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NUTRIENT RESEARCH OF CHOPPED SEMI-FINISHED PRODUCTS ENRICHED WITH A PROTEIN-CARBOHYDRATE COMPOSITION

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The difficulty in solving a multicomponent formulation problem is that five or more ingredients are currently used in product design. Solving a system of linear equations and inequalities with such a large number of variables manually presents significant difficulties, in which formulation errors are not excluded. In the work the methodology of computer modelling of multicomponent meat products is presented, which is realized on an example of technology of minced meat production. The aim of the research is to design the mathematical model of minced meat with the addition of new protein-carbohydrate compositions (PCC). The objects of research are minced meat, PCC, which includes chickpea flour, whey protein concentrate, ground soy and water for hydration. Implementation of the design method was carried out with the software system Microsoft Excel with the "Solution Finder" add-on. Work with the Excel spreadsheet processor is based on entering the data required for calculation, calculation formulas into the corresponding cells of the spreadsheet. The article presents the results of the study of the nutrient composition of minced meat with the addition of the new PCC. By means of mathematical modelling, the formulation of minced meat with PCC was optimized. Nutritional and energy value, vitamin, mineral and amino acid content of the obtained minced meat were determined. A targeted combination of ingredients made it possible to obtain food products with a given composition and properties.

Keywords: minced meat semi-finished product, minced meat, nutrient composition, system analysis, recipe optimization, mathematical model, protein-carbohydrate compositions, multicomponent meat products.

БАЙЫТЫЛҒАН ТАРТЫЛҒАН ЖАРТЫЛАЙ ФАБРИКАТТАРДЫҢ АҚУЫЗ-КӨМІРСУЛЫ ҚҰРАМЫНЫҢ ЖҮЙЕЛІ ТАЛДАУЫ

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Жаңа тағам өнімдерінің көпкомпонентті рецептісін табудың қиындығы оларды әзірлеуде бес ингредиенттен астам пайдаланылуы болып табылады. Бұл жағдайда рецепт бойынша қолмен есептеулерде елеулі қателердің болмай қалу ықтималдығы жоғары. Эксперименттерде тартылған еттің жаңа түрін әзірлеу рецептін қолдану үшін ет өнімдерінің көптеген компонентерін компьютерлік болжау нәтижелері берілген. Зерттеудің мақсаты – жаңа ақуыз-көмірсулар құрамы (АКҚ) қосу арқылы тартылған еттің математикалық моделін құрастыру. Зерттеу объектілері – тартылған ет, , оның құрамына ноқат ұны, АКҚ, сарысу протеинінің концентраты, тартылған соя окарасы және ылғалдандыруға арналған су кіреді. Жобалау әдісін жүзеге асыру Microsoft Excel- бағдарлама жүйесіндегі «Шешімді іздеу» қосымшасы арқылы жүзеге асырылды. Электрондық кестелік процессормен жұмыс істеу Excel электрондық кестенің сәйкес ұяшықтарына есептеуге қажетті мәліметтерді, есептеу формулаларын енгізуге негізделген. Мақалада жаңа АКҚ қосылған тартылған еттің зерттеу нәтижелері берілген. Математикалық модельдеу көмегімен АКҚ қосылған тартылған ет рецепті оңтайландырылды. Алынған тартылған еттің тағамдық және энергетикалық құндылығы, витаминдік, минералдық және аминқышқылдық көрсеткіші

анықталды. Ингредиенттердің мақсатты комбинациясы берілген құрамы мен қасиеттері бар тағам өнімдерін алуға мүмкіндік берді.

Негізгі сөздер: туралған ет жартылай фабрикаттары, тартылған ет, қоректік құрам, жүйелік талдау, рецептті оңтайландыру, математикалық модель, ақуызды-көмірсутекті құрамдар, көп компонентті ет өнімдері.

ИССЛЕДОВАНИЕ НУТРИЕНТНОГО СОСТАВА ОБОГАЩЕННОГО БЕЛКОВО-УГЛЕВОДНОЙ КОМПОЗИЦИЕЙ РУБЛЕНОГО ПОЛУФАБРИКАТА

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Трудность нахождения многокомпонентной рецептуры новых пищевых продуктов состоит в том, что при их разработке используется более пяти ингредиентов. При этом возникает большая вероятность неизбежности существенных ошибок в расчетах рецептуры ручным способом. В данном исследовании показаны результаты компьютерного прогнозирования многокомпонентных мясных продуктов на примере разработки рецептуры нового вида мясного фарша. Цель исследования – проектирование математической модели мясного фарша с добавлением новых белково-углеводных композиций (БУК). Объектами исследования являются мясной фарш, БУК, в состав которой входят мука нутовая, концентрат сывороточного белка, окара соевый фарш и вода для гидратации. Осуществление способа проектирования исполнялось программным обеспечением Microsoft Excel, вместе с надстройкой «Поиск решения». Основной базой для работы с данным процессором является введение необходимых для вычисления данных, а также формул для расчётов в соответствующие ячейки электронной таблицы. В статье приведены результаты исследования нутриентного состава мясного фарша с добавлением новой БУК. При помощи математического моделирования была оптимизирована рецептура мясного фарша с БУК. Были определены пищевая и энергетическая ценность, витаминный, минеральный и аминокислотный скор полученного мясного фарша. Целевое комбинирование ингредиентов позволило получить пищевые продукты с заданным составом и свойствами

Ключевые слова: рубленый мясной полуфабрикат, мясной фарш, нутриентный состав, системный анализ, оптимизация рецептуры, математическая модель, белково-углеводные композиции, многокомпонентные мясные продукты.

Introduction

According to nutrition scientists, the solution to the issue of food balance can be achieved due to their multicomponence. The design of multicomponent products is dictated by the possibility of regulating the chemical composition of products in accordance with modern requirements of the nutrition science. The main requirement is that the simulated multicomponent food products should be characterized as close as possible to the reference (scientifically based physiological norms) nutrient composition [1- 3].

The development of criteria for assessing the balance of food products has led to the development of a whole set of mathematical dependencies reflecting individual qualitative assessments of the multicomponent food balance [4].

The theory of a balanced diet states that food, i.e. the human diet itself, should contain a certain amount of nutrients corresponding to the daily norm for a given age group [5]. A food product is considered unbalanced if the amount of nutrients exceeds or falls short of the acceptable norm. Accordingly, this dependence of the human body on the amount of nutrients helps to assess the nutritional and biological value of the food being modeled [6].

The development of new technologies for meat semi-finished products will expand the range and increase the production of these products. Researchers in this field face the task of industrial production of semi-finished meat products and supplying them to public catering enterprises. The widespread use of meat semi-finished products of increased nutritional and biological value in pub-

lic catering enterprises will ensure the physiological nutrition standards of individual population groups. The use of meat semi-finished products of industrial production will also ensure high levels of sanitation, hygiene and food safety.

Various types of animal meat such as beef, horse meat, lamb, and pork are used for the preparation of semi-finished products [7,8].

Currently, various fillers are used to enrich meat semi-finished products. One of the most popular and effective fillers now are protein-carbohydrate compositions.

When incorporating fillers into the recipe composition of minced meat semi-finished products, it's essential to opt for those with minimal added ingredients. The inclusion of numerous ingredients diminishes the shelf life and marketability of semi-finished products, rendering them less appealing to consumers. Hence, minced meat was selected as the subject of this study.

Vegetable-origin proteins and carbohydrates can be used as ingredients to produce protein-carbohydrate compositions. Additionally, combinations of vegetable proteins and carbohydrates with those of animal origin can be utilized to create compositions with mixed ingredients [9].

Food products containing vegetable raw materials in the composition are rapidly gaining momentum among consumers, companies, and investors. At the same time, leguminous crops have become widespread, which encourages food companies to create meat analog products that include legumes as the main substitute for meat protein. Although many factors determine the popularity of plant-based foods, one of the main factors is their environmentally sustainable production. Many consumers are unaware of the environmental sustainability of legume-based meat alternatives compared to meat-based analogues. Economically safe sustainability in the entire food chain can be explained by the fact that the transition from meat products to legumes dramatically reduces the need for land and water use, as well as carbon sediment that occurs in the food production process. Replacing meat raw materials with at least one vegetable component begins to have an impact on the environment. As this impact increases, products based on legume meat analogues can play an important role in reducing carbon emissions and slowing global warming and can also help preserve the health of the planet for future generations [10].

Thus, the main purpose of the study is to design a mathematical model of minced meat with the addition of a new protein-carbohydrate composition of a combined composition, to enrich and reduce the cost of minced meat semi-finished product.

To achieve this goal, the following tasks were set:

- with the help of digital technologies to carry out a systematic analysis of the balance of the nutrient composition of the chopped semi-finished product, namely, to optimize the recipe of minced meat with beech, to investigate its chemical, vitamin, mineral, and amino acid composition.

Materials and research methods

The multicomponent minced meat was chosen as the object of research.

As a control sample, we took chilled minced meat in accordance with the state system of technical regulation of the Republic of Kazakhstan GOST 52675-2009, category B, during the production of which the recipe provides for a mass percentage of protein of at least 12.5%, a mass percentage of fat of no more than 27.0%.

During the research work, part of the meat raw materials was replaced with a new protein-carbohydrate composition, which includes chickpea flour, whey protein concentrate, ground soy and water for hydration.

The mass fraction of moisture was determined according to state standard GOST 9793; total protein – by the Kjeldahl method (GOST 25011); fat - refractometrically (according to GOST 23042). The amino acid composition was determined by capillary electrophoresis. The mineral composition was determined by atomic absorption method. The vitamin composition was determined using high-performance liquid chromatography (HPLC).

The recipe of the new minced meat was optimized by the simplex method. The system-analytical method of research was applied. To assess the level of balance of multicomponent foods, it is proposed to use six dimensionless partial indices:

1. PCBI –Prescription composition Balance Index (Ip);
2. VCBI – Vitamin composition Balance Index (Iv);
3. MCBI – Mineral Composition Balance Index (Im);
4. AACBI – Amino Acid Composition Balance Index (Ia);
5. EVBI – Energy Value Balance Index (Ie).

These indices make it possible to comprehensively assess the level of balance at each stage of food design.

The ideal balance of the product will be achieved when the partial balance indices are equal to one, i.e. Ip = 1, Iv =1, Im = 1, Ia = 1, Ie =1.

Literature review

Enriched products are products that look like traditional food, but in which certain ingredients have been added or replaced by using various techniques that have a positive effect on the body as a whole or on its individual functions. The main component of enriched products, according to the definition, is functional ingredients due to which the product shows useful, health-promoting benefits [11].

For fortified meat products the most suitable ingredients are: minerals, dietary fiber, vitamins, and polyunsaturated fatty acids [12].

For the supplementing of the nutrient deficiency the most promising direction in the production of enriched food products is the use of vegetable raw materials and products of their processing. Herbal supplements are rich in a wide range of biologically active substances such as minerals, vitamins, amino acids, dietary fiber, polyunsaturated fatty acids, and also contain various phytocomponents [13].

The researchers also suggest using unconventional vegetable raw materials in the production of semichopped products such as pumpkin, zucchini, sunchokes, raisins, sea kale, spent grains, milk thistle meal, rhubarb, soy milk, soy cheese (tofu) and protein-carbohydrate product (okara) etc. [14].

This is of great concern, considering that in 2015, the International Agency for Research on Cancer (IARC) classified processed meats as a Group-1 carcinogen for human colorectal cancer, and red meat was classified as probably carcinogenic to humans (Group 2A) based on a comprehensive review of epidemiologic evidence, combined with "strong mechanistic evidence supporting a carcinogenic effect" [15]. Based on this, the IARC has recommended reducing the consumption of red and processed meats for cancer prevention.

Therefore, considering the above-mentioned issues, in this short review, we aim to evaluate the use of meat extenders as substitutes of animal proteins and assess their impact on the technological properties of meat products, considering the most recently available findings on the topic. Overall, we first described the up-to-date sustainability-related issues related to meat products, then assessing the potential of different more conventional and emerging extenders potentially available for meat industry.

Results and discussion.

At the first stage of design, an information database of the ingredient composition for the production of a control sample of minced meat is formed in the Excel spreadsheet processor (Fig. 1). Also, Figure 1 shows summary data of the recipe composition of minced meat (control sample), with calculated values of the cost of 100 kg of product, partial indices of the balance of the recipe composition and energy value.

Ingredients	Xi	Recipe, kg	Mass fraction,%				Price, tg/kg	The content of components in the recipe, kg				EV, kcal
			fat	protein	carbohydrates	water		fat	protein	carbohydrates	water	
cutlet beef meat with the content of connective and adipose tissue 15%	X_1	54,0	16,00	20,00	0,00	69,20	2500,0	8,64	10,80	0,00	37,37	120,96
Cutlet pork meat with a mass fraction of adipose tissue 30%	X_3	10,0	33,30	14,30	0,00	52,00	1500,0	3,33	4,76	0,00	0,00	49,95
wheat bread	X_5	12,0	4,53	10,67	47,54	35,25	290,0					
Breadcrumbs	X_6	2,0	5,30	13,35	71,98	6,51	550,0	0,11	0,27	1,44	0,13	7,42
fresh onion	X_7	3,0	0,20	1,10	9,30	89,11	200,0	0,01	0,03	0,28	2,67	1,23
Drinking water	X_8	18,0	0	0	0	100	200,0	0,00	0,00	0,00	18,00	0,00
Ground allspice	X_9	0,1	8,7	6	72,1	8,46	1390,0	0,01	0,01	0,07	0,01	0,37
Food salt	X_{10}	0,9	0	0	0	0,2	100,0	0,00	0,00	0,00	0,00	0,00
Total, kg		100,00										
Composition of the product,%			12,6	13,8	7,5	67,6		12,1	15,9	1,8	58,2	
goal function							159009,00				Energy value, kcal	179,94
Balance Equations			12,6	13,8	7,5	67,6					Energy value, kJ	753,39
Daily rate, g			98,0	84,0	432,0							2500,00
Compliance, %			12,9	16,4	1,7							7,20
Compliance with the norm, shares			0,129	0,164	0,017							0,0720
PCBI - Ir			0,072									0,072

Figure 1 – Summary data of the recipe composition of minced meat (control sample), with calculated values of the 100 kg product cost, recipe composition and energy value balance indexes

Studies have shown (Fig. 1) that the cost of 100 kilograms of minced meat, which includes beef, lamb, chicken and beef fat, is 159009,00 tenge.

Figure 2 shows a summary data of the recipe for multicomponent minced meat with a protein-carbohydrate vegetable composition.

As a result, we received a recipe for minced meat, the cost of which was 138569,00 tenge per 100 kg, which is significantly lower than the cost of the control sample (159009,00 tenge per 100 kg), where, in turn, the level of balance of the compounding composition of composite minced meat increased significantly due to changes in its private indexes.

Ингредиенты	Xi	Recipe, kg	Mass fraction,%				Цена, тг./кг	The content of components in the recipe, kg				EV, kcal
			fat	protein	carbohydrates	water		fat	protein	carbohydrates	water	
Cutlet beef meat with the content of connective and adipose tissue 15%	X_1	41,0	16,00	20,00	0,00	69,20	2500,0	6,56	8,20	0,00	28,37	91,84
Minced chicken	X_4	10,0	18,00	18,00	0,00	63,00	1250,0	1,80	1,80	0,00	6,30	23,40
Wheat bread	X_5	0,0	4,53	10,67	47,54	35,25	290,0					
Breadcrumbs	X_6	2,0	5,30	13,35	71,98	6,51	550,0	0,11	0,27	1,44	0,13	7,42
Fresh onion	X_7	3,0	0,20	1,10	9,30	89,11	200,0	0,01	0,03	0,28	2,67	1,23
Drinking water	X_8	18,0	0	0	0	100	200,0	0,00	0,00	0,00	18,00	0,00
Ground allspice	X_9	0,1	8,7	6	72,1	8,46	1390,0	0,01	0,01	0,07	0,01	0,37
Food salt	X_{10}	0,9	0	0	0	0,2	100,0	0,00	0,00	0,00	0,00	0,00
PCC including: chickpea flour	X_{11}	6,0	4,10	28,40	12,10	53,20	500,0	0,25	1,70	0,73	3,19	11,75
okara soy mince	X_{12}	4,00	4,5	7,6	1,7	82	845,0	0,18	0,30	0,068	3,28	3,09
whey protein concentrate	X_{13}	5,00	6,3	80,0	4	5	1932,0	0,32	4,00	0,200	0,250	19,59
water	X_{14}	10,00	0	0	0	100	200,0	0,00	0,00	0	10,000	0
Total, kg		100,00										
Composition of the product,%			9,2	16,3	2,8	72,2		9,2	16,3	2,8	72,2	
goal function							138569,00				Energy value, kcal	158,69
Balance Equations			9,2	16,3	2,8	72,2					Energy value, kJ	664,45
Daily rate, g			98,0	84,0	432,0							2500,00
Compliance, %			9,4	19,4	0,6							6,35
Compliance with the norm, shares			0,094	0,194	0,006							0,0635
PCBI - Ir			0,049									0,063

Figure 2 – Summary data of the recipe composition of minced meat with PCC, with calculated values of the 100 kg product cost, recipe composition and energy value balance indexes

Figure 2 shows that the energy partial balance index of minced meat with PCC 0.063, which is a caloric value equal to 158,69 kcal, compared with the control sample of 179, 94.

The vitamin composition partial balance index of minced meat with PCC, VCBI = 1,524, increased by 0.25 compared to the control sample (1,277). Table 1 presents the research results of the vitamin composition in multicomponent minced meat.

Table 1 – Vitamin composition of minced meat.

Name of minced meat	Vitamins, mg/per 100 g of product						
	A	E	B_6	B_1	PP	B_5	B_2
Control sample	0,12	0,91	29,85	15,74	29,31	9,70	13,60
Test sample	0,33	1,51	25,87	10,83	21,81	13,29	17,09

According to the results of the study, it can be seen that the product contains vitamins necessary for the normal functioning of the human body, among which vitamin A can be distinguished, the content of which has doubled (0,33%), compared with the control sample (0,12%). The content of vitamins B_5 and B_2 increased by 3,5% as well.

The mineral composition partial balance index is equal ISMS = 0,098, when in the control sample it is equal to 0,090. Figures 3 and 4 show the mineral score of the control and test samples.

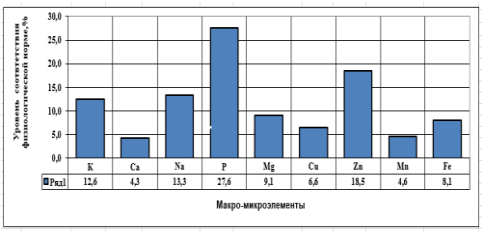

Figure 3 – Mineral composition of minced meat with PCC

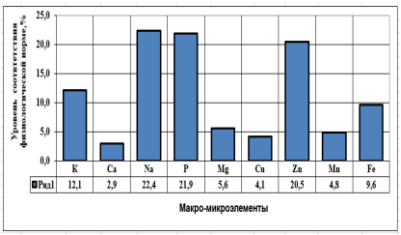

Figure 4 – Mineral composition of the control sample

From the data of the above diagrams, the mineral composition of the resulting minced meat with PCC was determined. Among the macronutrients, magnesium can be observed, the content of which increased by 3,5 % (9,1 mg), compared with the control sample (5.6 mg). The content of potassium (12,6%) and calcium (4,3%) has significantly increased. Among the microelements, cuprum can be distinguished, the content of which increased by 2,5% (6,6 mg), compared with the control sample (4,1 mg).

The amino acid score of multicomponent minced meat with PCC is calculated. The partial balance index of the amino acid composition is equal to AACBI = 1,145, which is lower than the value of the control sample (1,18). Figures 5 and 6 show graphic illustrations of the amino acid score of minced meat.

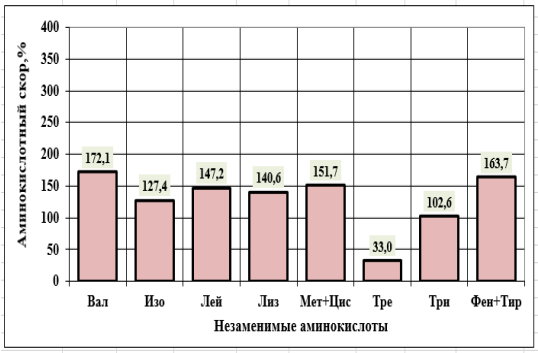

Figure 5 – The amino acid score of the control sample when calculating the formulation at the minimum cost of the product.

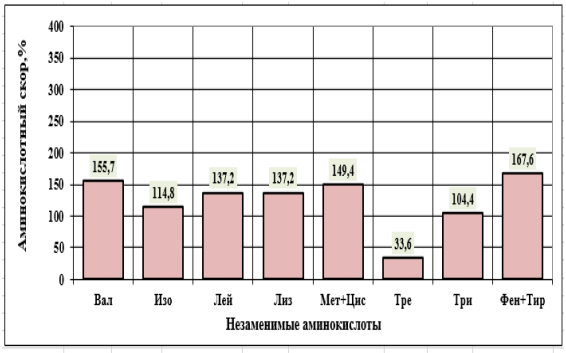

Figure 6 – Amino acid score of minced meat with PCC when calculating the recipe at the minimum cost of the product.

According to the results of the amino acid score research in minced meat with PCC, it can be concluded that the percentage of limiting acid threonine increases and is equal to 33,6, in comparison with threonine (33,0) of the control sample.

A comparative assessment of the compounding composition balance level of the composite minced meat with the control sample is given in Table 2.

Table 2 – Comparative assessment of the compounding composition balance level of multicomponent minced meat.

Ingredients	Index, X_I	Formulations, kg (excluding losses) and values of indicators	
		A control sample of minced meat at the minimum cost of the product	Minced meat with PCC at the minimum cost of the product.
Cutlet beef meat	**X_1**	54,0	41
Cutlet pork meat	**X_2**	10	-
Minced chicken	**X_3**	-	10
Wheat bread	**X_4**	12	-
Breadcrumbs	**X_5**	2	2
Fresh onion	**X_6**	3	3
Drinking water	**X_7**	18	18
Ground allspice	**X_8**	0,1	0,1
Food salt	**X_9**	0,9	0,9
PCC inc: chickpea flour	**X_{10}**	-	6
Okara soy mince	**X_{11}**	-	4
Whey protein concentrate	**X_{12}**	-	5
Water for hydration	**X_{13}**	-	10
Mass fraction, %			
Fat		12,6	9,2
Protein		13,8	16,3
Carbohydrate		2,8	2,8
Water		72,2	72,2
PCBI - Ir		**0,072**	**0,049**
Energy value, kJ		753,39	664,45
EVBI		**0,072**	**0,063**
The cost per 100 kg, tg.		159009,00	138569,00
VCBI – Iv		**1,277**	**1,524**
MCBI – Im		**0,090**	**0,098**
AACBI – Ia		**1,18**	**1,14**
the Harrington criteria		**0,234**	**0,330**

Conclusion.

The use of modern digital technologies makes it possible to solve complex technological problems in the design of multicomponent meat products efficiently and while at the same time accurately managing the design process.

The use of the Harrington criteria made it possible to make an integral assessment of the balance of the projected minced meat with PCC and to carry out a comparative assessment of the nutritional and energy value with the control sample.

According to the results of the research, it is clear that the recipe for minced meat with PCC is optimal, since the percentage of fat (9,2% - no more than 27.0%) and protein (16,3% - no less than 12.5) in the product is not lower than the indicators given in the state system of technical regulation of the Republic of Kazakhstan GOST 52675-2009.

The conducted studies indicate an increase in the balance level of the formulation composition of the resulting multicomponent minced meat with the new PCC. Specifically, the Vitamin Composition Balance Index increased from 1.277 to 1.524, the Mineral Composition Balance Index increased from 0.090 to 0.098, and the Amino Acid Composition Balance Index decreased from 1.18 to 1.14. Comparable redundancy indicator in the resulting minced meat with PCC is equal to 61.30, which shows a significant decrease compared to the control sample, where CRI = 66,72. This has a positive effect on the quality of minced meat with PCC, since the ideal value of the CRI is close to the reference value $\sigma = 0$. The generalized Harrington criteria shows a significant increase from 0.234 to 0.330, while reducing the cost of multicomponent minced meat with PCC by 12%.

Computer information systems can be used to conduct an economic analysis of production processes, perform a comparative assessment of the balance of products developed and used at the enterprise, and suggest ways to reduce production costs without compromising quality and increase profits. It is important to note that no capital expenditures are required for production in this case.

Thus, the resulting multicomponent minced meat is a product with high nutritional and biological value, at a reduced cost, due to the replacement of part of the meat raw materials with filler.

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БИДАЙ ҚАМЫРЫНЫҢ ҚАСИЕТІНЕ ГРЕК ЖАҢҒАҒЫ ҚАБЫҒЫНАН АЛЫНҒАН СУЛЫ –ЭТАНОЛДЫ ЭКСТРАКТЫНЫҢ ӘСЕРІН ЗЕРТТЕУ

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Әлеуметтік маңызы бар тағам өнімін – нанды қажетті компоненттермен байыту – халықтың дұрыс тамақтануын түзетудің кеңінен қолданылатын және тиімді механизімі. Ғылыми зерттеу жаңғақ қабығынан алынған сулы –этанолды экстрактысын нан пісірі технологиясында қолдану мүмкіндігін, оның ұн мен бидай қамырның наубайханалық қасиеттеріне әсерін зерттеуге негізделген. Мақалада емдік – профилактикалық қасиеттерге ие, тағамдық құндылығы жоғары жаңғақ қабығынан алынған сулы – этанолды экстрактының химиялық, аминоқышқылдық құрамы көрсетілген, оның қауіпсіздігі және қамырдың технологиялық қасиеттерін жақсарту үшін қолданудың қажеттілігі айқындалған. Грек жаңғағы қабығынан алынған сулы –этанолды экстрактын әртүрлі мөлшерлерде енгізу кезіндегі, ашу үдерісін сипаттайтын негізгі параметрлері: қамырдың көтерілу динамикасы ұның және бидай қамырының газ түзу, газ ұстау қабілеттеріне әсері зерттелінді. Сулы-этанолды экстрактыны қамыр иленетін судың мөлшеріне 10,20,30 және 40% көлемінде алмастыра отырып қосу арқылы зерттеу тәжірибелері жүргізілді. Бидай қамырының бақылау және сынамалық үлгілерін салыстырмалы бағалау кезінде 20% сулы – этанолды экстракт қосылған сынақ үлгісі ең оңтайлы сипатамаларға ие болды. Бұл ретте газ түзу қабілеті 18 %, газ ұстау қабілеті 19 % өсіп, сонымен қатар қамырдың ашу ұзақтығы қысқарды. Мақалад ингредиенттердің құрамын таңдау, қамырдың наубайханалық қасиеттерін жақсарту үшін грек жаңғағы қабығынан алынған сулы –этанолды экстрактыны қолдану қажеттілігі ғылыми негізделді.

Негізгі сөздер: грек жаңғағының қабығы, сулы-этанолды экстракт, газтүзу қабілеті, қамрдың ашуы.

ИССЛЕДОВАНИЕ ВЛИЯНИЯ ВОДНО –ЭТАНОЛЬНОГО ЭКСТРАКТА ИЗ СКОРЛУПЫ ГРЕЦКОГО ОРЕХА НА СВОЙСТВА ПШЕНИЧНОГО ТЕСТА

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Обогащение социально значимого продукта питания - хлеба важными компонентами - широко используемый и эффективный механизм коррекции питания населения. В основу научных изысканий