Enrichment of food products with local berry raw materials for the residents of border areas

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Abstract. The article deals with topical issues of forming a range of functional foods with useful properties in the border areas. Also, the article considers the technological possibilities of introducing berry raw materials into traditional food products.

1. Introduction

Border territories of the constituent entities of the Russian Federation in the Concept of their development are recognized as the most important resource of the country in many strategic aspects [1], [7]. As part of the development of agricultural production in these regions, the state declares “the creation of cooperatives for the harvesting and processing of wild plants, ... berries”; “the creation of enterprises for the production of ... food supplements based on biologically active substances”; the production cooperation aimed “at the processing of raw materials; the creation of enterprises for the extraction and processing of natural resources”; “organization of wholesale-distribution centers in the ... border areas for the sale of agricultural products, collecting agricultural products ..., its storage and marketing (in the future, it is possible to create processing sites on the basis of these centers with the release of finished food products);” one of the promising areas [1]. It is not by chance that in a number of key state documents aimed at ensuring the security of the state and its citizens, attention is directed to such areas of development. On the one hand, this is connected with the economic problems indicated in the documents in the regions remote from the center. For example, in relation to the border areas, the following is noted: their low share of participation in the formation of the gross regional product; weak activity of small and medium enterprises; low employment rates of the working population, a high level of migration; inefficient use of the natural resource potential of border areas. In such a situation, the proposed activities will contribute to the solution of regional economic problems.

On the other hand, these activities will allow solving issues related to ensuring a decent quality and standard of living of citizens, impossible without the realization of their right to safety, health and a healthy lifestyle, which are also part of the country’s security [4-6]. In this regard, the efforts of many Russian scientists are aimed at finding new, non-traditional types of food raw materials and developing recipes for the preparation of fortified or specialized food products based on it. One of the promising areas of scientific research in this aspect is the study of the possibility of increasing the nutritional value of products by including local ingredients in the recipe, which are the sources of vitamins, minerals and other biologically active components.
2. Materials and Methods

An information-logical model of technological processes of production and determination of the quality of the obtained enriched products based on the introduced varieties of sea buckthorn (krushenovidnaya) was taken as the object of study.

The area of distribution of wild species is extensive and includes a large part of Europe and Asia. Sea buckthorn in Siberia forms the largest thickets in the Altai Region, the Republics of Tyva and Buryatia, it is widely represented in the border areas. This makes it a promising raw material for use in food. The organization of its collection and processing will allow not only to solve the problem of enrichment of traditional products for the population, but also the task of attracting local labor resources for this, developing small or medium-sized enterprises. In the future, we can talk about improving the efficiency of using the natural resource potential of border areas. On the example of introduced varieties, the work showed a consistent information-logical model and research procedure, including the steps from studying the technological and biochemical characteristics of the raw materials and formulating the formulation using mathematical models, to producing and determining the consumer properties of the resulting enriched products. This model was considered as a system.

3. Results

The target state of the system of the object under consideration from the standpoint of a systematic approach to the overall goals of the global level, as recorded in strategically important state documents in the field of safety and ensuring the quality of life of the population, including border areas, adds goals of a lower order. They set the main vector of scientific research, including the following: conducting a study of the biochemical composition of the sea-buckthorn (krushinovidnaya) fruit of various regions; developing approaches and technologies for obtaining enriched food products based on it; identifying approaches to increase compliance with the safety and quality of new products.

The main factor generating the system under study is the contradiction between the situation in which the use of non-traditional types of local plant raw materials has a high potential for solving a number of problems (implementation of state policy in the field of healthy nutrition, environmental management, expanding the range of enriched products) and the lack of experimental justification for such a direction. Given the richness of the properties and composition of the fruit of sea buckthorn (krushinovidnaya), the presence of demand for enriched natural foods, the use of its fruits to produce such products is very important.

Analysis of the possibilities of food fortification through the use of local raw materials, the study of the range, biological features and biochemical composition of sea buckthorn fruits as raw materials for the production of puree are properties of the system. The properties of the system under study are specific biological, biochemical, chemical, and physicochemical parameters of the quality and safety of raw materials. Development of a model and substantiation of effective technological processes for obtaining puree from sea-buckthorn fruits, taking into account the biochemical parameters of raw materials (the content of dry substances, sugars, acids), is an element of connection between the studied parameters. This allows us to consider this network of interactions as a structure from the standpoint of a systematic approach.

Elements of the management system for the assortment and quality of fortified food products include the following: conducting a study of the morphological properties and chemical composition of fruits from different regions, identifying the promising varieties for industrial processing; developing a technological scheme for the production of puree, analyzing compliance with the safety and quality of raw materials (sea-buckthorn fruit) and processed products (natural puree, puree with sugar), analyzing the safety and quality of yogurt enriched recipes; conducting a mathematical modeling of process optimization.

The group of system-dependent factors for the submitted research related to the enrichment of food products is indicated by the state in the basic documents. It includes economic, managerial, and social factors, including the following: solving economic and migration problems, which were mentioned at the beginning of the article, issues of employment, providing the diet with essential nutrients.
4. Discussion

The general scheme for developing an innovative product using sea buckthorn is already described in our literature published in Russian [2], [3]. In total, 8 varieties of sea-buckthorn (krushinovidnaya) fruits during consumer maturity, growing in different climatic regions, were taken for research. At the first stage of the study, we determined the chemical composition, morphological features, their dependence on the growing area, the influence of the technological characteristics of the sea-buckthorn (krushinovidnaya) fruits on the production processes and the functional properties of new processed products with the addition of sea-buckthorn fruits. Also, we determined the quality indicators of the products based on vegetable raw materials, their compliance with the requirements of regulatory documents. The findings are also published in the sources [2], [3]. Average long-term data on sea buckthorn yields show that most varieties in the conditions of the Altai, Krasnoyarsk regions, and Khakassia have similar productivity. It was shown that all the samples of sea buckthorn studied had a balanced fatty acid composition. This characterizes the sea buckthorn fruit as a valuable food raw material. The fruits of different ecological groups differ in the accumulation of the following vitamins and minerals: vitamin C, carotenoids, and nicotinic acid. Its Vitamin E content is highest in the samples from the Republic of Tuva. On the basis of accumulation of macro and microelements, the samples introduced in the Krasnoyarsk Region and the Republic of Khakassia stand out. The total ash content of the sea-buckthorn fruit is determined by the biological characteristics of the variety. Microbiological indicators (the content of non-spore-forming microorganisms, mold fungi and yeast), sea buckthorn fruits meet the requirements of SanPiN 2.3.2.1078.

Technological processes for the production of processed products from sea-buckthorn fruits are presented in the form of an information-logical model, where the links and intensity of transients are indicated. For example, \( \lambda_{VI} \) is the intensity of the flow from link V to link I. In [3], the processes of the technological line were presented in the form of a model. As a result of a computational experiment, at different values of the intensities of the processes, we found that solving the Cauchy problem for a system of differential equations depending on the parameters \( x, y, z \) is a model of the dynamics of technological processes (where \( x \) is the dry matter content, \( % \); \( y \) is the sugar content, \( % \); \( z \) is the content of acids in the puree from the fruits of sea buckthorn, \( % \)).

The proposed method of scientific and practical research allowed us to create the structure of the technology for obtaining functional products from sea buckthorn fruits (puree, puree with sugar). The developed analytical model of technological processes for the production of sea-buckthorn puree made it possible to calculate the optimal values of the regime parameters for natural puree, and puree with sugar, respectively: 46.985 and 63.85\% is the solids content; 4.102 and 25.546\% is the sugar content; 1.024 and 0.964\% is the acid content. Laboratory experiments showed that the values obtained differ from the theoretical values by no more than 5\%.

The use of sea-buckthorn puree as a functional supplement made it possible to obtain new yogurt formulations that satisfy the daily need for \( \beta \)-carotene, vitamin E by 60\% and ascorbic acid by 70\%. The doses of the supplement are determined: 7 and 10\% for natural puree and sugar puree, respectively. Yoghurt is enriched with carbohydrates, fatty acids, and micronutrients. The payback period of the proposed technology is 2 years [2], [3].

5. Conclusion

Optimized technological parameters for the production of sea-buckthorn puree provide not only high-quality products with biological value for consumers, but they also contribute to the creation of new efficient production. The expected payback period is 2 years. During this time, the profit will exceed the initial cost of producing this product [2], [3]. The rationality of introducing the production technology of sea-buckthorn fruit puree into practical activity has been confirmed under the conditions of individual entrepreneur N. M. Popovenko (Chernogorsk, Russia). Enriched yogurts based on sea-buckthorn fruit puree have high tasting characteristics; they meet the requirements for physico-chemical quality indicators and have a high biological value.
Making puree from the sea buckthorn fruits had a positive impact on the physico-chemical and structural-mechanical characteristics of the finished product. Yoghurts with 7 and 10% supplementation of puree from the main raw materials had the best indicators on the accumulation of vitamins [2], [3]. A new product allows to rationalize the nutrition of the population with balanced products. It also makes it possible to expand the range of fermented milk products on traditional equipment without additional costs for instrumentation of the technological process.

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