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Теоретично обґрунтовано та експериментально підтверджено доцільність використання рослинних добавок у технології пряничних виробів. Обґрунтовано вплив вмісту рослинних добавок на формостійкість пряників. Проведена сенсорна оцінка органолептичних показників готових виробів та побудовані профілі органолептичної оцінки пряників. Встановлено, що рослинні добавки сприяють поліпшенню якості пряничних виробів

Ключові слова: кедровий шрот, кунжутне борошно, фітопорошок з гірчака зміїного, пряничні вироби, органолептична оцінка

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Теоретически обоснована и экспериментально подтверждена целесообразность использования растительных добавок в технологии пряничных изделий. Обосновано влияние содержания растительных добавок на формоустойчивость пряников. Проведена сенсорная оценка органолептических показателей готовых изделий и построены профили органолептической оценки пряников. Установлено, что растительные добавки способствуют улучшению качества пряничных изделий

Ключевые слова: кедровый шрот, кунжутная мука, фитопорошок с горца змеиноного, пряничные изделия, органолептическая оценка

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STUDY INTO EFFECT OF PLANT SUPPLEMENTS ON THE QUALITY INDICATORS OF GINGERBREAD AND SIMILAR SPICE-CAKES

M. Kravchenko
Doctor of Technical Sciences,
Professor, Head of Department*
E-mail: ktogh@knteu.kiev.ua

N. Yaroshenko
Postgraduate Student*
E-mail: ynatalya@email.ua

*Department of Technology and the organization of restaurant business
Kyiv national university of trade and economics
Kyoto str., 19, Kyiv, Ukraine, 02156

1. Introduction

Nutrition is one of the most ancient factors that affects health of the nation. Proper nutrition contributes to the prevention of diseases, prolongation of life, creation of conditions to improve the body's resistance to adverse effects of the environment. An important task for the food industry is to provide the population with products with high consumer properties.

In accordance with "Global Strategy on Food, Physical Activity and Health" of the World Health Assembly, a grad-

ual replacement of traditional assortment of food products with special ones that contribute to the maintenance of normal functioning of all organs and systems of a human body, to health and longevity, is the main direction in the development of the civilized market. The development of a strategy to create new scientifically based technologies for ecologically-friendly food products, including special purpose food products, is one of the main tasks of the world public policy related to food quality and safety [1].

Consumer demand for healthy foods, successes in the study of a physiological role of nutritional ingredients in a

diet are a factor of the growth of production of special purpose flour confectionery products [2].

The demand of Ukrainian consumers for healthy products, success in the study of a physiological role of nutritional ingredients in a diet is a factor of the growth of production of Ukrainian flour confectionery products for special purposes.

Gingerbread and similar spice-cakes are flour confectionery products of various shapes that contain a large amount of sugary substances and spices. Gingerbread and similar spice-cakes are made from wheat, or from a mixture of wheat and rye flour, sugar, honey, treacle, fat, baking powder, aromatic and flavoring substances and other raw products according to the formulation composition [3].

Gingerbread and similar spice-cakes enjoy a fairly high demand from the population today. It can be explained by a low cost and high flavoring qualities. However, at present, competitiveness of products is largely determined by the availability of a range of special products for health improvement purposes. The main disadvantage of confectionery products is low physiological value. Gingerbread and similar spice-cakes practically do not contain such important biologically active substances as vitamins, ω -3 fatty acids, nutrition fibers, minerals and a number of others.

The most important task of the present stage of food industry development is a provision of a full value composition, safety and quality of food products [4].

A search for natural nutrients of vegetable origin, which can increase a resistance of a human body to adverse environmental factors due to their antioxidant, antitoxic, anti-stress and immunopotential activity [5].

An important task to optimize a composition and to improve consumer properties of gingerbread and similar spice-cakes is a rational combination of different types of raw materials of natural origin [6].

In the process of selection of formulation components, it is especially important to take into account the effective impact on quality parameters of finished products. That is, to pay attention to characteristics that are standard in the normative documentation, namely – a mass fraction of moisture, alkalinity, organoleptic parameters [7].

Extending the assortment of products, improvement of organoleptic quality indicators, an increase in the food value of gingerbread and similar spice-cakes, which are prepared in restaurants and at enterprises of food industry, determine the relevance of present work.

2. Literature review and problem statement

Improvement of the structure of Ukrainian population nutrition implies an increase in the production of food products through the improvement of existing technologies and creation of new technologies, enrichment of products with biologically valuable substances: proteins, amino acids, vitamins, mineral salts.

Scientists have developed a classification of special-purpose products for different population groups [8].

Special purpose products are made from natural, traditional and non-traditional, environmentally friendly raw materials with high content of biologically active substances.

One of the sources of biologically active substances is vegetable supplements. They contain natural complexes of macro- and microelements in the most accessible and digestible form.

A priority direction is the use of raw materials of vegetable origin in the form of a powder or various kinds of extracts in the confectionery industry [9].

A promising way for the development of advanced technologies in flour confectionery products is the use of raw materials of vegetable origin: cedar oilcake, sesame flour, phyto-powder made from roots of snakeweed. Cedar oilcake and sesame flour are rich in dietary fiber, vegetable protein, vitamins, folic acid, antioxidants, as well as microelements necessary for health (potassium, calcium, magnesium, zinc).

An effective way to optimize the structure and individualization of population nutrition is the development of production of special purpose products using the following ingredients in their composition – concentrates of natural food components – vitamins, macro- and micronutrients, and food fibers [10].

A phyto-powder made from roots of snakeweed is used in food industry to provide a dietary component to products. The phyto-powder contains multivitamins, macro- and micronutrients, proteins and amino acids, antioxidants, food fibers. This makes it possible to normalize the metabolism, to improve the digestive process, to increase immunity of an organism. Snakeweed is used as an additive to rye flour in the production of bakery products [11].

The expediency of the use of grain composite mixtures (flour of flax seed and biomodified amaranth grains) in the protracted, sugar and sand biscuits technologies to expand a range of flour confectionery has been proved. A ratio of vegetable supplements to formulation components of flour confectionery products was established and conditions for the introduction of supplements were determined [12].

There are known methods and formulations for the preparation of flour confectionery products with therapeutic and prophylactic actions. A number of studies showed the possibility of using wheat germs, medicinal aroma herbs as supplements in the manufacture of products [13].

A new kind of spice-cakes with prophylactic purpose was developed that employ the use of soy protein hydrolyzate, wheat seeds, vitamin and mineral mixture and replacement of flour of first grade with second grade flour [14].

The use of sesame flour was proposed in paper [15]. Sesame flour significantly exceeds wheat flour by the content of essential amino acids: valine, lysine, phenylalanine and tyrosine, threonine. These products are characterized by high organoleptic characteristics.

The possibility to use cedar oilcake in the technology of making flour confectionery products was explored. Cedar flour contains 30.2–5.3 % protein, and the amount of essential amino acids, which it contains, is three times higher than the amount of essential acids in high quality wheat flour. The cedar oilcake also contains polyunsaturated fatty acids, tocopherols, and phospholipids [16].

The possibility of using cedar flour was investigated in the technology of production of flour confectionery products. Cedar flour contains a significant amount of protein while the amount of essential amino acids in it is three times higher than the volume of essential amino acids in wheat flour of higher grade. Cedar flour contains polyunsaturated fatty acids, tocopherols and phospholipids [17].

There is a technology [18] for a replacement of wheat flour with cedar flour in the ratio of 70:30 and 50:50. The formulation of flour confectionery products with the replacement of part of wheat flour with a part of cedar flour,

namely 50 %, was worked out and developed on the basis of the conducted research.

A technique for making flour from the waste products of fruit juices was patented by the company Ben Hill Griften (USA). The wastes are mixed with sesame flour and then ground. Citrus flour contains: 10.5 % of protein, 62.5 % of carbohydrates, 2.5 % of fat, 13.0 % of row fiber, 5.0 % of moisture. The use of flour will enable enriching the products with useful substances, as well as improve organoleptic indicators of product quality [19].

Thus, the introduction of vegetable supplements to flour confectionery products improves physical and chemical indicators of finished products, enriches products with biologically active substances, contributes to the extension of a range of products. The given products with supplements are characterized by sufficient shape stability, they have developed porosity and volume [20].

Production of flour confectionery for special purposes with the addition of vegetable supplements softens the influence of technogenic factors and provides the human body with a necessary daily norm of vital components.

Thus, the biologically-active food supplements of natural origin, which are necessary for our organism's normal functioning, are the components of health improving raw materials. Formulations of flour confectionery products are based on the achievements of modern science and the use of advanced biotechnology, which will make it possible to create products with a targeted therapeutic effect.

3. The aim and objectives of the study

The aim of present work is to determine an optimal dosage of vegetable supplements in the preparation of gingerbread and similar spice-cakes, to establish the effect of supplements on the organoleptic and physical and chemical parameters of the quality of finished gingerbread and similar spice-cakes.

To achieve the set objective, the following tasks were solved:

- to determine mass fraction of moisture and alkalinity in the finished products;
- to examine the dependence of boundary shear stress and the dependence of soaking of gingerbread and similar spice-cakes on the content of vegetable supplements;
- to determine and investigate the optimum dosage of vegetable supplements in the preparation of gingerbread and similar spice-cakes;
- to conduct sensory evaluation of organoleptic parameters of the finished products and to construct profiles of the organoleptic evaluation of gingerbread and similar spice-cakes.

4. Research materials and methods

Study objects – technology of flour confectionery products made from spice-cake dough with vegetable supplements.

Study subjects – cedar flour (Fig. 1, *a*); sesame flour (Fig. 1, *b*); phyto-powder made from roots of snakeweed (Fig. 1, *c*); gingerbread and similar spice-cakes with the addition of vegetable supplements.

Research methods – organoleptic, structural and mechanical, physical and chemical methods with the use of informational computer technologies and software [21].

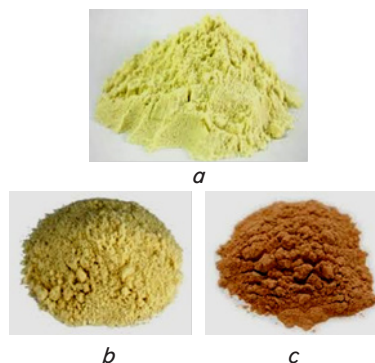


Fig. 1. Study subjects: *a* – cedar oilcake; *b* – sesame flour; *c* – phyto-powder made from roots of snakeweed

5. Results of studying the influence of the content of vegetable supplements on the quality parameters of gingerbread and similar spice-cakes

First of all, when conducting a study into the influence of vegetable supplements on the quality parameters of finished products, it is necessary to pay attention to the characteristics that are standardized in the normative documentation, namely, mass fraction of moisture, alkalinity, organoleptic characteristics.

Humidity was achieved by drying to a constant mass at a temperature of 105 °C. [22]. It was established in the course of research (Fig. 2) that within the content of cedar flour of 10...18 %, humidity is reduced by 1.6...11.8 % – from 12.92±0.13 % to 11.58±0.14 %, sesame flour – by 3.2...6.8 % – from 12.71±0.12 % to 12.24±0.13 %, while within the content of flour made from roots of snakeweed of 4...12 %, the moisture content of the finished products increased by 1.4...3.6 % – from 13.32±0.14 % to 13.60±0.13 %.

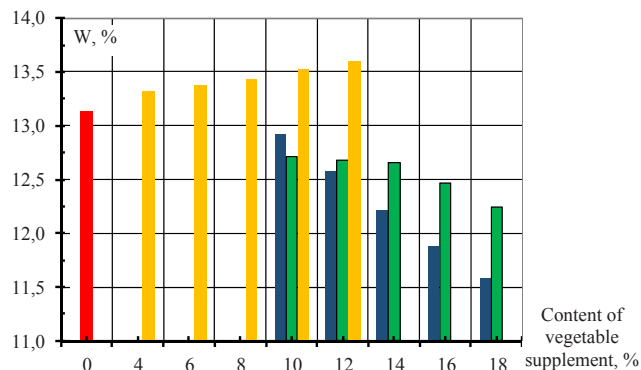


Fig. 2. Dependence of mass fraction of moisture in spice-cakes on the content of vegetable supplements: ■ – spice-cakes without supplements (control), ■ – flour made from roots of snakeweed, ■ – cedar flour, ■ – sesame flour

The alkalinity of gingerbread and similar spice-cakes was determined by the method of potentiometric titration using the ion analyzer AI-123 [23]. It was found (Fig. 3) in the course of the research that alkalinity decreased with an increase in the amount of vegetable supplements within the examined amount.

Thus, when wheat flour was replaced with cedar flour from 10 to 18 %, the alkalinity of the spice-cakes “Cedar” dropped by 22.4...30.6 % relative to control without supplements – from 0.38±0.01 to 0.34±0.01 degrees of alkalinity,

when replaced with sesame flour – by 6.1...10.2 % – from 0.46 ± 0.01 to 0.44 ± 0.01 degrees of alkalinity, when replaced with flour from roots of snakeweed from 4 to 12 % – by 4.1...16.3 % – from 0.47 ± 0.01 to 0.41 ± 0.01 degrees of alkalinity relative to the spice-cake dough without supplements.

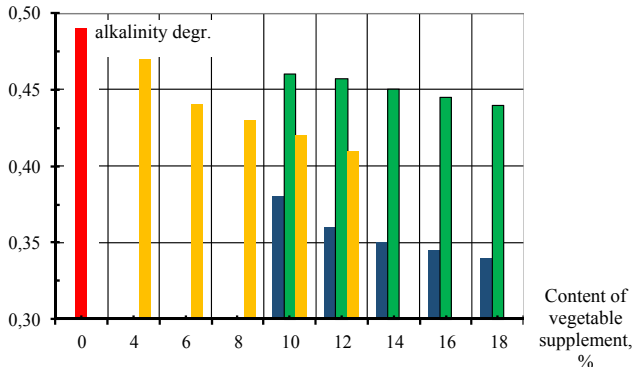


Fig. 3. Dependence of the alkalinity of spice-cakes on the content of vegetable supplements: ■ – spice-cakes without supplements (control), ■ – flour made from roots of snakeweed, ■ – cedar flour, ■ – sesame flour

The shape stability of the structure of gingerbread and similar spice-cakes was investigated using linear dimensions: a height of a spice-cake – H and a diameter – D [24]. It was established (Fig. 4) that the shape stability decreases slightly with an increase in the content of supplements. It should be noted that the pronounced decrease in the shape stability was characteristic of the spice-cakes with cedar flour, and was less pronounced for the gingerbread and similar spice-cakes with sesame flour and those made from a root of snakeweed.

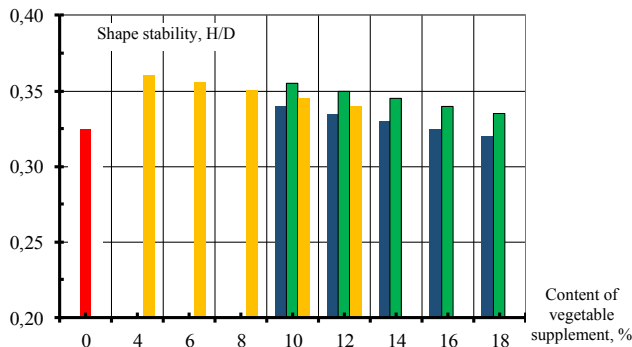


Fig. 4. Dependence of shape stability (H/D) of spice-cakes on the content of vegetable supplements: ■ – spice-cakes without supplements (control), ■ – flour made from roots of snakeweed, ■ – cedar flour, ■ – sesame flour

The resistance of a spice-cake structure was characterized by the boundary shear stress of the undamaged structure, which was investigated using the semi-automatic penetrometer “Labor” and calculated according to procedure [25].

A decrease in this parameter was established (Fig. 5) in the course of experimental studies into dependence of the boundary shear stress of spice-cakes on the content of vegetable supplements.

The data given in Fig. 5 indicate that within the limits of the content of cedar flour of 10...18 %, the boundary shear stress of spice-cakes was reduced by 8.9...26.0 % – from $(80.0 \pm 2.0) \times 10^3$ Pa to $(65.0 \pm 1.5) \times 10^3$ Pa, sesame flour – by

26.0...46.5 % – from $(65.0 \pm 1.5) \times 10^3$ Pa to $(47.0 \pm 1.1) \times 10^3$ Pa, and within the content of the flour from roots of snakeweed of 4...12 % – by 13.4...49.9 % – from $(76.0 \pm 1.9) \times 10^3$ Pa to $(44.0 \pm 1.0) \times 10^3$ Pa.

A procedure for determining the soaking of gingerbread and similar spice-cakes [26] is based on finding an increase in the weight of gingerbread and similar spice-cakes when immersed in water at a temperature of 20 °C for a set time. An analysis of data (Fig. 6) allowed us to establish a tendency of this parameter to increase with an increase in the content of vegetable supplements in gingerbread and similar spice-cakes.

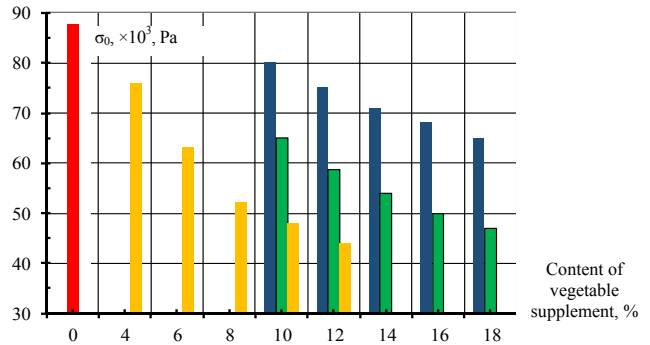


Fig. 5. Dependence of the boundary shear stress of spice-cakes on the content of vegetable supplements: ■ – spice-cakes without supplements (control), ■ – flour made from roots of snakeweed, ■ – cedar flour, ■ – sesame flour

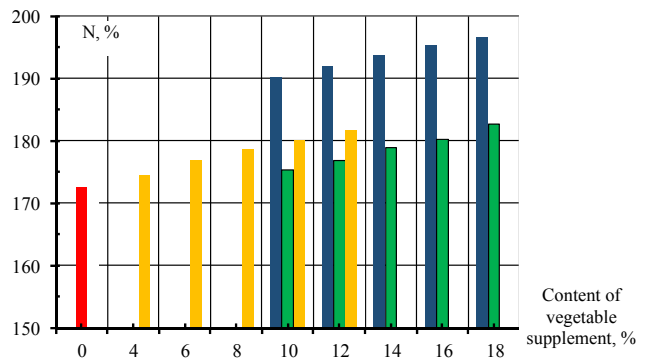


Fig. 6. Dependence of the soaking (N) of spice-cakes on the content of vegetable supplements: ■ – spice-cakes without supplements (control), ■ – flour made from roots of snakeweed, ■ – cedar flour, ■ – sesame flour

Thus, the replacement of wheat flour with cedar flour in the amount of 10...18 % contributes to an increase in soaking by 10.1...13.8 % relative to control – from 190.1 ± 1.5 % to 196.5 ± 1.6 %, the replacement with sesame flour in the amount of 10...18 % – by 1.5...5.9 % – from 175.3 ± 1.2 % to 182.7 ± 1.3 %, the replacement with flour made from roots of snakeweed in the amount of 4...12 % – by 1.2...5.3 % – from 176.4 ± 1.1 % to 181.7 ± 1.4 %. An increase in the soaking of spice-cakes with supplements is well correlated with the data obtained on the water retention capacity of vegetable supplements, which bind moisture better than wheat flour at the range of temperatures of 20...80 °C.

The next step was conducted with the help of experts and taking into account the weighting factors for parameters and descriptors. It was a comparative sensor analysis of organoleptic parameters of gingerbread and similar spice-cakes

with supplements within the limits of the examined content. A sensory analysis was based on the use of psycho-physiological reactions of tasters [27], which largely depend on many factors.

A profiling method with the use of a descriptive analysis of results, based on the requirements of the ISO international standards, was applied to determine the sensory characteristics. The studies were carried out to develop a 5-point sensory scale for the evaluation of spice-cake organoleptic parameters. That is, the score scale of sensory evaluation of organoleptic parameters with their general characteristics, which correspond to the quality level of the developed gingerbreads with the use of vegetable supplements, was given. A score quality evaluation is based on the quantitative expression of individual quality parameters of products using numerical magnitudes – scores and determination of the general quality of the developed gingerbread and similar spice-cakes on this basis [28].

The quality of gingerbread and similar spice-cakes was evaluated by a comprehensive quality parameter. It characterizes a set of properties that are used to evaluate the finished products. An expert survey questionnaire was compiled [29] to determine the meaningful quality parameters of gingerbread and similar spice-cakes and weighting factors of individual parameters. It was established in the course of research that for the formation of organoleptic parameters of the developed gingerbread and similar spice-cakes the determining characteristics are the expressiveness and purity of a flavor, convexity of the shape, naturalness of the color and softness of the consistency (Table 1).

It was established that for the formation of organoleptic parameters of the developed gingerbread and similar spice-cakes the determining characteristics are the expressiveness and purity of the flavor, convexity of the shape, naturalness of the color and softness of the consistency (Table 1).

Table 1

Results of a sensory analysis of organoleptic parameters of the spice-cake “Cedar” at different contents of cedar flour

Name of parameter	Weight factor of parameter	Characteristic	Weight factor of descriptor	Evaluation of parameter					
				Control spice-cake	«Cedar» spice-cake for the content of cedar flour, %				
					10	12	14	16	18
Shape	0.15	Regularity	0.2	5.0	5.0	5.0	5.0	4.7	3.9
		Convexity	0.5	5.0	4.9	4.8	4.6	3.9	3.1
		Indistinctness	0.3	5.0	5.0	4.9	4.9	4.0	2.9
Summarized score by descriptors				5.00	4.95	4.87	4.77	4.09	3.20
Total score by parameter				0.750	0.743	0.731	0.716	0.614	0.480
Surface	0.3	Rubicundity	0.3	5.0	5.0	5.0	5.0	5.0	5.0
		Absence of inflations	0.2	5.0	5.0	5.0	5.0	5.0	5.0
		Absence of cracks	0.2	5.0	5.0	5.0	5.0	4.6	4.2
		Evenness	0.3	5.0	5.0	5.0	5.0	4.8	4.7
Summarized score by descriptors				5.00	5.00	5.00	5.00	4.86	4.75
Total score by parameter				1.500	1.500	1.500	1.500	1.458	1.425
Color	0.1	Naturalness	0.5	5.0	5.0	5.0	5.0	4.8	4.4
		Uniformity	0.2	5.0	5.0	5.0	5.0	4.9	4.5
		Intensity	0.3	5.0	5.0	5.0	5.0	5.0	4.6
Summarized score by descriptors				5.00	5.00	5.00	5.00	4.88	4.48
Total score by parameter				0.500	0.500	0.500	0.500	0.488	0.448
Flavor and aroma	0.2	Expressiveness	0.4	5.0	5.0	5.0	4.9	4.4	3.8
		Absence of foreign flavor and aroma	0.2	5.0	5.0	5.0	5.0	4.5	4.2
		Purity	0.4	5.0	5.0	5.0	5.0	4.4	3.2
Summarized score by descriptors				5.00	5.00	5.00	4.96	4.42	3.64
Total score by parameter				1.000	1.000	1.000	0.992	0.884	0.728
Crack view	0.1	Degree of bakeness	0.2	5.0	5.0	5.0	5.0	5.0	5.0
		Absence of unkneaded parts	0.2	5.0	5.0	5.0	5.0	5.0	5.0
		Development of porosity	0.3	5.0	5.0	5.0	5.0	4.7	4.5
		Absence of cells	0.3	5.0	5.0	5.0	5.0	5.0	4.7
Summarized score by descriptors				5.00	5.00	5.00	5.00	4.91	4.76
Total score by parameter				0.500	0.500	0.500	0.500	0.491	0.476
Consistency	0.15	Softness	0.7	5.0	5.0	5.0	5.0	4.1	3.3
		Shortness	0.1	5.0	5.0	5.0	4.9	4.4	3.8
		Elasticity	0.2	5.0	5.0	5.0	4.9	4.3	3.8
Summarized score by descriptors				5.00	5.00	5.00	4.97	4.17	3.45
Total score by parameter				0.750	0.750	0.750	0.746	0.626	0.518
General score				5.00	4.99	4.98	4.95	4.56	4.07

Table 2

Results of a sensory analysis of organoleptic parameters of the spice-cake “Sesame” at different content of sesame flour

Name of parameter	Weight factor of parameter	Characteristic	Weight factor of descriptor	Evaluation of parameter					
				Control spice-cake	«Sesame» spice-cake for the content of sesame flour, %				
					10	12	14	16	18
Shape	0.15	Regularity	0.2	5.0	5.0	5.0	4.9	4.8	4.6
		Convexity	0.5	5.0	5.0	4.9	4.6	4.4	4
		Indistinctness	0.3	5.0	5.0	5.0	4.8	4.3	3.8
Summarized score by descriptors				5.00	5.00	4.95	4.72	4.45	4.06
Total score by parameter				0.750	0.750	0.743	0.708	0.668	0.609
Surface	0.3	Rubicundity	0.3	5.0	5.0	5.0	4.8	4.6	4.2
		Absence of inflations	0.2	5.0	5.0	5.0	5.0	4.8	4.5
		Absence of cracks	0.2	5.0	5.0	5.0	4.6	4.4	3.8
		Evenness	0.3	5.0	5.0	5.0	4.8	4.5	3.8
Summarized score by descriptors				5.00	5.00	5.00	4.80	4.57	4.06
Total score by parameter				1.500	1.500	1.500	1.440	1.371	1.218
Color	0.1	Naturalness	0.5	5.0	5.0	5.0	4.7	4.4	3.9
		Uniformity	0.2	5.0	5.0	5.0	4.8	4.5	4
		Intensity	0.3	5.0	5.0	5.0	4.9	4.7	4.4
Summarized score by descriptors				5.00	5.00	5.00	4.78	4.51	4.07
Total score by parameter				0.500	0.500	0.500	0.478	0.451	0.407
Flavor and aroma	0.2	Expressiveness	0.4	5.0	5.0	5.0	4.5	4.1	3.9
		Absence of foreign flavor and aroma	0.2	5.0	5.0	5.0	4.4	3.8	2.9
		Purity	0.4	5.0	5.0	5.0	4.7	4.2	3.4
Summarized score by descriptors				5.00	5.00	5.00	4.56	4.08	3.50
Total score by parameter				1.000	1.000	1.000	0.912	0.816	0.700
Crack view	0.1	Degree of bakeness	0.2	5.0	5.0	5.0	5.0	5.0	4.6
		Absence of unknaded parts	0.2	5.0	5.0	5.0	5.0	5.0	4.9
		Development of porosity	0.3	5.0	5.0	5.0	5.0	4.8	4.5
		Absence of cells	0.3	5.0	5.0	5.0	5.0	4.6	4.2
Summarized score by descriptors				5.00	5.00	5.00	5.00	4.82	4.51
Total score by parameter				0.500	0.500	0.500	0.500	0.482	0.451
Consistency	0.15	Softness	0.7	5.0	5.0	5.0	4.8	4.3	3.7
		Shortness	0.1	5.0	5.0	5.0	4.7	4.3	3.6
		Elasticity	0.2	5.0	5.0	5.0	4.6	4.1	3.7
Summarized score by descriptors				5.00	5.00	5.00	4.75	4.26	3.69
Total score by parameter				0.750	0.750	0.750	0.713	0.639	0.554
General score				5.00	5.00	4.99	4.75	4.43	3.94

The final stage of the studies was the construction of profiles of organoleptic evaluation depending on the content of a vegetable supplement, it is shown in Fig. 7.

On the profiles of organoleptic evaluation of the spice-cakes (Fig. 7), the total value of each of the organoleptic parameters was visually emphasized in the form of a fixed region. An analysis of the obtained data showed that the use of cedar flour up to 14 % (Fig. 7, *a*), sesame flour up to 12 % (Fig. 7, *b*), and flour made from roots of snakeweed up

to 8 % (Fig. 7, *c*), exerted a negligible effect on their organoleptic parameters.

Examined samples of the spice-cakes “Cedar” and “Sesame” are characterized by the regular, convex, not-indistinct shape, unburnt surface, there was no popping, no cavities or cracks, the color was from light to cream. The spice-cake “Roslynka” had a brownish color, a clearly expressed aroma of a vegetable supplement, without foreign flavors and aromas, with a soft, short and elastic consistency.

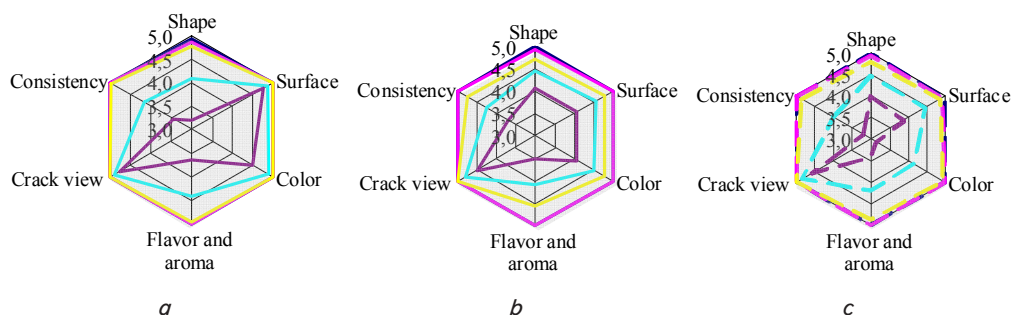


Fig. 7. Profiles of organoleptic evaluation of spice-cakes depending on the content of a vegetable supplement for the spice-cakes “Cedar” (a), “Sesame” (b): \square – 10 %, \circ – 12 %, \triangle – 14 %, \diamond – 16 %, \hexagon – 18 %, and for the spice-cake “Roslynka” (c): \circ – 4 %, \square – 6 %, \triangle – 8 %, \diamond – 10 %, \hexagon – 12 %, \heptagon – rational content of a vegetable supplement

Table 3

Results of a sensory analysis of organoleptic parameters of the spice-cake “Roslynka” at different content of flour made from roots of snakeweed

Name of parameter	Weight factor of parameter	Characteristic	Weight factor of descriptor	Evaluation of parameter					
				Control gingerbread	«Roslynka» spice-cake for the content of flour made from roots of snakeweed, %				
					4	6	8	10	12
Shape	0.15	Regularity	0.2	5.0	5.0	5.0	5.0	4.6	4.1
		Convexity	0.5	5.0	5.0	4.9	4.7	4.5	4
		Indistinctness	0.3	5.0	5.0	5.0	4.9	4.4	4.0
Summarized score by descriptors				5.00	5.00	4.95	4.82	4.49	4.02
Total score by indicator				0.750	0.750	0.743	0.723	0.674	0.603
Surface	0.3	Rubicundity	0.3	5.0	5.0	5.0	4.9	4.4	3.8
		Absence of inflations	0.2	5.0	5.0	5.0	5.0	4.9	4.5
		Absence of cracks	0.2	5.0	4.9	4.7	4.5	3.9	3.1
		Evenness	0.3	5.0	5.0	5.0	5.0	4.6	4.1
Summarized score by descriptors				5.00	4.98	4.94	4.87	4.46	3.89
Total score by parameter				1.500	1.494	1.482	1.461	1.338	1.167
Color	0.1	Naturalness	0.5	5.0	5.0	5.0	4.9	4.0	3.0
		Uniformity	0.2	5.0	5.0	5.0	5.0	4.5	3.5
		Intensity	0.3	5.0	5.0	5.0	4.9	4.2	3.1
Summarized score by descriptors				5.00	5.00	5.00	4.92	4.16	3.13
Total score by parameter				0.500	0.500	0.500	0.492	0.416	0.313
Flavor and aroma	0.2	Expressiveness	0.4	5.0	5.0	5.0	4.9	4.4	3.7
		Absence of foreign flavor and aroma	0.2	5.0	5.0	5.0	4.8	4.2	3.5
		Purity	0.4	5.0	5.0	5.0	4.9	4.0	3.1
Summarized score by descriptors				5.00	5.00	5.00	4.88	4.20	3.42
Total score by parameter				1.000	1.000	1.000	0.976	0.840	0.684
Crack view	0.1	Degree of bakeness	0.2	5.0	5.0	5.0	5.0	5.0	4.7
		Development of porosity	0.2	5.0	5.0	5.0	5.0	5.0	4.8
		Absence of cells	0.3	5.0	5.0	5.0	5.0	4.8	4.6
		Degree of bakeness	0.3	5.0	5.0	5.0	5.0	4.7	4.4
Summarized score by descriptors				5.00	5.00	5.00	5.00	4.85	4.60
Total score by parameter				0.500	0.500	0.500	0.500	0.485	0.460
Consistency	0.15	Softness	0.7	5.0	5.0	5.0	4.9	4.1	3.3
		Shortness	0.1	5.0	5.0	5.0	4.8	4.0	3.2
		Elasticity	0.2	5.0	5.0	5.0	4.9	3.7	2.9
Summarized score by descriptors				5.00	5.00	5.00	4.89	4.01	3.21
Total score by parameter				0.750	0.750	0.750	0.734	0.602	0.482
General score				5.00	4.99	4.97	4.89	4.35	3.71

Organoleptic parameters were evaluated according to the developed scale of the score quality evaluation [30]. Organoleptic characteristics of the spice-cake samples with varying levels of vegetable supplements were studied to assess the effectiveness of determination of differences between control and experimental samples.

The results of analysis were presented graphically in the form of petal diagrams. Their axes correspond to the scales of individual organoleptic parameters. The magnitude of organoleptic parameters was determined on a 5-point scale.

A significant reduction in the quality of spice-cakes, which was determined organoleptically, was detected (Fig. 8, 9) with a content of vegetable supplements above the specified concentrations. The overall evaluation of new products was 4.56...4.07 points for the spice-cake "Cedar" with a content of cedar flour of 16...18 %; 3.94...4.43 points for the spice-cake "Sesame" with a content of sesame flour of 14...18 %; 3.71...4.35 points for the spice-cake "Roslynka" with a content of flour made from roots of snakeweed bitter snake within 10...12 %.

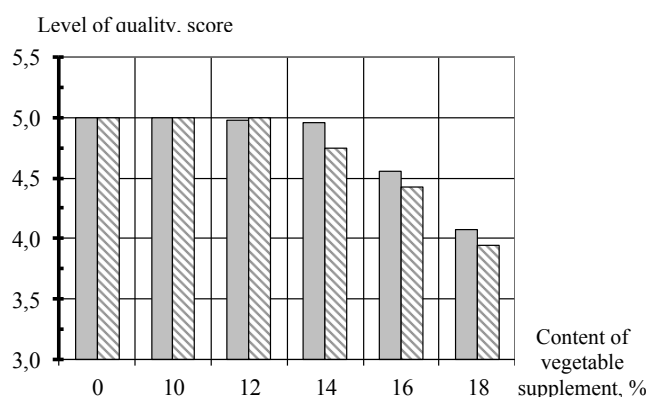


Fig. 8. General evaluation of organoleptic parameters of the spice-cakes "Cedar" and "Sesame" depending on the content of a vegetable supplement

6. Discussion of results of studying the influence of vegetable supplements on the quality of spice-cakes

The study into influence of the content of vegetable supplements on the mass fraction of moisture in the spice-cakes established (Fig. 2) that an increase in the amount of cedar and sesame flour in the formulation composition of gingerbread and similar spice-cakes leads to a decrease in their moisture content. The moisture content of gingerbread and similar spice-cakes somewhat rises with an increase in the content of flour made from roots of snakeweed.

Since the main hydrophilic substance that binds moisture in dough during heat treatment is starch [31], it can be assumed that a decrease in the moisture content of gingerbread and similar spice-cakes with the addition of cedar and sesame flour is associated with a decrease in the amount of starch in the system. The increase in humidity when adding flour made from roots of snakeweed is associated with an increase in the amount of fiber that is added to dough with this vegetable supplement. That is, the introduction of vegetable supplements contributes to a reduction in the intensity of moisture loss. The longer moisture is kept in gingerbread and similar spice-cakes, the longer gingerbread and similar spice-cakes remain soft.

Reduced alkalinity of gingerbread and similar spice-cakes when using vegetable supplements shows that they contain acid-containing substances that partially neutralize the alkaline substances of alkaline agents of baking powder.

Reduced shape stability can be explained by the fact that cedar flour contains the largest amount of residual vegetable oil, which contributes to some increase in the indistinctive form of the shape – 15 % if recalculated for dry matter, while in sesame flour and flour made from roots of snakeweed – 12.0 % and 8.2 %, respectively.

Data analysis in Table 1–3 shows that within the limits of the content of the vegetable supplement the total evaluation of organoleptic parameters by the descriptors for the spice-cakes "Cedar", "Sesame" and "Roslynka" is in the range of 4.95...4.99, 4.75...5.00, and 4.89...4.99 points, respectively.

Thus, it is obvious that the use of vegetable supplements is possible in the technologies of flour confectionery products make it possible to use them for the normalization of human body's functioning. It can be concluded based on the above results that the developed products for health-improving purposes in terms of organoleptic, physical-chemical, and structural-mechanical quality parameters are not inferior to the products prepared according to traditional formulation. Therefore, it is possible to give recommendations on the expediency of their use in the technology of flour confectionery products.

7. Conclusions

1. It was established based on the results obtained that gingerbread and similar spice-cakes contain moisture in various forms with a different binding energy, that is, it has a wide range of "connectedness". Changes in the forms of moisture binding in gingerbread and similar spice-cakes with vegetable supplements is explained by the higher moisture-retaining power of vegetable supplements. The retention of moisture in gingerbread and similar spice-cakes, especially during storage, will have a positive effect, as the processes of getting stale will tend to decrease. It was established that a reduction in the intensity of moisture losses in gingerbread and similar spice-cakes with the supplements occurs as a result of an increase in the amount of protein and fiber that can bind moisture.

The data given in Table 1–3, Fig. 6, show that the experimental samples of spice-cakes are distinguished by large volume, uniform structure when broken, lower density and greater soaking. Homogeneous porous structure of the products is predetermined by a decrease in the viscosity of dough for gingerbread and similar spice-cakes, and, given this, the particles of supplements are better distributed throughout the entire volume in the process of dough kneading.

It was established (Fig. 5) that spice-cakes with the addition of vegetable supplements have better rheological parameters than the control sample. Vegetable supplements help to reduce the density and viscosity of dough and make it more plastic. Gingerbread and similar spice-cakes with vegetable supplements have low density, soft and porous crumb with a flavor and aroma of the supplement.

2. An analysis of the results of study into dependence of a boundary shear stress of gingerbread and similar spice-cakes on the content of vegetable supplements established a decrease in the given parameter, which was organoleptically evaluated as an increase in the softness of spice-cakes.

3. Alkalinity in the developed spice-cakes with vegetable supplements decreases less intensively and, over a period of storage from 0 to 28 days, it ranges from $(0.57...0.64) \pm 0.02$ to $(0.10...0.15) \pm 0.01$ degrees of alkalinity.

4. Results of a sensory analysis of the developed types of spice-cakes showed that the products favorably differed from the control by flavor parameters, as they had pleasant sweet flavor, as well as a delicate aroma and taste of spices in the absence of foreign flavors. It was determined that the addition of cedar oilcake, sesame flour and phyto-powder made from a snakeweed to the formulation composition of products makes it possible to improve organoleptic param-

eters – color, flavor, texture; as well as increases the nutritional value. As can be seen from the obtained data in Fig. 6, the products did not have the same characteristics of flavor. The character and overall taste of the new spice-cake products change depending on the type of the introduced vegetable supplements.

It was established that the rational content of vegetable supplements for the spice-cake “Cedar” was the replacement of wheat flour with cedar flour in the amount of 14 %, for the spice-cake “Sesame” – with sesame flour in the amount of 12 %, for the spice-cake “Roslynka” – with flour made from a root of snakeweed in the amount of 8 %.

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