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QUALIMETRIC ASSESSMENT OF THE QUALITY OF SHORT DOUGH COOKIES WITH THE ADDITION OF CHOKEBERRY AND REDUCED FAT CONTENT

Summary. The work is devoted to the qualitative assessment of the quality of "Zirochka" cookies made from shortcrust pastry with the addition of chokeberry and reduced fat content. It has been experimentally proven that the quantitative assessment of the quality of "Zirochka" shortcrust pastry using the new technology with the addition of 5 % powder from dry chokeberry berries and a 22 % lower fat content in terms of structural properties is reduced by 14.9 %, since the component that ensures dough rise and fixes the structure during baking is removed from the raw materials. The generalized safety index of shortcrust pastry samples has the following values: for cookies according to the traditional recipe – 0.512; for "Zirochka" cookies – 0.633. The quality level of "Zirochka" cookies in terms of organoleptic indicators is slightly lower than the control sample (0.86 versus 0.96), but more than 0.80 (very good quality according to the Harrington desirability function graph). The quality level of "Zirochka" cookies in terms of the content of physiologically useful substances increases by 8.6 times compared to the control sample.

Keywords: structural, microbiological, organoleptic properties, physiologically beneficial substances.

Statement of the problem. The most common group among confectionery products is flour products, which include several hundred items and are most popular among different segments of the population. Most of such products have an unbalanced mineral and vitamin composition, contain a large amount of fats and carbohydrates, which gives them a high energy value. The use of new additives, in particular, of plant origin, to improve the quality of flour confectionery products and reduce the fat content in the recipe can contribute to increasing the nutritional value of the product, reducing its energy value. There is a need to improve and develop new types of flour confectionery products that would be rich in plant fibers, biologically active substances that increase human immunity and generally play an important physiological role. The use of plant additives to improve the quality of food products is a relevant topic in our country and abroad. In recent years, chokeberry has been attracting more and more attention – a plant that is widely distributed throughout Ukraine, and its fruits are rich in carotenoids, vitamins, macro- and microelements, strengthen the walls of blood vessels, normalize intestinal function, have an antispasmodic effect, and stimulate bile production. Therefore, we believe that the use of this plant as a biologically active additive in flour confectionery products made from shortcrust pastry is promising and relevant.

Analysis of recent research. In recent years, much attention has been paid to the quality of food products in our country and abroad [1]. The problems of food quality in Ukraine are solved by

Lozova T. M., Sydorenko O. V., Kuzmin O. V., Topolnyk V. G., Samokhvalova O. V., Oliynyk S. G. and others.

Thus, a group of scientists from the Department of Commodity Science, Technologies and Quality Management of Food Products of the Lviv University of Trade and Economics are investigating the quality characteristics and safety of various food products, including raw smoked sausages, processed cheeses, bakery products, etc. [2].

Another representative of the scientific school of the Lviv University of Trade and Economics, Lozova T. M., Doctor of Technical Sciences, Professor, deals with issues of quality management and safety of flour confectionery products – muffins, wafers with phytoadditives, sugar cookies [3].

The quality indicators of finished products can be determined by various methods, including qualimetry [4].

Thus, Kuzmin O. V., Doctor of Technical Sciences from the National University of Chemical Technology developed a method for comprehensive quantitative assessment of yeast quality according to the principles of qualimetry [5], he also considered the method for assessing the quality of food rations in hotel and restaurant establishments and determined comprehensive quality indicators for the group of energy substances, minerals and vitamins [6]. Together with Ph.D. Dietrich L. V. he assessed the quality of the innovative hot sweet dish souffle from the standpoint of the physiological needs of a preschool child's body using qualimetry methods [7].

The researchers also assessed the quality of dry multi-component milk mixtures [8] and wheat bread using oat germ meal and corn germ cake [9] using the principles of qualimetry.

The Department of Technologies in Restaurant Management, Hotel and Restaurant Business and Tourism of the Mykhailo Tugan-Baranovsky Educational and Scientific Institute of Economics and Trade of Kryvyi Rih National University constantly conducts research on improving the quality of flour confectionery products due to plant additives [10–13]. It has been proven, including with the help of qualimetry, that these additives have a positive effect on the baking properties of wheat flour, on the quality of fat in these products, improve the nutritional value, mineral composition of finished products.

Therefore, the problem of improving and determining the quality of food products remains relevant and is being solved in many directions, among which the use of qualimetry principles for calculating complex quality assessments looks particularly promising.

Formulation of the purpose of the article (task statement). The objective of this article is to determine the quality indicators of "Zirochka" cookies made from shortcrust pastry with the addition of chokeberry and reduced fat content in terms of structural-mechanical, organoleptic properties, safety, and content of physiologically beneficial substances according to the principles of qualimetry.

Main part. The quality of a food product is a set of properties that determine its ability to meet the human body's needs for energy, nutrients and flavorings, taking into account optimal physiological norms based on the concept of balanced nutrition. We studied the main groups of properties of "Zirochka" cookies made from shortcrust pastry with the addition of chokeberry and a fat content reduced by 22 % using the principles of qualimetry.

The hierarchical structure of properties that characterize the quality of the products we have developed consists of three levels. At the first level, quality is represented by four groups of properties: structural-mechanical, microbiological (safety), organoleptic, nutritional value (energy in terms of the balance of basic nutrients and biological in terms of the content of physiologically useful substances).

The group of structural-mechanical properties includes the ability to wet (P_1), %; specific volume (P_2), dm^3/kg; porosity (P_3), %, which characterize the taste of cookies, its brittleness. In accordance with the methods of qualimetry, a generalized assessment of structural properties was calculated by formula 1:

$$k = \sum_{i=1}^{3} m_i \cdot k_i, \quad (1)$$

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where m_i, k_i – weighting coefficient and evaluation of the property indicator characterizing the quality of the object.

The quality of products improves if the value of these indicators increases. Based on this, dependence 2 was used to quantify these indicators:

$$k_i = \frac{P_i}{P_{баз}}, \tag{2}$$

where P_i – the value of the indicator for the sample being evaluated;

$P_{баз}$ – the base value of this indicator for the control sample, which is made according to the traditional composition of the recipe components.

To determine the weighting coefficients of the indicators, a method was used in which the range of variation of the values ($P_{\max} - P_{\min}$) was calculated. The weighting coefficients were determined by formula 3:

$$m_i = \frac{\dfrac{P_i^{баз}}{P_{i\max} - P_{i\min}}}{\sum_{i=1}^{3}\left(\dfrac{P_i^{баз}}{P_{i\max} - P_{i\min}}\right)}. \tag{3}$$

The weighting coefficients were calculated by us and have the following values: wettability, $m_1 = 0.18$; specific volume, $m_2 = 0.29$; porosity, $m_3 = 0.53$. The differential and comprehensive assessment of the structural properties of the "Zirochka" cookies according to the modified recipe is given in Table 1.

Table 1

Comprehensive assessment of the structural properties of the studied shortbread cookie samples

№	Cookie sample name	Single estimates			Comprehensive assessment
		1 $m = 0,18$	2 $m = 0,29$	3 $m = 0,53$	
1	Control sample	1,00	1,00	1,00	1,00
2	With the addition of 5 % powdered dried chokeberry fruit and a 22 % reduced butter content ("Zirochka" cookies)	0,658	0,843	0,920	0,851

It was found that replacing 5 % of wheat flour with powder from dried chokeberry fruits reduces the complex of structural and mechanical properties by 14.9 %, since a component that ensures dough rising and fixes the structure during baking is removed from the raw material.

Then we established the quality indicator of the safety of cookies «Zirochka». According to the regulatory documentation for the control of the safety of food products (shortbread cookies), five indicators are provided. The requirements for two indicators have quantitative values, the requirements for three are substantive, in an alternative form.

Therefore, the mathematical model of the generalized safety indicator of shortbread cookies should have a veto function, which consists of an assessment of alternative indicators (from assessments of indicators that have an alternative nature). The generalized assessment of microbiological quality indicators of shortbread cookies samples manufactured using the developed technology was determined by formula 4:

$$K_{мб} = K_1 K_2 K_4 \sqrt{K_3 K_5}, \tag{4}$$

where $K_1K_2K_4$ – veto function, composed of alternative indicator estimates. K_j estimates take the value 1 (unit) if the requirements of regulatory documents are met and the value 0 (zero) if the requirements of regulatory documents are not met;

K_3K_4 – estimates of quantitative indicators.

To assess microbiological indicators, we used the following relationship 5:

$$K_i = 1,37 - \frac{\lg P_i}{\lg P_n}, \quad (5)$$

where P_i – is the value of the indicator of the sample being evaluated;

P_n – is the normalized value of the indicator.

With the value $P_i = P_n$, the score determined according to this dependence has a value of 0.37, which, according to the theoretical principles of qualimetry, corresponds to the score "satisfactory", that is, the products meet the requirements of regulatory documentation with a unilateral restriction of the indicator values.

In accordance with the data on the microbiological characteristics of the developed cookies, the generalized safety index of these samples has the following values: for cookies according to the traditional recipe – 0.512; for cookies "Zirochka" – 0.633.

The evaluation of organoleptic indicators was calculated using formula 6:

$$K = \exp^{-\exp|y|}, \quad (6)$$

where K – is the score;

y – is the value being coded.

The general and comprehensive organoleptic evaluation of shortcrust pastry products with chokeberry additives is given in Table 2:

Table 2

Quantitative evaluation of organoleptic parameters

№	Cookie sample name	Overall organoleptic assessment, score	Comprehensive assessment
1	Control sample	19,10	0,96
2	With the addition of 5 % powdered dried chokeberry fruit and a 22 % reduced butter content ("Zirochka" cookies)	17,55	0,86

As can be seen from the data in this table, the quality level of shortcrust pastry products with chokeberry additives in terms of organoleptic indicators is slightly lower than the control sample, but the value of the complex assessment of the developed sample is more than 0.80 (very good quality according to the Harrington desirability function graph).

The introduction of powder from dried chokeberry fruits into the shortcrust pastry recipe leads to the enrichment of the food product with physiologically useful substances, which increases its nutritional value. Table 3 shows data on the content of carotenoids, phenolic substances, and fiber in "Zirochka" cookies.

Table 3

The content of physiologically beneficial substances in shortbread cookie samples

№	Cookie sample name	Substance content		
		Carotenoids, mg/100 g	Phenolic substances, %	Cellulose, %
1	Control sample	0,08	–	0,05
2	With the addition of 5 % powdered dried chokeberry fruit and a 22 % reduced butter content ("Zirochka" cookies)	0,26	0,26	0,45

For a comprehensive quantitative assessment of the quality of products by the content of physiologically useful substances, it is necessary to convert the absolute values of nutritional value

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indicators into relative ones. For this assessment of single quality indicators, we propose to calculate the average value according to the range established in the study:

$$P_i^{баз} = \frac{\sum P_i}{n}. \quad (7)$$

The base value for carotenoids is 0.170; phenolic substances – 0.135; cellulose – 0.224. To determine the weighting factors of the indicators, a calculation method was used, the essence of which is the inverse dependence of the weighting factor value on the base value of the indicator, namely: the weighting factor is the greater, the smaller the value of the base indicator:

$$m_i = \frac{\frac{1}{\frac{P_i^{баз}}{\sum P_i^{баз}}}}{\sum\left(\frac{1}{\frac{P_i^{баз}}{\sum P_i^{баз}}}\right)} = \frac{\frac{\sum P_i^{баз}}{P_i^{баз}}}{\sum\left(\frac{\sum P_i^{баз}}{P_i^{баз}}\right)}. \quad (8)$$

Sum of base values $\sum P_i^{баз} = 0,170 + 0,135 + 0,224 = 0,529$

$$\sum\left(\frac{\sum P_i^{баз}}{P_i^{баз}}\right) = \frac{0,529}{0,170} + \frac{0,529}{0,135} + \frac{0,529}{0,224} = 9,393.$$

Weighting coefficients: carotenoids $m_{car} = 0.529/0.170/9.393 = 0.331$ (we took $m_{car} = 0.33$); phenolic substances $m_{p.s.} = 3.919/9.393 = 0.417$ (we took $m_{p.s.} = 0.42$); cellulose $m_c = 2.362/9.393 = 0.252$ (we took $m_c = 0.25$).

Table 4 shows the relative values (scores) of single indicators and the complex quality indicator of products by the content of physiologically useful substances, calculated according to formula 1, as well as the value of the complex indicator in comparison with the control sample, which shows an increase in the nutritional value of "Zirochka" cookies.

Table 4

Quantitative assessment of the quality of shortcrust pastry products by the content of physiologically beneficial substances

№	Cookie sample name	Single estimates			Comprehensive assessment	Comprehensive comparative assessment
		Carotenoids	Phenolic substances	Cellulose		
1	Control sample	0,471	0	0,223	0,211	1,0
2	With the addition of 5 % powdered dried chokeberry fruit and a 22 % reduced butter content ("Zirochka" cookies)	1,529	1,926	2,009	1,816	8,607

As you can see, the quality level of "Zirochka" cookies prepared by replacing part of the recipe components with powder from dried chokeberry fruits and with reduced fat content increases by 8.6 times in terms of the content of physiologically beneficial substances.

Conclusions. The method of qualimetry established quantitative indicators of the quality of shortbread cookies "Zirochka" with the addition of chokeberry and reduced fat content for different

groups of properties – structural-mechanical, safety, organoleptic, physiologically useful substances. The feasibility of using the addition of powder from dry chokeberry berries to increase the nutritional value of the developed products has been proven.

The prospects for further research in this direction are the calculations of a comprehensive quantitative assessment of the quality of shortbread cookies «Zirochka» using a new technology.

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КВАЛІМЕТРИЧНА ОЦІНКА ЯКОСТІ ПЕЧИВА З ПІСОЧНОГО ТІСТА З ДОБАВКОЮ ЧОРНОПЛІДНОЇ ГОРОБИНИ І ЗНИЖЕНИМ ВМІСТОМ ЖИРУ

Анотація

Робота присвячена проведенню кваліметричної оцінки якості печива «Зірочка» з пісочного тіста за новою рецептурою – з добавкою чорноплідної горобини і зниженим вмістом жиру. Плоди чорноплідної горобини висушувалися, подрібнювалися в порошок. Раніше встановлена оптимальна кількість добавки – 5 % від маси пшеничного борошна. Вміст вершкового масла зменшили на 22 % від необхідного за рецептурою пісочного тіста.

Ієрархічна структура властивостей, що характеризують якість розробленої нами продукції, складається з трьох рівнів. На першому рівні якість представлена чотирма групами властивостей: структурно-механічні, мікробіологічні (безпеки), органолептичні, харчова цінність (енергетична за збалансованістю основних харчових речовин і біологічна за вмістом фізіологічно корисних речовин).

В групу структурно-механічних властивостей входять здатність до намокання (P_1), %; питомий об'єм (P_2), дм^3/кг; пористість (P_3), %, які характеризують смак печива, його крихкість. Експериментально доведено, що кількісна оцінка якості пісочного печива «Зірочка» за новою технологією за структурними властивостями знижується на 14,9 %, оскільки з сировини вилучається компонент, що забезпечує під'йом тіста та закріплює структуру при випіканні.

В той же час узагальнений показник безпеки зразків пісочного печива має значення: для печива за традиційною рецептурою – 0,512; для печива «Зірочка» – 0,633.

Також рівень якості печива «Зірочка» щодо органолептичних показників декілька нижче за контрольний зразок (0,86 проти 0,96), але більше ніж 0,80 (дуже добра якість згідно з графіком функції бажаності Харрингтона).

Уведення в рецептуру пісочного тіста порошку з сухих плодів чорноплідної горобини призводить до збагачення харчового продукту фізіологічно корисними речовинами, що підвищує його харчову цінність. Рівень якості печива «Зірочка» за вмістом фізіологічно корисних речовин підвищується в 8,6 рази в порівнянні з контрольним зразком.

Ключові слова: структурні, мікробіологічні, органолептичні властивості, фізіологічно корисні речовини.