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**FLOUR-FREE  
GLUTEN-FREE  
COMPOSITIONS  
INFLUENCE ON  
QUALITATIVE INDICATORS  
OF COOKIES  
FROM BISCUITS DOUGH**

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**The topicality.** According to the World Organization of Gastroenterologists (FOG-OMGE), patients with active (clinically severe) celiac disease have an increased risk of death compared to the general population; patients with celiac disease should definitely not eat wheat, rye or barley in any form. However, there is the increased risk of death resumes after three to five years of strict adherence to a gluten-free diet, so it becomes especially important to develop technologies for confectionery products based on gluten-free flour compositions and study their quality indicators. **The purpose of the article** is to determine the influence of gluten-free flour compositions based on flaxseed, rice, sesame, pumpkin seed meal, sugar substitute on the quality of cupcakes. **Research methods.** The dependence of stress on the shear rate of biscuit dough based on gluten-free flour compositions has been determined using a Brookfield viscometer. The adhesive stress of the dough masses from the effects of different concentrations of the model system based on gluten-free flour compositions has been performed on a bursting machine MT-140/RV2. **Results.** The data of research of gluten-free flour compositions influence on qualitative properties of biscuit cake dough are resulted. An organoleptic evaluation of cupcakes for a gluten-free diet was carried out and the daily requirement for vitamins of people aged 18-59 when consuming this confectionery has been determined. **Conclusions and discussions.** Determining the effect of gluten-free compositions on the quality of biscuit dough and finished

products makes it possible to offer for a gluten-free diet three recipes for cupcakes based on compositions of rice-flax flour, sesame-flax flour and flax flour with pumpkin seed meal, added bougainvillea, carrot and pumpkin. Developed cupcakes for a gluten-free diet can be used in the diet of people aged 18-59 years for both dietary nutrition and general disease prevention.

**Keywords:** confectionery technology, flax flour, rice, sesame, pumpkin meal, sugar substitute.

### **The topicality of the problem**

*The problem formulation.* World statistics show that in recent decades, the number of people diagnosed with celiac disease in the world has increased significantly. This is partly due to improved diagnostic techniques. In some sources the reason is also called the used technological process of cultures processing. In addition to celiac disease, there is the “gluten sensitivity” concept, which, although accompanied by similar symptoms, but does not involve the immune system. A number of studies indicate that wheat allergy is caused by gluten. And removing gluten-containing foods from the diet has improved patient health (Kamalova & Pirogova, 2013; Millward et al., 2008).

Celiac disease affects the small intestine, which is responsible in the body for the function of nutrient absorption. As a result of genetic abnormalities in the small intestine it ceases to form the enzyme which is responsible for the breakdown of gliadin (one of the components of gluten). Because of this, vitamins, minerals and other nutrients are not absorbed, and the undigested gliadin itself becomes almost a poison and triggers immune reactions in the mucous membrane. Celiac disease is an autoimmune disorder that “causes the immune system to attack its own gut” when gluten (gluten) enters the body (Sanz, 2010, c. 135).

Therefore, the confectionery technologies development based on gluten-free flour compositions and the study of their quality indicators becomes especially relevant (Saloaara et al., 2010).

*The state of the problem study.* Investigating the technological properties of gluten-free raw materials, scientists have determined that gluten-free types of flour contain less of their own sugars and are characterized by lower sugar-forming ability compared to wheat flour, this is influenced by the dispersion of the particles, while the water absorption capacity of gluten-free flour depends more on the chemical composition and state of its biopolymers than on the dispersion (Drobot et al., 2011; Schneider & Kazennova, 2009).

Dorokhovych V.V. with students of Kyiv National University of Trade and Economics investigated the moisture absorption capacity of the dough using sucrose, fructose, sorbitol, lactitol, isolmat. The maximum result was given by fructose, the minimum was isolmat. Experiments have also been conducted on the effect of sugar substitutes on the amount of gluten in the dough, but only the osmotic pressure changes, sugar substitutes use less osmotically bound water, so the type and amount of sugar substitute does not affect the strength of the gluten. Replacing sugar with sugar substitutes leads to the fact that the caloric content of cupcakes is reduced, the amount of instant carbohydrates, the taste of products and their benefits increase. Replacement of butter as one of the forming components of the dough with fruit puree leads primarily to improved organoleptic characteristics, improve the quality of the dough, reduce fat and cholesterol in the finished product, as well as enrichment of cupcakes with additional

dietary fiber and vitamins of group B, PP and C (Yaremenko & A.M. Dorokhovitch, 2008; A.N. Dorokhovitch et al., 2007a; 2007b; V.V. Dorokhovitch & Yaremenko, 2008).

Thanks to the work of prof. V.I. Obolkina and students proved that the addition of non-traditional compositions of vegetable puree in confectionery increases the content of pectin by 2.3–2.9 times, fiber by 1.25–2.25 times, vitamins by 3.6–5, 1 times, minerals in 3.5–5.2 times, which confirms the effectiveness of technologies of fillings and jelly glaze using vegetable pectin-containing raw materials and polysaccharide complexes (Obolkina et al., 2012; Yovbak et al., 2013).

Researchers from Yeldiz University (Turkey) tried to get a delicious and healthy oriental gluten-free dessert based on corn, rice and potato flour, as well as corn and tapioca starch using soy protein and peas and glutaminase enzyme transfer. It has been experimentally proven that revani showed the best quality with a flour mixture containing corn and rice flour (in the amount of 62.5% and 37.5% respectively) and trans-glutaminase (TG) (Yildirim et al., 2018). A team of scientists led by E. Badiu (Badiu et al., 2014) found that the use of flour from rice, sorghum, corn, millet, buckwheat and amaranth allowed producing high-quality gluten-free bread. A team of scientists led by E. Badiu (Badiu et al., 2014) found that the use of flour from rice, sorghum, corn, millet, buckwheat and amaranth allowed producing high quality gluten-free bread.

A number of gluten-free flour products contain insufficient dietary fiber and minerals that are lost during flour processing. But whole meal flour has a much shorter shelf life because the grains that fall into the flour contain a lot of fat, which causes it to thicken quickly. Thus, the authors believe that extrusion of whole meal flour can help. The results of the study prove that this allows extending the shelf life of flour and cookies with improved organoleptic characteristics, fragility of the texture and increased content of dietary fiber (more than 8.4 per 100 g).

In recent years, scientists O. M. Shanina, K. O. Duhina, N. L. Lobachova, T. V. Havrysh have made a significant scientific and practical contribution to the technology of gluten-free confectionery development (Shanina et al., 2012; 2020; Riemsdijk van et al., 2011).

*Unresolved issues.* However, the question of the prospects for the use of gluten-free confectionery flour compositions with fruit and vegetable purees remains completely unexplored, which confirms the feasibility of further research.

## **Purpose and research methods**

*The purpose of the article.* The purpose of the article is to determine the effect of gluten-free flour compositions based on flaxseed, rice, sesame, pumpkin seed meal, sugar substitute on the quality of cupcakes.

*The methodological basis of the research* is the analysis of the shortcomings of gluten-free confectionery in view of the requirements of nutrition in the nutritional and biological value of products and finding ways to solve this problem in the gluten-free confectionery development.

*Research methods:* With Brookfield viscometer measured voltage dependence of the shear biscuit dough based on gluten-free flour compositions. The effective viscosity of the test samples was determined in the range of speeds LV (spindle speed from 0 to 4 c<sup>-1</sup>. Cylinder S-3 and mode B-2 were used in the experiments.

On the bursting machine MT-140 / RV2 was performed to determine the adhesion stress of the dough masses from the effects of different concentrations of the model system based on gluten-free flour compositions.

To determine the physico-chemical and technological quality indicators, the humidity, burn and burn of the developed cupcakes were calculated in comparison with the classical ones. The calculation of humidity was performed by the accelerated method, dried for 40 min at  $t = 130\text{ }^{\circ}\text{C}$ , after which the sample was cooled for one hour and weighed. The percentage of moisture was calculated by formula 1.

$$W = ((m_1 - m_2) / m_1) \cdot 100, \quad (1)$$

where  $W$  – product humidity, %;  $m_1$  is the mass of the raw sample, g;  $m_2$  is weight of dry sample, g.

Baking was defined as the difference in weight between the finished product and the weight of the dough. The calculation of baking in percent was calculated by formula 2.

$$M_b = (M_{sfp} - M_g) / M_{sfp} \cdot 100, \quad (2)$$

where  $M_b$  – baking the finished product, %;  $M_{sfp}$  – weight of the semi-finished product, prepared for baking, g;  $M_g$  – weight of the finished product after baking, g

Burn was defined as the excess weight of the finished product compared to the weight of flour used. The calculation of the burn in percent was calculated by formula 3.

$$M_c = (M_g - M_f) \cdot 100, \quad (3)$$

where  $M_c$  – cauterization of the finished product, %;  $M_f$  – mass of flour for dough, g

*Object of research* is quality indicators of cupcakes based on gluten-free flour compositions.

*Subject of research* is model samples of biscuit dough on the basis of rice-flax flour, sesame-flax and flax with pumpkin seed meal with the addition of banana-beet, apricot-banana puree, carrot and pumpkin; model samples with the addition of the above additives; cupcakes according to traditional recipes (<https://1000.menu/cooking/18114-vanilnye-kapkeiki-s-kremom>).

*The information base* is based on research covered in scientific articles and abstracts of reports of leading scientists in Ukraine and abroad.

## The research results

To determine the effect of gluten-free flour compositions based on rice-flax, sesame-flax and flaxseed meal with pumpkin seed meal with the addition of banana-beet puree, apricot-banana, and carrot-pumpkin on the quality of biscuit dough investigated the effective viscosity and adhesion stress of the dough. In all flour compositions of flax flour 20% is taken, other types of flour and meal are 80%. The obtained data are shown in table 1.

Adding fruit and vegetable puree to the dough with the replacement of wheat flour destabilizes and changes the viscosity of the biscuit cake. As the speed increased, the viscosity of the dough did not decrease gradually. The lowest effective viscosity was observed in the dough of a cupcake made of flax flour with pumpkin seed meal, the highest – in the dough of sesame-flax cupcake. The viscosity of the dough for cupcakes from flax flour with pumpkin seed meal and rice-flax was important, the dough closest

to the values of viscosity characteristics of the classic cupcake dough. This is due to the fact that sesame flour in combination with flax has a high fat and water absorption capacity, which significantly affects its structural and mechanical properties.

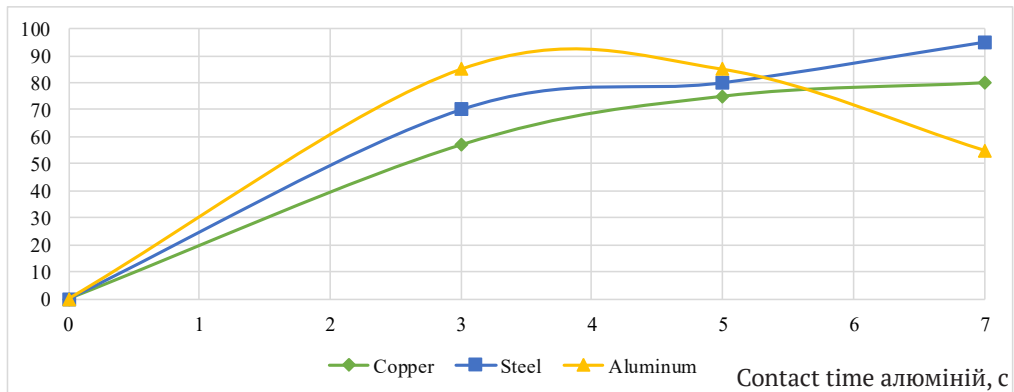
Table 1. Indicators of effective viscosity of biscuit cake cupcakes depending on the composition of gluten-free flour compositions

Classic cupcake		Rice-linen cupcake		Sesame and linen cupcake		Pumpkin-flax cupcake	
Rotation speed, c-1	Dynamic viscosity, Pa*c	Rotation speed, c <sup>-1</sup>	Dynamic viscosity, Pa * c	Rotation speed, c <sup>-1</sup>	Dynamic viscosity, Pa*c	Rotation speed, c <sup>-1</sup>	Dynamic viscosity, Pa*c
0	25,98	0	26,96	0	31,86	0	24,51
0,5	10,4	0,5	10,61	0,5	13,44	0,5	10,08
1	5,37	1	4,92	1	6,5	1	5,2
2	4,37	2	5,37	2	4,35	2	4,22
2,5	4,39	2,5	4,43	2,5	3,9	2,5	4,29
4	3,38	4	4,49	4	4,18	4	3,71

Source: own development

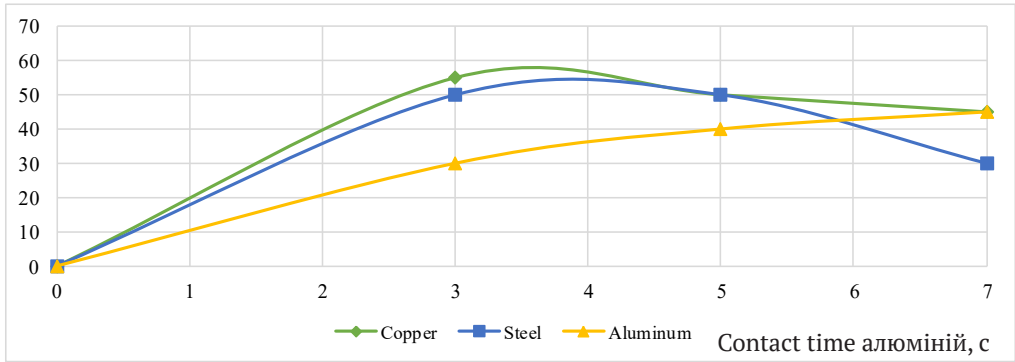
The adhesion stress of gluten-free biscuit dough depending on the composition of the flour mixture was studied (Fig. 1). The research results showed that the amount of adhesion stress is significantly affected by the time of contact of the workpiece with the working body of the equipment. The dough of a cupcake from flax flour with pumpkin seed meal is as close as possible to the dough of a classic cupcake in terms of the characteristic of the adhesive stress from the dough mass to the classical cupcake. When using rice-linen composition, the adhesive stress of the dough is minimal in value regardless of the plates' material, whereas for the dough based on sesame-flax composition the adhesion is maximum compared to other types of dough on a gluten-free basis and close to the values of the adhesion stress of the classic cupcake dough. The obtained data indicate an improvement in the quality of the dough and a decrease in the adhesion stress of the dough blank when using gluten-free rice-flax and pumpkin-flax compositions.

Adhesion stress, Pa



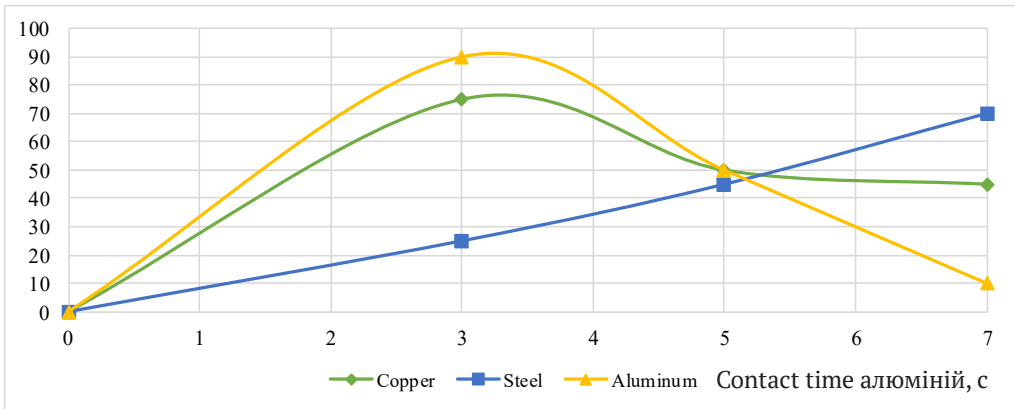
a)

Adhesion stress, Pa



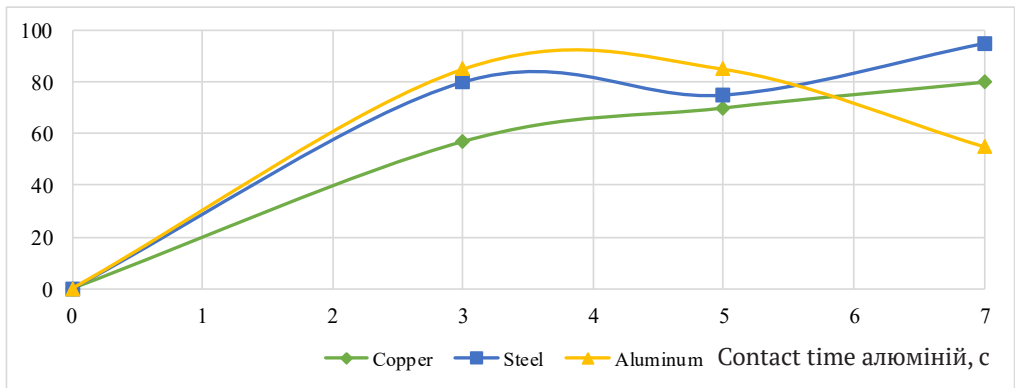
b)

Adhesion stress, Pa



c)

Adhesion stress, Pa



d)

Fig. 1. Dependence of dough masses adhesion stress from the duration of contact and plate material: a) control (classic cupcake); b) rice-flax; c) sesame-flax; d) pumpkin-flax.

Source: own development



Photomicrographs of four dough samples are shown in Figure 2. Replacement of wheat flour with gluten-free flour compositions changes the structural properties and dispersion of the dough.

The micrograph shows that the sample based on rice-linen composition has the most similar structure and retains a well-developed porosity, which is inherent in the classical sample. The lowest porosity according to the photo has a sample based on pumpkin-flax composition, which can be explained by the use of pumpkin-carrot puree, which has the highest dry matter content than apricot-banana puree or banana-beet puree.

On the basis of experimental researches of organoleptic indicators of the received model samples we have developed technologies and tested in laboratory conditions and the technology of flour gluten-free products has been offered. Data on organoleptic characteristics of cupcakes based on gluten-free flour compositions are shown in Figure 3. From the data given on the profile graph, it is visible that on all indicators, except aroma, finished products on the basis of rice-flax composition with use of banana-beet puree exceed organoleptic indicators of a classic cupcake. Low marks for flavor are characterized by cupcakes made on the basis of sesame-flax and pumpkin-flax flour composition. It is similar to the results of organoleptic evaluation of the classic cupcake in consistency and taste of finished products on pumpkin-flax and rice-flax bases.

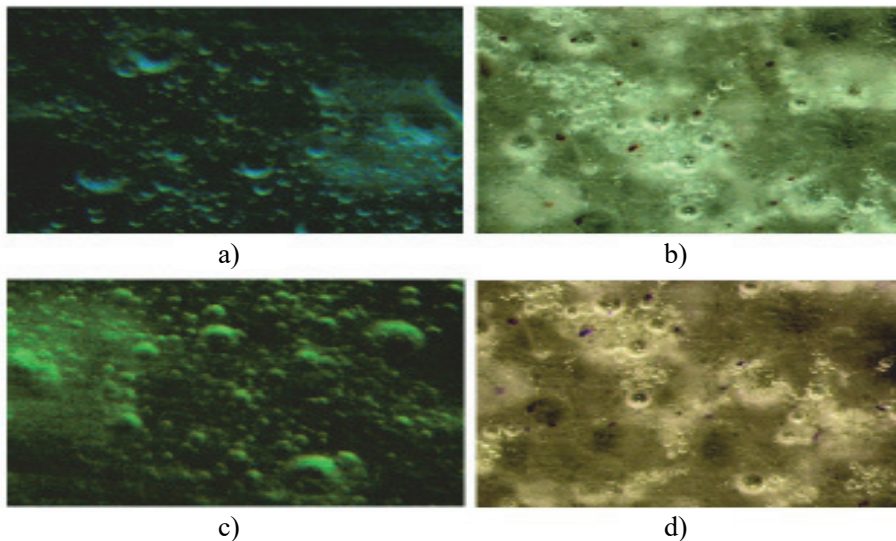


Fig. 2. Photomicrographs of biscuit dough classic and based on gluten-free flour compositions: a) control (wheat); b) rice-flax; c) sesame-flax; d) pumpkin-flax.

Source: own development

The evaluation of physicochemical (humidity,%) and technological indicators (baking and baking,%) of cupcakes based on gluten-free flour compositions. The results of these experimental studies are summarized in table 2. The lowest humidity is characterized by a sample based on sesame-flax composition, its humidity is almost 25%

lower than the humidity of the classic cupcake, while the finished products on pumpkin-flax and rice-flax bases are almost no different from the control (0...5 %).

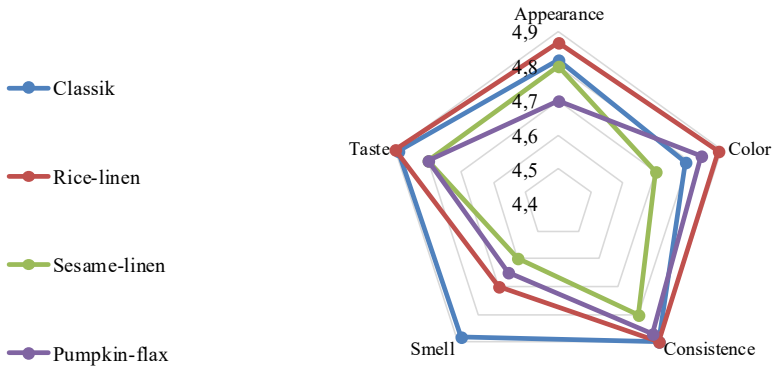


Fig. 3. Profilogram of organoleptic indicators of cupcakes of classical and on the basis of gluten-free flour compositions.

Source: own development

For baking, all types of cupcakes based on gluten-free flour compositions are less than the control: pumpkin-flax is 5.5 times, rice-flax is 2.2 times, sesame-flax is 1.6 times. Samples on rice-flax and pumpkin-flax flour composition have relatively the same values of cauterization (5.6... 8.9% of the value of cauterization of a classic cupcake), and almost 4 times less cauterization characterizes the sample on sesame-flaxseed basis. The obtained data correlate with experimental data of organoleptic evaluation, micrographs of finished products and structural and mechanical characteristics of the dough.

Tabl. 2. Physico-chemical (humidity,%) and technological indicators (burn and scorch,%) cupcakes based on gluten-free flour compositions

Indicator	Classic cupcake	Rice-linen cupcake	Sesame and linen cupcake	Pumpkin-flax cupcake
Humidity, %	40	42	30	40
Baked, %	22	10	14	4
Burn, %	46,6	49,2	12,2	42,8

Source: own development

Developed gluten-free flour products contain a significant complex of vitamins and dietary fiber. The recipe reduces the number of calories by reducing confectionery fat and replacing sugar with sugar substitute. Also, the protein content is increased due to the use of flaxseed flour, which enriches the product with vegetable protein by almost 40%, as well as increases the number of macro- and micronutrients several times. Provision of gluten-free confectionery products daily requirement for minerals for people aged 18-59 years is shown in table 3.



Tabl. 3. Providing gluten-free confectionery daily needs for vitamins, minerals and dietary fiber for people aged 18–59 years. Source: own development

Product	Minerals, vitamins and dietary fiber	Ensuring the daily requirement of nutrients, mg for people aged 18-59	
		Experiment	Control
Rice-linen	Sodium (Na)	87	82,4
	Potassium (K)	455,2	273,2
	Calcium (Ca)	145,2	46,5
	Retinol (A)	114	134,4
	Magnesium (Mg)	125,8	53,8
	Iron (Fe)	6,47	2
	Tocopherol (E)	3,64	0,51
	Thiamine (B1)	0,42	0,19
	Riboflavin (B2)	0,25	0,26
	Nicotinic acid (PP)	6,39	4,66
	Ascorbic acid (C)	0,65	4
Dietary fiber	3,5	3,24	
Sesa-me-linen	Sodium (Na)	87	73,8
	Potassium (K)	455,2	200,6
	Calcium (Ca)	145,2	34,7
	Retinol (A)	114	187,4
	Magnesium (Mg)	125,8	16
	Iron (Fe)	6,47	1,51
	Tocopherol (E)	3,64	0,6
	Thiamine (B1)	0,42	0,049
	Riboflavin (B2)	0,25	0,242
	Nicotinic acid (PP)	6,39	2,14
	Ascorbic acid (C)	0,65	4
Dietary fiber	3,5	0,76	
Pump-kin-flax	Sodium (Na)	87	72
	Potassium (K)	455,2	150,8
	Calcium (Ca)	145,2	37,9
	Retinol (A)	114	580
	Magnesium (Mg)	125,8	16,4
	Phosphorus (P)	413	16
	Iron (Fe)	6,47	1,47
	Tocopherol (E)	3,64	0,46
	Thiamine (B1)	0,42	0,057
	Riboflavin (B2)	0,25	0,246
	Nicotinic acid (PP)	6,39	2,16
Ascorbic acid (C)	0,65	2,6	
Dietary fiber	3,5	0,88	

A significant difference in minerals is observed between the classic cupcake and gluten-free samples in potassium and magnesium: pumpkin-flax exceeds the control by 3 and 7.5 times, respectively, rice-flax is by 1.7 and 2.3 times, respectively, sesame-flax is 2.3 and 7.8 times, respectively; as well as in calcium and iron: pumpkin-flax exceeds the control by 3.8 and 4.4 times, respectively, rice-flax is by 3.2 and 3.2 times, respectively, sesame-flax is by 4.2 and 4.3 times, respectively. The content of dietary fiber in gluten-free cupcakes exceeds the control by 4.6 times for sesame-flax-based products and 4.0 times for pumpkin-flax-based products. The content of dietary fiber in gluten-free cupcakes exceeds the control by 4.6 times for sesame-flax-based products and 4.0 times for pumpkin-flax-based products. The content of tocopherol in finished products is 6.1... 7.7 times higher than in the classic product.

### Conclusions and discussion of results

Thus, the expediency of using rice-flax, sesame-flax and flaxseed meal with pumpkin seed meal with the addition of banana-beet, apricot-banana, carrot-pumpkin puree has been proved in the technology of gluten-free flour products from biscuit dough. The introduction into the recipe of gluten-free flour compositions with the addition of fruit and vegetable puree leads to the creation of low-calorie enriched with mineral-vitamin ingredients and dietary fiber products in the appropriate direction.

The scientific novelty of the obtained results is that for the first time the regularity of the processes of gluten-free flour compositions influence with the fruit addition and vegetable puree on the quality indicators of biscuit dough has been determined. For the first time the regularity of the processes of gluten-free flour compositions influence with the addition of fruit and vegetable puree on the process of structure formation of biscuit dough and the technological indicators formation of its quality and humidity has been studied. The practical significance of the obtained results is manifested in the technology development for the production of gluten-free flour products of high nutritional value. Prospects for further research are to conduct research to develop technology for gluten-free flour products using a composition of dietary supplements to create products enriched with natural biologically active substances.

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## ВПЛИВ БОРОШНЯНИХ БЕЗГЛЮТЕНОВИХ КОМПОЗИЦІЙ НА ЯКІСНІ ПОКАЗНИКИ КАПКЕЙКІВ ІЗ БІСКВІТНОГО ТІСТА

**Актуальність.** Згідно з даними Всесвітньої організації гастроентерологів (ВОГ-OMGE), у пацієнтів з активною (клінічно вираженою) целиакією є підвищений ризик смерті в порівнянні із загальною популяцією населення, пацієнти із целиакією категорично не повинні вживати пшеницю, жито або ячмінь в їжу в будь-якому вигляді. Однак підвищений ризик летального результату поновлюється після трьох-п'яти років суворого дотримання безглютенової дієти, тому набуває особливої актуальності розроблення технологій кондитерських виробів на основі безглютенових борошняних композицій та вивчення їх показників якості. **Метою роботи є визначення впливу борошняних безглютенових композицій на основі** борошна лляного, рисового, кунжутного, шроту насіння гарбуза, цукрозамінника на показники якості капкейків. **Методи дослідження.** Залежність напруги від швидкості зсуву бісквітного тіста на основі **безглютенових борошняних композицій** визначали за допомогою віскозиметра Брукфільда. Адгезійне напруження тістових мас від впливу різної концентрації модельної системи на основі **безглютенових борошняних композицій** проводили на розривній машині МТ-140/RV2. **Результати.** Наведені дані дослідження впливу **безглютенових борошняних композицій** на якісні властивості бісквітного тіста. Проведена органолептична оцінка капкейків для безглютенової дієти і визначено забезпечення добової потреби у вітамінах людей віком 18–59 років при споживанні цієї кондитерської

продукції. **Висновки та обговорення.** Визначення впливу безглютенових композицій на якісні показники бісквітного тіста та готових виробів дають можливість запропонувати для безглютенової дієти три рецептури капкейків на основі композицій рисово-ляного борошна, кунжутно-ляного борошна та борошна ляного зі шротом насіння гарбуза з додаванням пюре бананово-бурякового, абрикосово-бананового, морквяно-гарбузового. Розроблені капкейки для безглютенової дієти можливо використовувати в раціоні людей віком 18–59 років як для дієтичного харчування, так і для загальної профілактики захворювання.

**Ключові слова:** технологія кондитерських виробів, борошно ляне, рисове, кунжутне, шрот гарбуза, цукрозамінник.

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## **ВЛИЯНИЕ МУЧНЫХ БЕЗГЛУТЕНОВЫХ КОМПОЗИЦИЙ НА КАЧЕСТВЕННЫЕ ПОКАЗАТЕЛИ КАПКЕЙКОВ НА ОСНОВЕ БИСКВИТНОГО ТЕСТА**

**Актуальность.** Согласно данным Всемирной организации гастроэнтерологов (ВОГ-ОМGE), у пациентов с активной (клинически выраженной) целиакией имеется повышенный риск смерти по сравнению с общей популяцией населения, пациенты с целиакией категорически не должны употреблять пшеницу, рожь или ячмень в пищу в любом виде.

Однако этот повышенный риск летального исхода возвращается после трех-пяти лет строгого соблюдения безглютеновой диеты, поэтому приобретает особую актуальность разработка технологий кондитерских изделий на основе безглютеновых мучных композиций и изучение их показателей качества. **Цель.** Целью исследования является определение влияния безглютеновых мучных композиций на основе муки льняной, рисовой, кунжутной, шрота семян тыквы, сахарозаменителя на показатели качества капкейков. **Методы исследования.** Зависимость напряжения от скорости сдвига бисквитного теста на основе безглютеновых мучных композиций определяли с помощью вискозиметра Брукфильда. Адгезионное напряжение тестовых масс от влияния различной концентрации модельной системы на основе безглютеновых мучных композиций проводили на разрывной машине МТ-140/RV2. **Результаты.** Определение влияния безглютеновых композиций на качественные показатели бисквитного теста и готовых изделий дает возможность предложить для безглютеновой диеты три рецептуры капкейков на основе композиций рисово-льняной муки, кунжутно-льняной муки и льняной со шротом семян тыквы с добавлением пюре бананово-свекольного, абрикосово-бананового, морковно-тыквенного. Разработанные капкейки для безглютеновой диеты можно использовать в рационе людей в возрасте 18–59 лет как для диетического питания, так и для общей профилактики заболевания.

**Ключевые слова:** композиции безглютеновой муки с фруктово-овощным пюре, технология кондитерских изделий, мука льняная, рисовая, кунжутная, шрот семян тыквы, сахарозаменитель, стевия.