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Technology Development of Protein-Fat Emulsion and Its Use in Food Production.

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ABSTRACT

In today's market, the production of high-quality, cost-effective, competitive products is impossible without the use of advanced technologies and innovative solutions. The objective of this research work is scientific testing of methods related to the development of innovative technology of protein-fat emulsion with a higher stability than its analogs. Scientific researchers are presented on the example of emulsified sausage goods. When developing the technology of protein-fat emulsion, the following raw materials were used: high-oleic sunflower oil, an aqueous solution of animal protein product "Kat-gel 95". The emulsion was obtained using a device for cavitation disintegration of liquid food media and water "Hielscher Ultrasound Technology UP" according to the developed modes. The conducted researches allowed to recommend the replacement from 15 to 20% of meat raw materials on the received emulsion in a formulation of sausage goods. The absence of pork fat in the sausage goods, as well as the replacement of meat raw materials in the composition of the product with the developed protein-fat emulsion, contributed to the improvement of the quality characteristics of the finished product, increasing the stability of sausages during storage, improving organoleptic properties, reducing the caloric content of meat products; reducing the risk of defects.

Keywords: emulsion, emulsion stability, technology, composition, raw meat.

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INTRODUCTION

In Russia, the food industry and in particular its significant part – the meat industry, is a key element of agriculture, determining the food security of the country [1]. The health of the population of all ages is determined by the use of high-quality and environmentally friendly food. Homogenization processes are quite common in the food industry. The devices used for carrying out the homogenization processes have a number of serious shortcomings and often do not meet modern requirements for productivity and quality of finished goods. Therefore, the relevance of equipping enterprises with modern technology, the creation of fundamentally new technologies that ensure the production of high-quality, high-dispersed, homogeneous, chemically pure emulsions, as well as the organization of production of environmentally friendly food does not weaken, but increases. To achieve this goal in the meat processing industry, special attention is paid to sausage products from fine minced meat, the composition of which assumes the addition of emulsions, suspensions, pastes, structural compositions from secondary protein-containing raw materials [2].

It is known that when preparing minced meat, the resulting fat emulsion is fragile and its stratification can occur. Therefore, an increase in the content of fatty raw materials leads to a decrease in the moisture binding capacity of minced meat. This can be avoided by replacing the fatty tissue with a protein-fat emulsion. Replacement of pork fat on the protein-fat emulsion allows to obtain a finished meat product with high structural-mechanical properties. The use of protein-fat emulsions in the technology of sausage products is the surest condition of preventing moisture loss during the heat treatment and the obstacle of obtaining a bouillon - fat drips.

Currently, there are a significant number of protein-fat emulsions obtained on the basis of water or a liquid component, with the addition of plasma or stabilized blood at different ratios of the protein product and fat.

However, with all the diversity of the component composition, traditionally used for their production are mainly mixing plants that work according to the type of cutter or homogenizer. In the cutter or the cutter-mixer add some water, protein products and process for 4-5 minutes then add minced fat raw material and process another few minutes, then add a blood or plasma. Salt is added at the last turn of the cutter bowl. The average duration of the emulsion-making process using a cutter is about 10-15 minutes. Then the emulsion is processed on machines of fine grinding of continuous or periodic action [3].

The shelf life of protein-fat emulsions obtained by this method at a temperature of 0 to 4 °C is not more than 48 hours. The thus obtained emulsion starts to flake after 18 to 24 hours, which affects the quality of sausage products and may cause various defects.

The purpose of the given research was to develop a technology of protein-fat emulsion, characterized by greater stability compared with analogues, reducing the time of its preparation, as well as the study of the quality characteristics of the finished product, which includes the developed protein-fat emulsion.

MATERIALS AND METHODS

During the scientific experiments the following research methods were used: analytical, organoleptic, measuring, calculation. The work was performed on the basis of the “Belgorod University of Cooperation, Economics and Law” Stavropol Institute of Cooperation (affiliate) in 2017. During the scientific experiment as the object of research was used protein product of animal origin “Kat-gel 95” Collagen protein product “Kat-gel 95” is a partially hydrolyzed connective protein tissue derived from collagen tissue of cattle

For the preparation of protein-fat emulsion in the working chamber of the device “Hielscher Ultrasound Technology UP” an aqueous solution of protein product of animal origin “Kat-gel 95” is supplied, obtained on the same machine and is treated for 4 minutes on the following technical characteristics of the device: the frequency of ultrasonic vibrations – 22 kHz, the range of intensity of action – up to 400 W, with gradually adding high-oleic sunflower oil. The ratio of components in the preparation of the emulsion is as follows: 47.6% of the mass of the finished emulsion of the liquid component, 4.8% of the protein product of animal origin “Kat-gel 95”, 47.6% of high-oleic sunflower oil.

Emulsifying capacity of sample minced meat systems (SMMS) was carried out according to the method proposed by Antipova L. V. [4], replacing the use of homogenizer in obtaining emulsion with the device “Hielscher Ultrasound Technology UP”. In determining the emulsifying ability of a portion of the minced meat, weighing 7 g was suspended in 100 cm³ of water by means of cavitation in the machine “Hielscher Ultrasound Technology UP” within 60 seconds. Then 100 cm³ of refined sunflower oil was added and the mixture was emulsified in the device “Hielscher Ultrasound Technology UP” for 2 minutes. After that, the emulsion was poured into 4 calibrated centrifuge tubes with a capacity of 50 cm³ and centrifuged at 500 c⁻¹ for 10 minutes. Further, the volume of emulsified oil was determined taking into account the height of the emulsion layer [4].

With the aim of establishing the optimum level of replacement of meat raw materials of protein-fat emulsion on the basis of the product “Kat-gel 95”, we have made 10, 15, 20 and 25% replacement of meat raw materials to the emulsion obtained using the ultrasonic processor “Hielscher Ultrasound Technology UP”.

RESULTS AND DISCUSSION

The finished protein-fat emulsion obtained using the ultrasonic processor “Hielscher Ultrasound Technology UP” was more stable, its delamination occurred within 240 hours. Indicators of stability of the protein-fat emulsion obtained using the ultrasonic processor “Hielscher Ultrasound Technology UP”, show that the mechanism of emulsion formation on the cavitation disintegrator has a different character in comparison with devices operating on the type of homogenizer. As a result of ultrasonic action cavitation bubbles appear on the dispersion site, which occur due to the amplified shock waves in the liquid located around, which contributes to the formation of high-intensity flows. Under the influence of high velocity, a violation of the agglomerates of the elements is committed and the number of collisions between single particles increases. As a result, the distance between the particles of the dispersed phase and the dispersion medium decreases, mass transfer increases, mixing improves, and droplets are combined [5].

Thus, as a result of the influence of ultrasound on mutually immiscible liquids, one of the liquids is transformed into a dispersed state of the other – that is, emulsification (ultrasonic dispersion of the liquid in the liquid). In all probability, in a liquid medium, due to the influence of ultrasound, alternating sound pressure is formed, and the liquid penetrates into the cracks and capillaries of the soluble substance. Because of the destruction of the protein solution structure, stabilization of the protein-fat emulsion take place, as single drops of fat are inside the cells of a continuous grid. Due to the rapid fusion of fragments of the protein product structure, the smallest drops of fat remain inside the cells of the restored grid even after the cessation of ultrasonic action [5; 6].

It has been noted that as a result of ultrasonic treatment of heterogeneous systems, two different processes occur simultaneously: the formation of an emulsion at the boundary of the phase separation and coagulation of its particles in the entire volume of the system. The integrity of adsorption-solvate layers varies due to ultrasonic action. Due to the liquid turbulization, the frequency of collisions of broken droplets increases, there is a balance between dispersion and aggregation of particles, which contributes to the formation of stable emulsions [6].

The conducted researches allowed to state, that emulsifying ability of the sample minced systems received by means of cavitation in the device “Hielscher Ultrasound Technology UP” makes up 96%. This indicator shows a high emulsifying ability of the protein product.

Based on the research above, with the aim of establishing the optimum level of replacement of meat raw materials with protein-fat emulsion on the basis of the “Kat-gel 95”, we have investigated the basic structural and mechanical properties of sample meat systems depending on the level of its introduction into the recipe of the sausage goods. At this stage, the obtained protein-fat emulsion was introduced into the sample minced meat systems from chilled beef and 10, 15, 20 and 25% of meat raw material was replaced with an emulsion [6-8]. Then the structural and mechanical parameters of raw minced meat and experimental samples of boiled sausage were determined. The data obtained are presented in table 1.

Table 1: Physico-chemical and structural-mechanical parameters of raw minced meat and experimental samples of boiled sausage (n=3; V< 14)

Indicators	Replacement level 10 %	Replacement level 15 %	Replacement level 20 %	Replacement level 25 %
Moisture content, %				
- raw minced meat	73,05	72,18	72,29	72,34
- finished product	67,02	67,63	67,74	67,82
Moisture-retaining capacity of the minced meat, % to total moisture	87,8	92,2	93,1	94,4
Plasticity, cm ²	6,37	6,06	5,86	5,72
The strength of adhesion, H/m ²	692,4	540,3	651,3	567,4
Shear stress limit, Pa	701,7	736,4	750,5	752,2
The degree of penetration, mm	5,17	4,57	4,32	4,24
The specific cutting resistance, H/m	166,0	198,0	197,0	201,0
Moisture-retaining capacity of the finished product, %	90,49	93,46	93,75	94,21
Organoleptic evaluation, score	3,95	4,25	4,65	4,65

It has been found that the addition of a protein-fat emulsion obtained by using an ultrasonic processor “Hielscher Ultrasound Technology UP” in the amount of 15 to 20% in the preparation of sample compositions contributes to the optimal characteristics of the structural and mechanical parameters of raw minced meat and experimental samples of boiled sausage. Further increase in the level of protein-fat emulsion leads to a slight increase in the structural and mechanical properties of sample minced meat systems and economically impractical. All the samples of boiled meat products are characterized by a lack of bouillon - fat drips and are resistant in storage.

CONCLUSION

On the basis of the conducted researches we draw the following conclusions:

1. It is recommended to produce protein-fat emulsions using the ultrasonic processor “Hielscher Ultrasound Technology UP” based on an aqueous solution of animal protein product “Kat-gel 95” and high-oleic sunflower oil. The ratio of components in the preparation of the emulsion is as follows: 47.6% of the mass of the finished emulsion of the liquid component; 4.8% of the protein product of animal origin “Kat-gel 95”; 47.6% of high-oleic sunflower oil.
2. When developing composition of sausage goods with high functional and technological properties, it is recommended to replace from 15 to 20% of meat raw materials with a protein-fat emulsion obtained on the basis of the protein product “Kat-gel 95” using the ultrasonic device “Hielscher Ultrasound Technology UP”.

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