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SELECTION OF COMPONENTS OF THE COMPOSITIONAL PROTEIN-CARBOHYDRATE MIXTURE TO IMPROVE THE QUALITY OF THE CHOPPED SEMI-FINISHED PRODUCTS

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Abstract: *Meat is one of the most significant and nutritious foods available for the masses, which helps to satisfy most of the needs of the body. It has is a good source of proteins, zinc, iron, selenium, and phosphorus followed by vitamin A and B-complex vitamins. The modern production of meat products develops in the direction of expanding assortment of production, combining and optimizing the component composition in order to increase the nutritional value, substances by including in the recipe of the functional ingredients. The article presents the results of the study of qualitative indicators of animal origin protein preparations and protein-carbohydrate composition based on beef collagen protein and mixture of oilseed cultures flour for use in the recipe of chopped semi-finished products to improve their biological value. The aim of the study was to determine and compare the qualitative indicators of animal origin protein preparations, to create a compositional protein-carbohydrate mixture based on the selected animal protein and flour of oilseed cultures, to study its functional-technological properties in view of being used in the recipe of the chopped semi-finished products. Based on the study and comparative analysis of qualitative indicators of animal origin protein preparations, the use of Helios-11 beef collagen protein in the composition of a protein-carbohydrate composition was selected and substantiated. Ratios of protein and mixture of oilseed cultures flour (1: 4) have been determined, which create the most favorable conditions for the correction of meat systems by their functional-technological properties, providing an acceptable and stable level of emulsifying and water-binding properties.*

Keywords: *meat products, animal proteins, oilseed cultures flour*

1. Introduction.

Meat is one of the most important and nutritious products available to the masses, helping to satisfy most of the body's needs. It is an important component of a well-balanced diet, as it is a good source of protein, zinc, iron, selenium and phosphorus, as well as vitamins A and B vitamins. The range of meat products available on the Ukrainian market today has a number of characteristics that reflect the key trends in the modern world. Thus, given the active rhythm of life of modern man, fast food products are especially popular - semi-finished products, due to the quality of which accurate demands are made, since today a culture of healthy nutrition is becoming a vital necessity. The active rhythm of life provokes irregular and monotonous nutrition, which leads to a decrease in the consumption of irreplaceable components. Irrational nutrition and environmental degradation make relevant the search for natural substances containing vitamins and

minerals necessary to increase the body's resistance to the negative effects of environmental damage. Domestic and foreign experience shows that the most effective way to combat nutritional deficiency is to enrich the vitamins and minerals of mass-produced products, including meat semi-finished products.

At the same time, one of the most important challenges facing the meat industry is to reduce the cost of the finished product. This requires the revision and improvement of the traditional methods of production of meat products, which is possible through the use of food additives and protein preparations of plant and animal origin, which allow to purposefully change the functional-technological and structural-mechanical properties of meat systems and to obtain the desired technological effect.

Today, the problem of product quality is of concern for both manufacturers and consumers. The popularity of healthy lifestyles encourages people to carefully choose the components of their diets, preferring natural ingredients. At the same time, the tense modern lifestyle determines a clear tendency to increase the frequency of consumption of semi-finished products, including meat. The analysis of the market of meat semi-finished products in recent years shows that chopped semi-finished products in cooled and frozen form are characterized by high demand among modern consumers, being a common family food [1].

Meat, which is a valuable protein raw material, in many cases still needs to be enriched with vitamins, minerals and other substances that are lacking for a balanced diet. This issue is of scientific and practical interest and does not lose its relevance, as shown by studies of domestic and foreign scientists [2].

A detailed analysis of scientific sources containing the results of experimental studies has shown that one of the most promising ways of enriching traditional meat products is the use of vegetable raw materials, in particular, oils and flour in their recipe. In the studies of Simakhina G., Pasichny V., Slobodyanyuk N. and etc. the scientific bases and practical aspects of functional additives based on vegetable raw materials in production technologies of chopped semi-finished products and minced meat have been highlighted [3]. The study of oilseeds cultures as promising sources for the production of biologically active components of food is described in the works of Stetsenko N., as well as in the works of foreign scientists [4-7].

Recently, in the meat industry, special attention is given to the ingredients of the protein nature and animal origin due to their compatibility with the main raw materials. Animal proteins significantly improve the structural and mechanical properties of foods, and above all their consistency, while playing the role of stabilizers, jelly-forming agents, improving the appearance of finished products.

Protein preparations based on connective tissue proteins, mainly collagen, are used to increase nutritional value, functional-technological and rheological parameters of finished products. Such proteins in physiological effect equate to dietary fibers having cytoprotective activity and normalize gut microbiocenosis. Scientists claim that collagen proteins improve the intestinal motility, and the breakdown products of these proteins, which are formed during heat treatment, stimulate the secretory function of the body [8].

Experimental and clinical trials by foreign scientists have shown that collagen-based dietary supplements can have a beneficial effect on skin health [9].

Works of Yancheva M., Polumbrik M. and others are devoted to the study of animal proteins qualitative indicators for the

purpose of use in the recipes of meat products [10].

2. Materials and methods.

Determination of the protein mass fraction was performed using the Keldal method, which is based on complete ashing (mineralization) of the sample in the process of heating with concentrated sulfuric acid in the presence of a catalyst (CuO), with futher determination of ammonia, bounded by acid. The amount of bound ammonia is determined by adding alkali (NaOH), whereby the ammonium sulfate is decomposed to ammonia, which is subsequently converted into a titrated acid solution taken in a certain amount, where it binds to the formation of ammonium salt. Then the acid residue is titrated and the amount of ammonia, which recalculated to the protein, determined [11].

The ash content was determined by ashing the dried sample at 500… 700 ° C in a muffle furnace to constant weight [11].

Determination of the mass fraction of moisture was performed by method of drying to constant weight. The sample of the product is dried in the drying cabinet at a temperature of 100 - 105 ° C for 3 - 5 hours, cooled in a desiccator from 20 to 120 minutes and weighed on analytical balance. Then again dried from 0.5 to 1.5 hours, cooled and weighed. If the difference between the last two weighings is greater than 0.0004 g, it is dried again and again until the mass is constant [11].

Mass fraction of fat was determined by a method based on repeated extraction of fat from a dried sample by volatile solvents followed by removal of the solvent and drying of the extracted sleeve to constant weight. The extraction was carried out in a Soxhlet apparatus, hexane was used as solvents [11].

Determination of moisture-retaining and fat-retaining capacity was performed by gravimetric methods as the difference between the mass fraction of water (fat) in the mince and the amount of water (fat) released during the heat treatment. The maximum amount of added water (oil), at which does not separate the aqueous (fat) phase during the test, in terms of 1 g of the preparation, was taken as the value of moisture-retaining (fat-retaining) ability [11].

Determination of the emulsifying ability of protein preparations was carried out by the method developed by Inklaar R. and Fourtuin J., by preparation of emulsions based on 1% aqueous dispersions and vegetable oil . Homogenization is carried out at the speed of rotation of the motor shaft 3000 rpm. For each sample, a series of emulsions with a fat phase content from 10% to 90% with an interval of 10% is prepared. Then, using a syringe, the emulsion is poured into tubes with a diameter of 5 mm, thermostated at 85 ° C for 20 minutes, then cooled with running water and centrifuged for 30 minutes at 6000 rpm. The criterion of the emulsions stability at the initial ratio of fat and water phases is the average for test tubes of the phase ratio in the system [11].

Determination of moisture-binding capacity was carried out by the "Press-method", which was developed by Grau R. and Hamm R. in modification of V. Volovinskaya and B. Kelman. The method is based on the separation of water by prototype with light pressing, adsorption of water released by filter paper and determining the amount of separated moisture by the size of the area of the stain left on the filter paper [11].

The determination of protein preparations pH was determined by a potentiometric method. The method is based on the measurement of the electromotive force of an element consisting of a comparison

electrode with a known potential value and an indicator (glass) electrode, the potential of which is due to the concentration of hydrogen ions in the test solution [11].

The degree of swelling was determined by the weight method, which is to determine the difference between the weight of the sample before and after swelling:

$$\alpha = \frac{m - m_0}{m_0} \times 100\ ,\%$$

where m_0 - the mass of the original mixture; m - the mass of the swollen mixture.

The viscosity was determined using a Rototest 2 viscometer [11]. the required speed of the rotor was setby means of a switching actuator by setting the lever in the position of the stages from 1a to 12 a. The rheological characteristics of the product were determined by the magnitude of rotation of the rotor (velocity gradient) and the resistance force of its rotation.

3. Results and discussion.

Previous studies have found that sesame, linseed, sunflower and pumpkin flour with unique chemical composition and pharmacological properties are promising raw materials for the enrichment of traditional meat products, in particular, chopped semi-finished products. It has been found that the ability of meat systems to bind moisture is increased with an increase in the degree of crushing of seeds, which can be explained by the microcrystallization of cellulose, which occurs in the process of fine grinding of grains. This is known to increase the ability of cellulose to absorb moisture and form a stable colloidal gel. It is also determined that the introduction into the meat systems of seeds, crushed to a particle size of 350 μm, increases fat-holding capacity, which is important technological value, since this indicator provides a gentle and homogeneous texture of the product, eliminates the separation of fat and reduces weight loss during heat treatment. Analytically, on the basis of the analyzed literature sources, it was established that all types of oilseeds we study have high nutritional value and functional and technological characteristics. And since, one of the most important indicators that determine the possibility of using any additive is its organoleptic properties, due to the peculiarities of the composition, the content of the individual components was determined based primarily on the results of sensory evaluation. For this purpose, the seeds of sesame, flax, sunflower and pumpkin, crushed to a particle size of 350 μm, were mixed in different proportions. After analyzing the results of organoleptic studies, it was decided to have an equal ratio of seeds four types in the mixture composition [12].

Thus, for further research, a mixture of seeds, which was finely ground to flour. In order to simplify the technological process, finished partially skimmed flour of TM “Sto Pudov” (Ukraine) oil cultures was used.

Animal proteins play an important role in the production of meat products. Their concentration in the finished product determines the protein and energy value of the finished products. Animal proteins have a high moisture retaining, emulsifying ability and thermal stability, which determines their multi-purpose. Therefore, in meat systems, there must be a sufficient amount of protein to realize these properties. Equally important advantages of animal proteins are the ease of use and preservation of their properties during long-term storage. The use of animal protein in the formulations of meat products can increase the yield of finished products and, thus, ensure the high quality

of the finished product while reducing its cost. Full-fledged animal proteins are significantly better than plant proteins in terms of biological value. It has been proved that, compared with plant, animal proteins are more balanced in amino acid composition and to a greater extent meet the body's needs for essential amino acids.

Special attention should be paid to beef proteins, which are almost identical to natural meat in amino acid composition. The degree of beef collagen protein hydrolysis allows the enzymes of the body to break down and convert it into energy necessary for human activity. Neutral pH and no odor make it possible to mix beef protein with different ingredients at different stages of meat production.

On the basis of the market analysis of animal protein preparations for the purpose of qualitative indicators research and comparison, protein preparations were selected: "ScanPro^{TM} T95", "Collagen Plus", "Helios-11".

ScanPro T95 is an animal protein based on collagen-containing raw materials (pork). It is used for the production of various types of meat products, including the production of chopped semi-finished products. It is applied in dry form or in the form of gels with a degree of hydration up to 1:15. In terms of organoleptic characteristics it is a fine powder (less than 106 μm) of light gray color with a neutral odor.

Collagen Plus is a beef collagen protein used in the meat industry. In the preparation of minced meat protein is added in dry form or in gel form. Capable of binding up to 20 units of water. The protein powder has a light color and a neutral odor.

Helios-11 is a long-fiber beef collagen protein (fiber sizes greater than 400 μm) of light gray color, with a neutral odor. Used in the technology of meat products in the form of gels, granules and in the dry form. One unit of protein is able to bind up to 20 units of water.

The results of the study of the physico-chemical parameters of the experimental protein preparations are shown in table 1.

Differences in the amount of protein, ash and fat can be explained by the different chemical composition of the raw materials entering the production and the different parameters of its technological processing. The moisture content of proteins is determined by modes, drying methods and the subsequent holding time before feeding the raw material for grinding (the material may collect moisture from the air).

Table 1.
Physico-chemical parameters of experimental protein preparations

Parameters	«ScanPro^{TM} T95»	«Collagen Plus»	«Helios-11»
Protein content,%	90.10	95.2	94.90
Ash content,%	2.61	1.14	0.98
Fat content,%	3.20	1.45	1.37
Moisture content,%	4.09	2.21	2.75
pH	8.10	8.10	7.85

«Collagen Plus» (3.82%) and «Helios-11» (2.21%) have the lowest moisture content. The low fat content in the protein preparation «Helios-11» (0.72) is explained by the use of higher quality raw materials and better alkaline treatment. The high content of ash in the proteins «ScanPro^{TM} T95» (2.81%) is a consequence of the inefficient technology of washing and removal of calcium salts. The high protein content of manufacturers such as «Collagen Plus» and «Helios-11» indicates a high level of raw material preparation technology for protein

production. The pH in the range of 5-9 does not directly affect the qualitative characteristics of the proteins.

To assess the level of functional and technological properties (moisture-retaining capacity - MRC and fat-retaining capacity - FRC) of the experimental protein preparations, appropriate studies were conducted, the results of which are shown in Figure 1.

The results of moisture-retaining and fat-retaining capacity analysis of the experimental protein preparations indicate that all protein preparations have high functional and technological properties, however, the «Helios-11» protein provides the highest performance.

Thus, the investigated additives - flour mixture from oil cultures and beef collagen protein «Helios-11» are promising and scientifically valid components for further use in the composition of complex mixtures for regulating the functional-technological properties of meat systems.

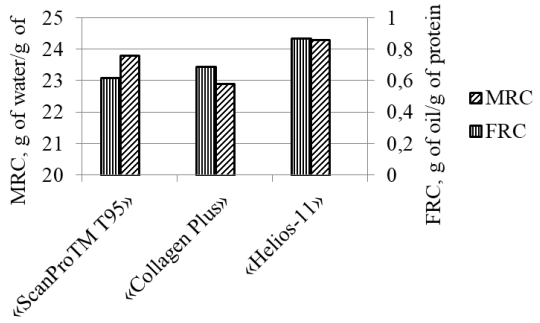

Fig. 1 Comparative moisture-retaining and fat-retaining capacity of animal proteins

In the next stage, a compositional protein-carbohydrate mixture obtained from flour of oils cultures (sesame, flax, sunflower and pumpkin) and collagen beef protein was investigated. The mixture was prepared by mixing the components in a dry form. To further justify the use of composite mixtures, their functional properties were studied under different component ratios and different degrees of hydration.

The study of the swelling of the protein-carbohydrate composition was performed using the ratio of protein : flour mixture from oils cultures equal to 1:4, 1:2, 1:1, 2:1, 4:1. The results obtained are presented in Figure 2.

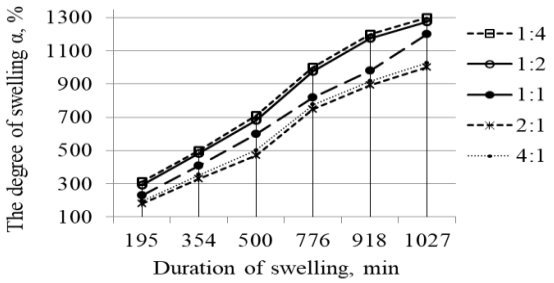

Fig. 2 Changes in the degree of swelling of the protein-carbohydrate composition depending on the ratio of protein : flour mixture from oils cultures

The results of the studies show that the swelling of the test mixture increases in the samples where the content of oil cultures flour is higher. This can be explained by the fact that the chemical component of the flour mixture is fiber, which binds to water chemically and capillary-osmotic, while the protein is only chemical, and depends on the content in its structure of free amino and carboxyl groups.

In order to establish the optimum value of the hydromodule for the protein-carbohydrate composition, a series of experiments was conducted, based on the addition to the mixture of different mass fraction of moisture at a temperature of 20-25 ºC. The results of the experiments showed that one part of the mixture can firmly bind 3-3.5 parts of water, so the recommended hydromodule is 1:3.

The investigated composite mixtures are intended to be used in the composition of emulsions, therefore, in the next stage, the stability and emulsifying ability were studied without heating the samples and with heating to 70 ° C for 20 min. (Fig. 3 and Fig. 4).

Thus, the results of the studies show that the highest rates have samples with a ratio

of protein : flour mixture from oils cultures 1:4 with a degree of hydration - 1:3.

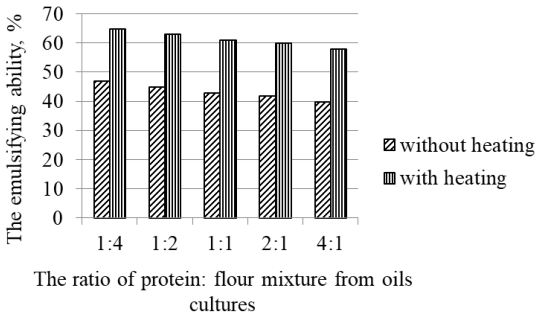

Fig. 3 Changes in the emulsifying ability of the protein-carbohydrate composition depending on the ratio of protein: flour mixture from oils cultures

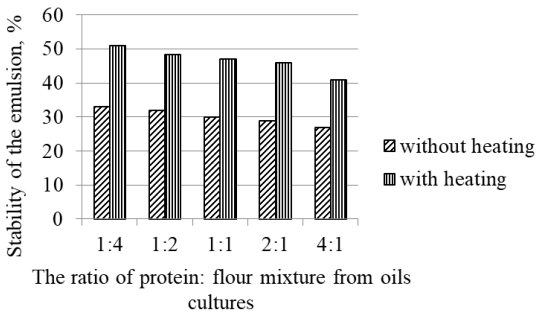

Fig. 4 Changes in the emulsifying ability of the protein-carbohydrate composition depending on the ratio of protein: flour mixture from oils cultures

Next, the optimal duration of gel retention and the effect of temperature on its viscosity were determined experimentally. The results are presented in the form of a graph (Fig. 5).

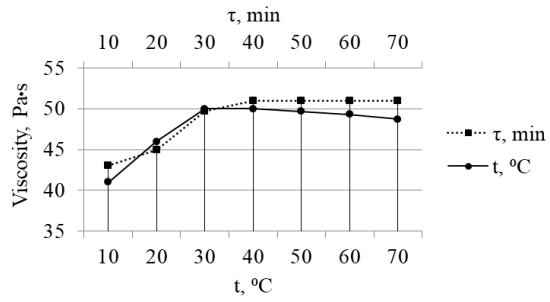

Fig. 5 Effect of temperature and exposure time on gel viscosity

Studies have shown that the optimum duration of the gel edurance is 30 minutes, during this time the gel stabilizes and with further aging its strengthening is not observed. As can be seen from Figure 5, heating to a temperature of 30-40 ° C increases the viscosity of the gel, and with a further increase in temperature this figure decreases slightly, which can be explained by the denaturation of proteins.

4. Conclusions.

The use of beef collagen protein «Helios-11» as a part of a protein-carbohydrate composition was substantiated on the basis qualitative indicators of studies and comparison of animal origin protein preparations in order to use them in the formulation of chopped semi-finished products and to improve their quality.

Ratios of protein and flour mixture from oils cultures (1:4) were selected, which create the most favorable conditions for the correction of meat systems by functional-technological properties, which contribute to the regulation of quality and are able to counteract the deficiencies of meat raw materials.

The revealed features of functional-technological properties of composite protein-carbohydrate mixtures depending on the ratio of components and the level of hydration, what are the basis for further research.

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