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Advances In Technological Productivity And Biological Evaluation Of Sausage Products.

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ABSTRACT

The article presents a technology developed for the production of cooked sausage using emulsion based on squash puree. Experimental studies confirmed that protein emulsion in the recipe of a meat product made it possible to reduce its cost and at the same time retain nutritional properties and biological value of the finished product. The analysis of organoleptic indicators and physico-chemical properties of sausage samples, as well as histological analysis have been conducted. The sample with vegetable-protein emulsion in its composition had a higher organoleptic evaluation. The calculation of the amino acid score of the samples has found that in Samples I and II, there were no limiting amino acids compared to Control sample, where valine (96%), threonine (94%) and lysine (89%) were limiting. When calculating the level of the daily need for amino acids (according to the WHO FAO), it has been found that 100 g of the sausage product developed (Sample 1) largely satisfies the needs of the human body. There was a significant increase in the content of linolenic polyunsaturated fatty acid in Sample 1 by 1.5%, which was caused by its high content in flaxseed oil. According to the histological analysis, it has been noted that the sample with the emulsion had a denser structure without cavities. Thus, in the course of the research, the applicability of the additive being used in the food industry as an ingredient in the formulations of functional foods to increase their biological value has been confirmed.
Keywords: cooked sausages, quality of sausages, structure of meat products, histological analysis, flaxseed oil.

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INTRODUCTION

In the modern food industry, various ways of improving the quality of food products and technological process are applied. The most cost-effective and easily applicable is the use of food additives that resulted in food additives being widespread.

Sausages are known to be widely distributed in the market of meat products due to their availability and variety. However, manufacturers often use low-grade meat raw materials and cheap vegetable components with low biological and nutritional value to reduce the cost of products. Sausages are rarely considered by consumers as a basic source of nutrients, because during the heat treatment process most of the nutrients are destroyed, and the remaining quantities of them do not satisfy physiological needs of the human body. An effective way to solve this problem is to develop affordable cooked sausages; so, boiled pork and beef sausage of the middle price segment was selected as an object for enrichment with nutrients.

MATERIALS AND METHODS

In order to study the effect of the plant-protein complex on consumer, functional-technological and physicochemical properties of cooked sausages, under laboratory conditions, there were following samples produced: boiled sausage with a vegetable component and protein additive, sausage with a vegetable-protein emulsion and a control sample produced according to the classical formulation.

We applied standardized methods of analysis. The weight fraction of moisture in the finished products was determined according to GOST 9793-74. The weight fraction of protein was determined according to GOST 25011-81. The content of amino acids and their ratio was studied using the “Capel 105/105M” capillary electrophoresis system. Comparison of the samples’ amino acid compositions, the reference protein’s one and daily requirement of nutrients was carried out according to the recommendations of the Food Committee of the World Health Organization (FAO / WHO).

The weight fraction of ash was determined in accordance with GOST R 51432-99 and recommendations. The weight fraction of fat in the finished samples was determined in the Soxhlet apparatus in accordance with the recommendations and GOST 042-86. Histological analysis was performed on samples of 10×10×4 mm, fixation in a 10% aqueous solution of formalin; histological sections were made on a freezing microtome MK-25M. Then the sections were stained with hematoxylin and eosin according to the standard technique. Microscopy was performed using a light microscope.

RESEARCH RESULTS

To study the feasibility of vegetable-protein emulsion in the formulations, samples of sausage products were selected. Sample I contained squash puree in the form of pre-treated protein-vegetable emulsion of flaxseed oil, squash puree and hydrated Star-Gel 50 protein supplement taken in a 1:1.3:1 weight ratio, respectively (Table 1).

The protein supplement contained meat albumin 50%, whey milk protein concentrate 15%, egg albumin 13% and whey 20%. Production of a stable emulsion is possible only after pretreatment of proteins used in the formulation. The introduction of pre-treated protein emulsion into the chopped raw meat allowed obtaining a homogeneous stuffing and avoiding overheating of the stuffing composition that could lead to premature denaturation of proteins and reducing their moisture binding ability. At the same time, adding of summer squash reduced the amount of water applied, providing the necessary emulsion structure.

Prototypes were produced, and their organoleptic evaluation was carried out using the sensory method. Its results were systematized in Figure 1. In Control sample, the emulsion was revealed to contribute to an increase in the stability of the consistency and color of the minced meat system, increase in the adhesion of minced meat and reduced probability of syneresis as a result. In turn, this allowed predicting the improvement of the consistency, appearance of the product and its attractiveness for the consumer.

The analysis of the amino acid composition of the samples was also carried out. Its results were systematized in Table 2. The biological value of proteins was determined by the method of calculating the

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amino acid score that is the ratio between the amount of the studied essential amino acid in 1 g of protein and its amount in 1 g of the reference protein.

The chemical analysis of the samples found that the highest protein content was in Sample I, i.e., higher than in Sample II and Control by 0.2 and 2.2%, respectively. It could be assumed that in the sample with the most densely bound structure of the emulsion, the heat treatment caused the less loss of the protein component than in other samples. The fat contents in Samples I and II were less than in Control sample, since the fat raw material partially was replaced by the protein emulsion.

The comparison of the samples in terms of their nutritional values revealed that the sausage product developed with a protein-vegetable emulsion would satisfy the average need of the human body for protein for 21.3% and fat for 12%. The results of the amino acid analysis are shown in Table 3.

The calculation of the amino acid score of the samples found that in Samples I and II, there were no limiting amino acids compared to the Control sample, where valine (96%), threonine (94%) and lysine (89%) were limiting. So, this was due to the fact that the protein supplement contained complete protein of animal origin.
When calculating the level of replenishment of the daily need for amino acids (according to the WHO/FAO), it was found that 100 g of the sausage product developed (Sample I) would satisfy the daily need for lysine for 36%, phenylalanine for 23%, leucine+isoleucine for 83%, methionine for 19%, valine for 61%, threonine for 30.9% and tryptophan for 44%.

To evaluate the effect of the flaxseed oil added, the fatty acid compositions of the samples were analyzed and the contents of saturated and unsaturated acids were compared with those for daily consumption required (Table 4).

In the sample with a vegetable-protein emulsion based on flaxseed oil, the content of polyunsaturated acids was revealed to be 3.82% that in turn amounted to 34.7% of the daily consumption rate; saturated acids 9.56% - 31% of the daily consumption rate. A significant increase in the content of linolenic polyunsaturated fatty acid was also noted in Sample I by 1.5%, which was caused by its high content in linseed oil.

The results of the histological analysis of the samples are shown in Figure 2 (a-c). The interaction between the particles of muscle fibers was moderately tight; the porosity degree was expressed slightly; the size and shape of vacuoles were relatively uniform; the degrees of dispersion, destruction and interconnectedness of structures were similar. A significant amount of broth was detected in Sample II and Control.

Table 1 – Formulations of sausage samples

Ingredient	Content, %		
	I	II	Control
Pork semifat trimmed	40	40	40
Premium beef trimmed	25	20	25
Beef trimmed B	15	15	15
Nitrite curing mixture	1.8	1,8	1.8
Protein-vegetable emulsion, incl.:	25	–	–
Protein supplement	3	3	–
Summer squash	4	10	–
Flaxseed oil	3	–	–
Water	15	20	10
Yield, %	105	105	92

Table 2 – Results of physico-chemical analysis of samples

Parameter	Content (% of DN*)		
	I	II	Control
Protein, %	17.4±0.2 (21.3%)	17.2±0.2 (21%)	15.2±0.03 (18.6%)
Fat, %	11.7±0.4 (12.1%)	11.1±0.5 (10.7%)	14.6±0.4 (15.1%)
Carbohydrates, %	2.5±0.1	1.9±0.2	0
Moisture, %	60.2±0.1	60.6±0.08	62.6±0.08
Ash, %	0.1±0.01	0.1±0.01	0.1±0.01

*% of the average daily body need for protein, fats and carbohydrates.

Table 3 – Amino acid analysis results

Amino acid profile, mg% (AS, %)			
Arginine	660±0.02	598±0.02	440±0.02
Lysine	582±0.02 (112)	580±0.02 (110.7)	490±0.02 (89)
Tyrosine	302±0.02	296±0.02	267±0.02
Phenylalanine	564±0.02 (143)	560±0.02 (138)	437.4±0.02 (132)
Gistidine	214±0.02	167±0.02	163±0.02
Leycin + isoleucine	1511±0.02 (132)	985±0.02 (129.5)	965±0.02 (116)
Methionine	213±0.02 (112)	205±0.02 (104)	203±0.02 (103)
Valine	681±0.02 (101)	573±0.02 (102)	564±0.02 (96)
Proline	574±0.02	528±0.02	478±0.02
Threonine	298±0.02 (106)	295±0.02 (104.5)	287±0.02 (94)
Alanine	484±0.02	475±0.02	386±0.02
Glycine	490±0.02	489±0.02	378±0.02
Tryptophan	151±0.02 (137)	148±0.02 (134)	121±0.02 (108)

Table 4 – Fatty acid compositions of sausage samples

№	Parameter	Content		
		I	II	Control
	Saturated FA, incl.:	9.56	9.2708	9.4073
1	Caprin $C_{10:0}$	0.0192	0.0192	0.0184
2	Lauric $C_{12:0}$	0.0188	0.0128	0.0129
3	Myristic $C_{14:0}$	0.441	0.438	0.451
4	Pentadecane $C_{15:0}$	0.012	0.012	0.013
5	Palmitic $C_{16:0}$	5.843	5.6932	5.684
6	Maragarine $C_{17:0}$	0.111	0.010	0.108
7	Stearic $C_{18:0}$	3.116	2.987	3.12
	Monounsaturated FA, incl.:	11.764	11.134	10.927
8	Myristolein $C_{14:1}$	0.01	0.004	0.003
9	Palmitoleic $C_{16:1}$	0.936	0.933	0.946
10	Oleic $C_{18:1}$	10.82	10.197	9.978
	Polyunsaturated FA, incl.:	3.82	2.293	2.2851
11	Linoleic $C_{18:2\ \omega 6}$	2.0592	2.048	2.047
12	Linolenic $C_{18:3\omega 3}$	1.675	0.148	0.147
13	Arachidonic $C_{20:4\ \omega 6}$	0.0856	0.0854	0.0853

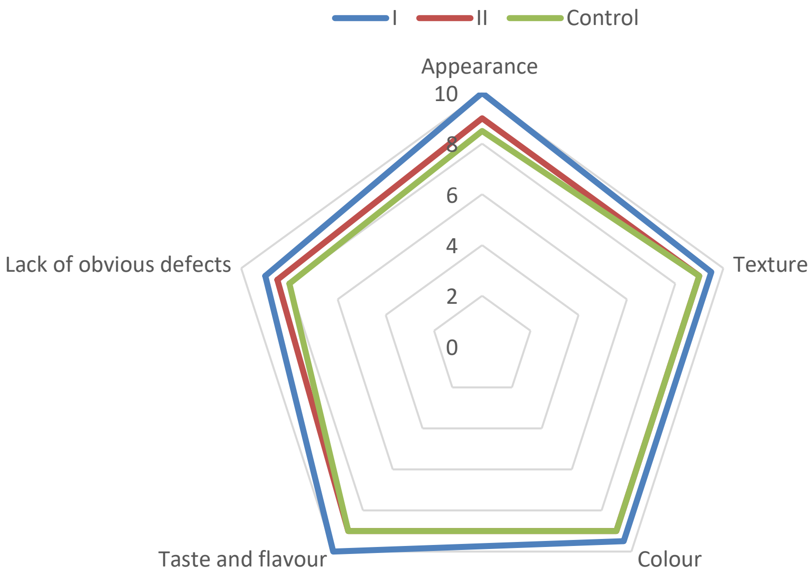

Figure 1 – Sensory analysis results

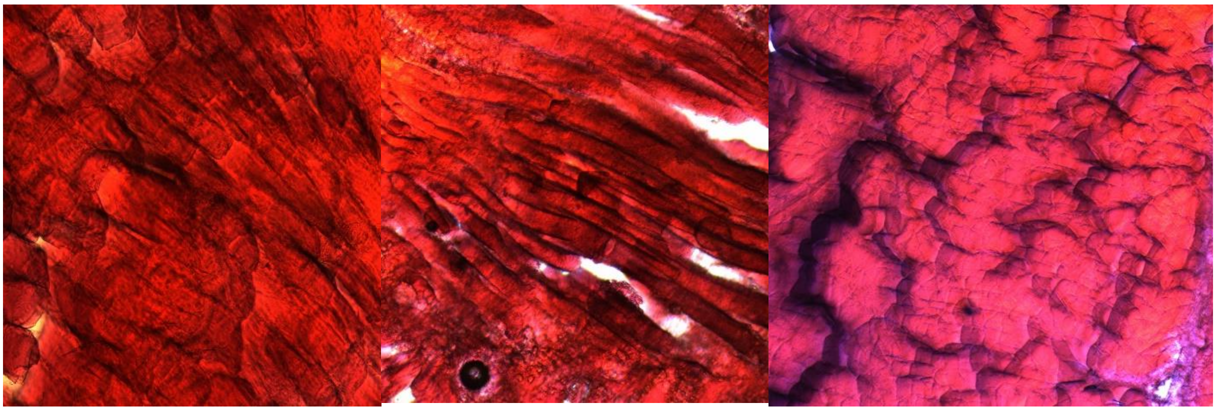

Figure 2 a, b and c – Results of histological analysis of samples

The study of the samples with respect to the structural arrangement of muscle fiber particles and connective tissue found a relative adherence of fibrous elements. Microcavities and microvoids were evenly spaced and characterized by a uniform oval shape. In the structure formation according to the histological pattern, a sample with a plant-protein emulsion was characterized by a good relationship between the muscle fiber particles and connective tissue ones. The stuffing was well dispersed; its structural elements were interconnected.

CONCLUSIONS

The study revealed that the adding of a plant-protein emulsion containing a high-protein supplement, summer squash and flaxseed oil had a significant effect on the formation of a dense structure and reducing the number of water pockets in comparison with Control sample. According to the nutritional and biological values analysis, the sample with emulsion was also assessed higher, as it was marked for an increase in the amount of protein that was balanced in its amino acid composition, with flaxseed oil in the composition of the plant-protein emulsion contributing to an increase in the content of polyunsaturated fatty acids in the finished product.

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