Results of studies of samples of boiled-smoked loin with different injection levels

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Abstract. Today, the production of boiled-smoked pork products is aimed at using intensive salting methods using technological methods of injection with multi-component brines and subsequent mechanical processing. This makes it possible to improve both the organoleptic characteristics of pork products (tenderness, consistency) and the economic indicators of the efficiency of the enterprises. The article presents the results of studies of the effect of multicomponent brines on the main functional and technological characteristics of boiled-smoked pork products. The influence of multicomponent brines on such indicators as the output of the finished product, physical and chemical indicators, organoleptic indicators has been studied.

1. Introduction
At the present stage of food industry development, the meat industry occupies one of the leading places in the food industry and is constantly introducing new types of meat products [1-9]. Meat industry enterprises are engaged in the production of a wide range of products, introducing scientific research [10-17]. The main categories of products are meat and offal, semi-finished products, sausages, canned meat. The range of meat products is constantly expanding and corresponds to the basic principles of food combinatorics [16-25]. At the enterprises of the industry, new approaches are being introduced to ensure the quality and safety of products [24-32].

Delicacy meat products made from pork in the form of whole muscle products: loin, ham, brisket are very popular with Russian consumers. The market for meat delicacies is saturated and highly competitive; quality is one of the most important indicators of the competitiveness of products.

The production of whole-muscle gourmet products is the most rational use of raw meat, the ability to preserve the original type of raw materials and balance its final composition.

One of the mandatory and defining operations in the production of boiled-smoked delicacies is the ambassador, which is currently carried out by injecting brines into the thickness of the raw material with the use of subsequent mechanical processing (massaging, tumbling, tenderizing).

During the salting operation, an organoleptic profile is formed in meat products: taste, aroma, smell, consistency, color, as well as such technological characteristics as the output and physicochemical composition of the finished product.
The intensity of change depends directly on the speed and uniformity of the distribution of the components of the curing mixture and their concentration. Moreover, the severity of these changes largely depends on the nature of the distribution of curing substances, the concentration of table salt and a number of other factors.

The ambassador protects the meat from spoilage, has preservative properties, by reducing the activity of water and suppressing the development of microflora, as a result of salt exposure.

The aim of the research is to study the influence of multicomponent brines on the quality of boiled-smoked pork delicacies.

2. Materials and methods
Figure 1 shows a diagram of the production of the investigated boiled-smoked pork delicacies.

![Diagram of the production of boiled-smoked delicacies](image)

**Figure 1.** Scheme of the production of boiled-smoked delicacies.
The brine preparation (the brine recipe is shown in Table 1) was carried out on the brine preparation plant. The device for preparing brine is a container with a connected circulation pump, the components are introduced through a funnel. The device consists of a container with a volume of 400 liters, to which a circulation pump is connected, dry components are fed through a funnel connected by a pipeline.

The container is filling up. Dry components are fed into a funnel, mixed, circulating through the volume of the tank, using a circulation pump, which also, pumping the brine through the pipeline, ensures its supply to the injector.

The preparation time for the brine is 3-7 minutes. The rapid and homogeneous mixing of the liquid and dry brine components is based on the physical Venturi principle, which is the pressure drop when a liquid or gas stream flows through the constricted part of the pipe.

After the brine is ready, it is fed into the injector using a circular pump.

When making up the brine, part of the water is replaced with flake ice to lower the brine temperature. Flake ice is added to the brine until the brine temperature reaches –2 °C.

### Table 1. Recipe of multicomponent brines using complex food additives.

| Brine name       | Ingredient name           | Quantity of ingredient per 1001 of brine, kg |
|------------------|---------------------------|---------------------------------------------|
| № 1 Zaltech      | NaNO₂,                    | 2.776                                       |
|                  | NaCl                      | 3.493                                       |
|                  | Selzbauch Premium Mix     | 3                                           |
|                  | Preservative              | 0.4                                         |
|                  | Drinking water            | 90.331                                      |
|                  | NaNO₂, 0.9%               | 2.776                                       |
|                  | NaCl                      | 3.493                                       |
| № 2 Wiberg       | Means for stuffing ham comix 4060 | 5                                            |
|                  | Preservative              | 0.4                                         |
|                  | Drinking water            | 88.3                                        |
|                  | NaNO₂,                   | 2.7                                          |
|                  | NaCl                      | 3.3                                         |
| № 3 Control sample | Complex mixture          | 6                                            |
|                  | Preservative              | 0.4                                         |
|                  | Drinking water            | 87.6                                        |

3. Results and discussion

Within the framework of these studies, the ingredient composition of the injection brine was determined, designed for a 30% injection level of raw materials and providing a product output of 105%.

In the course of the research, brines containing 3.5% sodium chloride and 2.8% nitrite salt were taken, and in the first variant, the different content of the complex additive of the company Zaltech is 2.5, 2.75 and 3%; in the second variant, the content of the Wiberg complex additive is 4.5, 4.75 and 5%.

The required content of these complex additives was determined based on the recommendations of the manufacturers.

During the experiment, at each technological stage, we determined the mass of the samples, the output and water-holding capacity of the finished products after they were cooled to 6 °C.

Table 2 shows the values of the output of control samples and test samples from chilled pork, sprinkled with brines of the control composition and brines with the use of Zaltech and Wiberg additives.

It was found that with an increase in the content of complex food additives in the composition of the injection brine, the output of the finished product in the samples increases. At the same time, the values in the sample with the complex additive Zaltech remain higher than the values of the control sample and the sample with the complex additive Wiberg.
Table 2. The output of the finished product depending on the concentration of the complex additive.

| Brine       | Content of complex additives in brines, % |
|-------------|-------------------------------------------|
| Zaltech     | 2.5                                      |
|             | 2.75                                     |
|             | 3                                        |
| 99.2±1.07   | 102.5±1.3                                |
| 4.5         | 4.75                                     |
| 101.7±1.9   | 103.75±1.07                              |
| Wiberg      | 5                                        |
| Control sample | 7                                      |
| 104.1±1     |                                          |

When complex food additives containing animal protein are introduced into the brine, an increased output of the finished product is noted compared to the control sample containing only hydrocolloids.

According to the data obtained, in order to achieve the target output of 105%, 3% of Zaltech complex additive and 5% of Wiberg complex additive must be added to the brines.

Organoleptic testing was carried out immediately after preparation and after 6 days of storage at a temperature of 6 °C. It showed that the samples containing Zaltech additive were juicy, had a delicate texture, and a slightly pronounced ham taste. Samples containing Wiberg additives are inferior to Zaltech samples in taste characteristics, samples are similar in rheological properties.

Assessment of the organoleptic characteristics of the finished product showed that all samples have high indicators of appearance, consistency, including in the cut. The consistency is uniform and there is no broth in the thickness of the product.

The results are shown in table 3.

Table 3. The results of the organoleptic evaluation of the samples sprinkled with brines.

| Sample name     | Appearance | Sectional color | Taste | Smell | Consistency | Overall score |
|-----------------|------------|-----------------|-------|-------|-------------|---------------|
| Zaltech         | 5          | 4.5             | 4.7   | 4.7   | 4.8         | 4.74          |
| Wiberg          | 5          | 4.2             | 4.5   | 4.6   | 4.5         | 4.56          |
| Control sample  | 5          | 4.2             | 4.5   | 4.5   | 4.6         | 4.56          |

Thus, in the course of experimental studies, it was found that the use of brines containing complex mixtures from Zaltech and Wiberg makes it possible to obtain a given output of experimental products. It should be noted that brine with Zaltech additive is most effective when added to brine at a dosage of 3%.

As evidenced by the data of the literature review, to intensify the salting process, mechanical processing of raw materials is used.

As a mechanical treatment, vacuum massaging was selected, with the following mode, rotation frequency 8 rpm, cycle duration 30 minutes, rotation 20 minutes, rest 10 minutes.

Meat raw material after extrusion with brine, in the ratio of 30% brine to raw meat, was sent for massaging. For the experiment, the massaging time was 2, 4 and 6 hours.

Based on the data obtained, the following conclusion can be drawn: when massaging for 2 hours, a decrease in mass by 1.8% is observed, with an increase in the duration of the operation to 4 hours and 6 hours, an increase in the mass of the massaged raw material is observed due to the redistribution of brine components throughout the volume of raw meat.
Thus, it is possible to note the relationship between the duration of massaging and the amount of bound brine and, therefore, the relationship between the duration of massaging and the output of the finished product, and the maximum amount of bound brine and minimum losses were observed in the sample after 6 hours of massaging.

The main technological operations for the production of boiled-smoked products are the processes of salting, cooking, smoking, etc. The degree of product structure change is determined not only by the technological stages, but also by the product composition.

During heat treatment, proteins coagulate, that is, their coagulation, which directly affects their ability to retain moisture. At the next stage, the influence of complex brines on changing the composition and properties of finished products was considered.

Experimental samples from pork loin, sprinkled with brines in an amount of 30% to the mass of raw materials, brines containing additives from Zaltech and Wiberg, and a control sample, after massaging, were heat treated at a temperature of 85-90 °C until a temperature in the thickness of the product reached 72.5 °C. After that, the samples were cooled to a temperature of 20 °C, followed by smoking. The finished samples were cooled to a temperature of 4-6 °C and investigations were carried out.

Samples made of pork loin according to the proposed technology (figure 3), the formulation of which included functional additives Zaltech and Wiberg at dosages of 3 and 5%, respectively, were characterized by the following physicochemical parameters and the output of finished boiled-smoked pork loin (table 4).

| Table 4. Physicochemical parameters of boiled-smoked pork loin. |
|------------------|-----------------|-----------------|----------------|
| Indicators       | Zaltech         | Composition     | Control sample |
| Protein content, % | 22.2            | 22.03           | 19.85          |
| Fat content, %   | 3.5             | 3.8             | 3              |
| Moisture contents, % | 69.6          | 70              | 50.3           |
| NaCl, %          | 2.2             | 1.9             | 2.1            |

![Figure 2. Change in the mass of raw meat during the operation of massaging.](image)
The use of Zaltech and Wiberg additives in the brines had a significant effect on the moisture content in the finished product. The animal protein contained in Zaltech and Wiberg supplements allows you to bind additional units of moisture. The effect of higher fat and protein content in experimental samples is also related to this.

No significant differences were found in the content of table salt.

4. Conclusion
The qualitative and quantitative composition of multicomponent brines for injecting pork loin in an amount of 30% by weight of raw materials has been determined. It was found that in order to obtain a given output of the finished product of 105%, it is necessary to use, in addition to the main curing components, complex food additives from Zaltech and Wiberg in the amount of 3 and 5% per 100 liters of brine.

It was found that the optimal duration of massaging pork loin with an injection level of 30% by weight of raw materials, at a massager rotation frequency of 8 rpm in a mode of 20 minutes of rotation and 10 minutes of rest, was 6 hours. Further mechanical action led to disruption of the integrity of muscle fibers and weight loss of pork loin.

Evaluation of the organoleptic characteristics of the finished product showed that all samples have high indicators of appearance, consistency, including in the cut. The consistency is uniform and there is no broth in the thickness of the product.

Studies of samples of boiled-smoked loin with an injection level of 30% to the mass of raw materials for physical and chemical indicators indicate the high nutritional value of products. The use of Zaltech and Wiberg additives in the brines did not have a significant effect on the moisture content in the finished product. The loin injected with brines containing functional additives with pork protein exceeded the control in protein content, so the addition of Zaltech additive to the brine in an amount of 3% by weight of the brine resulted in an increase in the protein content of the finished product by 0.3% compared to the control sample.

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