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IMPROVEMENT OF SHORTBREAD BISCUIT RECIPE WITH ADDITION OF VEGETABLE POMACE POWDER

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The article presents the results of obtaining carrot and pumpkin pomace powders and adding them to modified shortbread biscuit recipes for enrichment with carotenoids and dietary fiber. Carrot and pumpkin powders are obtained by convective drying. The carotenoid content, according to the experimental data, was 5.22 mg per 100 g of pumpkin powder and 13.4 mg per 100 g of carrot powder. The developed recipes for shortbread biscuits, as expected, were distinguished by a high content of dietary fiber and carotenoids, excellent organoleptic evaluation, but at the same time they had low water-absorption, which was reflected in the rapid staleness of the products. The satisfaction of the daily requirement for dietary fiber when taking 50-75 g of enriched biscuits is more than 11%, in vitamin E - more than 28%, beta-carotene - more than 2.5%. The calorie content of the experimental biscuits was reduced by 2.7%.

***Key words**: shortbread biscuit, carrot pomace, pumpkin pomace, powder*

INTRODUCTION

The annual increase in the prevalence of "diseases of civilization" associated with nutritional disorders requires maximum improvement of the diet. Every day a person is exposed to stress of varying quality, which each body counteracts in its own way. The struggle of the immune system often results in deficiencies of macro– and micronutrients. Thus dietary supplements and fortified food products which are able to treat lack of important nutrients should be developed.

Flour confectionery products are not usually associated with a healthy diet, but the interest of researchers in this area of the food industry isn't about to end. Trends in enriching the composition of shortbread biscuits include the addition of fruit and vegetable pomace (a secondary raw material from juice production) in a fresh or dried form into the recipe. There are well-known works of Russian and foreign researchers on the use of fruit and vegetable pomace's components in biscuit recipes. The advantages of enriching biscuits with such additives include the following:

1) the positive effect of pomace on the rheological properties of shortcrust pastry [1];
2) increasing the antioxidant properties of biscuits due to the biologically active substances of the pomace [1-3];
3) increasing the resistance to lipid oxidation of biscuits during storage [2];
4) increasing the shelf life of biscuits [4];
5) increasing the biological value of the finished product [2, 3, 5, 6], including the increase in the content of dietary fiber [7, 8];

6) reducing the glycemic index of the product [7];
7) processing of secondary raw materials from juice production is economically profitable.

According to scientific works, the pomace of such plants as apples [5, 7], carrots [5, 6, 8, 9], beets [5, 6], pumpkin [9, 10], grapes [1] (including seeds [9]), hawthorn fruits [5], orange [3], lemon [2], pineapple [4], pomegranate [9] has already been successfully tested in the enrichment of biscuits. At the same time, studies also mention a negative effect of adding fruit and vegetable pomace to the recipe of flour confectionery products - it's an increase in staleness of a product and its excessive hardness [1]. Therefore, a number of researchers also propose technologies for obtaining aqueous-alcoholic extracts from fruit and vegetable pomace [1, 2].

THE OBJECT OF THE RESEARCH

The objects of the research are shortbread biscuit and carrot and pumpkin pomace in a fresh and dried state.

THE PURPOSE AND TASKS OF THE RESEARCH

The purpose of the research is to study the possibility of using dried carrot and pumpkin pomace in the recipe for low-calorie shortbread biscuits.

To achieve this goal, the following tasks should be completed:

- to obtain carrot and pumpkin pomace powder and evaluate its quality indicators;
- using one of the classic recipes for shortbread biscuit, to develop the fortified ones with the addition of carrot and pumpkin powder and evaluate the quality of the finished product.

METHODS OF THE RESEARCH

During the work, scientific literature on fortification of shortbread biscuits was analyzed and summarized.

The mass fraction of moisture in fresh and dried pomace was determined by the thermogravimetric method by the difference in mass of the sample before and after drying in a moisture testing oven at a temperature of 105°C for several hours (until constant weight).

Bulk and tapped density of the powders was measured using a technical balance and a graduated cylinder. A sample of powder of a certain weight was placed in a graduated cylinder so that the volume occupied by the sample could be measured. When determining tapped density, the sample of powder must be tapped. After this, the mass of the sample is divided by the occupied volume and the result is expressed in kg/m^3.

Quantitative determination of carotenoids in experimental powders was carried out according to the method [11], that involves extracting carotenoids and chlorophyll with 70% ethanol, measuring the optical density of the solution on a spectrophotometer at a wavelength of 440.5 nm, and calculating the carotenoid content using empirically derived formulas.

The chemical composition of control and test samples of biscuits was determined by calculation using literature data [12] with the help of a spreadsheet processor.

Water-absorption was determined by immersing the whole product in water for a period of time and weighing it according to GOST 10114-80 Biscuits. Method for determination of swelling in water.

The organoleptic assessment of the enriched biscuits was carried out using a developed five-point scale, taking into account the significance coefficients of individual indicators. The minimum score is 3.7 points, the maximum is 18.5 points.

RESULTS OF THE RESEARCH

1 Obtaining pomace powder

The choice of raw materials (carrots and pumpkin) for enriching biscuit recipe with dried pomace was made on the basis of data from previous studies [13], which resulted in the formulation

of fortified “Tykvennoe” biscuits with a high content of beta-carotene, vitamin E and dietary fiber. Carrots and pumpkin are available raw materials in the Kaliningrad region and are characterized by a high content of beta-carotene, that, in turn, is included in the list of micronutrients recommended for fortifying confectionery products with [14].

Carrot and pumpkin pomace was obtained in laboratory conditions by grinding the raw materials and squeezing the juice manually through cheesecloth. The moisture content of carrot pomace was 85.0%, pumpkin one – 90.3%. The pomace was dried using a convective method on an electric dryer Scarlett SC-420 at a temperature of 55-60 °C for 8-10 hours. The dried pomace was ground in a mill to the state of micropowder. Physical quality indicators of the finished powders are presented in Table 1.

Table 1 – Physical quality indicators of pomace powders

Indicator	Pumpkin pomace powder	Carrot pomace powder
Moisture, %	7.9	7.3
Bulk density, kg/m^3	722.4 (medium density powder)	526.9 (light density powder)
Tapped density, kg/m^3	792.3	545.7
Powder yield from fresh pomace, %	7.4	8.9
Carotenoid content, mg/100 g	5.22 (in fresh pumpkin – 1.50 [12])	13.4 (in fresh carrots – 12.0 [12])
Estimated dietary fiber content, %	29.7 (in fresh pumpkin – 2.0 [12])	33.5 (in fresh carrots – 2.4 [12])

As a result, we obtained pumpkin (Figure 1) and carrot (Figure 2) fine pomace powders of yellow and orange colors, respectively. Each powder had a weak odor of pumpkin and carrot.

Figure 1 – The appearance of pumpkin pomace powder

Figure 2 – The appearance of carrot pomace powder

Taking into account the results of powders' evaluation, it was decided to introduce carrot and pumpkin pomace powders into shortbread biscuit recipe.

2 Developing and evaluation of new recipes

Taking as a basis a set of enriching ingredients from the previously developed recipe for "Tykvennoe" biscuits (lupine flour, vegetable oil, dried carrot and pumpkin pomace) [13], we composed experimental recipes. Replacing butter with sunflower oil allows to enrich the product with unsaturated fatty acids (linoleic and oleic), as well as eliminate the presence of trans isomers of fatty acids in the finished biscuit. Lupine flour improves the amino acid composition of biscuit protein and flavor and aroma properties.

As a control formulation we had chosen the recipe No. 157m "Cvetochek" [15] with moderate energy value. The control and experimental formulations are shown in Table 2.

Table 2 – The control and experimental shortbread biscuit recipes

Ingredient	The ingredient content, g per 100 g of finished product		
	Biscuit No. 157m «Cvetochek» (control formulation)	Biscuit «Cvetochek», fortified with carrot-pumpkin pomace powder (formulation No. 1)	Biscuit «Cvetochek», fortified with carrot-pumpkin pomace powder and pectin (formulation No. 2)
Wheat flour	48.8	48.4	48.4
Lupine flour	-	7.6	7.6
Powdered sugar	31.5	25.0	25.0
Inverted sugar syrup	0.49	0.49	0.49
Butter	24.4	-	-
Sunflower oil	-	19.5	19.5
Melange	19.5	19.5	19.5
Vanilla powder	0.24	-	0.24
Carrot pomace powder	-	2.45	1.96
Pumpkin pomace powder	-	2.45	1.96
Apple pectin	-	-	0.98

Experimental recipe No. 1 included carrot and pumpkin pomace powders, the amount of which was selected in such a way as to replace a total of 20% of butter. The amount of powdered sugar was also reduced by 20.6% and the total amount of wheat and lupine flour was recalculated into dry matter.

In experimental formulation No. 2, in addition to carrot-pumpkin powder, apple pectin was introduced (a hydrocolloid widely used as a food thickener). The purpose of adding pectin to shortbread biscuit was to supplement the insoluble dietary fiber of the pomace (cellulose) with soluble fiber (pectin) in order to balance the product in terms of indigestible carbohydrates, to improve the fat-holding capacity of the shortbread dough and to improve the quality of the finished product. Pectin was added in combination with carrot-pumpkin powder at a mass ratio of 1:4 for pectin and vegetable powder, respectively. This mixture replaced 20% oil.

The appearance of the finished biscuit samples is shown in Figures 3-5.

Figure 3 – Biscuits cooked according to the control

Figure 4 – Biscuits cooked according to formulation No. 1

Figure 5 – Biscuits cooked according to formulation No. 2

formulation

The biscuits made according to the control recipe were a pale product with surface irregularities, and the dough exhibited pronounced adhesive properties and was difficult to mold. Because of hard molding issue, irregular biscuit shapes and surface irregularities were subsequently observed. The experimental recipes were adjusted, among other things, to change the consistency of the dough to the characteristic one of shortbread biscuit. Biscuits made according to recipe No. 1 were distinguished by positive organoleptic characteristics: the biscuits turned out to be bright in color, lupine flour imparted a characteristic flavor; the dough became crumbly and did not spread so the products turned out to be of the correct shape and with a smooth surface. Biscuits made according to recipe No. 2 had the same attractive appearance, smell and taste.

The chemical composition of the control and experimental biscuits, established by the calculation method, as well as some indicators of biscuit quality are given in Table 3.

Table 3 – The chemical composition and physical quality indicators of the control and experimental biscuits

Nutrient	The control formulation		Formulation No. 1		Formulation No. 2		The requirments of GOST 24901-2014
	Content in 100 g of biscuits, g	*% satisfaction of the daily intake of the nutrient*	Content in 100 g of biscuits, g	*% satisfaction of the daily intake of the nutrient*	Content in 100 g of biscuits, g	*% satisfaction of the daily intake of the nutrient*	
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Solids, g	94.3	-	95.1	-	95.7	-	no less than 84.0
Moisture, g	5.7	-	4.9	-	4.3	-	no more than 16.0
Protein, g	7.2	-	10.5	-	10.5	-	not defined
Fat, g	21.7	-	21.3	-	21.3	-	no more than 40.0
Carbohydrates (digestible), g	63.3	-	57.7	-	58.0	-	total sugar – no more than 45.0
Dietary fibers, g	1.6	*6.5*	5.3	*21.2*	5.7	*22.8*	not defined
Beta-carotene, mg	0	*0*	0.35	*7.0*	0.28	*5.6*	not defined
Vitamin E, mg	1.04	*6.9*	8.74	*58.3*	8.75	*58.3*	not defined
Energy value, kcal	477.3	-	464.2	-	465.4	-	not defined
Water-absorption, %	157 ± 13		117 ± 9		111 ± 9		no less than 150 %
Organoleptic value, points	13.9 (good product)		14.9 (excellent product)		15.6 (excellent product)		-
Yield, %	82.4		84.2		83.6		-

The developed recipes No. 1 and No. 2 are characterized by a higher protein content, a slightly lower content of digestible sugars and a high amount of indigestible ones. The biscuits are also enriched with vitamin E and beta-carotene. When consuming a daily dose of this product (50-75 g), the daily intake of dietary fiber will be satisfied by more than 11%, in vitamin E - by more than 28%, beta-carotene - by more than 2.5%. Experimental samples are also characterized by a slightly lower calorie content (by 2.7%).

CONCLUSIONS

In the course of the work, carrot and pumpkin pomace in native and dried form was obtained in laboratory conditions. When assessing its properties, it was concluded that it contains sufficient carotenoids and dietary fiber.

As experimental recipes, modifications of the classic recipe for shortbread biscuit No. 157m were developed with the addition of lupine flour, replacing butter with sunflower oil, reducing its share by introducing carrot and pumpkin pomace powders, as well as pectin. The results of calculating the chemical composition of test samples of biscuits demonstrated a decrease in calorie content, an increase in the mass fraction of dietary fiber, vitamin E and beta-carotene, which justifies the introduction of dried carrot and pumpkin pomace into the recipe for shortbread biscuit to reduce its calorie content, as well as increase its biological value.

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ИССЛЕДОВАНИЯ ПО СОВЕРШЕНСТВОВАНИЮ РЕЦЕПТУРЫ ПЕЧЕНЬЯ СДОБНОГО С ДОБАВЛЕНИЕМ ВЫСУШЕННОГО ОВОЩНОГО ЖМЫХА

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В статье приведены результаты по получению порошков морковного и тыквенного жмыха и внесению их в состав модифицированных рецептур сдобного печенья для обогащения каротиноидами и пищевыми волокнами. Морковный и тыквенный порошки получены методом конвективной сушки. Содержание каротиноидов, по экспериментальным данным, составило 5,22 мг на 100 г тыквенного порошка и 13,4 мг на 100 г морковного порошка. Разработанные рецептуры сдобного печенья ожидаемо отличались повышенным содержанием пищевых волокон и каротиноидов, отличной органолептической оценкой, однако при этом имели низкую намокаемость, что выражалось в быстром черствении изделий. Удовлетворение суточной потребности в пищевых волокнах при приеме 50–75 г экспериментального печенья составляет более 11 %, в витамине Е – более 28 %, бета-каротине – более 2,5 %. Калорийность опытного печенья снижена на 2,7 %.

Ключевые слова: *сдобное печенье, морковный жмых, тыквенный жмых, порошок*.