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Research paper

Prospects of Using Poultry by-Products in the Technology of Chopped Semi-Finished Products

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Abstract

In this paper the technology of preparation the protein-fat emulsion and its effect to sensory, physicochemical and microbial characteristics of meat cutlets are presented. The protein-fat emulsion consists of 75% of the chicken crests, 15% of the vegetable oil and 10% water. The protein, fat and ash content of emulsion are 9.53%, 6.38% and 0.95%, respectively. The amino acid composition of the protein-fat emulsion includes a complete set of essential amino acids - 36.2%. Adding of protein-fat emulsion as an ingredient in meat cutlets increase the total protein content, improves the sensory parameters and consistency of meat cutlets.

Keywords: *chicken by-products; emulsion; protein; meat; technology.*

1. Introduction

Manufacturers often introduce into the formulation of chopped semi-finished products plant material, protein and fat, protein and collagen emulsion prepared on the basis of the low valued collagen raw material [1]. Manufacturers replace valuable raw meat by low-grade. At the same time, the nutritional and biological value of meat products decreases. However, the use of raw materials with high collagen content in chopped semi-finished products is possible without negative influence on the quality of the finished product. For this purpose, preliminary processing of this raw material is recommended, which allows improving the functional and technological parameters, increasing the nutritional and biological value [2].

The perspectives of complex use of proteins, both of vegetable and animal origin, that allow rational use of the functional properties of protein preparations, i.e. their introduction into the composition of meat products in the form of multicomponent compositions of emulsion, structure-forming or structured types, have been proved by the works of domestic and foreign researchers [3].

Involvement in the production of secondary raw meat industry contributes to solving environmental problems, expanding the range of food products and improving their quality. Low-grade raw materials, including collagen-containing ones, contain valuable protein in considerable quantities [4].

When analyzing the deficiency of animal protein in fodder and food rations, it is established that the production of animal protein is sufficient to provide scientifically-based nutrition standards recommended by domestic science. At the same time, irrational or insufficiently full use of secondary protein-containing resources is the reason for the situation with food and feed provision, environmental problems at the enterprises of the industry [5]. American scientists note the economic feasibility of effective use of secondary slaughter products of animals. The cost of recycling, as well as its negative impact on the environment, is an additional incentive for more efficient use of meat by-products and other types of secondary raw materials [6].

An analysis of domestic and foreign literature sources, including patents, has shown that at present there are different directions in the use of collagen-containing raw materials and its waste. One of the main directions that can be distinguished is production of protein-fat additives, emulsions, hydrolysates; multifunctional drugs; structured products (such as chips, extrudates); gelatin [7].

When justifying rational ways of using secondary collagen-containing resources of the meat industry in the production of food products, it is expedient to systematize them according to microstructural characteristics and the ratio of protein-fat for the formation of differentiated approaches, means, methods of processing into nutritional supplements or functional collagen substances.

By-products of the second category in terms of food and biological value are close to the veined meat of Class I. They contain a significant amount of essential amino acids. Protein preparations obtained from by-products have high biological value, good water-binding and emulsifying properties [8].

Protein supplements are substances that are not prescribed as mandatory in the formulation and are introduced into meat sausages or other meat products to improve the quality or rational use of raw materials [9]. They are used in the development of certain types of sausage products, cutlets, pates, as their optimal ratio between protein and fat is often disrupted in the in the direction of increasing fat content [10, 11]. When using one or another type of protein supplements, one should take into account their effect on the product and especially on the qualitative composition of the protein, which depends to a considerable extent on the composition of essential amino acids in it. By combining proteins, based on their mutual enrichment, it is possible to improve the amino acid composition of the proteins of the product.

Rebezov M.B., Zinina O.V. noted that a certain content of collagen in meat raw materials does not reduce, but on the

contrary, increases its nutritional value, makes it more adequate digestive process occurring in the gastrointestinal tract [12]. However, the increase in the share of ballast substances in meat products due to connective tissue components has its own peculiarities and limitations. First of all, this concerns the effect of collagen on the biological value of the meat protein system. This is due to the fact that the role of ballast substances is performed mainly by non-digestible elements of connective tissue. The main mass of collagen is split to amino acids and, together with the products of proteolase and other proteins, participates in the process of metabolism. Therefore, it is possible to increase the content of connective tissue in meat products only to the extent that it does not significantly change the biological value of meat proteins [13].

An important direction in the rational use of meat raw materials is the production of protein concentrators of various food products based on the processing of by-products, poultry in particular. The protein content of such by-products is 15-18%, that is the same as in meat [14].

Taking into account the literature data and our own research, a method for preparing a protein enricher from sub-products of the 2nd category of poultry (chicken crests) has been suggested. Analyzes of the conducted studies have established that in chicken combs there are various vitamins, minerals, macro and microelements [15]. Estimating the nutritional and biological value of chicken crests, the presence of water-soluble vitamins, although in limited quantities, has been established: thiamine, ascorbic and pantothenic acids [15]. Research has allowed characterizing crests as a high-grade food product with presence of a unique biologically active component - hyaluronic acid [16].

The aim of the work is to study the quality characteristics of chopped semi-finished meat, manufactured with the introduction of a protein-fat emulsion, produced on the basis of collagen-containing raw materials - chicken crests.

2. Materials and Methods

2.1. Preparation of Protein-Fat Emulsion

Chicken crests are washed, then remove excess parts of the scalp, place in a bath and process with a microbial enzyme preparation "Bifilact-A." The treatment is carried out at a temperature of 85-90 ºC, for 30-35 minutes. Treatment with an enzyme preparation allows improving the functional and technological parameters, increasing the nutritional and biological value of chicken crests, and hence protein-fat emulsion. After the treatment with the enzyme preparation, chicken crests are chopped on a cutter with a lattice diameter of 2-3 mm for 6-7 minutes, vegetable oil, for example cotton, is added to the crushed chicken crests, chopped on a cutter for 3-4 minutes, then drinking water is added and chopped another 2-3 minutes. To obtain a stable emulsion with the best organoleptic characteristics and emulsifying properties, a series of experiments with different content of crests, vegetable oil and water were carried out. As a result, the following mixtures were tested:.

Table 1: Formulation of protein-fat emulsion

Treatment	Chicken crest	Vegetable oil	Water
1	75%	20%	5%
2	75%	17,5%	7,5%
3	75%	15%	10%
4	75%	10%	15%
5	75%	5%	20%

The repetition of the experiments is fivefold. The addition of water varied between 5% and 20% of the total weight of the protein-fat emulsion. And the total amount of added vegetable oil and water was planned by us in the range of 25-28% at the rate of 72-75%.

2.2 Determination of Proximate Composition

The determination of the chemical composition of meat was based on the determination of the following constituents: moisture, fat, ash and protein. The methods were performed as described by [17].

2.3 Amino Acid Determination

Liquid chromatography was used to quantify amino acids. The instrument used was a Shimadzu LC-20 Prominence liquid chromatography system (Shimadzu, Japan) equipped with fluorometric and spectrophotometric detectors. The chromatographic column used was a SUPELCO C18, 5 µm (Sigma-Aldrich, USA) offering a surface area of 200 m2/g. The chromatographic analysis was performed under a linear gradient with an eluent flow rate of 1.2 ml/min, where the column was heated in an oven at 400℃. Amino acids were detected using fluorometric and spectrophotometric detectors at wavelengths of 246 nm and 260 nm following acidic hydrolysis and treatment with a phenylisothiocyanate solution in isopropyl alcohol to give phenylthiohydantoins. Identification and estimation has been performed with comparing to an amino acid standard solution (AAS18 Sigma-Aldrich Denmark A/S, Brondby, Denmark) and plotting the associated calibration curve.

2.4 Sensory Analysis

A sensory evaluation was done by a panel of twelve (12) skilled persons (aged 23-58). In case of defects in flavor and aroma (inadequate pronounced flavor, weedy flavor, slightly acid flavor), consistency and structure, color and packaging, the score mark has been reduced for each defect according to the special sensory evaluation scale. The evaluation scale ranged from 1 to 5 points, where 1 – Unliked extremely; 5 – Liked extremely.

2.5. Statistical Analysis

Statistical analysis was performed using Statistica 12.0 (STATISTICA, 2014; StatSoft Inc., Tulsa, OK, USA). The differences between samples were evaluated using ANOVA method. The differences were considered to be statistically significant at $p \leq 0.05$.

3. Results and Discussions

All the obtained protein-fat emulsions were examined for protein, fat and ash content. The results are shown in Table 2.

Table 2: Proximate composition of protein-fat emulsion**, %**

Treatment	Proximate composition, %			
	protein	fat	ash	water
1	8,25	7,6	0,88	83,27
2	8,34	6,41	0,91	84,34
3	9,53	6,38	0,95	83,14
4	9,65	5,1	0,99	84,26
5	9,7	5,65	1,08	83,57

Protein-fat emulsion containing 15-20% of water does not meet the requirements for emulsions. Therefore, the most optimal is an emulsion containing 75% of chicken crests obtained by chopping with a plate diameter of 2-3 mm, 15% vegetable oil and 10% water. The preparation of the protein-fat emulsion was as follows: 75% of the chicken crests were introduced into the cutter and chopped for 5-6 minutes, then 15% of the vegetable oil was added thereto, chopping was carried out another 3-4 minutes, then 10% water was added, and then again chopping for 3 minutes. The protein concentrator has a uniform pasty consistency. It can be used in the production of meat products. This approach to the preparation of a protein enrichment enhances the moisture-binding

ability, improves nutritional and biological value, balances the amino acid composition, and improves the digestibility of in vitro proteins by pepsin and trypsin. The quality of protein-fat emulsion is estimated not only by its chemical composition and functional-technological properties, but also by indicators of biological value. In connection with this, we studied the amino acid composition of the protein-fat emulsion The amino acid composition of the protein-fat emulsion (PFE) (Table 1) includes a complete set of essential amino acids - 36.2% of their total number. In this case, the amino acid index (ratio of essential acids to interchangeable ones) is 0.57, i.e. is at the "ideal protein" level, according to FAO / UNO.

Table 3: Amino acid composition of protein-fat emulsion

Name of amino acid	Content, mg / 100 g
Essential amino acids (total)	3955,43
valine	511,21
isoleucine	482,50
Leucine	831,11
lysine	880,18
methionine	214,65
threonine	451,21
tryptophane	107,00
phenylalanine	430,73
Replaceable amino acids (total):	7888,96
alanine	630,00
arginine	587,35
asparagine acid	1021,36
histidine	153,22
aminoacetic acid	511,00
glutamine acid	1788,31
proline	501,33
serine	430,93
tyrosine	365,49
cystine	380,22
oxyproline	410,15

Thus, the use of protein-fat emulsion in the production of chopped semi-finished products contributes not only to obtaining a product with good consumer properties, but also to solving the issue of rational use of raw materials. The addition of protein-fat emulsion to the semi-finished forcemeat provides a homogeneous consistency and improved structure of the forcemeat, since the protein concentrator is characterized by high functional technological parameters - moisture and fat-binding, fat-emulsifying abilities, stability of the emulsion, which are achieved during the fine grinding process. Semi-finished minced meat - cutlets - made according to the recipe shown in Table. 4. As a control, a sample prepared according to a conventional formulation without introducing a protein-fat emulsion was adopted. The level of replacement of meat raw materials by a protein-fat emulsion was determined by the optimal organoleptic characteristics of prototypes of cutlets with the introduction of 10 to 50% of PFE. On the basis of organoleptic parameters, the sample with the introduction of a protein-fat emulsion - 20%, was the most acceptable, and the consistency of ready-made semi-finished products turned out to be the decisive factor in choosing the level of introduction. For further research as a developmental prototype, cutlets with the introduction of a protein-fat emulsion in an amount of 20% of the weight of the raw material were selected (Table 4).

Table 4: Recipe of cutlet

Ingredient	kg/100 kg	
	Control sample	Developmental prototype
Horse meat	65,0	65,0
Protein-fat emulsion	—	20,0
Horse fat	7,0	—
Wheat flour	6,0	—
Water	7,0	---
Onion	6,5	6,5
egg melange	2,5	2,5
dried bread crumbs	4,5	4,5
Salt	1,1	1,1
Coriander	0,2	0,2
Black powdered pepper	0,2	0,2

The organoleptic characteristics of the developed cutlets were determined by a descriptive method, the results are shown in Table. 5. The presented studies show that the introduction of a protein-fat emulsion into the composition of semi-finished products improves the consistency, increasing the density, juiciness and softness of the product.

Table 5: The organoleptic characteristics of the developed cutlets

Indicator	Characteristics	
	Control sample	Developmental prototype
Appearance and view on the cut	The shape of the cutlets is oval; the surface is without torn and broken edges, evenly breaded with wheat breadcrumbs. On the cut the forcemeat is uniform, well stirred	
Taste and smell	In its raw form is characteristic to high quality raw materials	
	After heat treatment, the smell is characteristic to product, with a pleasant aroma of spices. Taste is pleasant, expressed meat	After heat treatment, the smell is characteristic to product, with a pleasant aroma of spices. Taste is pleasant

The results of determination of the physicochemical parameters are shown in Table 6. The results of the determination of microbiological indicators, as well as their permissible levels, regulated by CU TR 034/2013 "On the safety of meat and meat products" for semi-finished meat chopped molded, breaded are presented in Table 7.

Table 6: Physicochemical parameters of the researched cutlets

Indicator	Indicator value		
	Normed according to GOST (All-Union State Standard) 32951-2014	Determined in the course of work	
		Control sample	Developmental prototype
Mass fraction of protein,%, not less than	10,0	18,6+/- 0,4	24,5,7+/-
Mass fraction of fat,%, not more than	50,0	8,4+/-0,2	12,6+/-0,1
Mass fraction of sodium chloride,%, not more than	1,8	1,1+/-0,1	1,0+-0,1

Table 7: Microbiological indicators of researched cutlets

Indicator	Indicator value		
	Normed CU TR 32951-2014	Determined in the course of work	
		Control sample	Developmental prototype
The number of mesophilic aerobic and facultative-anaerobic microorganisms, CFU / g, not more than	5*10^6	1,2*10^3	3,6*10^3
Bacteria group of coliform bacillus coliforms) 5 0.0001 g	Not permitted	Not discovered	Not discovered
Mold, CFU / g, not more than	500	Not discovered	Not discovered

4. Conclusion

Thus, according to the results of physical and chemical studies, it can be concluded that the developed cutlets for food value are not inferior to the control sample, and also meet the requirements of GOST (All-Union State Standard) 32951-2014. The sample of cutlets with the introduction of protein-fat emulsion differs by more juicy consistency, pleasant smell and taste. It is advisable to use in technology of chopped semi-finished meat products, a protein concentrator, obtained on the basis of modified collagen-containing raw materials. This allows us to rationally use the sub-products of category 2 and obtain products with the required level of nutritional and biological value and various functional orientations, regulate AFT and colloid-chemical processes in meat systems. The use of protein-fat emulsions (PFE) in the manufacturing of semi-finished products will save the main meat raw materials, as well as obtain a product with high nutritional value. Complex use of protein ingredients, which have sufficiently high functional properties, biological value, made it possible to obtain a protein-fat emulsion, to expand the technological possibilities of using byproducts of protein obtained by deep processing of poultry.

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