

SUBSTANTIATION OF THE DEVELOPMENT OF FORMULATIONS FOR ORGANIC CUPCAKES WITH AN ELEVATED PROTEIN CONTENT

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З метою розроблення рецептур органічних кексів з підвищеним вмістом білка досліджено та проаналізовано амінокислотний склад чотирьох зразків борошна: борошна пшеничного, борошна пшеничного органічного, борошна житнього органічного та борошна гречаного органічного. Встановлено, що найвищою біологічною цінністю відрізнявся зразок борошна гречаного органічного (68,69 %). Досить високу біологічну цінність мають білки борошна житнього органічного – 67,85 %. Виходячи з даних щодо дослідження сировини, розроблено дві рецептури органічних кексів: "Гречаник" та "Житниця". У рецептурі кексу "Гречаник" використано гречане органічне борошно, а також інші органічні інгредієнти: цукор тростинний, сироп агави, масло вершкове, олію кунжутну, фезаліс сушений, ізюм сушений, яйця, висівки лляні. У кексі "Житниця" використано 66 % пшеничного органічного та 34% житнього органічного борошна, а також органічну сировину: цукор тростинний, сироп рисовий, масло вершкове, олію сезамову, журавлину сушену, шовковицю сушену, яйця, висівки житні.

Встановлено, що розроблені кекси відрізнялися високими органолептичними показниками. З фізико-хімічних показників якості досліджено масову частку вологи, лужність та масову частку золи. З показників безпечності визначено вміст токсичних металів та афлотоксину В1. Зразки нових кексів відповідали за показниками якості та безпечності нормативній документації. Найвищим вмістом білка відрізнявся кекс "Гречаник" – 7,1 г/100 г, а найнижчим – контрольний зразок на основі пшеничного борошна (4,9 г/100 г). Ці результати вказують на те, що використання гречаного органічного борошна у кондитерській і хлібопекарській промисловості є перспективним у плані створення функціональних екологічно чистих виробів. Враховуючи той факт, що Україна є переважно постачальником органічної сировини, а не готової продукції, отримані результати можуть використовувати підприємства кондитерської промисловості для розширення асортименту органічних виробів.

Ключові слова: амінокислотний склад, безпечність, білковий склад, борошно гречане органічне, борошно житнє органічне

1. Introduction

Underlying the organic production is a philosophy of environmentally-friendly and caring attitude towards nature, as well as the consumer-centered production whose focus is the quality and safety of the resulting product. Ukraine is an agricultural country with the volume of land with organic status reaching 289,551 hectares. Therefore, development of the market for the finished organic products based on grain crop raw materials is an important issue. Organic farming has been rapidly evolving since the beginning of 1990ies in almost all European countries. As of 2015, the number of countries that develop organic farming was 179, with the volume of areas cultivated under organic production equal to 50.9 million hectares compared with 11 million in 1999 [1]. In other words, over 16 years the volumes of organic land in

the world grew by 4.6 times. Current trends favored by consumers, as well as climatic problems, will also contribute to an increase in the organic agriculture worldwide.

According to estimates based on the official statistics, the export of organic flour from grain in 2017 rose to 31 tons against 12 tons over a previous year. The base of the exported volume was the buckwheat flour (98 %), with about 0.5 ton of wheat flour shipped. The geography of deliveries over the reported period included Moldova and Croatia. In 2016, the total volume of organic production in Ukraine was estimated at the level of USD 22 million (17 % larger than in 2015). At the same time, a multitude of factors, particularly the average return on investments at a level of approximately 300 %, make the organic farming one of the most attractive areas for investing in Ukraine [2]. Given these data, one can argue that Ukraine has a high potential in

the global market of organic grain crops while the economic attractiveness of organic production gives reason to believe that its volumes will grow in the nearest future.

In recent years, Ukraine has become a powerful supplier of organic products to the world market. The main organic products exported from Ukraine are cereal, oilseeds and legumes, wild berries, mushrooms, nuts, and medicinal herbs. In this case, in the domestic market, demand for organic and environmentally-friendly products has remained insignificant. The main problem is that the range of such products is limited and shops where one can buy organic products operate mainly in big cities. In addition, Ukraine is a supplier of raw materials, rather than the finished product. However, the resources of the Ukrainian food industry make it possible to produce finished products based on organic materials. Therefore, it is an important scientific task to search for the formulations to produce organic products. Since a considerable amount of grain crops is cultivated in Ukraine, including organic, it is a promising direction to develop flour-based bakery organic products. However, given the high demands of modern consumers, the finished organic products should be enriched with essential nutrients and satisfy human needs for biologically valuable substances. Thus, food products are characterized by a deficiency of essential amino acids, mineral elements (iodine, selenium, iron), vitamins, polyunsaturated fatty acids, and dietary fiber [3].

Of special biological importance are the proteins since they are the main substances out of which built cells of living organisms are built. Vital processes that are important in the body proceed with a direct participation of proteins. The biological value of proteins characterizes the capability to provide for plastic processes and the synthesis of metabolically-active substances [4]. It is generally known that the essential amino acids are not synthesized in humans and higher animals and must come into the body with food products; that necessitates a constant search for the improvement of protein composition of foodstuffs [5].

Thus, the relevance of the chosen subject of present study is predetermined by that the production of organic products is a very promising trend in the food industry. At the same time, a given direction has been underdeveloped in Ukraine although it is a powerful supplier of organic grain crop raw materials to the EU countries.

In order to comprehensively study the scientific problem on the development of organic food products, it is a relevant task to choose and examine the raw materials. Another important challenge is to investigate quality and safety indicators of the proposed products.

A review of the world market shows a high demand for organic products, as well as the rapid development of organic agriculture in Australia, Argentina, China, and Brazil. A significant share of the market in Switzerland, Germany, and Austria accounts for organic food products. Given this, extending the range of organic finished products is an important task in the food industry.

2. Literature review and problem statement

It should be noted that international market is particularly interested not only in organic raw materials, but also the finished organic products. Therefore, it is interesting to study organic raw materials in order to develop the finished

organic products with improved nutritional value. Given the number of alimentary diseases, in addition to that the products must be environmentally friendly, they should also be enriched with useful nutrients. Amino acids in a diet are needed for the body to control growth and tissue restoration. Essential amino acids are required in sufficient amount in the daily diet [7]. Environmentally clean and protein-enriched products can be of considerable interest to consumers. However, the current range of organic products with improved consumer properties is limited.

Thus, paper [8] investigated a variety of Pakistani wheat flour for the content of amino acids; there are other studies related to the amino acid composition of spelt [9]. It was established that in terms of the content of many amino acids the flour from spelt is better than that from wheat. However, the main problem of applying various types of flour from wheat in bread and bakery and confectionery industry is the insufficient quality of gluten. Thus, up to 50 % of gluten are washed off the flour from spelt. Given this, the bakery and confectionery products made from this type of flour have low quality.

The possibilities for enrichment of mineral and amino acid composition of grain after harvesting were examined. Thus, the amino acid composition of flour made from wheat grain sprouted in a solution of food sea salt was investigated. Part of essential amino acids in it increased by 5.7 % of their total content as compared with wheat flour [10]. Although this method is effective, it is inappropriate for the production of organic foodstuffs, because the raw materials, in order to obtain the status of "organic product", should not be exposed to additional treatment.

Paper [11] proposed techniques for enriching the flour products using protein concentrates and isolates. The study indicates that the concentrates and isolates from the protein of organic brown rice are not inferior in terms of the amino-acid composition to soy products. That allows using both products in the confectionery and bread and bakery industry [11]. It is worth noting that the manufacture of concentrates and isolates is a costly process that significantly increases the cost of the finished product. Organic products are distinguished by higher cost, which is why enriching them with concentrates and isolates is economically impractical.

There are data from research into the amino-acid composition of pea flour. Thus, it contains a large volume of aspartic acid, threonine, serine, glycine, alanine, valine, isoleucine, leucine, tyrosine, phenylalanine, histidine, lysine, and arginine. At the same time, glutamic acid, proline, methionine, and tryptophan were found in similar or lesser amounts in comparison with wheat flour. It was established that regular and organic flour, made of the same crop, may differ for the amino acid composition. It was found that there is no significant difference between the organic and regular pea flour in the amino-acid composition. However, there were significant differences in the content of separate amino acids between the protein composition of buckwheat regular and organic flour; the organic flour demonstrated higher biological value [12]. These results allow us to assume that organic flour can be better in terms of the amino acid composition. However, experimental research is needed to confirm this hypothesis in each particular case.

There are experimental data on the application in the production process of oatmeal cookies of the flour made from soy shoots in the amount of 5.8–13 %, as well as triticale flour in the amount of 39.0–50.6 %, leading to a

significant improvement of the protein composition of the cookies. Replacing 30 % of wheat flour with okara in the technology of cookies made it possible to enrich the product with essential amino acids [13]. However, a review of the market gives reason to believe that the organic triticale flour and the organic flour from soy shoots are missing.

An analysis of the scientific literature allows us to argue on that the main problem in the development of organic products is the limited range of organic raw materials. Significant scientific achievements concerning the enrichment of the protein composition of flour products sometimes cannot be applied for products under the status of "organic". That relates either to a significant increase in the cost of the finished products or to the peculiarities of the technological process. Therefore, in order to develop the organic flour confectionery products, it is expedient to apply alternative types of organic flour (buckwheat, rye, rice, etc.). However, it should be noted that the regular flour and the organic flour may differ for the amino acid composition. Therefore, analysis of the well-known sources on the chemical composition of foods may produce inaccurate data in relation to the organic products. Taking the above into consideration, experimental research into the amino acid composition of organic flour is needed. To study and model the formulations of cupcakes, we propose the kinds of organic flour made from the Ukrainian raw materials: rye, buckwheat, and wheat.

3. The aim and objectives of the study

The purpose of this research is to substantiate the development of formulations of cupcakes with an elevated content of protein. This would make it possible to extend the range of organic flour-based pastry products.

To accomplish the aim, the following tasks have been set:

- to study the amino acid composition of the samples of organic flour, amino acid score, a coefficient of difference in the amino acid score, biological value, and the usability factor of the examined samples;
- to investigate indicators of quality and safety of the finished cupcakes;
- to explore the content of protein in the finished products.

4. Materials and methods

4.1. Materials and methods to study the amino acid composition of flour

The examined materials were the samples of wheat flour (control sample), organic wheat flour, whole grain buckwheat flour, non-sifted, and whole grain rye flour, sifted (Fig. 1).

We determined amino acids using the method of ion-exchange chromatography at the automatic amino acid analyzer T 339, made in the Czech Republic (Prague). Work of the automatic amino acid analyzer is based on the principle of carrying out all the operations of analysis in the continuous stream of eluent. The principle of operation implies that the eluent from a container passes using the dosing pump through the chromatographic column. At the outlet of the column, a micropump continuously pumps to the eluent a ninhydrin reagent in the predefined ratio to eluent. A

mixture of the eluent and ninhydrin reagent is fed along a capillary tube to the reactor, which is heated to a temperature of 95–98 °C, and is then sent into the flow cuvette. The intensity of the obtained coloration is measured by photocolourimetry using a photocell, which receives the light from the source through the wall of the cuvette. The photocell signals are amplified and registered by a recording potentiometer in the form of a chromatogram. The area of peaks along the chromatogram is calculated and compared with the area of peaks of amino acids with a known concentration. By comparing these areas, one computes the absolute amount of an amino acid in the examined sample.

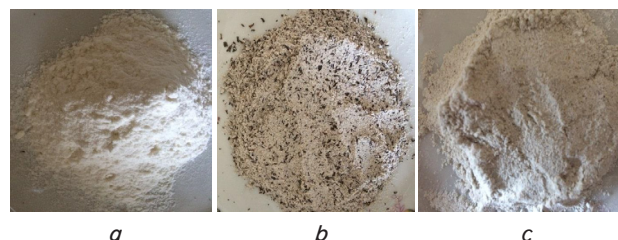


Fig. 1. Samples of the examined organic flour: *a* – organic wheat flour; *b* – whole grain organic buckwheat flour, non-sifted; *c* – whole grain organic rye flour, sifted

The amino acid score (AAS) of each essential amino acid is calculated according to the recommendations of the scale by FAO/WHO, adopted for the classification of protein, from formula:

$$C_j = (AK_j / AK_c) \times 100 \%, \quad (1)$$

where C_j is the amino acid score of the j -th amino acid of protein, %; AK_j is the content of essential amino acid per 1 g of the examined protein, mg/g of protein; AK_c is the content of essential amino acid per 1 g of the reference protein, mg/g of reference protein.

In addition to the amino acid score, we computed the indicators of quality for the flour proteins, particularly, a coefficient of difference for the amino acid score (CDAS), biological value (BV), and the usability factor of the amino acid composition (U). The indicator CDAS characterizes the excess amount of essential amino acids that are used for plastic needs. The lower CDAS, the higher the biological value of protein. The usability factor of the amino acid composition describes the balance of essential amino acids relative to the standard.

The coefficient of difference for the amino acid composition (R_c) is calculated from formula:

$$R_c = (C_{\min} \times \sum AK_c) / \sum AK_j, \quad (2)$$

where C_{\min} is the minimal amino acid score; AK_c is the content of essential amino acid per 1 g of reference protein, mg/g; AK_j is the content of essential amino acid per 1 g of the flour protein, mg/g of protein.

A biological value (BV) of the food protein (%) is determined from formula

$$\text{Biological value} = 100 - R_c, \quad (3)$$

where R_c is the rationality coefficient of the amino acid composition.

The usability factor (a_j) to assess the biological value of proteins in the flour was calculated from formula:

$$a_j = C_{\min} / C_j, \quad (4)$$

where C_{\min} is the minimal amino acid score; C_j is the amino acid score of the j -th essential amino acid. The average value for the usability factor (A_j): $A_j = \sum a_j / n$ (3).

4. 2. Materials and methods to study parameters of quality and safety of the finished products

Based on the study into the amino acid composition of flour, we chose formulations for the cupcakes "Grechanyk", "Zhytnitsa", made entirely from organic raw materials (Fig. 2). The cupcake "Stolichnyy" served as control.

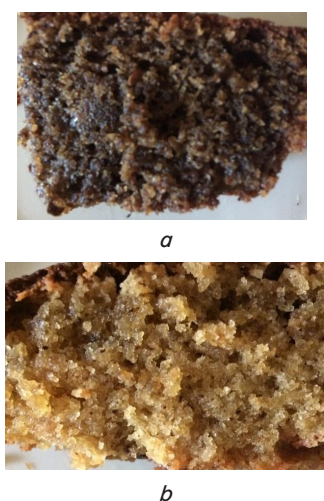


Fig. 2. Samples of the developed cupcakes:
a – "Grechanyk", b – "Zhytnitsa"

We used generally accepted procedures to study the content of toxic elements in the finished products: copper, zinc, lead, and cadmium were determined by the atomic-absorption method; arsenic – by the colorimetric method; mercury – by the method of flameless atomic absorption.

Among the physical-chemical indicators, we defined a moisture content – drying to the constant mass at 105 °C (Fig. 3); the mass fraction of ash, non-dissolved in a solution with a mass fraction of hydrochloric acid of 10 % – by wet ashing of the sample in nitrogen acid and burning it in an electric furnace; the alkalinity – by a potentiometric method (Fig. 4).



Fig. 3. Drying cabinet for measuring the moisture content of finished goods SNOL (Ukraine)



Fig. 4. Examining the alkalinity of finished products at PH-150 MI (Ukraine)

A protein content in the finished products was determined by the Kjeldahl method, which is based on the destruction of organic compounds under the action of boiling sulfuric acid

5. Results of studying the amino acid composition of organic flour and the indicators of quality and safety of the finished products

For the analysis of protein composition of a product, decisive is the comprehensive analysis and study of the content of nonessential and essential amino acids, determining the rational composition and the biological value of protein. Table 1 gives data on the content of the nonessential and essential amino acids in the proteins of different kinds of flour.

Essential amino acids play a very important role in the human body as their scarcity in food affects the regeneration of proteins. One of the most valuable amino acids is lysine, whose deficiency in nutrition leads to the disruption of hematopoiesis, reducing the amount of red blood cells and hemoglobin in the blood, disturbance of bone calcification and muscle dystrophy. An analysis of experimental data, given in Table 3, allows us to conclude that the greatest amount of lysine was demonstrated by organic buckwheat flour. The indicator of the amino acid score was 104 %; the lowest – in plain wheat flour (the indicator of the amino acid score is 36 % only).

Leucine stimulates the synthesis of muscle protein. Its highest content was demonstrated by organic buckwheat flour and organic wheat flour (90 % and 91 %, respectively) [16].

It should be noted that the organic buckwheat flour was also noted by the highest content of such essential acids as isoleucine, threonine, and methionine + cystine.

In addition to the amino acid score, we also calculated the coefficient of difference for the amino acid score (CDAS), biological value (BV), the utilization factor (U) (Table 3). For the reference protein, it is equal to 0. The biological value of the food protein is the magnitude inverse to CDAS; for the reference protein, it is equal to 100 %.

The balance of essential amino acids based on the ratio to the physiologically required norm is numerically characterized by the utilization factor. The utilization factor shows the degree of indigestibility of amino acids; it is a numerical characteristic that sufficiently enough reflects the balance of essential amino acids [15].

Table 1

Amino acid composition of the examined samples of flour,
mg/20 ml of sample

Amino acid title	Organic rye flour	Organic buck-wheat flour	Organic wheat flour	Wheat flour
Lysine	0.27	0.58	0.30	0.24
Threonine	0.32	0.39	0.38	0.33
Cystine	0.10	0.15	0.18	0.19
Valine	0.29	0.28	0.57	0.32
Isoleucine	0.14	0.22	0.26	0.23
Leucine	0.50	0.64	0.92	0.72
Tyrosine	0.16	0.21	0.35	0.26
Histidine	0.15	0.23	0.24	0.19
Arginine	0.34	0.88	0.41	0.38
Aspartic acid	0.74	1.16	0.68	0.61
Seren	0.46	0.63	0.73	0.61
Glutamic acid	2.71	2.32	5.64	4.93
Proline	1.18	0.48	1.94	1.48
Glycine	0.40	0.75	0.56	0.50
Alanine	0.40	0.59	0.51	0.43
Methionine	0.10	0.19	0.15	0.15
Phenylalanine	0.41	0.43	0.67	0.69
Total	8.65	10.1	14.5	12.3

Table 2

Amino acid score of the examined flour

Amino acid title	FAO/WHO scale, g/100 g	wheat flour	organic rye flour	organic buckwheat flour	organic wheat flour
Valine	5	52	67	55	79
Isoleucine	4	46	41	55	46
Leucine	7	84	82	90	91
Lysine	5.5	36	56	104	37
Phenylalanine + Tyrosine	6	130	109	105	118
Threonine	4	67	91	97	66
Methionine + Cystine	3.5	80	67	96	64

Thus, based on Table 3, the largest biological value and, consequently, the smallest coefficient of difference for the amino acid score, were demonstrated by the proteins of organic buckwheat flour, although the difference in these parameters was not significant between all the samples. The second place, in terms of the biological value, was taken by organic rye flour. Note that the utilization factor of the wheat flour and the organic wheat flour was at the same level – 0.53 %, and the highest utilization factor was demonstrated by the sample of organic buckwheat flour.

Table 3

Quality indicators of the flour proteins

Indicator	Wheat flour	Organic rye flour	Organic buck-wheat flour	Organic wheat flour
CDAS,	34.80	32.15	31.31	34.02
BV, %	65.20	67.85	68.69	65.69
U, %	0.53	0.55	0.63	0.53

Based on data of present research, we modeled the formulations of cupcakes, in which wheat flour was replaced with the organic kinds of flour. Since the highest biological value was demonstrated by the proteins of organic rye flour and organic buckwheat flour, these types of flour were chosen to replace the traditional wheat flour in the formulation of the cupcake "Stolichny". The flour in the formulation of the cupcake "Grechanyk" was replaced completely, and for the cupcake "Zhytnitsa", based on the results of organoleptic estimation, we chose a mixture of organic wheat flour and organic rye flour in the amount of 34 % and 66 %, respectively. To make the cupcakes, we took only organic raw materials of the Ukrainian and foreign origin. Summarized formulations per 1 ton of the finished product are given in Table 4.

Table 4

Summarized formulations of the developed cupcakes per
1,000 kg of the finished product

Raw material	"Grechanyk"	"Zhytnitsa"
Organic buckwheat flour	302.86	–
Organic wheat flour	–	202.86
Organic rye flour	–	100.00
Organic cane sugar	200.00	200.00
Organic agave syrup	27.12	–
Organic rice syrup	–	27.12
Organic cream butter	201.15	201.15
Organic sesame oil	26.00	–
Organic sesame oil	–	26.00
Organic dried fezalis	54.00	–
Organic dried raisin	173.00	–
Organic dried cranberry	–	114.00
Organic dried mulberry	–	113.00
Organic eggs	27.00	27.00
Organic flax bran	10.59	–
Organic rye bran	–	10.59
Organic baking powder	0.9	0.9
Food salt	0.9	0.9

Thus, in order to produce the new cupcakes, in addition to wheat flour, we replaced another part of the traditional raw materials. Thus, cream butter in both samples was replaced with a mixture of organic cream butter and organic vegetable oil. Vegetable oils are a promising source of essential fatty acids, which is why adding them to the formulations of cupcakes may have a positive impact on the fat-acid composition. In addition, it is important to comply

with the recommendations of the World Health Organization (WHO) on healthy nutrition, in particular reducing the proportion of sugar in a daily diet. Thus, the recommended norm of sugar consumption is 50 g per day, but in order to prevent various diseases, this amount could be reduced to 25 g per day. That was the reason why we changed powdered sugar in the formulations of cupcakes for the bran – flax and rye, and sugar was replaced in the sample "Grechanyk" with a mixture of organic cane sugar and organic agave syrup, and in the cupcake "Zhytnitsa" – with a mixture of organic cane sugar and organic rice syrup. These syrups are considered to be promising sweeteners, they contain less carbohydrates than regular sugar. To improve taste properties of the cupcakes, as well as the mineral composition, the formulations were supplemented, in addition to raisin, other kinds of dried fruits – organic dried fezalis, organic dried cranberry, and organic dried mulberry. Characteristics of the sample of cupcakes based on their organoleptic indicators are given in Table 5.

Table 5

Characteristics of cupcakes based on their organoleptic properties

Indicator	"Stolichny"	"Grechanyk"	"Zhytnitsa"
Shape	regular, no dents, no damage		
Surface state	Smooth, uniform, without cracks, fractures, not burnt		
Crust coloration	Brown, uniform		
Crumb state and color	Elastic, well baked, light yellow	Elastic, well baked, brown	Elastic, well baked, golden shade
Porosity structure	medium porosity, uniform		
Flavor	pleasant	pleasant, with raw materials aroma	pleasant, with raw materials aroma
Taste	pleasant	pleasant, special aroma from dried fruits	pleasant, spicy taste of bran and the used combination of dried fruits
Aftertaste	pleasant	pleasant, with a taste of bran and buckwheat flour	pleasant, spicy taste of the used rye flour
Crumb chewiness	well chewed		

According to data in Table 5, the developed samples are distinguished by high organoleptic characteristics; the raw materials used render them a special taste and aroma.

We defined the following physical-chemical indicators (Table 6): mass fraction of moisture; alkalinity, calculated for dry substance; and a mass fraction of ash, non-dissolved in a solution with a mass fraction of hydrochloric acid of 10 % (Tble 6).

Data from Table 6 indicate that the developed samples of cupcakes meet the regulatory requirements for the physical-chemical indicators.

Since the developed products were made from organic raw materials, it is important to study safety indicators of the finished products (Table 7).

Table 6

Physical-chemical quality indicators of the developed cupcakes

Indicator	Norm	"Stolichny"	"Grechanyk"	"Zhytnitsa"
mass fraction of moisture, %	6–32	18.0	21.0	19.5
alkalinity, calculated for dry substances, in degrees, not exceeding	2.0	1.7	1.6	1.6
mass fraction of ash, non-dissolved in a solution with a mass fraction of hydrochloric acid of 10 %, %, not exceeding	0.1	0.07	0.07	0.07

Table 7

Safety indicators of cupcakes

Indicator, mg/kg	"Stolichny"	"Grechanyk"	"Zhytnitsa"
lead	0.002	0.001	0.001
cadmium	<0.002	<0.002	<0.002
arsenic	0.15	0.003	0.003
mercury	<0.01	<0.01	<0.01
copper	1.4	1.5	1.2
zinc	3.4	3.5	4.0
aflatoxin B1	<0.003	<0.003	<0.003

Based on data from Table 7, all the samples meet the national standard of Ukraine for cupcakes in terms of the content of toxic elements and aflatoxin B1. The products made from organic raw materials contain twice less lead than control, the content of arsenic is also significantly lower.

The protein content increased in both developed samples, testified by data on the content of protein in the finished products (Fig. 5).

Fig. 5 shows the protein content increased in the developed samples, compared with control, in the sample "Grechanyk" – by 1.44 times, in the sample "Zhytnitsa" – by 1.3 times. Therefore, the application of alternative kinds of flour in the formulations of cupcakes improved the protein composition.

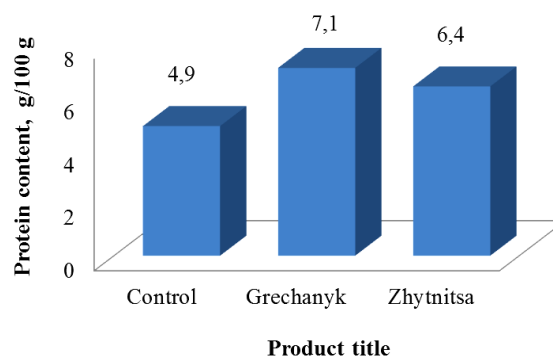


Fig. 5. Protein content in the examined samples of cupcakes

6. Discussion of results of studying the quality and safety of organic cupcakes based on rye and buckwheat flour

The study into organic flour and the development of cupcakes formulations based on it, is continuation of the scientific

work in the field of organic production of the finished products in Ukraine. The first stage involved studying the export potential of the state in the market of organic food products, as well as the investigation into the structure of organic farming in Ukraine.

The results obtained allow us to argue on that the most promising raw material, in terms of the amino acid composition, for the production of pastries is the organic buckwheat flour. That is confirmed by the well-known scientific data on that the buckwheat proteins are rather well balanced in terms of the content of essential amino acids. For the content of tryptophan, buckwheat is not inferior to the products of animal origin; for the content of valine, buckwheat can be compared to milk; for leucine – to beef, for phenylalanine – to milk and beef [17]. The organic rye flour, based on the results obtained, demonstrated a somewhat worse amino acid composition than the buckwheat flour. However, the combination of rye and wheat flour in the formulation of the cupcake "Zhytnitsa" contributed to an increase in the content of protein. Thus, there are data on that the bread, baked from rye flour with the addition of ginger, was considerably better for the content of lysine than wheat bread [18]. It should be noted that in order to improve consumer properties of flour products, the effect of beans flour on the quality of cupcakes was investigated [19]. Researchers also studied the impact of the use of flour in combination with powders of medicinal herbs on the quality indicators of pastry products [20]. The possibilities of applying flour from a mixture of wheat of various kinds were explored [21]. Scientists established the effect of oatmeal flour on the nutritional value of flour products [22]. However, the above papers did not deal with the problems of the development of organic products. Suggested formulations includes ingredients that cannot be used in the production of organic food products, because of the lack of such ingredients with the status of "organic". In paper [23], authors investigated the possibilities of using organic buckwheat flour for the production of gluten-free bread; however, the protein composition of the finished product was not analyzed [23]. Information about scientific research in the field of development of organic pastry products is extremely limited; most of the scientific papers address the development of organic farming. Nevertheless, extending the range of the finished organic products would contribute to increasing the demand for them, thereby increasing the volumes of organic farming.

The data obtained can form a basis for the development of not only organic cupcakes, but other bakery or pastry products as well. Another significant advantage of buckwheat flour is that it does not contain gluten and thus can be recom-

mended for the development of dietary products. In addition, the data obtained could help expand the range of environmentally friendly organic pastry products with an elevated content of proteins. The main disadvantage of this study is the lack of data on the amino acid composition of the developed products. Research into the fat-acid, amino acid, and mineral composition of the developed cupcakes will be a further step in this field. A significant limitation in terms of expanding the range of organic products is its high cost, associated with the features of the organic agriculture and the need for certification. However, with respect to the modern trends related to ecological consumption, such products could be available in the market and enjoy a demand.

7. Conclusions

1. We have examined the samples of organic flour for the amino acid composition. Based on an analysis of the obtained data, the best amino acid composition was demonstrated by buckwheat flour. Thus, the amino acid score of lysine in it is 104 %, leucine 90 %, methionine + cystine 96 %. We determined in the samples of organic flour the amino acid score, the coefficient of difference for the amino acid score, biological value, and the utilization factor. The highest biological value (66.69 % and 67.85 %) and, accordingly, the lowest coefficient of difference for the amino acid score, were demonstrated by the samples of organic buckwheat flour and organic rye flour; the lowest biological value (65.69 % and 65.20 %) were demonstrated by organic wheat flour and wheat flour. The highest utilization factor was demonstrated by organic buckwheat flour – 0.63 %.

2. We investigated safety and quality indicators of the developed cupcakes. All the samples of cupcakes met the standards documentation in terms of the content of toxic elements and aflatoxin B1. The products made from organic raw materials contained twice less lead than control: 0.01 mg/kg, while in control – 0.02 mg/kg. The arsenic content is also significantly less in the developed products, 0.03 mg/kg compared to 0.15 mg/kg in control. The developed samples are distinguished by high organoleptic characteristics; their physical-chemical indicators corresponded to the standard.

3. The protein content was determined in the developed cupcakes. The replacement of wheat flour with the alternative kinds of organic flour made it possible to increase the content of protein. The indicator grew, compared with control, in the sample "Grechanyk" – by 1.44 times, in the sample "Zhytnitsa" – by 1.3 times.

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