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DEVELOPMENT OF TECHNOLOGY OF BOILED SAUSAGE FROM NON-TRADITIONAL RAW MATERIALS

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This paper considers the possibility of improving the functional and technological properties of boiled camel sausage with the addition of hump fat and chicken fillet. The effect of pumpkin peel powder on lipid oxidation, functional and technological properties of sausages from combined meat was investigated. Camel meat as a meat product has many advantages, for example, low fat content, high nutritional value, and its taste is barely distinguishable from beef. At the same time, it has the following disadvantages: sweetish taste, coarse-fiber structure; camel sausage has a lower shelf life compared to beef sausage; it is harder due to the content of hydroxyproline. To improve the functional and technological properties, dried rowan powder and pumpkin peel powder of the "Winter Sweet" variety, a zoned variety, were added in different quantities for comparison. The control sample was made in accordance with GOST for boiled sausage, with the replacement of fat with hump fat, and the replacement of beef with camel meat. For experimental samples, a plan for a full-factor experiment was built, taking into account the material balance. Additives varied in 3 levels, from 3 to 6 %. 7 samples with control were in total with the control sample being the sausage prepared according to the same recipe but without additives. There were three parallel experiments in each sample. It was revealed that hydrated rowan powder has a negative effect on taste but, at lower doses, it gives a spicy taste to the sausage while the addition of hydrated powder from pumpkin peels improves taste and organoleptic characteristics. Thus, one can conclude that waste in the form of pumpkin peels is also a valuable and useful product for improving the functional, technological, and organoleptic characteristics of sausage. The result of this study shows that when hydrated rowan powder and pumpkin peel powder are added, the problem of taste, aftertaste, smell, and shelf life is solved in the selected ratio, while the sausage also becomes more tender overall

Keywords: fat-retaining capacity, water-holding capacity, vegetable additive, boiled sausage, camel meat

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1. Introduction

The number of camels in Kazakhstan is growing from year to year, according to data from the Bureau of National Statistics [1].

Animal proteins from meat and meat-derived products represented one of the major challenges to achieving sustainable food production. From this point of view, the partial replacement of meat with non-meat substances with a high protein content opens up interesting opportunities for changing the formulation of more sustainable meat products, which are also characterized by potential health benefits [2]. Plant-based ingredients (legumes, cereals, tubers, and fruits) are widely used to replace up to 50 % of meat. Mushrooms allow the use of higher proportions of meat substitute, with adequate results in reformulated foods with reduced sodium content. In general, the use of meat fillers increases the yield of products with slight organoleptic changes. These many possibilities make the use of meat thinners the most viable and interesting approach to producing healthier meat products with less environmental impact [3].

A comparative assessment of the chemical composition of the meat of different slaughter animals shows that the moisture content of camel meat is higher than that of some types of meat and is 70.0 %, horse meat – 69.6 %, lamb – 67.6 %, beef meat – 64.8 %, and pork meat – 64.8 %, in meat – 54.3 %. Accordingly, camel meat (9.4 %) is inferior to beef and lamb (15.3 % each in both types of meat), horse meat (9.9 %), and pork (27.8 %). Venison meat and eggs contain less fat – 8.5 % and 3.5 %, respectively. A comparative assessment of the chemical composition of the meat of different slaughter animals shows that camel meat is significantly lower in total protein content than meat of other species. Despite the fact that camel meat has a lower ash content than beef, camel meat has a higher magnesium content – 25.1 mg/100 g. The most important minerals are phosphorus and iron, in camel meat – less than in other types of meat. Phosphorus in camel meat is slightly less (198.0 mg/100 g) than in beef (187.0 mg/100 g), but in horse meat (185.0 mg/100 g), in pork (182.0 mg/100 g)), and more than in lamb (178.0 mg/100 g). According to this indicator, venison occupies a leading place – 220.0 mg/100 g.

The quality of proteins in different types of meat is different, so the indicator of essential amino acids in a camel was higher than the indicator calculated in horse meat (174) (one-humped 261.9, two-humped 225.0). beef (165), pork (110), and ostrich (112). Lamb (190) and goat meat (209) are the most important amino acids, similar in terms of this indicator to camel meat. In addition, the main feature of camel meat is its low cholesterol content [4, 5].

Camel meat as a source of high-quality meat can be an alternative to beef, while economically less expensive. Dietary fiber is a key ingredient that is lacking in meat and meat products, and regular consumption of the latter has been linked to various health conditions. In addition to the many health benefits, fiber improves many of the technological properties of foods. So, in order to increase the proportion of dietary fiber and increase the shelf life of sausage, it was decided to investigate the effect of dried rowan powder and powder from dried pumpkin peel. Pumpkin peel powder was added in order to increase the content of dietary fiber, rowan powder was used as an antioxidant. Powders were added in dry form and hydrated.

Based on the above, we can conclude that research into the possibility of creating boiled sausage using camel meat and hump fat is relevant.

2. Literature review and problem statement

Analysis of data shows that the fat content in camel by-products is 2.25 times lower than in beef by-products, and in pork by-products – 6.5 times, which will make it possible to obtain a protein hydrolyzate with a higher storage capacity. It has been established [6] that the maximum degree of hydrolysis, the highest yield of protein hydrolysate in dry form is achieved at a temperature of 45 °C with a hydrolysis duration of 8 hours with the addition of 15 % pancreatic suspension. As a result of the research, the possibility of using camel by-products in the production of protein hydrolysate has been substantiated, the optimal modes for obtaining protein hydrolysate have been established, and its nutritional value has been assessed.

Studies have also been conducted comparing sausage from calf meat and meat from the semi-tendon muscles of a camel. They were evaluated for changes in physicochemical characteristics, organoleptic properties, and microstructure. It turned out that calf sausage contained significantly more vitamin E, whereas camel sausage had a better fatty acid profile and higher iron content. Camel meat had a higher pH but the same myofibrillar protein content as beef [7]. If we consider the meat of calves and camel meat, then the article does not describe the age of camels, camel meat is not so fully described. It is also doubtful that camel meat under the same processing conditions was comparable to calf meat, given the different amounts of hydroxyproline.

Attention was paid to the study of camel meat as a raw material for the production of sausages, namely the longest muscle. The factors influencing the strength of the longitudinal dorsi muscle and the large psoas muscle of the camel are determined when comparing them with those of beef. The total collagen content was slightly higher, whereas the insoluble collagen content was significantly higher in the muscles of older animals. The value of the Warner-Bartzler shear force was significantly ($P<0.05$) higher for camel meat than for beef, and this value increased with age for camel meat. Camel meat had significantly higher pH values than beef 6 and 24 hours after slaughter, and the muscles of the longus dorsi and psoas major muscles of young animals had significantly higher pH values than older ones [8].

In [9], the effect of gum arabic on beef sausages and camel sausages was compared. Studies have been conducted on the effect of adding gum arabic powder to beef and camel sausage in terms of express analysis, physicochemical properties, and sensory properties. The ratio of beef to camel meat is 2:1, the meat was crushed, stirred, and divided into 3 parts: control (0 % gum arabic powder), beef (3 % gum arabic powder), and camel (3 % gum arabic powder). The samples were sent to the laboratory for analysis, and the results obtained were subjected to analysis of variance using gum arabic of the multiple Duncan test. Camel sausage with 3 % gum arabic powder was higher in moisture content, followed by beef sausage with 3 % gum arabic powder. While the control beef sausage (0 % gum arabic powder) showed the highest percentage of protein, fat, and ash. Camel sausage with 3 % gum arabic powder and control beef sausage showed the highest values of cooking losses with significant differences. Camel sausage with 3 % gum arabic powder showed significant differences ($p<0.05$) in texture and overall acceptability lower than the control sausage. It can be concluded that the addition of gum arabic powder had a significant impact on some of the physicochemical properties of camel sausage. In particular, pH and cooking losses; camel sausage had less significant differences in some organoleptic evaluative traits, such as texture and overall acceptability. The addition of gum arabic to camel sausage does not affect the taste [9]. At the same time, this source provides information that camel sausage is not an alternative to beef sausage, no conditions are given under which camel sausage would be comparable to beef sausage.

In order to increase the shelf life of cooked sausages and improve structural indicators, sodium nitrite and other substances are used. Natural dyes, antioxidants, and dietary fiber are increasingly used in scientific work. There are attempts to exclude the content of sodium nitrite from formulations while changing the color of the sausage and reducing the shelf life. Therefore, most studies are aimed at reducing sodium nitrite in the formulation of sausages. Thus, in [10], the possibility of developing new types of boiled sausages with a decrease in the composition of Vi nitrites in the composition of sausages, by enriching with dried goji berries (*Lycium chinense*) or butternut squash powder (*Cucurbita moschata*) was considered. Butternut squash powder was made from pumpkin pulp. Samples made with 5 or 10 g per kg^{-1} sodium nitrite alone were taken for control. The rest varied respectively 5 and 10 g of goji berry powder and butternut squash powder. The combination of 0.75 % goji berries and 0.75 % pumpkin powder most preferably preserves the color characteristics of sausages but the addition of 0.5–1.0 % goji berries effectively inhibits protein oxidation, lipolysis, and lipid oxidation. It is concluded that the addition of goji berries and pumpkin powder can be used as additives for the development of new functional meat products with a halved nitrite content.

The goal of [11] was to establish the potential concentrations of 0.5 and 1.0 % goji berries and/or pumpkin pulp powder alone or in combination as additives for processing cooked and smoked beef tenderloin with 1/2 reduced nitrite content. The separate use of goji berries or pumpkin pulp powder leads to certain deviations in sensory quality and technological properties. Addition as a combination, containing 1.0 % goji berries and 0.5 % pumpkin powder, guarantees good quality, improves sensory properties, and color characteristics. It also inhibits oxidative changes in cooked and smoked beef tenderloin with a halved nitrite content.

The possibility of using powdered extract of sea buckthorn fruit (*Hippophae rhamnoides*) and pumpkin seed flour (*Cucurbita pero L.*) for the production of functional cooked-smoked products from horse meat was studied in order to improve the quality of the national product. The authors of work [12] established the potential of two concentrations of 0.5 % and 1.0 % powdered extract of sea buckthorn fruit (*Hippophae rhamnoides*) and pumpkin seed flour (*Cucurbita pero L.*) as additives for the processing of functional cooked-smoked delicacy from horse meat "Jaya" with improved quality and resistance to oxidation. The introduction of 1.0 % pumpkin seed flour and especially 1.0 % powdered sea buckthorn extract improves the oxidative stability and quality of the new functional horse meat delicacy, while maintaining its organoleptic and color characteristics. Based on the conclusions made in these works, it can be concluded that it is not possible to completely replace nitrate salts in the recipes of meat products but there is a partial replacement.

The results of studies into the effect of additives in the composition of a semi-finished product from camel meat are described in [13]. Sea buckthorn and ginger were used as herbal additives, the ratio of herbal additives for optimal improvement of the quality of the semi-finished product was revealed, and quality indicators were examined. The work provides information on the possibility of softening the structure of camel meat for the production technology of boiled sausages but does not use hump fat.

In [14], the physicochemical, emulsifying, and textural properties of a beef emulsion prepared with four different levels (0.0 %, 0.2 %, 0.4 %, and 0.6 %) of pumpkin powder were evaluated. Some technological properties of beef emulsions have been determined, such as emulsion capacity, emulsion stability, pH, apparent viscosity, and emulsion color values. The use of pumpkin powder reduced cooking losses by 17.38–21.99 % ($p<0.01$). The highest values of the emulsion capacity were determined in samples containing 0.4 % pumpkin powder ($p<0.01$). The addition of pumpkin powder increased the values of the emulsion capacity compared to the control ($p<0.01$). All textural properties of the beef emulsion changed with the addition of 0.6 % pumpkin powder ($p<0.05$). The addition of 0.2 % and 0.4 % pumpkin powder increased the apparent viscosity, while the apparent viscosity decreased at 0. 6 % pumpkin powder was used ($p<0,05$). The optimal concentration of pumpkin powder for beef emulsion was determined to be 0.4 %. The study was conducted to evaluate the physicochemical, emulsifying, and textural properties of a beef emulsion prepared with four different pumpkin powder ratios. Pumpkin is a good source of carotenoids, pectin, minerals, vitamins, and various bioactive molecules, so we assume that pumpkin powder can be used to enrich meat recipes and meat products with dietary fiber. In the study, pumpkin powder improved color, electrical conductivity, electrical conductivity, textural properties, and thus improved the quality of emulsified meat products. Therefore, when preparing emulsified meat products, the addition of pumpkin powder is believed to provide producers and consumers with many advantages.

The possibility of using pumpkin pulp powder and pumpkin seed powder in beef meat patties was also studied. The results showed that the use of pumpkin powder and pumpkin seeds makes it possible to reduce the amount of meat, as well as to give functionality to the product, while not causing negative changes in the quality of beef patties [15].

Since camel sausages have a short shelf life, the possibility of adding spoilage inhibitors was studied. Polyphenols inhibit the growth of microorganisms, especially bacteria. Due to the antioxidant and antibacterial activity of phenolic compounds, plant extracts represent an alternative to chemical preservatives used in the meat industry, especially nitrates (III) [16]. They can inhibit the growth of spoilage and pathogenic microflora, inhibit the oxidation of meat ingredients (lipids and proteins), and prevent discoloration. Rowan powder is very rich in polyphenols. Accordingly, rowan powder can be used for partial replacement of sodium nitrite in the production of sausages.

Berries contain a relatively high total phenol content (12.4–50.8 mg/g GAE) and exhibit high antioxidant activity. Crowberry, rowan, cloudberry have been shown to inhibit the formation of methyl linoleate-conjugated diene hydroperoxides by more than 90 % cranberry, lingonberry, chokeberry, gooseberry, blueberry, and lingonberry extracts when used at 500 ppm. Raspberry and black current extracts were less effective with inhibition of 88 % and 83 %, respectively [17].

Study [18] reports that the powder from the pomace of rowan and chokeberry has a high fiber content (>550 g/kg). In the study, the content of soluble dietary fiber was 7.7 % and 7 % (dry weight). The corresponding values of the content of insoluble dietary fiber were 5.9 and 5.2 % (dry weight) in rowan and chokeberry, respectively.

Dietary fiber, such as cellulose, pectin, or fibers extracted from rice, corn, wheat, and beets, can be used to improve the texture of a variety of meat products, including salami and sausages. Meanwhile, it is also suitable for cooking lean meat products such as «diet burgers». Since dietary fiber is also able to increase hydration properties, its inclusion in meat can give a rich juiciness [19].

The effect of tannic acid, date seed extract, catechin, and green tea extract on lipid oxidation, microbial load, and textural properties of camel sausages has been investigated. Experimental samples were stored for 12 days in the refrigerator. Tannic acid and catechins showed higher activity in all antioxidant analyses compared to green tea extract and date seed extract. Lipid oxidation and microbial growth were higher in the control sausages compared to other samples. Also, tannic acid and catechins at the level of 200 mg/kg were more effective in slowing down lipid oxidation and reducing the number of microbes ($p<0.05$). Sausages treated with tannic acid and date seed extract were found to have higher hardness, stickiness, and chewing rates compared to other treatments ($P<0.05$). The best taste was found in samples of sausages treated with tannic acid and catechin. Thus, pure phenolic compounds have proven to be more effective in preserving the microbial and organoleptic qualities of camel meat sausages compared to with phenolic extracts for 12 days of storage at 4 °C [20].

The effect of dietary fiber extracted from pumpkin (pumpkin fiber) on the physicochemical properties, textural properties, and organoleptic characteristics of chicken sausages was investigated. The addition of different levels of pumpkin fiber affected the approximate composition of chicken sausages ($p<0.05$), excluding the protein content. Chicken sausages with 2 % and 3 % pumpkin fiber had a higher overall acceptability than controls ($p<0.05$). The results show that the addition of pumpkin fiber made it possible to obtain acceptable chicken sausages and improve their quality characteristics [21].

The physicochemical properties of Frankfurt sausages made from pumpkin flour as a filler and partial replacement for wheat flour were evaluated. Three compositions with substitutions for pumpkin flour were evaluated: 10, 20, and 30 %, as well as a control composition without substitution. The highest protein values were measured at 20 % substitution. The results showed that up to 20 % of the replacement of wheat flour with pumpkin flour guaranteed good quality of sausages, which led to a new possible development of the meat industry [22].

The effect of the grinding level of the plant additive on the functional properties is presented, which showed that the best results in terms of moisture-retaining, water-binding, and fat-retaining capacity are provided by particles with a size of 600 microns. The rational parameters of the preliminary preparation of the plant additive for mixing with minced meat, associated with hydration on the hydraulic module, are determined. This stage of the technological process provides the greatest water-holding capacity, and the ratio of the vegetable additive to refined oil of 1:3 provides a high fat-holding capacity [23].

As shown by [4–23], rowan powder has antioxidant capacity and was not added to camel sausages, and the study of other scientists serves as a justification for the choice of rowan powder. Rowan powder will make it possible to reduce the concentration of sodium nitrite in the recipe for boiled camel sausage. The powder of pumpkin pulp and seeds in the composition of camel sausages was studied but the powder from the pumpkin peel dried at 60 °C in a ventilated drying oven was not used. The rationale for adding pumpkin powder from the peel is the content of pectin, vitamin A, C, E, and B6, potassium, manganese, thiamine, folic acid, niacin, iron, magnesium, phosphorus, and fiber. Accordingly, pumpkin peel powder is a waste product of processing but, nevertheless, it is a source of valuable dietary fiber and nutrients.

The disadvantage of camel meat as a meat raw material is a coarse-fiber structure, sweetish taste. Hump fat is not used in sausages due to the fluidity of fat; it is unstable during the production process. The finished product is obtained with flaws (streaks) and does not meet the requirements of the regulatory documents regarding boiled sausage. Therefore, it is advisable to conduct a study on improving the taste and color of boiled sausages with the addition of camel hump fat. At the same time, hydrated rowan powder can be chosen as an antioxidant, and in order to improve the physical and technological properties of the finished product, hydrated pumpkin peel powder can be added.

3. The aim and objectives of the study

The purpose of this study is to develop the technology of boiled sausages from non-traditional meat raw materials: flour from pumpkin peel and rowan powder. This will make it possible to improve the functional and technological properties of the sausage, its taste and color, as well as reduce the cost and increase the shelf life.

To accomplish the aim, the following tasks have been set:

– to investigate the effect of organoleptic characteristics in the compositions of cooked camel sausage with and without different levels of additive;

– to investigate the functional and technological properties of experimental samples in comparison with the control one;

– to determine the effect of powders on the level of thiabarbituric number.

4. The study materials and methods

The object of the study is the technology of boiled sausages based on camel meat and hump fat. The subject of the study is the effect of hump fat and vegetable additives on the organoleptic, functional, and technological properties of cooked sausages.

The hypothesis of the study assumes that is it possible to obtain boiled sausages based on camel meat and with the addition of hump fat, corresponding to regulatory documents on moisture, organoleptic assessment, shelf life, and comparable to boiled beef sausages.

The raw material for the production of camel sausage is camel meat of the 1st category, the highest grade, chicken fillet, hump fat, salt, spices, water, sodium nitrite in a reduced amount in recipes with the addition of rowan powder.

Boiled sausage from non-traditional raw materials was made on the basis of the material balance. Camel meat of the highest grade, category 3.7 kg was purchased from a store of non-traditional meat raw materials. The meat was twisted with the addition of 0.8 kg of hump fat and 3.5 kg of chicken fillet. Humpback fat was previously prepared. The finished minced meat was left to freeze. The next day, the minced meat was laid in the cutter; salt, spices, 1.5 kg of ice water, and sodium nitrite 0.0005 kg were added. Then, after cutting, the minced meat was divided into portions of 1 kg, pumpkin peel powder and rowan powder were added according to the experimental plan. We stuffed it into the shells with a syringe to fill the shell with minced meat. The finished samples were subjected to heat treatment and cooled. After cooling, the finished samples were subjected to laboratory experiments and tasting.

Control, camel sausage without additives. T1 – boiled sausage according to the same recipe as the control but with the addition of 3 % pumpkin peel powder. T2 – boiled camel sausage with the addition of 6 % pumpkin peel powder. R3 – boiled sausage according to the same recipe as the control but with the addition of 3 % rowan powder. R4 – boiled camel sausage with the addition of 6 % rowan powder. S5 – boiled sausage with the addition of a mixture of 3 % (1.5 %+1.5 % pumpkin and rowan powder, respectively); S6 – boiled camel sausage with the addition of a mixture of 6 % (3 %+3 % pumpkin and rowan powder, respectively).

Rowan powder was bought in the online store “Berries of Karelia”, freeze-dried red rowan powder. Pumpkin “Winter sweet” was bought in a supermarket in Almaty (Kazakhstan). The pumpkin was washed, peeled. The cleaned peel was dried in a drying cabinet SHS-1, manufactured in the russian federation, at a temperature of 65 °C, for 16 hours. Next, the dried peel was crushed in a laboratory mill SM-3C, made in Japan. Camel meat and hump fat were purchased in a specialized store of non-traditional meat, Almaty; chicken fillet was bought in a supermarket, Almaty.

Camel meat, chicken meat, 50 % ice were laid in the cutter according to the recipe, a solution of sodium nitrite 2.5 %, spices. We cut it to a temperature of +1 °C, stopped, raised, cleaned the lid of the cutter. The second stage was adding the fat emulsion and the rest of the ice was cuttered to +4 °C, the third stage was the introduction of hydrated powders and hump fat; we cut it until the pattern was reached (the size of the inclusions of hump fat should not be 2–3 mm). The hump fat was crushed to 3 mm before application and pre-frozen.

This technology allows us to get a delicate structure of minced meat without fibrosity. Also, the addition of hump fat, pre-frozen, at the end avoids defects in the form of streaks in the finished product. The powders were hydrated to evenly distribute and obtain a uniform color on the section. The tiabarbiturate number is given for the 3rd day after the production of boiled sausages. The shelf life increased from 10 (in control) days to 6 weeks (in prototypes); all sausages were in a polyamide casing.

Lipid oxidation was assessed by measuring substances reacting with thiobarbituric acid (TBARS) during maturation. Sausage samples (1.5 g) were mixed with 6 ml of a 7.5 % trichloroacetic acid (TCA) solution comprising 0.1 % propyl gallate (PG) and 0.1 % ethylenediaminetetraacetic acid, disodium salt (EDTA), and homogenized in a blender for 30 s. After filtration through Whatman ashless paper filter, 2 ml of filtrate was added to 2 ml of 0.02 M thiobarbituric acid in vitro. The tubes were incubated at room temperature in the dark for 20 h. The optical density was then measured at 530 nm against a blank solution prepared from 5 ml of distilled water and 5 ml of TBARS reagent using a UV-visible spectrophotometer (model UV-103, Shimadzu, Japan). Changes in TBKR values during maturation were calculated arithmetically and expressed in milligrams of malondialdehyde per kilogram of sausage sample. For each batch, measurements were carried out in a threefold repetition.

Organoleptic evaluation of cooked sausages was carried out on a 9-point hedonistic scale, in accordance with ISO 8586-1 (1993) and ISO 8586-2 (2008); it was evaluated by a board of 15 people. The board included employees of the department and students at the Almaty Technological University.

Statistical analysis was performed using the response surface method, in each experiment 3 parallel tests were carried out, on the basis of which the mathematical expectation and standard deviation were calculated [24]. The effect of powder levels in the cooked sausage formulation on the properties of cooked camel sausage was investigated using the response surface methodology.

The input variables were the doses of applied herbal additives, the resulting – taste, smell, color, functional and technological properties of the finished products, and the thiabarbituture number. Input variables were added in the range from 0 to 6 %, in increments of 1.5 %.

5. Results of investigating the effect of powders on the functional and technological properties of cooked sausages from non-traditional raw materials

5. 1. Influence of organoleptic characteristics of boiled camel sausage compositions with and without different levels of additive

For the development of the recipe, a 2^3-experiment plan was drawn up. The objective function was organoleptic characteristics, moisture content of finished products, thiabarbiturate number, and the functional and technological properties of finished products.

Powders were added both in dry and hydrated form; Table 1 gives information on control and experimental samples with the addition of hydrated powder. The addition of powders in dry form adversely affected all the characteristics of cooked sausages.

Table 1

Organoleptic characteristics of prototypes and control samples

Parameter	Control	**T1**	**T2**	R3	R4	S5	S6
Color	8.24±0.52	7.98±0.48	8.05±0.61	7.74±0.43	7.95±0.47	6.91±0.44	7.23±0.51
Taste	8.69±0.63	7.52±0.85	8.71±0.64	7.32±0.81	7.91±0.58	8.82±0.63	7.82±0.63
Tenderness	8.11±0.48	7.92±0.63	8.13±0.67	7.23±0.82	7.79±0.88	6.81±0.38	7.19±0.57
Juiciness	7.68±0.34	7.58±0.44	7.75±0.35	7.48±0.49	7.59±0.57	6.21±0.24	6.91±0.24
General eligibility	7.88±0.67	7.20±0.53	7.90±0.71	7.14±0.56	7.83±0.72	7.88±0.43	7.15±0.51

Note: All values are the mean ± standard deviation for three repetitions

Since in meat products from camel meat, according to the results of organoleptic analyzes, deficiencies in the form of a specific smell and sweetish taste were found, the effect of hydrated powders on the elimination of these shortcomings was initially investigated. The effect of powder levels in the cooked sausage formulation on the properties of cooked camel sausage was investigated using the response surface methodology. The response surface for the effect on the taste of boiled camel sausage is shown in Fig. 1.

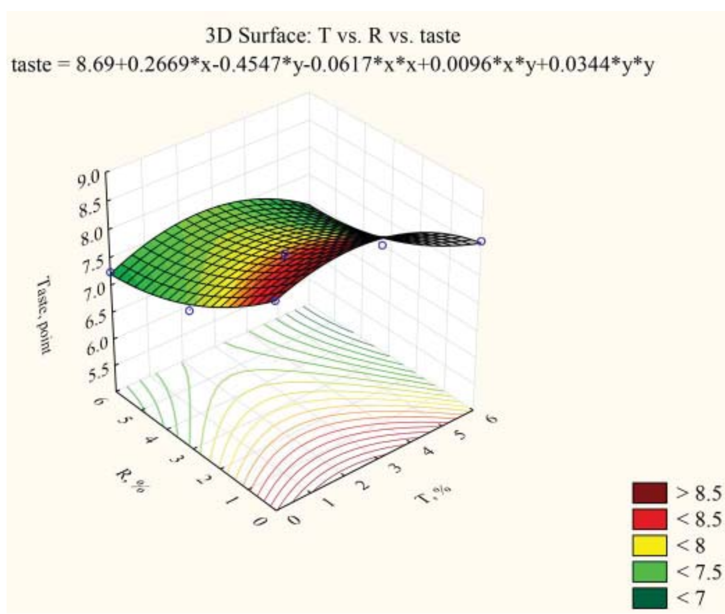

Fig. 1. The response surface of the effect of powders on the taste of boiled camel sausage

The response surface of the effect of varying the levels of rowan powder and pumpkin peel powder on the color of cooked sausages is shown in Fig. 2.

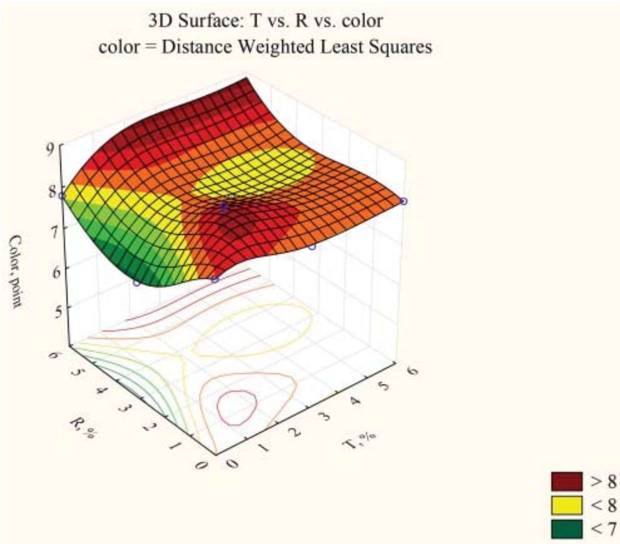

Fig. 2. The response surface of the dependence of the variation of the levels of added powders on the color of cooked sausage

The S5 and T2 variants showed a better result compared to other prototypes.

5. 2. Studying the functional and technological properties of experimental samples in comparison with control

The effect of rowan powder and pumpkin peel powder on the functional and technological properties of experimental samples is shown in Fig. 3, 4.

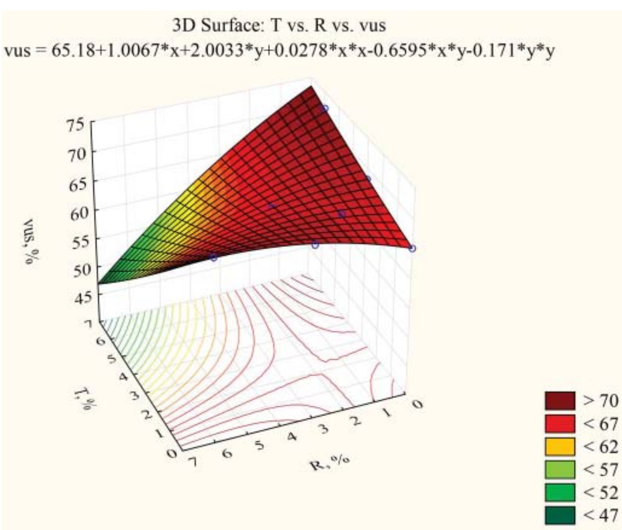

Fig. 3. The response surface of the water-holding capacity of cooked sausage depending on the levels of addition of rowan powders and pumpkin peel

As shown in Fig. 3, in order to improve the moisture retention capacity, the ideal ratio is where there is less pumpkin peel powder and more rowan powder. It should also be noted that rowan powder gives a spicy taste to the sausage. Therefore, option S5 (3 % mixture) is optimal.

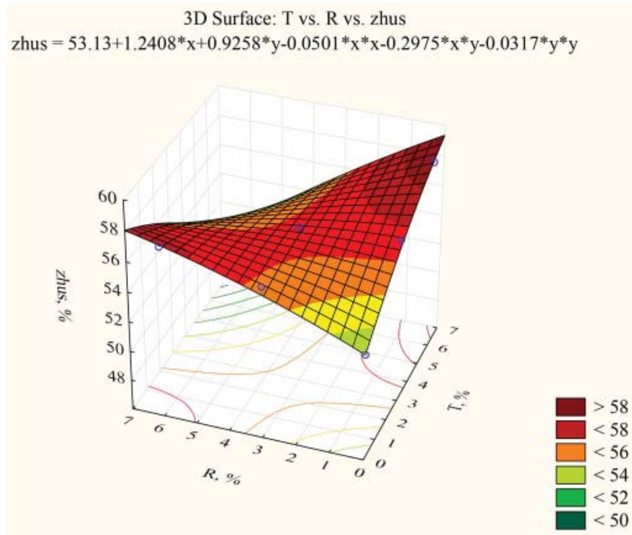

Fig. 4. The response surface of the dependence of fat-holding capacity on the levels of addition of rowan powders and pumpkin peel

As shown in Fig. 3, 4, the addition of powders affects the functional and technological properties of the finished product. Pumpkin powder has a positive effect on fat retention capacity but has a negative effect on water retention capacity.

5. 3. Determining the effect of powders on the level of thiabarbituric number

The effect of powders on oxidative processes is shown in Fig. 5.

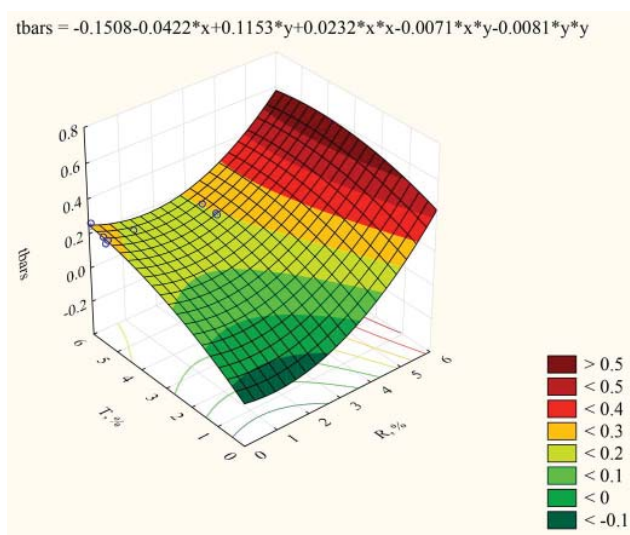

Fig. 5. The response surface of the influence of variation when adding powders on the level of thiabarbiturate number

As shown in Fig. 5, with the greater addition of powders, the amount of malonaldehyde increases, which adversely affects the shelf life of cooked sausage. The optimal option is also S5 (1.5 %T+1.5 %R).

6. Discussion of results of a study on the development of boiled sausage technology from non-traditional raw materials

A feature of the proposed method is the use of hump fat in the recipe, replacing beef with camel meat. Since camel meat has a coarse consistency, some were replaced with chicken fillet. The hump fat in the process of treatment was not stable and caused many defects. The manufactured products did not comply with regulatory documents. To solve this problem, the hump fat was pre-crushed and frozen, in this form it was added at the last stage of cutting.

In [25], the behavior of hump fat in the recipe of the national sausage Sukuk (dry fermented sausage) was also studied. A comparison was made between hump fat in the recipe and beef fat. As a result, beef fat was chosen because it showed the best results.

In [26], the authors reviewed the recipes of fermented sausages using hump fat and camel meat compared with sausages made from beef and beef fat. According to the profile of fatty acids, camel sausages are inferior to beef sausages. In terms of lipid oxidation resistance, camel sausages are more stable than beef sausages. Also, in terms of the fibrousness of the sausage and the cutting resistance, the camel sausage was worse.

By adding chicken meat, the consistency of camel sausages has become more tender, due to the addition of hump fat at the end of cutting, a uniform consistency has been obtained and problems with sausage defects have been solved. The taste of sausages was regulated by varying the added herbal additives.

Pumpkin peel powder is a good source of carotenoids, pectin, minerals, vitamins, and various bioactive molecules. Pumpkin peel powder improved the color, textural properties of meat products. Also, based on the data given in Table 1, the best results in terms of taste were shown by samples: control, T2 (3 % pumpkin peel powder), and S5 (3 % mixture: pumpkin peel powder and hydrated rowan powder). After processing the experimental data by the method of surface responses (Fig. 1), it was concluded that the taste of boiled camel sausage becomes better when hydrated pumpkin peel flour is added. Compared to beef, camel meat has a sweeter taste due to its high glycogen content and higher amount of protein.

The addition of rowan powder adversely affects the taste of boiled sausage due to its bitter taste. Rowan is a source of sorbic acid; in this regard, it is used in the formulation of camel sausages, to increase shelf life and antioxidant action on hump fat. The color of boiled sausage is influenced by both powders, but if when 6 % rowan powder is added, the color becomes dark red, then when only pumpkin peel powder (6 %) is added, the color of the sausage changes to a lighter one. The juiciness of boiled sausage was also determined, as well as tenderness; we came to the conclusion that the addition of 3 % pumpkin gives the most acceptable perception of tenderness and juiciness.

The results of this study into the quality of finished sausages showed that the addition of 3–6 % of dietary fiber extracted from pumpkin peels and more water had a significant impact on the quality characteristics of camel sausage. Adding dried pumpkin peel powder is an excellent source of dietary fiber. In particular, pumpkin peel powder improves the following qualities of camel sausages: physicochemical and textural properties.

Based on the results shown in Fig. 2, it can be concluded that with the partial replacement of nitrite salts with herbal additives, the optimal option is sample S5 (1.5T+1.5R), nevertheless, the control sample turned out to be better in color. As a result of data processing, the optimum for the quadratic function is at 0 % of the additives since this is the use of nitrite salts according to the recipe. With a decrease in nitrite salts, the color changes, and the next optimum can only be seen when using the weighted least squares method.

Camel meat, compared to other traditional meats, shows low water-holding capacity (1.37±0.1 while beef has 2.44±0.11). This also results in high losses during heat treatment. In terms of the water-holding capacity of cooked sausage, the best results were shown by mixtures: sample (Fig. 3) S6 (addition of 6 % in equal proportions of pumpkin peel powder and rowan powder), and sample S5 with 3 % powder mixture. The increase in the water-holding capacity of these samples is due to the addition of powder from pumpkin peels. It is assumed that the reason may be pectins contained in the pumpkin peel. And also, by increasing the active acidity in the process of preparation by adding hydrated rowan powder.

The fat-holding capacity of boiled camel sausage was shown in Fig. 4, according to which the optimum lies when adding hydrated powders in the form of a mixture (1 % rowan and 5 % powder from pumpkin peels). And also, the R6 sample would be ideal if it were not for the deterioration of taste.

The effect on the level of malonaldehyde is shown by the thiabarbiturate number. The response surface is shown in Fig. 5. The desirability function for the thiabarbituture number (Fig. 6) and the results showed that the addition of both powders in combination and separately increases the thiabarbituture number; the less we add, the better, therefore, the S5 option is the best here as well.

Camel meat is rich in Mb (heme protein), and several authors report the pro-oxidant effect of this protein in its oxidized state on lipid oxidation [27, 28]. This makes camel meat more susceptible to lipid oxidation and therefore to the development of unpleasant odors (foreign odors) and may limit its shelf life. To solve this problem, the use of antioxidants is one of the main strategies to extend the shelf life of camel meat [29].

A limitation of this study is the varying data on the composition of hump fat and camel meat, depending on the age and conditions of the camels. Also, the quality of the product depends on the quality of the raw materials. The disadvantages are that the addition of hump fat without prior preparation gives the finished product that does not meet the quality of regulatory documents. The disadvantages of using hump fat are the difference in composition and properties of hump fat from lard. When using hump fat, excess moisture appears in the finished product; in order to solve this problem, the hump fat was pre-prepared and pumpkin peel powder was added in order to retain moisture. The development of this study will be the establishment and refinement of the technology of boiled sausages from non-traditional raw materials using beef fat.

7. Conclusions

1. The organoleptic characteristics of the sausage are positively affected by the addition of hydrated powder S5 in

smaller doses (3 % pumpkin peel powder + 3 % freeze-dried red rowan powder). The taste was better in sample S5; in terms of tenderness, sample T2 (3 % powder from pumpkin peels) turned out to be better; in terms of juiciness, T2 is also better than the rest of the samples. According to the general acceptability, samples T2 and S5 were similar in results. In terms of color, the best result was shown by the control sample. Therefore, rowan powder did not affect the color of the sausage. The addition of hump fat in the control sample led to a specific smell and an unusual aftertaste (the aftertaste remains), with the addition of herbal additives, the taste disappears, a pleasant aftertaste remains. Thus, it is confirmed that herbal additives improve the taste and smell of sausages, comply with the regulatory document. Experimental samples with the addition of herbal additives have a taste and smell peculiar to this type of product, without foreign taste and smell, with the aroma of spices, moderately salty. Color from dark pink to pink. The consistency is elastic.

2. The study into the functional and technological properties of experimental samples by the surface response method showed the following. The optimum is at the intersection of 3 % rowan powder and 3 % pumpkin peel powder. This suggests that the water-holding capacity of the finished product was better in experimental sample S6. Also, the addition of hydrated rowan powder has a positive effect on the water retention capacity of the finished product. Pumpkin peel powder, on the contrary, shows an inverse relationship: the more pumpkin peel powder, the lower the value of the water-holding capacity of the finished products.

Pure powders have the maximum effect on the fat-holding capacity of finished samples. Thus, experimental samples T3 (6 % pumpkin peel powder) and R5 (6 % rowan powder) have a high fat-retaining capacity. Also in the optimum zone is sample S5, but it is inferior to samples T3 and R5.

3. Comparison of the experimental samples by the value of the thiabarbituric number showed that T2 and the control sample demostrated the lowest value. This is due to the fact that in the control sample, the addition of sodium nitrite is similar to the classical recipe of boiled sausages, and in the experimental samples it was reduced by 2 times (0.19).

This may indicate that experimental samples T2 and S5 turned out to be the best, which proves the possibility of using hump fat in the formulations of cooked sausages and the influence of the selected powders.

Conflicts of interest

The authors declare that they have no conflicts of interest in relation to the current study, including financial, personal, authorship, or any other, that could affect the study and the results reported in this paper.

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Data availability

The data will be provided upon reasonable request.

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