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Use of vegetable raw materials in production of vegetable - berry purees with the set organoleptic, technological properties and nutrition value

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Abstract. An important component of the population's nutrition is vegetable raw material, including root vegetables. High-quality, standard raw materials are used for fresh sale in retail trade and at catering establishments; they are also laid for winter storage. However, there is a sufficient amount of substandard raw materials - in size, shape, deformation, and violation of integrity. Moreover, such raw materials have a high nutritional value. This paper presents the rationale for the recipe composition of blended types of purees using roots and wild berries. With the help of mathematical modelling, the optimum ratios of the components are determined, at which there is a high correlation between the organoleptic characteristics, technological properties and the content of biologically active substances. The results of the work make it possible to use substandard vegetable raw materials and wild berry stocks rationally. They allow wide use of new types of purees, including its use as semi-finished products for enhancing the nutritional value in the confectionery industry.

1. Introduction

The main types of root crops in the Krasnoyarsk Territory are potatoes, beets, carrots, radishes and some others. Currently the use of Jerusalem artichoke is expanding. This vegetable raw material is used in fresh and processed form; it is affordable and available in the consumer market. Wild berries - lingo berries, cranberries, and sea buckthorn in fresh and processed form are in great consumer demand, however, they have a fairly high cost and every year their resources are limiting.

In terms of nutritional value, berries and vegetables have therapeutic, therapeutic and prophylactic properties. The functional properties of vegetables have a proven effect. So, carotenoids carrots (6–9 mg%) are actively involved in the metabolism of carbohydrates, redox processes. In carrots, root crops accumulate 2 times more alkaline substances than acidic ones, which helps to maintain acid-base balance in the body [1].

Beets contain up to 8 mg% iodine, which is important for areas with iodine deficiency, such as Krasnoyarsk Territory. The ratio of sodium and calcium in beets is 10:1, which contributes to the dissolution of calcium and the removal of its excess from the body. Pectin substances of beet (1.13 - 1.36%) and carrots (2.6 - 2.98%) have antioxidant activity, have a bactericidal effect on the intestinal microflora, and contribute to the elimination of cholesterol. The presence of ballast substances and low calorie content in the composition of beets and carrots makes them indispensable in therapeutic and prophylactic nutrition [2].

Jerusalem artichoke is a root vegetable with a unique chemical composition. The nutritional value of its tubers is due to the high content of functional ingredients. The most valuable is inulin - a polysaccharide, which is contained mainly in tubers and makes up to 80% of the total amount of carbohydrates. Inulin causes an intensive growth of bifidobacteria in the body, prevents the development of pathogenic microflora, helps to restore the disturbed activity of the gastrointestinal tract.

The use of Jerusalem artichoke in raw and processed form causes a significant decrease in blood glucose and cholesterol levels [3,4].

Pectin substances and dietary fibbers of Jerusalem artichoke have a beneficial effect on intestinal motility, restore the microbial flora, and are able to remove metals from the body. Raw Jerusalem artichoke is able to reduce the level of cholesterol in the blood by 30 - 46%. Due to the high content of potassium and silicon, products based on Jerusalem artichoke exhibit antiarrhythmic action. Due to their high iron content, tubers are recommended to be used for anemia [5].

Jerusalem artichoke tubers are widely used as a raw material for the production of inulin and dietary fibber, as well as an enriching additive in various foods.

Sea buckthorn fruits are a valuable raw material for the presence of vitamins: the content of vitamin C in different varieties ranges from 200 to 1000 mg per 100 g; vitamin A in sea buckthorn (11mg / 100g) is dissolved in oil, therefore it is actively absorbed by the human body. Sea buckthorn is the richest source of tocopherol (vitamin E), which has a positive effect on the cardiovascular system [6,7].

Sea buckthorn flavonoids (up to 150 mg%), lingo berries (400–600 mg%), cranberries (up to 250 mg%) have a P-vitamin, antioxidant effect [8]. Berries cranberries, lingo berries, sea buckthorn are a source of pectin. Sea buckthorn contains 0.3-0.4%, in cranberries and lingo berries - 0.5– 0.7% [9.10].

Pectins are able to bind and excrete heavy metal ions, reduce the amount of sugar in the blood and the salt content in the muscles, increase the activity of vitamins. Pectins have a bactericidal effect against staphylococcus, salmonella, and they are used to treat gastrointestinal diseases [11].

In addition to the listed ingredients in sea buckthorn, cranberries, lingo berries there is a wide range of minerals. Due to the presence of benzoic acid, these types of berries have an antiseptic effect [12,13].

At the same time, the choice of vegetable and berry raw materials was carried out taking into account technological properties, such as high concentration of colouring substances, microbiological activity and the gelling ability of berries.

The aim of the work is to develop a prescription composition of vegetable and berry purees with specified organoleptic characteristics, technological properties and nutritional value.

2. Materials and methods

The following types of purees were chosen as objects of study: “Jerusalem artichoke-cranberry”, “Cranberry beetroot”, “Sea-buckthorn carrot”. Various compositions of vegetable and berry raw materials were investigated - from 80:20 to 20:80% with an interval of 10%. The basic scheme of the production of the combined puree types was the preparation and processing of non-standard root crops (cleaning, washing, bringing to a soft consistency by the steam-convection method (convection mode: T = 100 ° C, steam 100%) with further wiping to a homogeneous consistency. Fresh berries were inspected, washed, heated (steam-convection apparatus, convection mode, T = 80 ° C). The lingo berries and cranberries were wiped; juice was pressed from the sea buckthorn. Vegetable and berry puree (or juice) were combined in various ratios by ektsionnym method (convection mode T = 90 ° C, without steam) to a solids content of 20%, according to the regulatory documentation for this type of product. Organoleptic characteristics of all types of samples (colour, taste, aroma, texture) were determined by a 5-point scale. To substantiate the nutritional value of purees, the most significant functional ingredients for each type of puree were determined according to the procedures approved by regulatory documents. Regression analysis of experimental data was carried out in “Statistica 6” applied system and the optimal ratio of ingredients was chosen by MathCAD 2001 program.

3. Research results

The determining indicators of the quality of all compositions are organoleptic indicators - colour, taste, aroma and texture. The organoleptic quality assessment of all types of samples, conducted by experts by a 5-point system, is presented in figure 1.

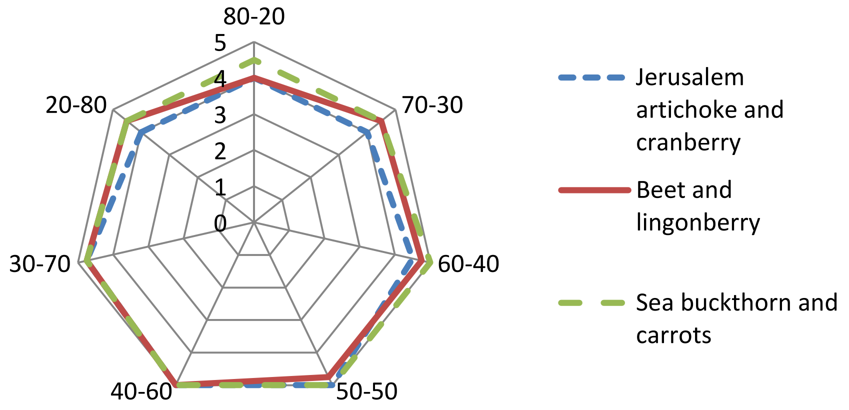


Figure 1. Organoleptic evaluation of various types of vegetable and berry puree compositions, score.

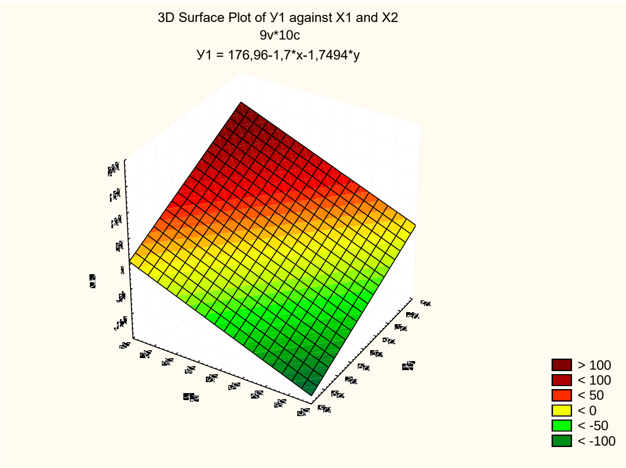
No less important indicators of the quality of purees are their technological properties - active acidity (pH) and gelling ability, forming the strength of the jelly (P). Therefore, we investigated the changes in the indices depending on the concentration of the vegetable and berry component. To determine the optimal ratio of prescription components, a regression analysis of the experimental data was performed. The pH (U_1) and the strength of the jellies (U_2) were chosen as the response function. As variable factors we chose the concentration of vegetable puree (X_1), the concentration of berry puree (X_2). Experimental data are shown in table 1.

Table 1. Changes in the active acidity and gelling ability of purees depending on the variation of prescription components.

X_1 (vegetable purees), %	X_2 (berry purees), %	$У_1$ (pH)	$У_2$ (S)
1	2	3	4
"Jerusalem artichoke and cranberry" puree			
80	20	5.4	110
70	30	5.7	120
60	40	5.9	160
50	50	4.3	180
40	60	3.6	210
30	70	3.33	250
20	80	3.02	270
"Beet and lingonberry" puree			
80	20	3.5	150
70	30	3.8	180
60	40	4.1	200
50	50	3.55	300
40	60	3.43	330
30	70	2.9	350
20	80	2.7	380
"Sea buckthorn and carrots" puree			
80	20	4.1	160
70	30	3.9	190

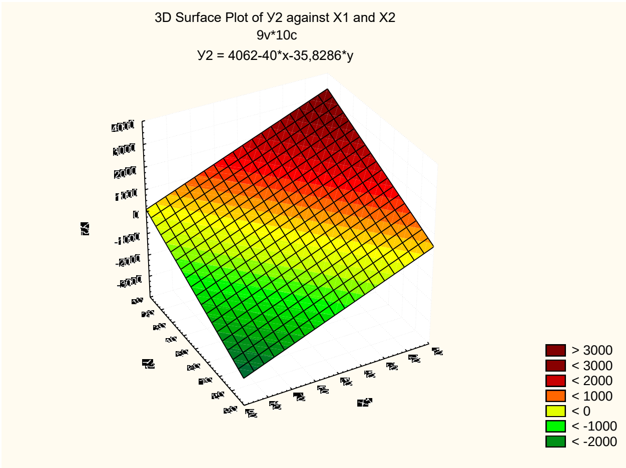
60	40	3.7	220
50	50	3.4	250
40	60	3.2	300
30	70	2.8	320
20	80	2.6	340

As a result of the regression analysis, models were constructed that describe the technological properties of all types of samples. The reliability of the models obtained was evaluated using the R correlation coefficients, R^2 determination, F Fisher criterion. The data obtained are presented graphically (figures 2-7).



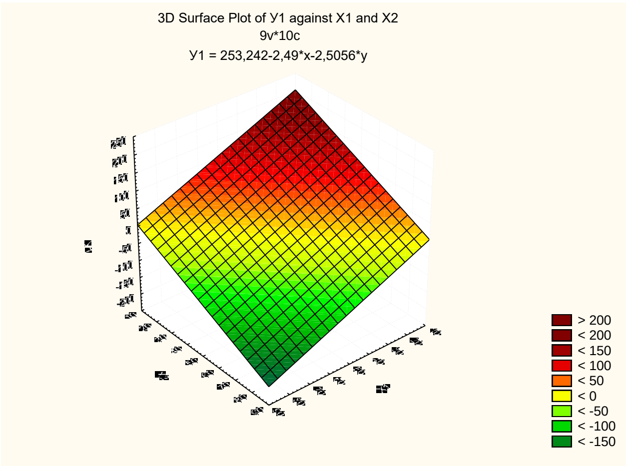
$R=0,914554$ $R^2=0,83641$ $F=10,22568$

Figure 2. The optimal ratio of components of "Jerusalem artichoke-cranberry" puree by the value of active acidity (pH).



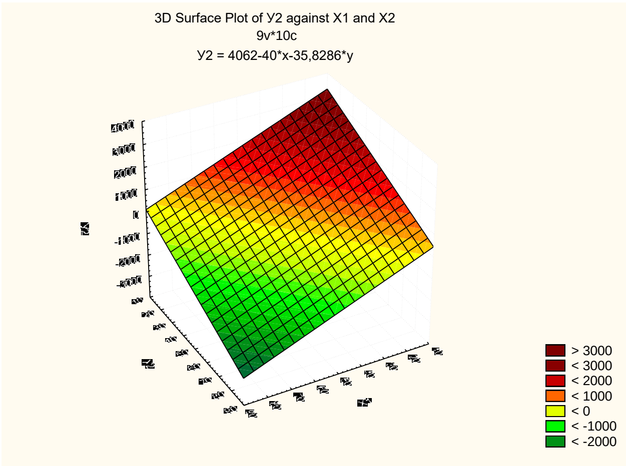
$R=0,976597 R^2=0,953741 F=41,23529$

Figure 3. The optimal ratio of components of "Jerusalem artichoke-cranberry" puree by the strength of jelly (S).



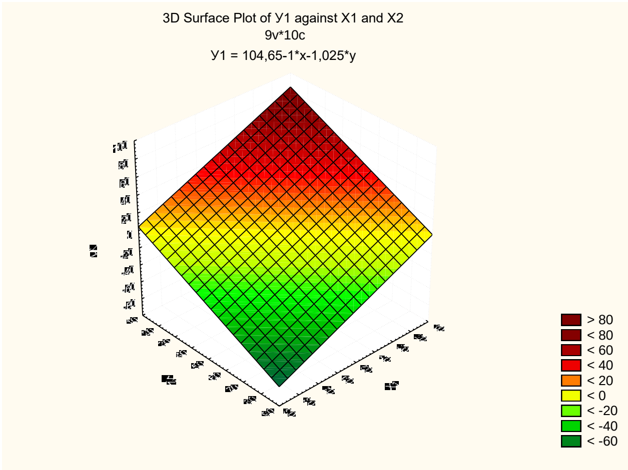
$R=0,792611 R^2=0,628233 F=3,379709$

Figure 4. The optimal ratio of components of the "Beet root - cowberry" puree by the value of active acidity (pH).



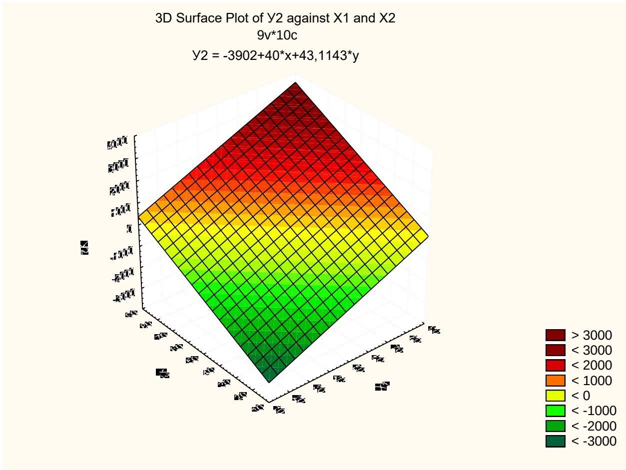
$R=0,976597 R^2=0,953741 F=41,23529$

Figure 5. The optimal ratio of components of "Beet root - cowberry" puree by the strength of jelly (S).



R=0,997321 R^2=0,994648 F=371,7143

Figure 6. The optimal ratio of components of the “Sea buckthorn carrots” puree by active acidity (pH).



R=0,994572 R^2=0,989173 F=182,717

Figure 7. The optimal ratio of components of the carrots - sea buckthorn puree on the strength of jelly (S).

Based on the results of the regression analysis, we obtained mathematical models that adequately describe the experimental data that were used to further predict the formation of technological indicators of new types of mashed potatoes.

In further studies, samples were used that were evaluated by organoleptic characteristics of at least 4.75 points (by a 5-point scale). On this basis, the maximum and minimum dosage of the components of purees was determined, as well as the limits of the functions used (table 2).

Table 2. Data to determine the optimal ratio of components of vegetable and berry puree.

The ratio of components				Limits of functions			
X_1 (vegetable puree), %		X_2 (berry puree), %		У_1 (pH)		У_2 (П)	
X_1 min	X_1 max	X_2 min	X_2 max	У_1 min	У_1 max	У_2 min	У_2 max
Jerusalem artichoke - cranberries puree							
30	50	50	70	3.33	4.3	180	250
Beet root – lingonberry puree							
30	60	40	70	2.9	4.1	200	350
Carrots - sea buckthorn puree							
30	50	50	70	2.8	3.4	250	320

4. Discussion of results

The colour, taste, aroma, texture of new types of purees are of primary importance. The high content of mono- and disaccharides in pureed vegetables gives a sweet taste, which made it possible to develop compositions of purees without sugar. The high content of organic acids in the berries eliminated the additional introduction of acids.

In the production of " Jerusalem artichoke -cranberry" puree, a high organoleptic assessment (4.75-5.0) was obtained by samples of 50:50, 40:60, 30:70. These compositions had a rich pink color, sweet-sour taste, cranberry flavour. Gentle texture. The rating of 4.75-5.0 points was "Beet-cowberry" puree in the ratio of 40:60, 50:50, 40:60, 30:70. Samples had a dark purple colour, taste from sweet to sour-sweet, lingonberry flavour. In the production of carrots-sea buckthorn puree, organoleptic evaluation of 4.75-5.0 points was also obtained for samples 40:60, 50:50, 40:60, 30:70. At the same time, the puree had a delicate texture of rich orange color, sweet in taste, with the aroma of sea buckthorn.

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The presence of acids, carbohydrates in the vegetable-berry system under the action of temperature leads to an increase in the amount of pectin substances capable of forming jelly. With an increase in the dosage of berry puree, the amount of acids increases (a decrease in the value of active acidity is observed), which leads to an increase in gelling ability.

Analysis of changes in the organoleptic and technological indicators of various compositions of vegetable and berry purees, the use of regression equations and the MathCAD 2001 program made it possible to determine the optimal ratio of prescription components of the combined purees. The optimal ratio of vegetable and berry ingredients was (%):

- for “Jerusalem artichoke – cranberry” puree: 41:59;
- for “Beetroot - Lingonberry” puree: 45:55;
- for “Carrot-sea buckthorn” puree: 43:57.

With these ratios, the highest correlation between organoleptic and technological parameters was observed.

The content of the most significant biologically active substances was determined in specific types of vegetable and berry puree (table 3).

Table 3. Content of the most significant biologically active substances in new types of purees (100 g).

The name of the most significant biologically active components	Jerusalem artichoke - cranberries puree	Beet root – lingonberry puree	Carrots - sea buckthorn puree
Inulin, g	6,00±0,5	-	-
Pectin substances, g	3,74±0,08	0,55±0,06	0,61±0,04
Cellulose, g	2,33±0,03	2,21±0,4	1,79±0,04
Vitamin C, mg	26,30±1,8	10,44±1,6	43,25±1,1
β-carotene, mg	-	4,03±0,09	5,23±0,29
Calcium, mcg	21,60±1,6	33,01±0,9	25,2±1,1
Iron, mcg	1,04±0,03	0,92±0,02	0,97±0,05

5. Conclusion

These types of purees are designed for use in the confectionery industry. The use of new types of vegetable and berry purees will allow to diversify the taste properties, improve the structural indicators of various groups of confectionery products, as well as increase the nutritional value by introducing in the composition of the functional ingredients - inulin, β-carotene, fiber and others (depending on the type of puree) absent in traditional.

By adding sugar or pectin to puree, it is possible to adjust the taste, gelling ability and use it purposefully in the production of jelly, jelly, marmalade and marshmallow, to use as fillings for sweets, fillers in cream and protein creams.

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