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Protein-Carbohydrate Complexesin The Meat Products Technology.

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ABSTRACT

This article presents the technology of new formulations for cooked sausages with protein-carbohydrate complexes of plant origin applied. Herbal supplements used in the formulation of meat product make it possible to reduce its cost, at the same time preserving the nutritional properties and biological value of the finished product and increasing the amino acid content. The conducted analysis of the composition of the finished product has proved the feasibility of the filler used.

Keywords: meat product, cooked sausage, pumpkin protein-carbohydrate complex, technology, formulation.

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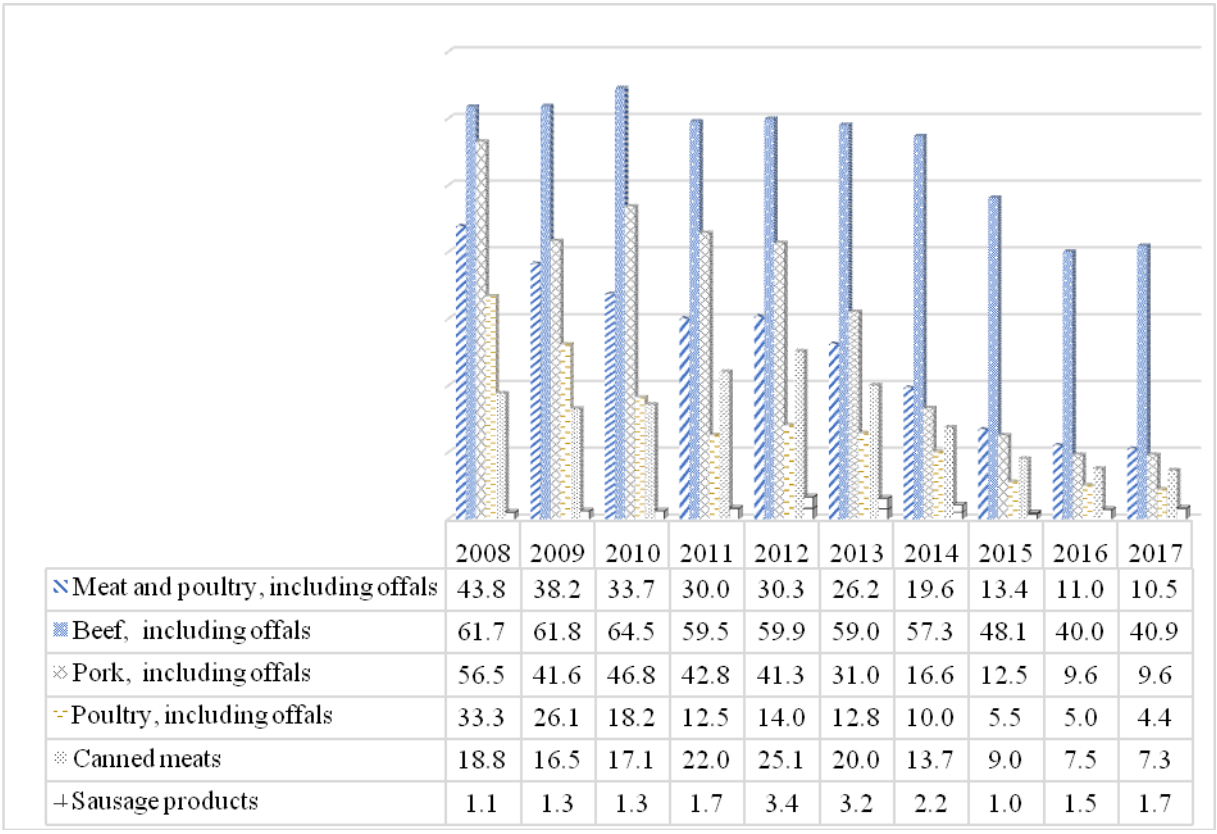
INTRODUCTION

The estimation of the current state of the meat industry dynamics in many countries has proved the growth of transformation processes in meat processing enterprises with respect to new requirements, standards, market relations and working conditions at a constant decrease in production costs. The main difficulties in the work of processing industries are caused by the inconstancy of prices for raw meat, reduced supply of meat and raw materials from other countries due to the food embargo, low competitiveness of the raw material base and its slow growth, as well as low quality of resources. Since 2014, Russia has experienced a decrease in import deliveries of many food resources, including meat and meat products. The dynamics of the share of imports can be seen in Figure 1 that shows the shares of meat and meat products imported into Russia in the period of 2008-2017.



	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Meat and poultry, including offals	43.8	38.2	33.7	30.0	30.3	26.2	19.6	13.4	11.0	10.5
Beef, including offals	61.7	61.8	64.5	59.5	59.9	59.0	57.3	48.1	40.0	40.9
Pork, including offals	56.5	41.6	46.8	42.8	41.3	31.0	16.6	12.5	9.6	9.6
Poultry, including offals	33.3	26.1	18.2	12.5	14.0	12.8	10.0	5.5	5.0	4.4
Canned meats	18.8	16.5	17.1	22.0	25.1	20.0	13.7	9.0	7.5	7.3
Sausage products	1.1	1.3	1.3	1.7	3.4	3.2	2.2	1.0	1.5	1.7

Figure 1: The share of imports of certain goods in their commodity

According to the data represented, the share of imported varieties of meat and meat products was noted to decline during the period under review, which confirmed the intensification of state instruments of support and subsidies to agriculture in terms of increasing their own production and raw materials base. Another issue is the economic affordability of meat and meat products for the population of Russia in view of shrinking real purchasing power of the incomes of working citizens. This problem should be solved by reducing the cost of meat products and finding ways to replace imported ingredients with domestic ones.

The prevailing conditions do not allow enterprises to maintain a high level of the product quality at previous prices. The only solution is to increase the production of meat products with protein fillers of plant origin. The combinations of that kind make it possible to reduce the cost of meat products produced and at the same time preserve the nutritional and biological value of the finished product [1].

Modern studies of this problem showed the relevance of the development direction of the meat products technology under consideration. Moreover, an approach of an integrated use of protein-carbohydrate fillers of plant origin in meat production is developing. The analysis of current situation with respect to the fillers applied has shown that imported ingredients are most often used, but our production has great potential

for using our own grown protein-carbohydrate fillers, such as chickpea, mustard, flax and pumpkin that are no less effective in the production of high-quality meat products.

In this regard, there is a need and demand to search and develop new technologies for the application of innovative formulations for the production of meat products. In addition, it should be noted that the Doctrine of Food Security of the Russian Federation provides for the search and development of fundamentally new food products with the fillers and by-products of the food industry to be added [2]. All of the above confirms the relevance and timeliness of the study presented.

MATERIALS AND METHODS

Russian and Western scientists (Brazhnikov A.M., Zhuravskaya N.K., Lipatov N.N., Rogov I.A., Salavatulina P.M., Titov E.N., Tolstoguzov V.B., RivasH.J., Tarrant P.V. et al.) showed the relevance of the integrated use of protein-carbohydrate components of plant origin and prospects of food of a combined composition. In the Russian market,the predominant share of protein technological ingredients (primarily soy concentrates, isolates and textured forms) were noted to be represented by products of foreign manufacturers. Domestic soy flour dominates among protein components. Russia has large resources of vegetable protein-carbohydrate raw materials that can be effectively used in the production of high-quality meat products.

In the work, generally accepted standardized methods of analysis of the objects under study were used.

The weight fraction of moisture in raw materials and finished products was determined according to GOST 9793-74, GOST R 514-79 and GOST 28561-90.

Determination of the weight fraction of protein was carried out according to GOST 25011-81,GOST R 51438-99 and the recommendations.

The weight fraction of ash was determined in accordance with GOST R 51432-99 and the recommendations.

The weight fraction of fat in raw materials and finished products was determined in the Soxhlet apparatus in accordance with the recommendations, GOST 042-86and GOST 8756.21-89.

The trace element composition of the raw material was determined after burning organic substances (in a muffle furnace) on the ICAP 5030 atomic adsorption photometer.

Vitamins were determined by capillary electrophoresis on the “Capel-105 M” in accordance with the methodological instructions attached to the equipment, as well as GOST R 52741-07.

The content of macronutrients was determined according to GOST R 51429-99, GOST R 51430-99 and the recommendations.

RESULTS AND DISCUSSION

In developing fundamentally new meat products, one should first of all take into account their chemical composition for the appropriate combination of fat and protein. This problem was solved by adding protein preparations of plant origin to sausage filling. The replacement of muscle protein with vegetable one will be accompanied by an increase in such properties as WBC (water-binding capacity), WHC (water holding capacity) and FHC (fat-holding capacity), that is, additional consumer properties of the product with its nutritional value preserved and cost reduced [3].

The results of laboratory studies of the chemical composition of the finished sausage products with pumpkin protein-carbohydrate complex allowed determining the appropriate ratio in the complex that was 1:2. In the process of the research, the pH of pumpkin powder was proved to be neutral, i.e., pH = 7, so this filler did not have a significant impact on the functional, technological and physicochemical properties of the finished product.

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Protein-carbohydrate naked-seeded pumpkin complexes and their influence on the functional and processing qualities of the meat systems prototypes were studied in the laboratory. There were used samples of gray and heat-treated sausage filling; different levels of the complex under study were added to it. The resulting formulations of the control and test samples are presented in Figures 2 and 3.

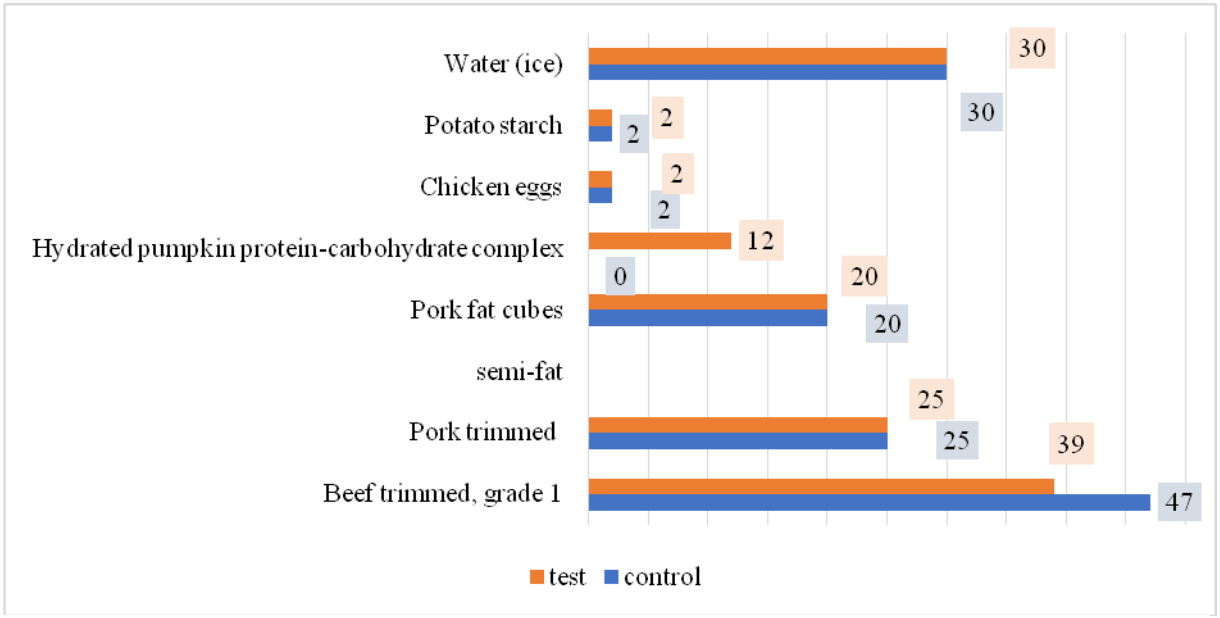

Figure 2: Formulations for cooked sausages "Universitetskaya" (control) and "Volgogradskaya" Grade 1; unsalted raw materials, kg/100 kg

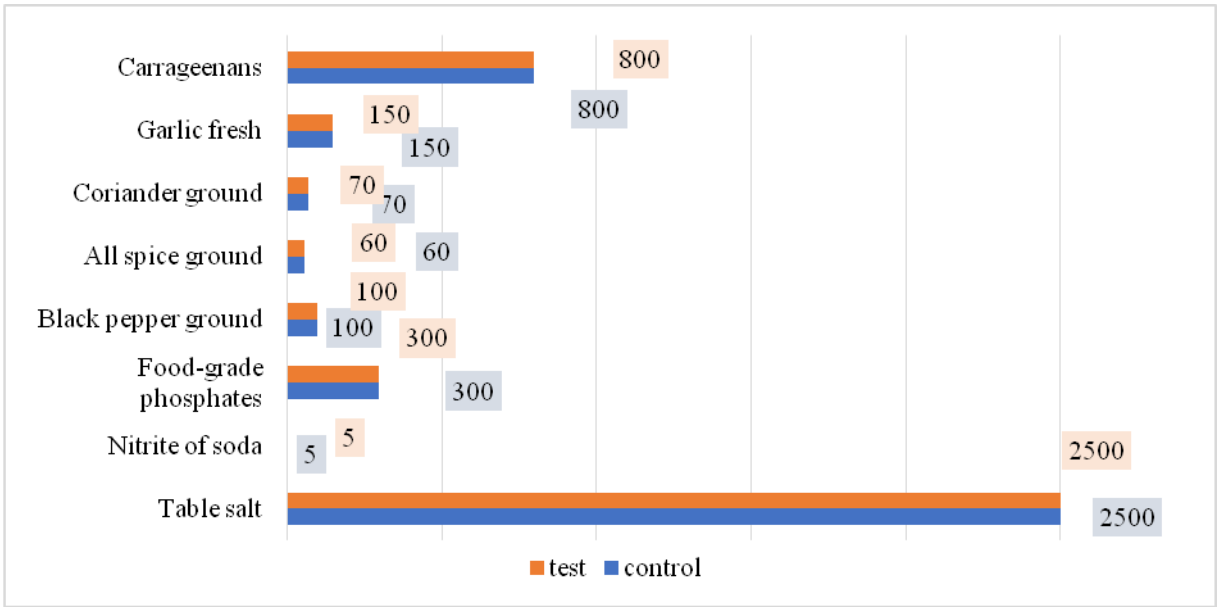

Figure 3: Formulations for cooked sausages "Universitetskaya" (control) and "Volgogradskaya",Grade 1; spices and materials, g/100 kg of unsalted raw materials

Given the existing functional and processing characteristics of the protein components and complexes studied, as well as the properties of the finished sausage filling, the sequence of adding fillers was as follows:

- beef, Grade 1 salted, aged;
- salt to unsalted raw material;

- phosphates;
- carrageenan;
- sodium nitrite;
- water (ice) in the amount of 2/3 of the total amount of added moisture, divided.

After water was added, the temperature of the sausage filling was monitored (not higher than 5°C); the beef was being cut for 4.5-5.0 minutes. Then the following ingredients were added:

- chicken eggs;
- hydrated (1:2) pumpkin-protein-carbohydrate complex;
- pork semi-fat;
- remaining part of water 1/3.

Then the cutting process was continued for 3-4 minutes. 1-2 minutes before the end of cutting, starch, pork fat and spices were added.

Experimental data on quality indicators of raw sausage filling and finished product of the control and test samples of the "Volgogradskaya" cooked sausage, Grade 1 are shown in Figures 4 and 5.

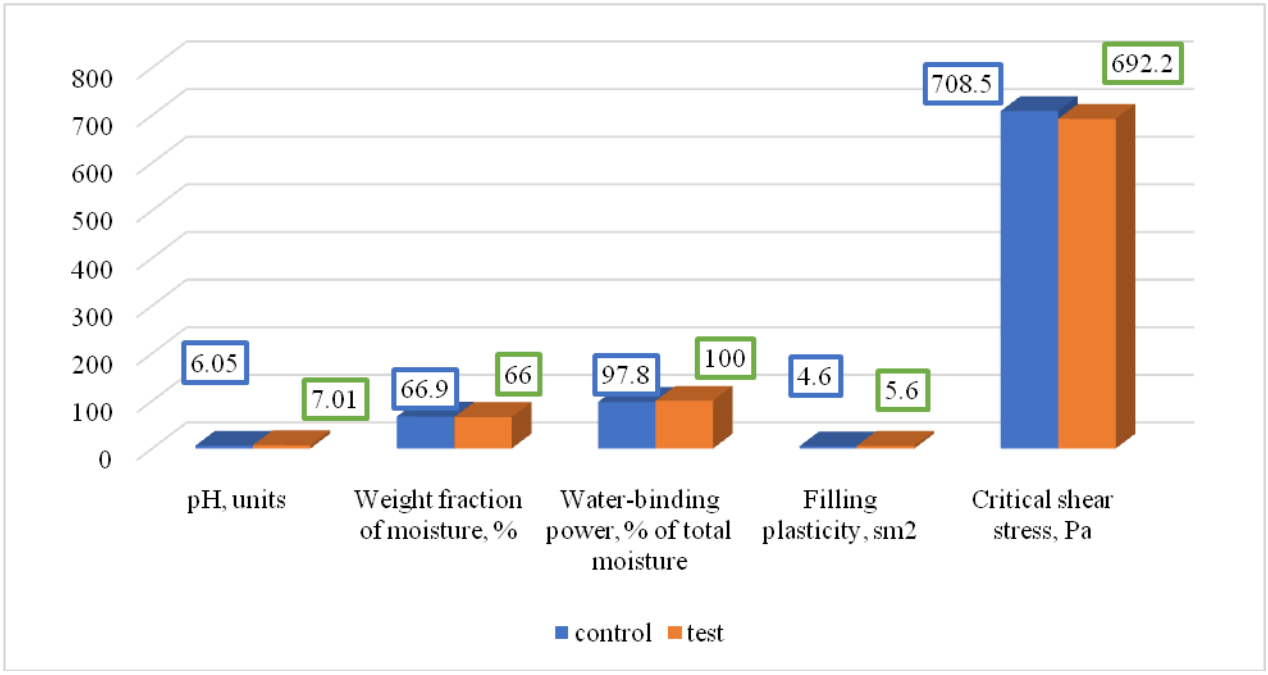

Figure 4: Qualitative characteristics of filling and finished product, control and test ("Volgogradskaya") samples of cooked sausage, Grade 1 (n=3, V<16)

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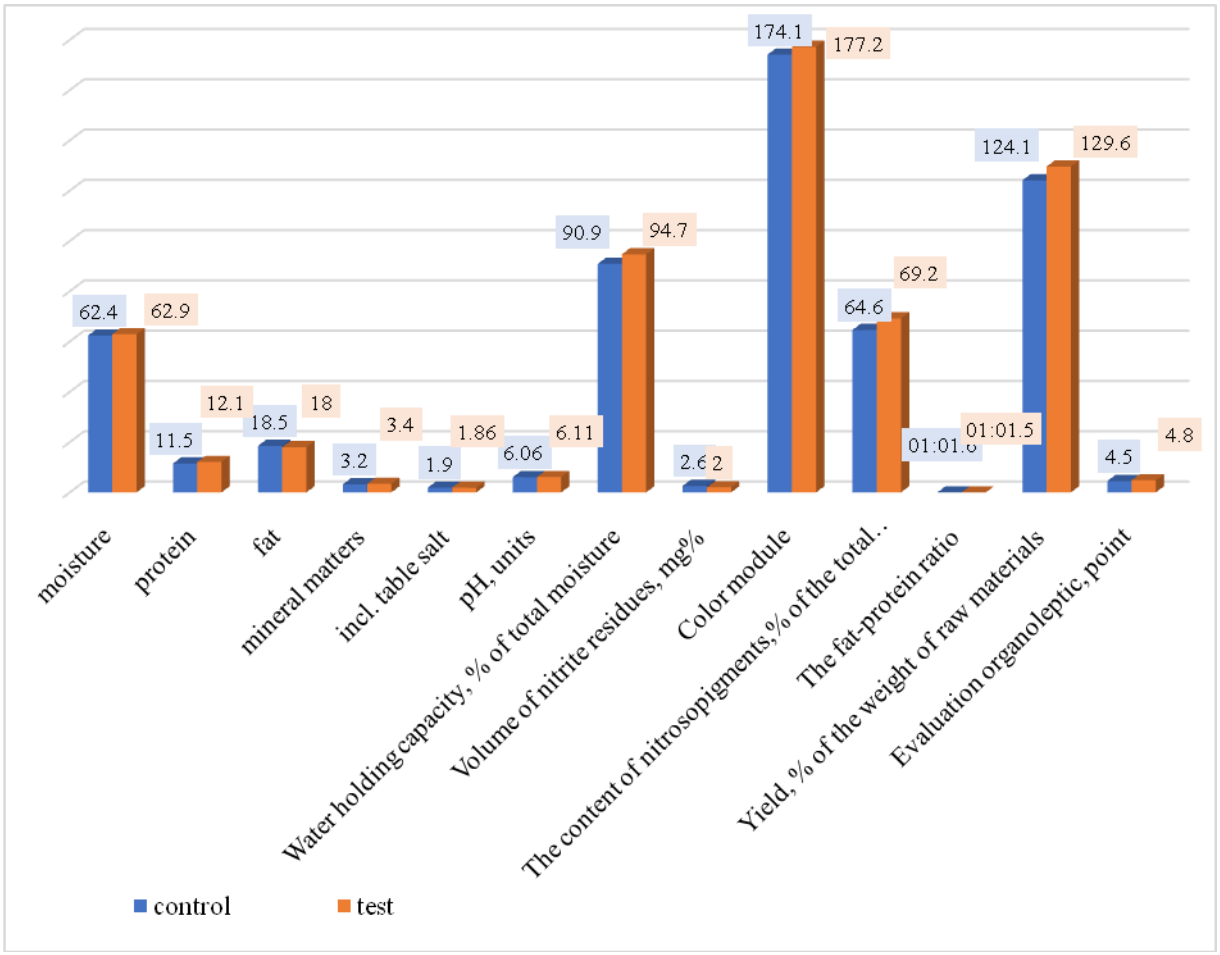

Figure 5: Qualitative characteristics of the finished product, control and test ("Volgogradskaya") samples of cooked sausage, Grade 1 (n=3, V<16)

The comparison of the two obtained samples compositions showed that the pH of the control and test samples were at the same level, which proved the appropriate volume of the moisture added. Nevertheless, the pre-hydration of the test sample by adding the protein-carbohydrate complex in a ratio of 1:2 caused a decrease in moisture in the test sample by 0.5% compared with the control one.

The protein-carbohydrate complex considerably increased the water-binding capacity of sausage filling up to 100% of the total volume of moisture. In the control sample, this indicator was lower by 2.2%. The pumpkin protein-carbohydrate complex increased the WBC indicator of the finished product, which was explained by its functional properties [4].

A new complex added to the studied sample of cooked sausage showed that this caused a slight drop in strength characteristics, which proved a change in the critical share stress index due to a decrease in the share of myofibrillary proteins. On adding the pumpkin protein-carbohydrate complex, plasticity increased and was 5.6 cm^2.

The heat treatment indicated a slight increase in the pH in all samples by 0.04 units. The final values of the moisture content corresponded to GOST R 52196-03 in the sausages above. The moisture level in the prototype was 62.9%, which was by 0.5% more than in the control sample.

Evaluating the WHC criterion in tests a usage samples revealed them to have higher level by 3.8% compared with the control sample. This fact was explained by high gel-forming properties of the protein-carbohydrate complex [5].

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To assess the color of the samples studied, spectral analyzes were carried out; their results in the visible light area are shown in Figure 6.

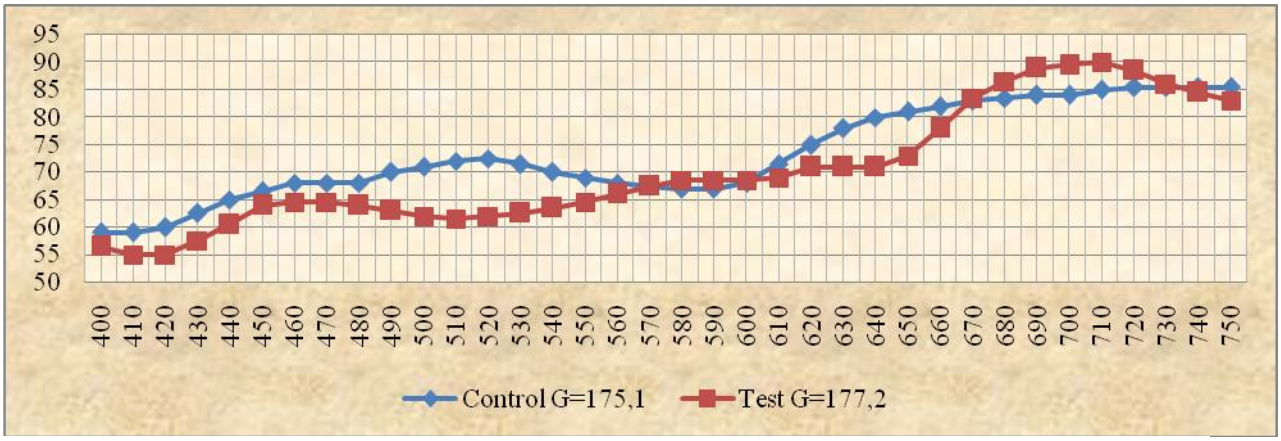

Figure 6: The reflection spectra of control and test samples of cooked sausage

Evaluation of the curves presented proved a slight difference between the sausage samples. Their organoleptic evaluation showed that the protein-carbohydrate complex added did not substantially affect the taste of the sausages, so the prototype had better organoleptic evaluation.

Comparison of the chemical compositions of the two Volgogradskaya sausage samples Grade 1 showed an increase in the amount of protein in the test sample by 0.6%(12.1% in the test sample and 11.5% in the control one). Thus, the prototype contained more protein and less fat, which had a positive effect on the ratio between proteins and fats and was higher evaluated in terms of organoleptic properties.

For a more detailed assessment of the biological composition of the cooked sausage with the hydrated pumpkin protein-carbohydrate complex included in its composition, the amino acid composition of the two samples was studied. The results of the analysis are presented in Table 1.

Table 1: Amino acid composition of cooked sausage of the 1st grade, control and experimental ("Volgogradskaya") samples

Amino acid	Content, g per 100 g of protein		FAO / WHO reference, g per 100 g of protein	Amino acid score, %	
	control	test		control	test
Isoleucine	4.10±0.2	4.46±0.06	4.0	102.50±5.0	111.5±1.5
Leucine	6.71±0.08	7.86±0.14	7.0	95.90±1.14	112.29±2.0
Lysine	6.43±0.10	7.34±0.12	5.5	116.91±1.81	133.46±2.18
Methionine + cystine	2.82±0.05	3.30±0.05	3.5	80.57±1.43	94.29±1.43
Phenylalanine + tyrosine	5.74±0.09	6.32±0.11	6.0	95.67±1.50	105.33±1.83
Threonine	4.20±0.08	4.52±0.08	4.0	105.0±2.0	113.0±2.0
Valine	4.75±0.07	5.37±0.08	5.0	95.0±1.4	107.4±1.6
Tryptophan	1.01±0.02	1.06±0.02	1.0	101.0±2.0	106.0±2.0
The number of essential amino acids	36.31±0.61	38.92±0.63	36.0	–	–
Asparaginous	8.17±0.13	8.60±0.14	–	–	–
Glutamine	9.41±0.14	10.50±0.17	–	–	–
Proline	2.83±0.04	3.31±0.04	–	–	–

Glycine	3.53±0.06	3.48±0.06	–	–	–
Alanine	3.86±0.05	4.04±0.06	–	–	–
Histidine	3.51±0.04	4.22±0.04	–	–	–
Arginine	4.50±0.05	4.75±0.05	–	–	–
Serine	2.80±0.03	2.90±0.04	–	–	–

Evaluation of the data obtained showed the amino acid score in the test sausage sample with respect tocertain independent amino acids (lysine, leucine and valine) to be higher than the FAO standard. The amino acids like methionine and cystine were limiting, since their score was 94.3%.

In accordance with the SanPiN 2.3.21078-01, microbiological indicators of cooked sausage were examined for the presence of mesophilic aerobic and optionally anaerobic microorganisms (QMAFAnM), coliform bacteria, S.aureus, pathogenic microorganisms, including Salmonellaand sulfite-reducing clostridia [6].

The results of the bacteriological studies of the cooked sausages samples prepared according to the developed formulation proved that there were no coliform bacteria, S.aureus (in 1 g of the product), pathogenic microorganisms, Salmonella (in 25 g of the product) or sulfite-reducing curdridia (in 0.01 g of the product) (Table 2).

Table 2: Indicators of microbiological safety of samples

Indicator	SanPiN	Control	Test
The number of mesophilic aerobic and optionally anaerobic microorganisms, CFU, in 1 g of product	$1.0x10^3$	$0.85x10^3$	$5.0x10^2$
E. coli bacteria and S.aureus, in 1 g of product	not allowed	not detected	
Sulfite-reducing hydrostrides, in 0.01 g of product	not allowed	not detected	
Pathogenic microorganisms, incl. Salmonella, 25 g of the product	not allowed	not detected	

The study showed that the pumpkin protein-carbohydrate complex used in the "Volgogradskaya" cooked sausage Grade 1 made it possible to increase the availability of macromolecules and their connection with food enzymes, which improved the digestibility of the product. The results of the study confirmed the theoretical data on the ability of enzymes to increase the absorption of food.

The results of the biological value analysis of the cooked sausage samples are presented in Figure 7.

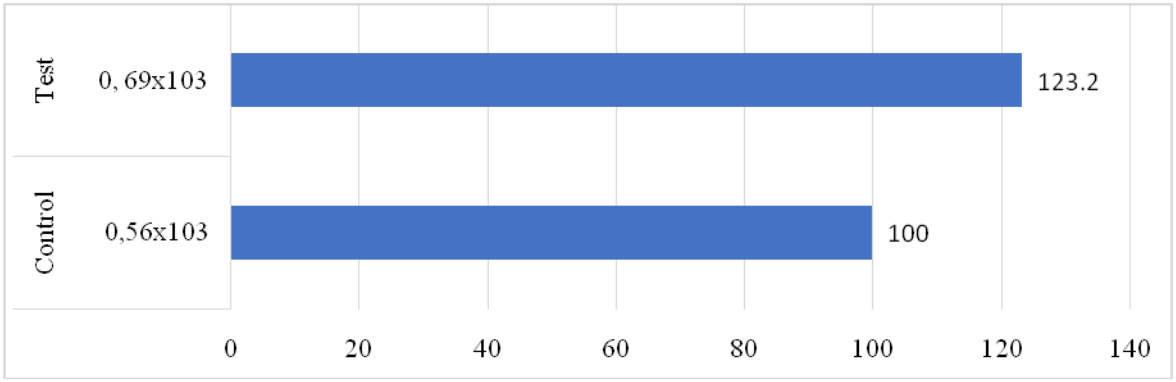

Figure 7: The biological value of the samples studied

The analysis of the data obtained showed that the prototype's indicator of biological value was higher than the control's one (Figure 7). This means that the formulation developed for the manufacture of the "Volgogradskaya" cooked sausage Grade 1 can substantially increase the nutritional value of the existing

product and its competitive position in the market.

CONCLUSIONS

The study conducted by the team of authors proved that the new protein-carbohydrate complexes added to meat products reduced its cost, which affected the growth of profits. Moreover, the nutritional value and composition of proteins in the cooked sausage prototype was higher and more qualitative than in the control sample [7, 8 and 9]. Therefore, the resulting formulation will allow broaden the existing range of sausages without considerable investment. The protein-carbohydrate complexes based on naked-seeded pumpkin seeds allows this type of product to be used in the diet not only for mass consumption.

The pumpkin protein-carbohydrate complex technology in meat products determines the following recommended doses for filling: from 2 to 10 % wt. If pumpkin seed oil is used, the dose should be 0.04 to 4.0 % wt.

At the end of this study, we note that the expansion of sausage formulations enable using of new products in various consumer groups with nutritional habits [10 and 11]. Protein-carbohydrate complexes are quite diverse, so they must be used in the production of meat products with specified consumption parameters.

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