A new generation of soy proteins for sustainable food production

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Abstract. One of the promising directions in the creation of meat products is the development and production of products of combined composition, combining a balanced complex of nutrients necessary for the body. In recent years, soy processing products have been most intensively used as a vegetable component in the production of meat products. Protein additives obtained by processing soybeans are widely used in the meat processing industry due to their high functional and technological characteristics, a positive effect on the organoleptic characteristics and nutritional value of the product. The purpose of the work is to study the nutritional value and technological parameters of the soy protein concentrate "Arkon-S". The theoretical part of the research was carried out on the basis of the Department of Food Technologies of Don State Agrarian University, the development of pilot batches of products - in the production conditions of the sausage factory in Rostov-on-Don. The developed technology for the production of cooked sausages with soy concentrate "Arkon-S", the functional properties and nutritional value of which, in combination with economic feasibility, allow it to be used as a protein ingredient in the production of combined meat products.

1. Introduction
Soybeans are the most common among pulses and oilseeds. It serves as a raw material for a wide range of food products, and the high content of protein and valuable food components allows it to be used as an inexpensive and healthy substitute for meat [1, 2, 3].

In recent years, soy processing products have been most intensively used as a vegetable component in the production of meat products. They are most widely used in sausage production, to give products the appropriate texture, increased nutritional properties, high taste and functional qualities while reducing the cost of basic raw materials [4, 5].

One of the features of soybean processing products is the binding of fat and water in the minced meat systems and providing a stabilizing effect. Soy products better retain water, proteins, and better balance food in terms of nutritional value and physiological needs of the body [6, 7, 8].

Soy contains in its composition a significant amount of high-value protein, dietary fiber, minerals that determine its nutritional value and attract numerous researchers to find the most effective ways to use soy and its processed products in order to create new types of functional products and increase their nutritional value [9].
Soy proteins are traditionally produced in various forms: soy flour, soy protein concentrate, and soy protein isolate. Currently, a new generation of soy proteins has appeared on the market — functional concentrates Arko-S, Danpro-HVX, Danpro-S-760, which are obtained as a result of acid washing and high-temperature treatment [10].

The purpose of the work is to study the nutritional value and technological parameters of the soy protein concentrate "Arkon-S".

2. Materials and methods
The theoretical part of the research was carried out on the basis of the Department of Food Technologies of Don State Agrarian University, the development of pilot batches of products - in the production conditions of the sausage factory "VEPOZ", Rostov-on-Don.

As objects of research, we used:
- raw meat - trimmed beef first grade, trimmed semi-fat pork, lateral fat;
- high-functional soy protein concentrate "Arkon-S" (Netherlands, SEZ No. 77.99.04.916.D.008850.12.02);
- other ingredients according to the recipe.

Experimental studies provided for the use of modern physicochemical, structural-mechanical, functional-technological, microbiological and organoleptic research methods, according to State standards.

In addition, the study was conducted using methods of statistical data analysis, comparison, analogy and systematization.

3. Results and discussion
At the beginning of the research, the assessment of the main physical and chemical parameters of the soy protein concentrate "Arkon-S" (Netherlands, SEZ No. 77.99.04.916.D.008850.12.02) was carried out.

Soy protein concentrate "Arkon-S" contains: 68-70% protein, 7.8-8.0% moisture, 0.9-1.0% fat, 4.9-5.0% ash, does not contain cholesterol, has a neutral taste, high solubility, water binding and fat emulsifying ability. The fatty acid composition of soy protein concentrate "Arkon-S" is presented in Table 1.

| Name                     | Content, mg/100 g |
|--------------------------|-------------------|
| The amount of lipids     | 95-97             |
| Triglycerides            | 80-83             |
| Peaceful acids (amount)  | 15-18             |
| - palmitic               | 10-12             |
| - stearic                | 3.0-4.0           |
| Monounsaturated          | 13-15             |
| - oleic                  | 13-15             |
| Polyunsaturated          | 48-50             |
| - linoleic               | 41-43             |
| - linolenic              | 5-7               |

The research methodology provided for the study of the effect of soy protein concentrate "Arkon-S" on the technological properties of model minced meat systems. As a control sample, minced meat was used, consisting of trimmed beef 1 grade, trimmed semi-fat pork and side lard.

Soy concentrate "Arkon-S" was added to the minced meat in the form of a pre-prepared gel. The gel was prepared in a cutter, with the addition of 4 parts of cold water, until a glossy shine was formed. Soy concentrate was introduced into the model minced meat systems, replacing part of the trimmed beef of the 1st grade in an amount from 10% to 30% (Table 2).
Table 2. Recipes of experimental model minced meat.

| Ingredients                     | Control  | Replacement level |
|---------------------------------|----------|-------------------|
|                                 | 10%      | 20%               |
|                                 | 30%      |                   |
| Unsalted raw materials, kg (per 100 kg of raw materials) |          |                   |
| Beef trimmed 1 grade            | 60.0     | 50.0              |
| Pork trimmed semi-fat           | 25.0     | 25.0              |
| Lateral fat                     | 15.0     | 15.0              |
| Soy concentrate "Arkon-S"       | -        | 2.0               |
| Hydration water                 | -        | 8.0               |
| Total                           | 100.0    | 100.0             |

In experimental samples there was an increase in pH from 6.03 to 6.11, which is associated with the presence of soy protein concentrate "Arkon-S" (pH 7.1), the control sample had the lowest pH value of 5.8. The moisture binding capacity of the test samples exceeds the control data, which is caused by a decrease in the amount of myofibrillar proteins involved in the structure formation of the finished product and an increase in the moisture content due to the preliminary hydration of the soy concentrate (Table 3).

Table 3. Moisture binding capacity of minced meat systems with different levels of soy protein concentrate in the formulation.

| Replacement level | Moisture binding capacity, % of total moisture |
|-------------------|-----------------------------------------------|
| Control           | 79.16                                         |
| 10% protein       | 85.53                                         |
| 20% protein       | 87.25                                         |
| 30% protein       | 88.19                                         |

In the production conditions of the sausage factory "VEPOZ" (Rostov-on-Don), prototypes of combined sausages with different levels of replacement of meat raw materials with soy protein concentrate "Arkon-S" were developed. As a control, we used the "Separate" sausage recipe (State Standard 33673-2015 "Cooked sausage products: Technical conditions"), the protein additive was introduced into the recipe of the experimental samples (Table 4).

Table 4. Recipe of prototypes of combined sausages with different levels of substitution of meat raw materials.

| Ingredients                     | Control  | Replacement level |
|---------------------------------|----------|-------------------|
|                                 | 10%      | 20%               |
|                                 | Control  |                   |
| Unsalted raw materials, kg (per 100 kg of raw materials) |          |                   |
| Beef trimmed 1 grade            | 60.0     | 50.0              |
| Pork trimmed semi-fat           | 25.0     | 25.0              |
| Lateral fat                     | 15.0     | 15.0              |
| Soy protein concentrate "Arkon-S" | -      | 2.0               |
| Hydration water                 | -        | 8.0               |
| Total                           | 100.0    | 100.0             |

Food additives, spices, materials, g (per 100 kg of unsalted raw materials)

| Ingredients         | Control  | 10% | 20% | Control  |
|---------------------|----------|-----|-----|----------|
| Sugar               | 150.0    | 150.0| 150.0| 150.0    |
| Table salt          | 2500.0   | 2500.0| 2500.0| 2500.0   |
| Sodium nitrite      | 6.4      | 6.4 | 6.4 | 6.4      |
| Black pepper        | 100.0    | 100.0| 100.0| 100.0    |
The organoleptic assessment carried out indicates that the assessment indicators of the prototypes using the soy protein concentrate "Arkon-S" correspond to the characteristics of the Otdelnaya boiled sausage, and in some positions, in particular, the consistency and juiciness, slightly exceed the values of the control sample (Table 5).

**Table 5. Organoleptic characteristics of cooked sausages.**

| Test samples | Appearance | Color | Flavor | Taste | Consistency | Juiciness | Average rating |
|--------------|------------|-------|--------|-------|-------------|-----------|----------------|
| Control      | 4.5        | 4.6   | 4.3    | 4.7   | 4.3         | 4.3       | 4.45           |
| 10%          | 4.5        | 4.6   | 4.4    | 4.7   | 4.5         | 4.3       | 4.50           |
| 20%          | 4.5        | 4.5   | 4.3    | 4.7   | 4.5         | 4.3       | 4.46           |
| 30%          | 4.3        | 4.4   | 4.2    | 4.5   | 4.2         | 4.3       | 4.31           |

With an increase in the amount of concentrate to 30%, these indicators decrease, the smell and taste are unusual for this type of product, they have a characteristic soy taste. Table 6 shows the physicochemical indicators of the quality of the prototypes of the combined sausages.

**Table 6. Physicochemical indicators of the quality of prototypes.**

| Test samples | Content, % |
|--------------|------------|
|              | Moisture   | Protein   | Fat     | Ash       | Carbohydrates |
| Control      | 65.16 ± 1.32 | 11.10 ± 0.20 | 20.21 ± 0.18 | 2.33± 0.01 | 1.2 ± 0.02 |
| 10%          | 68.71 ± 1.37 | 11.41 ± 0.22 | 15.22 ± 0.16 | 2.53± 0.02 | 2.04± 0.01 |
| 20%          | 68.74 ± 1.30 | 11.45 ± 0.23 | 15.17 ± 0.12 | 2.55 ± 0.03 | 2.18 ± 0.01 |

In comparison with the control, there was a decrease in the mass fraction of fat, which is a positive factor in the light of modern trends in the field of healthy nutrition. The results of the analysis of the chemical composition of cooked sausages indicate that the formulations containing from 10% to 20% soy concentrate have a fairly high biological value.

The value of the yield of finished products is one of the criteria that determine the economic feasibility of the production of cooked sausages, which, at the same time, is closely related to the functional properties of the proteins of the minced meat system, which determine the juiciness of the finished product. The results of determining the yield and weight loss of sausages are presented in Table 7.

**Table 7. Yield and weight loss of cooked sausages.**

| Indicators     | Control    | 10%        | 20%        |
|----------------|------------|------------|------------|
| Output, %      | 113.3 ± 1.7 | 117.6 ± 1.8 | 117.8 ± 1.8 |
| Weight loss, % | 13.1 ± 0.3  | 11.3 ± 0.3  | 11.2 ± 0.3  |

The results of determining the yield indicate that the maximum value of the investigated indicator for the sample containing 20% soy concentrate "Arkon-S".
4. Conclusion
On the basis of the studies carried out, the expediency of using the hydrated soy concentrate "Arkon-S" in the production technology of combined sausages has been confirmed. In the experimental samples there was an increase in pH from 6.03 to 6.11, which is associated with the presence of soy protein concentrate "Arkon-S" (pH 7.1), the control sample had the lowest pH value - 5.85 compared to the experimental. In comparison with the control, in the experimental samples there was a decrease in the mass fraction of fat, an increase in the total content of protein and carbohydrates, formulations containing from 10% to 20% of soy concentrate have a fairly high biological value. Organoleptic evaluation of model minced meat systems showed that the use of soy protein concentrate "Arkon-S" in an amount of no more than 20% does not cause deterioration in performance; with an increase in the amount of isolate up to 30%, their decrease occurs, the smell and taste are unusual for this type of product, they have a characteristic soy taste. The use of soy protein concentrate "Arkon-S" in the technology of combined sausages made it possible to increase the water-holding capacity, reduce losses during heat treatment and the consumption of raw meat.

5. Acknowledgments
This work was carried out as part of a state assignment SSI NIIMMP of the Ministry of Science and Higher Education, No 1021032427412-9.

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