PERIÓDICO TCHÊ QUÍMICA
ARTIGO ORIGINAL

ESTUDO DO EFEITO EM PÓ DE SEMENTES DE ESPINHEIRO-MARÍTIMO NA PRODUÇÃO DE PRODUTOS À BASE DE CARNE DEFUMADA A PARTIR DE CARNE DE CAMELO E DE BOVINO

STUDY OF SEA BUCKTHORN SEED POWDER EFFECT ON THE PRODUCTION OF COOKED-SMOKED MEAT PRODUCTS FROM CAMEL MEAT AND BEEF

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RESUMO

As propriedades de consumo da carne dependem em grande parte da composição física e química. O valor da carne de camelo é determinado pelo seu alto teor de nutrientes, em uma forma facilmente digerível, necessária para o funcionamento normal do corpo. No entanto, o principal obstáculo ao uso de carne de camelo na produção de embutidos é a dureza da carne e a fraca capacidade de ligação da mistura da carne de camelo. Assim, pesquisas nessa área são relevantes. Este artigo representa o estudo do efeito de sementes de espinheiro-marítimo em pó nos indicadores de qualidade de produtos à base de carne defumada cozida a partir de carne de camelo e carne bovina. Nesse sentido, estudou-se a composição química do pó de sementes de espinheiro-marítimo que apresentou alto teor de proteínas e polissacarídeos. Verificou-se que o pó das sementes de espinheiro-marítimo é uma fonte de substâncias biologicamente ativas como tocoferol 62,15 ± 2,13 mg / 100 g, carotenóides 4,21 ± 0,22 mg / 100 g e flavonóides 1,54 ± 0,06% .06% justificando, assim, a escolha do pó das sementes de espinheiro-marítimo como parte do produto de carne defumada cozida a partir de carne de camelo e carne bovina. Foi cientificamente comprovado que o pó das sementes de espinheiro-marítimo aumenta os parâmetros funcionais e tecnológicos, melhora as características estruturais, mecânicas e de cor do produto acabado. Em particular, aumenta o rendimento do produto em 6,8%, o teor de umidade em 9,35%, a capacidade de ligação à umidade em 2%, a capacidade de retenção de gordura em 3,5%; a força de cisalhamento foi de 5,8 N / m. Como resultado do estudo, foi proposto o uso de sementes de espinheiro-marítimo em pó na produção de produtos à base de carne de camelo e bovina.

Palavras-chave: Carne de camelo, processamento de carne, composição química, propriedades funcionais e tecnológicas, flavonóides.

ABSTRACT

Consumer properties of meat largely depend on the physical and chemical composition. The value of camel meat is determined by its high content of nutrients in an easily digestible form necessary for the normal functioning of the body. However, the main obstacle to the use of camel meat in the production of sausage products is meat hardness and weak moisture-binding capacity of camel meat. Thus, research in this area is relevant. This article represents the study of sea buckthorn seed powder effect on the quality indicators of cooked-smoked meat products from camel meat and beef. In this regard, the chemical composition of the sea buckthorn seed powder was studied, which showed a high content of proteins and polysaccharides. It was found that the powder from the sea buckthorn seeds is a source of such biologically active substances as tocopherol 62.15 ± 2.13 mg/100 g, carotenoids 4.21 ± 0.22 mg/100 g, and flavonoids 1.54 ± 0.06%.06%. The choice of powder from the sea buckthorn seeds as part of cooked-smoked meat product from camel meat and beef is justified. It has been scientifically proven that the powder from the sea buckthorn seeds boosts the functional and technological parameters, improves the structural, mechanical and color characteristics of the finished product. In particular, it increases the product yield by 6.8%, the moisture content by 9.35%, the moisture-binding capacity by 2%, the fat-holding capacity by 3.5%; the shearing force was 5.8 N/m. As a result

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of the study, the use of sea buckthorn seed powder in the production of meat products from camel meat and beef has been proposed.

Keywords: Camel meat, meat processing, chemical composition, functional and technological properties, flavonoids.

1. INTRODUCTION

The development of mass food under market relations is directly related to the solution of such tasks as improving the quality of the products made, switching to a labile range of meat products considering the consumers' demand. Development of formulations and technologies of new types of products with original or unique organoleptic indicators with maximum use of all resource sources including non-traditional raw materials is promising and cost-effective (Lisitsyn *et al,*2007).

The camel meat is an unconventional type of raw meat; its properties resemble horsemeat. It is of red color without marbling, tough, dense texture, peculiar smell. Due to its easy digestibility by the human body, camel meat (and fat) is used as diet meat. However, these qualities of camel meat have not been sufficiently studied (Kadim, I. T. *et al*, 2013, Abdelhadi *et al*, 2012, Abril *et al*, 2001, and etc.).

In the Republic of Kazakhstan and in neighboring countries (Russian Federation, Uzbekistan, Turkmenistan) people mainly are occupied with dairy camel breeding as well as breeding to produce wool and further processing products. Meat camel breeding is very far behind in development due to the high content of connective tissue in camel meat, its coarse-fibred structure, which causes meat hardness that is a major obstacle to its widespread use. For this reason, camel meat is mainly used for food only at home (Lisitsyn *et al*, 2018).

In order to improve the quality of sausage made from camel meat, Kalalou and other scientists (Kalalou *et al*,2004) used Selected Lactic Acid Bacteria. The proposed method has shown good results in organoleptic characteristics and structural and mechanical properties of the product. However, the process of production of camel sausage using lactic acid bacteria requires very strict control of microbiological indicators in the maturation process.

Abdel Moneim and E. Suliman (Abdel Moneim *et al*, 2014) studied the sensory characteristics, juiciness, consistency of camel meat sausage as well as the effect of the season, the age of the meat-producing animal and the time of raw meat storage for the sausage production on these indicators. As a result of the study, scientists propose using fresh or frozen raw meat.

Engy (Engy, F. Zaki, 2017) studied the possibility of adding protein emulsion in the production of camel meat sausages. The study suggested the addition of protein emulsion in an amount of 4%, which improves the organoleptic characteristics, moisture-binding capacity, fat-holding capacity, juiciness, consistency of the finished product.

Minimal costs for the breeding and management of camels, the high yield of meat products, fat and other products shows the need to process camel meat and thereby obtain additional resources of raw meat.

In this regard, the development of high-quality meat products from camel meat requires scientifically based methods and modes of its processing, the use of intensive processing methods and effective salting methods.

This study was aimed at developing a new cooked-smoked meat product from camel meat using powder from sea buckthorn seeds in order to activate the maturation processes and impart the improved structural and mechanical parameters, organoleptic indicators, and physical and chemical parameters to the finished product.

2. MATERIALS AND METHODS

2.1 Samples

Laboratory studies of test samples were held in the research laboratory of the V.M. Gorbatov All-Russian Research Institute of the Meat Industry (Moscow, Russian Federation). The test sample of cooked-smoked meat product from camel meat was made from the meat of the Kazakh double-humped camel (Bactrian) at the age of two; camel meat and beef were purchased at Daulet-Beket LLP camel farm (Akshi village, Almaty region, Kazakhstan). Powder from the sea buckthorn seeds was purchased from The Semins' Private Apiary (Moscow, Russian Federation).

The test samples were produced at the meat processing research center of Almaty Technological University (Almaty, Republic of Kazakhstan).

2.2 Chemical composition

The chemical composition of meat and meat products was determined by commonly known methods.

Two-hundred grams of product sample were placed in plastic containers, frozen and then dried in a thermal freeze dryer (Modulyol-230, Milford-UK) for 5 days under 100-mbar pressure at −50 °C. The frozen dry samples were ground to a homogeneous mass in a grinder (Panasonic-Mixergrinder-Model MX119N-Japan) for chemical analyses. The moisture was determined by weighing 200 g meat sample before and after drying in a thermal freeze dryer for 5 days. The proximate chemical composition of the product was determined according to the standard methods of the AOAC (2000).

Protein was determined using a Foss Kjeltec 2300 nitrogen/protein analyzer (State standard P 50258). Fat was determined by Soxhlet extraction method using petroleum ether (State standard 23042-86). Ash content was determined by ashing samples in a muffle furnace at 500 °C for 24 h (State standard 31727-2012)

2.3 Determination of the pH

Determination of the pH of meat and meat products. The pH of meat products was monitored using a portable pH meter (Hanna waterproof pH meter, Model Hi 9025) fitted with a plastic body open junction, conic (Hanna FC200B) and a temperature adjusting probe. The pH probe and the thermometer were inserted into the product to a similar depth (2 cm).

2.4 Mineral composition

A mixed standard solution was prepared from a 1000 μg/ml multi-element solution (Darmstadt, Germany) and inhouse standard reference materials used for validation of the method. Evaluation of mineral levels in the samples was carried out after complete digestion using a Milestone 1200 MDR microwave system at a temperature of 200 °C in closed (PTFE) vessel. In brief 5 ml of conc. HNO_3 and 1 ml of 30% H_2O_2 were added to each digestion vessel. They were then heated to 200 °C over a 5-min period and then held at 200 °C for another 20 min. The digest obtained was collected in 50-ml volumetric flasks and made up to volume. Measurements were carried out on the ICP-OES system (Perkin Elmer Model 3300) equipped with a low-flow Gem Cone nebulizer in addition to an ultrasonic nebulizer for low concentrations.

2.5 Sensory indicators of meat products

Sensory evaluation was carried out using score assessment. Ten points scores of intensity and desirability scales were used in the experiment. There was from 1 point (very slight) to 10 point scores of intensity (very strong) and similar for desirability: from 1 point (undesirable) to 10 point (very much desirable). All processed meat products were sensory investigated by six-panel. Products were prepared as half of chubs and 2.5 mm slices and presented to panelists on disposable dishes in white glow light (250 1x). The next sensory parameters were investigated: 1-taste, 2 – smell and aroma, 3 – appearance, 4 – consistency, 5 – view at the cut, 6 – juiciness. (State standard 9793-74, 23041-78).

3. RESULTS AND DISCUSSION:

Sea buckthorn seeds are one of the by-products of the sea buckthorn berries processing. Being a natural concentrate of biologically active substances, sea buckthorn seeds are not widely used. Like any recycled material, sea buckthorn seeds can be considered as a cheap, economically feasible plant component (Lamo *et al*, 2014).

The seeds of sea buckthorn are a natural concentrate of proteins, fats, and carbohydrates (Table 1). Analysis of the chemical composition of seeds showed that seeds contained a significant amount of dietary fiber.

Unlike sea buckthorn pulp, seeds contain slightly fewer carotenoids and ascorbic acid. However, this raw material is rich in such natural antioxidants as tocopherols. Sea buckthorn seeds are far superior to other berries and nuts in this essential protective combination of cell membranes.

Recently, flavonoid compounds were of considerable interest not only as vitamin-like substances but also as strong antioxidants. The presence of flavonoids in the seeds increases the value of the latter. The data obtained show that buckthorn seeds are a promising source of functional ingredients.

Table 1. *Chemical composition of sea buckthorn seeds*

Indicator	Content
Proteins, %	20.06±1.15
Lipids, %	12.07±0.65
Carbohydrates, %, including:	
Cellulose	14.21±0.68
Pectin	2.46±0.05
Starch	0.51±0.55
Mono- and disaccharide	1.25±0.52
Minerals %	3.3
Carotenoids, mg	4.21±0.22
Flavonoids, %	1.54±0.06
Tocopherol, mg	62.15±2.13
Ascorbic acid, mg	6.54±0.32
Thiamine, mg	1.02±0.07
Riboflavin, mg	0.25±0.01
Pantothenic acid B3, mg	0.35±0.02
Nicotinic acid B5, mg	0.38±0.02
Pyrodoxine hydrochloride B6, mg	0.26±0.02
Folic acid Bc, mg	0.056±0.06

Analysis of the amino acid composition of seeds (Table 2) showed a high content of arginine and histidine, which are essential for children, in the non-essential amino acids. Seed proteins also contain a lot of glycines and glutamic acid, which are used separately as flavoring agents.

Table 2. *The amino acid composition of proteins of sea buckthorn seeds (mg/100 g of product)*

Amino Acid Name	Sea Buckthorn Seeds
Essential Amino Acids	
Valin	888
Leucine	1998
Phenylalanine	847
Lysine	1085
Methionine	24
Threonine	655
Tryptophan	297
Isoleucine	745
6538	8583
Non-essential Amino Acids	
Cystine	208
Arginine	5608
Alanine	637
Aspartic	1239
Glycine	2810
Serine	1515
Proline	857
Histidine	577
Tyrosine	519
Glutamic	6317

Further, the amino acid score of proteins in the sea buckthorn seed powder (Table 3) was studied in comparison with other seeds.

The method of chemical scores allows establishing the likely efficiency of utilization of the studied protein in the first approximation. It has been established that all essential amino acids are present in the protein of the powder from sea buckthorn seeds; the content of lysine, the basic amino acid that limits the nutritional value of vegetable proteins in the sea buckthorn seeds, is approximately at the same level as oilseeds.

Vitamins are biologically active substances that are necessary for the implementation of the mechanisms of enzymatic catalysis, the normal course of metabolism, maintaining homeostasis, and biochemical provision of body functions. The vitamin composition of the seeds of sea buckthorn is presented in table 4.

Table 4. *Vitamin composition of sea buckthorn seeds*

Indicators	Content
Carotenoids, mg %	6.01 ± 0.22
Flavonoids, mg %	2.2 ± 0.06
Tocopherol, mg %	88.7 ± 2.13
Ascorbic acid, mg %	9.34 ± 0.32
Thiamine, mg %	1.45 ± 0.07
Riboflavin, mg %	0.35 ± 0.01
Pantothenic acid B3, mg %	0.5 ±0.02
Nicotinic acid B5, mg %	0.54 ±0.02
Pyridoxine hydrochloride B6, mg %	0.37 ±0.02
Folic acid Bc, mg %	1.14 ±0.06

Thus, the sea buckthorn seeds have a huge energy potential, because they contain a significant number of proteins, fats, and carbohydrates. Experimental studies have shown the high nutritional value of sea buckthorn seeds, which is characterized by the presence of water- and fat-soluble vitamins, including the ones of antioxidant action.

3.1 Study of the effect of sea buckthorn seed powder on the functional and technological properties of the finished product.

When forming the structural-mechanical and functional-technological properties of meat products, the content of structure-forming agents — polysaccharides in the system and their qualitative composition — are of particular importance. The carbohydrate-water and carbohydrate-lipid interactions are associated with the properties of polysaccharides; therefore, water and fat-holding capacity are some of the mandatory indicators for evaluating the functional ingredient for sausage production.

Traditionally, starch, wheat flour is used in the production of sausages as a moisture-holding component, the chemical composition of which contains not less than 70% of carbohydrates, about 65% of which is starch with the feature of high moisture-binding capacity.

Figure 1 presents the results of the study of the functional and technological properties of the powder of sea buckthorn seeds.

The analysis of the data in Figure 1 shows that sea buckthorn seeds have high functional and technological properties. The moisture-holding capacity of the seeds of sea buckthorn compared to the traditionally used wheat flour is 8% higher, and the fat-holding capacity of the seeds of sea buckthorn compared to the widely used wheat and rice flour is higher by 10% on average.

The experimentally determined values of moisture- and fat-holding capacity of sea buckthorn seed powder do not fully reflect the nature of moisture-binding and holding under conditions closest to the actual sausage production technology, therefore, for more accurate formulation of the recipe, test samples were made and studied, which included the minced meat with the addition of 5%, 10%, and 15% of sea buckthorn seed powder.

Functional and technological properties were defined as a set of indicators that characterize the levels of moisture-binding capacity, pH, moisture, and sensory characteristics.

One of the main physical and chemical indicators that normalize the technological process is the pH. This indicator determines the features of structure formation in the finished product as well as the shelf life (Figure 2).

An increase in the pH value by 0.4-0.8 was observed in the test samples with an increase in the amount of the powder from sea buckthorn seeds introduced, which is caused by a higher pH value of sea buckthorn seeds.

It was established that the sample with the addition of 10% of the plant component when reaching the pH value of 6.5-6.7, the minced meat has a pronounced taste, flavor, delicate texture, it binds water well, i.e. acquires the properties required to produce high-quality sausages.

In the production of sausages, quality indicators related to the moisture content and moisture-binding capacity, which affects the yield of finished products, are of particular importance.

Technological properties and some physical and chemical indicators of the test samples are presented in Table 5.

With the addition of the sea buckthorn seed powder, the moisture-binding capacity of minced meat increases due to the increase in pH.

Analysis of the study results showed that the highest moisture-binding capacity value is observed with the addition of 15% of the sea buckthorn seed powder into the minced meat. The increase in moisture-binding capacity allows increasing the yield of finished products by 9.35%, which will help to increase the economic efficiency of minced meat production.

At the stage of development of the composition of the test samples, the effect of the dose of the sea buckthorn seed powder added in the amount of 5%, 10% and 15% on the rate of elastic-plastic deformation of minced meat was studied. The results of experimental studies are presented in Figure 3.

The data presented in Figure 3 showed that with the addition of 15% of sea buckthorn seed powder, the deformation force increased by 54%, which leads to undesirable compaction of the minced meat system.

When adding 10% of sea buckthorn seed powder, the structure is compacted by 43% compared to the control, which according to literary data, is within the recommended limits.

To clarify the optimal amount of powder from sea buckthorn seeds, test samples of cooked smoked sausages were made with a different dose of added powder from sea buckthorn seeds and their organoleptic characteristics were studied (Figure 4).

The data presented in Figure 4 showed that cooked smoked sausage with the addition of 10% of hydrated sea buckthorn seed powder has the best organoleptic properties. Increasing the amount of powder from the sea buckthorn seeds to 15% leads to a deterioration in the taste and aroma of sausages.

In order to achieve an intensive and stable coloring of meat products, sodium nitrite is added in the amount prescribed by the formulation, as part of the curing mixture.

Under the action of curing ingredients, a significant amount of metmyoglobin is formed, which prevents the formation of nitroso myoglobin. Therefore, the process of metmyoglobin recovery to myoglobin during curing is essential.

Optimum reducing conditions are created at pH 5.7, i.e. close to the isoelectric point of the proteins of the meat, however, the moisture-binding capacity of the meat is minimal. In our case, the pH values of meat systems are in the range of 6.4-6.7, which creates optimal conditions for good moisture-binding. To obtain a good color under these conditions, the presence of reducing substances in a sufficiently large amount is required, which is achieved by adding the powder from the sea buckthorn seeds.

Reducing sugars (for example, glucose) are used to create reducing conditions. When glucose is used with sucrose, the color is significantly improved. Sucrose itself does not create reducing conditions, however, the intermediate products of its anaerobic decomposition (phosphoglyceraldehyde, fructose-6-phosphate, etc.), which are formed under the action of bacterial enzymes, have a significant reducing (recovering) effect.

Such biologically active substances with reducing properties as tocopherol, carotenoids, flavonoids, ascorbic acid present in the sea buckthorn seeds allow refusing the addition of glucose.

Ascorbic acid not only restores the oxidative forms of heme pigments, but also protects nitroso pigments from oxidation, and enhances the antibacterial properties of nitrite relative to *CI. Botulinum,* inhibits the reaction of peroxide oxidation and prevents the formation of alkylating mutagens like nitrosamines from nitrites (by 32-35%).

Due to the presence of biologically active substances with regenerating properties in sea buckthorn seeds, the process of colouring formation in finished meat products was studied with a study of the residual degree of stability of nitroso pigments, sodium nitrite content and nitroso pigments content. Table 6 presents the colour stability of the finished product with a different dose of sea buckthorn seeds added.

Following the data presented in table 6, the colour stability of the finished meat products increased with the introduction of the powder from sea buckthorn seeds; thus, with the introduction of 5%, it increased by 4.5%, with the introduction of 10% it increased by 5%, which may be due to the high reducing activity of tocopherols, flavonoids, reducing sugars and ascorbic acid present in the sea buckthorn seed composition.

4. CONCLUSIONS:

The results of the study have shown that the addition of powder from sea buckthorn seeds in an amount of not more than 10% helps to improve the functional and technological properties of minced meat. Sea buckthorn seeds bind water due to the protein system and polysaccharides, as a result of which the stability of the finished product is maintained, the losses during heat treatment are reduced, the juiciness and the yield of the product increases. In addition, the introduction of 10% of the sea buckthorn seed powder contributes to the colour stability of the finished product. In connection with the above, the amount of added hydrated powder from sea buckthorn seeds in the recipe of cooked smoked camel meat and beef sausage is approved at 10%.

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Table 3. Amino acid score of the sea buckthorn seed powder

Amino Acids	FAO protein	Sea buckthorn Seeds	Sunflower Seeds
Lysine	5.5	56.27	62.0
Threonine	4.0	59.326	107.5
Leucine	7.0	81.4	92.8
Isoleucine	4.0	53.12	90.0
Tryptophan	1.0	84.71	160.0
Valin	5.0	64.18	104.0
Methionine + Cystine	3.5	10.17	108.0
Tyrosine + Phenylalanine	6.0	59.66	128.0
Utilisation Ratio		0.15	0.62

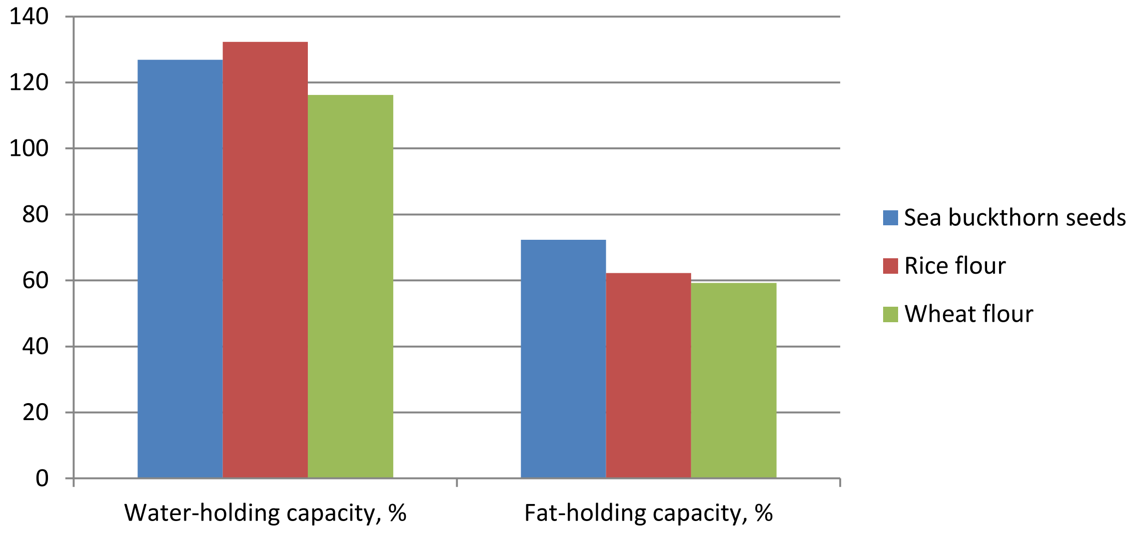

Figure 1. *Water- and fat-holding capacity of the sea buckthorn seeds powder*

Table 5. *Technological, physical, and chemical indicators of test samples with the added sea buckthorn seed powder*

Indicators	Control	Test		
		Amount of sea buckthorn seeds, %		
		5	10	15
pH	6.0	6.4	6.7	6.8
Moisture content,%	52.6	56.61	61.95	66.51
Moisture-binding capacity, %	72.15	73.23	74.15	78.26
Yield, %	85	88.2	91.8	94.35

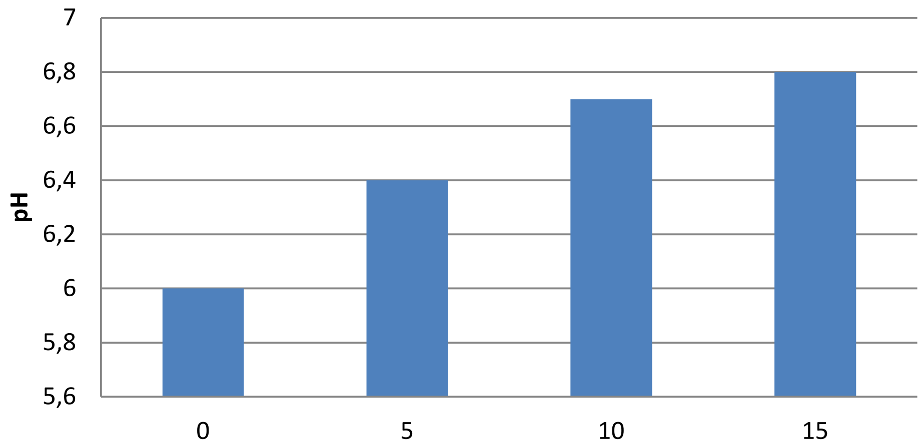

Figure 2. *The pH value of the minced meat with the addition of sea buckthorn seed powder*

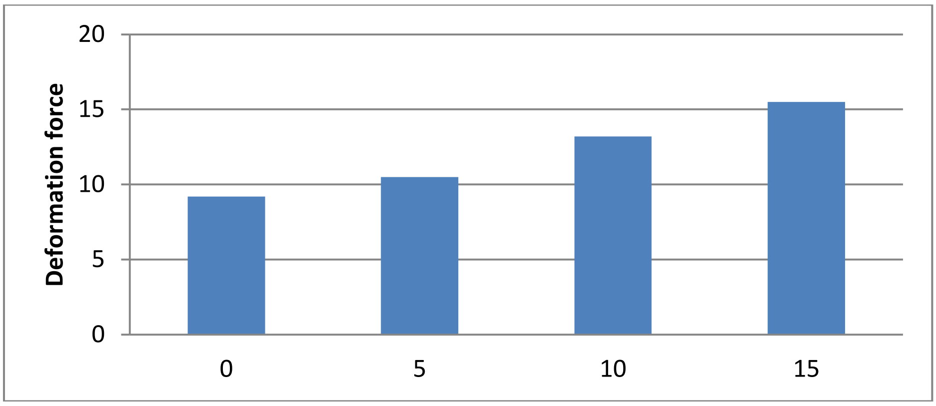

Figure 3. *The change in the minced meat deformation force with the addition of different amounts of sea buckthorn seeds*

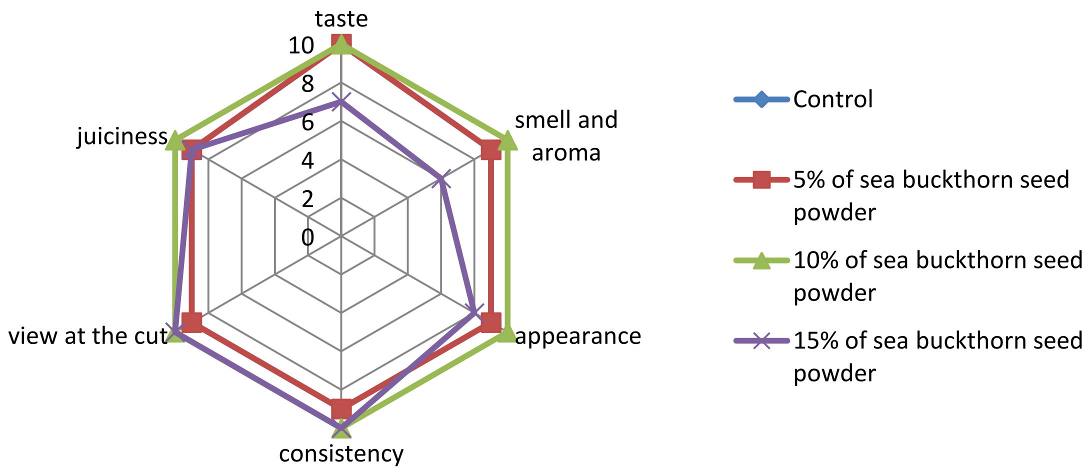

Figure 4. *Organoleptic properties of cooked-smoked sausages with different amounts of added sea buckthorn seed powder*

Table 6. *The colour stability of the finished product*

Indicators	Control	Sea buckthorn seed powder, %	
		5	**10**
Stability, %	89.3±2.1	94.3±2.3	95.8±1.9
Residual amount of sodium nitrite, %	0.0040±0.0001	0.0030±0.0001	0.0020±0.0001