The innovative process for grinding of raw material in the production of cooked smoked sausages

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Abstract - This paper represents the results of research on the samples of cooked smoked sausages produced from frozen blocks of meat using innovative method for grinding of raw materials by means of milling. During the study of meat products, the controls were presented by samples of cooked smoked sausage produced from thawed raw meat using the conventional technology (grinding of meat on the mincing machine with holes' diameter of 5 mm and preparing of meat emulsion in cutter). The experimental samples of cooked smoked sausage were produced using the grinding of frozen raw material by the milling tool only with further preparation of minced meat in a mixer. The structure of minced meat in experimental samples had a smaller particle size of muscle tissue (120 to 350 microns) compared to the control. It was found that the minced raw material temperature was ranged from minus 2,9 ℃ to minus 0,5 ℃. This eliminates the possibility of meat protein thermal denaturation in the raw material during the grinding on a milling machine instead of two or three cutting machines provided by traditional technology. As a result, it was found that the new method for grinding of frozen raw meat by the means of milling did not reduce the physicochemical and microbiological quality parameters of cooked smoked sausages while their sensory parameters (appearance, texture and flavor) were well defined.

Keywords: manufacturing of cooked smoked sausages, grinding of raw meat, processing of frozen raw materials.

I. INTRODUCTION

For decades smoked sausages have had a good demand in the consumer market of meat products due to their taste. Currently, the share of smoked sausages accounts for over 26% of the total amount of sausage products in Russia, while the share of cooked smoked sausages is 8.7%. Constant interest of buyers for cooked smoked sausages in modern conditions of the market is due to the fact that, on the one hand, these sausages are high quality meat products with high nutritional value and good taste, and on the other hand, these products are not too expensive compared to uncooked smoked sausages.

Historically, the production of cooked smoked sausages is related to the need for product with a long shelf life. Resistance to microbial spoilage is achieved by prolonged double smoking leading to a considerable reduction of the moisture content during the drying process and high salt concentration.

Currently, the production of cooked smoked sausages with guaranteed safety, high quality and long shelf life is considered as one of the most important technological challenges. This could be achieved due to such technological methods as the use of food supplements and modern packaging as well as the introduction of innovative approaches intensifying and optimizing the process of sausage manufacturing.

In modern conditions of meat industry, one of the most urgent tasks is to develop resource-saving equipment. The Gorbatov's All-Russian Meat Research Institute team invented and proved the new method for grinding of frozen meat blocks by milling. The main characteristic of this method is energy- and resource-saving [1, 2].

II. MATERIALS AND METHODS

Experimental blocks of meat that was cut from the frozen meat blocks of industrial size (second grade beef) were used to produce experimental samples of cooked smoked sausage from frozen raw material grinded by new method. The

temperature of the meat in the center of the block before the grinding was in the range of minus 12 °C to minus 14 °C. The following conventional research methods for meat and meat products were used to study the experimental samples [3]:

- Determination of moisture content in accordance with GOST 9793-74;
- Determination of protein content in accordance with GOST 25011-81;
- Determination of fat content in accordance with GOST 23042-86;
- Method for evaluation of water binding capacity of meat (compression method);
- Determination of pH using portable pH meter "Zamer";
- Structural and mechanical tests using universal testing machine "Instron";
- Determination of microstructural indicators in accordance with GOST 51604-2000;
- Sensory tests in accordance with GOST 9959-94 (color, flavor, odor, texture, appearance, overall assessment).

III. RESULTS AND DISCUSSION

Produced samples of cooked smoked sausage had the following designations: sample No. 1 (control) - produced using traditional technology (grinding of thawed raw materials in mincing machine and preparation of minced meat in cutter); sample No. 2 (experimental) - obtained by grinding of frozen raw material with milling tool only and preparation of minced meat in mixer. Formulations of samples No. 1 and No. 2 did not differ. This formulation is shown in Table 1.

Table 1. Formulation of cooked sausage (sample No. 1, sample No. 2)

Raw materials, spices etc.	Standard value for cooked sausages
Materials, kg per 100 kg of unsalted raw material	
Trimmed beef of second grade	70
Bacon	30
Spices and materials, g per 100 kg of unsalted raw material	
Salt	900
Nitrite	1600
Black pepper powder	100
Jamaica pepper powder	50
Sugar	200

Grinding of thawed raw meat for production of control sausage samples was carried out in mincing machine with holes' diameter of 5 mm. Then meat emulsion was prepared in a cutter with the addition of bacon.

To produce the experimental samples of sausage, second grade beef grinded by milling was processed in mixer for 3-4 minutes with addition of nitrite, salt and spices. After that, grinded bacon was added and mixed for about 2 minutes. Mixing was performed to obtain homogeneous minced meat and uniform distribution of pieces of structural components. The total duration of mixing did not exceed 6-8 minutes.

The next step was minced meat filling (control and experimental) in fibrous coating with diameter of 45 mm and then sending them to heat treatment.

The heat treatment of sausage samples was carried out according to the modes specified in the Technology instructions within GOST R 55455-2013 "Cooked smoked sausages. Technical specifications".

Microbiological examination was carried out for samples of cooked smoked sausages No. 1 and No. 2. The results are shown in Table 2.

Table 2. Microbiological examination results for sausage samples

Parameter		Standard value	Results for samples	
			No. 1	No. 2
Product weight (g) in which following microbes are not allowed:	Coliforms	1.0	Not detected	Not detected
	Sulfite-reducing clostridia	0.01	Not detected	Not detected
	S. aureus	1.0	Not detected	Not detected
	Pathogenic microorganisms, including Salmonella	25.0	Not detected	Not detected
	L. monocytogenes	25.0	Not detected	Not detected

Experimental samples were stored for 30 days at 0 to 6 °C. The results of microbiological studies have demonstrated the compliance of experimental sausage samples with the requirements of TR CU 021/2011 and TR CU 034/2013.

According to the results of microstructural and structural-mechanical studies of cooked smoked sausage samples it was found that:

- sample No. 1 had heterogeneous minced meat with insignificant amount of vacuoles; the shear force was at minimum values (not included in sampling) 28.83 N/m^2;
- sample No. 2 had heterogeneous minced meat with small amount of vacuoles; the shear force was at minimum values (not included in sampling) 33.50 N/m^2.

The microstructure of the sample No. 1 was characterized by the compacted surface layer with a thickness of 250 to 350 microns; fine-grained protein mass was penetrated with clearly defined medium-sized and often elongated oval vacuoles filled with fat and glutin. The surface layer also included coarse-grained structural elements of minced meat - fascicles of muscle fiber, fragments of connective and adipose tissue.

Minced meat in the central layers of the sample was less compact as compared with the surface layer and was characterized by large fascicles of muscle fiber in the transverse and longitudinal sections, and by the fragments of adipose and connective tissue up to 1200 - 1500 microns. Between the particles of coarse-grained tissue, there was fine-grained protein mass penetrated with large and medium vacuoles, often merging with each other and forming narrow gaps ranging in size from 157 to 450 microns. The composition of the structural elements of minced meat was loosened. Fibers in muscle fascicles mostly retained transverse striations and lied freely in relation to each other. Destructive changes were detected as micro-cracks and transverse gaps in fibers forming fine-grained protein mass in destruction sites. On cross sections of muscle, fibers had polygonal shape.

Fragments of dense connective tissue were characterized by expanded loosened collagen fascicles. Adipose tissue was detected as groups of intact round cells filled with fat; portion of the fat was distributed into the individual vacuoles and as varying size droplets into the fine-grained protein mass of minced meat (Figure 1).

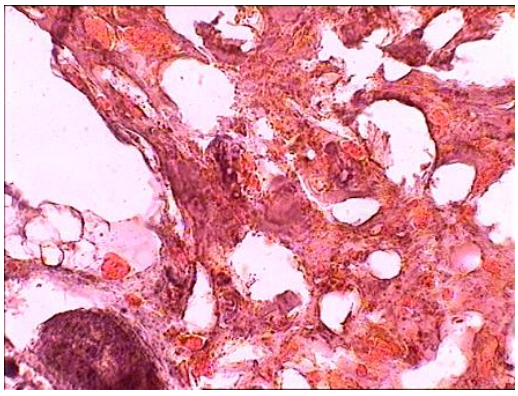

Figure 1 - The microstructure of sausage sample No. 1. Magnification power is x 350

The microstructure analysis of sausage sample No. 2 has found that the minced meat in central layers of the sample was less compact as compared with the surface layer and was characterized by fascicles of muscle fiber in the transverse and longitudinal sections, and by the fragments of adipose and connective tissue of 700 to 1500 microns. Between the particles of coarse-grained tissue, there was fine-grained protein mass ranging from 120 to 350 microns penetrated with large and medium vacuoles, often merging with each other. The arrangement of the structural elements of minced meat was denser than in the sample No. 1. Transverse striations of muscle fibers were clearly expressed; the fibers lied freely in relation to each other. Destructive changes were detected as micro-cracks and transverse gaps in fibers forming fine-grained protein mass in destruction sites.

Fragments of dense connective tissue were loosened. Adipose tissue was detected as groups of intact round cells filled with fat; portion of the fat was distributed into the individual vacuoles and as varying size droplets into the fine-grained protein mass of minced meat (Figure 2).

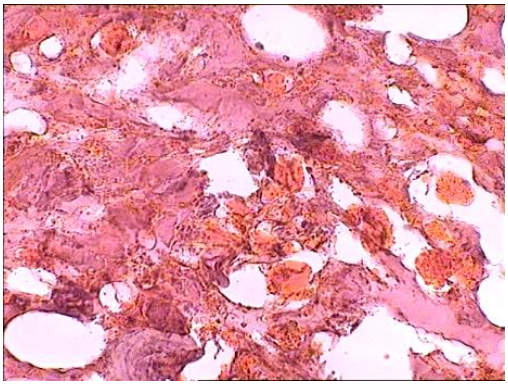

Figure 2 - The microstructure of sausage sample No. 2. Magnification power is x 350

The results of the color characteristics of the samples are presented in Table 3.

Table 3. Comparison of the color characteristics

	Lightness, L	Redness, a	Yellowness, b
Control sample	61.8	10.9	11.8
Experimental sample	66.7	14.4	14.8

The control sausage sample was produced according to the standard technological scheme, the experimental sample with the use of new method of comminution. Color is one of the main characteristics, which determines the preference when choosing a product. In general, the color characteristics of the experimental

sample were higher compared to the control sample.

Sensory evaluation of finished product samples was also carried out. The panelist noted that the sample No. 1 had expressed pleasant flavor and dark red color without outflows under the coating; inclusion of bacon pieces was seen on slices, which is typical for cooked smoked sausage.

Sample No. 2 had moderately salty meat flavor and pleasant odor; sausage color was dark red and more saturated compared with sample No. 1.

IV. CONCLUSIONS

Comprehensive research found that the new method for grinding of frozen raw meat materials by milling did not reduce physicochemical and microbiological quality parameters of cooked smoked sausages while their sensory characteristics (appearance, texture and flavor) were well defined. In comparison with the control, the structure of the experimental samples of minced meat had a smaller muscle tissue particle size of 120 to 350 microns.

Experimental study of grinding of frozen raw meat materials by milling showed that minced meat temperature measured directly after the grinding was in the negative range of temperatures (from minus 0.5 ℃ to minus 2.9 ℃) for all cutting conditions. This eliminates the possibility of thermal denaturation of the protein in the raw material during the grinding process and improves sanitation conditions of minced meat [4, 5].

Experimental producing of meat products showed the possibility to improve the quality of sausage products manufactured from frozen meat by the means of milling. As a results of the research, technical specification was developed for the production of experimental-industrial milling grinder designed for grinding of frozen meat blocks of industrial sizes.

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