Results of semi-finished horse meat products research using protein fortifiers after heat treatment

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Abstract. Meat products play a key role in human nutrition. It is necessary to introduce and apply new, extraordinary approaches to solving a number of problems in order to intensify technological processes and create environmentally safe, harmless and optimal technologies for processing raw materials. In the production of meat products, the main requirement for raw materials is its balance in all ingredients, proteins, fats, carbohydrates, minerals, as well as the balance of proteins in amino acid composition. Horse meat fully meets this requirement. One of the most dynamically developing branches of the meat industry is the production of semi-finished meat products. The purpose of the research is to study semi-finished horse meat products using protein fortifiers after heat treatment. As a result of heat treatment, meat products acquire new characteristic taste, aromatic qualities, a dense texture and are better absorbed. In the steamed test products, the moisture content increased by 1.01%, the fat decreased by 0.87%, and the protein increased by 1.01%. In fried semi-finished products, the loss of vitamins was: thiamine (B1) - 30%, riboflavin (B2) - 10%, niacin (PP) - 15%, tocopherol (E) - 17.5%, A and C - 19.97 and 70 % respectively. In steamed semi-finished products, the loss of vitamins in niacin (B1) - 10%, riboflavin (B2) - 10%, niacin (PP) - 10%, tocopherol (E) - 12.2%, A and C - 15 , 02 and 60% - respectively. The study of the mineral composition of fried and steamed semi-finished products showed that the loss of mineral substances was: potassium - 23.3 and 19.8%; sodium - 15 and 10.24%; calcium - 10 and 5.04%; magnesium - 21.9 and 12.75%; phosphorus - 20.1 and 10.7%; iron - 4.98 and 3%; zinc - 5.04 and 2.9%, respectively. In general, 0.81 is consumed from the amount of NAC products exposed to frying; steam treatment: 0.88.

1. Introduction
Today, in the field of processing and storage of agricultural raw materials and products based on it, technologies have insufficient compliance with modern scientific achievements [1-5]. It is necessary to introduce and apply new, extraordinary approaches to solving a number of problems in order to intensify technological processes and create environmentally safe, harmless and optimal technologies for processing raw materials [6-8].
At present, in the production of meat products, attention is not fully paid to those sources of protein, which, according to the traditional technology of the meat industry, are sent to the production of technical products or to the production of protein feed, although the feedstock in terms of chemical composition and sanitary condition meets the requirements for food products. [9-11]. Therefore, one of the priority directions in the development of the meat industry is the development of new types of food products using all types of protein-containing raw materials [12-18].

However, the search for new ways to use unconventional raw materials in food production continues to be one of the urgent tasks in the meat industry [17-22].

The problem of a lack of animal proteins exists all over the world, so the need to solve it is urgent [18-27]. There are many ways to solve this problem, one of them seems to be the development of a product with a high protein content, and inexpensive. At the same time, by-products are sources of protein since they are a by-product of processing raw meat. Rational use of by-products solves several problems: firstly, inexpensive raw meat; secondly, solving the problem of their disposal.

In the production of meat products, the main requirement for raw materials is its balance in all ingredients, proteins, fats, carbohydrates, minerals, as well as the balance of proteins in amino acid composition [25-32]. Horse meat fully meets this requirement.

Horse meat has a beneficial effect on the human body due to the content of a large amount of linoleic and linolenic fatty acids, which prevent the deposition of cholesterol on the walls of blood vessels. As a dietary product, it is recommended to use it in case of insufficient nutrition to restore protein reserves. Currently, there are numerous data on the physicochemical, biological properties of horse meat, which testify to its high nutritional value and confirm the possibility of using it as a therapeutic dietary product.

Horse meat products, which have been subjected to various heat treatments, to the maximum extent, preserving its biological and nutritional value, are widely used in medical and dietary nutrition. The effectiveness of the use of dietary meals, which include horse meat, in the treatment of alimentary obesity, atherosclerosis, liver diseases, has been proven by research by specialists from the Kazakh Institute of Nutrition and Federal Scientific Centre for Food Systems named after V. M. Gorbaty, RAS.

2. Material and methods
The technology and formulation of a protein fortifier and chopped semi-finished horse meat was developed. On the basis of the studies carried out, the regulatory and technical documentation for the chopped semi-finished product with the addition of a protein fortifier (enterprise standard) was approved.

A patent for a useful model of the Republic of Kazakhstan No. 3373 dated 12.11.2018 was received. Method for the production of semi-finished meat products [24]. Pilot-industrial approbation of the developed technology recipe was carried out in the production conditions of Semol LLP, Semey (East Kazakhstan region, Kazakhstan).

The research was carried out according to the following guidelines:

- GOST 23042 Meat and meat products. Methods for determining fat;
- GOST 25011 Meat and meat products. Protein determination methods;
- GOST 33319 Meat and meat products. Method for determining the mass fraction of moisture (corrected);
- GOST 31727-2012 (ISO 936) Meat and meat products. Method for determining the mass fraction of total ash;
- GOST 9957 Meat and meat products. Methods for the determination of sodium chloride content (with amendment);
- GOST R 55484 Meat and meat products. Determination of sodium, potassium, magnesium and manganese content by flame atomic absorption;
- GOST R 55573. Meat and meat products. Determination of calcium by atomic absorption and titrimetric methods;
• GOST 32009-2013. (ISO 13730: 1996) Meat and meat products. Spectrophotometric method for determining the mass fraction of total phosphorus (with Amendment);
• GOST 26928 Food products. Method for determination of iron;
• GOST 26934 Raw materials and food products. Method for determination of zinc (with Amendment No. 1);
• GOST R 55482 Meat and meat products. Method for determining the content of water-soluble vitamins;
• GOST R 53157 Poultry by-products. Commodity Specification.

3. Results and discussion
For research, the prepared semi-finished products were subjected to heat treatment. The quality indicators of finished products were studied.

Heat treatment of semi-finished products consists in heating the product on a baking sheet with the addition of fat or in a steam environment to a temperature inside the product of 70 °C, because culinary readiness is determined by the denaturation of soluble proteins. As a result of heat treatment, meat products acquire new characteristic taste, aromatic qualities, a dense consistency and are easier to digest.

In the experimental steamed products, the moisture content increased by 1.01%, the fat decreased by 0.87%, and the protein increased by 1.01% (table 1).

| Indicators | Fried | Steamed |
|------------|-------|---------|
| Moisture   | 65.73±0.2 | 70.21±0.6 |
| Fat        | 17.19±0.4 | 13.86±0.3 |
| Protein    | 15.12±0.2 | 13.82±0.18 |
| Ash        | 1.96±0.01 | 2.11±0.03 |

It was found that due to a decrease in the moisture content in the finished fried semi-finished products, the loss of a part of the extractives (from 13.68% to 15.12%). A significant (from 14.73% to 17.19%) increase in the lipid content in the experimental finished sample in comparison with the semi-finished product indicates the transition of a part of the lipids into the product.

Heat treatment also affects vitamins. So, in fried semi-finished products, the loss of vitamins was: thiamine (B1) - 30%, riboflavin (B2) - 10%, niacin (PP) - 15%, tocopherol (E) - 17.5%, A and C - 19.97 and 70%, respectively (figure 1 and table 2).

In steamed semi-finished products, the loss of vitamins was 10% for niacin (B1), 10% for riboflavin (B2), 10% for niacin (PP), 12.2% for tocopherol (E), A and C for 15.02 and 60% - respectively.
Table 2. Vitamin composition of finished products, mg / 100 g.

| Indicators | Fried       | Steamed     |
|------------|-------------|-------------|
| A          | 0.620±0.01  | 0.657±0.01  |
| B1         | 0.018±0.01  | 0.024±0.01  |
| B2         | 0.123±0.01  | 0.138±0.01  |
| PP         | 2.45±0.1    | 2.58±0.1    |
| E          | 0.65±0.01   | 0.73±0.01   |
| C          | 0.15±0.01   | 0.204±0.01  |

The study of the mineral composition of fried and steamed semi-finished products showed that the losses of mineral substances were: potassium - 23.3 and 19.8%; sodium - 15 and 10.24%; calcium - 10 and 5.04%; magnesium - 21.9 and 12.75%; phosphorus - 20.1 and 10.7%; iron - 4.98 and 3%; zinc - 5.04 and 2.9%, respectively (figure 2).

![Figure 2. Mineral composition of finished products, mg / 100 g.](image)

Biological value, being the main indicator of protein quality, does not exclude the possibility of using other criteria for food quality. Interacting with a protein product, our body, as it were, consumes a protein form with a certain ratio of essential amino acids and assimilates only this form - the rest is excreted from the body. Thus, the body perceives food according to a nonlinear law, and this nonlinearity is fixed in an ideal protein product (Food and Agriculture Organization, FAO). In our case, the essential amino acid with the minimum value is methionine + cystine (A / F = 0.81: 0.88) (table 3). In order to compare different protein sources of a product according to the degree of their use by the body, it is advisable to correlate the proportion of the used amount of essential amino acids to their total amount in the protein source. Thus, in general, 0.81 of the amount of essential amino acids of products exposed to frying is consumed; steam treatment: 0.88.

Table 3. Amino acid composition of the standard and protein developed products.

| NAC                  | FAO g / 100g (F) | Semi-finished products g / 100g (A) | A/F |
|----------------------|------------------|-----------------------------------|-----|
|                      | Fried            | Steamed                           |     |
| Valin                | 5.0              | 5.4                               | 1.08| 1.12|
| Isoleucine           | 4.0              | 5.8                               | 1.45| 1.58|
| Leucine              | 7.0              | 10.61                             | 1.51| 1.51|
| Methionine + cystine | 5.5              | 4.48                              | 0.81| 0.88|
| Threonine            | 4.0              | 8.62                              | 2.15| 2.275|
| Tryptophan           | 1.0              | 1.49                              | 1.49| 1.57|
| Phenylalanine + tyrosine | 6.0          | 7.46                              | 1.24| 1.24|
4. Conclusion
As a result of heat treatment, meat products acquire new characteristic taste, aromatic qualities, a dense consistency and are better absorbed.

In the steamed test products, the moisture content increased by 1.01%, the fat decreased by 0.87%, and the protein increased by 1.01%.

In fried semi-finished products, the loss of vitamins was: thiamine (B1) - 30%, riboflavin (B2) - 10%, niacin (PP) - 15%, tocopherol (E) - 17.5%, A and C - 19.97 and 70%, respectively. In steamed semi-finished products, the loss of vitamins was 10% for niacin (B1), 10% for riboflavin (B2), 10% for niacin (PP), 12.2% for tocopherol (E), A and C for 15.02 and 60% respectively.

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In general, 0.81 is consumed from the amount of essential amino acids of products exposed to frying; steam treatment: 0.88.

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