producing fermented cultured milk product for gerodietic diet.](image-url)
In the conditions of the experimental shop of the Research Institute of Children's Nutrition - a branch of FGBUN "Research Center of Nutrition and Biotechnology" experimental batches of two types of sour-milk product for gerodietic diet: with baobab fruit pulp powder and rosehip fruit powder were produced. As a result of research on the product, the following data presented in tables 1-4 and figure 2.

Table 1. Indicators of the content of fat, protein, carbohydrates and dietary fiber in fermented dairy products for gerodietic diet.

| Indicator name                  | Indicator values |
|---------------------------------|-----------------|
|                                 | sour milk product with baobab pulp powder | sour milk product with rosehip fruit powder |
| Mass fraction of fat, %         | 1.55            | 6.00            |
| Mass fraction of protein, %     | 4.26            | 6.00            |
| Mass fraction of carbohydrates, %| 5.94            | 6.00            |
| Including                       |                 |                 |
| Mass fraction of lactose, %     | 3.82            | 3.49            |
| Mass fraction of fructose, %    | 0.03            | 0.09            |
| Mass fraction of galactose, %   | 0.84            | 1.24            |
| Mass fraction of sucrose, %     | 1.07            | 1.01            |
| Dietary fiber, g/100 g          | 0.54            | 0.16            |

The fat, protein, and carbohydrate content of the product was in line with calculated and current scientific recommendations, such as reduced calories and sufficient high-quality protein containing essential amino acids [3-5, 15]. The caloric value of the product was 55 kilocalories, which suggests that it can be used in the diet of an elderly person, without a high load on the digestive system. The study also showed the presence of dietary fiber in the product, which gives it prebiotic properties. The content of dietary fiber in the product with rosehip fruit powder was slightly lower than their content in the product with baobab pulp powder.

Figure 2. Amino acid content in fermented milk product for gerodietic diet, mg /100 g.
A study of the amino acid composition of the product proteins confirmed its high biological value. The product contained 43% of indispensable amino acids, as well as important substitutable amino acids, which with age can be synthesized by the body to a lesser extent.

Table 2. Vitamin content in fermented dairy product for gerodietic diet.

| Indicator name                               | Indicator value / Satisfaction of the daily requirement at the consumption of 200 g of the product (%) | sour milk product with baobab pulp powder | sour milk product with rosehip fruit powder |
|----------------------------------------------|--------------------------------------------------------------------------------------------------|------------------------------------------|-------------------------------------------|
| Vitamin A (retinol), µg·экв/100 g             | 48.6/10.8                                                                                         | 74.35/23.7                                |                                           |
| Vitamin D3 (calciferol), µg/100 g             | 0.627/12.4                                                                                       | 0.862/24.9                                |                                           |
| Vitamin E (tocopherol), mg/100 g              | 0.364/4.8                                                                                        | 0.761/10.1                                |                                           |
| Vitamin B1 (thiamine), mg/100 g               | 0.266/34.4                                                                                       | 0.313/41.7                                |                                           |
| Vitamin B2 (riboflavin), mg/100 g             | 0.394/43.7                                                                                       | 0.421/46.7                                |                                           |
| Vitamin B5 (pantothenic acid), mg/100 g       | 0.527/21.0                                                                                       | 0.542/21.6                                |                                           |
| Vitamin B6 (pyridoxine), mg/100 g             | 0.116/11.5                                                                                       | 0.129/12.9                                |                                           |
| Vitamin PP (niacin), mg/100 g                 | 0.448/4.5                                                                                        | 0.604/6.0                                 |                                           |
| Vitamin B (folic acid), µg/100 g              | 21.35/10.6                                                                                       | 33.16/16.7                                |                                           |
| Vitamin B12 (cyancobalamin), µg/100 g         | 0.89/59.3                                                                                        | 1.22/81.1                                 |                                           |
| Vitamin C (ascorbic acid), mg/100 g           | 2.46/5.4                                                                                         | 5.83/12.9                                 |                                           |

When using baobab pulp powder there were slight differences in the content of vitamins B1, B2, B5, B6, PP compared with rosehip fruit powder. The most noticeable was a higher content of vitamins A, D3, E, B, B12, C when using rosehip fruit powder.

Table 3. Mineral content in fermented dairy products for gerodietic diet.

| Indicator name                               | Indicator value / Satisfaction of the daily requirement at the consumption of 200 g of the product (%) | sour milk product with baobab pulp powder (1) | sour milk product with rosehip fruit powder (2) |
|----------------------------------------------|--------------------------------------------------------------------------------------------------|------------------------------------------|-------------------------------------------|
| Calcium (Ca), mg/100 g                       | 136.27/27.2                                                                                       | 153.35/30.6                                |                                           |
| Phosphorus (P), mg/100 g                     | 80.23/20.1                                                                                       | 82.17/20.5                                |                                           |
| Potassium (K), mg/100 g                      | 181.3/14.4                                                                                       | 174.4/13.9                                |                                           |
| Sodium (Na), mg/100 g                        | 77.9/11.9                                                                                        | 78.4/12.0                                 |                                           |
| Magnesium (Mg), mg/100 g                     | 33.8/16.8                                                                                       | 15.5/7.7                                  |                                           |
| Copper (Cu), mg/100 g                        | 0.082/16.3                                                                                       | >0.004/0.7                                |                                           |
| Manganese (Mn), mg/100 g                     | 0.0021/0.1                                                                                      | 0.33/0.03                                 |                                           |
| Iron (Fe), mg/100 g                          | 0.03/0.05                                                                                       | 0.02/0.04                                 |                                           |
| Zinc (Zn), mg/100 g                          | 0.15/0.3                                                                                         | 0.16/0.3                                  |                                           |
| Selenium (Se), µg/100 g                      | 3.26/11.8                                                                                       | 3.5/12.7                                  |                                           |
| Iodine (I), µg/100 g iodine in milk           | 22.31/29.7                                                                                       | 28.36/37.8                                |                                           |

The study of the mineral composition of the products showed a high percentage of satisfaction of the daily requirement for calcium, phosphorus, potassium, sodium, magnesium, selenium, and iodine. Copper content was higher in the product with baobab pulp powder. When using rosehip fruit powder, a higher content of such trace elements as calcium, manganese, and iodine was noted in the product. The use of baobab pulp enriches the product with potassium, magnesium, to a greater extent than the use of rosehip fruit powder.
Based on the data obtained, the percentage of satisfaction of the daily requirement for vitamins and minerals, at the consumption of 200 grams of product, calculated in accordance with the Norms of consumption of nutrients [15], is at a sufficient level for almost all of the items studied.

Table 4. The content of organic acids in fermented dairy products for gerodietic diet.

| Indicator name            | Value of the indicator | sour milk product with baobab pulp powder (1) | sour milk product with rosehip fruit powder (2) |
|---------------------------|------------------------|---------------------------------------------|-----------------------------------------------|
| malic acid, mg/kg         | < 0.05                 | < 0.05                                      |                                               |
| citric acid, g/kg         | 1.75                   | 2.15                                        |                                               |
| succinic acid, mg/kg      | < 0.002                | < 0.002                                     |                                               |
| Lactic acid, g/kg         | 6.81                   | 9.52                                        |                                               |
| acetic acid               | 75.17                  | 85.92                                       |                                               |
| oxalic acid, mg/kg        | < 0.003                | < 0.003                                     |                                               |

When studying the products for the presence of organic acids, the presence of citric, lactic, acetic acid and minor content of malic, succinic and oxalic acids, with their higher content noted in the product with rosehip fruit powder. In order to give the product probiotic properties, we used starter cultures Streptococcus thermophilus, Lactobacillus delbrueckii subsp. Bulgaricus. According to the content of lactic acid microorganisms, the product meets the requirements of TR CU 033/2013 Technical Regulations of the Customs Union "On the safety of milk and dairy products" for dairy products.

4. Conclusion
As a result of the research it was found that the developed sour-milk product corresponds to the modern trends in the composition of products for gerodietic nutrition. The product contains an optimal amount of protein, the study of the amino acid composition of which confirmed the high biological value of the product.

Reduced fat content, the presence of vitamins, minerals and dietary fiber, achieved through the use of natural ingredients will contribute to good digestibility of the product. Calculation of the daily requirement for vitamins and minerals at the consumption of 200 grams of the product showed a fairly high percentage of their necessary intake in the body for people 60 years and older.

A higher content of vitamins A, D₃, E, B₁₂, C, calcium, manganese, iodine was noted when using rosehip fruit powder compared to using baobab fruit pulp powder. The content of potassium, magnesium and copper in the product increases to a greater extent when baobab fruit pulp is applied.

The presence of citric, lactic and acetic acids and insignificant content of malic, succinic and oxalic acids was found in the product. Their higher content was noted in the product with rosehip fruit powder.

By introducing starter cultures containing lactic acid microorganisms Streptococcus thermophilus, Lactobacillus delbrueckii subsp. Bulgaricus, product has probiotic properties.

Organoleptic characteristics of the product were highly appreciated. The product had a homogeneous consistency, sour milk taste and smell with a touch of added flavoring, the color corresponding to the color of the added components.

The project of normative and technical documentation for the production of sour-milk product for gerodietic nutrition was developed. The use of the developed technology will expand the range of products for the nutrition of the elderly, taking into account the needs of their body and having a positive effect on health and longevity.

Acknowledgments
The scientific research work on the preparation of the manuscript was carried out at the expense of the grant for performance of the state task in the direction No. 0529-219-0060 "Development of Specialized Children's and Gerodietic Nutrition Products and Evaluation of their Effectiveness."
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