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# A flour composite mixture for gluten-free confectionery

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## ABSTRACT

The article is devoted to the development of a recipe for a gluten-free flour composite mixture based on buckwheat, rice, and corn flours for the preparation of confectionery products, as well as the enhancement of its nutritional value using locally produced flaxseed and chickpea flours. For the production of gluten-free sugar cookies, two types of gluten-free flour composite mixture have been developed: a) rice, buckwheat, and flaxseed flour and b) rice, corn, and chickpea flour. The optimal flour ratio is 40:30:30. The physic-chemical and organoleptic indicators of gluten-free sugar cookies obtained using the gluten-free flour composite mixture align with the indicators specified in the standard. The developed gluten-free composite flour mixture is characterized by a fairly high satisfaction level with the balanced nutrition formula regarding basic nutrients. The levels of protein, carbohydrate, and fat satisfaction increased by 64, 37, and 118%, respectively, with the addition of flax to the rice and buckwheat mixture. Adding chickpeas to the rice and corn mixture increased protein and fat satisfaction by 35.5 and 27%, respectively, while carbohydrates remained almost unchanged.

**Keywords:** gluten-free flour confectionery, rice, buckwheat, flax, chickpea

## INTRODUCTION

The number of people suffering from celiac disease and gluten sensitivity is increasing every year worldwide, including Georgia. The most common treatment for such people is a lifelong gluten-free diet, which has increased demand for gluten-free flour products. A significant shortcoming of available gluten-free products is their low protein content and high levels of fat and salt. To comply with recommendations regarding nutrition, it is necessary to develop the products and change the recipe **[1]**.

The number of products intended for gluten-free diets in Georgia is still small, mainly represented by imported products, which are expensive. In addition to bakery products, thanks to their convenience, unique taste, and texture, gluten-free flour confectionery such as cookies, cakes, muffins, and crackers are of great interest. Scientists have recently developed technologies for producing gluten-free flour products, but more is needed. There is evidence in the literature about the preparation of gluten-free flour products, their nutritional value, and their sensory properties. The problems of knowledge and information in this area of research have been identified, and the need for further research is noted.

The main way to produce gluten-free products is to completely replace gluten-containing raw materials with non-toxic grain crops. In addition, rice, buckwheat, and corn are mostly used as gluten-free flour. The nutritional value of their products is because they consist mostly of starch-containing products. Therefore, two or three gluten-free raw materials should be combined, or the recipe's nutritional value should be increased using raw materials rich in essential amino acids, vitamins, mineral substances, and dietary fibers. For this purpose, it is promising to use non-traditional local raw materials, the right selection of which provides the normalization of the functions of the digestive system and, in general, metabolism in the bodies of patients with celiac disease **[2]**, **[3]**, **[4]**.

Based on the above, developing a gluten-free flour composite mixture recipe using local, non-traditional raw materials is relevant.

The novelty of the research lies in the development of a recipe of a gluten-free composite flour mixture based on buckwheat, rice, and corn flours and increasing its nutritional value using flaxseed and chickpea flours.

Flour products are primarily made of wheat flour. The production of gluten-free products is a big challenge for manufacturers. The main fraction of gluten (glutenin and gliadin) plays a decisive role in forming technological properties that determine the dough's water absorption capacity, viscosity, and elasticity. Consequently, gluten removal poses a serious problem for manufacturers. The main task is to find a suitable substitute for gluten. Food safety, acceptability, and availability are also big concerns because they should comply with the FDA-approved recommendations **[5]**.

Although the number of gluten-free products on the market has increased, there are still some gaps in their nutritional value and organoleptic indicators. Commercially viable gluten-free products are low in nutritional value, especially in protein and dietary fiber content, and have a high glycemic index. On the other hand, from an organoleptic viewpoint, gluten-free products do not have the appropriate texture, mechanical properties, taste, and aroma. This results from selecting raw materials containing many carbohydrates **[6]**.

The composition of gluten-free flour dominates in forming gluten-free products' texture and organoleptic indicators. However, other factors such as grain milling methods, flour particle sizes, and processing may have a specific influence. Gluten-free cookies, cakes, cupcakes, and crackers are inferior to wheat-based products in terms of consumer properties. Further research is needed to obtain more delicious and edible gluten-free products **[7]**, **[8]**.

The goal of the work is to develop a recipe for a gluten-free flour composite mixture for the preparation of flour confectionery.

To improve the structure and quality of gluten-free flour products and to extend their shelf life, pseudocereals (amaranth, buckwheat), completely ground grains, a dietary fibre obtained from secondary products of fruit and vegetable processing, and alternative flours (chia seeds, chestnut, etc.) are used. The reason for this is their ability to absorb water and form a gel, resulting in the texture's formation and thickening **[9]**.

Various scientists have investigated the possibility of using nontraditional raw materials with low starch content to increase the nutritional value of gluten-free products **[9]**. Flax and chickpea additives have been common in Georgia since ancient times, and in recent years, farmers' interest has grown **[10]**.

Flaxseed flour contains a large amount of easily digestible protein, omega-3 oils, vitamins of group B, and other useful substances. Flax occupies the first place in dietary nutrition. The gastrointestinal tract does not absorb many substances in flaxseed flour, but they remove toxins and bad cholesterol. These include cellulose, phenolic polymers, lignin, etc. Phytoestrogens contained in flour ensure the metabolism of hormones, maintain their natural level, and also have an antioxidant effect **[11]**, **[12]**, **[13]**, **[14]**.

Non-traditional flour is an additional source of protein and a valuable alternative to a nutrient-rich and useful raw material in the production of flour products. Legumes like chickpeas have become more relevant in baking because they have properties beneficial to human health. It reduces obesity and type 2 diabetes. It is a source of bioavailable protein. The chemical composition of chickpea flour is characterized by the content of starch and proteins, 37% and 23%, respectively, and the amount of fat, which is equal to 5%. The albumin and globulin fractions predominate among proteins. It can be used to develop innovative products of high biological value **[15]**. Adding chickpea flour to food increases its nutritional value and maybe a new way to reduce the amount of acrylamide in the product **[14]**.

Numerous studies have been conducted by various researchers on the possibility of using non-traditional raw materials such as amaranth **[15]**, grape seed **[5]**, flax seeds **[8]**, **[11]**, soya **[9]**, chickpea **[6]**, **[10]**, and chestnut flours **[14]** to increase the nutritional value and quality of gluten-free products.

## Scientific Hypothesis

The quality indicators of gluten-free flour pastry products prepared using the gluten-free composite mixture obtained from rice, buckwheat, and corn flour align with those specified in the standard. Adding flax and chickpea flour increases the mix's nutritional value.

## MATERIAL AND METHODOLOGY

### Samples

The objects of the study are control samples of sugar cookies **[16]**, in which wheat flour is entirely replaced by a basic gluten-free flour composite mixture, and test samples, in which gluten-free flour composite mixtures completely replace wheat flour. The basic gluten-free flour composite mixture was prepared by mixing rice and buckwheat flour or rice and corn flour. In contrast, the gluten-free flour composite mixtures were made by adding flaxseed or chickpea flour to the essential composite mixtures. Flax and chickpeas are grown on various farms in western Georgia. We bought the rest of the raw materials, such as rice, buckwheat, sugar, molasses, and essences, at the Kutaisi market. We obtained the flour by grinding these raw materials in the laboratory and then sifted into a sieve with mesh sizes of 0.5 mm.

## Chemicals

All reagents used were of U.S.P. purity or higher. All solvents, including water, were used with the LC/MS label.

## Animals, Plants and Biological Materials

Rice (*Oryza sativa*), buckwheat (*Fagopyrum esculentumi*), flax (*Linum usitatissimum*) chickpea (*Cicer arietinum L.*), corn (*Zea mays*).

## Instruments

The mass of the sample was determined by an electronic digital analytical balance SF-400C model (Toms, Qilin, China).

For the control and experimental baking of sugar cookies, we used an electric oven with a proofer FDE-903-HR Primax Fast Line Combi Oven (Primax, Via Gemona, San Vito al Tagliamento (PN), Italy).

## Laboratory Methods

Organoleptic and physico-chemical research methods according to the ISO-International Organization for Standardization were used.

Organoleptic indicators were determined on a 10-point scale according to the following characteristics: surface condition, colour, taste, smell, sectional view, and shape **[17]**, where 1 means extreme dislike, and 10 means extreme like. At least 5 testers took part in the assessment of organoleptic indicators. They were selected from Akaki Tsereteli State University staff working at the Department of Food Technology and students. Final scores were calculated as the arithmetic mean for each characteristic.

To evaluate the quality of the finished products, we measured the moisture content of cookies, alkalinity, swelling capacity, and organoleptic indicators.

We determined the moisture content of the sugar cookies by drying up the test sample at a temperature of 130 $^0$C to a constant weight. The initial mass of the sample and the mass after drying were determined with a weighing accuracy of 0.01 g. We calculated the mass loss by the difference in mass of the test sample before drying and after drying according to the state standard GOST 5900-2014 **[18]** and expressed the result as a percentage:

$$\text{W \%} = \frac{M_1 - M_2}{M_1} \, x \, 100 \, \%, \tag{1}$$

Where:
W % is the sample's moisture content (as a percentage), M1 is the sample's initial mass before drying (in grams), and M2 is the sample's mass after drying (in grams).

The alkalinity of cookies was determined by neutralizing the alkaline substances in the sample with a solution of sulfuric acid (Sulphuric acid, $H_2SO_4$, LenReaktiv, ≥99.0%) with a concentration of 0.1 mol.dm$^{-3}$ in the presence of the indicator bromothymol blue (Bromothymol blue, $C_{27}H_{28}Br_2O_5S$, LenReaktiv, ≥99.5 %) until the formation of the yellow body. The method determines the alkalinity of flour confectionery made using chemical leavening agents according to the state standard GOST 5898-87 **[19]**.

To determine the cookies' swelling capacity, we immersed the finished products in water at 20 °C for 2 minutes and determined the mass increase using an analytical digital scale. The formula expresses the swelling capacity of cookies, GOST 10114-80 **[20]**.

$$\Psi \, \% = \frac{M_2}{M_1} \, x \, 100 \, \%, \tag{3}$$

Where:
Ψ % – the swelling capacity of cookies (as percentage); $M_1$ – the mass of swelled cookies (in grams); $M_2$ – the mass of dry cookies (in grams).

Organoleptic indicators were determined on a 10-point scale according to the following characteristics: surface condition, color, taste and smell, appearance of the fracture, and shape, GOST 24901-2014 **[17]**.

The baking temperature of sugar cookies in an electric oven was 230-240 °C. The baking time was 5 minutes. The moisture content of the sugar dough was 16-16.5%. We determined the readiness of cookies based on moisture and appearance. The moisture content of the finished products was 9.5-10 %. For all samples, the baking temperature and duration were not changed.

## Description of the Experiment

**Sample preparation:** Due to its high fat and sugar content, we prepared the sugar cookie dough in two stages. In the first stage, we prepared an emulsion to obtain a homogeneous dispersion system to dissolve fat and water. Emulsion plays a special role in determining the quality of cookies since it largely determines the technological process of product preparation. We used an emulsifier to obtain an emulsion and chummed all the raw materials provided by the recipe except flour.

**Number of samples analyzed:** we analyzed 10 samples.

**Number of repeated analyses:** All measurements of instrument readings were performed two times.

**Number of experiment replication:** The number of repetitions of each experiment to determine one value was three times.

**Design of the experiment:** At the beginning of the experiment, we determined the content of moisture content, alkalinity, and swelling capacity of gluten-free flour composite mixtures. The physic-chemical parameters (moisture content, alkalinity, and swelling capacity) of sugar cake with flaxseed and chickpea flours were studied. Content of key nutrients (proteins, fats, and carbohydrates) in gluten-free flour composite mixture Based on the data obtained, we have developed the recipe for gluten-free flour composite mixtures for gluten-free confectionery.

## Statistical Analysis

A statistical analysis of the obtained data is carried out for the analysis of the physicochemical indicators (moisture, ability to fight, alkalinity) of the test samples of the sugar cookies; the reliability of the obtained data was evaluated by the mathematical statistics methods using the Windows IBM SPSS Statistics software program (version 20.0, IBM, Armonk, New York, USA). We calculated the arithmetic average of the measured value. Then, we computed the error of each measurement and calculated the squared errors to compute the absolute measurement error. We selected the reliability value $p = 0.95$ **[21]**. Based on the number of measurements and the reliability value, the Student's coefficient equals $t = 3.75$ (Figures 1, 2, 3 and 4) **[21]**. We used statistical functions of the average arithmetic value and standard error to describe the ordered sample.

The results were interpreted graphically using Microsoft Excel. In Tables 1, 2, 3 and 4, and Figures 1, 2, 3 and 4, the data of typical tests are presented, and each value is an average of at least three determinations.

## RESULTS AND DISCUSSION

The characterization of gluten-free raw materials and literary data showed that to develop a recipe for gluten-free flour confectionery, it is necessary to use two types of flour simultaneously. Accordingly, we prepared a composite mixture using two flours. Therefore, based on the purpose of the research, we conducted the study in two stages: in the first stage, we made two recipes of a main composite mixture from rice, buckwheat, and corn flours with different ratios of components: the first: rice + buckwheat, and the second: rice + corn. We calculated the recipe for a 100 kg mixture and changed the components' ratio. We considered five options for each when preparing both mixtures. In the second stage, to increase the nutritional value, we added flaxseed flour to the basic composite mixture of rice and buckwheat and chickpea flour to the mixture of rice and corn flour.

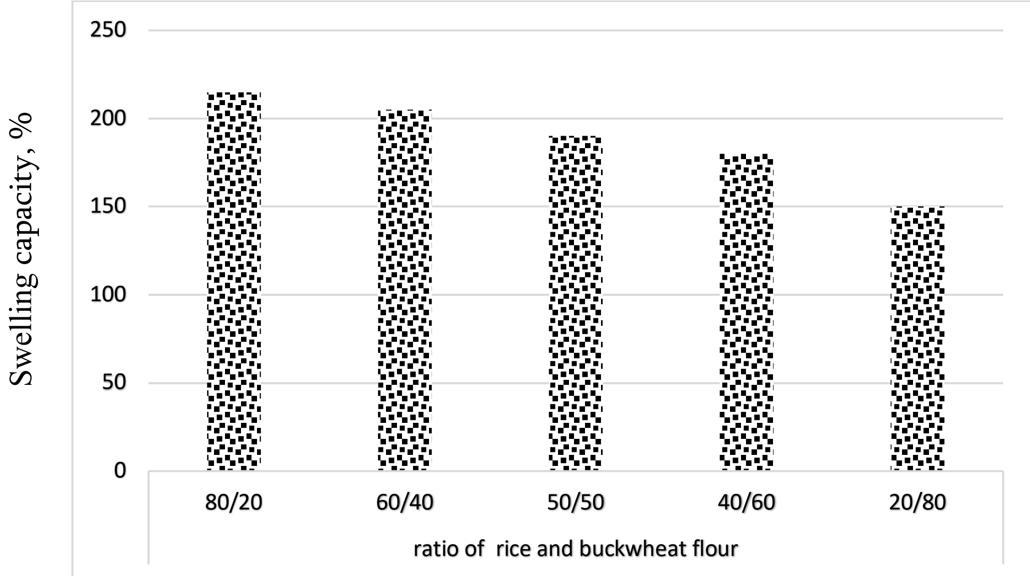
To develop a gluten-free composite mixture recipe, we prepared sugar cookies called "Jubilee" **[16]**, in which wheat flour was completely replaced by a flour composite mixture obtained with different ratios of components.

To prepare the sugar cookies, we kneaded the dough on emulsion according to the generally accepted technology **[30]**, **[31]**, **[32]**, **[33]**. We kneaded and shaped the dough using a composite mixture. During the work, it was revealed that increasing the amount of rice flour in the rice and buckwheat made it easier to shape the dough. The study results are presented in Table 1 and shown in Figure 1.

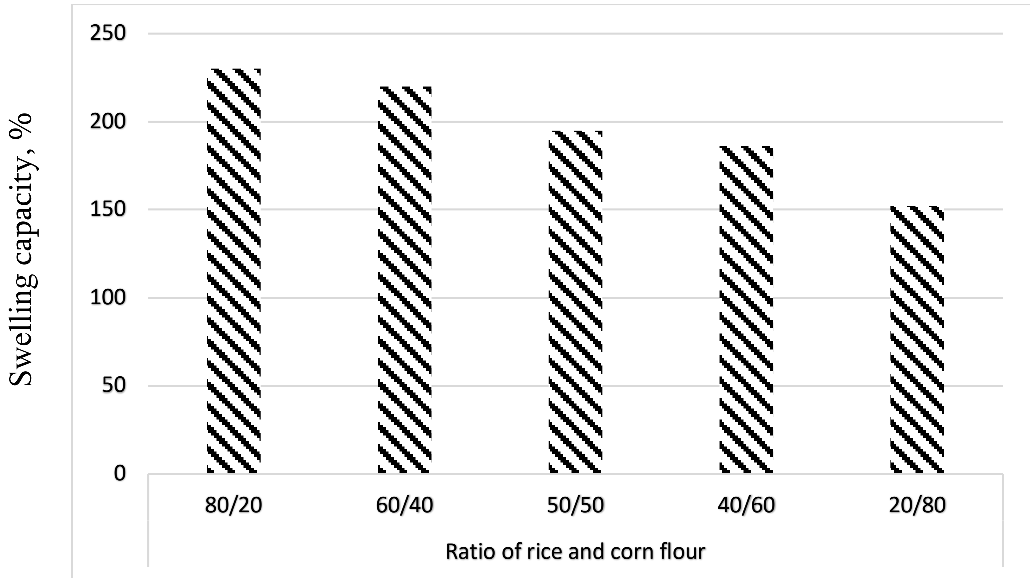
**Table 1** Physic-chemical indicators of gluten-free sugar cookies.

| Quality indicators | The ratio of rice and buckwheat flours | | | | | The rice and cornmeal mixture | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 80:20 | 60:40 | 50:50 | 40:60 | 20:80 | 80:20 | 60:40 | 50:50 | 40:60 | 20:80 |
| Alkalinity, degrees | 1.0 ±0.1 | 1.1 ±0.1 | 1.3 ±0.1 | 1.4 ±0.1 | 1.4 ±0.1 | 1.0 ±0.1 | 1.1 ±0.1 | 1.1 ±0.1 | 1.0 ±0.1 | 1.1 ±0.1 |
| Moisture content,% | 9.0 ±0.3 | 9.2 ±0.2 | 9.4 ±0.2 | 9.5 ±0.2 | 10.0 ±0.2 | 8.0 ±0.2 | 8.1 ±0.2 | 8.0 ±0.2 | 8.0 ±0.2 | 8.0 ±0.2 |

Note: $p < 0.05$. All values are expressed as the mean ±SD (standard deviation).




a)




b)

**Figure 1** The swelling capacity of gluten-free sugar cookies. Note: a) based on rice and buckwheat flours; b) based on rice and corn flours.

The research determined that the swelling capacity of cookies obtained from the composite mixture of rice and buckwheat increases with an increase in rice flour. This is probably related to rice flour's higher starch content than buckwheat flour. The moisture content of the products increases with the increase in buckwheat flour, while the alkalinity remains almost unchanged.

The moisture and alkalinity of the sugar cookies obtained from the mixture of rice and corn did not change and were 8.0% and 1 degree, respectively. As the proportion of cornmeal decreased, swelling capacity increased due to corn and rice's different starch contents and properties.

The organoleptic evaluation of the finished products revealed that the gluten-free sugar cookies based on rice and buckwheat had a straight, round shape. As the amount of buckwheat flour in the mixture increases, its specific aroma becomes more robust. For example, when the mixture contained 80% buckwheat flour, the product had a pronounced taste and smell of buckwheat. The taste and smell could have been more pronounced when adding 50-60% buckwheat flour. The aroma and smell of rice flour were enhanced at lower levels of buckwheat flour in the mixture. All products had an even brownish-gold color.

All the products based on the rice and corn mixture had a regular shape and a smooth surface with small swellings. Products with a high cornmeal content had a pronounced bitter taste of corn. The color varied from yellowish gold to dark brown. By increasing the proportion of rice flour, the characteristic taste of corn flour decreased. However, products with a high content of rice flour had a typical rice taste. The surface of the products was slightly rough, of a light cream color, and had a crunchy consistency.

Thus, to prepare sugar cookies, we have chosen two essential flour composite mixtures: 1. rice and buckwheat and 2. rice and corn, in which the ratio of components is 50:50.

In the next stage, flaxseed flour was added to the basic composite mixture of rice and buckwheat, and chickpea flour was added to the mix of corn and rice. We prepared the mixture with different ratios of components. To determine the optimal ratio of the components in the gluten-free mixture, we prepared sugar cookies, to this, we calculated the recipe for sugar cookies per 1 kg of finished product. We took the products obtained from the basic composite mixture as a control.

The optimal moisture content of the dough and the amount of water to be added were determined experimentally. To obtain satisfactory-quality gluten-free cookies, it is necessary to prepare a dough with a moisture content of 30%, while the moisture content of a sugar dough made of second-grade wheat flour is 18-20%. This is due to the high water absorption capacity of the gluten-free raw material compared to wheat flour. The dough became dense and sticky by further increasing the moisture content of the semi-finished product. Dough-forming was complicated.

Thus, when preparing sugar cookies from non-traditional raw materials, one must consider their ability to absorb water and select the dough's moisture content.

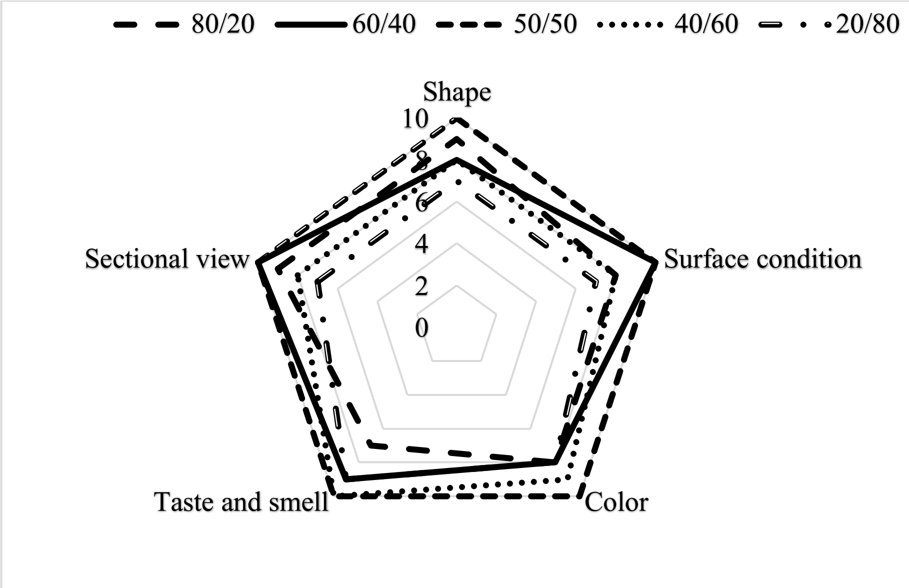
The physico-chemical and organoleptic characteristics of sugar cookies are presented in Table 2 and shown in Figure 2 and Figure 3.

**Table 2** The physicochemical parameters of sugar cake with adding flaxseed and chickpea flours.

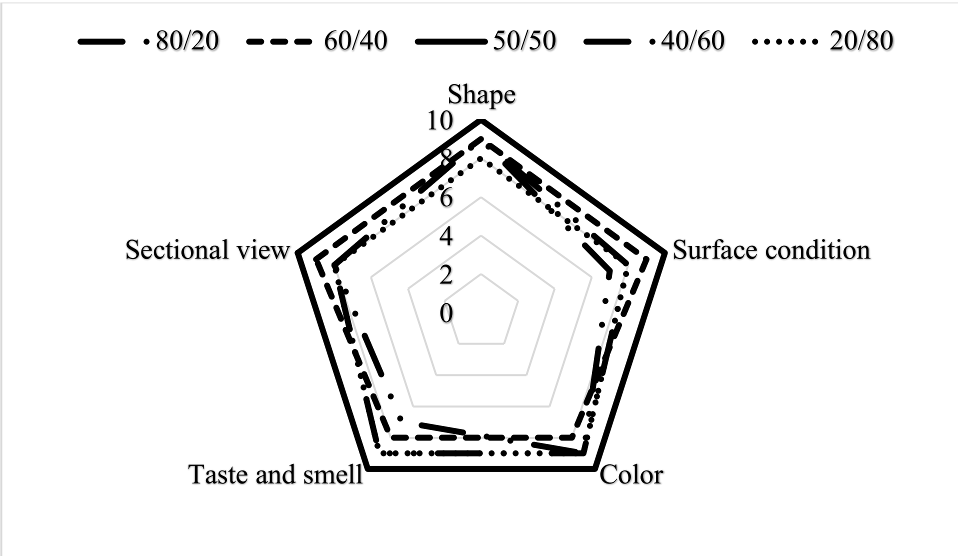
| Quality indicators | Rice flour + buckwheat flour + flaxseed flour | | | | | Rice flour+ corn flour+ chickpea flour | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | control sample | 40:40:20 | 40:30:30 | 30:40:30 | 30:30:40 | control sample | 40:40:20 | 40:30:30 | 30:40:30 | 30:30:40 |
| Alkalinity, degrees | 1.3 ±0.1 | 1.1 ±0.3 | 1.0 ±0.3 | 0.9 ±0.4 | 0.8 ±0.3 | 1.1 ±0.2 | 1.1 ±0.2 | 1.2 ±0.4 | 1.2 ±0.3 | 1.2 ±0.3 |
| Moisture content,% | 9.4 ±0.5 | 9.8 ±0.4 | 10.0 ±0.5 | 9.5 ±0.5 | 10.0 ±0.3 | 10.0 ±0.3 | 9.8 ±0.2 | 10.0 ±0.3 | 9.5 ±0.4 | 10.0 ±0.3 |
| Swelling capacity,% | 190 ±2.0 | 185 ±2.3 | 180 ±1.9 | 180 ±1.9 | 180 ±2.0 | 195 ±2.1 | 195 ±2.3 | 200 ±2.3 | 195 ±1.9 | 200 ±2.1 |

Note: $p < 0.05$. All values are expressed as the mean ±SD (standard deviation).

The obtained results show that the physicochemical indicators of the gluten-free sugar cookies using the composite mixture obtained with gluten-free flours agree with the indicators specified in the standard.



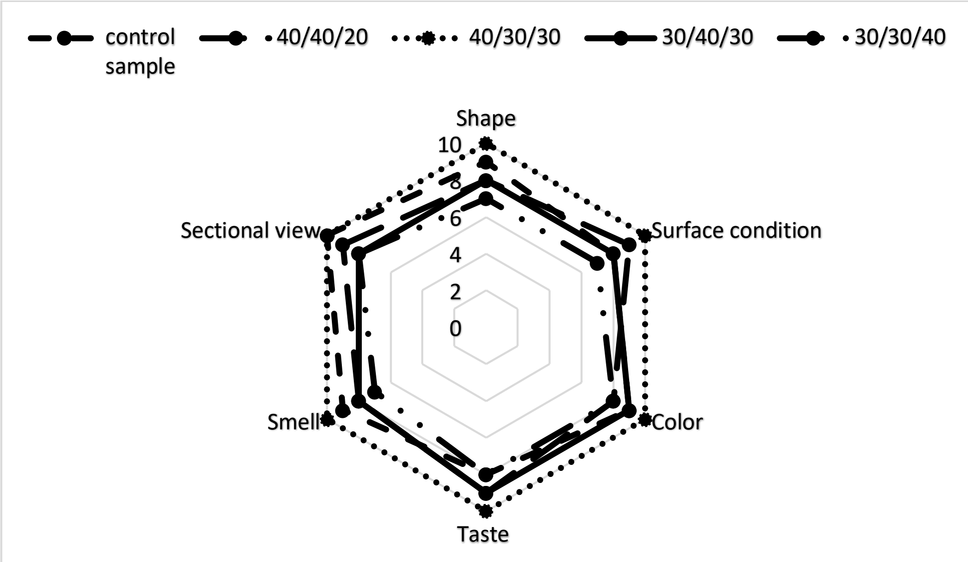

a)



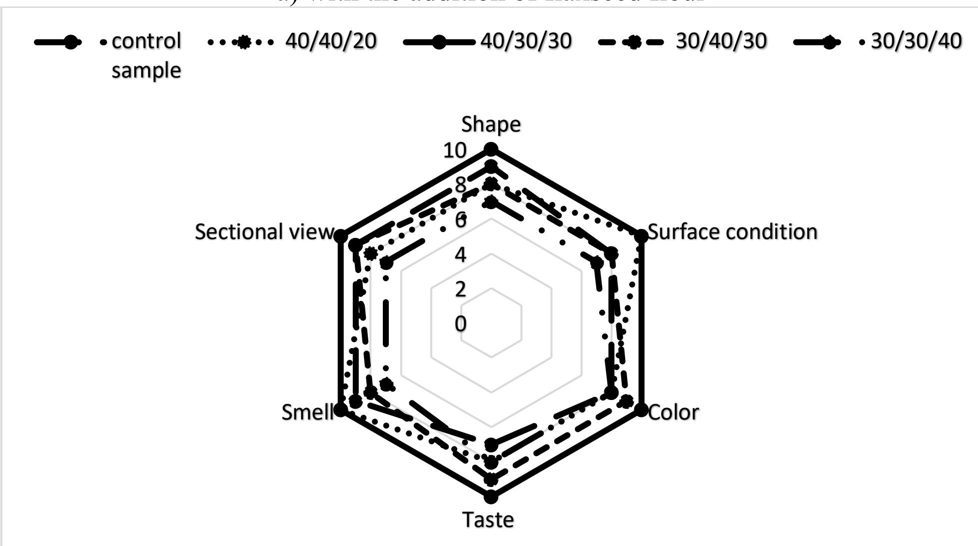

b)

**Figure 2** Organoleptic evaluation of cookies obtained from a composite mixture of gluten-free flour. Note: a) rice and corn; b) rice and buckwheat.

By increasing the dosage of flaxseed flour in the composite mixture of rice, buckwheat and flaxseed flour, the nut flavour in the finished products becomes stronger, and cookies become softer and fatter due to the lipids contained in the flaxseed flour. The color of the products remains almost unchanged. The addition of flaxseed flour reduces strength and alkalinity, but the moisture remains almost unchanged. In the composite mixture of rice, corn, and chickpea flours, increasing the share of chickpea flour increased the finished products' swelling capacity due to the cellulose and protein content.




a) with the addition of flaxseed flour




b) with the addition of chickpea flour

**Figure 3** Organoleptic indicators of sugar cookies with the addition of flaxseed and chickpea flour.

Based on the conducted studies, two gluten-free composite flour mixtures have been proposed: one made from rice, buckwheat, and flaxseed flours and the other from rice, corn, and chickpea flours in a ratio of 40:30:30. In order to use in the research, we prepared 1 kg of composite mixture with the given ratio of components.

Based on the ratio of the components, we calculated the recipe for 1 t of gluten-free flour composite mixture, presented in Table 3.

**Table 3** Recipe for a gluten-free composite flour mixture.

| Name of raw material | Dry substances,% | consumption of raw material, kg on 1 ton of finished products | | consumption of raw material, kg on 1 ton of finished products | |
|---|---|---|---|---|---|
| | | in nature | in dry substances | in nature | in dry substances |
| Rice flour | 86.0 ±0.1 | 400.0 ±5.0 | 344.0 ±4.3 | 400 ±5.0 | 344.0 ±4.3 |
| Buckwheat flour | 88.9 ±0.1 | 300.0 ±5.0 | 266.7 ±4.4 | - | - |
| Flaxseed flour | 93.1 ±0.1 | 300.0 ±5.0 | 279.3 ±4.7 | - | - |
| Corn flour | 88.9 ±0.1 | - | - | 300 ±5.0 | 266.7 ±4.4 |
| Chickpea flour | 86.0 ±0.1 | - | - | 300 ±5.0 | 258.0 ±4.3 |

Note: $p < 0.05$. All values are expressed as the mean ±SD (standard deviation).

Various scientists have used the gluten-free raw materials selected for our gluten-free flour blends. For example, a review article by the authors presents the preparation of bread, cakes, pates, and snacks for the dietary nutrition of patients with celiac disease using rice, buckwheat, corn, and quinoa flour **[22]**. Also, 14 recipes for instant pasta using various structure formers have been developed from a mixture of rice, buckwheat, and soy flour **[23]**. A gluten-free bread recipe was developed using corn, buckwheat, and plantain flour in the following ratio 40:40:20 **[24]**. Scientists developed eight recipes that used 100% beans, chickpeas, peas, kiwicha, quinoa, lentils, corn, and bean flour **[25]**. A team of scientists created gluten-free cookies from the following mixture of flours: corn, rice, and soy flour **[26]**. According to the authors, non-puffing popcorn flour (RPF raw popcorn flour), puffing corn corn meal (PPF) and a mixture of them (1:1), in addition to corn flour as a control sample, were used to prepare recipes for gluten-free cakes and cookies **[27]**. In a study by other researchers, wheat flour was replaced with defatted flour made from flax, sesame, chia, and poppy seeds to increase the nutritional value of traditional commercial cookies **[28]**. Gluten-free biscuits have been developed using composite rice-chickpea flour with acacia, apricot, or karaya gum exudate. The approximate composition of rice, chickpeas, and their compound flours was measured **[29]**. Based on the results of the analysis of the literature data, it was established that the rational ratio of corn and rice is 80:20. This proportion ensures proper physicochemical indicators and high organoleptic indicators of finished gluten-free bakery products. It was established that the manufactured gluten-free bakery products exceeded the control sample regarding physico-chemical parameters, namely, porosity, acidity, dimensional stability, and moisture content of the crumb **[34]**. The appropriateness of our choice of buckwheat and flax as enrichments is confirmed by scientists who developed a recipe for gluten-free muffins enriched with buckwheat, almond, and flax flour. The mentioned additives significantly increase the protein content compared to products prepared with wheat flour **[35]**. The obtained data on the physiochemical parameters of sugar cookies are consistent with the data of other authors in the scientific literature, according to which the moisture content of muffins made from flax and chickpea flour does not change compared to control samples made from wheat flour **[35]**. According to other authors, replacing wheat flour with chickpea flour reduced the springiness, cohesiveness, chewiness, springiness, and specific volume of the cake **[36]**. Some authors' articles found that the rational ratio of corn and rice is 80:20. This proportion ensures proper physical and chemical characteristics and high organoleptic characteristics of finished gluten-free bakery products. It has been established that the manufactured gluten-free bakery products are superior to the control sample in terms of physicochemical parameters, namely porosity, acidity, dimensional stability, and crumb moisture **[28]**. Gluten-free rice flour biscuits were made using chestnut flour (0, 30, 40 and 50%) and date seed flour (0, 10 and 20%). %) and modified starch (0.3, 0.5, 0.6, and 0.9%). In this work, the physicochemical, rheological, and sensory properties of the prepared preparations were studied. The results showed that the dough's moisture content, specific volume, and viscosity were lowest in the control and highest in the variant containing 20% date seed flour, 30% chestnut flour, and 0.9% modified starch **[37]**. Other studies have shown that amaranth and its compounds have more viscous properties and improved water-holding capacity than wheat flour. Differences were also found in the geometric and textural properties of the dough and cookies. However, amaranth-oatmeal cookies were acceptable in color, taste, and texture with no significant differences in sensory quality compared to wheat flour cookies **[15]**. Chickpeas, almonds, and flax seeds were used in high concentrations to formulate a gluten-free muffin recipe for the first time. These muffins were more nutritious than the traditional recipes available. No health hazards were found in these cupcakes. Some sensory characteristics of the muffins were slightly lower and comparable to wheat/rice based muffins **[35]**. Gluten-free biscuits have been developed using composite rice-chickpea flour with acacia, apricot or karaya gum exudate. The approximate composition of rice, chickpeas and their compound flours was measured. Replacing rice flour with chickpea flour up to 20% (by weight) significantly impacted its immediate composition and adhesive properties. The addition of exudate further improved the stickiness and viscoelasticity of the dough **[29]**. Lentil biscuits were developed that contained the highest amount of protein and fiber, but lower fat and carbohydrate content compared to other samples. In terms of color, the corn biscuits were the lightest, with greater brightness, less redness, and more yellowness **[25]**. Some researchers prepared different dough samples with different concentrations of flaxseed meal (i.e. 15 g, 17 g, 20 g and 22.5 g) and thus optimized them by rheological testing of the dough samples. Cookies prepared from different dough samples with different flaxseed concentrations were tested for rheological properties, and the texture profile of the formulations was analyzed **[38]**. Our results on the chemical composition of sugar cookies are consistent with those of other scientists, who believe that replacing wheat flour with gluten-free rice, almond, chickpea, and flax flour increased the protein content. cake by 2-3 times, from 4.25 g in the control to 14.64 g in the test sample

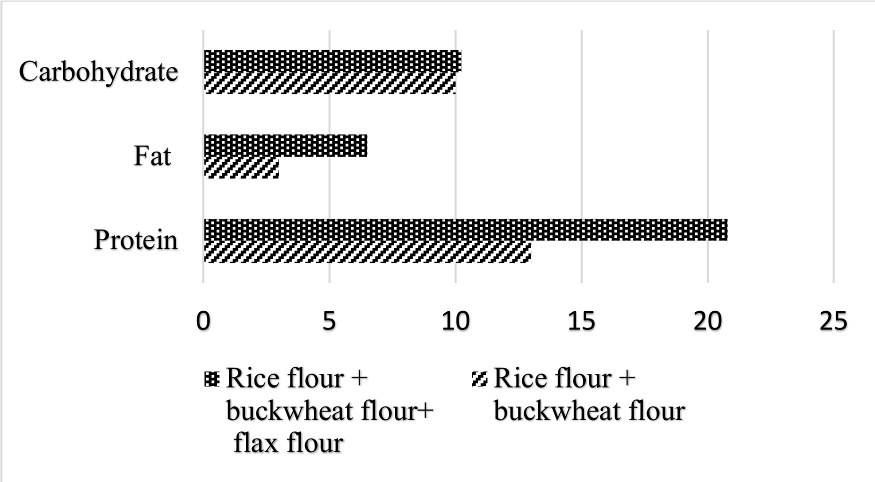
**[35]**. According to the authors, moisture, protein, ash, and fat increased due to increasing chickpea flour substitution rates. However, the carbohydrate content was reduced compared to other control biscuits. Thus, the nutritional value of sweet cookies was increased compared to control samples **[40]**. According to some scientists, biscuits with higher protein content showed higher acceptability than biscuits with higher starch content and no added protein **[41]**. Flaxseed is an excellent source of nutrients, including protein, soluble and insoluble dietary fiber, and omega-3 fatty acids. Flaxseed proteins can improve the biological parameters of bread and unleavened flatbreads (chapatis) **[42]**. Scientists have determined the optimal amount of ground flaxseed flour substitute in baked goods and assessed the effect of flaxseed on the sensory and nutritional qualities of these baked goods. Flaxseed, when replacing flour by 30-50%, significantly increased the nutritional quality of several nutrients without affecting the overall acceptability of baked goods **[43]**. The addition of chickpea flour at low doses (2% by weight) increases bread volume by 20%. It reduces crumb hardness by 40% due to increased gas retention (no holes within the pores) and superior homogeneity of the starch-protein network. The combination of chickpea meal and pumpkin seed has many benefits reflected in the improved nutritional quality of the final product, including increased protein and dietary fiber content, improved mineral and fatty acid profile, increased total phenolic content, and antioxidant activity compared to the control sample **[6]**. To determine the nutritional value of a gluten-free composite flour mixture, we calculated the content of proteins, fats, carbohydrates, and the satisfaction level of the daily need for nutrients (following the balanced nutritional formula) **[39]**. The results are shown in Table 4 and Figure 4.

**Table 4** Content of key nutrients, proteins, fats and carbohydrates in gluten-free flour composite mixture.

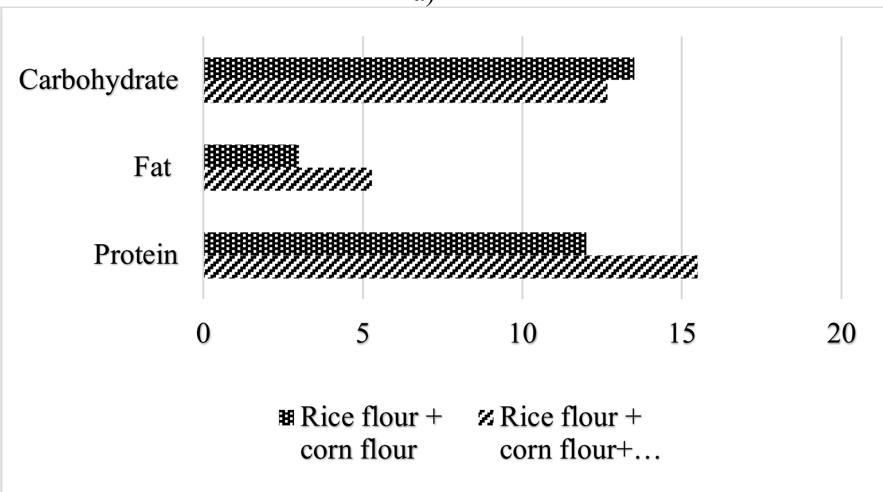
| **Key nutrients** | **Norm of the daily need** | **Rice flour + buckwheat flour** | **Rice flour + buckwheat flour + flaxseed flour** | **Rice flour+ corn flour** | **Rice flour+ corn flour+ chickpea flour** |
|---|---|---|---|---|---|
| **Proteins, g** | 90 | 12.2 ±1.05 | 18.7 ±1.03 | 10.8 ±1.05 | 13.93 ±1.05 |
| **Carbohydrates, g** | 400-500 | 45.0 ±1.23 | 46.08 ±1.25 | 58.5 ±1.22 | 56.67 ±1.16 |
| **Fats, g** | 90 | 2.3 ±0.93 | 5.88 ±0.95 | 2.3 ±0.92 | 4.75 ±0.87 |
| **Nutritional value, kkal** | | 249.5 ±1.21 | 312.04 ±1.20 | 297.9 ±1.22 | 325.15 ±1.23 |

Note: $p$ <0.05. All values are expressed as the mean ±SD (standard deviation).

As can be seen from the table data, in gluten-free composite mixtures with the addition of flax and chickpea flours, the protein content increased by 53.3 and 28.7%, respectively, and the fat content increased by 2.5 times and 2 times, respectively. The carbohydrate content remained virtually unchanged or decreased slightly, and also, the nutritional value of the flour composition mixture increased by 25.1% with the addition of flax flour, and by 9.1% with the addition of chickpea flour.




a)




b)

**Figure 4** The satisfaction levels of key nutrients in a gluten-free flour composite mixture. Note: a) In a composite mixture of rice, buckwheat, and flaxseed flour, b) In a composite mixture of rice, corn, and chickpea flour.

The developed gluten-free composite flour mixture is characterized by a reasonably high satisfaction level with the balanced nutrition formula. As seen in Figure 4 (a), adding flax to the rice-buckwheat mixture increased the protein satisfaction level by 64%, the carbohydrate satisfaction level by 37%, and the fat satisfaction level by 118%. Figure 4 (b) illustrates that with the addition of chickpeas to the rice-corn mixture, the protein satisfaction level increased by 35.5%. At the same time, carbohydrates remained almost unchanged, and the fat satisfaction level increased by 27%.

## CONCLUSION

Research has led to the developing of a gluten-free flour blend designed specifically for making gluten-free sugar cookies.

- The following flours are recommended for the flour mixture to produce gluten-free sugar cookies: rice, buckwheat, and corn flour. To increase the nutritional and biological values of the products, flaxseed, and chickpea flours were added to the gluten-free composite mixture;
- Two gluten-free flour composite mixtures have been developed: a) rice, buckwheat, and flaxseed flours and b) rice, corn, and chickpea flours. The optimal ratio of flours is 40:30:30, respectively.
- The physicochemical and organoleptic indicators of gluten-free sugar cookies using the composite mixture obtained with gluten-free flours are consistent with the indicators specified in the standard;
- The developed gluten-free composite flour mixture is characterized by a reasonably high satisfaction level with the balanced nutrition formula regarding proteins, fats, and carbohydrates of the primary nutrients. The levels of protein, carbohydrate, and fat satisfaction increased by 64, 37, and 118%, respectively, with the addition of flax to the rice and buckwheat mixture. Adding chickpeas to the rice and corn mixture increased protein and fat satisfaction levels by 35.5 and 27%, respectively, while carbohydrates remained almost unchanged.

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