Substantiation of the technology of functional milk-containing products using wild plants

S M Dotsenko¹, Yu A Guzhel¹ and D D Zverkov²

¹ Federal State Budgetary Educational Institution of Higher Education "Amur State University", 21, Ignatievskoe shosse, Blagoveshchensk, 675028, Russia
² Federal State Military Educational Institution of Higher Education "Far Eastern Higher Combined Arms Command School of the Order of Zhukov named after A.I. Marshal of the Soviet Union K.K. Rokossovsky", 158, Lenina, Blagoveshchensk, 675021, Russia

E-mail: G-Yuli-85@mail.ru

Abstract. The article substantiates the possibility and expediency of creating milk-containing products of a functional orientation based on wild garlic, pine nut kernel and wild garlic-nut composition. New methods have been developed for transforming wild-growing raw materials and milk-kefir products into food systems with significant amounts of physiologically valuable and biologically active ingredients. For the received products, code designations are defined and given in accordance with national standards. The article presents the results of a study of the biochemical composition of innovative products.

1. Introduction

It is known that the current level of development of food technology is directly dependent on the fact to what extent the needs of a person for certain nutritional factors are satisfied, ensuring the functioning of the body, adequate to the conditions of its habitat in a particular environment [1-4].

At the same time, one of the main problems of modern civilization is the peroxidation syndrome, which manifests itself under stress of any origin, radioactive and ultraviolet radiation, exposure to electromagnetic fields, excessive consumption of fats and carbohydrates, low temperatures, etc. [1].

In this regard, the development and creation of food systems in the form of functional products with the effect of antioxidant protection is relevant.

2. Materials and methods

The purpose of the research is to substantiate the technology and method for obtaining functional milk-containing products using the pine nut kernel and wild garlic.

Tasks:

- Substantiate the possibility and expediency of using physiologically valuable ingredients (PhVI) and biologically active substances (BAS) of the pine nut kernel and wild garlic in the formulation of milk-containing products with a given physiological effect.
- Substantiate technological approaches and develop a scheme for obtaining milk-type food systems with significant amounts of PhVI and BAS in their composition.
On the basis of the substantiated biochemical composition of the obtained food systems, give a coded designation to the developed functional food products.

3. Results

An analysis of the literature data found that the pine nut kernel is a source of significant amounts of vitamins E in the amount of 63.8% of the recommended daily intake (RDI), K - 44.9%, B1 - 30.3%, PP - 27.4% of RDI, as well as mineral substances Fe - 55.3%, Mg - 62.8%, P - 82.2%, Zn - 58.6%, Cu - 147.2%, Mn - 382.7% of the RDI. They also contain Se in an amount of 1.3%. With the content of proteins and fats at the level of 14.0% and 68.37%.

At the same time, wild garlic, as one of the widely available representatives of wild-growing raw materials, is also distinguished by a high content of vitamins A in the amount of 77.8%, C - 111.1%, K - 18.0% and β-carotene - 84.0% of RDI. At the same time, wild garlic contains a significant amount of such a trace element as cobalt in the amount of 39.0% of the RDI, as well as Se, Cr and Zn.

According to the followers of Shabrov A.V., Dadali V.A. et al. scientists, the combination of vitamins E and C makes it possible to protect cells both by additive and conjugated mechanisms, which can be considered as synergism of two antioxidants, i.e. manifestation of a more significant antioxidant effect than with a simple summation of the antioxidant effect of each of the components (additive effect).

Vitamin A and Zn, vitamin E and Se, vitamin E and β-carotene are also synergistic [1].

At the same time, the authors also note that synergism takes place both in ternary and more complex systems: vitamins (A + C) + Se, vitamins (E + A) + Se, vitamins + bioflavonoids [1].

It has been established that the effectiveness of natural antioxidants is maximally manifested in certain concentration intervals, which is confirmed by the data regulated by GOST R 2349-2005 (15-50% of RDI) and GOST R 54059-2010 (class B - antioxidant effect) [5;6].

Obtaining complexes of physiologically valuable and biologically active ingredients with a given composition and properties, followed by their inclusion in a certain type of food system, is associated with the appropriate transformation of the feedstock and the correct choice of the so-called basic food system.

As a basic food system, a dairy product, in particular, a kefir product with a mass fraction of fat equal to 1.0-2.5%, with a mass fraction of solids, respectively - 9.1-11.0%, with a total organic acid content of 0.9%, proteins - 2.9-3.0%, carbohydrates - 3.9-4.0% and minerals - 0.69-0.70% with an acidity of 85-120 °T. With an energy value of 39-53 kcal/100 g [7;8].

As possible options for the implementation of the technological process, three were selected, including the preparation of an initial polydisperse system of high homogeneity by disintegrating a component in the form of a wild-growing raw material in a kefir medium at a certain ratio.

At the same time, in accordance with the accepted options, a coarsely ground mass of wild garlic, a pine nut kernel, as well as a mixture based on a kefir-ramson binary composition were used as the initial wild-growing raw material.

At the first stage of the study, according to figure 1 of the technological scheme for the preparation of products, a kefir-ramson dispersed system is prepared by disintegrating a coarsely ground mass of wild garlic in a kefir medium in the presence of a solution of ascorbic acid at a ratio of components of 3:1, respectively. The resulting dispersed system is subjected to heating in order to obtain a coagulation structure.
The mode of thermal acid coagulation of proteins in the finished kefir-ramson dispersed system is determined by the formula:

$$v = \frac{t_2 - t_1}{T \cdot V}$$  \hspace{1cm} (1)

Where \( t_2, t_1 \) are the final and initial temperatures of the kefir-ramson dispersed system, °C; \( T \) is the duration of heating, s; \( V \) is the volume of the heated product, l.

For the case under study, the heating intensity was 0.183 °C/(s l), which made it possible to conduct experiments under the same modes and parameters.

Table 1 shows data on the biochemical composition of innovative dairy-ramson products.

This section presents the results of the study. Here you can use tables, figures and formulas. An example of the design of the table is presented below (table 1)
Table 1. Biochemical composition of innovative products.

| Products                | Proteins | Fat  | Carbohydrates | Carotenoids | Se  | Cr  | Zn  | Co  | Energy value, kcal/100 g |
|-------------------------|----------|------|----------------|-------------|-----|-----|-----|-----|--------------------------|
| Kefir-ramson dispersed system | 2.8      | 1.8  | 4.5            | 140.0       | 1.05| 0.2 | 0.4 | 0.05| 1.0 45.40                |
| Coagulate pulp fraction  | 5.0      | 3.2  | 8.0            | 200.0       | 20.0| 21.0| 0.4 | 0.8 | 0.1 2.0 80.80           |
| Serum                   | 1.0      | 0.4  | 3.0            | 70.0        | -   | 0.5 | 0.1 | 0.1 | 0.02 0.2 19.60          |

* - % of the recommended daily intake (RDI)

Analysis of the data in table 1 shows that the innovative products obtained by the proposed method have significant amounts of vitamins: according to the kefir-ramson dispersed system - C = 200.0%, A = 20.0%, β-carotene = 21.0% of the recommended daily allowance consumption; for the coagulate-pulp fraction - C = 100.0%, A = 40.0%, β-carotene = 42.0% of the recommended daily intake; for whey - C = 100% of the recommended daily intake. Therefore, these products have the following product codes:

- Vitamin C - ascorbic acid (B-I-1,2,3 GOST R 54059-2010).
- β-carotene (B-I-1,2,3 GOST R 54059-2010).

At the second stage of the study, a protein kefir-nut dispersion system was prepared, using kefir with a mass fraction of fat of 1.0% as a milk component, and a pine nut kernel as a wild-growing raw material at a weight ratio of 75% : 25%, respectively. The technological scheme for the preparation of innovative products is similar to the scheme shown in figure 1. According to which the disintegration of the pine nut kernel was carried out in a kefir medium to an ultrathin and ultra-homogeneous state with the simultaneous introduction of ascorutin with a concentration of 1 mg/% (weight) into this medium. Then, the resulting protein kefir-nut disperse system was heated to form a structure in the form of a coagulate-beet pulp fraction. The resulting fraction was separated from whey and its moisture content was adjusted to 55-75%. Then the coagulate-beet pulp fraction with moisture: 70-75% was used in the preparation of cocktails with lemongrass, lingonberries, cranberries, etc.; 65-70% - mashed potatoes and sauces with lemongrass, cranberries, cranberries and viburnum, etc.; 60-65% - dessert pastes with lemongrass, lingonberries, cranberries, viburnum rowan, etc., as well as snack bars with wild garlic, basil, garlic, onions (feather), etc.; 55-60% - granulated concentrate by molding into granules and drying, followed by the production of grits, powder and flour. On the basis of whey, fruit and berry drinks were prepared - strawberry, cloudberry, etc.

The biochemical composition of innovative products in this category is presented in table 2.
Table 2. Biochemical composition of innovative products.

| Products                                      | Content  | vitamins, mg/100 g | minerals, mg/100 g | Energy value, kcal/100 g |
|-----------------------------------------------|----------|--------------------|--------------------|--------------------------|
|                                               | basic substances, % |                     |                    |                          |
| Protein kefir-nut dispersed system            | proteins | 5.6                | 17.7              | 6.6                      |
|                                               | fat      | 2.3                | 13.5              | 25.0                     |
|                                               | carbohydrates | 25.0              |                   | 1.6                      |
|                                               | E        | 62.7               |                   | 143.7                    |
|                                               | K        | 0.32               |                   | 2.20                     |
|                                               | C        | 202.10             |                   |                          |
|                                               | P        | 120.0              |                   |                          |
|                                               | Zn       | 95.5               |                   |                          |
|                                               | Mg       | 40.0               |                   |                          |
|                                               | P        | 180.0              |                   |                          |
|                                               | Cu       | 71.0               |                   |                          |
|                                               | Mn       | 38.2               |                   |                          |

Analysis of the data presented in table 2 shows that the products obtained by the proposed method meet the requirements of national standards [5;6].

At the same time, they have:

- Antioxidant effect (class B).
- The effect of maintaining the cardiovascular system (class B).
- The effect of maintaining the immune system (class E).

Thus, the proposed method provides the claimed technical result, and therefore can be used in specialized nutrition (cosmonauts, military personnel, etc.).

4. Discussion

At the third stage, a kefir-nut-ramson base was prepared by disintegration in a kefir medium with a mass fraction of fat of 1.0% of a previously prepared nut-ramson composition. Why did they take pine nut kernels and coarsely ground mass of wild garlic with a weight ratio of pine nut kernel: wild garlic equal to 1: 1, and the weight ratio of kefir: the resulting nut-ramson composition was 60%: 40%, which in general can be represented as 60% : 20% : 20%. This weight ratio of the components made it possible to have a protein-carbohydrate-dispersed medium with a protein content of 5.02% and carbohydrates of 6.22%.

Then, the protein-carbohydrate dispersed medium was heated, in which, under the action of lactic and ascorbic acid contained in wild garlic, thermal acid coagulation of proteins took place with their precipitation on the pulp fraction. Further, the coagulate-pulp fraction was separated from the whey and the content of dry substances in its composition was adjusted within the range of 30-45%. At the same time, the obtained coagulate-pulp fraction with a content of 30-35% of solids was used in the preparation of cocktail drinks, with a content of 35-40% - in the preparation of purees and sauces, and with a content of 40-45% - in the preparation of snack bars. Drinks were prepared on the basis of whey.

Thus, the proposed method was implemented according to a waste-free technological scheme.

Table 3 shows the biochemical composition of innovative functional products.
Table 3. Biochemical composition of innovative products.

| Products                  | proteins, % | fat, %  | carbohydrates, % | vitamins, mg/100 g | minerals, mg/100 g | Energy value, kcal/100 g |
|---------------------------|-------------|---------|-------------------|---------------------|---------------------|--------------------------|
| Kefir-nut-ramson base     | 5.02        | 14.2    | 6.22              | 1.9                 | 11.0                | 20.0                     | 1.2                     | 1.4                     | 58.0                     | 350.0                     | 19.0                     | 14.0                     | 9.0                     | 20.0                     | 4.0                     | 24.0                     | 1.2                     | 24.0                     | 1.4                     | 12.0                     | 14.0                     | 16.0                     | 32.0                     | 88.0                     | 10.0                     | 168.7                     |
| Coagulate pulp fraction   | 10.1        | 28.0    | 12.3              | 3.7                 | 22.0                | 38.0                     | 2.3                     | 2.7                     | 115.0                    | 130.0                    | 0.5                     | 3.8                     | 2.0                     | 351.6                     |
| Serum                     | 1.0         | 2.8     | 4.2               | 3.0                 | 2.1                 | 8.0                     | 10.0                    | 3.0                     | 3.0                     | 4.2                     | 6.9                     | 18.0                    | 2.5                     | 46.0                     |

* - % of the recommended daily intake (RDI)

Analysis of the data given in table 3 shows that in all products obtained by the proposed method there are groups of natural antioxidant systems that allow you to regulate the processes of free radical oxidation and, in particular:

- Group I – vitamins (E+K+C+ β-carotene).
- II group – micronutrients (Zn+Mg+P+Cu+Mn+Co).

Thus, the proposed method makes it possible to obtain products of an expanded range of functional orientation for specialized purposes, containing groups of natural antioxidant systems capable of regulating free-radical oxidation processes in the body in accordance with the national standards of the Russian Federation [5;6].

The proposed methods are protected by RF patents for inventions [9;10].

5. Conclusion

As a result of the research carried out:

- The possibility and expediency of using wild garlic and pine nut kernels in the creation of products of a functional orientation on a milk-kefir basis with a given physiological effect are substantiated.
- Substantiated technological approaches to the transformation of the initial wild-growing raw materials in the form of wild garlic, pine nut kernel and ramson-nut composition in a kefir medium using a coagulant in the form of ascorbic acid, ascorutin and lactic acid contained in the kefir product.
- Developed basic technological schemes for creating functional products based on new methods protected by RF patents for inventions.
- It has been established that the resulting food systems contain physiologically valuable ingredients and biologically active substances in significant amounts, and therefore have the specified antioxidant effect (class B), the effect of maintaining the activity of the cardiovascular system (class B), as well as the effect of maintaining the immune system (class E) for which coded designations are given in accordance with national standards.
References

[1] Shabrov A V, Dadali V A and Makarov V G 2003 Biotechnological bases of the action of food micronutrients (Moscow: Avvallon) 108

[2] Tutelyan V A, Sukhanov B P and Austrievskikh A N 1999 Biologically active additives in human nutrition (assessment of quality and safety, efficacy, characteristics, use in preventive and clinical medicine) (Tomsk: NTL) 296

[3] Tutelyan V A 2001 Biologically active food additives as an integral element of optimal nutrition. Vestnik St. Petersburg - GMA im. I.I. Mechnikova 15-9

[4] Tutelyan V A 2002 Micronutrients in the diet of a healthy and sick person (Moscow: Kolos) 256

[5] GOST R 52349-2005 Functional food products. Terms and definitions 2005 (Moscow: Standartinform) 3

[6] GOST R 54059-2010 Functional food ingredients. Classification and general requirements 2011 (Moscow: Standartinform) 8

[7] Skurikhin I M and Tutelyan V A 2002 Chemical composition of Russian food products (Moscow: DeLi print) 236

[8] Stepanova L I 1999 Handbook of the technologist of dairy production. Technology and formulations (St. Petersburg: Giord) 199

[9] Dotsenko S M, Guzhel Yu A and Zverkov D D 2021 Method of preparing functional products RF Patent No. 2756001

[10] Dotsenko S M, Guzhel Yu A and Zverkov D D 2021 Method of preparing functional products of specialized orientation RF Patent No. 2760594