CHAPTER 22

TECHNOLOGY AND QUALITY OF SHORTBREAD CONFECTIONERY WITH MEAL

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INTRODUCTION

Providing the population of Ukraine with a full-fledged balanced diet is one of the most important problems of the state.

Improving the structure of nutrition of the population of Ukraine involves increasing the production of food products, thanks to the improvement of existing ones and the creation of new technologies. Real food products are unbalanced in their chemical composition and do not contain essential nutrients in the required quantities and ratios. The search for natural food substances of plant origin that are able to increase the resistance of the human body to the negative impact of the environment due to antioxidant, antitoxic activity is relevant. Scientific theoretical and practical studies show that it is impossible to achieve a high preventive effect with the help of traditional food products, and the creation of universal food products is also problematic. An effective and quick way to optimize their nutritional value is to use biologically active raw materials, which are a concentrate of natural minor food components – vitamins, macro- and microelements, individual fat acids, and phospholipids.

1. Analytical review of flour confectionery products

In Ukraine, the production of special-purpose products with antioxidant immunomodulatory effects is insufficient, so expanding the range of these products is relevant. One of its solutions is the development of scientific and methodological foundations for creating food products with a balanced chemical composition through the use of plant biologically active raw materials. The domestic market is dominated by food additives, mainly of foreign production, so research into domestic plant raw materials and secondary products of their processing is of significant scientific and practical interest.

Currently, the urgent task is the waste-free comprehensive use of valuable plant raw materials. From this point of view, secondary raw materials – cake, meal, pomace, which remain after the manufacture of the main product (juices, wine, oil, etc.) and contain a large number of biologically active compounds in natural proportions that are best absorbed by the body – deserve some attention.

Flour confectionery is a group of food products with a fairly wide range. They differ significantly in their recipe composition and organoleptic properties, which is achieved primarily by including various ingredients in the recipes and using certain technological operations. The main ingredients of the shortbread cookie recipe are: wheat flour, butter, granulated sugar, eggs, baking powder, ammonium, salt.

Flour confectionery, as a group of products characterized by increased demand from the population, requires scientifically substantiated regulation of the nutrient composition, protein and carbohydrate raw materials.

Regulation of the chemical composition of such flour products to increase their nutritional value is a way to create new generation products. For this purpose, various types of both traditional and non-distributed biologically active raw materials are used.

The priority direction today is recipe and technological innovations to expand the range, increase the nutritional and biological value, and reduce the calorie content of flour confectionery.

A directed change in the nutritional value of flour confectionery is achieved by including useful (desirable) components in their recipe or removing undesirable (unuseful) components. When developing the latest technologies for flour confectionery, it is envisaged to use so-called functional ingredients, which include dietary fiber, proteins, vitamins, antioxidants, which contribute to increasing nutritional and biological value and reducing energy value[1].

So, currently the range of additional and non-traditional raw materials used for the production of flour confectionery products is quite wide, but the potential of secondary plant products from oil raw materials is not used to the full extent.

Based on the analysis of the domestic market of biologically active raw materials, we concluded that some of its types used in flour confectionery technologies can be attributed to dietary supplements, but some of them occupy an intermediate position between dietary and food additives due to their biological activity and functional and technological properties, in particular, affecting the structural-mechanical, sensory properties and nutritional value of flour confectionery products.

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[1] Rusu I. E., Marc R. A., Mureșan C. C. Hemp (Cannabis sativa L.) flour-based wheat bread as fortified bakery product. *Plants*, 2021. No. 10(8), p. 155.

The concept of the nutritional value of biologically active raw materials, which include oilseed meals and hemp processing products, as components of flour confectionery products should be considered from the standpoint of their safety, as well as the transformation of individual nutrients in the technological flow.

As already noted, the development of technologies for flour confectionery products with a regulated nutrient composition involves the involvement of secondary plant raw materials of increased biological value in the technological process, which is a relevant area of research in the context of state policy on resource conservation, rational use of raw materials, increasing high-quality domestically produced products, and increasing the orientation of domestic enterprises to the development of import-substituting products. Recently, oilseeds and their processing products have been gaining increasing popularity as products that are beneficial to human health. Among them, the most common are meals. Meal is a by-product of oil extraction production. It is obtained after the extraction of fat from oilseeds.

The main products of industrial hemp seed processing in Ukraine are crushed hemp seeds, hemp oil, hemp flour, hemp bran, and hemp protein.

The use of oilseed meals and hemp flour allows you to easily and quickly eliminate the deficiency of essential nutrients, primarily micronutrients, to some extent it is aimed at changing the metabolism of individual substances, increasing the body's non-specific resistance to the effects of adverse environmental factors, and obtaining a mechanism for a non-drug safe way to regulate and maintain human health.

2. Substitution of the composition of model dough for cookies using composite mixtures

Flour confectionery products have high taste qualities, but an unbalanced chemical composition due to the high content of fats, sugars and low – dietary fiber, unsaturated fatty acids, minerals, proteins. Meals have a valuable chemical composition, because they contain unsaturated fatty acids, minerals, proteins and dietary fiber represented by fiber. Therefore, it is important to investigate the possibility of using meals in the technology of flour confectionery shortbread products instead of wheat flour[2].

The use of oilseed meals (soybean, sunflower, sesame, walnut, flax, hemp, etc.) allows you to enrich the chemical composition of flour confectionery products with protein, lipids, dietary fiber, vitamins and minerals (Table 1),

[2] Sheludko V. M., Kholobtseva I. P. Legumes in the technology of flour confectionery products. Improving the technology of butter cookies enriched with calcium by using protein-mineral additives. *Eastern-European Journal of Enterprise Technologies*, 2021, No. 4(11(112), p. 42–49.

they have pronounced sorption, antioxidant, detoxifying, complex-forming properties[3].

Analysis of the chemical composition of hemp flour showed that hemp flour has a significantly higher protein content, on average by 58% compared to wheat flour. From the point of view of physiological value, not only the amount of protein in the product is important, but also its completeness, which is characterized by the presence of essential amino acids and their quality, namely, proximity to the "ideal protein". To assess this compliance, the amino acid score indicator is used, which characterizes the degree of proximity of the composition of the studied protein to the composition of the ideal protein[4].

The calculation of the amino acid scores of wheat and hemp flour proteins is given in Figure 1.

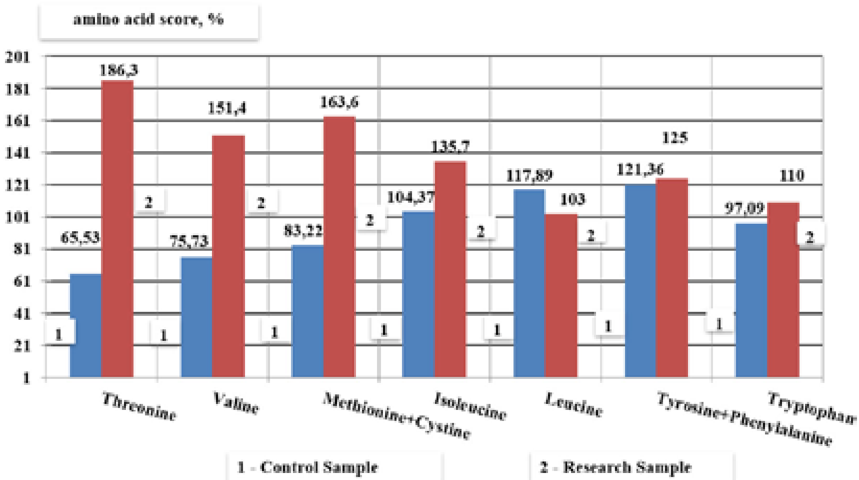

Fig. 1. Amino acid score of hemp and wheat flour proteins, %

The amino acid scores of threonine and valine in hemp flour exceed the corresponding values of wheat flour by approximately 2.8 and 2.00 times, methionine with cystine by 1.97 times, isoleucine by 1.3 times, and tryptophan by 1.13 times. The amino acid scores of tyrosine and phenylalanine for both types of flour are practically at the same level, while the amino acid score

[3] Švec I. The Mixolab parameters of composite wheat/hemp flour and their relation to quality features. *LWT – Food Science and Technology*. 2015. Vol. 60 (1), p. 623–629.

[4] Mihoc M. Nutritive quality of romanian hemp varieties (Cannabis sativa L.) with special focus on oil and metal contents of seeds. *Chemistry Central Journal*. 2012. Vol. 6, p. 1–12.

Table 1

Mineral composition of hemp flour (n=5, p≤5)

Name	Content per 100 g of flour	
	Wheat flour wholemeal	Hemp flour
Zinc, mg	0,0007	0,17021
Potassium, mg	122	1888
Magnesium, mg	16	3490
Phosphorus, mg	86	18200
Iron, mg	1,2	161,97
Calcium, mg	16	2040
Cobalt, mg	0,0015	0,00121
Manganese,mg	0,0006	0,08891

of hemp flour is slightly lower for leucine. The amino acid score of lysine in hemp flour exceeds the value of wheat flour by 1.73 times, which is especially important, since lysine is the limiting amino acid for proteins in both types of flour.

Analyzing the carbohydrate composition, it can be noted that the total carbohydrate content in hemp flour is lower, mainly due to mono- and disaccharides by 71%, and the starch content is of particular interest, which is lower by 78% compared to wheat flour. It is worth noting that the content of dietary fiber in hemp flour is 2 times higher than in wheat flour.

The ratio of ω–3 and ω–6 fatty acids in hemp flour is 1:3.6 compared to wheat flour, where the ratio is 1:16. Thus, the studied hemp flour is characterized by balance and high biological value due to the high content of essential ω–3 and ω–6 fatty acids.

The next stage was the study of the mineral composition, the results are given in Table 1.

Analysis of the mineral composition indicates a significant predominance of hemp flour over high-grade wheat flour in all studied mineral elements. The magnesium content in hemp flour is approximately 21.8 times higher than in wheat flour. A similar trend is observed for phosphorus, the content of which exceeds the indicator of wheat flour by 21.2 times, the calcium content in hemp flour is also significantly higher by approximately 12.8 times.

The use of hemp flour depends on physicochemical indicators and technological properties. The main physicochemical properties that allow us to assess the influence of additives on the formation of cookie quality are water-holding, water-absorbing and fat-retaining and fat-absorbing capacity, which affect the formation of dough (Figure 2).

The combination of these properties ensures the formation of rheological properties of the dough and affects the quality of cookies.

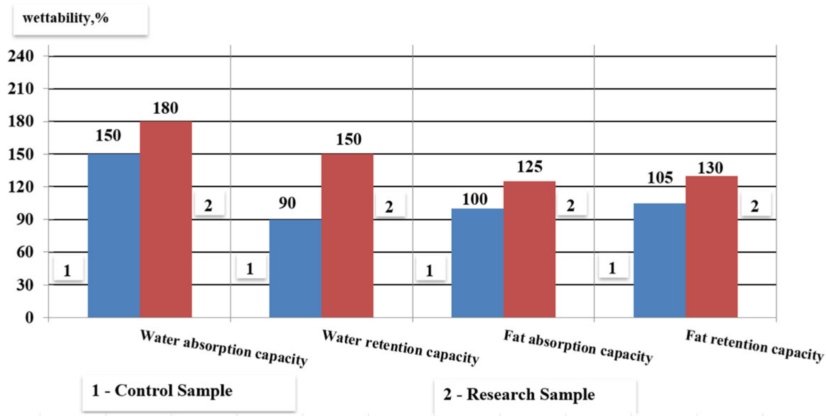

Fig. 2. Water-absorbing, fat-absorbing and fat-retaining capacity

The water-holding capacity of hemp flour is 60% higher than the indicator in the control sample. The fat-holding capacity of hemp flour is 130%, and for the control sample it is 105%, which is 25% higher. According to the established chemical composition, hemp flour contains 58% more protein, which is able to bind and retain moisture. The high concentration of dietary fiber, the content of which is 15 times higher than that of wheat flour, in combination with a reduced proportion of starch, affects the water-holding and fat-absorbing capacity of hemp flour. The obtained physicochemical indicators positively characterize hemp flour for use in a composite mixture and allow us to assume an improvement in the plasticity of the shortcrust pastry semi-finished product and obtaining the necessary friability of the finished cookies.

The quantity and quality of raw gluten in a mixture of two types of flour in different concentrations from 10% to 50% were studied. The results of the study of gluten obtained from a mixture of hemp and wheat flour, in particular its quantity, extensibility, elasticity and water-holding capacity, are given in Table 2.

Increasing the dosage of hemp flour in the mixture leads to a gradual decrease in the content of raw gluten. At the maximum studied addition (50%), this indicator decreases by 38.4% relative to the control. The water-holding capacity of the composite mixture, on the contrary, increases with an increase in the proportion of hemp flour – from 84% in the control to 120% at a dosage of 50%. The increase in hydration capacity can be explained by the significant water-absorbing capacity of hemp flour fibers and proteins. Adding hemp flour in an amount of 10…50% leads to a gradual decrease in the gluten elasticity index from 72.55 units of the IDK device in the control sample to 31.53 units of

Table 2

Compositional mixtures of wheat and hemp flour

Hemp Blend	Ratio %	Indicator			
		Raw gluten content, %	Water holding capacity, %	Elasticity, units of IDC	Extensibility, cm
Wheat Flour / Hemp Flour	100/-	25	84	72.55	13.5
	90/10	23.2	90	58.3	10
	80/20	21.24	102	51.6	4
	70/30	19.25	108	44.93	1
	60/40	17.35	114	38.23	0
	50/50	15.39	120	31.53	0

the IDK device at 50% replacement. The most critical changes were recorded in the elasticity index, when adding 30% hemp flour, the extensibility is reduced to a minimum level (1 cm), and at a dosage of 40–50%, gluten completely loses its ability to stretch. The decrease in extensibility has a positive effect on the formation of the structure of the shortcrust pastry semi-finished product.

An important feature of meals is the high content of protein and dietary fiber, minerals, especially Calcium, Magnesium, Phosphorus (Table 3). The carbohydrate composition of meals has certain features: the total carbohydrate content is up to 40%, dietary fiber is mainly represented by fiber, their content in some types is about 50% of the total amount of carbohydrates, while the polysaccharides of wheat flour are mainly represented by starch, the content of which reaches 85%. The indicated differences in the carbohydrate component of meals and wheat flour affect the dough formation process and structural and mechanical properties of the dough[5].

The use of several types of meals in the composition allows you to balance the content and optimal ratio of minerals, amino acid composition of proteins.

It was found that hemp flour and sunflower and flax seed meals, compared to wheat flour, contain more protein – 2.5–3.5 times, fat – 4.5–10 times, the total carbohydrate content decreased almost 2 times, but the fiber content increased more than 10 times. Meals have a wide range of minerals and their content is significantly higher than in wheat flour, respectively: Potassium – 9.5–10.5 times, Calcium – 18.5–200 times, Magnesium – 15–45 times,

[5] Lan Y. et al. Genotype x environmental effects on yielding ability and seed chemical composition of industrial hemp (Cannabis sativa L.) varieties grown in North 90 Dakota, USA. *Journal of the American Oil Chemists' Society.* 2019. Vol. 96. No. 12, p. 1417–1425.

Table 3

Chemical composition of meal (per 100 g of product, n=5, p≤5)

Meal Name	Name of substances							
	Protein, g	**Fat, g**	**Carbohydrates, g**	**incl. Fiber, g**	**Ash, g**	**PFA,mg**	**Water, g**	**Potassium, mg**
Flaxseed	30,5±0,5	10,2±0,5	39,5±0,5	35,00±0,5	1,5±0,1	8,4±0,5	12,0±0,5	790,00±5
Sesame	39,81±0,5	7,37±0,5	32,40±0,5	18,64±0,5	1,9±0,1	6,2±0,5	13,0±0,5	1194,37±5
Walnut kernels	42,74±0,5	6,32±0,5	27,50±0,5	10,85±0,5	1,8±0,1	4,5±0,5	10,5±0,5	1712,42±5
Soybean	44,7±0,5	6,0±0,5	26,3±0,5	22,9±0,5	1,4±0,1	5,4±0,5	12,2±0,5	1600±5
Sunflower	40±0,5	12,5±0,5	39,8±0,5	32,6±0,5	1,2±0,1	8,8±0,5	12,5±0,5	647±5
Milk thistle	28±0,5	9,6±0,5	34,2±0,5	30,1±0,5	1,2±0,1	7,9±0,5	13,1±0,5	920±5
Pumpkin seeds	45±0,5	9±0,5	25±0,5	21±0,5	1,5±0,1	7,6±0,5	12,2±0,5	1200±5
Coconut	22±0,5	12±0,5	55±0,5	50,8±0,5	1,3±0,1	7,4±0,5	11,0±0,5	1600±5
Rapeseed	36±0,5	3,5±0,5	35±0,5	13±0,5	7,5±0,1	7,6±0,5	11±0,5	1400±5
Mustard	35±0,5	5,0±0,5	32±0,5	12±0,5	6,5±0,1	7,0±0,5	9±0,5	1350±5
Hemp flour	28,4±0,5	12,2±0,5	31,54±0,5	15,0±0,5	8,3±0,1	8,0±0,5	10,5±0,5	1888±5

Continuation of table 3

Meal Name	Name of substances						
	Calcium, mg	**Magnesium, mg**	**Sodium, mg**	**Phosphorus, mg**	**Iron, mg**	**Manganese, mg**	**Copper, mg**
Flaxseed	1140,00±5	380,00±5	54,00±0,5	600,00±5	77,00±1	0,77±0,02	0,15±0,006
Sesame	3542,25	1296,86±5	180,53±5	1730,27±5	146,59	–	–
Walnut kernels	319,47	511,47±5	7,89±0,5	1453,68±5	5,93	0,49±0,02	1,359±0,05
Soybean	217	200±±5	5±0,5	603±5	9	0,2±0,01	0,3±0,01
Sunflower	367	317±5	160±5	860±5	6,1	0,080±0,004	0,251±0,01
Milk thistle	1660	420±5	4±0,2	960±5	8	0,1±0,005	0,116±0,005
Pumpkin seeds	90	600±5	30±0,5	1150±5	16	0,35±0,01	0,2±0,01
Coconut	65	260±5	40±0,5	500±5	8,5	0,4±0,02	0,18±0,007
Rapeseed	680	500±5	15±0,4	1100±5	15	0,050±0,003	0,160±0,05
Mustard	550	480±5	12±0,4	1020±5	13	0,4±0,02	0,13±0,005
Hemp flour	2040	3490±5	7±0,4	18200±5	161,97	0,089±0,003	0,15±0,006

Phosphorus – 12–14 times, Iron – 14.5–110 times. The results obtained suggest that the use of a composition of sunflower meal, flax seed, and hemp flour in a ratio of 70:20:10 (MC) will significantly increase the nutritional value of shortbread products made with their use and optimize the ratio of Calcium, Magnesium, and Phosphorus[6].

The inclusion of meal composition (MC) in the dough composition has a positive effect on its structural and mechanical properties, increases the nutritional value of the finished product, and helps reduce the glycemic index[7].

Hemp flour protein consists predominantly of edestin (globulin) – 65% and albumin – 33%, unlike soybean protein, in addition, it has a high content of sulfur-containing amino acids, methionine and cysteine – 163.6%, as well as arginine and glutamic acid. According to scientists who studied the amino acid composition and physicochemical properties of hemp seeds, the digestibility of protein is higher compared to soy protein[8].

Hemp flour has a high energy value, contains about 28% of proteins, which are balanced in amino acid composition, including: lysine, tryptophan, leucine, phenylalanine, etc. The percentage of protein absorption in hemp flour is 90.8–97.5[9].

It should be noted that hemp seeds and their processed products are gluten-free, so they can be consumed by people with celiac disease, who are contraindicated in oats, wheat, rye and barley.

To determine the possibility of using MC in flour mixtures for dough compositions, it was important to investigate their most important functional and technological properties, including those that most affect the structure and quality of the dough. Traditional shortcrust pastry is an emulsion system, the main components of which are wheat flour, butter, sugar[10].

A feature of obtaining high-quality shortcrust pastry is quick kneading in order to prevent the dough from tightening due to the absorption of water by gluten and starch in flour. Therefore, one of the most important functional and technological properties of meals is their water-absorbing, fat-absorbing,

6 Radočaj O., Dimić E., Tsao R. Effects of hemp (Cannabis sativa L.) seed oil press-cake and decaffeinated green tea leaves (Camellia sinensis) on functional characteristics of gluten-free crackers. *Journal of Food Science*, 2014. No. 79, p. 318–325.

7 Blazhenko M., Falendysh N., Shpak V. Effect of hemp seed by-products on wheat dough fermentation. *Ukrainian Food Journal*. 2024. Volume 13. Issue 4. P. 737.

8 Marchenko Zh. Yu., Primakov O. A. Hemp farming in Ukraine – a modern stage of development and opportunities. Bast and industrial crops. *Euphytic*, *International Journal of Plant Breeding*. 2020. Volume 140, p. 65–72.

9 Crimaldi M., Faugno S., Sannino M., Ardito L. Optimization of Hemp Seeds (Canapa Sativa L.) Oil Mechanical Extraction. *Chemical engineering transactions*. 2017. Vol. 58, p. 373–378.

10 Dorokhovych V. V. Determination of the influence of sunflower seed meal on the structural parameters of dough and physicochemical parameters of shortbread cookies. *Scientific works of the National Institute of Chemistry and Food Technology*. 2021. Volume 27. No. 1. P. 160–167.

fat-retaining ability, because these characteristics significantly affect the formation of dough.

It was found that the water-absorbing, fat-absorbing and fat-retaining capacity of MC is on average 20%, 18% and 48% higher than that of wheat flour, respectively, which is explained by the higher content of protein, dietary fiber, which, as is known, have a higher water-absorbing capacity than wheat flour starch. The results obtained suggest that the use of MC in the recipe of shortcrust pastry should provide better quality, because they will compete with starch and gluten of wheat flour for water.

The addition of MC causes a change in the structural and mechanical properties of shortcrust pastry, reduces plastic and elastic properties, which is explained primarily by a decrease in gluten content, due to the fact that MC prevents the formation of a gluten framework[11].

An important technological characteristic of the dough is its moisture content. Accordingly, the moisture content of shortcrust pastry is 18.5–19.5%. In the experimental samples, the content of hydrated gluten is lower, due to the fact that wheat flour starch and dietary fibers and proteins of MC compete for moisture, which have a higher hydration capacity, which will allow obtaining a plastic dough structure[12].

A technological scheme for the production of shortcrust pastry (biscuits) from MC has been developed.

The proposed technology is carried out in V stages.

Stage I. Preparation of raw materials for production. Wheat flour of high-grade, sugar, MC are sieved on sieves of appropriate sizes (d = 1.4 × 10-3 m). Butter is cleaned, tempered to 25±1°C, cut into pieces.

Stage II. Preparation of shortcrust pastry is carried out in two stages:

first, an emulsion is prepared from all raw materials, except wheat flour of high-grade and MC flax, then pre-mixed wheat flour with MC is added to the emulsion and mixed until a homogeneous plastic mass is formed. The humidity of the formed dough is 20.0±1%.

Stage III. Forming of products. The finished dough is cut into pieces and rolled out to a thickness (h = 4…5×10-3 cm) and formed depending on the assortment of shortcrust pastry, then spread on a pastry sheet.

Stage IV. Baking-drying. The formed products are baked at a temperature of 220–225 °C for 10–12 minutes. The moisture content of the shortbread is 5.0±0.2%.

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11 Medvedeva A. O., Antonyuk I. Yu. Technology of biscuits and muffins of increased nutritional and biological value. *Journal of Chemistry and Technologies*. 2023. V. P. 10.

12 Struk O., Grytsyk A., Mikitin M., Obodianskyi M., Stasiv T., Svirska S. Research of biologically active substances of hemp seeds, hemp seed oil and hemp pomace. *Science Rise: Pharmaceutical Science*. 2022. No. 5 (39). P. 46–54.

Stage V. Cooling and packaging. The shortbread semi-finished product is cooled to a temperature of 20±2°C on baking sheets. The cooled shortbread semi-finished product is packed in packs, boxes or bags made of heat-sealing paper, corrugated boxes, in accordance with current regulatory documentation, which ensure the tightness of the packaging and are allowed for use and contact with food products.

The influence of the meal composition on the physicochemical properties was determined in accordance with the requirements of DSTU 3781:2014 by the following indicators: moisture, alkalinity, wettability. The results of the study of the physicochemical indicators of flour confectionery shortbread products with shortbread are given in Table 4.

The studied physical and chemical indicators are within the regulatory limits of the State Standard of Ukraine.

The hydration capacity of gluten in the experimental samples is lower than in the control by 25%, which allows to reduce the baking time by 3 min, and the final humidity of the experimental shortbread product and the control is 5.0±0.2%

The wettability of the control sample is lower than the experimental sample. Thus, when baking a shortbread semi-finished product for 12 min at a temperature of 225°C, the wettability of the control is 160%, and of the experimental sample – 168%. The wettability of the experimental samples is higher than the control, which is explained by the content of dietary fiber in the meals and a smaller amount of starch in the recipe.

The studied chemical composition of the control and experimental samples (Table 5).

The results of the table indicate that MC increase the nutritional value of shortbread cookies for all studied components. According to the results of the conducted studies, it was found that when adding the MC composition, the protein content increased by 84.31%, and fiber by 188.33%. Among the mineral substances, the content of Potassium increased by 3 times, Calcium by 8 times,

Table 4

Physico-chemical indicators of baked shortcrust pastry, n=5, p≤0.05

Baked shortcrust pastry semi-finished product	Humidity, %	Alkalinity, degrees	Wettability, %
DSTU requirements	2.0–8.5	2.0	150
3781:2014	5.0±0.2	1.2±0.06	160±5
Control sample	5.0±0.2	1.2±0.06	168±4
Research sample*	5.0±0.2	1.2±0.06	168±4

Note: – baked shortcrust pastry with 20% MC.*

Table 5

Analysis of the chemical composition of sand products with meal (per 100 g) n=5, p≤0.05

Nutrient Name	Shortbread cookies (control)	Shortbread cookies with 20% MC
Protein, g	5.1±0.2	9.4±0.30
Fat, g	18.50±0.5	19.10±0.5
Carbohydrates, g	68.90±0.5	65.70±0.5
Fiber, g	1.80±0.09	5.19±0.20
Water, g	5.0±0.2	5.0±0.2
Energy Value, kcal	451±10	446.4±10
Macroelements, mg		
Potassium	58.0±0.4	179.43±0.50
Calcium	14.0±0.2	112.67±0.40
Magnesium	12.0±0.2	68.90±0.50
Sodium	10.0±0.1	15.25±0.20
Phosphorus	50.0±0.4	166.85±0.40
Iron	0.8±0.04	4.76±0.20

Magnesium by 5 times, Phosphorus by 3 times, Iron by 5 times, and the ratio Mg:Ca:P approaches the recommended one and is 0.58:1:1.52.

The studied amino acid composition of shortbread products (Table 6).

According to the obtained data, the limiting amino acid in the sample from CS is Lysine, but the amino acid ratio is higher, and the total content of amino acids in the developed products is higher.

Table 6

Amino acid composition of sand semi-finished product from CS, mg per 100 g, n=5, p≤0.05

Name of the indicator	Recommended by FAO/WHO, mg/100 g	Shortbread cookies (control)	Shortbread cookies with MC,%	AA scor., %
Essential AA, mg				
Valine	5000	352±2	535.87±2	10.72
Isoleucine	4000	310±2	463.56±2	11.59
Leucine	7000	584±3	820.45±2	11.72
Lysine	5500	246±2	358.27±2	6.51
Methionine	3500	212±2	275.29±2	7.87
Threonine	4000	271±2	290.60±2	7.27
Tryptophan	1000	85±0.5	281.90±2	28.19
Phenylalanine	6000	490±2	496.68±3	8.28
Total essential amino acids, mg		2550±4	3522±3	–

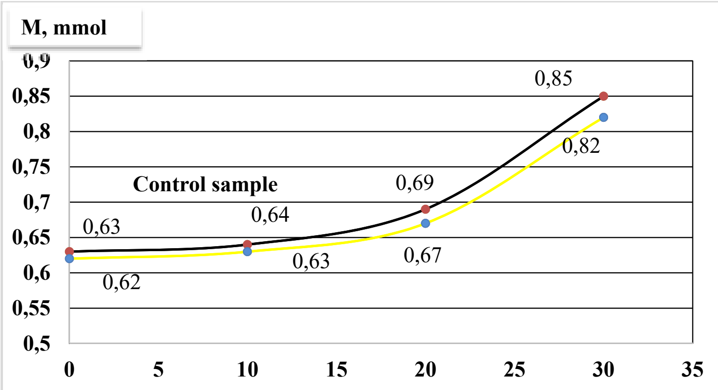

Fig. 3. Peroxide value indicators of sand product samples during storage

One of the important indicators of the consumer value of confectionery products is their shelf life. The microbiological indicators of finished products were studied during storage for 30 days in sealed cardboard packaging at a relative humidity of not more than 75% (Table 7).

As shown by the obtained data, the microbiological indicators of the products do not exceed the norm of DSTU 3781:2014.

Table 7

Microbiological indicators

Indicator name	Cookie		Control method
	sugar glaze	sugar, shortbread, glazed pastries of all kinds	
Mesophilic aerobic and facultative anaerobic microorganisms, CFU in 1 g, not more than	$5 \cdot 10^3$	$1 \cdot 10^4$	According to GOST 10444.15
Product weight (g), in which it is not permissible: – bacteria of the Escherichia coli group (coliforms); – pathogenic microorganisms, in particular bacteria of the genus Salmonella	 0.1 25	 0.1 25	According to GOST 10444.15
Mold fungi, CFU in 1 g not more than	–	100	According to GOST 10444.12
Yeast, CFU in 1 g. not more than	–	50	According to GOST 10444.12

Shortcrust pastry is characterized by a high fat content, so it was important to determine the degree of its oxidation during storage.

As shown by the studies of the peroxide value of fat immediately after preparation of the experimental sample was 0.62±0.03 Mmol/100 g of active oxygen, the control sample was 0.63±0.03 Mmol/100 g of active oxygen. After 30 days of storage, these indicators were respectively: 0.8±0.03 Mmol/100 g of active oxygen, respectively, in the traditional product 0.85±0.03 Mmol/100 g of active oxygen.

At the next stage, the microbiological safety indicators of sand products were studied. During storage, the presence of Escherichia coli bacteria, pathogenic microorganisms and mold was not detected (table). The content of toxic elements did not exceed the maximum permissible concentrations provided for by San PiN 42-123-4089 (Table 7).

The content of toxic elements in cookies should not exceed the maximum permissible concentrations provided for by the Ministry of Health and SN No. 5061 and indicated in Table 8.

Table 8

Toxic element content

Toxic element name	Maximum permissible levels, mg/kg. not more than	Control methods
Lead	0.5	According to GOST 26932
Cadmium	0.1	According to GOST 26933
Arsenic	0.3	According to GOST 26930
Mercury	0.02	According to GOST 26927

CONCLUSIONS

Based on the conducted research, a concept for a comprehensive solution to the problem was developed – the creation of flour confectionery products using new types of processed products of plant origin, which are characterized by a high content of biologically active substances and the use of which will allow to increase the nutritional and biological value, to provide certain therapeutic and prophylactic properties to the developed food products. A methodology for optimizing flour confectionery recipes was proposed and implemented, taking into account modern provisions of nutrition. A justified choice of plant additives, including oilseed meal and hemp flour, was made, and regulated levels of their content in flour confectionery products made of shortcrust pastry were determined.

Theoretical and experimental studies determined their functional and technological properties. The effectiveness of their use in compositions was proven in order to maximize the degree of use of biologically active substances, improve the organoleptic and rheological characteristics of products. The possibility of regulating the functional and technological properties of oilseed meal and hemp flour and predicting the quality of flour confectionery products with their use has been proven. Using mathematical optimization methods, technologies and recipes have been scientifically substantiated and developed, and their comprehensive quality assessment has been carried out.

SUMMARY

Improving the structure of nutrition of the population of Ukraine involves increasing the production of food products, thanks to the improvement of existing ones and the creation of new technologies. Real food products are unbalanced in their chemical composition and do not contain essential nutrients in the required quantities and ratios. The search for natural food substances of plant origin that are able to increase the resistance of the human body to the negative impact of the environment due to antioxidant, antitoxic activity is relevant.

This study focuses on establishing the scientific and methodological framework for formulating food products with balanced chemical profiles by incorporating biologically active plant raw materials. Advancing waste-free, comprehensive processing of valuable plant resources stands as an urgent task for the industry. These processing by-products retain a high concentration of biologically active compounds in their native proportions, ensuring optimal bioavailability and assimilation by the human body.

The use of oilseed meals allows you to enrich the chemical composition of flour confectionery products with protein, lipids, dietary fiber, vitamins and minerals, they have pronounced sorption, antioxidant, detoxifying, complex-forming properties

Bibliography

1. Rusu I. E., Marc R. A., Mureşan C. C. Hemp (Cannabis sativa L.) flour-based wheat bread as fortified bakery product. *Plants*, 2021. No. 10(8), p. 155.
2. Sheludko V. M., Kholobtseva I. P. Legumes in the technology of flour confectionery products. Improving the technology of butter cookies enriched with calcium by using protein-mineral additives. *Eastern-European Journal of Enterprise Technologies*, 2021. No. 4(11(112), p. 42–49.
3. Švec I. The Mixolab parameters of composite wheat/hemp flour and their relation to quality features. *LWT – Food Science and Technology*. 2015. Vol. 60 (1), p. 623–629.

4. Mihoc M. Nutritive quality of romanian hemp varieties (Cannabis sativa L.) with special focus on oil and metal contents of seeds. *Chemistry Central Journal*. 2012. Vol. 6, p. 1–12.

5. Lan Y. et al. Genotype x environmental effects on yielding ability and seed chemical composition of industrial hemp (Cannabis sativa L.) varieties grown in North 90 Dakota, USA. *Journal of the American Oil Chemists' Society*. 2019. Vol. 96. No. 12, p. 1417–1425.

6. Radočaj O., Dimić E., Tsao R. Effects of hemp (Cannabis sativa L.) seed oil press-cake and decaffeinated green tea leaves (Camellia sinensis) on functional characteristics of gluten-free crackers. *Journal of Food Science*, 2014. No. 79, p. 318–325.

7. Blazhenko M., Falendysh N., Shpak V. Effect of hemp seed by-products on wheat dough fermentation. *Ukrainian Food Journal*. 2024. Volume 13. Issue 4. P. 737.

8. Marchenko Zh. Yu., Primakov O. A. Hemp farming in Ukraine – a modern stage of development and opportunities. Bast and industrial crops. *Euphytic, International Journal of Plant Breeding*. 2020. Volume 140, p. 65–72.

9. Crimaldi M., Faugno S., Sannino M., Ardito L. Optimization of Hemp Seeds (Canapa Sativa L.) Oil Mechanical Extraction. *Chemical engineering transactions*. 2017. Vol. 58, p. 373–378.

10. Dorokhovych V. V. Determination of the influence of sunflower seed meal on the structural parameters of dough and physicochemical parameters of shortbread cookies. *Scientific works of the National Institute of Chemistry and Food Technology*. 2021.Volume 27. No. 1. P. 160–167.

11. Medvedeva A. O., Antonyuk I. Yu. Technology of biscuits and muffins of increased nutritional and biological value. *Journal of Chemistry and Technologies*. 2023. V. P. 10.

12. Struk O., Grytsyk A., Mikitin M., Obodianskyi M., Stasiv T., Svirska S. Research of biologically active substances of hemp seeds, hemp seed oil and hemp pomace. *Science Rise: Pharmaceutical Science*. 2022. No. 5 (39). P. 46–54.

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