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Biomodifying chicken stomachs for manufacturing ham product

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Abstract. A deeper processing of secondary meat raw materials determines the profitability and cost-effectiveness of production. The larger volume of poultry meat is produced, the more organ meat is obtained as a by-product. A higher share of collagen-containing by-products in high-grade meat products becomes possible due to the preliminary biomodification of raw materials, in particular enzymatic processing. The paper suggests using chicken stomachs as part of ham after they were subjected to enzymatic collagenase treatment. This biomodification method makes it possible to produce ham with high organoleptic characteristics from poultry meat and chicken stomachs in a ratio of 60% and 40%.

1 Introduction

Modern industrial poultry farming is of great importance for food security. This is derived from the fact that poultry converts feed nutrients into products more efficiently than other animals.

In the structure of global meat production of all types, poultry meat production has taken the first position since 2016. According to Rosstat, the poultry products (including chicken paws) in the Russian Federation exceed 5 million tons per year. While domestic production of animal protein is growing, its consumption (raw and deeply processed) per capita is also increasing [1].

According to the classification of the World Food Organization (FAO), poultry meat can be classified as an indispensable food. Meat contains a complete and balanced set of essential amino acids, unsaturated fatty acids, vitamins, macro nutrients and trace elements. The amount of essential amino acids reaches 92% in the protein of broiler chicken meat, 88% in pork protein, 72% in beef protein. The qualitative composition of poultry meat determines the possibility of using this raw material to manufacture healthy and specialized nutrition [2].

Poultry meat is used in manufacturing a wide range of meat products. And today it actively displaces meat of slaughtered animals (beef, pork) from recipes. A wide range of poultry meat products is characterized by an affordable price, high quality indicators, which allows it to compete with products made from livestock meat.

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With the market saturated with meat products, manufacturers face the task of increasing the product competitiveness by improving their quality, expanding the range, developing new types of products taking into account the requirements of consumers.

Currently, the development level of the meat industry requires an integrated approach to the problem of using all types of raw materials. When slaughtering and processing poultry, industry enterprises receive not only the main raw materials, but also a large number of by-products. Obviously, a higher amount of processed poultry entails an increasing number of by-products. That is, the industry annually produces about 1.7 million tons of by-products, which makes the task of processing secondary products of poultry enterprises one of the most promising areas.

Most of this raw material is sold in its natural form – chilled or frozen. By this the company receives a negligible profit, compared to selling a processed finished product. The most important factor of economic growth and well-being of the enterprise is manufacturing products with high added value.

By-products obtained in the production of poultry meat as accompanying raw materials have a high biological value, due to the content of vitamins and trace elements in them in a biologically accessible form. In addition, involving by-products in manufacturing meat products increases the processing depth of raw animal materials and reduces their cost. At present, the secondary food raw materials of the poultry processing industry, which include by-products, are not widely used in manufacturing food products of deep processing. The only factor limiting the full-scale use of offal in meat products is their specific organoleptic properties and increased strength characteristics. In this regard, developers are required to take a reasonable approach to modifying the properties of by-products [3].

Chicken stomachs, as high-protein and low-fat raw materials, can become the basis for creating healthy food products. Containing all essential amino acids, they also serve as a source of glycine, proline, and oxyproline, responsible for collagen synthesis in the human body. The rich mineral composition, including thiamine, folic acid, niacin, increase the value of this raw material as a component of meat products for a healthy balanced diet [4]. Chicken stomachs are mainly sold to the population frozen or chilled, sometimes used in the manufacture of culinary products. This is due to the fact that the composition of this raw material contains a large amount of collagen, which belongs to proteins with low functional and technological properties. Preliminary preparation of these raw materials destroys (softens) collagen, which contributes to its better assimilation by the body.

The purpose of enzymatic pre-treatment of collagen-containing raw materials is to disperse collagen fibers while maintaining the three-helix structure of the molecules. The products of enzymatic processing of collagen-containing raw materials differ from the products of hydrothermal decomposition of collagen, such as gelatin or glue [5].

To modify the structure of the collagen fiber, various methods of processing collagen-containing raw materials are used, contributing to the partial and complete transition of collagen into a dispersed state [5].

In domestic and foreign practice, such techniques as cooking in water, marinade, milk, or whey, processing with weak solutions of organic acids (acetic, ascorbic), hydrogen peroxide solution are used in order to improve the functional and technological properties of raw materials (swelling, strength characteristics) and increase the degree of digestibility. This treatment disaggregates and disintegrates the structural elements of the collagen fiber, which loosens the connective tissue [4, 5].

Traditionally, chicken offal is used in the technology of canned food, pates, and ready-made culinary products. The manufacturing of these products requires long-term medium- and high-temperature heating of raw materials, which leads to a decrease in its strength, but at the same time is accompanied by a decrease in their nutritional and biological value (protein loss) and additional energy consumption [6, 7].

The most promising biotechnological methods include preparating secondary collagen-containing raw materials, which will improve their organoleptic and structural-mechanical characteristics. This will expand the possibilities of raw materials while enriching products with macro nutrients and trace elements. [7, 8, 9]

The presented work aims at substantiating the modes of preliminary biotechnological processing of chicken stomachs with a view to their further use in ham.

2 Materials and methods

Scientific research was carried out at the Department of Food Technology of Animal Origin (Kemerovo State University); physico-chemical, microbiological, and sanitary-hygienic indicators were analysed at the Kemerovo Testing Laboratory.

The objects of research include:

- by-products with a high content of connective tissue (chicken stomachs);

- enzyme preparation of collagenase from hepatopankereas of Kamchatka crab (Paralithodes camtschatica), produced by OOO BioloT (St. Petersburg), in accordance with TU 9281-004-11734126-00 Food collagenase (health certificate No. 77.99.11.928.D.003869.06.04 of 02.06.2004, issued by the State Sanitary and Epidemiological Service of the Russian Federation). The drug had a standard proteolytic activity of 750 U/mg;

- chicken stomachs after enzymatic treatment;

- ham products with different amount of chicken stomachs treated with collagenase.

The first stage of the research consisted in selecting optimal conditions for biomodifing chicken stomachs (the enzyme concentration and the duration of exposure of raw materials).

Chicken stomachs were ground with a hasher, treated with a collagenase solution with a concentration of 0.5 units, 1 unit, 2 units, 3 units, 4 units by weight of raw materials and were let to stand for 1, 3, 6, 24, and 48 hours at the same temperature of 0-4 ˚C.

The efficiency of enzymatic treatment was evaluated by the accumulation of non-protein nitrogen and the change in strength characteristics after heat treatment. Optimal conditions for biomodification of raw materials were established on the basis of the results obtained.

At the second stage, the maximum permissible level of treated stomachs in the ham recipe was determined, which does not deteriorate the organoleptic characteristics of the product.

Mince for ham was prepared in a massager in two stages with intermediate maturation for 24 hours at a temperature of 0-4 ˚C. The ham was shaped into an artificial polyamide casing. The heat treatment was carried out by steam at a temperature of 80-85˚C until the temperature reached 74 ± 2˚C in the center of the samples.

At the final stage, the ham quality was assessed by organoleptic, physico-chemical, microbiological, and sanitary-hygienic indicators.

Non-protein nitrogen was determined by Kjeldahl method, the amount of penetration was measured with a conical KP-3 plastometer, organoleptic parameters were assessed on a 5-point scale in accordance with GOST 33609-2015 using descriptors of the general organoleptic profile.

3 Results and discussion

At the first stage of the experiment, collagen-containing raw materials underwent enzymatic processing in order to identify the optimal concentration of the preparation and the duration of exposure.

Figure 1 shows non-protein nitrogen in chicken stomachs accumulated after enzymatic treatment.

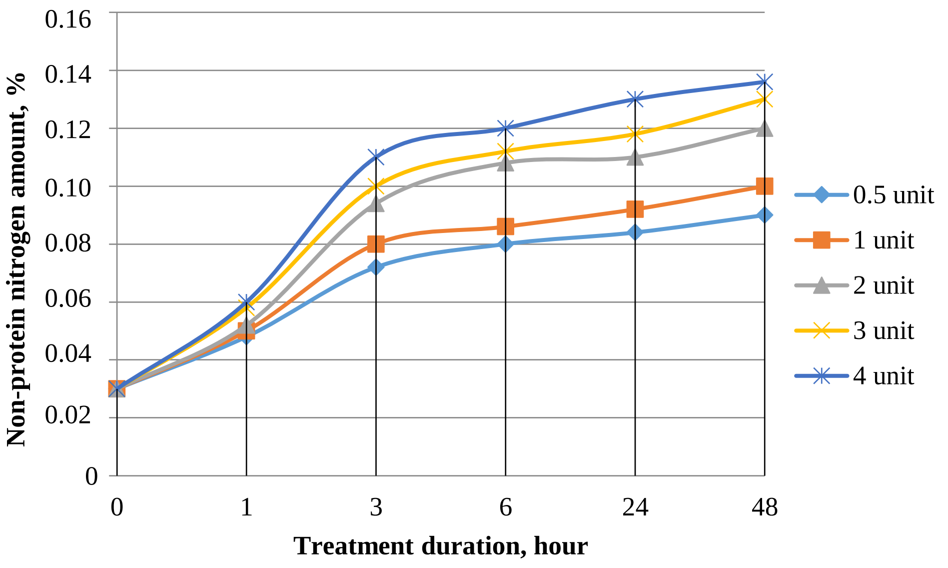

Fig.1. Dynamics of non-protein nitrogen accumulation during enzymatic treatment of chicken stomachs

With a processing time of less than 3 hours there is insufficient hydrolysis of collagen fractions, so that their potential self-structuring after extraction from raw materials is not provided. The processing time over 24 hours leads to a greater loss of collagen fractions and deterioration of the functional characteristics of the final product.

A higher concentration of enzymes and longer treatment led to the complete destruction of globular muscle proteins, an ointment-like structure, and the release of part of the protein substances into the filtrate. Increased protein content in the filtrate can be characterized as an undesirable phenomenon, leading to a gradual decrease in the protein amount in the fermentation product with an increase in the concentration of the preparation used for fermentation.

Analysis of the data obtained suggests that the maximum rate of accumulation for non-protein nitrogen is observed for the first 24 hours, then the rate of accumulation begins to decrease. Therefore, enzymatic treatment for over 24 hours is considered impractical.

It should be noted that the greatest structure changes observed visually occurred with the sample treated with the collagenase enzyme preparation with a concentration of 2 units per 1g of protein cured for 24 hours. The connective tissue was well softened, but the structure was not destroyed. This sample was used for further research.

At the next stage, a recipe was developed for poultry ham with fermented chicken stomachs. The optimal ratio of stomachs and chunky poultry meat was selected. For this purpose, experimental samples were produced with different proportions of stomachs from

0% to 100%. Chicken stomachs are known to ave a complex morphological composition. A large amount of connective tissue has a significant impact on the biological value, structural and mechanical properties of raw materials.

The decisive indicator for the optimal amount of chicken stomachs in the new product composition is the assessment of the samples for structural and mechanical properties. Six samples of different ratios of stomachs to poultry meat (in 20% intervals) were made to determine the consistency of the product. It was found that the instrumental method for determining the hardness of the product is consistent with organoleptic assessments. Thus, the degree of penetration decreased with an increase of stomach content in the product composition (figure 1).

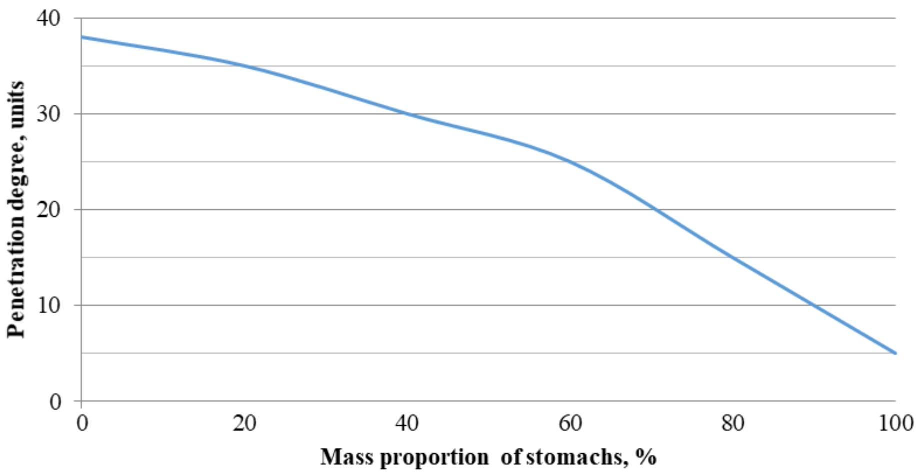

Fig. 2. Studying the structural and mechanical characteristics of hams depending on the proportion of chicken stomachs

During the experiment, it was determined that 60% is the maximum permissible stomach content in the product. This proportion does not deteriorate the consistency of the product.

At the next stage, a test batch of ham was produced from poultry meat and chicken stomachs. For comparison, a control sample was made (without chicken stomachs), and experimental samples contained 20, 40, and 60% of fermented chicken stomachs. The assessment of organoleptic parameters of the ham product, made of poultry meat and stomachs, is shown in Figure 3.

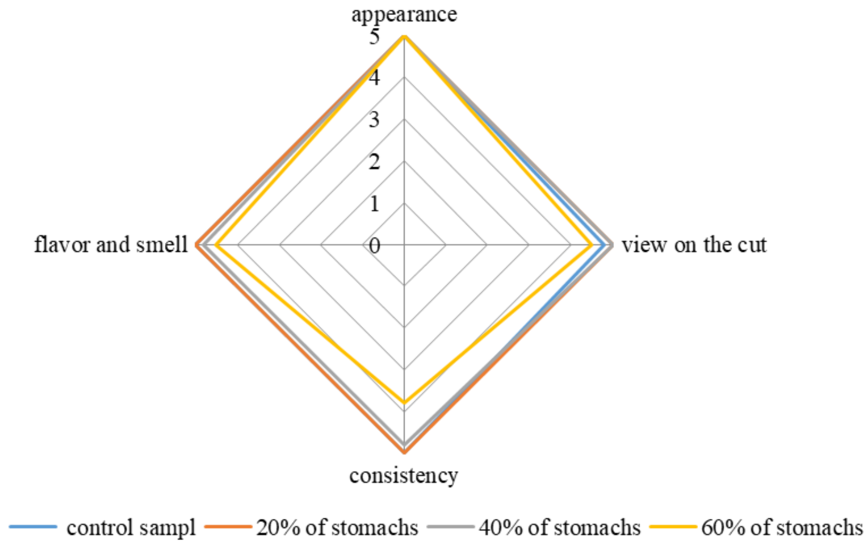

Fig. 3. Profilogram of organoleptic analysis of samples

All samples were positively evaluated by tasters. Comparing organoleptic parameters of the control and experimental samples suggests that adding 20-40% of fermented stomachs increases the attractiveness of ham in terms of "view on the cut", giving a beautiful marbled pattern. Adding 60% of stomachs worsens the consistency of the product.

To study the physico-chemical, microbiological, and hygienic parameters, the control sample and the ham containing 40% of fermented stomachs were sent to Kemerovo Testing Laboratory.

Table 1 presents the results of the physico-chemical parameters of the ham.

Table 1. Physico-chemical parameters of ham

Indicators	**Sample**	
	control	**with 40% of stomachs**
Protein mass fraction, %	13.4	16.00
Fat mass fraction, %	2.6	2.4
Mass fraction of sodium chloride, %	2.0	2.1
Mass fraction of sodium nitrite, %	0.0048	0.0047

According to the data obtained, 40% of fermented chicken stomachs in the ham recipe increases the mass fraction of protein by 19.4%, compared to the control recipe. The studied ham samples are comparable in fat content. In terms of salt content and residual sodium nitrite, the products comply with regulatory requirements for a similar product group.

The test report on microbiological and sanitary safety indicators showed full compliance of the new product with the requirements of TR CU 034/2013 "On the safety of meat and meat products" and TR CU 021/2011 "On food safety".

4 Conclusion

Based on the results obtained, it can be concluded that chicken stomachs are promising raw materials for the production of restructured products. This type of raw materials makes it possible to rationally use secondary raw materials, expand the range of meat products, reduce their cost, enrich the diet of people with missing substances. It is appropriate to apply the method of biotechnological modification of the raw materials containing collagen using collagenase from the hepatopancreas of the Kamchatka crab. The functional and structural-mechanical properties of such raw materials are improved. The best changes in raw materials are achieved when treated with an enzyme preparation with a concentration of 2 units per 1 gram of protein and then cured for 24 hours at a temperature of 0-4˚C. A ham recipe has been developed with chicken stomachs not exceeding 40%. The resulting product has original organoleptic characteristics, a high protein content, and a low fat content.

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