

## **Enrichment of minced meat with the protein-carbohydrate compositions**

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**Abstract.** The functional properties of minced meat enriched with protein-carbohydrate compositions were evaluated. The optimal amount of adding buckwheat and chickpea flour to minced meat has been established in comparison with their nutritional value. Optimization of minced meat recipes has been carried out.

**Keywords:** enriched minced meat, buckwheat flour, chickpea flour, functional properties

The scientific basis for a modern food production strategy is the search for new sources of protein and vitamins. It is known that protein is a vital building material for the human body. Plant-based food protein sources have a high bioavailability due to their protein content, relatively good digestibility and nutritional value, and their low fat content. The currently existing new ideology in the field of protein consists in the production of combined meat products based on meat and vegetable protein raw materials obtained from various sources, subject to the mutual enrichment of their compositions, a combination of functional and technological properties, an increase in biological value, an improvement in the organoleptic characteristics of finished products, a decrease in its cost. Providing the population with high-quality food products in sufficient volume will help improve the nutritional structure of the population as a whole.

Studies of Kazakhstani and foreign authors have shown that it is promising to use processed products of grain and leguminous crops in the technology of combined meat products, which provide high nutritional and biological value, contribute to an increase in the flexibility of

recipes, a stable and uniform distribution of ingredients, and minimization of losses in the production process, which ultimately leads to a product of consistent quality. The introduction of raw materials of plant origin into minced meat can be considered as one of the ways to obtain high-quality meat products with controlled properties [1, 2].

The aim of the study is the possibility of enriching minced meat with protein-carbohydrate compositions (PCC) based on vegetable raw materials. To achieve this goal, the main functional properties of the combined minced meat were studied, formulations were optimized and developed, and a comparative assessment of the biological value of minced meat with PCC was carried out. To obtain PCC, chickpea and buckwheat flour was used as plant raw material, which was added to minced meat in an amount of 10% and 20% instead of the meat part. The functional properties were used to determine the chemical composition, the quantitative content of amino acids, vitamins and mineral components in comparison with the control. Functional indicators were determined by the system-analytical method of research in a Microsoft Excel spreadsheet processor with the "Search for a solution" add-in [3]. As a result of the studies carried out, it was found that when 10% PCC is added, there is an increase in protein, carbohydrates and other indicators of the functional orientation. The development of the minced meat recipe with the addition of chickpea and buckwheat flour was carried out by replacing a part of the minced meat in the Assorti minced recipe with protein-carbohydrate compositions, the production of which provides for a protein mass fraction of at least 12.5%, a fat mass fraction of no more than 27.0 %, in accordance with ST RK GOST R 52675-2009. A technological scheme for obtaining minced meat with the addition of PCC is presented. The objective of the study was also a comparative assessment of the biological value of the developed minced meat with a control sample.

The optimization of the control sample formulation is shown in figure 1.

№	A	B	C	D E F G				H	I J K L				M	N	
	Ингредиенты	X <sub>i</sub>	Рецептура, кг	Массовая доля, %				Цена, тг./кг	Содержание компонентов в рецептуре,				Цена, тг	ЭЦ, ккал	
			жира	белка	углеводов	воды		жира	белка	углеводов	воды				
1	говядина 2 категории	X <sub>1</sub>	45,0	9,80	20,00	0,00	70,20	2250,0	4,41	9,00	0,00	31,59	101250,00	75,69	
2	баранина	X <sub>2</sub>	20,0	9,60	19,80	0,00	70,60	1950,0	1,92	3,96	0,00	14,12	39000,00	33,12	
3	курица	X <sub>3</sub>	20,0	8,20	21,20	0,00	70,60	1250,0	1,64	4,24	0,00	14,12	25000,00	31,72	
4	жир говяжий	X <sub>4</sub>	15,0	99,60	0,00	0,00	0,40	2500,0	14,94	0,00	0,00	0,06	37500,00	134,46	
5	Итого		100,00												
6	Состав продукта, %			22,9	17,2	0,0	59,9		22,9	17,2	0,0	59,9	202750,00		
7	Функция цели							202750,00						Энергетическая ценность, ккал	274,99
8	Балансовые уравнения			22,9	17,2	0,0	59,9							Энергетическая ценность, кДж	1151,38
9	Норма для пожилых, г			40,0	50,0	20,0									2500,00
10	Соответствие норме, %			57,3	34,4	0,0									11,00
11	Соответствие норме, доли			0,573	0,344										0,1100
12	ИСПС -Up			0,582										ИСЭЦ -	0,110

Fig. 1 – Summary data of the recipe composition of the control sample of minced meat with the calculated values of the cost of 100 kg of the product, partial indices of the balance of the recipe composition and energy value

Figure 2 shows a data matrix for designing a recipe for a multicomponent minced meat with a protein-carbohydrate composition, in the production of which buckwheat flour was used. This matrix was introduced into an Excel spreadsheet processor, together with the necessary formulas and balance equations, to optimize the recipe for a semi-finished meat product with PCC and balance it in terms of mineral, vitamin, fatty acid and amino acid composition.

Ингредиенты	Рецептура, кг	Массовая доля, %				Цена, тг./кг	Содержание компонентов в рецептуре,				Цена, тг	ЭЦ, ккал
		жира	белка	углеводов	воды		жира	белка	углеводов	воды		
говядина 2 категории	X <sub>1</sub>	9,80	20,00	0,00	69,20	2250,0	0,00	0,00	0,00	0,00	0,00	0,00
баранина 2 категории	X <sub>2</sub>	9,60	19,80	0,00	69,70	1950,0	0,00	0,00	0,00	0,00	0,00	0,00
курица	X <sub>3</sub>	8,20	21,20	0,00	69,70	1250,0	0,00	0,00	0,00	0,00	0,00	0,00
жир говяжий	X <sub>4</sub>	99,60	0,00	0,00	0,30	2500,0	0,00	0,00	0,00	0,00	0,00	0,00
БУК в том числе: мука гречневая	X <sub>5</sub>	1,20	13,60	71,90	9,00	500,0	0,00	0,00	0,00	0,00	0,00	0,00
порошок клубней топинамбура	X <sub>6</sub>	0,01	7,9	79,52	5,55	845,0	0,00	0,00	0	0	0,00	0
плазма крови	X <sub>7</sub>	0,1	84,0	0	8	1932,0	0,00	0,00	0,000	0,000	0,00	0,0000
казеинат натрия	X <sub>8</sub>	1	86,0	2	6	3600,0	0,00	0,00	0	0,000	0,00	0
Вода	X <sub>9</sub>	0	0	0	100	200,0	0,00	0,00	0	0,000	0,00	0
Итого		0,00										
Состав продукта, %			0,0	0,0	0,0	0,0		0,0	0,0		0,0	
Функция цели						0,00					0,00	0,00
Балансовые уравнения			0,0	0,0	0,0	0,0					0,00	0,00
Норма для животных, г			40,0	50,0	20,0						2500,00	
Соответствие норме, %			0,0	0,0	0,0						0,00	0,00
Соответствие норме, долл			0,000	0,000	0,000						0,000	0,0000
НСРС -Ур			0,000								НСЭЦ	0,000

Fig. 2 – Data matrix for designing a recipe for semi-finished meat product with PCC

As can be seen from figure 4, the data matrix shows the ingredient composition of minced meat with the addition of a protein-carbohydrate composition. And also the chemical composition of each of the ingredients used and the price per kilogram of the corresponding type of raw material are presented.

Next, in the "Search for a solution" dialog box, we entered the optimization parameters of the objective function, variable cells and the necessary constraints in accordance with the recipe, as shown in figure 3.

Параметры поиска решения

Оптимизировать целевую функцию:  ↑

До:  Максимум  Минимум  Значения:

Изменяя ячейки переменных:  ↑

В соответствии с ограничениями:

- ↑
- ↑
- ↑
- ↑
- ↑
- ↑
- ↑
- ↑
- ↑
- ↑
- ↑

Сделать переменные без ограничений неотрицательными

Выберите метод решения:  Параметры

Метод решения

Для гладких нелинейных задач используйте поиск решения нелинейных задач методом ОПГ, для линейных задач - поиск решения линейных задач симплекс-методом, а для негладких задач - эволюционный поиск решения.

Fig. 3 Parameters of finding a solution when optimizing the recipe for semi-finished meat products with PCC

Figure 3 also shows the selection of the "Minimum" icon, which indicates the search for a solution to optimize the recipe with a minimum cost of 100 kg of product.

Thus, the options for minced meat recipes were optimized with the replacement of meat raw materials with PCC № 1, with the addition of buckwheat flour and PCC № 2, with the addition of chickpea flour in the amount of 10% and 20%.

The obtained results of the study are presented in tables 1-3.

Table – 1. Chemical composition of the test samples

Indicators	Samples				
	Control	Sample № 1 (PCC based on <b>buckwheat</b> flour 10%)	Sample № 2 (PCC based on <b>chickpea</b> flour 10%)	Sample № 3 (PCC based on <b>buckwheat</b> flour 20%)	Sample № 4 (PCC based on <b>chickpea</b> flour 20%)
Fat, %	22.9	17.3	17.5	16.5	16.6
Protein, %	17.2	18.2	18.6	17.5	18.2
Carbohydrates, %	0	4.2	3.1	5.3	4.3
Water, %	59.9	59.2	60.0	59.4	59.9

Table 1 shows that the largest amount of protein contains experimental sample № 2 (18.6%), with the addition of 10% protein-carbohydrate composition based on chickpea flour. With the addition of PCC based on buckwheat flour, sample № 1 shows a higher percentage of protein (18.2%). A further increase in the PCC content of minced meat leads to a decrease in the amount of protein. The highest percentage of carbohydrates (5.3%) shows sample № 3, with the addition of PCC based on buckwheat flour in the amount of 20%, where the protein content also exceeds the control sample.

Table – 2. Amino acid composition of the test samples.

Amino acid score, %	Samples				
	Control	Sample № 1 (PCC based on <b>buckwheat</b> flour 10%)	Sample № 2 (PCC based on <b>chickpea</b> flour 10%)	Sample № 3 (PCC based on <b>buckwheat</b> flour 20%)	Sample № 4 (PCC based on <b>chickpea</b> flour 20%)
Valine	159.4	160.3	157.0	150.7	143.9
Isoleucine	113.1	363.9	362.9	354.2	351.4
Leucine	118.1	120.4	119.0	111.2	109.0
Lysine	85.1	107.8	107.4	92.4	109.6
Methionine + Cystine	114.3	100.9	100.5	93.0	84.4
Threonine	52.3	211.4	209.8	198.5	212.2
Tryptophan	116.5	136.7	132.8	135.3	136.2
Phenylalanine + Tyrosine	139.8	139.3	138.3	126.3	124.7

Table 2 shows the amino acid rate of the control and test samples. As a result of the study, it can be seen that prototypes № 1-2 do not have limiting amino acids, when prototype № 3 contains two limiting amino acids (lysine - 92.4%, methionine + Cystine - 93%) and the amino acid rate of prototype № 4 contains one limiting amino acid (methionine + cystine - 84.4%).

Table – 3. Fatty acid composition of the test samples

Lipid composition,%	Samples				
	Control	Sample № 1 (PCC based on <b>buckwheat</b> flour 10%)	Sample № 2 (PCC based on <b>chickpea</b> flour 10%)	Sample № 3 (PCC based on <b>buckwheat</b> flour 20%)	Sample № 4 (PCC based on <b>chickpea</b> flour 20%)
Saturated fatty acids	11.98	8.66	8.66	8.46	8.24
Monounsaturated fatty acids	8.91	6.75	6.77	6.43	6.40
Polyunsaturated fatty acids	0.97	0.97	1.03	0.82	1.03

Table 3 shows the decline in saturated and monounsaturated fatty acids with an increase in the percentage of protein-carbohydrate compositions № 1-4. While the content of polyunsaturated fatty acids increases with the addition of 10% PCC № 2, and with a further increase in the percentage of filler, the indicator remains stable (1.03%).

Table 4 shows variations in minced meat recipes with the addition of protein-carbohydrate compositions.

Table – 4. Optimization options for minced meat recipes and their cost.

Ingredients	Samples, kg/100				
	Control	Sample № 1 (PCC based on <b>buckwheat</b> flour 10%)	Sample № 2 (PCC based on <b>chickpea</b> flour 10%)	Sample № 3 (PCC based on <b>buckwheat</b> flour 20%)	Sample № 4 (PCC based on <b>chickpea</b> flour 20%)
beef of 2 category	45	30	30	30	20
lamb of 2 category	20	20	20	20	20
chicken	20	30	30	20	30
beef fat	15	10	10	10	10
PCC including: buckwheat flour	-	3	3	4	4
Jerusalem artichoke tubers powder	-	2.5	2	3	3

blood plasma	-	1	0.5	1	1
sodium caseinate	-	0.5	1	2	2
Water	-	3	3.5	10	10
Total, kg	100	100	100	100	100
Price, tg	202750.00	176944.50	177456.00	172167.00	162167.00

As a result of the study, it can be concluded that the most optimal formulations of minced meat with the addition of PCC are recipes № 1 and № 2. The use of a protein-carbohydrate composition based on buckwheat and chickpea flour in an amount of 10% improves the functional properties of minced meat, namely, to increase the amount of protein by 1-1.4%, carbohydrates by 4.2-3.1%.

When using PCC № 1 and № 2 in these percentages, the amino acid rate does not contain limiting amino acids. Minced meat is enriched with vitamins and minerals necessary for human life through the addition of buckwheat and chickpea flour as part of PCC.

Thus, the resulting minced meat can be considered products of increased nutritional and biological value, while reducing the cost by 12.5-12.7% in comparison with the control sample.

### References

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