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Study of the Nutritional Value and Microstructure of Veal Cutlets with the Addition of Siberian Cedar Nut Seed Cake

[1]Berik Idyryshev, [1]Almagul Nurgazezova, [2]Maksim Rebezov, [1]Samat Kassymov, [3]Kuralay Issayeva, [1]Assel Dautova, [1]Zhibek Atambayeva, [1]Rysgul Ashakayeva and [4]Anuarbak Suychinov

[1]Department of Food Production Technology and Biotechnology, Shakarim University of Semey, Kazakhstan
[2]Department of Research, V. M. Gorbatov Federal Research Center for Food Systems, Russia
[3]Department of Biotechnology, Toraighyrov University, Kazakhstan
[4]Department of Meat, Kazakh Research Institute of Processing and Food Industry, Kazakhstan

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Corresponding Author:
Anuarbek Suychinov
Department of Meat, Kazakh Research Institute of Processing and Food Industry, Kazakhstan
Email: asuychinov@gmail.com

Abstract: The article presents the results of the study of the nutritional value of meat cutlets from veal with the addition of cedar nut cake. The chemical and mineral composition of the cake obtained from the seeds of Siberian cedar growing on the territory of Eastern Kazakhstan has been determined. Four variants of cutlets with the addition of 0, 5, 10, and 15% of cedar cake are developed. The results of the analysis show that increasing the amount of cedar oil cake in the composition of meat semi-finished products increases the protein content ($P<0.01$) but at the same time the fat content in the experimental samples decreases ($P<0.01$) due to lower fat content in the veal meat. In terms of fatty-acid composition, the cutlets are characterized by high PUFA content (48.08%), followed by MUFA (29.46%) and SFA (22.46%). The developed cutlets are enriched with magnesium (100.4 mg/100 g) and calcium (75.3 mg/100 g), and iron content is 2.78 mg/100 g. The analysis of microstructure showed that cedar nut cake is evenly distributed among the muscle fibers in minced meat. The inclusion of cedar nut cake in the recipe for veal cutlets helps to improve the mineral, amino-acid, and fatty-acid composition and allows this product to be classified as a functional dietary product.

Keywords: Cedar Nut Cake, Pressing, Cutlets, Nutritional Value, Veal

Introduction

Functional foods differ from traditional products in nutritional value, and taste and have physiological effects. Usually, such products contain ingredients that provide functional properties or complexes with specific amino acids, minerals, dietary fiber, or a particular group of biologically active substances (Kakimov *et al*., 2017; Khramtsov *et al*., 2009). For the production of functional meat products, dietary meat raw materials such as veal, horse meat, venison, etc. are used (Okuskhanova *et al*., 2017; Stanisławczyk *et al*., 2021; Yılmaz and Gecgel, 2009). Veal is the most appropriate meat by chemical composition, organoleptic and structural-mechanical properties. Veal is the meat of a 3-8-month-old calf. It has a more delicate taste than beef and is very tender. 100 grams of veal meat contains 19.7% of protein, 2% of fat, and 76.8% of water. The meat contains various vitamins: PP, B1, B2, B5, B6, B9, and E, as well as magnesium, calcium, potassium, sodium, iron, phosphorus, and copper. The abundance of digestible amino acids and minerals makes veal the healthiest meat (Vavrišínová *et al*., 2019; Williams, 2007).

Veal meat rich in vitamins and minerals contributes to good regulation of blood glucose levels. Calf meat is good for the health of the skin, mucous membranes, and digestive and nervous systems. The amount of cholesterol in veal (51 mg/100 g) is similar to in beef (50 mg/100 g) but less than in lamb (66 mg/100 g). It also has gelatin, which contributes to better blood clotting. That is why veal is always recommended to eat for patients suffering from cardiovascular diseases. Doctors also advise including veal in the diet of diabetics, hypertensive people, and people suffering from anemia (Gordynets *et al*., 2004; Meleshchenya *et al*., 2019). Veal by its chemical composition is a promising raw material both for use in the daily diet and for the production of products for children, dietary and specialized (functional) food.

To solve food and environmental problems, secondary raw materials of plant origin are widely used as valuable sources of natural components. These raw materials are used in the food and feed industry as a source of proteins, carbohydrates, and several biologically active substances. Protein concentrates are obtained by processing protein-rich grains (Kassenov *et al*., 2019; Yang *et al*., 2020).

In Kazakhstan, one of the most important plant resources is the seeds of Siberian cedar, growing in the East Kazakhstan region. However, processing of Siberian cedar seeds on an industrial scale is not produced. The seeds of cedar (*Pinus sibirica du tour*) consist of 64% fat and the remaining 36% are other nutrients. A cedar nut seed meal is a squeezed cedar nut. Cedar nut seed meal contains 55% of easily digestible proteins, 25% of cedar oil, up to 20% of dietary fiber, and other macro-and micronutrients (Kadri *et al*., 2015; Nergiz and Dönmez, 2004). Cedar nut seed meal contains 17 essential amino acids, including the most important ones: Lysine, methionine, tryptophan, etc. These amino acids in the human body play a huge role in strengthening the immune system and regulating cholesterol levels. Along with this, cedar seed cake is rich in macro-and microelements, polysaccharides, and vitamins E and B. The mineral composition is characterized by a high content of potassium, magnesium, phosphorus, copper, and zinc. In addition, cedar cake is rich in active iodine. It is useful for gastric ulcers, duodenal ulcers, gastritis, hyperacidity, kidney disease, and nervous disorders. Regular use of cedar cake in the diet strengthens the immune system and removes toxins from the body (Morgillo *et al*., 2019; Motovilov *et al*., 2010). It has the property to adsorb toxins and remove them from the body (Khanturgaev *et al*., 2018).

Especially useful is the consumption of products based on the cake of cedar seeds at high athletic training loads, reduced immunity, metabolic disorders, physical weakness, kidney disease, nervous system, gastrointestinal tract, and pneumonia, to normalize the biochemical composition of the blood.

For food purposes, a cake of cedar seeds is used both alone and as a part of a variety of products. For making ready-made dry breakfasts cedar nut seed meal is used both in pure form and mixed with various fruits.

The use of various plant components in meat semi-finished products leads to the enrichment of the product with plant protein, as well as vitamins, and macro-and microelements necessary for the body. The use of plant raw materials in the development of functional products in the production of meat products is one of the most promising methods (Galina *et al*., 2020).

There is little known about the use of Siberian cedar seeds in the technology of meat and meat product production. The use of whole cedar nuts (kernels) in the production of functional meat products has several technological disadvantages since the whole grain has a high-fat content and soft consistency. This, in turn, makes it difficult to transform the grain into a homogeneous mass. As a result, the most suitable raw material, in this case, can be considered a secondary product remaining in the pressing of oil from the seeds of cedar nuts-cedar nut seed meal (Valero-Galván *et al*., 2019).

The purpose of the work is to study the nutritional value (chemical, amino acid, fatty acid, and mineral composition) and microstructure of meat cutlets from veal with the addition of cedar nut seed meal.

Scientific Hypothesis

As the traditional beef and pork meat products are rich in fat, including saturated fatty acids, so we hypothesize that using low-fat veal meat in combination with cedar nut seed meal might be a good source of essential nutrients, polyunsaturated fatty acids, amino acids, and minerals.

Materials and Methods

Methods of Cutlets Preparation

Cedar nut seed meal is obtained by pressing on an electric oil press Dream Modern ODM-01 (Fig. 1).

The technological process for the production of cutlets is divided into the following operations: Preparation of raw materials, making minced meat, forming semi-finished products, storage and sale (Fig. 2).

Veal is cut, deboned, and trimmed. Chicken is also subjected to deboning and trimming. The obtained cutlet meat is ground on a grinder with a 2-3 mm diameter of the screen. Then cedar nut cake and eggs are added, combined with chopped onion, salt, and pepper, and mixed in mixers for 5-10 min. Ready minced meat is dosed, formed, and breaded in breadcrumbs. Finished semi-finished products are stored. Veal meat is replaced by cedar nut cake from 5 to 15% according to the recipe (Table 1).

Determination of the Chemical Composition

Determination of the chemical composition is carried out by the method of one sample weight of the analyzed product. The method consists of consecutive determination of moisture, fat, ash, and protein content in one sample (Antipova *et al*., 2001).

Determination of Moisture Content

A sample of ground product weighing (2-3) g, taken to the accuracy of 0.001 g, is dried in a metal box with a glass rod in a drying closet at 150°C for 1 h. The moisture content is calculated by the formula (1):

$$x_1 = \left(m_1 - m_2\right) \cdot 100 / \left(m_1 - m\right) \quad (1)$$

where:
x_1: Moisture content, %
m_1: Weight of the sample with the metal box before drying, g
m_2: Weight of the sample with the metal box after drying, g

m: Weight of the metal box, g

Determination of Fat Content

After moisture determination, (10-15) mL of solvent (ethyl ether) is poured into the dried sample. Fat extraction is carried out for (3-4) min in 4-5-fold repetitions. During the process, the sample is stirred periodically and the solvent with the extracted fat is drained each time. After the last drain, the residual solvent is evaporated in the air. The sample is dried in the drying oven at 105°C for 10 min. The fat content is determined by the formula (2):

$$x_2 = \left(m_1 - m_2\right) \cdot 100 / m_0 \quad (2)$$

where:
x_2: Fat content, %
m_1: Weight of the sample with the metal box before fat extraction, g
m_2: Weight of the sample with the metal box after fat extraction, g
m: Weight of the metal box, g

Determination of Ash Content

After fat extraction, the sample is transferred into a pre-calcined and weighed crucible. The samples remaining on the walls of the metal burette are washed off with a small amount of solvent, which is then removed by heating in a water bath. In the crucible, 1 mL of magnesium acetate is added to the dry, degreased sample and charred on an electric stove. Then is placed for 30 min in a muffle furnace (temperature 500-600°C). In the same way, 1 mL of magnesium acetate is mineralized. The ash content is calculated according to formula (3):

$$x_3 = \left(m_1 - m_2\right) \cdot 100 / \left(m_1 - m\right) \quad (3)$$

where:
x_3: Ash content, %
m_1: Ash weight, g;
m_2: Mass of magnesium oxide obtained after mineralization of magnesium acetate solution, g
m_0: Weight of the sample before ashing, g

Determination of the Fatty Acid Composition

Determination of the fatty acid composition is carried out according to the "Methodology of gas chromatographic determination of fatty acids and cholesterol in food and blood serum" in a specialized laboratory (MVIMN-1364, 2000). The method for determining fatty acids is based on (1) separation of lipids by extraction with organic solvents, (2) methanolysis of lipids to obtain methyl esters of fatty acids, (3) gas-chromatographic separation of fatty acids, (4) quantitative determination by internal standard using a graduation chart, which expresses the dependence of peak area ratio of methyl esters of fatty acids to internal standard and concentration of corresponding fatty acids.

Determination of the Amino Acid Composition

The amino acid composition is determined by GCMS-QP 2010 Ultra chromatomass spectrometer (Shimadzu Corporation, Japan), according to the test method (MVIMN-1663, 2000). A sample weighing 1 g is transferred to a conical flask and a 1000 cm^3 extraction solution is added. The mixture is shaken for 60 min using a mechanical shaker and 100 cm^3 of supernatant liquid is transferred from it into a beaker. About 5.0 cm^3 of sulfosalicylic acid (reagent grade 99%, LLP "Kazbiohim", Almaty, Kazakhstan) is added to it and continued mixing with a magnetic mixer for 5 min. The mortar is filtered to remove the sludge. The pH of the obtained solution is adjusted to 2.20 using sodium hydroxide solution (assay percentage ≥98%, LLP "Kazbiohim", Almaty, Kazakhstan). The solution is transferred into a measuring flask and increased volume with a citrate buffer. The chromatography is performed following SOPs available for the equipment. The same amount (±0.5%) of standard solution and sample must be entered into the column unless an internal standard is used (for chromatographic systems requiring a low sodium concentration) and unless the amino acid ratio in standard solutions and the sample should be as close as possible.

The amino acid content of the test sample, $g.kg^{-1}$, is calculated using the formula:

$$w = \frac{A_b \times c \times M \times V_b}{A_c \times m \times 1000}$$

where:
A_b: Amino acid peak area in hydrolyzate and extract
c: Molar concentration of amino acid in standard solution, mol/dm
M: Amino acid molecular weight
V_b: Total hydrolyzate volume or calculated total dilution volume of the extract cm
A_c: Amino acid peak area in a standard solution

Determination of the Mineral Composition by Mass Spectrometry

The weight of the sample (1-2 g) is ashed for 4 h at 400°C, and then at 600°C for 2 h using a muffle furnace. Then microwave decomposition is performed for 20 min at t = 180°C. After microwave decomposition, the samples are topped up to 10 mL with 1% HNO_3 solution. The content of macro-and trace elements is determined on a Varian ICP-MS 820 inductively coupled plasma mass spectrometer (Varian Company, Australia). Calibration/Quality Control Standard IV-ICPMS-71A solutions (Inorganic Ventures Company, USA) are used as standard solutions. The instrument is warmed up for about 30 min after plasma ignition and the sensitivity is adjusted with 54 Var-TS-MS setting solutions (Ba, Be, Ce, Co, B, Pb, Mg, Tl, Th) diluted to 10 µg/L. To calibrate the mass spectrometer, three IV-ICPMS-71A working standards containing 10, 50, and 100 µg/L of the required elements are used (Okuskhanova *et al*., 2016).

All qualitative indicators of meat cutlets are conducted in an accredited testing laboratory LLP "NUTRITEST" (Almaty, Kazakhstan).

Histological Study

The minced meat samples for histological study are taken frozen for fixation and without defrosting are placed in fixing liquid -10% neutral formalin. Non-frozen minced meat samples with and without vegetable additives are taken for fixation immediately after obtaining minced meat and are carefully placed for fixation in 10% neutral formalin to avoid destroying the block formed by minced meat. After fixation, the minced meat samples are filled with paraffin. The slices are obtained on sled microtome MS-2 with a thickness of 10-30 µm. The sections are stained with hematoxylin and eosin according to the conventional technique. Hematoxylin stains cell nuclei, eosin stains cell protoplasm, and to a lesser extent, various noncellular structures. The technique consists of staining the sample with Mayer's hematoxylin for 1 min, then flushing with running water, and rinsing with distilled water. After that, it is treated with Eosin solution (10 s) for staining in blue color and rinsed with water. Microscopic investigation of prepared sections is carried out using an MS-100 trinocular microscope. Digital microphotographs are taken using a digital microphotography adapter with a resolution of 9 megapixels at × 4, × 10, and × 40 magnifications.

Statistics

All experiments are performed in triplicate and results are expressed as mean ± SEM. One-way ANOVA followed by multiple comparisons of Dunnett's test is applied for statistical differences among various study groups using Excel-2007 and Statistica 12 PL software (StatSoft, Inc., Tulsa, OK, USA). P-value <0.05 is considered statistically significant.

Results

Studying the Quality of Cedar Nut Seed Cake

At the beginning of the research the chemical composition (mass fraction of proteins, carbohydrates, fat, and ash) of cedar nut cake growing in the eastern region of the Republic of Kazakhstan, left after cold pressing and thermal extraction of cedar nut is studied. Cedar nut seed meal cake is a concentrate of biologically valuable nutrients-proteins, lipids, and carbohydrates. The mass fraction of proteins in cedar nut seed cake is 39.3%, fat 17.8%, and carbohydrates 34.7%. Obtained results are presented in Table 2.

The analysis of the research results presented in Table 2 allows us to conclude that cedar nut cake, regardless of the method of production, is characterized by a high content of proteins and carbohydrates. When comparing the chemical composition of cedar nut seed meal with other structure-forming agents, it follows that the content of protein, fat, and ash is considerably higher than that of wheat flour but less than that of soybean flour. The use of vegetable flour, especially soybean meal is widespread, and improves the fat-emulsifying and stabilizing ability, adsorption of water and fat, and gel-forming ability of minced meat (Malav *et al*., 2015; Singh *et al*., 2008).

It is of interest to study the amino acid composition of cedar nut cake-Table 3.

Table 3 shows that the total content of essential amino acids in cedar nut cake is 42.44 and 40.77% of the total amino acid content of the cake obtained by cold and thermal pressing, respectively. If we compare the amino acid composition of cedar nut cake and cedar nut, we can conclude that the proteins of cedar nut cake are richer in the following amino acids: Threonine (by 16%), lysine (by 14%), valine (by 14.0%), tyrosine (by 13%), phenylalanine (by 11%), methionine (by 10%), leucine + isoleucine (by 6%).

Further research is aimed at studying the vitamin and macro- and microelement composition of cedar nut cake (Fig. 3 and Table 4). According to the results presented in Fig. 4, the content of B vitamins and vitamin E in cedar cake after cold extraction is higher than in cedar cake obtained by hot extraction. This trend is explained by the loss of vitamins during heat treatment.

In terms of mineral composition, cedar cake is rich in phosphorus, magnesium, calcium, and iron. The method of cake production slightly affects the content of these elements. However, the method of cold pressing maintains a higher amount of mineral substances than the hot method. Thus, the calcium content by the cold method is 32.2 mg/100 g, while by the hot method the calcium content decreased to 29.4 mg/100 g. The same trend is observed for phosphorus, magnesium, iron, zinc, and iodine (Table 4). The mineral composition of cedar nuts is rich in potassium, phosphorus, magnesium, calcium, iron, copper, etc. (Table 4). In the kernels and cake of cedar nuts, high content of macronutrients-potassium, phosphorus, magnesium, as well as trace elements-manganese, copper, zinc, and cobalt is observed. Potassium plays an important role in cellular metabolism, participates in the neuromuscular system, regulates intercellular osmotic pressure, and improves skeletal muscle function. Phosphorus is involved in the formation of bone tissue and affects the function of nerve cells and enzymes. Magnesium reduces the risk of atherosclerosis, and promotes the absorption of calcium; manganese influences the activity of many enzymes involved in the formation of bone tissue and blood formation and affects insulin metabolism. Zinc is involved in the growth processes of the human organism; copper is a component of many enzymes and proteins; iron is involved in blood formation, and oxygen transport (He and MacGregor, 2008; Shenkin, 2004).

Thus, based on the conducted research, it is revealed that the cedar cake remaining after cold pressing is the most valuable source of protein and essential amino acids. In comparison with the cake after thermal extraction, cold-pressed cedar cake is more enriched with vitamins, and macro- and microelements.

Studying the Quality of Meat Cutlets

Veal meat contains a low amount of fat (1.91%), whereas beef and pork have 15.36 and 32.25%, respectively. In addition, veal contains 78.16% of moisture, 18.9% of protein, and 1.03% of ash.

According to the results of the analysis, it is determined that with increasing the amount of cedar nut cake in the composition of meat semi-finished products the protein and carbohydrate content increases compared with the control, but there is a decrease in the amount of fat in the experimental samples due to lower fat content in veal. Thus, when comparing the protein content in the control and experimental samples, it is determined a significant increase ($P<0.01$) of protein in the experimental samples (18.13 to 20.52%) than in the control (13.0%). The fat content decreased significantly in the experimental samples. While the control fat content is 25.0%, the experimental fat content varies from 7.19 to 7.9%. The mass fraction of ash in the cutlet samples is not significantly changed (Table 5).

According to the results of the chemical analysis, the optimal amount of cedar nut seed meal addition is 10%. In further studies, Variant 2 with the addition of 50% veal and 10% cedar cake is selected for further research due to the optimal content of protein, fat, and moisture. A lower moisture content hurts the consistency and structure of the meat cutlet with cedar cake.

It is known that frequent consumption of meat products is linked to an increase in the consumption of saturated fats, which negatively affects the physiological functions of the human body (Rubio *et al*., 2006). Therefore, the optimal ratio of fatty acids in meat products is achieved by combining vegetable and animal raw materials.

As can be seen from Table 6, cutlets contain almost all the essential fatty acids that are necessary for the human body. In particular, the high content of polyunsaturated fatty acids, which play an important role in the human body and prevent atherosclerosis, reflects the biological value of cutlet products. PUFA content above 10% of the fatty acid composition is considered high and refers to a product that has functional and positive properties for the human body. Diet therapy is one of the most universal and effective ways to prevent disease, including cardiovascular disease. To reduce the risk of cardiovascular diseases, it is necessary to include foods low in saturated fat in the diet (Katz and Meller, 2014; Wang and Hu, 2017). Among the fatty acids, PUFAs have considerable beneficial effects on the human body. The physiological daily requirement for Polyunsaturated Fatty Acids (PUFAs) is 9-11 g for an adult, of which omega-3 fatty acids (including linolenic acid) are 1-2% of the daily caloric intake. Products with a high content of PUFA have a positive effect on heart disease, arthritis, and malignancies (Glick and Fischer, 2013; Rajaram, 2014).

The results of the amino acid composition showed that the cutlets with cedar nut cake contain all essential amino acids required by the human body (Table 7). Among the nonessential amino acids, the highest content amounted to glutamic acid (2825 mg/100 g), and aspartic acid (1668 mg/100 g). The content of glycine, arginine, and alanine is almost the same. The lowest content is determined for cystine (250.7 mg/100 g) and histidine (591.5 mg/100 g).

The essential amino acids are represented by 8 amino acids, among which lysine (1510.1 mg/100 g) and leucine (1449.5 mg/100 g) are predominant. The content of tryptophan is 228.1 mg/100 g, and methionine is 459.8 mg/100 g. Threonine (795.9 mg/100 g), isoleucine (742.0 mg/100 g) and phenylalanine (719.8 mg/100 g) contained almost equal proportions. Valine amounted to 944.7 mg/100 g.

The content of macro- and microelements in the veal meat cutlets is presented in Table 8. The developed cutlets have a higher content of calcium (75.3 mg/100 g), magnesium (100.4 mg/100 g), and iron (2.78 mg/100 g).

Thus, the consumption of 100 grams of cutlets satisfies more than 15% of the daily requirement of the human body in magnesium and iron.

Table 1: Recipe for experimental meat cutlets

Ingredient, %	Control	Variant 1	Variant 2	Variant 3
Veal	-	55.0	50.0	45.0
Chicken meat	-	25.0	25.0	25.0
Beef	54.0	-	-	-
Beef fat	5.0	-	-	-
Cedar cake	-	5.0	10.0	15.0
Egg mix	-	5.0	5.0	5.0
Wheat bread	13.0	3.0	3.0	3.0
Red onion	-	4.0	4.0	4.0
Onion	3.0	-	-	-
Black pepper	0.1	0.2	0.2	0.2
Salt	1.2	1.0	1.0	1.0
Breadcrumbs	2.0	1.8	1.8	1.8
Water	21.7	-	-	-

Table 2: Chemical composition of cedar nut cake

	Value of the indicator	
Indicator	Cedar nut seed meal after cold pressing	Cedar nut seed meal after hot extraction
Protein, %	39.3	38.5
Carbohydrate, %	34.7	33.8
Fat, %	17.8	18.9
Moisture, %	4.6	5.4
Ash, %	3.6	3.4

Table 3: Amino acid composition of cedar nut cake

	Amino acid content, g/100 g of protein	
Aminoacid	Cedar nut seed meal after cold pressing	Cedar nut seed meal after hot extraction
Phenylalanine	7.61±0.38	7.24±0.36
Leucine + Isoleucine	16.67±0.84	15.55±0.80
Lysine	6.10±0.36	6.85±0.34
Threonine	3.65±0.19	2.51±0.18
Valine	4.14±0.20	4.03±0.20
Methionine	2.24±0.12	2.31±0.10
Tryptophan	2.03±0.05	1.20±0.06
Arginine	14.12±0.70	13.20±0.67
Glutamic acid	10.06±0.50	11.33±0.57
Serine	6.58±0.33	6.76±0.34
Proline	5.25±0.26	5.45±0.27
Alanine	5.22±0.26	5.22±0.27
Glycine	4.71±0.24	4.95±0.24
Aspartic acid	4.42±0.22	4.52±0.22
Tyrosine	3.14±0.17	3.07±0.16
Histidine	2.64±0.13	4.34±0.13
Cystine	1.42±0.07	1.47±0.07

Table 4: Macro- and micro-element composition of cedar nut cake

	Element content, mg/100 g of product	
Element	Cedar nut seed meal after cold pressing	Cedar nut seed meal after hot extraction
Phosphorus (P)	1665.0±65.500	1584.0±72.700
Magnesium (Mg)	568.0±23.100	497.0±23.300
Calcium (Ca)	32.2±01.400	29.4±01.300
Iron (Fe)	13.76±0.700	13.27±0.500
Zinc (Zn)	9.66±0.400	8.24±0.200
Iodine (I)	0.58±0.020	0.28±0.010

Table 5: Chemical composition of veal meat cutlets, %

	Meat cutlets			
Indicator	Control	Variant 1	Variant 2	Variant 3
Protein	13.00±0.380	18.13±0.48*	18.22±0.42*	20.52±0.68*
Carbohydrate	5.80±0.150	5.81±0.16	7.69±0.14*	8.28±0.17*
Fat	25.00±0.650	7.19±0.10*	7.90±0.15*	7.22±0.16*
Water	54.35±1.760	67.08±1.91**	64.35±1.14**	62.27±1.21*
Ash	1.85±0.050	1.79±0.05	1.84±0.03	1.71±0.050

*P<0.01; ** P<0.01 vs. control

Table 6: Fatty acid composition of veal meat cutlets, %

Name	Quantity
Saturated fatty acids:	22.459±02.246
C12:0 lauric	0.038±00.004
C14:0 myristic	0.793±00.079
C15:0 pentadecanoic	0.227±00.023
C16:0 palmitic	13.081±01.308
C17:0 margarine	0.448±00.450
C18:0 stearic	5.761±00.576
C20:0 arachinic	0.417±00.042
C21:0 geneicosanic	1.040±00.104
C22:0 beguene	0.118±00.012
C23:0 tricosanic	0.537±00.054
Monounsaturated fatty acids:	29.454±02.945
C14:1 (cis-9) myristoleic	0.235±00.024
C16:1 (cis-9) palmitoleic	1.123±00.112
C17:1 (cis-10) margarinoleic	0.185±00.112
C18:1 (cis-9) oleic	26.679±02.668
C20:1 (cis-11) eicosene	1.232±00.123
Polyunsaturated fatty acids:	48.087±04.809
C18:2n6c linoleic	33.039±03.304
C18:3n6 Y-linoleic	13.025±01.303
C18:3n3 linolenic	0.670±00.067
C20:2 eicosadienoic	1.099±00.110
C20:3n6c (cis-8,11,14) eicosatrienoic	0.255±00.026

Table 7: Amino acid composition of veal meat cutlets, mg/100 g

Name	Quantity
Non-essential amino acids	
Asparagine	1668.0±19.90
Glutamic	2825±52.70
Serine	802.8±19.10
Histidine	591.5±07.61
Glycine	1009.8±17.30
Arginine	1035.2±16.70
Alanine	1058.5±20.80
Tyrosine	624.6±10.70
Cysteine	250.7±04.21
Proline	793.6±15.40
Essential amino acids	
Valine	944.7±15.20
Threonine	795.9±10.10
Methionine	459.8±06.49
Phenylalanine	719.8±14.60
Leucine	1449.5±23.90
Isoleucine	742.0±10.30
Lysine	1510.1±25.90
Tryptophan	228.1±03.09

Table 8: Mineral composition of veal meat cutlets, mg/100 g

Name	Quantity	Daily requirement, mg	Satisfying the daily requirement of 100g, %
Calcium (Ca)	75.300±15.060	1000	7.53
Magnesium (Mg)	100.400±20.080	400	25.10
Iron (Fe)	2.780±00.560	14	19.80
Zink (Zn)	0.948±00.270	12	7.90

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Microstructure of Cutlets

Microstructure of Minced Beef Without Plant Additives

At a low magnification of the microscope, the crosswise and longitudinally dissected muscle fibers are mainly observed in the visual field according to Fig. 5. Fragments of connective tissue are also present in the histological sections. The connective tissue fragments consist of fibers and fat cells. The boundaries between muscle fibers are well distinguished. Part of the muscle fibers is divided into small fragments.

When analyzing histological sections of minced meat under a medium magnification microscope, the preserved nuclei of muscle fibers and cells of connective tissue elements according to Fig. 6 can be distinguished. Also, the cross-cutting pattern of muscle fibers of minced meat without vegetable additives is observed.

Some serial histological sections show tendon fragments among muscle fibers (Fig. 7). At medium magnification, the connective tissue forming the tendons is distinguished by nuclear elements according to Fig. 8.

Microstructure of Minced Meat with Cedar Nut Cake after Freezing

According to Fig. 9, there are spaces between the transverse and longitudinal dissected muscle fibers, in which frozen liquid is located before fixation of frozen minced meat. This histological section does not reveal fragments of plant tissue. Plant tissues are found in the majority of histological sections made from frozen minced meat with the plant additive.

Thus, according to Fig. 10, fragments of connective tissue, and large and small tissue particles of cedar cake powder are observed in the histological section among loosely located muscle fibers. The nuclei of the cells of the plant additive are rounded and much larger than the nuclei of muscle fibers and connective tissue cells. Nuclei of muscle fibers and connective tissue cells are poorly visible under magnification of × 4 lens in comparison with plant tissue nuclei.

At medium magnification (lens × 10) nuclei in tissues of animal origin are well distinguished, and nuclei of tissues of animal origin are much smaller than nuclei of cells of tissues of plant additive (Fig. 11). In frozen minced meat, cells of cedar nut fragments have the shape of polyhedrons with rounded corners. Cell nuclei of plant tissue cells are round in shape.

In the cells of plant tissue of frozen minced meat, besides nuclei, intracellular inclusions in the form of rounded formations of pink color and grains of pink color stained with hematoxylin-eosin are distinguished. The nuclei of plant tissue are located mainly in the center of the cells. On this cut, a fragment of fatty tissue with large cells and unstained inner space is found next to the plant tissue inclusion. The fat contained within the fat cells is removed during the process of pouring tissue into paraffin. Plant tissue particles, fragments of muscle fibers, and connective tissue can fit tightly together as in this cut (Fig. 11). In general, the fragments of tissues of animal and plant origin placed on fixation in the frozen form are arranged rather loosely according to Fig. 12.

Microstructure of Cooled Minced Meat with Cedar Nut Cake

Cooled minced meat with plant additives has a densified structure (Fig. 13). On microsections from cooled minced meat with plant additives, longitudinally and transversely dissected muscle fibers are arranged with small spaces between them. There is also a fine-structured mass colored pink. Fatty tissue with a characteristic structure of cells of uncolored content and visible cell membrane.

a) cedar nut

b) Production of oil and seed meal of cedar nuts on the oil pressing machine

Fig. 1: Cedar nut seed meal preparation

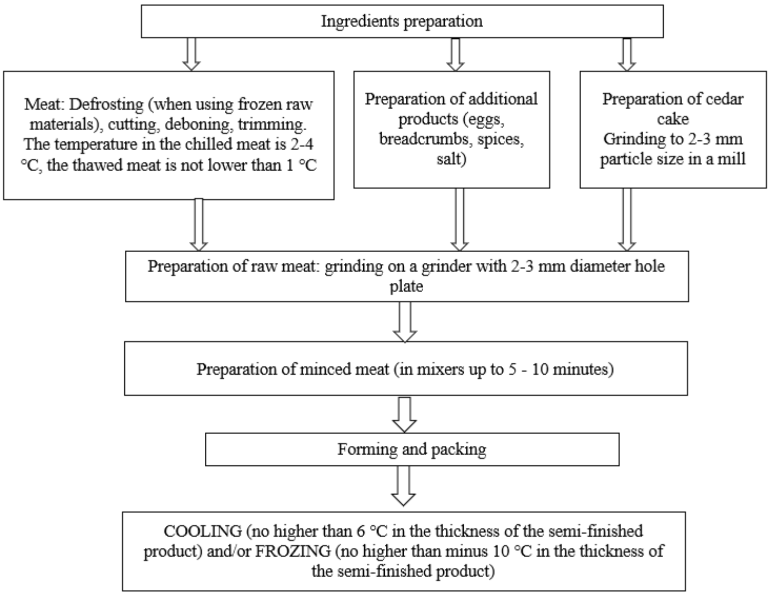

Fig. 2: Technological scheme of meat cutlets production

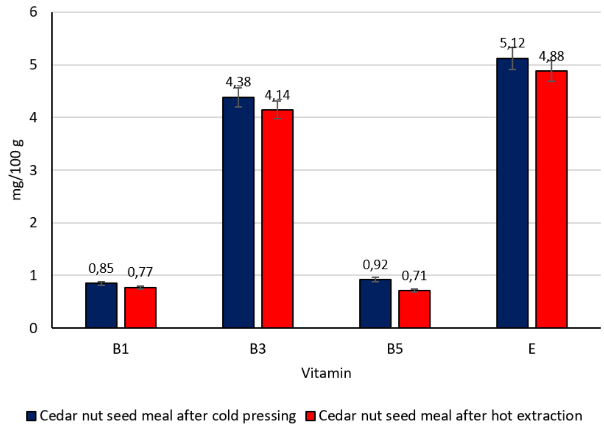

Fig. 3: Vitamin composition of cedar nut seed meal

Fig. 4: View of veal cutlets with the addition of cedar nut seed meal

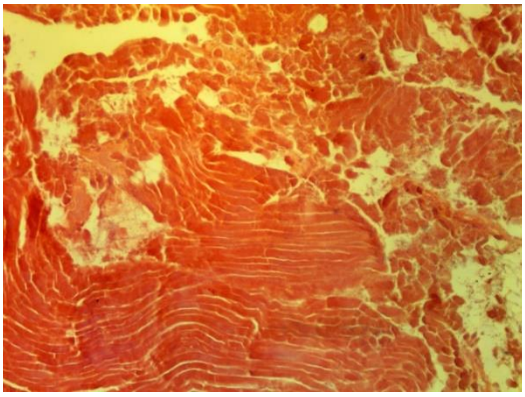

Fig. 5: Longitudinally and transversely dissected muscle fibers arranged in bundles, connective tissue fibers, and fat cells in minced meat without plant additives (magnification x4). Hematoxylin-eosin staining

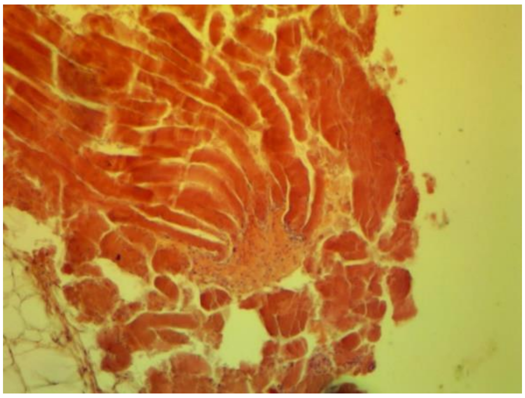

Fig. 6: Well-preserved nuclear elements of muscle and connective tissues (magnification x10). Hematoxylin-eosin staining

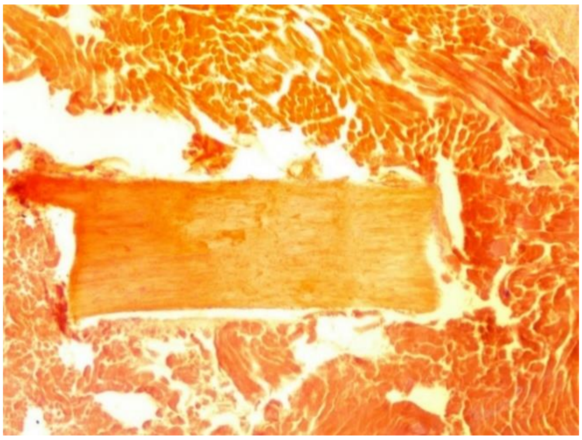

Fig. 7: Fragment of tendon among transversely and longitudinally dissected muscle fibers of minced meat without plant additives (magnification x4). Hematoxylin-eosin staining

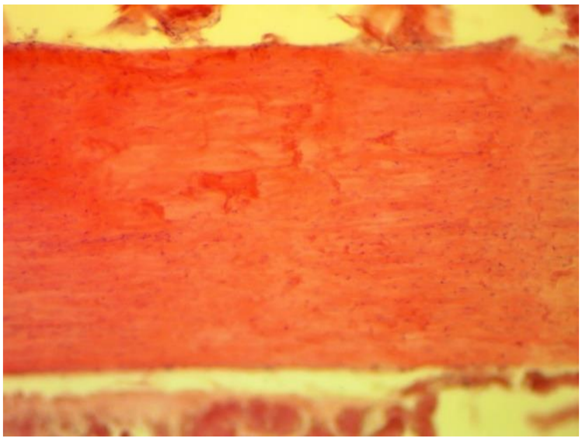

Fig. 8: Nuclei of connective tissue of tendon in minced meat without plant additives (magnification x10). Hematoxylin-eosin staining

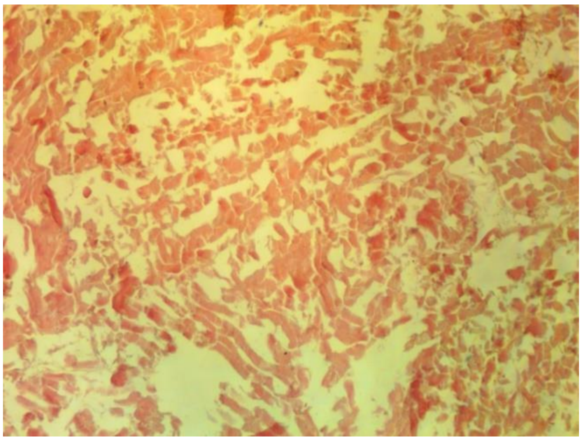

Fig. 9: Microstructure of minced meat in samples after freezing. The area without detection of plant tissue fragments (magnification x4). Hematoxylin-eosin staining

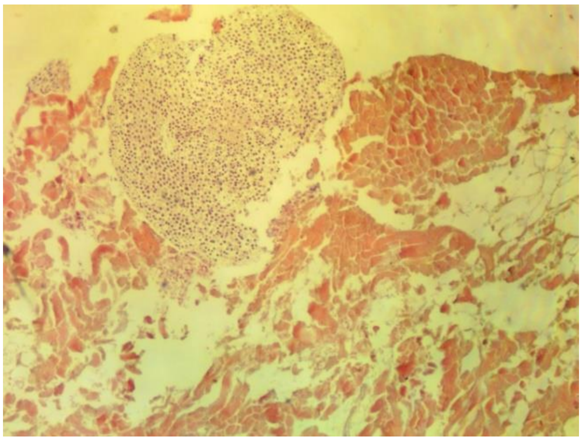

Fig. 10: Histological preparation of frozen minced meat with plant additive. Muscle fibers, connective tissues, large and small tissue particles of plant supplement (magnification x4). Hematoxylin-eosin staining

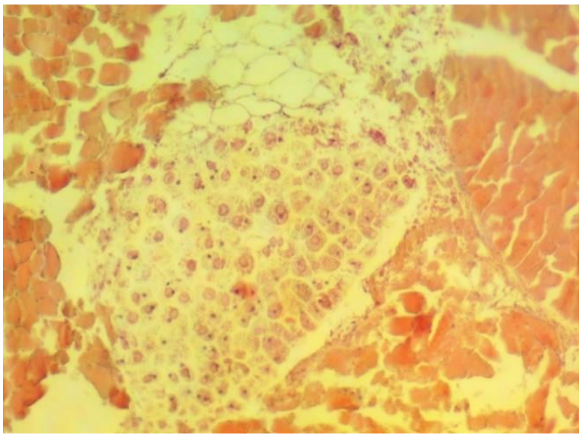

Fig. 11: Frozen minced meat with plant additive (magnification x10). Hematoxylin-eosin staining

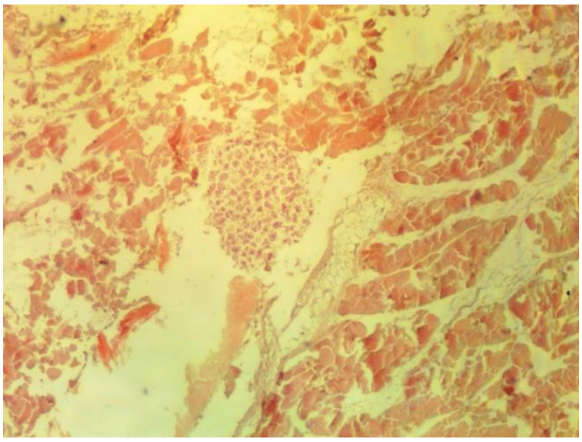

Fig. 12: Frozen minced meat with plant additive (magnification x4). Hematoxylin-eosin staining

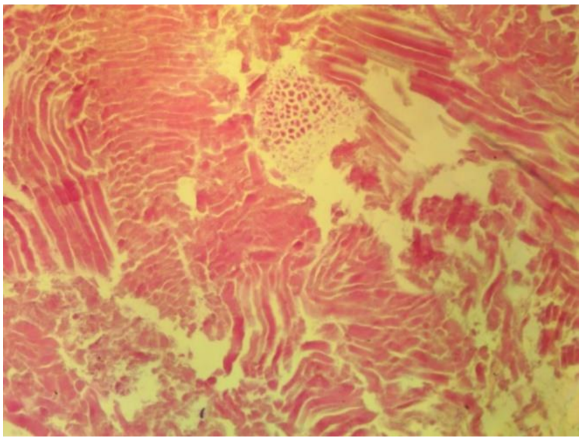

Fig. 13: Cooled minced meat with plant additive (magnification x4). Hematoxylin-eosin staining

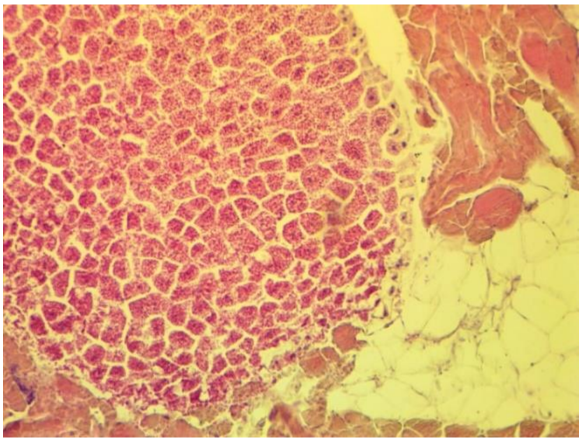

Fig. 14: Structure of the fragment of plant additive of cedar nut cake in minced meat. (Magnification x10). Hematoxylin-eosin staining

Fragments of plant tissue of pink color with nuclei of blue color are distinguishable at low magnifications. Nuclei of muscle fibers and connective tissue cells are visible at medium magnification (Fig. 14). Herewith, nuclei of cells of plant tissues are much larger than those of animal tissues. Cedar nut tissue cells are polyhedron-shaped with a large number of oxyphilic grains. Some plant tissue particles retained the structure of the nut kernel (nut kernel). In these plant tissue fragments, we can distinguish inner cells of cedar nut with characteristic granularity and round cell nucleus (cell nucleus), as well as cells of the outer shell of cedar nut kernel (nut kernel of Pinus sibirica or cedar nut kernel.), which consists of flatter cells without granularity and with the cytoplasm of bluish color when stained with hematoxylin-eosin (Fig. 14).

The fine structure of tissues and cells of minced meat components of plant origin during freezing and refrigerated storage within the applicable terms practically does not change. The distribution of plant enriching additives in the mass of minced meat is uniform.

Based on the research, the following conclusion can be made: In the process of mechanical processing of minced meat, a compact mass is formed, containing both fragments of muscle bundles and muscle fibers destroyed in varying degrees. Plant enrichment additives are also dispersed. Both plant tissue particles and individual cells or their fragments are formed. The ripening processes and autolytic changes are most pronounced in the muscle tissue of chicken meat and to a lesser extent in the muscle tissue of veal. In the case of using plant raw materials - cedar nut cake, numerous small drops of lipids are diffusely distributed in the minced meat.

Freezing of minced semi-finished products and their cold storage for 3 months has a positive effect on the overall structural composition of products. This is due to additional processes of degradation of fragments of both animal and plant origin. They result in a greater formation of a fine-grained protein mass, which gives the minced meat a more compact and homogeneous structure and, as a consequence, organoleptic characteristics (Ahmad *et al*., 2020; Kehlet *et al*., 2020). The main part of the fine-grained mass is formed from the muscle tissue of chicken meat, so autolysis in it goes with higher speed and in less time.

Conclusion

Thus, from the analysis of the results presented, it is revealed that the use of veal and cedar nut seed meal in the technology of meat cutlets has a positive effect on the quality of the finished product. Ready veal cutlets contain an optimal amount of monounsaturated and polyunsaturated fatty acids. Minerals contained in it (magnesium, iron) satisfy more than 15% of the daily needs of human physiology. Considering the quality of the product, there is reason to recommend it as a functional dietary product for the prevention of cardiovascular diseases. To normalize the functions of the cardiovascular system is recommended to include in the diet designed cutlets of veal, as it contains little fat and cholesterol, and the protein content is consistent with the physiological norm of humans.

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Author's Contributions

Berik Idyryshev: Writing, Investigation, investigation and original draft preparation.

Almagul Nurgazezova: Revision and editing, supervision.

Maksim Rebezov and Anuarbak Suychinov: Revision and editing, validation

Samat Kassymov: Formal analysis and resources.

Kuralay Issayeva: Methodology.

Assel Dautova and Rysgul Ashakayeva: Literature review and references.

Zhibek Atambayeva: Microstructure analysis, and methodology.

Ethics

This article is original and contains unpublished material. The corresponding author confirms that all of the other authors have read and approved the manuscript and that no ethical issue is involved.

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