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IMPROVEMENT OF THE RECIPE COMPOSITION OF SPECIAL-PURPOSE GLUTEN-FREE CHOCOLATE MUFFINS

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Abstract. The paper considers how gluten-free flours, in particular, those made from coconuts and brown rice, can be used in the technology of gluten-free chocolate muffins in order to expand the range of special purpose products. Studies by domestic and foreign authors dedicated to using different flour types in today's gluten-free technologies have been analysed. It has been proved that wheat flour can be fully replaced with gluten-free flour mixtures in the recipe of chocolate muffins. Analysis of the chemical composition of coconut flour has shown its higher fat content, compared with wheat flour, and twice as much protein and dietary fibre (18%). Coconut flour exceeds wheat flour not only in the main macronutrients, but also in the content of the main minerals. Brown rice flour, too, contains more fats and vitamins of the B-group than wheat flour does, and is a source of sodium, magnesium, phosphorus, silicon, and sulphur. It contains up to 80% of starch and, like coconut flour, is gluten-free. Replacing wheat flour in the classical muffin recipe with mixtures of coconut and brown rice flours in the ratios 30:70, 40:60, and 50:50 reduces the moisture content and density of the dough. The moisture content in the finished muffins, too, is lower by 0.7, 1.2, and 1.5% respectively. It has been confirmed that if the gluten-free flour mixture contains over 50% of coconut flour, it reduces the specific volume of resulting muffins and worsens their quality parameters. The Harrington method was used to estimate the comprehensive quality index of the chocolate muffins. This has shown that full substitution of wheat flour for a mixture of gluten-free flours in the ratio 40:60 (coconut flour:brown rice flour) allows achieving the best-balanced sensory characteristics. Gluten-free muffins have a pleasant brown colour of the crust, their crumb is quite soft, homogeneous, and porous, with a balanced taste and an aroma of cocoa combined with light coconut notes.

Keywords: coeliac disease, gluten-free flour, coconut flour, brown rice flour.

Introduction. Formulation of the problem

Nutrition has always been one of the main factors determining a person's physical condition and directly affecting life quality and expectancy. That is why nowadays scientists and manufacturers are paying ever more attention to developing food products for customers with special nutritional requirements [1] .

Coeliac disease (gluten disease, gluten enteropathy, Gee's disease, enteric disease, intestinal infantilism) is a chronic disease of the small intestine caused by congenital protein (gluten) intolerance.

WHO/FAO defined gluten as a protein fraction found in wheat, rye, barley, oats, or their crossbred varieties (e.g. triticale) and their derivatives. Like other prolamins, it is soluble neither in water nor in 0.5M NaCl. Prolamins are defined as a protein fraction that can be extracted by 40–70% aqueous ethanol [2].

Coeliac disease used to be considered a very rare illness that only affects children. Then, in the mid-nineteenth century, it became possible to diagnose coeliac disease with the help of special serological tests of blood that detected disease-specific antibodies, and the perception of this disease changed significantly. It was found that coeliac disease (gluten enteropathy) was a pathology common in different social groups and affecting not only children, but adult people, too [3].

According to the World Gastroenterology Organisation, about 1% of our planet's population are now ill with coeliac disease [4].

For coeliac patients, many countries developed the technologies and organised the manufacture of gluten-free bread, pasta, biscuits, muffins, cakes, baking mixes, etc. In the Ukrainian market, gluten-free products are mainly imported and distributed through specialised shops or purchased online [5].

Gluten-free restaurant foods, too, are quite popular with consumers. To learn the promising food trends, experts from the American National Restaurant Association conducted an annual survey. 1300 professional chefs, members of the American Culinary Federation took part in it. As a result, ten major trends were announced, one of which was the introduction of gluten-free cuisine. Its idea is giving up foods, including confectionery, based on wheat, rye, barley, and replacing them completely with rice, buckwheat, millet, and legumes [6].

Analysis of the catering market in Europe, in particular, in France and England, shows that in most restaurants, particularly in the specialised ones, gluten-free products are found not only as separate items in the menu, but as special menus. This is because eating food based on gluten-free raw materials not only contributes to treatment of coeliac patients, but the gluten-free diet is also beneficial to healthy people's working efficiency [1].

The largest amounts of gluten are contained in wheat, barley, and rye. Gluten-free flour (from rice, oats, and maize) has specific technological properties different from those of wheat flour. Therefore improvement of the confectionery technology for catering enterprises requires a series of studies to determine the effect of the new components on the sensory, physicochemical, structural, and mechanical properties of finished products [7].

Analysis of recent research and publications

According to the traditional technology, the main ingredient of cakes is wheat flour. It has a high content of carbohydrates (70g/100g) and calorific value (334kcal/100g), is low in minerals and vitamins, which combine with the peripheral parts of a grain [8], and contains gluten. That is why scientists are searching for alternative types of gluten-free flour from non-traditional raw materials.

Today, scientists pay much attention to the developing new recipes and improving the methods of manufacturing gluten-free products based on vegetable raw materials in order to obtain food with appropriate organoleptic, structural, mechanical, and physicochemical parameters [9-12].

In the National University of Food Technologies, a group of scientists led by Professor A. Dorokhovych developed a wide range of gluten-free confections. This range includes sugar biscuits, butter and shortbread biscuits, those made from whipped egg whites, cakes, muffins, honey bread, and wafers based on gluten-free rice, buckwheat, maize, and soya flour [3].

A team of scientists led by E. Badiu established that using flour from rice, sorghum, maize, millet, buckwheat, and amaranth allowed producing high-quality gluten-free bread [2].

Researchers from Yeldiz University (Turkey) tried to obtain the tasty and healthy oriental gluten-free dessert *revani* based on maize, rice, and potato flour, and on maize and tapioca starch, with the use of soya and pea protein and the enzyme trans-glutaminase. They experimentally proved that revani showed the best quality with a flour mix containing maize and rice flours (in the amount 62.5% and 37.5% respectively) and trans-glutaminase (TG) [13].

N. Danovych, Y. Krasyna, and O. Kazmyna gave reasons for production of gluten-free wafers from a mixture of buckwheat flour and grape seed powder in the ratio 1:0.3. By its organoleptic and physicochemical characteristics, the product is non-inferior to traditional wafers made with the use of wheat flour [14].

A number of scientific developments confirm that addition of alternative types of malt flour, such as maize, rice, and oat flours, with the reduced calorific value 325, 283, and 287kcal respectively, in combination with other natural additives, modifies the calorific and nutritional value of confectionery [15,16].

A number of gluten-free flour products contain not enough dietary fibre and minerals that are lost during flour processing. But wholegrain, especially maize flour has a far shorter shelf life period, as maize grain germs that get into flour contain a lot of fats causing fast rancidification of flour. Thus, the authors [17] believe extrusion treatment of wholegrain maize flour can help. The research results prove that it allows extending the shelf life of flour and obtaining biscuits with improved organoleptic characteristics, crumblier texture, and an increased content of dietary fibre (more than 8.4 per 100g) [17].

The developments of the team of authors [18] demonstrated how using extruded maize flour in the technology of semi-finished biscuits improved their quality and increased their shelf life.

The authors led by V. Dotsenko gave reasons for using extruded rice flour as a raw material for flour confectionery [19].

The effectiveness of rice, buckwheat, and maize flour in the biscuit technology was proved by several studies. According to them, adding rice flour into the recipe makes it unnecessary to use any improvers, since the quality of the confections obtained is high enough. On the other hand, using maize and buckwheat flour requires adding extra components to improve the texture of the biscuits: maize starch for buckwheat flour products, and inulin BENEOTM ST for maize flour biscuits [20,21].

The latest scientific and practical achievements in developing and improving the technologies of gluten-free products and consumers' increasing demand for them (involving catering enterprises, too) stimulate

further studies of gluten-free raw materials in Ukraine to prove their effectiveness in flour confectionery production.

Quite a lot of scientific developments confirm the effectiveness of using rice flour and composite mixtures based on it in the technology of gluten-free foods [22,3,13]. Its wide use is due to its functional properties and ability to add certain structural and mechanical characteristics to gluten-free flour products without any extra structure-forming agents [21]. A disadvantage of rice flour made by the traditional technology, though, is a high starch content and too small amounts of dietary fibre, essential amino acids, vitamins, macro- and micronutrients. This results from the processing of rice grain before grinding and reduces the nutritional value of foods based on it. Besides, the consumer properties of rice flour-based confections are significantly inferior to those of wheat flour foods [22].

Recently, in the gluten-free flour market, manufacturers have been offering brown rice flour as a substitute for traditional rice flour [23].

A way to enrich the chemical composition of gluten-free foods and improve their consumer properties, including the taste and aroma, could be the use a mixture of brown rice flour and coconut flour, the demand for which has been growing recently.

The scientists [24,25] claim that the higher is the dose of coconut flour added to the recipe of flour mixtures, the more it reduces the content of carbohydrates and increases that of protein, fat, cellulose, soluble and insoluble dietary fibre, and bioactive substances. Water and fat absorption increases, too. The coconut flour content as high as 10% allows obtaining foods with much better sensory characteristics than in the control samples.

The dietary fibre composition of coconut flour (60±1.0g/100g flour, 56% of soluble and 4% of insoluble fibre), the effect of its dosage on absorption of minerals, the glycaemic index of finished products, and the ability to lower cholesterol effectively – all this confirms that coconut flour can be used as a functional product and enriching ingredient in flour-based food technologies [26].

Quite a number of scientific developments by domestic scientists confirm the effectiveness of coconut flour in the technology of cakes [27].

A comparative analysis of the chemical compositions of wheat, coconut, and brown rice flours is presented in Table 1.

The data in this table indicate that coconut and brown rice flours are sources of a wide range of natural macro- and micronutrients. Compared with wheat, coconut flour contains significantly more fat and twice as much protein and fibre (18%). Along with the main macronutrients, coconut flour also exceeds the wheat flour in the content of the main minerals, primarily sodium, potassium, calcium, magnesium, iron, phosphorus, sulphur, and silicon.

Table 1 – Comparative characteristics of wheat, coconut, and brown rice flours

Parameter	Flour type		
	Patent wheat [28]	**Coconut [27]**	**Brown rice [23]**
Proteins, g	10.3	20.0	7.9
Fat, g	1.1	16.6	2.9
Carbohydrates, g, including:	69.0	60.0	77.2
Mono- and disaccharides, g	0.2	2.0	0.7
Starch, g	68.7	40.0	73.2
Fibre, g	0.1	18.0	3.3
Minerals, mg:			
Sodium	3.0	20.0	12.0
Potassium	122.0	356.0	100.0
Calcium	18.0	43.0	8.2
Magnesium	16.0	39.0	48.0
Phosphorus	86.0	95.0	150.0
Iron	1.2	2.25	2.3
Zinc	1.97	0.78	1.42
Manganese	–	1.31	1.25
Chlorine	–	120.0	25.0
Sulphur	–	44.0	46.0
Silicon	–	–	100.0
Vitamins, mg:			
B_1	0.43	0.06	0.14
B_2	0.16	0.01	0.021
B_3	4.9	0.96	3.3
B_5	0.49	0.2	0.82
B_6	–	0.06	0.44
B_9	–	30.0	0.019
E	2.71	0.72	0.11
K	1.92	12.0	–
Calorific value, kJ	1396	1948	1547

Compared with wheat flour, brown rice flour contains more fat, is characterised with a wide range of B vitamins, and is a source of sodium, magnesium, phosphorus, silicon, and sulphur. Brown rice flour contains a lot of starch (up to 80%) and, like coconut flour, does not contain gluten at all.

Consumption of foods made from gluten-free flour rich in natural macro- and micronutrients (their content is especially high in coconut flour) has a positive effect on the human body, its immune, cardiovascular, and nervous systems.

The **purpose of the research** is to study the properties of coconut and brown rice flours, to determine and further use in production the recipe composition of special purpose gluten-free chocolate muffins. To achieve this goal, the following **objectives** were formulated:

– to perform comparative analysis of the sensory and physicochemical quality parameters of the selected flour samples (wheat, coconut, and brown rice);

– to determine the ratio of the recipe components of a coconut and brown rice flour mixture for special-purpose gluten-free chocolate muffins;

– to estimate the complex quality index using the Harrington method, and to study the physicochemical parameters of the products obtained.

Research materials and methods

In the course of the research, it was suggested to replace completely wheat flour with a brown rice and coconut flour mixture in the recipe of chocolate muffins.

In the research, patent wheat flour and brown rice flour produced by the brand *Ms. Tally* were used. The latter is made according to Specifications of Ukraine 10.6-31680679-003.2013 from brown rice grown in Ukraine. Also, coconut flour of the brand *Nutiva* (Thailand) was used [27]. The quality parameters of the test samples of flour are given in Table 1.

To determine the optimal ratio of the components in the recipe mixture, wheat flour was completely replaced with the gluten-free types, coconut and brown rice, in the following ratios:

• control - 100% wheat flour;

• Sample 1 – 30:70, coconut and brown rice flours respectively;

• Sample 2 – 40:60, coconut and brown rice flours respectively;

• Sample 3 – 50:50, coconut and brown rice flours respectively.

The recipe compositions of the test samples of muffins are shown in Table 2.

The test samples were prepared according to the traditional technology, which involves the following steps:

1. *Preparation of raw materials.* Performed in accordance with the regulatory documentation [29].

2. *Preparation of emulsion.* Margarine (temperature 10-12°C) was cut into pieces. They were whipped with a beater running slow until a homogenous mass was formed. Then the rotation was sped up, sugar, milk (at room temperature), and sieved cocoa powder were added, and the mixture was whipped for another 10 minutes. The final mixture was heated to 50-60°C.

3. *Kneading the dough and moulding the semi-finished product.* The mixture cooled down to room temperature. Then processed eggs, baking soda, crushed roasted nuts, and sifted flour were added to it. The dough was thoroughly mixed so that no lumps were left, and then placed nto prepared moulds.

4. *Baking the products.* Baked for 15-20 min at 180°C.

5. *Decoration of the products.* After baking, the products were cooled down and decorated with powdered sugar, fresh berries, and mint leaves.

The research involved the use of the generally accepted methods of organoleptic assessment and physicochemical analysis (in triplicate) [29, 30], the dialectical method of inquiry, and the methods of theoretical generalisation.

The moisture content of the flour and finished products was determined by the standard method [31], which is also used to determine the moisture content of muffins made with the use of flaxseed [32].

Table 2 – Recipe composition of the test samples of chocolate muffins, g

Ingredients	Samples			
	Control	Sample 1 (30:70)	Sample 2 (40:60)	Sample 3 (50:50)
Patent wheat flour	8.0	–	–	–
Coconut flour	–	2.4	3.0	4.0
Rice flour	–	5.6	5.0	4.0
Sugar	11.0	11.0	11.0	11.0
Milk	5.0	5.0	5.0	5.0
Margarine *Stolychny Kyivsky* (50% fat)	10.0	10.0	10.0	10.0
Eggs	5.0	5.0	5.0	5.0
Roasted peanuts	5.0	5.0	5.0	5.0
Baking soda	0.2	0.2	0.2	0.2
Cocoa powder	5.0	5.0	5.0	5.0
Weight of the finished product	**50**	**50**	**50**	**50**

To determine the mass fractions of moisture in the flour and the chocolate muffins, the 5 g test samples were weighed in pre-prepared weighing bottles with caps. The open bottles with the samples were placed in a drying cabinet SESh-3M heated to (105±2)°C, where they were dried to constant weight. After drying, the weighing bottles with the samples were loosely capped and placed in a desiccator for 30 minutes, then weighed tightly closed. To prevent the formation of crusts on the surface, to facilitate and accelerate the drying process while determining the mass fraction of moisture in the dough, additional 25g of calcined sand was added to the bottles.

The mass fraction of moisture (W) was calculated as the ratio of the mass of moisture to the mass of a weighed sample portion of the product, expressed as a percentage [29,30].

The state of moisture in the dough was determined by thermogravimetry. The use of this method allows differentiating the moisture in the product more clearly by the forms of bonds. The study was performed using a derivatograph Q-1000 in the temperature range 20-240°C with a heating rate of 2.5°C per minute [11].

The density of the dough was determined using the method described by the team of authors from Akure Federal University of Technology [24]. According to it, a 100ml calibrated measuring cylinder was carefully filled with dough samples of a certain mass (m). The dough cylinder was gently shaken to distribute the dough evenly, and the volume (V) occupied by the dough was checked. The density was calculated as:

$$G=m/V. \quad (1)$$

The specific volume of the chocolate muffins was calculated as the ratio of the volume of the finished products to their weight [33]. The volume of the muffins was determined after the cooling was complete (2 hours after baking). To determine their volume, the container was completely filled with millet. The excess of the millet was again removed with a ruler. Then, the same container, now with a muffin inside, was filled with millet again. The excess of the millet was again removed with a ruler, and the volume of millet that did not fit in the container was checked. To do this, the millet that did not fit in the container was placed in the measuring cylinder, and the volume of the millet was measured. The resulting value was the volume of the finished muffin.

The alkalinity of the chocolate muffins results from chemical leavening agents added to their composition. In this research, the standard method was used [29,30]. It is based on the following: alkaline substances contained in the pre-prepared extract (from a product sample) are neutralised by hydrochloric acid ($0.1 mol/dm^3$) in the presence of bromothymol blue as an indicator until a light yellow colour appears. The discrepancy of two parallel definitions should not exceed 0.2deg.

The quality of the samples was assessed by one of the main and probably the most successful methods of assessing the quality of an object under study by a set of parameters, using Harrington's generalised desirability function. The latter is based on transforming the natural values of individual responses into a dimensionless scale of desirability (preferences). To this end, the organoleptic properties of the object were studied, the basic points on the desirability scale were determined, a generalised desirability function was constructed, a generalised quality index was calculated, and the results and conclusions were analysed.

The desirability scale is one of psychophysical scales. Its purpose is to establish a correspondence between physical parameters (characterising the functioning of the object investigated) and psychological parameters (describing the customer). To obtain a desirability scale, one can use the existing tables of correspondences (Table 3) [34-36].

Table 3 – Standard points on the Harrington desirable scale

Desirability	Points on the desirability scale
Very good	10.0–8.0
Good	less than 8.0–6.0
Satisfactory	less than 6.0–4.0
Bad	less than 4.0–2.0

The quality characteristics of different types of gluten-free flour directly depend on the quality of the raw materials it is obtained from. Coconut and brown rice flours are relatively new types on the Ukrainian flour market. They are not intended for production of a specific group of foods and, depending on their properties, can be used in different technologies. That is why there is a need for a more detailed study of their sensory and basic physicochemical quality characteristics in order to establish whether they can be used in the recipe of muffins.

The results from Table 4 make it clear that all the test samples differ in their quality characteristics. Flour from brown rice has a creamy colour due to the presence of the peripheral parts of rice grains that remains unpolished. Thus, the recipe composition of chocolate muffins should be improved.

Coconut flour has a light, unobtrusive, somewhat sweetish taste, because it contains more sugars than cereal flours do.

All flour samples have almost the same water content 9–10 %. However, the different contents and properties of fats, proteins, and starch in wheat, coconut, and brown rice flours can result in different technological properties during muffin production. Thus, the authors [37] researched the use of rice flour combined with sorghum flour in the technology of muffins. They found that this combination reduced the moisture content of the dough and of finished products and increased the porosity and crumbliness of the latter.

Table 4 – Quality characteristics of wheat, coconut, and brown rice flours (the tests were repeated in triplicate); n=3; p≤0.05

Flour type	Parameter					
	Smell	Taste	Colour	Crispness	Mass fraction of moisture, %	Acidity, deg.
Patent wheat	Characteristic of this type flour, without mouldy, stale smells or other off-odours	Slightly sweet, without bitter or sour aftertaste	White with a yellowish tint, without particles that break the colour homogeneity	Absent	9.0	3.4
Coconut	Spicy, slightly sweet, without mouldy, stale smells or other off-odours	Sweetish, pleasant. Without the strong, saturated taste characteristic of coconuts	Varies from white to marble	Absent	9.6	2.4
Brown rice	Almost absent. No mouldy, stale smells or other off-odours	Almost absent. No bitter or sour aftertaste	Cream-coloured, without particles that break the colour homogeneity	Absent	10.0	2.5

The sensory characteristics of ready muffins are their shape, condition of the surface, colour, taste, aroma, and cross-sectional view (that characterises the porosity). For quantitative determination of the quality characteristics of the muffins with different ratios of the components, the authors have developed a grading scale allowing estimation in points. The quality parameters of the control sample are given in Table 5.

Each characteristic has been analysed in details for more illustrative estimation. The research results are presented in the form of profiles (Fig. 1 and 2).

According to the results obtained (Fig. 1), Sample 2 has been graded the highest: the area of its polygon (Fig. 1c) is significantly bigger than that in the other samples (Fig. 1a, b, d).

Chocolate muffins based on coconut and brown rice flours are not inferior to the control sample in their appearance, and have a developed porosity seen in a cross-section, which consists mainly of small, thin-walled pores. A higher coconut flour content in the test samples of chocolate muffins significantly improves the taste and smell of finished products. The muffins acquire a pleasant coconut aroma. This may result from the increased sugar content in the gluten-free samples and the slightly lower starch content, compared with the control sample, due to using coconut flour. Besides, gluten-free flour is completely free of gluten-forming proteins, which contribute to formation of the viscoplastic characteristics of dough. It is commonly known that the traditional muffin technology involves the use of wheat flour with low gluten quality values. If these requirements are not complied with, it reduces the plasticity of dough and results in a low quality of prepared foods [25]. Being quite rich in fat, as compared with wheat and rice flour, coconut flour introduced into the recipe in higher doses is observed to improve the cake crumb texture. Researchers point out the effectiveness of increasing the margarine and egg melange content in order to better the sensory characteristics of rice flour-based gluten-free products [1].

Table 5 – Sensory quality of the control sample of muffins according to regulatory documents (the tests were repeated in triplicate); n=3; p≤0.05

Description	Parameter				
	Shape	Condition of the surface	Colour	Taste and smell	Cross-sectional view
	Regular, corresponding to the shape the recipe requires	Even, without cracks, which indicates the correct choice of a cooking temperature; not burnt	Ranging from light brown to brown; corresponding with the recipe ingredients	Chocolate taste, cocoa smell, no off-odour	The product is porous, homogeneous, with no undermixed inclusions

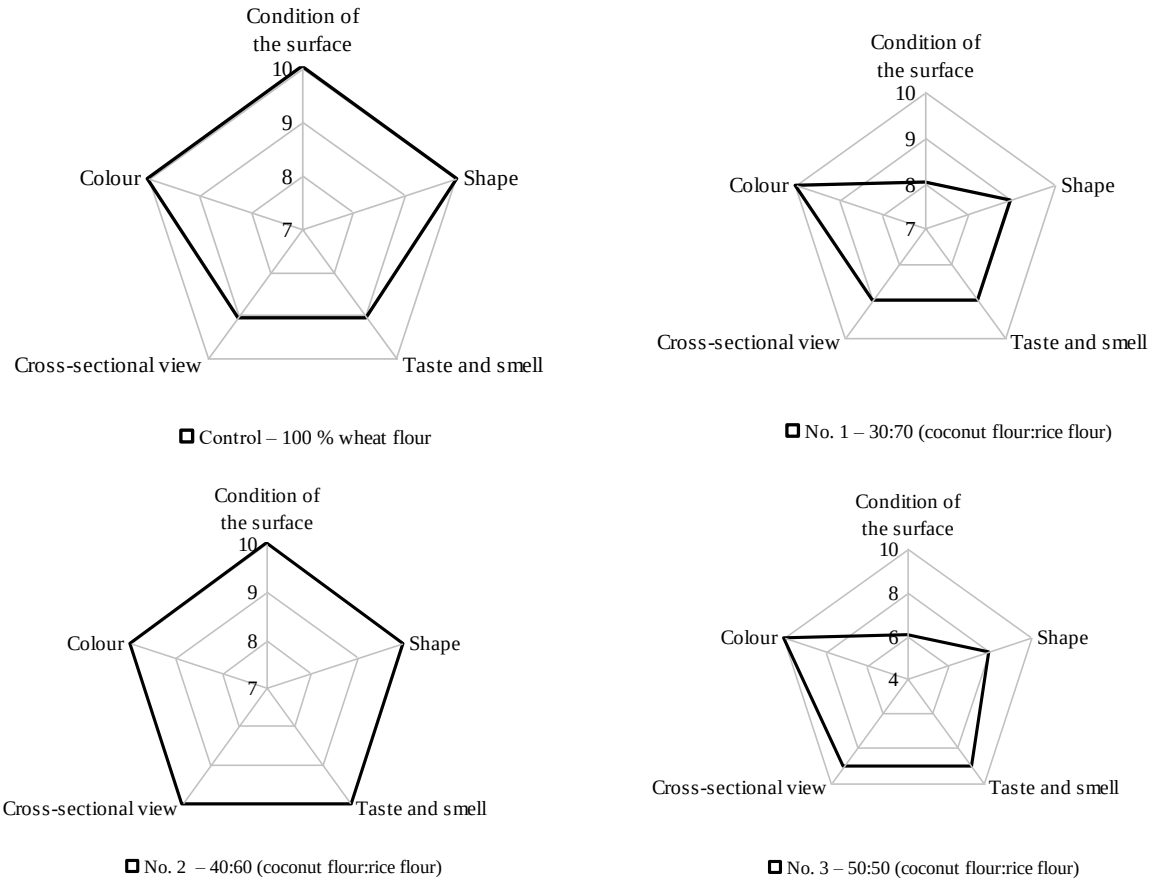

Fig. 1. Characteristics of the simple quality indicators of the samples tested

But adding as much as 50% of coconut flour reduces the specific volume of the products. The crust is getting thicker. The structure of the crumb is worsening too, it becomes less porous, thicker, non-uniform, especially near the centre of products. The research [38] proves the efficiency of using 40% of coconut flour in biscuits [38].

The results of the comprehensive quality assessment using the Harrington method have allowed confirming that the best organoleptic characteristics are achieved if the classical chocolate muffin recipe is modified, as suggested, by replacing wheat flour completely with a mixture of gluten-free coconut and brown rice flours (40:60 respectively). This ratio of the components (Table 6) allows obtaining muffins with well-balanced sensory qualities, an attractive brown colour, a surface typical of muffins, and quite soft, homogeneous and porous crumb with a pleasant taste and aroma of cocoa combined with light coconut notes.

The chemical composition of the components and the flour mixture recipe determine the properties of the dough and the quality of the ready muffins [22]. The obtained values of the physicochemical quality parameters of the samples (Table 6) also confirm the right choice of the ratios of the flour samples selected.

The data from Table 6 show that replacing wheat flour with coconut and brown rice flours reduces the moisture content of the dough and its density. This can be explained by the different fractional compositions of proteins in wheat flour and in coconut and brown rice flours. Gluten-free types of flour do not contain the gluten-forming proteins gliadin and glutenin, which have significant hydrophilic properties [39].

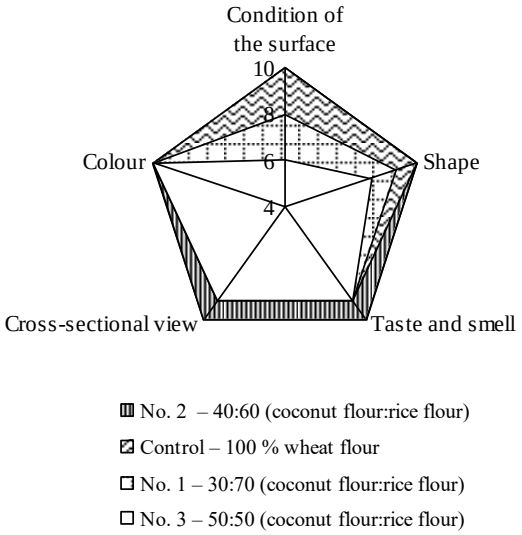

Fig. 2. Characteristics of the comprehensive quality assessment by the Harrington method

Table 6 – Physicochemical quality parameters of traditional chocolate muffins (control sample) and of special-purpose gluten-free chocolate muffins

Parameter	Content in muffins without filling (State Standard of Ukraine 4505:2005. Cakes. General specifications)	Sample			
		Control	Sample 1 (30:70)	Sample 2 (40:60)	Sample 3 (50:50)
Parameters of the quality of dough					
Mass fraction of moisture, %	20.0	20.2	20.1	20.1	19.7
Density of the dough, g/cm³	0.96	0.96	0.94	0.94	0.92
Free moisture, of the total moisture content, %	27.0	27.0	30.6	30.4	30.1
Bound moisture, of the total moisture content, %	72.0	72.0	69.4	69.6	69.9
Parameters of the quality of muffins					
Mass fraction of moisture, %	10.0–31.0	18.5	17.8	17.3	17.0
Specific volume, cm³/g	1.70	1.70	1.77	1.78	1.78
Alkalinity, deg	2.0–3.0	2.2	2.3	2.4	2.4

The increase in free moisture in the gluten-free flour samples can be attributed to the high content of dietary fibre (18% of fibre in coconut flour), which forms less strong bonds with water and release it more easily due to the capillary nature of the bonds. And the content of bound moisture correlates with the content of starch (73.2% of starch is contained in brown rice flour).

Conclusion

The properties of gluten-free types of flour have been studied. It has been found that the creamy colour of brown rice flour and the sweet taste of coconut flour are appropriate in the recipe of gluten-free chocolate muffins with improved organoleptic properties. Recipe compositions of the mixture of coconut flour and brown rice, in the ratios 30:70, 40:60, 50:50 respectively, have been suggested and investigated. It has been found that all test samples were of high quality. A comprehensive evaluation of the prepared muffins by the Harrington method has confirmed that the ratio of components 40:60 allows obtaining muffins with a fairly soft, homogeneous, and porous crumb, pleasant taste, and aroma of cocoa combined with light coconut notes. Increasing the dosage of brown rice flour (up to 60%) leads to an increase in the specific volume of muffins, which indicates their more porous structure (due to a larger volume of the gas phase).

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УДОСКОНАЛЕННЯ РЕЦЕПТУРНОГО СКЛАДУ ШОКОЛАДНОГО КЕКСУ «ГЛЮТЕН-ФРІ» СПЕЦІАЛЬНОГО ПРИЗНАЧЕННЯ

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Анотація. У статті висвітлено питання щодо використання безглютенових видів борошна, а саме кокосового та борошна з коричневого рису, у технології шоколадного кексу «Глютен-фрі» з метою розширення асортименту продуктів спеціального призначення. Проаналізовано наукові праці вітчизняних та закордонних авторів, присвячені

використанню різних видів борошна у сучасній технології безглютенової продукції та встановлено можливість повної заміни пшеничного борошна на суміші безглютенового борошна у рецептурному складі шоколадного кексу. Досліджено хімічний склад кокосового і борошна з коричневого рису та з'ясовано, що у порівнянні з пшеничним, кокосове борошно містить значно більше жирів, вдвічі більше білків і клітковини (18%). Поряд з основними макронутрієнтами, кокосове борошно також перевищує пшеничне за вмістом основних мінеральних речовин. Борошно з коричневого рису порівняно з пшеничним борошном також містить більше жирів і характеризується широким спектром вітамінів групи В, є джерелом натрію, магнію, фосфору, кремнію та сірки. Воно містить багато крохмалю (до 80%) і, подібно до кокосового борошна, взагалі не містить глютену. Заміна пшеничного борошна в класичному рецепті шоколадного кексу на суміш кокосового та борошна з коричневого рису у співвідношеннях: 30:70, 40:60 та 50:50 сприяє зменшенню вологості та густини тіста. Зменшується і вміст вологи у готових кексах на 0,7, 1.2 та 1,5% відповідно. Підтверджено, що збільшення у борошняній безглютеновій суміші вмісту кокосового борошна понад 50% сприяє зменшенню питомого об'єму готових виробів та погіршенню їх якісних показників. Визначення комплексного показника якості готових виробів за методом Харрінгтона підтвердили, що запропонована повна заміна пшеничного борошна у рецептурі кексу шоколадного на суміш безглютенового борошна у співвідношенні компонентів: 40:60 (кокосове борошно: борошно з коричневого рису) дозволяє отримати готові кекси з найкращими гармонійними органолептичними якостями. Безглютенові кекси «Глютен-фрі» мають привабливий коричневий колір скоринки, характерну для кексів поверхню, достатньо м'який, однорідний та пористий м'якуш з приємним смаком та ароматом какао, в поєднанні з легкими нотками кокосу.

Ключові слова: целіакія, безглютенові вироби, кокосове борошно, борошно з коричневого рису..

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