Development of the production technology for semi-finished meat products with addition of mushrooms

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Abstract. The study aims to provide an analytical substantiation of a promising direction – development of specialized meat products enriched with macro- and micronutrients, dietary fiber and organic acids. To create conditions for a balanced diet and to improve the health of the population, we propose to use a technique that employs non-traditional resources of plant origin. Meat occupies one of the first places in nutrition, since it contains almost all nutrients needed for the human body. A product has been developed with addition of oyster mushrooms to increase its nutritive value. The formulation for pork cutlets was taken as a basis. The main raw materials used were pork and mushrooms, and auxiliary raw materials were bread, crackers, onions, melange, salt, pepper, and water. All raw materials were pre-processed, mixed and molded before use. As a result, an improved production technology of semi-finished meat products with mushrooms was proposed. The expediency of using mushrooms in production of semi-finished meat products was substantiated, studies of the effect of mushroom addition on properties of cutlets were conducted, and sensory assessment was performed. Introduction of mushrooms into the formulation improved the sensory properties of the finished product, improved the color and texture. In addition, the product exhibited tender texture, enhanced chewiness, and decreased stiffness. Calculation of the energy value of the control and experimental samples of the product showed that the use of the filler reduced the calorie content of the new product by 28.34 kcal. Thus, semi-finished products with inclusion of mushrooms can be recommended for both mass meals and diet food.

1. Introduction
One of the many basic requirements for the latest food technologies is an increased range of products due to creation of new combined products with a professionally selected composition of food and
biological substances [1–7]. The lack of important food nutrients such as proteins, vitamins in the diet of an average person, the current unfavorable environmental situation, and the need to economically use secondary resources put forward a task to manufacture meat products and use various types of raw materials, including raw materials of plant origin, namely mushrooms [8–12].

Any food product must contain components that are required for normal metabolism for each human body in a required ratio [13–17]. Full implementation of the proposed technologies will increase the range of functional products in case of deficiency of dietary protein, vitamins, and dietary fiber [18–20]. Meat is central to nutrition due to essential nutrients necessary for the body [21–24]. Meat diversifies the human diet and include food rich in tastes [25–28].

Mushrooms are a valuable food product. Mushrooms contain an entire complex of macronutrients (carbohydrates, proteins, fats), micronutrients (almost the entire complex of B vitamins, fat-soluble vitamins D and E, macro- and microelements, dietary fiber, organic acids, enzymes) and they do not contain plant starch. Mushrooms differ from plants in the absence of starch. Fresh mushrooms contain 84–94% water. About half of dry solids are nitrogenous compounds, which on average are 70% proteins. Glycogen and sugar from the group of carbohydrates are found in mushrooms (trehalose is a non-reducing disaccharide; mannitol is a polyhydric alcohol; chitin as part of the fiber fraction). Instead of fiber, the shells of mushroom are composed of a specific substance – fungine. Mushrooms contain about 0.5% fat, most of it is located in the fruiting layer of the pileus.

Oyster mushrooms are dietetic food, since 100 g of mushrooms contain only 33 kcal. Despite the low calorie content, the nutrient content needed for the human body in oyster mushroom is high. The amount of amino acids and protein in mushrooms significantly exceeds that in vegetables and can compete with dairy and meat products. In protein content and amino acid composition, oyster mushrooms are closer to plant raw materials compared with raw materials of animal origin. Oyster mushroom protein contains all the essential amino acids that human needs.

Vitamins A and E found in large quantities make oyster mushroom an anti-cancer product. Oyster mushrooms contain a large amount of biologically active substances. According to studies, the juice of this mushroom prevents the growth of colibacillus, and due to its bactericidal properties, mushrooms remove radioactive substances from the human body. Regular addition of mushrooms to the diet makes a person more resistant to X-ray effects.

Oyster mushroom is involved in elimination of various salts of heavy metals and radionuclides from the human body; it enhances immunity, and has an antiviral effect. The indisputable advantage of oyster mushroom polysaccharides is their low toxicity. The fruiting bodies of mushrooms contain compounds that delay the aging process of the body due to their antioxidant activity. Oyster mushrooms are involved in elimination of cholesterol from the body, which reduces the risk of atherosclerosis.

2. Materials and methods
The product was produced according to the formulation presented in table 1.

Table 1. Formulation.

| Raw materials         | %   |
|-----------------------|-----|
| **Main raw materials**|     |
| Pork                  | 46.16 |
| Mushrooms             | 11.54 |
| **Auxiliary raw materials** |   |
| Bread                 | 13  |
| Crackers              | 4   |
| Bow                   | 2   |
| Melange               | 2   |
| Salt                  | 1.2 |
| Pepper                | 0.1 |
The sensory evaluation of the resulting product was carried out, namely, the appearance, color, taste, flavor, texture, etc., and the energy value of the product was determined by the calculation method.

The production process includes the following technological operations: meat, lard, onion, and garlic were ground using a mincer with a 2–3 mm hole disk. White bread, previously soaked in water, was ground using the mincer with the same hole disk. Frozen eggs were previously thawed in water not exceeding 45 °C. This product must be used immediately for its intended purpose. Dry eggs in the form of egg powder were mixed with water in a ratio of 274 g of egg powder and 726 g of water. Flour for breading was passed through a sieve and magnetic catchers. Salt used in a dry form was previously sieved.

To produce a high-quality product, pork was used with a fatty tissue content of 30%, and a connective tissue content of not more than 15%.

The components were placed into the meat mincer according to the formulation. The ingredients were filled in the order specified in the formulation and stirred until smooth. The finished minced meat was transferred to a molding machine to shape the minced meat into cutlets.

3. Results
Traditionally, semi-finished products are made from raw meat. If vegetable or any other raw materials (for example, mushrooms) are introduced into the formulation, the biological value of products can be increased due to a large amount of vitamins and dietary fiber, while the cost of products can significantly reduce. For example, oyster mushrooms can be added to the minced meat.

In our study, we used an edible mushroom of the genus Pleurotus, family Pleurotaceae, sp. Pleurotus ostreatus (oyster mushroom). Almost all species from the genus Pleurotus are edible. The species is restricted to countries with a temperate climate, including Ukraine and Russia, where seven species of oyster mushrooms grow, of which five are edible.

In terms of sensory properties, new products are not inferior to traditional ones. Addition of mushrooms has a beneficial effect on the sensory properties of the finished product, primarily color and texture.

The mushroom added to the formulation imparts the finished product with tender texture, enhanced chewiness, and decreased stiffness (table 2).

| Sample                        | Appearance | View and color in section | Odor | Taste | Consistency | Juiciness | Overall rating |
|-------------------------------|------------|---------------------------|------|-------|-------------|-----------|----------------|
| Control: Pork cutlets         | 7.5        | 7.2                       | 8.5  | 8.6   | 7.4         | 8.1       | 7.9            |
| Experimental: Pork cutlets    | 7.7        | 7.4                       | 8.7  | 8.8   | 7.8         | 8.4       | 8.1            |
| Pork cutlets with mushrooms   | 7.7        | 7.4                       | 8.7  | 8.8   | 7.8         | 8.4       | 8.1            |

Based on the results of the experiments, certain properties were evaluated. At the same time, samples containing oyster mushrooms in their formulation were distinguished by a uniform texture, and did not have voids and gray spots.
Similar to the control, samples of chopped semi-finished products with mushrooms have a pleasant appearance, color, and flavor.

According to the protocols of the descriptive panels, the optimal dosage of mushroom as a substitute was determined and amounted to 20% replacement of minced meat. Samples with application rates of 30% and 40% differed in the minimum texture ratio.

A five-point scale was used to evaluate appearance, flavor, texture, taste, juiciness, and color of the samples (figure 1).

![Figure 1. Sensory evaluation of samples.](image)

Based on the results obtained, the optimal dosage for replacing raw meat with mushrooms was equal to 20%.

Analysis of the data obtained showed that the appearance of the samples is pleasant, uniform, without gray spots and voids; without foreign taste and smell.

According to the descriptive panels, control samples and samples with 20% content of oyster mushrooms showed similar results during evaluation of sensory properties.

In the study, the energy value of the sample product was found to decrease by 28.34 kcal, and amounted to 186.92 kcal.

4. Conclusion

In the study, the percentage of a vegetable component in the cutlet formulation that does not impair the taste of the finished product was determined and amounted to 20%. The data obtained show that the developed product containing dietary fiber and micro- and macronutrients exhibits improved sensory properties. This product can be used to expand the range of meat products.

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