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EFFICIENCY OF USING THE ANIMAL PROTEIN COMPLEX IN THE TECHNOLOGY OF COOKED SAUSAGE

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Abstract. The research is dedicated to the development of recipes of cooked sausages and their diversification through including in the recipes poultry meat, and by-products of processing meat and milk. The meat products most affordable and popular with the Ukrainian people are selected for the study: cooked sausages and poultry meat wieners. The main components of the recipes are: red poultry meat, mechanically deboned poultry meat, medium-fat pork. In the recipes of the products developed, 10 % of the basic raw material was replaced with a hydrated protein-carbohydrate-mineral supplement. According to physico-chemical indicators, the protein-carbohydrate-mineral supplement in the technology of cooked sausage products allows us to get ready-made products with excellent quality parameters.It has been established that adding protein-carbohydrate-mineral supplement to the formulation significantly effects on the physico-chemical, functional, and technological parameters and biological value of meat products. The experimental data obtained show that the moisture content of the fresh stuffing for the sausages Kuryacha and the wieners Videnski is by 0.9 and 1.7%, respectively, higher than that in the control samples. The water-binding power in the fresh stuffing of the control samples is by 5% lower than in the test samples. In the finished product, the moisture-holding capacity is higher in the test samples (by 5.9% in the sausages Kuryacha, by 3.8% in the wieners Videnski). The study has shown that the amino acid score difference coefficient (AASDC) in the control sample of cooked sausage was by 11.2% higher than in the sample of the cooked sausage Kuryacha. In the control sausages, it was 13.0% higher than in the Videnski wieners. The developed cooked sausage products with the proteincarbohydrate-mineral supplement can be introduced into production as functional products with improved biological value.

Key words: cooked sausages, wieners, protein, protein-carbohydrate-mineral supplement, animal proteins, amino acid composition.

ЕФЕКТИВНІСТЬ ВИКОРИСТАННЯ КОМПЛЕКСУ ТВАРИННИХ БІЛКІВ В ТЕХНОЛОГІЇ ВАРЕНИХ КОВБАСНИХ ВИРОБІВ

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Анотація. Дослідження присвячено розробці рецептур варених ковбасних виробів та розширенню їхнього асортименту за рахунок використання у рецептурах м'яса птиці та вторинних продуктів переробки м'ясної та молочної галузей. Для досліджень обрано найбільш популярні серед населення України та доступні по ціні м'ясні продукти: варені ковбаси і сосиски із м'яса птиці. Основні складові рецептур: червоне м'ясо птиці, м'ясо птиці механічного обвалювання, свинина напівжирна. У рецептурах розроблених продуктів замінювали 10 % основної сировини гідратованою білково-вуглеводно-мінеральною добавкою. За фізико-хімічними показниками встановлено, що білково-вуглеводно-мінеральна добавка в технології варених ковбасних виробів дозволяє отримувати готові продукти з відмінними показниками якості. Встановлено, що додавання білково-вуглеводно-мінеральної добавки до рецептур суттєво впливало на фізико-хімічні, функціонально-технологічні показники та біологічну цінність м'ясних продуктів. Отримані експериментальні дані показують, що вміст вологи в сирому фарші ковбаси «Курячої» і сосисок «Віденських» на 0.9 і 1.7% відповідно вище, ніж в контрольних зразках. Вологозв'язувальна здатність в сирому фарші контрольних зразків на 5% менша, ніж у дослідних зразках. У готовому продукті вологоутримувальна здатність вище в дослідних зразках (ковбаса «Куряча» на 5.9%, сосиски «Віденські» на 3.8%). Проведені дослідження показали, що коефіцієнт різниці амінокислотного скору (КРАС) в контрольному зразку вареної ковбаси на 11.2% більший ніж в зразку вареної ковбаси «Куряча», в сосисках контролю на 13.0% більше ніж сосисок «Віденських». Розроблені варені ковбасні вироби з білково-вуглеводно-мінеральною добавкою можуть бути впроваджені у виробництво як функціональні вироби з покращеною біологічною цінністю.

Ключові слова: варена ковбаса, сосиски, білок, білково-мінерально-вуглеводна добавка, тваринні білки, амінокислотний склад.

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Introduction. Formulation of the problem

The meat processing branch of the food industry is the largest consumer of all types of food supplements. Their application allows not only increasing the output and expanding the range of products, but also obtaining an economic effect when using mixed meat raw materials. At present, we can see a sharp shift of priorities in the processing industry. In the context of the global food crisis, production of goods with specified properties and different price categories becomes inevitable. However, the requirements to the quality of these products are high, because they must, on the one hand, satisfy the principles of balanced, adequate nutrition, and on the other, be cheap and smooth out the differences in the properties of meat systems made from raw materials of different quality.

The task of the food industry, while creating products with given characteristics, is the search for new technologies that can predict and stabilize the quality of meat systems due to the action of the major biopolymers, mainly proteins and polysaccharides.

Analysis of recent research and publications

The meat industry is one of the oldest sectors of the food industry. The importance of the meat industry in a country's economy is determined, above all, by the fact that it provides the people of the country with products that are the main source of protein nutrition.

In the food industry, a large group of substances is used, that are defined as dietary supplements. This is a group of substances both of natural origin and artificially obtained, the use of which is necessary to improve the technology of special products (dietary, therapeutic), preserving the necessary properties, increasing the stability, and improving the sensory properties of food products. Usually, dietary supplements are divided into several groups: food additives that improve the look of the products; additives that change the consistency; flavourants; sweeteners and condiments; dietary supplements that improve the preservation of food and prolong the shelf life. The use of dietary supplements is permissible only if they are not harmful to human health (no matter how long the product containing them is consumed), and only if the technological targets cannot be achieved otherwise. The widespread use of dietary supplements, in the modern sense, began only at the end of the XIX century, and quickly reached its peak nowadays in all countries of the world. Nowadays, 500 to 5000 dietary supplements, standardized and safe for human health, are allowed across the globe [1].

Given the shortage of domestic protein-based raw materials, in particular, those of animal origin, in the food industry, there is currently a decline in production and consumption, but there is a process of constant expansion and renewal of the range of finished products, and an active search for ways of processing available raw materials, improvement and intensification of technological processes. The problem is exacerbated by the unfavourable conditions prevailing in livestock farming due to the changes in the country's economic and political life that has negatively affected the production of meat and meat products in Ukraine in general. Despite this, new types of food and functional and technological protein-based supplements are being introduced, a new ideology of production of healthy food is being developed and implemented, the revision of traditional principles of processing raw materials and ensuring biological safety of food takes place. The modern market of food ingredients depends on import and is dominated by foreign products. The main reasons are the government's lack of interest in supporting domestic manufacturers of food ingredients and a high risk of organizing a full cycle of production.

It is protein products that are mainly presented on the market in the form of soy protein isolates with high functional and technological characteristics. Nowadays, in meat food production, there is an increase in the use of animal protein extracted from collagen-containing raw materials (pork and beef skin). High functional and technological properties of such preparations, especially water-binding power and gelling ability, can significantly improve the rheological properties of food products, their consistency and sensory parameters, enrich meat products with dietary fibres. Recent studies have shown that collagen from connective tissue acts as dietary fibres in human diet, stimulating the secretion of gastric juice and intestinal peristalsis, having a positive effect on the beneficial microflora. Connective tissue elements (collagen, glucosamines, mucopolysaccharides) are similar to vegetable dietary fibres, have cation-exchange capacity, contribute to the excretion of various toxins from the body, including toxic metabolites and anthropogenic pollutants, take part in regulating cholesterol metabolism. As collagen is amino acid deficient, and gels based on it lose their stability after their heat treatment is repeated, the combination of animal collagen proteins with milk proteins and polysaccharides will make for these disadvantages, ensure the rational use of meat raw materials, reduce the cost, and improve the quality of meat products [2-4].

One of the ways in solving the problem of animal protein deficiency is the maximum possible involvement of by-products of processing animal raw material on the basis of evaluation and creation of new food forms of

protein. Collagen-containing raw materials do not contain enough tryptophan, cystine, and cysteine to be adequately equivalent to muscle tissue. However, in modern conditions, it is possible to select formulations where they will not only reduce, but, in some cases, increase the amino acid balance of the product, bringing its quantitative ratio of amino acids close to the requirements of FAO/WHO. In many EU countries, such proteins are viewed as meat and are not specified in the mandatory list of ingredients [5,6].

Over the past thirty years, the leading scientists in the meat and dairy industries M.M. Lipatov, N.A. Zhuravska, A.G. Khramtsov, O.P. Chagarovsky have developed technologies of milk protein-carbohydrate concentrates produced from milk whey and skim milk. They can be recommended to the technology of meat products of the combined composition as an alternative to soy preparations [7].

Alginate and carrageenans, fibres, starch, pectin, gums, textured proteins, soy isolates and concentrates are widely used in industry to stabilize the quality and improve the texturization of meat products. However, among the various supplements, chitosan, a biopolymer, has not drawn technologists' attention yet, neither by its stabilizing properties nor as a means of improving the structural and mechanical characteristics.

Research papers by domestic and foreign scientists are dedicated to studying the properties and possible applications of chitosan and its derivatives in the food industry: N.V. Bozhko, V.I. Tishchenko, A.I. Albulov, V.M. Bykova, V.P. Varlamov, L.I. Dinzburg, E.A. Kurkina, L.A. Nudga, V.V. Sadovy, T.M. Safronova, A. Komisarczyk, I. Krucinska, L. Szosland, and many others. Though chitosan is used in the meat industry as coating for cuttings, in manufacture of sausage casings, in the composition of pâtés and canned food, technologists have never used it as a structure-forming agent to develop a comprehensive dietary supplement for cooked sausages [8-12].

The results we obtained earlier after studying the composition, functional and technological properties of the protein-carbohydrate-mineral supplement (PCMS) *Rekord-75* [13] and of model stuffing containing it, prove that the PCMS *Rekord-75* is an effective fat emulsifier, introduction of which into the meat systems in the amount of 1–3% in the dry state or 10–20% in the hydrated state positively effects on both the functional and technological properties (FTP) and organoleptic characteristics of the forcemeat. The supplement *Rekord-75* has effective gelling properties. Its mixing in the composition of meat systems in the form of gel in the amount up to 20% (hydromodule 1:7) allows improving the structural and mechanical characteristics of forcemeats [14]. The preventive properties of chitosan and calcium chloride, which are part of the protein-carbohydrate-mineral supplement, their ability to slow down the absorption of radioactive strontium in the human intestine, the immune-stimulating and hepatoprotective properties, the ability to lower the level of cholesterol and lipids in the blood, stimulate haematopoiesis, as well as the enterosorbent and cancer-preventing effect [15-18] determine high biological value and prophylactic properties of meat products with the dietary supplement *Rekord-75*. Thus, a number of positive characteristics of the PCMS *Rekord-75* (functional, technologic, and biomedical) predetermine the possibility of its use in meat products technology in order to regulate technological properties and obtain products with a high biological value.

The purpose and objectives of the study. The purpose of the work is to develop recipes of cooked sausage with partial replacement of fresh sausage meat with animal proteins, and to increase the product output.

To achieve the main goal of the study, it is necessary to solve a number of **tasks**, namely:

1. to confirm experimentally the practical importance of using the protein-carbohydrate-mineral supplement in recipes of sausage products, as an alternative to fresh sausage meat;
2. to study the physical and chemical, qualitative and nutritional properties of new types of cooked sausage products;
3. to investigate the biological value of the newly developed cooked sausage products.

Research materials and methods

Raw materials and auxiliary materials were used in accordance with the current norms and specifications. The protein-carbohydrate-mineral supplement *Rekord-75* consists of collagen protein of pig skin *PreGel95* – 75%, the serum protein concentrate KSB UV 65–20%, chitosan – 3%, and calcium chloride – 2% (Patent of Ukraine №120718 dated 10.11.2017). The protein-carbohydrate-mineral supplement (PCMS) was hydrated in a meat-cutting machine and held before use at a temperature of 4±2°C for 24 hours. The forcemeat was prepared in a meat-cutting machine according to the classic technological scheme of making cooked sausages. In the course of the research, chemical, physico-chemical, biochemical methods of research were used. Standard test methods were used to determine the functional and technological properties of the forcemeat samples: the moisture content of the minced meat, its moisture-retaining power in relation to the total moisture content of the sample, the mass fraction of protein (according to State Standard 25011-81), the mass fraction of fat (in accordance with State Standard of Ukraine ISO 1443: 2005), the mass fraction of moisture (according to State Standard of Ukraine ISO 1442:2005), the mass fraction of ash (according to State Standard 9147), the hydrogen index (pH) (according to State Standard of Ukraine ISO 2917-2001), the mass fraction of amino acids (by ion-exchange chromatography on an automatic analyser T-339 by Microtechna, Czech Republic). On the basis of the obtained characteristics, for a more complete description of cooked sausage products, the following was calculated: amino acid score, potential biological value (PBV), amino acid score difference coefficient (AASDC), utilization (rationality)

factor, redundancy factor (σ) of the amino acid composition of protein [19].

To test the penetration, a cone with an angle of 45° at the vertex, with the weight (together with the rod) t=67.82 g, was used. The prepared sample was placed on the object stage of the cone penetrometer, and the load on the cone was increased until the structure of the sample was completely destroyed. The depth of penetration and the load rate were measured, the boundary displacement stress (θo, Pa) was calculated using the Rehbinder formula:

$$\theta_o = (K_\alpha \cdot M \cdot g)/h^2_{max}, \quad (1),$$

where θ_o – boundary displacement stress, Pa;

K_α – Rehbinder constant, which depends on the angle α at the vertex of the cone; (K=4.1 N/kg at a cone with the vertex angle 45°);

M – weight of the load acting upon the cone, kg;

h_{max} – depth of penetration of the cone, m.

Results of the research and their discussion

When developing the technology of cooked sausage products with the protein-carbohydrate-mineral supplement, the data were used that had been obtained in the study of the composition and properties of protein preparations, chitosan and calcium chloride, their effect on the model forcemeat systems. The recipes were also formulated basing on the modern principles of healthy nutrition, selection of such types of raw materials and their proportions that would provide the necessary qualitative characteristics of the product. In order to improve the sensory parameters and increase the biological value of the developed cooked meat products, we suggest using chicken eggs and leucine in the recipe of wieners. Cooked sausages and wieners were taken as the controls in accordance with State Standard of Ukraine 4529:2006. The PCMS in the hydrated form was added to the recipes in the amount 10 % instead of the main raw material [20] to enrich the final products with protein and calcium, and improve their quality indicators (Table 1).

Additional ingredients (salt, sodium nitrite, ground black pepper, food phosphate, complex flavouring additive) were added in quantities used in cooked sausages and wieners made by similar recipes. The PCMS gel *Rekord-75* and the sausage and wiener forcemeat were prepared in a meat-cutting machine. The gel was prepared with the protein to water ratio 1:7. After preparation in the meat-cutting machine, the gel was kept at a temperature of 0–4 °C for 24 hours. Taking into account the FTP of the PCMS *Rekord-75* and the properties of the model forcemeat systems, to prepare the wiener forcemeat, the following components were put into the meat-cutting machine first: poultry meat, mechanically deboned poultry meat, sodium nitrite, salt on the unsalted raw material, phosphates (complex flavouring additive), the PCMS gel *Rekord-75*, and, in portions, moisture in the form of ice (2/3 of the total added moisture). When adding ice, the forcemeat temperature was being controlled as it should not be above 5 °C when chopping lean meat material. Chopping (cutting) at the second stage was carried out at a speed of 3000 rpm for 3–4 minutes. The ready forcemeat was stuffed into a polyamide casing. Sausages and wieners were cooked in a steam-air medium in a step-by-step mode: at 55 °C – 15 minutes, 65 °C – 20 minutes, 75°C – 30–60 minutes, until the temperature reached 70°C inside the product. The temperature inside the product was controlled using a thermocouple. Then, the sausages were cooled to 10°C, weighed to determine the yield, and further studies were performed. The qualitative characteristics of the raw forcemeat and the finished control and experimental samples of the Kuryacha sausages and the Videnski wieners are presented in Table 2.

Table 1 – Recipes of the control and experimental samples of the developed grade I sausage products

Recipe components	Cooked sausage Stolova (control), State Standard of Ukraine 4529:2006	Cooked sausage Kuryacha	Wieners Do snidanku (control), State Standard of Ukraine 4529:2006	Wieners Videnski
Red poultry meat, kg	73	63	57	47
Mechanically deboned poultry meat (MDM), kg	20	20	10	10
Medium-fat pork, kg			27	27
Dry milk, kg	4	4	3	3
Chicken eggs, kg	3	3	3	3
PCMS (hydromodule 1:7), kg	–	10	–	10
Water (ice) additional, kg	25	25	25	25
Salt, g	2200	2200	2200	2200
Sodium nitrite, g	7.5	7.5	6.0	6.0
Sugar, g	–	–	200	200
Black pepper, g	80	80	60	60
Complex flavouring additive Doktorskaya combi, g			1200	1200
Phosphates, g	300	300		
Leucine, g				2000

Table 2 – Qualitative characteristics of the raw forcemeat and finished products

Parameter	Cooked sausage		Wieners	
	Stolova (control)	Kuryacha	Do snidanku (control)	Videnski
Raw forcemeat				
Mass fraction of moisture, %	68.9	69.8	69.3	71.0
pH	5.95	6.01	5.9	6.05
Water-binding power, % to total moisture	89.62	95.46	90.1	95.4
Boundary displacement stress, Pa	638.7	647.5	568.2	662.5
Ready product				
Moisture, %	65.7	67.9	68.7	70.4
Protein, %	12.9	13.2	14.1	18.1
Fat, %	26.4	23.1	22.0	19.0
Ash, %	3.0	3.2	2.8	3.0
pH,	6.04	6.12	6.08	6.12
Moisture-holding power, % to total moisture	81.9	87.8	78.6	82.4
Penetration, mm	3.0	1.5	3.2	1.7
Protein to fat ratio	**1:2.05**	**1:1.75**	**1:1.56**	**1:1.05**
Output, % of the weight of raw material	113.4	117.2	115.6	118.2

Chemical composition is one of the characteristics of the quality of the product, its nutritional and energy value, which depend on the quantitative ratio of moisture, fat, protein and indicate the stability of the product during storage. A comparative analysis of the chemical composition and energy value of the developed meat products did not reveal significant variations between the samples, which confirms the high nutritional value of both the control and the experimental samples.

The obtained experimental data show that the moisture content of the raw stuffing of the sausages Kuryacha and the wieners Vidensky is, respectively, by 0.9 and 1.7% higher than in the control samples, which corresponds to the input of raw materials. The water-binding power in the raw samples of minced stuffing is 5% less than in the experimental samples, and in the finished product the moisture-holding power is higher in the experimental samples (the sausages Kuryacha by 5.9 %, the wieners Videnski by 3.8%).Introduction of the PCMS gel *Rekord-75* positively effected on the structure of the sausage Kuryacha and the wieners Videnski, due to high gelling ability of the supplement, and to the ability of chitosan and calcium to interact with muscle proteins and improve the gelling properties of the system. The boundary displacement stress in the Videnski wieners is more than 94.3 Pa compared with the control samples, and penetration is almost twice as little. The general chemical composition of the samples shows that the protein content in the wieners Videnski is higher by 4% than in the control sample, but according to the composition of the raw material, the developed product corresponds to the products of Category I, which are manufactured in accordance with State Standard of Ukraine 4529:2006 "Cooked sausages from poultry and rabbit meat. General specifications" and Technical Specifications of Ukraine 10.1.-02070938-266:2018 "Cooked sausage products, wieners, thick wieners, meat loaves, and meat-containing products with protein-carbohydrate-mineral supplements."

Thus, on the basis of the studied qualitative characteristics of the control and experimental samples, it has been found out that introduction of the PCMS *Rekord-75* to sausages and wieners can increase the FTP of the product and allows obtaining a product with high organoleptic parameters and lower cost by reducing the amount of raw meat in the recipe.

The analysis indicates that the raw forcemeat produced using the PCMS has high functional and technological properties and provides, in comparison with the control samples, higher organoleptic parameters and output of the finished product.

The developed samples of sausage products have better quality characteristics compared with the control samples as for the content of protein, fat, penetration value.

To build most human proteins, 20 amino acids are required in definite amounts. Besides, it is not the exact amount of each amino acid that matters, but their ratio, as close as possible to the protein composition of the human body. Violation of the balanced amino acid composition of food protein leads to violation of synthesis of the body's own proteins, upsetting the dynamic balance of protein anabolism and catabolism to the collapse of the body's own proteins, including enzyme ones. Lack of any amino acid limits the use of other amino acids in the process of biosynthesis of protein.

Some amino acids can be less available when in food proteins, there are inhibitors of digestive enzymes (for example:, legumes), or because of thermal damage of proteins and amino acids during culinary processing.

According to the amino acid composition, the balanced amino acid composition (BAC) has been

calculated – the ratio of the number of essential amino acids to the number of substitutes. For a perfect high-quality food product, this value should approach 0.40. The BAC of the test sample is 0.54.

Boiled sausage products are a whole complex of chemicals that includes proteins, fats, carbohydrates, vitamins, minerals, and water. Each group of substances fulfils its specific functions in the life of the organism. In the process of cooking, the components that are part of it are subject to biochemical and physico-chemical transformations that create the structure, taste, colour and smell of food. The quantitative ratio between proteins and fats in the product affects the digestibility of these nutrients. The optimum ratio between protein and fat in meat products should be 1 (0.8):1 [21,22].

Insufficient amount of protein in foods makes it necessary to create alternative products with the optimum ratio of the components of the formulation to achieve the desired technological effect. As a result, we have developed a leucine-enriched meat product with high protein and low fat for people ill with sarcopenia. Leucine is important for the muscle mass and is a precursor of the synthesis of protein in the body. It promotes the regulation of mRNA translation, thereby increasing the synthesis of muscle proteins, and is a strong secretory genotype of insulin. Leucine has immense value for human health, it actively participates in the processes of synthesis and decomposition of proteins. Due to leucine, the nitrogen balance is maintained in the body, without which the exchange of sugars and proteins is impossible [23-25].

The source of a fuller nutritional value of the protein is the amino acid SCORE. It allows detecting essential amino acids (the limiting ones) in a protein-containing product, by comparing the amino acid content of the product under study with their content in a theoretical "ideal" protein according to FAO/WHO data.

In order to determine the biological value of the cooked sausage Kuryacha with PCMS and the Videnski wieners with PCMS enriched with leucine, the Institute of Food Resources at the UAAS has calculated the amino acid and protein content in the control samples and in the developed products (Table 3).

Table 3 – Amino acid content of finished products

Amino acid	**FAO/WHO mg/ 100 g protein (2011)**	**Wieners Do snidanku (control)**		**Wieners Videnski**		**Sausages Stolova (control)**		**Sausages Kuryacha**	
		mg/ 100g protein	amino acid SCORE, %	mg/ 100g protein	amino acid SCORE, %	mg/ 100g protein	amino acid SCORE, %	mg/ 100g protein	amino acid SCORE, %
Protein content, %		14.1		18.1		12.9		13.2	
Valine	40	35.4	88.5	39.9	99.75	38.4	96.0	45.4	113.5
Isoleucine	30	49.3	164.3	52.3	174.3	36.0	120.0	52.3	174.3
Leucine	61	57.1	93.6	89.1	146.0	47.1	77.2	89.1	146.0
Lysine	48	59.4	123.8	69.1	143.9	56.4	117.5	79.4	165.4
Threonine	25	38.5	154.0	53.4	213.5	18.5	74.0	23.5	94.0
Phenylalanine + tyrosine	41	44.5	108.5	43.5	106.2	34.5	84.1	38.5	206.1
Methionine + cystine	23	35.2	141.3	45.4	197.2	35.2	141.3	45.4	197.4
Amount of essential amino acids		319.4		392.7		266.1		373.6	
Potential biological value of protein, %		78.5		89.7		74.0		87.0	
Amino acid score difference coefficient (AASDC), %		21.5		10.3		26.0		13.0	
Amino acid utilization factor (U)		0.43		0.84		0.56		0.75	
Comparative redundancy factor σ (CRF), g/100 g control sample		1.19		1.46		0.99		1.39	
Essential amino acids index		1.23		1.48		1.25		1.35	
First limiting amino acid		Valine		Valine		Threonine		Threonine	
First limiting amino acid SCORE, %		88.5		99.75		74.0		94.0	

According to the above results (Table 3), in the sample enriched with leucine, the value of amino acid SCORE of leucine is 2.6 times higher than in the control sample. In the control sample, the lowest amino acid SCORE is that of valine, and it is 88.5%. Valine (99.75%) is also the limiting amino acid in the test sample; in the samples of cooked sausage, the limiting

amino acid with indicators 74.0 and 94.0%, respectively, is threonine.

To estimate the degree of protein use, the AASDC was calculated. It is known that the lower the AASDC, the more fully amino acids are used in the product. The AASDC shows the average excess amount of amino acid score of the essential amino acids of the ideal protein compared with the lowest score of the essential amino acid of the protein in question.

The potential biological values of the developed cooked sausage products are: the Videnski wiener – 99.75%, the Kuryacha sausage – 94%, that is by 11.2 and 20% higher, respectively, which indicates a high nutritional value. The research has shown that the AASDC in the control sample of cooked sausage was 11.2% higher than in the sample of cooked sausage Kuryacha, and in the control wieners by 13.0% higher than in the Videnski.

Amino acid utilization factor characterizes the balance of essential amino acids in relation to the physiologically necessary norm and is used to compare the protein composition of the sausages based on their amino acid composition and the use of amino acids in the body. The value of the amino acid utilization factor of the test samples (0.84 and 0.75) characterizes how balanced the amino acids are compared to the standard.

The redundancy factor, that determines the proportion of essential amino acids not used for the anabolic needs of the body, in the developed samples is 1.46 and 1.39, respectively.

Assessment of the research results. The developed technology of manufacture of cooked sausage products has been tested on the production facilities of Myasni Delikatesy, Ltd. (Kyiv). Clinical studies of the use of the protein-carbohydrate-mineral supplement *Rekord-75* and leucine in gerodietetic products to improve providing elderly people with protein have been conducted at the State University "Institute of Gerontology" named after D.F. Chebotarev, NAMS of Ukraine (Department of osteoporosis). It has been confirmed that the introduction of the technologies is technologically and economically practical.

Conclusion

Adding the PCMS *Rekord-75* to the formulation of sausages and wieners allows us to increase the FTP and to get a product with high organoleptic characteristics and lower cost due to reducing the amount of meat raw materials in the recipe. It has been established that the developed samples of the grade 1 cooked sausage Kuryacha and the grade 1 wieners Videnski with PCMS have a better balanced amino acid composition compared with the control samples. The AASDC is 6.0% and 0.25%, respectively, the amino acid utilization factor is 0.75 and 0.84, which testifies to the high digestibility of the developed sausage products.

In the future, the improvement and optimization of the sausage recipes will be carried out taking into account the preliminary results of experimental research on the selection of the basic raw materials, the ratio of the components, the level of replacement of meat raw material with the PCMS.

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