The object of the study is the production of cooked sausages from beef and chicken breast with the addition of soy isolate and chickpea flour. The problem to be solved is to development of combined meats. An improved recipe for boiled sausage with the addition of soy isolate and chickpea flour is proposed. Its process is fully described. The technology is distinguished by its simplicity of preparation. According to the developed technology, several samples of boiled sausage were experimentally produced, combined according to the ratio 100:0, 70:30, 80:20, 60:40 based on a balanced ratio of the main food components, providing increased digestibility and digestibility. Production tests of the product development were carried out. The quality assessment of the organoleptic and physico-chemical parameters of the finished product was carried out according to generally accepted methods.

The effect of soy isolate on the quality characteristics of combined cooked sausages containing chickpea flour and 10% beef fat was studied. Recipes containing premium beef and chicken breast in a 60:40 ratio were examined for their physical and organoleptic properties. The inclusion of soy isolate and chickpea flour significantly increased the moisture content, moisture and fat resistance, and finished product yield, and reduced cooking losses compared to the control sample. Furthermore, the sausages were less red with the addition of at least 5% soy isolate and chickpea flour. The results of the organoleptic evaluation showed that some quality characteristics of light sausages, such as juiciness and density, can be improved by the addition of soy isolate. Both sausages with 3% soy isolate and the control light sausages were darker and denser

Keywords: soy isolate, chickpea flour, boiled sausage, beef meat, chicken breast

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DEVELOPMENT OF TECHNOLOGY FOR COOKING BOILED SAUSAGE WITH THE ADDITION OF SOY ISOLATE AND CHICKPEA FLOUR

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1. Introduction

The growing consumer demand for functional and healthy foods has stimulated the search for new natural ingredients that can improve both the nutritional and technological qualities of meat products. Processed meat, especially sausages, is one of the most widely consumed food categories in the world.

The current level of development of the meat industry of the agro-industrial complex requires a new approach to the integrated use of all types of raw materials of animal origin, which is expected to increase the share of the market with food products of domestic production to 100% [1].

The paper [2] showed the modern ways to improve the quality and nutritional value of meat products, including national meat products. The experiment used meat products from horse beef, beef, camel meat, mutton and a hydrated vegetable protein composition.

The paper [3] discusses the meat industry has met new challenges since the World Health Organization classified processed meat in carcinogenic Group 1. In relation to this, the functional food concept in meat processing has gained importance, especially in reducing carcinogenic N-nitroso compounds and polycyclic aromatic hydrocarbons (PAHs) as an additional imperative, apart from the usual fat and salt reduction and product enrichment with functional ingredients. PAH reduction relies on control of the smoking process, but there is also a possibility they could be degraded by means of probiotic microorganisms or spices. The reduction of N-nitroso compounds could be provided by lowering the amount of added nitrite/nitrate, using substitutes for these chemicals, and/or by preventing conditions for the creation of N-nitroso compounds. Nevertheless, fat and salt reductions still remain topical, and rely mostly on the use of functional ingredients as their substitutes.

Kazakhstan is one of the world's leading meat producers thanks to its large livestock population. However, despite the active use of modern technologies, Kazakhstan's meat processing industry remains underdeveloped. Therefore, Kazakhstan could become a model territory for modern research into developing new technologies for the production of cooked, semi-smoked sausages.

In this regard, the processing of livestock raw materials is necessary, leading to an increase in the production and assortment of meat products.

Thus, the relevance of the scientific topic related to the study of soy isolate as functional ingredients is due to the need to:

– increase the biological and technological value of food products;

– introduce ingredients with proven positive physiological effects;

– develop methodological approaches to assess the stability and effectiveness of biologically active components in products.

Therefore, research aimed at developing and substantiating the parameters of the use of soy isolates in food systems is relevant.

2. Literature review and problem statement

The article [4] presents the results of studies of the functional and technological properties of protein hydrolysates when they are included in the formulations of meat products, in particular, boiled sausages. It has been shown that hydrolysates have significant potential as sources of biologically active peptides with antioxidant, antimicrobial and hypotensive activity, which opens up prospects for their use in the development of functional food products.

Protein hydrolysates are a set of low molecular weight peptides that are released during the enzymatic hydrolysis of food proteins [5]. However, the mechanisms influencing the distribution of biologically active peptides in complex food matrices are not fully understood. However, the mechanisms influencing the distribution of biologically active peptides in complex food matrices remain to be fully understood.

Sources of protein for obtaining hydrolysates can be milk, fish, meat, by-products of slaughter and vegetable proteins (legumes, cereals). By-products of the food industry are increasingly used as environmentally friendly and economically profitable raw materials [3]. At the same time, the question of the effect of a particular type of protein raw material on the composition and functionality of the resulting peptides in the finished product remains open. Current research focuses on the growing interest in peptides derived from food proteins and their potential to develop functional ingredients.

The work [4] emphasizes that biologically active peptides from various sources have a wide range of physiological effects, including regulation of blood pressure, antioxidant activity, and effects on the intestinal microflora. However, despite the rapid development of this field, there remains insufficient data on the interaction of peptides with other components of food systems, especially in multicomponent matrices such as meat products. This limits the possibilities of forecasting.

The remaining scientific gaps may be due to both the fundamental complexity of modeling the behavior of peptides in multicomponent food systems and the lack of standardized conditions for the production of hydrolysates for various types of raw materials. This limits the predictability of their activity in the finished product and requires clarification of the terms of use. The process of obtaining hydrolysates is carried out using protease enzymes. The choice of a protease (for example, trypsin, papain, and subtilisin) affects the depth and profile of hydrolysis [5, 6].

The advantage of enzymatic hydrolysis over acidic or thermal hydrolysis is the preservation of the biological activity of amino acids and the selective cleavage of protein without destroying sensitive components. In addition, methods for designing peptides and proteolytic pathways in silico are widely used to predict biological activity and accelerate mass production of bioactive fractions.

The functional properties of protein hydrolysates depend on the amino acid composition, the length of the peptides, and the degree of hydrolysis. For example, short peptides containing hydrophobic amino acids often exhibit antioxidant and hypotensive activity [7]. However, the question of how stable these properties are when peptides are incorporated into real formulations and after heat treatment remains unresolved. One of the ways to overcome these limitations is to use mild temperature conditions, combined proteases and encapsulation of peptides to increase their stability and mask the bitter taste.

However, the use of protein hydrolysates in food products is associated with a number of technological difficulties. These include decreased stability during heat treatment, the appearance of bitterness in the mouth, and a possible decrease in storage activity. Therefore, scientists are actively developing encapsulation and soft processing methods that help preserve biological activity before eating [8].

Accordingly, the effectiveness of such methods in specific food systems (including meat products) requires additional testing. Since it is necessary to pay attention, the grown plant raw materials differ from their origin and, of course, from the varieties, which affects their content. Considering the above, the use of soy isolate in boiled sausages is a promising direction. They allow not only to increase the nutritional value of the product, but also to use by-products of processing, such as collagen-containing raw materials. Thus, this study, aimed at optimizing the formulation of sausages with soy isolates, fully fits into the modern concept of functional nutrition and sustainable production [9]. The work of this study is the production of cooked sausages fortified with protein hydrolysates obtained from collagen-containing raw materials (in particular, beef legs with fetlock).

The study [10] is aimed at eliminating the lack of data on the effect of hydrolysate concentration and process parameters on the functional, physicochemical, and antioxidant characteristics of meat products.

The article [11] studied the adding soy protein isolate (SPI) to meat dough on the protein structure and water distribution in emulsified sausages was studied. With the SPI addition (5%), ionic and hydrogen bonds in the test with SPI (liquid test- SPI) significantly decreased and increased accordingly. The disulfide bonds in sausage with SPI (sausages-SPI) increased significantly compared to sausage without SPI. Protein solubility in the test-SPI did not show a significant decrease in protein solubility after heat treatment compared to the control (dough). Water migration did not change and increased significantly with the addition of SPI. SPI increased the viscosity and shear stress of the emulsified sausage during processing. Rheological analysis showed that the protein decomposition time in the SPI test was higher than in the control. Raman spectroscopy revealed a decrease in the level of the α-helix and an increase in the level of β-layer during heat treatment. In conclusion, SPI mainly influenced the change in protein structure in emulsified sausages. Proteins are difficult to dissolve themselves when they are deeply processed, however this is not enough. It is must take into account that proteins are always accompanied by fats in a meat product, and a preliminary conclusion can be drawn from a deeper study.

The study [12] investigated the effect of soy protein isolate (SPI) addition to buffalo meat on the production, quality, and shelf life of emulsified sausage (ES). The quality of ES was assessed by pH, moisture content, thiobarbituric acid (TBA), total bacterial count (TBC), yeast and mold counts, as well as organoleptic characteristics, instrumental measurements of color and texture. It was found that pH and moisture content changed slightly, while the TBA count remained unchanged. The TBC of a fresh ES sample was in the range of 3.7–4.3 log CFU/g. ES was acceptable to tasters, and the addition of SPI did not affect its acceptability. The addition of SPI increased the Hunter L and b values, but decreased a value and instrumental hardness. During storage (0°C), the L, a, and b values fluctuated irregularly. It was concluded that the addition of SPI slightly improved the texture, juiciness, and color of the emulsified sausage.

All this allows to assert that it is advisable to conduct research on the development of combined meats, since the work itself examined camel meat and hump fat with the addition of hydroisolate, which affects the nutritional value of the sausage product itself.

3. The aim and objectives of the study

The aim of the study is to develop a technology for the production of boiled sausages with the addition of soy isolate**s** and chickpea seeds. This will expand research to produce sausages without loss of quality, and the addition of soy isolate**s** will increase the shelf life and increase the value of sausages.

To achieve this aim, the following objectives were completed:

– development of technological scheme for boiled sausage made from combined meat with soy isolates and chickpea flour;

– analysis of the physicochemical composition of sausages with the addition of soy isolate and chickpea flour;

– conducting organoleptic tests of cooked sausages with the addition of soy isolate and chickpea flour;

– developing recipes for the preparation of cooked sausages from beef and chicken breast.

4. Materials and methods

4. 1. The object and hypothesis of the study

The object of the study is the production of cooked sausages from beef and chicken breast with the addition of soy isolate and chickpea flour.

The hypothesis of the study suggests that the addition of soy isolate and ground chickpeas to a sausage product reduces the specific smell and taste of meat, as well as improves protein absorption and increases the nutritional value of the product, making it more attractive for preventive nutrition.

The introduction of soy isolate and chickpea flour into the cooked sausage recipe will improve their functional characteristics (water-holding capacity, fat-resistant capacity), and when mixing these materials, it will ensure the maximum protein content without deteriorating the organoleptic properties.

The following assumptions were made. The pH level was maintained constant during production (approximately 7.0). The main factors affecting the effectiveness of the physicochemical characteristics are the temperature and duration in the heating chamber.

The following simplifications were made:

– the use of soy isolate and chickpea flour without comparison with others;

– the physicochemical characteristics were assessed based on the content of protein, fat, carbohydrates, and moisture;

– the sensory evaluation was preliminary and did not include an expert group. In addition, for the analysis of the recipes, the water-holding capacity, moisture-binding capacity, and fat-retaining capacity were studied.

The following ingredients were used: Sausage product: the main component used ground beef. Each sample was used to enrich soy isolate and chickpeas.

4. 2. Preparation of curd samples

The following materials were used as objects of research:

– beef meat with fat-lock compound;

– soy isolate in powder form, obtained by enzymatic hydrolysis and chickpea seeds;

– sample No. 1 100:0 (Beef:chicken breast ratio, %);

– sample No. 2 70:30;

– sample No. 3 80:20;

– sample No. 4 60:40.

4. 3. Chemical analysis

Quantitative determination of protein content was conducted in Nutritest testing laboratories. The determination method is based on a preliminary determination of protein concentration in the product (Kjeldahl method or a method using reference data).

The mass fraction of moisture was determined in accordance with GOST 9793-74 by drying the sample at a temperature of 103–105°C until a constant mass was obtained.

The mass fraction of fat was determined by the Soxlet method in accordance with GOST 23042-86. The method includes repeated extraction of fat with a solvent from a dried sample, removal of the solvent and drying of the fat until a constant mass is obtained. Petroleum ether was used as a solvent.

The anthrone method was used to determine the mass fraction of carbohydrates (glycogen), which involves heating monosaccharides with inorganic acids, converting them into furfural (oxymethylfurfural), and then using anthrone to obtain colored compounds. The color intensity is determined colorimetrically and indicates the amount of carbohydrates analyzed.

5. Results of the study of sausage products with additives

5. 1. Development of a technological scheme for the production of sausage products cooked from combined meat with the addition of soy isolate and chickpea flour

The technological scheme for the production of sausage products cooked from combined meat is shown in Fig. 1.

After grinding on a spinning top, the minced meat is placed in a cutter for fine grinding, then the dry ingredients are added in portions for 4–5 minutes and mixed until minced meat is obtained with a temperature not exceeding 10°C.

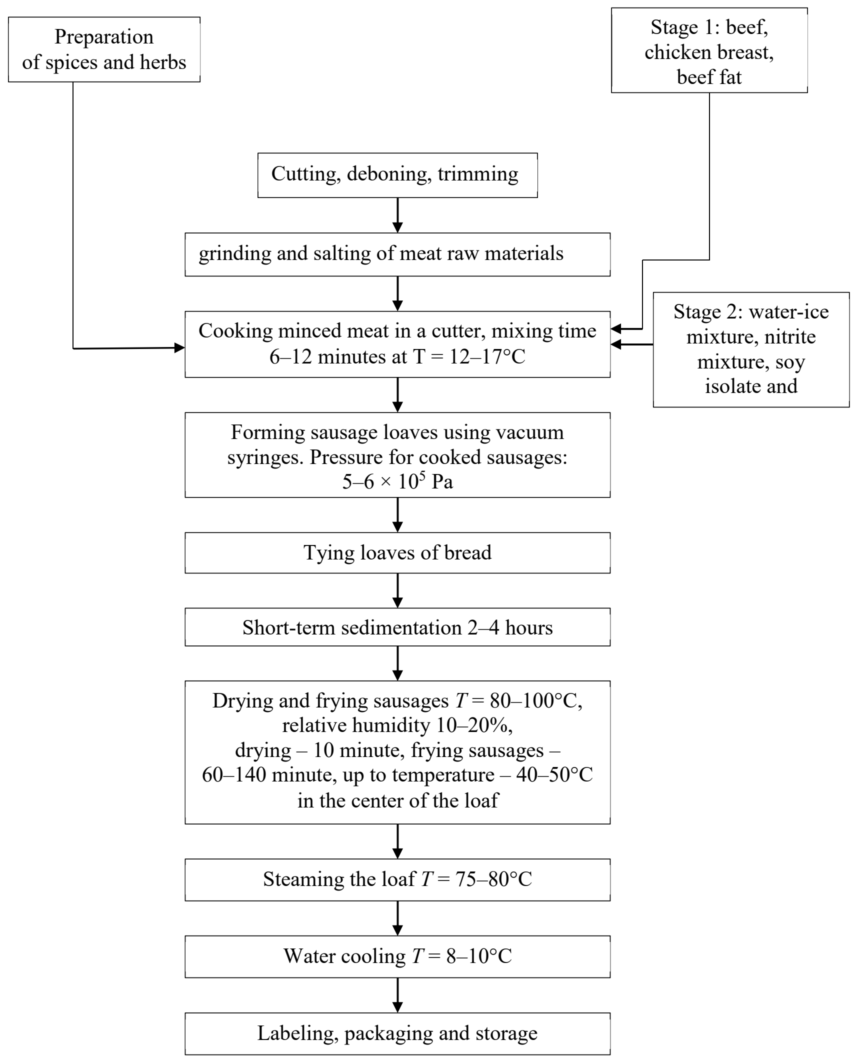

Fig. 1. Technological scheme of boiled sausage made from combined meat with the addition of soy isolate and chickpea flour

The order of immersion in the cutter is as follows:

– meat raw materials beef, chicken breast;

– dry mixture, water in the amount of 5–15% (grind for 1–2 minutes at a temperature of 0–4°C);

– vegetable ingredients, stir for 3–5 minutes;

– spices, spices, stir for another 2–3 minutes.

– beef fat, 1–2 minutes before the end of mixing, add the total mixing time is 6–12 minutes at a minced meat temperature of 12–17°C. The temperature of the finished minced meat is 12–18°C.

The finished minced meat is transferred to vacuum syringes and the shells are filled in accordance with the operating requirements specified in the passport for the syringe. The optimal pressure value for boiled sausage is $5–6 \times 10^5$ Pa. The shells filled with minced meat are licked or clamped with clips. The heat treatment of boiled sausages is carried out in workshops (precipitation, cooling after cooking) and in thermal chambers (drying, roasting, cooking). Short-term precipitation lasting 2–4 hours is carried out in suspension on special frames. The equipment for heat treatment is a continuous-action chamber with automatic temperature and humidity control. The drying of boiled sausages is carried out at a temperature of t = 50–60°C, relative humidity of 40–45%, duration of t = 20–30 min. Roasting of boiled sausages in thermal chambers is carried out at a temperature of t = 75–85°C, relative humidity equal to 50–60% to the temperature in the center of the loaf (45 ± 5)°C. Loaves of boiled sausages are boiled with steam or circulating moist air at a temperature of (65 ± 5)°C and relative humidity of (90–100)% until a temperature of (71 ± 1)°C is reached in the center of the loaf.

5. 2. Analysis of the physico-chemical composition of sausage products with the addition of soy isolate and crushed chickpeas

The physicochemical composition of the experimental samples of boiled sausages is shown in Table 1.

Table 1

Chemical composition of the studied samples depending on the ratio of meat

Indicators, %	Ratio, beef/chicken breast, %			
	Sample No. 1, 100:0	Sample No. 2, 70:30	Sample No. 3, 80:20	Sample No. 4, 60:40
Moisture	65.8	69.3	70.9	72.5
Protein	18.9	18.8	19.5	20.2
Fat	14.3	10.1	7.8	5.5
Carbohydrates	0	0.6	0.7	0.6
Ash content	1	1.2	1.1	1.2

The chemical composition of the samples presented in Table 1 showed that the protein content ranges from 18.8% to 20.2% and higher in sample No. 4, fats – 5.5% to 14.3%, the largest amount of fat is contained in sample No. 1.

5. 3. The results of organoleptic parameters in the preparation of formulations with the addition of soy isolate and chickpea seeds

To determine the optimal percentage of beef and chicken breast in a meat product, organoleptic characteristics were studied, which assessed appearance, consistency, color and appearance on the section, odor and taste, shape and size on a 5-point scale (Table 2).

Table 2

Organoleptic parameters of the studied samples depending on the composition of meat raw materials

Number	Beef/chicken breast ratio, %	Organoleptic parameters, score					Average score
		Appearance	Consistency	Color and appearance in the section	Smell and taste	Shape and size	
No. 1	100:0	4.8	4.8	4.8	4.9	5.0	4.86
No. 2	70:30	4.8	4.6	4.6	4.5	5.0	4.70
No. 3	80:20	4.8	4.7	4.7	4.8	5.0	4.80
No. 4	60:40	4.8	4.8	4.7	4.9	5.0	4.84

The results presented in Table 2 indicate that the experimental samples are not inferior in appearance to the control: loaves with a clean, dry surface, consistency – elastic, cut-uniform, minced meat evenly mixed, shape and size – smooth loaves 35 cm long in the shell, 70 mm in diameter. The differences in the studied samples were shown in color – from pink to dark pink, the samples received from 4.4 to 4.8 points, while the low score was sample No. 3. The taste and smell of the samples differed depending on the ratio of meat raw materials (from 4.5 to 4.9 points), and samples No. 2 and No. 4 received low scores. It should be noted that when using only beef, a sweet and specific taste was felt in the test sample, which refers to the taste characteristics of beef meat.

The properties of poultry meat differ significantly from beef, especially in terms of technological properties. Poultry meat has a lower content of muscle pigments, which are responsible for the formation of color and are crucial. A higher percentage of muscle tissue in the formulation results in cobas with a denser structure and better quality. In the production of boiled sausages of the highest and first-class quality, poultry meat weighing no more than 30% is usually used.

The analysis of the research results allowed to establish that sample No. 3, in which the ratio of meat raw materials (beef/ chicken breast) is 80:20, is close to the control sample in terms of the average score.

To study the effect of herbal additives on the functional and technological properties and consumer qualities of boiled sausages, control and experimental samples of meat products were developed. Boiled sausage produced using a well-known standard technology was used as a control sample. Boiled sausages (samples) were cooked on a cutter by adding vegetable additives to minced meat.

Various ratios of these additives were mixed with meat raw materials. In experimental samples of cooked sausages, soy isolate from chickpea flour accounted for 0 to 5% of the total amount of raw materials. To determine the optimal herbal ingredients and their amount in sausage products, a total of four variants were tested on three different samples (Table 3).

To study the effect of herbal additives, the functional and technological properties and consumer qualities of boiled sausages were determined by moisture binding, moisture retention, cutting force and organoleptic parameters.

Table 4 shows the results of studies to determine the optimal formulation of boiled sausages.

The introduction of various herbal additives with different ratios of dry powder and soy isolate led to an increase in the moisture-retaining and water-binding abilities of the experimental samples Fig. 2.

Table 3

Recipes of boiled sausages with the addition of soy isolate and dry chickpea seed powder

Name of ingredients	The content of the ingredients in the prototypes, kg per 100 kg				
	In the control sample	No. 1	No. 2	No. 3	No. 4
Ground beef of the first grade	70.0	60.0	60.0	60.0	60.0
Chicken breast	20	25.0	25.0	25.0	25.0
Beef fat	10.0	10.0	10.0	10.0	10.0
Soy isolate	–	0.0	1.0	2.0	3.0
Chickpea flour	–	5.0	4.0	3.0	2.0
Total	100.00	100.0	100.00	100.00	100.00

Table 4

Determination of the optimal formulation of boiled beef sausages with vegetable additives (soy isolate and chickpea flour)

Samples of boiled sausages	Component content in kg per 100 kg of raw materials	Moisture-retaining ability, %	Moisture binding capacity, %	Fat-holding capacity, %	Cutting force, kg/cm^2
Control, experience	–	–	58.82 ± 1.1 7	61.43 ± 1.23	51.38 ± 1.0 3
Experience 1	0.0	5.0	62.15 ± 1.2 4	62.35 ± 1.25	51.85 ± 1.0 4
Experience 2	1.0	4.0	62.12 ± 1.2 4	62.78 ± 1.26	52.34 ± 1.0 5
Experience 3	2.0	3.0	62.43 ± 1.2 5	63.84 ± 1.28	53.12 ± 1.0 6
Experience 4	3.0	2.0	62.65 ± 1.2 5	64.12 ± 1.28	53.64 ± 1.0 7

The consistency of meat products is the most important indicator of quality, which was assessed using the shear stress index. The results showed that the addition of plant components affected the consistency of the final beef products, and the cutting force differed depending on the ratio of soy isolate and chickpea flour. The result was achieved in experiment No. 4, which corresponded to the sensory properties of these samples.

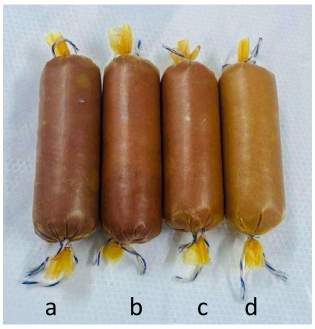

Fig. 2 Appearance of the finished product: *a* — experience 1, *b* — experience 2, *c* — experience 3, *d* — experience 4

5. 4. Development of recipes for cooking sausage products boiled from beef and chicken breast

Based on the experimental work carried out and the analysis of the results, the formulations and technologies of boiled sausages from beef and chicken breast have been scientifically substantiated and developed (Table 5).

Table 5

Recipes of sausage products boiled from beef and chicken breast

The name of meat raw materials, food additives, ingredients and materials	The norm for boiled sausages of the first grade		
	Control	Boiled sausage "Beef – A»	Boiled sausage "Beef – B»
Unsalted raw materials, kg, per 100 kg			
Ground beef of the first grade	70	60	60
Chicken breast	20	25	25
Beef fat	10	10	10
Soy isolate	–	3	4
Chickpea flour	–	2	1
Spices and materials, g, per 100 kg of unsalted raw materials *			
Salt mixture	2020	2020	2020
Table salt	450	450	450
Sodium ascorbate	50	50	50
Granulated sugar	150	150	150
Ground black or white pepper	100	100	100
Ground allspice	100	100	100
Garlic, fresh or canned, peeled, crushed	120	120	120
Shell	Artificial shell with a diameter of 45–140 mm		

Entrance control and acceptance of raw materials are carried out strictly on the basis of the "Rules of production control at meat industry enterprises", approved in accordance with the established procedure.

Entrance control is carried out for all objects and materials: beef, chicken breast, food ingredients, spices, auxiliary materials. Entrance control for compliance with the requirements and regulations of regulatory documentation consists of checking the availability and correctness of the accompanying documents, conducting a visual inspection, and an organoleptic assessment.

After grinding on a spinning top, minced meat is placed in a cutter for fine grinding, then dry ingredients are added in portions for 4–5 minutes and mixed until minced meat is obtained at a temperature not exceeding 10°C.

The order of immersion in the cutter is as follows:
– meat raw materials (beef 80%, chicken breast 15%);
– dry mixture, water in the amount of 5–15% (grind for 1–2 minutes at a temperature of 0–4°C);
– soy isolate from chickpea flour, stir for 3–5 minutes;
– spices, spices, stir for another 2–3 minutes.
– add beef fat 1–2 minutes before the end of mixing.

The total mixing time is 6–12 minutes at a minced meat temperature of 12–17°C. The temperature of the finished minced meat is 12–18°C. The finished minced meat is transferred to vacuum syringes and the shells are filled in accordance with the operating requirements specified in the passport for the syringe. The optimal pressure value for boiled sausage is $5–6 \times 10^5$ Pa.

The shells filled with minced meat are licked or clamped with clips. Since product information is applied to their surface of protein and polyamide shells using a pre-lithographic method, twine binding (or clip application) is done only at the ends of the loaves. The heat treatment of boiled sausages is carried out in workshops (precipitation, cooling after cooking) and in thermal chambers (drying, roasting, cooking). Short-term precipitation lasting 2–4 hours is carried out in suspension on special frames.

The equipment for heat treatment is a continuous-action chamber with automatic temperature and humidity control. Drying of boiled sausages is carried out at a temperature $t = 50–60$°C, relative humidity equal to 40–45%, duration $t = 20–30$ min.

Roasting of boiled sausages in thermal chambers is carried out at a temperature of $t = 75–85$°C, relative humidity equal to 50–60% to the temperature in the center of the loaf (45 ± 5)°C.

Loaves of boiled sausages are boiled by steam or circulating moist air at a temperature of (65 ± 5)°C, when using a shell, belkozin is cooked at a temperature of (73–76)°C and relative humidity of (90–100)% until a temperature of (71 ± 1)°C is reached in the center of the loaf.

The use of special equipment allows to control the technological process during the heat treatment of meat products.

6. Discussion of the results of the study of the physicochemical properties of enriched soy isolate and chickpea flour

To draw conclusions about its functional characteristics, its physicochemical properties were studied.

According to the data in Table 1, the addition of soy isolate and chickpea flour significantly improved the textural and functional properties of the product in all samples. However, according to the analyzed parameters, sample No. 4 demonstrated the highest protein content (over 20%) and fat (less than 6%). The data in Table 2 confirm that the addition of soy isolate and chickpea flour improves taste, appearance, and aroma. All samples were assessed on a five-point scale, with results close to 5 points. This demonstrates that all five samples can be used in the same dosage. Organoleptic properties showed that soy isolate and chickpea flour impact the quality of cooked beef and chicken breast sausages, which acquire a stable color and tender texture due to the high water-binding capacity of the meat system. In this regard, a recipe for a cooked sausage product made from a combination of beef and chicken breast was developed, with a 60:40 ratio. The only changes were the dosages of soy isolate and chickpea flour, ending up at 3% soy isolate and 2% chickpea flour. This is particularly important for developing the product's functional properties. Similar analyses were conducted using salmon protein isolates in [7] and found predominantly high protein and fat contents. This impacted human health and reduced shelf life. In paper [8], the importance of waste management in agriculture and livestock farming was considered. This study presents an overview of the enzymatic hydrolysis of protein from livestock, poultry, wastewater, and plants, as well as its various applications in the food, feed, pharmaceutical, and other industries.

According to the data in Table 4, the addition of soy isolate and chickpea flour significantly improves the textural and functional properties of the product. Thus, the water-holding capacity (WHC) increased from 58.82% (control) to 62.65% with the addition of 3% soy isolate and 2% chickpea flour, indicating improved water-binding capacity and fat-resistant properties.

Similar improvements in the appearance of cooked sausage products, shown in Fig. 2, due to the addition of soy isolate, were also observed in the cooked sausage recipes in Table 5, confirming the versatility of this approach.

However, soy isolate levels in the range of 5–7% should be tested, which could potentially provide a compromise between improved functional properties and acceptable taste characteristics.

In future studies, the effect of aroma-masking additives (cereal flours and oilseeds) on odor control at concentrations >5% should be studied.

7. Conclusions

1. The relationships between the process parameters (processing temperature, temperature of the heat chamber and the mixing process) have been established and the block diagram has been developed in 2 stages of addition.

2. The protein:fat ratio in the finished sausages is 2:1 and indicates an increase in the amount of proteins. It was found that when boiled 4% soy isolate and 1% dry chickpea seed powder are added to the sausage formulation, the moisture content increases by 3.8%, 4.6%, 2.8%, respectively; the protein content increases by 2.7%, 4.5%, 3.2%; the fat content decreases by an average of 45%, which significantly reduces the caloric content of ready-made boiled sausages (by an average of 30%) corresponds to the recommendations of a healthy diet.

3. The choice of soy isolate and dry chickpea seed powders in the formulation of boiled beef sausages is justified, it is proved that when using 3% soy isolate and 2% dry chickpea seed powders, the moisture-retaining ability increased by 6.5%, 6.6%, 5.9%; moisture binding capacity by 4.9%, 3.1%, 1.8%, fat-holding capacity by 3.87%, 4.8%, 2.86%, respectively. It is proved that the introduction of boiled 3% soy isolate and 2% dry chickpea seed powders into the sausage formulation It helps to increase the output by an average of 3.73%.

4. The content of aromatic substances in plants makes it possible to hide the specific smell and taste of meat raw materials, and the content of natural pigments helps to stabilize the color of sausages.

Conflict of interest

The authors declare that they have no conflict of interest in relation to this study, whether financial, personal, authorship or otherwise, that could affect the study and its results presented in this paper.

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Data availability

The data will be provided upon reasonable request.

Use of artificial intelligence

The authors confirm that artificial intelligence technologies were used in the preparation of this manuscript exclusively for translating words and sentences into English.

The authors declare the use of generative AI tools under full human supervision for the following task: translation of text fragments into English.

No AI tools were used for generating scientific content, data analysis, interpretation, or conclusions.

The authors bear full responsibility for the final version of the manuscript.

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Authors' contributions

Aibala Taspoltayeva: Conceptualization, Methodology, Resources, Software; **Elmira Kanseitova:** Project administration Conceptualization, Methodology; **Zhazira Zheleuova:** Project administration Supervision, Resources; **Birol Kilic:** Conceptualization, Methodology; **Marat Abishev:** Resources, Software.

References

1. Turisbekova, G., Aitmukhanbetova, D. (2020). Development of the meat processing industry of the Republic of Kazakhstan. Problems of the agricultural market, 1, 127–134.
2. Kenenbai, Sh. Y., Uzakov, Ya. M., Tortay, A. N., Omirkhan, A. A. (2025). Study of the effect of plant-based components on the quality indicators of meat products. The Journal of Almaty Technological University, 148 (2), 99–107. https://doi.org/10.48184/2304-568x-2025-2-99-107

3. Vasilev, D., Glišić, M., Janković, V., Dimitrijević, M., Karabasil, N., Suvajdžić, B., Teodorović, V. (2017). Perspectives in production of functional meat products. IOP Conference Series: Earth and Environmental Science, 85, 012033. https://doi.org/10.1088/1755-1315/85/1/012033
4. Clemente, A. (2000). Enzymatic protein hydrolysates in human nutrition. Trends in Food Science & Technology, 11 (7), 254–262. https://doi.org/10.1016/s0924-2244(01)00007-3
5. Idowu, A. T., Benjakul, S., Sinthusamran, S., Sookchoo, P., Kishimura, H. (2018). Protein hydrolysate from salmon frames: Production, characteristics and antioxidative activity. Journal of Food Biochemistry, 43 (2), e12734. https://doi.org/10.1111/jfbc.12734
6. Colla, G., Rouphael, Y., Canaguier, R., Svecova, E., Cardarelli, M. (2014). Biostimulant action of a plant-derived protein hydrolysate produced through enzymatic hydrolysis. Frontiers in Plant Science, 5. https://doi.org/10.3389/fpls.2014.00448
7. Grasso, S., Brunton, N. P., Lyng, J. G., Lalor, F., Monahan, F. J. (2014). Healthy processed meat products – Regulatory, reformulation and consumer challenges. Trends in Food Science & Technology, 39 (1), 4–17. https://doi.org/10.1016/j.tifs.2014.06.006
8. Etemadian, Y., Ghaemi, V., Shaviklo, A. R., Pourashouri, P., Sadeghi Mahoonak, A. R., Rafipour, F. (2021). Development of animal/plant-based protein hydrolysate and its application in food, feed and nutraceutical industries: State of the art. Journal of Cleaner Production, 278, 123219. https://doi.org/10.1016/j.jclepro.2020.123219
9. Mohammadian, M., Madadlou, A. (2016). Characterization of fibrillated antioxidant whey protein hydrolysate and comparison with fibrillated protein solution. Food Hydrocolloids, 52, 221–230. https://doi.org/10.1016/j.foodhyd.2015.06.022
10. Kozhakhiyeva, M., Kaldarbekova, M., Yessengaziyeva, A., Uzakov, Y., Medeubayeva, Z., Kuzembayeva, G., Aitbayeva, A. (2025). Devising a technology and optimizing processing parameters for making functional boiled sausage fortified with protein hydrolysates. Eastern-European Journal of Enterprise Technologies, 3 (11 (135)), 52–60. https://doi.org/10.15587/1729-4061.2025.330002
11. Sha, L., Liu, S., Liu, D. (2020). Effects of soybean protein isolate on protein structure, batter rheology, and water migration in emulsified sausage. Journal of Food Processing and Preservation, 44 (9). https://doi.org/10.1111/jfpp.14711
12. Mohamed, H. M., Emara, M. M., Nouman, T. M. (2015). Effect of cooking temperatures on characteristics and microstructure of camel meat emulsion sausages. Journal of the Science of Food and Agriculture, 96 (9), 2990–2997. https://doi.org/10.1002/jsfa.7468