Development of technology of gingerbread products enriched with raw materials of the Far Eastern region

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Abstract. Providing the population with high-quality food products enriched with physiologically significant nutrients at an affordable price is a priority task of the state policy and the government of the Russian Federation. The article shows the possibility of expanding the range of gingerbread products enriched with natural raw materials of the Far Eastern region. The technologies of the production of berry powders recommended as functional ingredients have been developed. It has been established that the replacement of flour with powder from Kamchatka bilberry pomace in the amount of 5.5% or powder from common barberry in the amount of 7.5%, soy deodorized flour of the highest grade in the amount of 5% and food additive from Daurian larch wood "Arabinogalactan" in the amount of not more than 3% in gummy gingerbread recipe contributes to obtaining a product that meets the requirements of GOST 15810-2014 and safety indicators of the requirements of the Technical Regulations of the Customs Union (TR CU) 021/2011 "On Food Safety". Laboratory studies of the developed gummy gingerbread have proved compliance with the requirements of regulatory documents for organoleptic, physicochemical and microbiological indicators. The technology development and the use of berry powders in the production, which make it possible to enrich traditional food products, is of practical interest. The expediency of using regional raw materials to expand the range of flour confectionery products of increased nutritional and biological value has been proved.

1 Introduction

Providing the population with food is a global problem. To solve it, the number of chemicals synthesized by man has sharply increased in the last century. The harm of many substances intended for human consumption was determined with great delay. The development of industry has worsened the ecological situation, which is reflected in the quality of raw materials and ready-to-eat food products. A person in everyday life is constantly faced with increased level of psycho-emotional stress. The nutrition of the majority of the population is not balanced, we have begun to consume more fats and simple carbohydrates, less macro- and micronutrients. Violation of
The rules of balanced nutrition leads to an increase in the mass index, a decrease in the body’s resistance to adverse environmental factors, and the development of concomitant diseases. The role of food has changed. Along with the delivery of nutrients, food must also perform a protective function. Therefore, more and more people want to have complete and healthy food in their diet. Enrichment of basic, daily food products, as one of the ways to get a complete and healthy food, is mandatory for many developed countries, such as the USA, Canada and developing countries in Asia, Latin America, Africa, which is legally regulated [1-3].

To prevent diseases and improve the culture of nutrition, the concept of functional nutrition has been developed, in which the leading role is given to the creation of new products, balanced in composition, enriched with functional components [4-7].

The composition of functional products may include many active ingredients: water-soluble and fat-soluble vitamins, ascorbic acid; antioxidants; biologically significant elements such as potassium, magnesium, calcium, iodine, iron, selenium, zinc; amino acids, including essential ones; dietary fiber; unsaturated fatty acids; prebiotics, etc. [8-12].

The improvement of modern food production technologies is directly related to the use of natural food components containing a wide range of biologically active substances. In recent years, there has been an increased interest in processed raw materials of the Far Eastern region as a source of nutrients. Expansion of the range of competitive products with high taste qualities is expedient on the basis of the integrated use of regional resources. Crops, growing in ecologically favorable areas are leaders in the content of the most important food biologically active components created by nature itself, which was confirmed by scientists from the Far Eastern State Agrarian University [13-15].

Wild-growing edible fruit and berry crops of the Russian Far East cover a very significant taxonomic range. More than 150 species of fruit and berry plants grow on the territory of the region, of which about 80 are edible for humans. Among the wild berries, Kamchatka bilberry is of particular interest. Among the crops cultivated by the population of the Amur region and little used in the food industry — barberry is of particular interest.

The nutritional value of berry raw materials and products of its processing is the main qualitative characteristic. The defining properties of processed berries are low energy and high nutritional value, original organoleptic properties that form stable consumer preferences [16, 17].

Kamchatka bilberry grows in Kamchatka, in the north of the Khabarovsk Territory, on Sakhalin, Shantar and Kuril Islands, as well as on the islands of Hokkaido and Honshu in Japan.

Ripe Kamchatka bilberries contain water- and fat-soluble vitamins; the amount of ascorbic acid accumulates up to 192 mg. The total sugar content in Kamchatka bilberries was 5.3%, while monosaccharides contained 4.1%, and disaccharides – 1.9%. The sugars contained glucose, galactose, mannose and fucose. Glucose, galactose, mannose and fucose are found in the composition of Kamchatka bilberry sugars. Kamchatka bilberries contain copper, cobalt, zinc, chromium, manganese, boron, iron, molybdenum, 17 amino acids, including 7 essential ones. The protein of Kamchatka bilberries is dominated by arginine and glycine, aspartic acid.
and it can serve as a raw material for flavor additives, confectionery, food concentrates, production of non-alcoholic and alcoholic products.

The study of the antibacterial properties of Kamchatka bilberry suggests an increased microbiological reliability of finished products using raw materials obtained from Kamchatka bilberry.

The common barberries contain water- and fat-soluble vitamins, calcium, magnesium, phosphorus, iron, manganese, potassium, sodium, iodine, sugars, alkaloids (berberine), tannins, dyes, mineral salts and dietary fiber.

Over the past decades, soy flour has been very actively used in the food industry. The inclusion of a small amount of soybean flour into the recipe, as a constituent ingredient, allows increasing the nutritional value and yield of the finished product, gives it a more delicate structure and an attractive appearance. Soy flour contains water- and fat-soluble vitamins, potassium, magnesium, selenium, calcium, copper, zinc, iron, phosphorus, dietary fiber and polyunsaturated fatty acids. 100 grams of flour contains 50% of the daily protein requirement. Soy protein contains all the necessary composition of amino acids and vitamins for the normal functioning of the human body.

The food additive “Arabinogalactan” has proven itself well when obtaining a product with improved organoleptic quality indicators of products and extended shelf life. Arabinogalactan is a polysaccharide of plant origin, obtained from the wood of the Daurian larch, is a biologically active substance. It can be used as the main component of dietary supplements intended for the prevention of systemic diseases and immunity boosting.

Due to the properties of a stabilizer, prebiotic, source of fiber and soluble dietary fiber, arabinogalactan can be used to prolong the shelf life and increase the storage capacity of food products for the production of functional foods [18].

Kamchatka bilberries and barberries are sources of citric, malic, tartaric, and succinic acids, which are antioxidants [19]. Researchers of the Pacific State Medical University have proven that Kamchatka bilberries, barberries, soybean phospholipids and arabinogalactan have a strong hepatoprotective and immunostimulating effect. These raw materials have proven themselves excellently in the complex therapy of liver diseases, recovery from serious illnesses and antibiotic intake, which is very important in the spread of the new coronavirus infection Covid-19.

Therefore, there is a need for further study of the possibility of using natural Far Eastern raw materials in the technology of functional food products of systemic action.

Gummy gingerbread was chosen for enrichment with natural Far Eastern raw materials. Gingerbread is very popular among flour confectionery products. Gingerbread is consumed by all segments of the population, it is an everyday food product. The increase of the nutritional value and consumer properties of gingerbread products is an urgent task for the food and processing industry.

The purpose of the study is the development of new types of gingerbread products of a functional orientation, increased nutritional and biological value using raw materials of the Far Eastern region – Kamchatka bilberries, barberries, soy flour and a food additive from Daurian larch wood “Arabinogalactan”.

Research objectives are technology development for obtaining powder from berry raw materials; improvement of the formulation and technology of gingerbread products enriched with processed raw materials of the Far Eastern region; conducting of the comprehensive assessment of the quality of finished products.
2 Materials and methods

The research was carried out in the laboratories of the Department of Product Technology and Public Catering and the Department of Chemistry of the Faculty of Technology of the Far Eastern State Agrarian University. The objects of the study were Kamchatka bilberry (Vaccinium praestans), common barberry (Berberis vulgaris), powder from Kamchatka bilberry pomace, powder from barberry fruits, soy deodorized flour, food additive “Arabinogalactan”, produced from Daurian larch (Siberian) and flour confectionery – gummy gingerbread, produced according to the standard recipe (control samples), gummy gingerbread “Krasnichnye” and “Barbarisovye”, enriched with biologically active components (experimental samples).

The conventional, standard and modified research methods were used. The physicochemical, microbiological and organoleptic indicators were studied in accordance with GOST 53159-2008 “Organoleptic analysis. Methodology” and GOST 15810-2014 “Confectionery products. Gingerbread products. General technical conditions”. The technological operations were carried out according to the traditional scheme for the experimental and control samples [16].

Powder from Kamchatka bilberry (Vaccinium praestans) pomace and powder from barberries (Berberis vulgaris) were added to the dough at the stage of its preparation in the amount of 3.5%, 5.5%, 7.5%. Soy flour and arabinogalactan were added in the amount of 5% and 3% by weight of flour of a standard recipe respectively.

3 Results

To obtain berry powders, the technologies for obtaining pomace from Kamchatka bilberry, followed by drying at a temperature of not more than 60 ° C and grinding have been developed. The powder from barberries was obtained according to a similar scheme under more gentle conditions without preliminary juice separation.

To obtain powder from Kamchatka bilberry pomace, raw materials were collected in the southern regions of Sakhalin Island. The collected fresh berries were sorted from damaged berries and impurities and washed in cold running water with a temperature not exceeding 20°C. The juice was squeezed by pressing. The resulting berry pomace was dried at a temperature of 55-60°C, the drying time was 180-240 minutes. The berry pomace was cooled to a temperature of 18-20°C. Then berry pomace was grinded to powder, packed and stored at a temperature not higher than 20 °C.

To obtain powder from common barberries, raw materials were collected on the territory of the Amur region. Fresh berries were inspected and washed in cold running water with a temperature not exceeding 20°C. The berries were dried at a temperature not higher than 45-50°C, the drying time was 180-240 minutes. The berries were cooled to a temperature of 18-20°C. Then dried berries were grinded to powder, packed and stored at a temperature not higher than 20 °C.

Pomace from Kamchatka bilberry and dry fruits of common barberry are shown in Figures 1 and 2. The appearance of the obtained powders is in Figures 3 and 4.
Berry powders were produced by the authors of the article in laboratory conditions. The food additive “Arabinogalactan” was provided by LLC “Ametis” (Figure 5). The premium deodorized soybean flour was produced by LLC “Amurkor” (Figure 6).
Syrup is cooled to a temperature of 30-40°C. Then the syrup is mixed with melange, and margarine softened at a temperature of 40°C for 1-2 minutes. The dry ingredients are combined separately. The wheat flour, soy flour, berry powder, arabinogalactan and chemical baking powder are mixed according to the recipe for 10-12 minutes. The resulting dough is molded and baked at a temperature of 220-240°C for 7-8 minutes. Gingerbreads are cooled to a temperature of 40-45°C and then glazed. The glazing of products consists of three stages: preparation of syrup for glazing, glazing, drying and curing of glazed products. Gingerbreads are dried in a drying chamber at a temperature of 60-65°C for 5 minutes, and then at 20-22°C for 3 minutes. After drying, the gingerbreads are sent for curing. Packing, marking, transportation and storage of gingerbread products must be carried out in accordance with the requirements of the current regulatory documentation. Gingerbreads are stored in dry, clean, well-ventilated warehouses, not infected with barn pests, at a temperature not exceeding 18°C and relative humidity of 65-75%. The shelf life of gummy gingerbread is 30 days. According to the results of an organoleptic evaluation, the best indicators were in samples containing 7.5% of powder from barberry fruits and 5.5% of powder from Kamchatka bilberry pomace (Table 1).

Table 1. Organoleptic indicators of gingerbread products

<table>
<thead>
<tr>
<th>Indicators</th>
<th>Samples</th>
<th>Rate</th>
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<tbody>
<tr>
<td>The control sample</td>
<td>Gingerbread «Krasnichnyye»</td>
<td>Gingerbread «Barbarisovye»</td>
</tr>
<tr>
<td>Taste and flavor</td>
<td>Products with a rich sweet taste and aroma, without foreign tastes and smells</td>
<td>Products with a rich sweet taste and aroma, characteristic of the taste of nuts and Kamchatka bilberries, without foreign taste and smell</td>
</tr>
<tr>
<td>Structure</td>
<td>Products with soft, bound structure, not crumbling when broken</td>
<td></td>
</tr>
<tr>
<td>Color</td>
<td>Cream. The color of the crumb is uniform throughout the volume of a product</td>
<td>Lilac. The color of the crumb is uniform throughout the volume of a product</td>
</tr>
<tr>
<td>Condition in a cut</td>
<td>Baked products, with a uniform well-developed porosity, without voids, hardening and traces of unmixed</td>
<td></td>
</tr>
<tr>
<td>Surface</td>
<td>Dry, without large cracks, swellings, sinkholes, not burnt, without sagging</td>
<td></td>
</tr>
<tr>
<td>Shape</td>
<td>Correct, not blurry, without dents, with a domed top. Bottom surface is flat</td>
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The tasting analysis was carried out according to the scoring of organoleptic indicators developed by the authors (Figures 7 and 8).
Fig. 7. Tasting analysis of the organoleptic indicators of gingerbread "Barbarisovye".

Fig. 8. Tasting analysis of the organoleptic indicators of gingerbread "Krasnichnye".

Table 2. Physicochemical indicators of gingerbread products

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Control</th>
<th>Experiment 1 (3.5 %)</th>
<th>Experiment 2 (5.5 %)</th>
<th>Experiment 3 (7.5 %)</th>
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<tbody>
<tr>
<td>Mass fraction of moisture, %</td>
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<tr>
<td>Mass fraction of total sugar</td>
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<tr>
<td>Density, g/cm³</td>
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<tr>
<td>Wetness, %</td>
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<tr>
<td>Mass fraction of fat, %</td>
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<td></td>
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<tr>
<td>Mass fraction of ash, %</td>
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<td></td>
<td></td>
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<tr>
<td>Alkalinity, deg.</td>
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It was established that the physicochemical indicators of the control and experimental samples were within the limits established by GOST. The inclusion of additives from Kamchatka bilberry pomace, barberries, soy flour and arabinolagactan into gummy gingerbread increased the content of total sugar compared to the control sample by an average of 5.0%. Wetness increased in the experimental samples compared to the control one. The mass fraction of moisture increased in the experimental samples by 17.5% and 16.1%. Pectin substances introduced with plant natural ad\textit{ditives exhibit a high gelling ability, forming heat-resistant protein-saccharide complexes. Moisture binds better during dough making and evaporates less during baking, which helps to reduce shrinkage and increase the yield of finished products. Therefore, the introduction of the proposed additives prolongs the freshness of finished products.

The investigated control and experimental samples were stored in the package at room temperature. After ten, twenty and thirty days of storage, the indicators of the control sample deteriorated, in particular, the hardness and flavor of the product decreased, crumbling appeared. The experimental samples had a rich flavor of the introduced berry additives. The microbiological indicators of the products remained within the normal range.

The energy value of gingerbread “Krasnichnye” is 312.1 kcal. The nutritional value per 100 grams of the product is as follows (in gr.): proteins – 7.9; fats – 4.5; carbohydrates – 64.0. The content of vitamins is as follows (in mg.): B1 – 0.36; B2 – 0.92; B6 – 0.58; B12 – 0.37; E – 0.05; C – 5.8. The content of mineral substances is as follows (in mg.): Ca – 17.6; P – 58.1; Na – 24.0; Mg – 27.9; K – 138.0; Fe – 9.54.

The energy value of gingerbread “Barbarisovye” is 338.2 kcal. The nutritional value per 100 grams of the product is as follows (in grams): proteins – 6.1; fats – 4.5; carbohydrates – 72.9. The content of vitamins is as follows (in mg.): B1 – 0.11; B2 – 1.0; B6 – 0.61; B12 – 0.17; E – 0.06; C – 0.94. The content of mineral substances is as follows (in mg.): Ca – 18.4; P – 58.0; Na – 28.0; Mg – 25.2; K – 143.0; Fe – 17.

Gingerbread products are a source of carbohydrates and incomplete proteins. Gingerbreads made according to standard technologies contain up to 76–79% of carbohydrates and 4.5–6.5% of proteins. Experimental samples contain carbohydrates from 64 to 72 g and proteins from 6.1 to 7.9 g. Consequently, the calorie content of the product decreases, but the protein content increases. The addition of soy flour allows enriching gingerbread products with high-grade proteins.

The use of experimental additives in the production of experimental samples helps to preserve freshness, increase digestibility, improve the organoleptic properties of the product, enrich the product with vitamins, minerals, dietary fiber, and high-grade proteins.

4 Discussion

When improving existing technologies and designing products of a functional orientation, it is necessary to exclude artificial additives and use natural components containing a whole range of nutrients. The considered berry raw materials, Kamchatka bilberry and common barberry, are little used in the food industry and not yet sufficiently studied. In the pharmaceutical industry, the additives introduced into the developed recipe for gingerbread are actively researched and used for the production of medicinal products and as biologically active additives.

Raw materials used for food production must be technological, affordable in terms of production and cost. Therefore, researchers are increasingly using regional raw materials, allowing not only to enrich the diet, but also to reduce its cost. Considering these factors, it is necessary to increase the potential of the Far Eastern raw materials for food purposes.

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- The development of recipes for gummy gingerbreads “Krasnichnye” and “Barbarisovye” was carried out taking into account changes in the consumer properties of
finished products. The change in the chemical composition in order to increase the nutritional value was carried out by inclusion of berry powders. Berry raw materials have high humidity and are a good environment for the development of microorganisms. About 5% of moisture is in a bound state, the rest is free and can be removed during drying. When drying berry raw materials, water activity decreases to values below the level required for the development of microorganisms and makes it possible to reliably preserve powders for a long time. Using low-temperature evaporation, it becomes possible to reduce the loss of biologically active substances berry raw materials and to obtain ingredients for industrial use.

A promising raw material for the production of flour confectionery, including gingerbread, is soy flour, which is widely used in the food industry. The recommended application dose is from 1% to 5%. The increased emulsifying properties of the flour make it possible to lower the prescription norms for adding of ingredients (eggs, fats). The use of soy flour increases the machinability of the dough. It enables precise dosing of piece products, which is important in the industrial production of gingerbread products. The presence of fat and protein in flour makes it possible to obtain products with a finely porous and soft, regular crumb structure. Due to the manufacturability, soy flour gives shape stability to gingerbread products. Arabinogalactan has the properties of a prebiotic, water-holding capacity, which is especially important in the production of flour confectionery.

All recommended additives are technological and available for manufacturers in the Far Eastern region. Their use will expand the range of gingerbread products of increased nutritional and biological value, which can be recommended for the daily nutrition of the population.

5 Conclusions

The technologies of obtaining berry powders have been developed. The recipes for gummy gingerbread with a high content of biologically active components and high-grade protein, with a reduced calorie content, with high organoleptic properties are experimentally obtained. The conducted studies allowed to substantiate the expediency of using the selected ingredients and to establish their optimal dosage. It is recommended to apply the powder from Kamchatka bilberry pomace in the amount of 5.5%, the powder from the fruits of common barberry in the amount of 7.5%, soy flour in the amount not more than 5%, arabinogalactan in the amount of 3%.

In further work, it is planned to identify new raw material sources of the Far Eastern region for the creation of enriched food products; to obtain experimental samples and examine the quality of the resulting products in accordance with the requirements of regulatory documents and to expand the line of functional food products.

References


E3S Web of Conferences 371, 01080 (2023) AFE-2022