Effective use of meat of meat-and-egg chicken and eggs for the production of specialized semi-finished products

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Abstract. Poultry meat is a full-value food product for the population. It is widely used in general and specialized diets. Thanks to the work of breeders, breeds of meat-egg chickens with high egg production and high-quality meat were bred. At the same time, the meat of meat-egg chickens is somewhat inferior in organoleptic parameters to broiler meat, which to a lesser extent allows it to be used in the production of specialized meat-based food products.

The paper presents the results of research on the development and production of specialized semi-finished products for the nutrition of pregnant women, using meat of meat-egg chicken. To increase the organoleptic characteristics and nutritional value of the developed semi-finished products, a new product from chicken eggs is introduced into the latter – egg coagulated melange, enriched with kelp. Kelp is a source of iodine in a bioavailable form. Calcium enrichment of the developed semi-finished products was carried out by the product of the chicken egg-shell processing - a mineral concentrator, in which calcium is in an easily digestible form.

The conducted studies, the results of which are presented in this article, allowed to establish that the enrichment of functional ingredients based on chicken eggs led to an increase in the nutritional value of semi-finished products, an improvement in organoleptic indicators. The introduction of kelp in the composition of enriched melange reduced the loss of iodine.

Thus, efficient processing of poultry products was carried out: meat of meat-egg chicken (processing of the shell and the egg itself).

1. Introduction
Currently, the production of poultry meat and its processed products is increasing. Since 2019, the annual production of poultry meat has been above 5 million tons. According to experts, by 2024 it may increase to 5.3 million tons.

The poultry industry is characterized by certain features, among which the following can be noted: rapid reproduction of livestock, use of high-tech methods of cultivation, high feed conversion rate. The use of modern processing methods has allowed to expand the range of products manufactured on the basis of poultry meat. Also, an important criterion for the purchase of poultry meat for the population and meat processing enterprises is the low cost of such raw material and products of its processing.
The range of products based on poultry meat is increasing: there are new types of sausage products with the inclusion of mechanically deboned poultry meat, the range of semi-finished products is expanding.

Poultry meat is a full-value food product. It is characterized by a high content of high-grade protein at the level of 17.2-23.8%. The amino acid composition of poultry meat is represented by interchangeable and essential amino acids. Thus, poultry contains lysine - 8.7%, isoleucine - 3.6%, and valine - 4.8%. The amino acids ratio characterizes the high balance of chicken meat protein in seven amino acids. The studies presented in the open press, conducted by Shestapalova I.A., Uvarova N.A., proved that the meat of laying hens has a rational coefficient of amino acid composition \( R_c = 0.62 \) [1]. Unlike meat of slaughtered animals, poultry has a lower level of defective proteins. More than 85% of the protein substances in the muscle tissue of poultry are full value. The digestibility of poultry proteins also exceeds the digestibility of meat of slaughtered animals (80 and 75%, respectively).

Chicken fat is easily digestible, contains more than 20% PUFA and is close in composition to the composition of olive oil. In small quantities, it contains cholesterol. The main polyunsaturated acids are oleic (37-43%) and linoleic (18-23%). The fractional composition of lipids in various muscles and skin of chicken carcasses is presented in Table 1. [2].

**Table 1.** Fractional composition of lipids in different muscles and skin of chicken carcasses, % of total fat.

| Lipid fractions      | Pectoralis | Femoral muscle | Skin  |
|----------------------|------------|----------------|-------|
| Diglycerides         | 0.9        | 1.4            | 1.1   |
| Monoglycerides       | 0.9        | 1              | 0.7   |
| Free fatty acids     | 2.4        | 2.6            | 1.4   |
| Triglycerides        | 25.5       | 55             | 86.8  |
| Phospholipids        | 62.1       | 34.3           | 8.1   |
| Cholesterol          | 6.4        | 4.7            | 1.3   |
| Cholesterol esters   | 1.2        | 0.7            | 0.4   |

Organoleptic indicators of poultry of meat-egg chicken are somewhat inferior to broiler meat. So the meat of the first is more dense, more tough. At the same time, the meat of meat-egg chickens is characterized by a more pronounced aroma and taste, which is achieved by the content of 0.9-1.2% of extractive substances in it, which cause the release of digestive juices and stimulate appetite.

The morphological features of poultry are that the fat in poultry is distributed more evenly, muscle fiber is thinner, and connective tissue is contained in a smaller amount than in meat of slaughtered animals. Poultry is less calorific, which allows it to be used in the production of dietary meals and ready-made food products [3]. The chicken skin consists of connective and adipose tissue in large quantities. Its use in the production of meat products can increase the moisture-retaining, moisture-binding and texture-forming ability, increasing the organoleptic and structural properties of products.

Eggs are the products of the poultry industry. Over the past 50 years, there have been significant changes in the egg processing industry. Today, in Europe and the United States, more than 30% of total egg consumption is accounted for by processed eggs, and the rest are sold in shell. In Russia, only 10% of eggs are used in processed form: frozen and pasteurized products: melange, protein and yolk, egg powder, omelets.

Eggs are a full-value and one of the most versatile food products. For many years, the egg was subject to negative advertising, mainly related to cholesterol content, which also led to a decrease in consumption. This was a negative sign, although eggs offered many positive effects in the consumer's diet. Comprehensive researches have shown that dietary cholesterol has no significant effect on serum cholesterol. Eggs are now recognized as highly nutritious foods with unique ingredients that contain potential nutraceuticals with special health benefits. Thanks to these recognized benefits, egg consumption has increased significantly in recent years. In many ways, this higher consumption is a result of the increased use of eggs as an ingredient in various egg products for further processing [4].
Eggs are considered as a healthy food that is well suited to a high-protein, low-carb diet. Egg is considered as the most perfect food of nature, containing an excellent source of protein with high biological value, while having a moderate amount of calories (about 150 kcal/100 g), a high ratio of unsaturated fatty acids and saturated fatty acids, as well as an excellent source of minerals and all vitamins. The yolk provides all the fat and contains half of the protein, most of the calcium, phosphorus, iron, zinc and vitamins B6, B12, A and folic acid, as well as half of riboflavin and thiamine. Egg white contains about half of the protein and riboflavin. [5] The multifunctionality of eggs makes them the preferred ingredient in many food recipes, they can be used not only in the confectionery, meat and processing industries, but also sold as a ready-made dish. The egg has a high nutritional and biological value, high culinary versatility [6].

Now, research is continuing on the development of new types of products based on eggs and its components. Thus, in the work [7], the use of egg yolk separated by centrifugation to produce ready-made culinary products was proposed.

In the work [8], the application of the coagulation process to produce coagulated protein and the development of products based on it is proposed.

Coagulated egg-based products - coagulated egg melange, obtained by the technology of coagulated protein, was used to produce semi-finished products from poultry [9]. The use of egg melange in the production of meat products is limited. The introduction of more than 5% of melange in the composition of minced meat leads to the formation of a liquid structure and thus the impossibility of products forming. Coagulated melange can be added in larger quantities, improving organoleptic parameters and nutritional value [10].

Deeper processing of poultry products – eggshells, is possible by using it in the production of mineral concentrator. To do this, the prepared, disinfected shell is crushed to a powdery state. The shell is a source of easily digestible calcium and contains 11.5% crude protein, 35% calcium and 1% phosphorus. Calcium is represented in the composition of calcium carbonate CaCO3 - 98.4%, phosphoric acid salts of calcium and magnesium Ca3(PO4)2 - 0.7%. The data given in the literature on the calcium absorption from shell powder, powder from the shell and putamen indicate the absorption of calcium of the order of 75-80% [11].

The modern consumer is interested in purchasing products with maximum production preparation in order to save time for their production at home.

All the above suggests that it is advisable to use poultry meat in processed form, for example, semi-finished products [12].

2. Materials and Methods
The paper presents data on the development of semi-finished products of a high degree of readiness from poultry - meat-egg chickens for the nutrition of pregnant women.

At the first stage of development, the main needs of pregnant women in micro- and macro-nutrients were identified. Insufficient intake of calcium and iodine from food was established.

Natural sources of functional food ingredients containing high amounts of these nutrients have been identified. The mineral concentrator from eggshell was selected as the source of calcium. As a source of iodine, kelp powder "Laminar" was chosen.

At the second stage of the study, the formulation of semi-finished products was calculated using linear programming, artificial intelligence methods, and statistical modeling. Calculations were carried out based on the fact that specialized semi-finished products supply the body from 15 to 30% of the daily needs of a pregnant woman in vitamins and minerals.

Linear programming allowed to calculate an approximate recipe for the industrial production of semi-finished products. Correction of the recipe was carried out in the computer mathematics system Mathematica.

The calculation of the recipe, considering the enriching components and taking into account more factors, is carried out in stages using the universal computer mathematics system Matlab and its editor FuzzyLogic. The data obtained by different programs had similar values.
According to the obtained recipe, the technology of semi-finished products of a high degree of readiness was developed. In the composition of semi-finished products, instead of melange, coagulated melange enriched with iodine was introduced. A separate study was the technology of production of iodine-enriched coagulated melange. Melange coagulation was carried out by the method of limited acid-salt hydrolysis during heat treatment. Iodine enrichment was carried out using dried kelp, kelp powder "Laminar". The nature of the kelp distribution in melange was determined experimentally.

The level of introduction of coagulated melange into the composition of semi-finished products was established. Coagulated melange was added in the amount of 10, 15, 20, 25%.

Also, the loss of iodine at the stages of the technological process, depending on the method of application and calcium, is determined.

3. Results and Discussion

To produce semi-finished products of a high degree of readiness for the nutrition of pregnant women, a standard technology for the production of chopped semi-finished products was chosen. In addition, the technology is expanded by the stage of coagulated iodine-enriched melange production, as well as the stage of bringing semi-finished products to a high degree of readiness.

The technology of coagulated melange production, which consists in carrying out a limited acid-salt hydrolysis during heating, is determined. The number of introduced components was determined, at which we obtain the highest yield and high organoleptic parameters: 0.25% of citric acid, 0.8% of salt, heating to a temperature of 88°C.

Iodine enrichment was carried out by introducing kelp. The option of applying washed kelp; washed and watered kelp; dry crushed kelp and Laminar kelp powder was considered. Dry crushed kelp and kelp powder had a uniform distribution over the volume of melange. They were selected for further research.

The level of kelp application was determined experimentally. It was found that with the introduction of kelp powder in an amount of 0.5 to 1.5% in the coagulated melange the mass fraction of iodine increases rapidly from 0.8 mg/100 g to 2.1 mg/100 g, the loss of iodine is insignificant. Further increase in the amount of introduced kelp powder from 1.5 to 2.0% slightly increases the iodine content (up to 2.5 mg/100 g). At the same time, a strongly pronounced specific aroma of iodine also appears. Thus, for enrichment, it is recommended to carry iodine into the melange at the coagulation stage in an amount of 1%.

The introduction of crushed kelp slightly increased the iodine level from 0.2 to 0.4 mg/100 g. Thus, dried kelp is impractical to use.

The influence of the level of melange application in semi-finished products on organoleptic parameters was determined. This identified the following indicators of the severity of the taste and aroma of coagulated egg: 1 – taste and aroma of melange is not noticeable; 2 – taste and aroma of melange is slightly notable; 3 – taste and aroma of melange seems more pronounced; 4 – significant taste and aroma of egg, interrupting the taste of the flavor of the main raw material. As a result of the tasting assessment, the following results were obtained: when applying coagulated melange in an amount of 10, 15%, 1 point was assigned to the severity of the taste and aroma of coagulated melange; adding melange in an amount of 20% revealed the aroma and taste of melange more pronounced (2 points); adding melange in the amount of 25% revealed a significant aroma of melange, a significant taste of coagulated melange (4 points).

Thus, the introduction of coagulated melange in the amount of 25% leads to the appearance of a pronounced aroma and taste of melange, which interrupts the smell of the main meat raw materials.

The introduction of coagulated melange improved the structural and mechanical properties of semi-finished products: juiciness, tenderness, softness of semi-finished products increased with the introduction of melange compared to samples without it, which was noted as a positive effect in changing the consistency. The indicators improved with the introduction of up to 20% of coagulated melange. The introduction of 25% of melange led to loosening of semi-finished products and
deterioration of their quality indicators. Graphically, the structural and mechanical properties are shown in Figure 1.

Figure 1. Changes in the structural and mechanical properties of semi-finished products with different content of coagulated melange.

The technology of semi-finished products involves bringing to culinary readiness, further cooling and freezing.

The level of iodine in semi-finished products was determined depending on the method of application at the stages of the technological process. After baking semi-finished products with direct introduction of kelp powder to minced meat, iodine losses amounted to 51.0%; further technological processes (cooling, freezing, quenching) led to an increase in losses to 57.6%. This is a fairly high loss of iodine.

When adding iodine in the composition of coagulated melange, the losses decreased by 15-17% and amounted, respectively: after baking – 38.8%; baking, freezing and stewing - 40.8%.

It was found that the introduction of iodine in the composition of coagulated melange reduced the loss of iodine.

The level of calcium in semi-finished products was determined at the stages of the technological process. It was found that after baking, the calcium loss was 0.7%; baking and further stewing increased the calcium loss to 1.6%. In general, this is a low loss, which indicates a good stability of calcium in semi-finished products.

4. Conclusion

1. The technology of production of semi-finished products of high degree of readiness for nutrition of pregnant women has been developed.
2. The introduction of coagulated melange in an amount of up to 20% improved the organoleptic characteristics of semi-finished products. Such indicators as juiciness, tenderness, and softness have increased.
3. Enriched coagulated melange allowed to reduce the loss of iodine in semi-finished products.
4. Calcium from the mineral concentrator from eggshell is stable, the value of losses during processing is low.
5. The developed semi-finished products made it possible to carry out deep processing of poultry and chicken eggs.

References

[1] Shestopalova I A 2012 Scientific Journal of SRI ITMO. Series "Processes and devices of food production 2 pp 46-51
[2] Gonotsky V A at al. 2004 *Mechanically deboned meat poultry* (Alfa-Design) p 200

[3] Danyliv M, Danyliv M M, Vasilenko O A, Ozherelieva O N and Derkanosova N M 2018 *Production Engineering of the Low Fat Meat Products*

[4] Sunwoo H H and Gujral N 2015 *Chemical Composition of Eggs and Egg Products. In: Cheung P., Mehta B. (eds) Handbook of Food Chemistry* (Springer, Berlin, Heidelberg)

[5] Froning G W 2008 *Egg products industry and future perspectives. In Y. Mine (Ed.), Egg Bioscience and Biotechnology* (Ontario, Canada: Wiley) pp 307–320

[6] Carrillo S, Rios V H, Calvo C, Carranco M E and Casas M 2012 *J. Appl. Phycol.* 24 pp 593 – 599

[7] Anderson, K E 1993 *Egg quality: future trends, in Proceedings Florida Poultry Institute, Tampa* pp 9–11

[8] Stefanova I L and Klimenkova A Yu 2015 *Meat technologies* 4 pp 22 -27

[9] Stefanova I L, Kuznetsova T G and Borisova V L 2016 *Poultry and poultry products* 4 pp 55-58

[10] Stefanova I L, Shakhnazarova L V and Borisova V L 2018 Medico-biological evaluation of semi-finished products based on poultry meat for the nutrition of pregnant women *World and Russian trends in the development of poultry farming: realities and challenges of the future: a collection of scientific articles based on the results of the XIX International Conference. - Sergiev Posad: (WPSA) Russian branch of SE "Scientific Center for Poultry Farming"* pp 564-567

[11] Alford L R, Holmes N E, Scott W J and Vickery J R 1950 *Aust. J. Appl. Sci.* 1 pp 208–14

[12] Danyliv M M, Korolev I S, Plutalova M V and Vasilenko O A 2016 *Tekhnologiya of meat semi-finished products with reduced fat content technologies of food and processing industry of agrarian and industrial complex are products of healthy food* (9) pp 35–42