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TECHNOLOGY OF MINCED POULTRY PRODUCTS WITH INCREASED DIETARY FIBER CONTENT**ZHANG FENG^{1,2}, T. STEPANOVA¹, T. GOLOVKO³, M. GOLOVKO³, F. PERTSEVOI¹, O. VASYLENKO^{1*}, V. PRYMENKO⁴**¹Sumy national agrarian university, Sumy, UKRAINE²Research Institute of Food Science and Engineering Technology, College of Food and Bioengineering, Hezhou University, CHINA³State Biotechnological University, Kharkiv, UKRAINE⁴Dnipro Faculty of Management and Business of Kyiv University of Culture, Dnipro, UKRAINE

*e-mail: vasylenko.sumy@gmail.com

ABSTRACT The basis of the state policy of Ukraine in the field of healthy nutrition of the population for the period until 2025 is to preserve and strengthen the health of the population, prevention of diseases caused by poor and unbalanced nutrition. Food products enriched with irreplaceable components, including dietary fibers, have been developed. The article substantiates the use of broiler meat as the main ingredient of the recipe, selects and studies the vegetable supplement of oat bran, which contains dietary fibers. The functional-technological and organoleptic indicators of minced meat models with different amounts of vegetable additives were studied, as a result, the optimal dose of introduction was determined and the formulation of the product made from broiler meat with an increased content of dietary fibers was developed. Optimal modes of heat treatment of the semi-finished product using a steam convection oven and modes of cold treatment of the finished product in "shock" freezing chambers were selected. The thermophysical characteristics of the new product were studied, and the duration of its freezing was calculated using Planck's formula. The technology of production of a functional product from broiler meat is proposed. The developed product is characterized by high organoleptic characteristics, such as juiciness of the product, pleasant smell and taste, uniform consistency, as well as a large yield of the finished product. The product contains dietary fibers, in one portion their amount is 8 g, which contributes to the satisfaction of 40% of the body's daily need for this food substance. The optimal recipe and technology of chicken cutlets with dietary fibers have been scientifically substantiated and developed. The possibility of producing chicken cutlets with a high content of dietary fiber has been theoretically and experimentally substantiated. Based on the analysis of the chemical composition and the study of the content of dietary fibers, functional-technological and organoleptic indicators of six vegetable supplements, the feasibility of introducing the vegetable supplement "Oat bran" into the recipe of chicken cutlets was substantiated. The effectiveness of thermal processing of chicken cutlets with increased dietary fiber content when using a convection oven in the steam + convection mode compared to the traditional method of processing has been proven. The raw materials for the production of the finished product were selected, the recipe was developed, the heat treatment parameters were selected, and the technology of quick-frozen finished product was developed. The developed ready-made poultry dish has an increased nutritional value due to the content of dietary fibers. It is taken into account that dietary fibers should be a mandatory part of the diet. Their total content in one portion is 8 g per 125 g of the finished product, which meets the daily need for this indicator by 40%.

Keywords: poultry cutlet; minced meat products; convection oven; steam cooking; chicken meat; broiler; dietary fiber; oat bran; diet food.

ТЕХНОЛОГІЯ ФАРШЕВИХ ВИРОБІВ З ПТИЦІ З ПІДВИЩЕНИМ ВМІСТОМ ХАРЧОВИХ ВОЛОКОН**ДЖАН ФЕНГ^{1,2}, Т. М. СТЕПАНОВА¹, Т. М. ГОЛОВКО³, М. П. ГОЛОВКО³, Ф. В. ПЕРЦЕВОЙ¹, О. О. ВАСИЛЕНКО^{1*}, В. Г. ПРИМЕНКО⁴**¹Сумський національний аграрний університет, Суми, УКРАЇНА²Науково-дослідний інститут харчової науки та інженерних технологій, Коледж харчової та біоінженерії, Університет Хечжоу, КИТАЇ³Державний біотехнологічний університет, Харків, УКРАЇНА⁴Дніпровський факультет менеджменту і бізнесу Київського університету культури, Дніпро, УКРАЇНА

АНОТАЦІЯ В основу державної політики України в галузі здорового харчування населення на період до 2025 року покладено збереження та зміцнення здоров'я населення, профілактика захворювань, зумовлених неповноцінним та незбалансованим харчуванням. Розроблено харчові продукти, збагачені незамінними компонентами, зокрема і харчовими волокнами. У статті обгрунтовано використання м'яса бройлерів як основного інгредієнта рецептури, підбрано та вивчено рослинну добавку висівки вівсяні, що містить харчові волокна. Досліджено функціонально-технологічні та органолептичні показники фаршевих моделей з різною кількістю рослинної добавки, в результаті встановлено оптимальну дозу введення та розроблено рецептуру продукту з м'яса бройлерів з підвищеним вмістом харчових волокон. Підбрано оптимальні режими теплової обробки напівфабрикату з використанням пароконвекційної печі та режими обробки готового продукту холодом у камерах «шокового» заморожування. Вивчено теплофізичні характеристики нового продукту, і за допомогою формули Планка розрахована тривалість його заморожування. Запропоновано технологію

виробництва функціонального продукту з м'яса бройлерів. Розроблений продукт характеризується високими органолептичними характеристиками, такими як соковитість виробу, приємний запах та смак, однорідною консистенцією, а також великим виходом готового продукту. Продукт містить харчові волокна, в одній порції їх кількість становить 8 г, що сприяє задоволенню 40% добової потреби організму в цій харчовій речовині. Науково обґрунтовано і розроблено оптимальну рецептуру та технології котлет курячих з харчовими волокнами. Теоретично та експериментально обґрунтовано можливість виробництва курячих котлет з високим вмістом харчових волокон. На основі аналізу хімічного складу та дослідження вмісту харчових волокон, функціонально-технологічних і органолептичних показників шести овочевих добавок обґрунтовано доцільність введення овочевої добавки «Вівсяні висівки» в рецептуру курячих котлет. Доведена ефективність термічної обробки курячих котлет з підвищеним вмістом харчових волокон при використанні конвекційної печі в режимі пара + конвекція в порівнянні з традиційним способом обробки. Підібрано сировину для виробництва готового продукту, розроблено рецептуру, підібрано параметри термічної обробки та розроблено технологію швидкозамороженого готового продукту. Розроблена готова страва із м'яса птиці має підвищену харчову цінність за рахунок вмісту харчових волокон. Враховано, що харчові волокна мають становити обов'язкову частину раціону. Зазальне їх вміст однієї порції становить 8 г на 125 г готового продукту, що у 40 % задовольняє добову потреба у цьому показнику.

Ключові слова: котлета з птиці; фаршеві вироби; конвекційна піч; варка на пару; м'ясо курки; бройлер; харчові волокна; висівки вівсяні; дієтичне харчування.

Introduction

In recent years, scientists have been interested in the study of food raw materials that are specific to a certain geographical region [1,2], but are not used to prepare regional dishes [3]. Minced meat with bran is such a rare food product, despite its advantages over regular cutlets.

In the preparation of minced meat for the production of therapeutic and prophylactic products, it is proposed to use hydrated powdered milk and vegetable semi-finished products in an amount of 5-10% by weight of minced meat [4].

Patented is a method for obtaining a functional meat product containing meal of medicinal plants: Eleutherococcus root, valerian root, peppermint leaves, thyme herb and motherwort herb. The authors note that the product is enriched with dietary fiber, essential oils and magnesium, which leads to an improvement in intestinal motility and blood formation in the human body. In addition, a biologically active food supplement improves the structural properties, color and organoleptic characteristics of the product [5].

There are known developments of semi-finished chopped meat and vegetable products, where oat bran is used as a breeding of the product [6]. Bran is often used as fillers for vegetarian yogurts [7] and yogurts with natural fillers [8, 9], so it is also advisable to use them in other food products. Thus, there are a large number of technologies for creating functional products that contain ingredients that are beneficial to human health, including dietary fiber.

In view of the foregoing, our task was to develop a product from broiler meat with a high content of dietary fiber. Since chopped products are the most popular among consumers, the positive quality of which is high organoleptic indicators, including the juiciness of the product, cutlets were chosen as the product.

Purpose of the work

To scientifically justify and develop the production technology of chicken cutlets with dietary fiber. In theory

and experimentally justified the possibility of producing chicken cutlets with a high content of dietary fiber. Based on analysis chemical composition and study content food fibers, functional and technological and organoleptic indicators six vegetable additives justified expediency introduction of the vegetable additive "Oat Bran" into the recipe of chicken cutlets. Proven efficiency of thermal processing of chicken cutlets with increased content of food fibers when using a convection oven in steam + convection mode compared to the traditional way of processing.

Presenting main material

Currently, the food industry is developing in the direction of expanding the range of ready-to-eat products, as this is required by the modern pace of life of the population. The priority of the production of quick-frozen ready-made food products, including those based on poultry meat, is explained by their rationality, compactness and speed of preparation [10].

Considering that consumers are more and more concerned about their health, the products produced must not only have high organoleptic characteristics with minimal time spent on its preparation, but also comply with the principles of healthy nutrition. Today, scientists pay great attention to the study of increasing individual indicators of a food product by adding concentrated food additives. To increase the protein content of food products such as sausages [11], sauces [12,13], is added protein isolate [14] that containing more than 90% pure protein. Such a product is also the bran of cereal crops containing a large amount of fiber, more than 40% of dietary fiber, and even their minor addition to food products significantly increases their biological value.

It should be noted that the use of poultry meat in recipes determines the high biological value of the product due to the content of complete proteins and polyunsaturated fatty acids, in addition, the development of products from poultry meat is economically beneficial. When choosing meat from various types of birds according to the main essential substances, the most promising raw material is broiler meat, it contains the optimal ratio of protein and fat, the amount of essential

amino acids practically corresponds to the reference protein, and broiler meat has the most complete vitamin composition and the least amount of cholesterol [15].

Deficiency of dietary fiber in the diet of the population of Ukraine reaches 60%, which is estimated as a risk factor for a number of diseases - endocrine, gastrointestinal tract. One of the ways to eliminate the deficiency of dietary fiber in the diet of the population is the development of new products with obvious health benefits and high organoleptic characteristics [16,17]. Currently, developments in this direction are actively underway. In the production of semi-finished chopped meat and vegetable products, it is proposed to use hydrated flakes from sprouted rye or wheat and a protein-fat emulsion from rice flour and vegetable oil; soy protein fiber or wheat fiber. Which makes it possible to obtain a chopped meat and vegetable semi-finished product with a balanced chemical composition with a high nutritional value, preventive and dietary orientation [18,19].

The objects of research in this work were:

- broiler chicken meat of the first category in a chilled state according to the State Standard of Ukraine 32951-2014;

- herbal supplement "Oat Bran" (State standart of Ukraine 68311059-009-2011);

- mince models with different amounts of vegetable additives;

- chicken cutlets.

Based on this, minced models were studied:

- control - with the ratio of minced meat components: bread: water 5:1:1.5, the amount of bread is 20% by weight of meat;

- sample 1 - with the ratio of minced meat components: vegetable additive: water 19.8:1:3, the amount of the introduced additive is 5% by weight of the meat;

- sample 2 - with a ratio of minced meat components: vegetable additive: water 10.1:1:3, the amount of the introduced additive is 10% by weight of the meat;

- sample 3 - with the ratio of minced meat components: vegetable additive: water 6.6:1:3, the amount of the introduced additive is 15% by weight of the meat.

Sampling for sensory, physicochemical studies was carried out in accordance with State Standards 26809 and IDF 122B.

The nutritional value was determined by calculation with the help of data taken from reference literature, regarding the composition of raw materials [20].

The biological value coefficient of protein was calculated according to a well-known method relative to the ideal protein [15].

Moisture-binding capacity was determined by pressing.

Water-retaining capacity - by the amount of moisture separated during the heat treatment.

pH was studied - potentiometrically on a universal

pH-14 ionometer.

The thermophysical characteristics of the product were determined on an IT-187 instrument.

Discussion of the results

In the Sumy region, the most common is the meat of broiler chickens of the first category of TOV "Nasha Ryaba". It is known that the chemical composition of meat is formed depending on the breed, fatness, age, conditions of keeping and feeding the bird. Given these factors, it was necessary to study the chemical composition of poultry meat (Fig. 1).

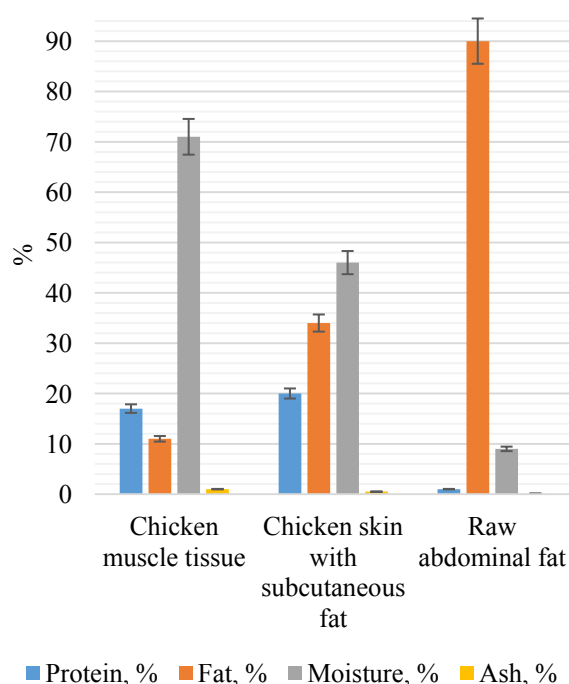


Fig. 1 - Chemical composition of broiler chickens

Fig. 1 shows that in muscle tissue the amount of protein exceeds the amount of fat by 1.5 times, and in the skin, on the contrary, the amount of fat prevails almost 1.7 times over the amount of protein. Thus, it is advisable to use poultry skin to normalize the chemical composition of products.

To characterize the biological value of proteins in the muscle tissue of a broiler chicken with skin, its amino acid composition for essential amino acids was determined, presented in table 1.

According to the content of essential amino acids, the proteins of the pulp of broiler chickens practically correspond to the standard, which indicates their high biological value.

The coefficient of biological value of the pulp of broiler chicken is 94%, for comparison, in the meat of beef and pork, the biological value is 75%. Therefore, the presence of connective tissue proteins of the skin does not reduce the biological value and does not reduce the digestibility of the protein in the human body.

Table 1 - Amino acid composition of the broiler chicken meat, g/100 g of protein

n=3, $\alpha \leq 0.05$

Essential amino acids	Chicken meat	FAO/WHO	BVC, %
Isoleucine	3.8	4.0	95.0
Leucine	7.4	7.0	105.7
Lysine	8.5	5.5	154.5
Methionine + cysteine	3.4	3.5	97.1
Phenylalanine + Tyrosine	7.1	6.0	118.3
Threonine	4.4	4.0	110.0
Tryptophan	1.4	1.0	140.0
Valine	4.7	5.0	94.0

On the Ukrainian market, herbal supplements containing dietary fiber are produced in a large assortment. According to the chemical composition studied by us, organoleptic indicators and functional and technological properties of herbal supplements, the most suitable for the semi-finished product are oat bran from the local market. Since the color of the additive is white, which will not differ from the color of the finished chopped poultry meat product, in addition, the additive has a fairly high moisture-binding and water-retaining capacity of 63 and 83%, respectively, as well as one of the highest indicators of the total amount of food fibers (45%). The content of cellulose in the vegetable additive is 5%, hemicellulose - 13%, lignin - 22%, pectin - 4.5%, which subsequently determines the functional and technological properties of the additive itself and the stuffing systems containing it [20].

Before making a herbal supplement, it is necessary to carry out the process of its swelling. The dependence of the degree of swelling on time, shown in Fig. 2.

Changes at a temperature of 100 °C were not studied, since the herbal supplement acquires a pronounced steamed aftertaste. With an increase in the duration of the process, the degree of swelling increases, such dynamics is observed at any temperature from 14 to 75 °C. For example, at a temperature of 75 °C, after 20 minutes, the degree of swelling is 275%, and at a duration of 140 minutes, the degree of swelling increases to 340%. However, a sharp increase in the degree of swelling is observed up to 60 min, then the process slows down and the rate increases only by 14%. Thus, the rational parameters of the swelling process are: temperature 75 °C and duration 60 min. At the same time, 1 g of oat bran binds 3.25 g of water, the herbal supplement is introduced into the formulation in a hydrated form.

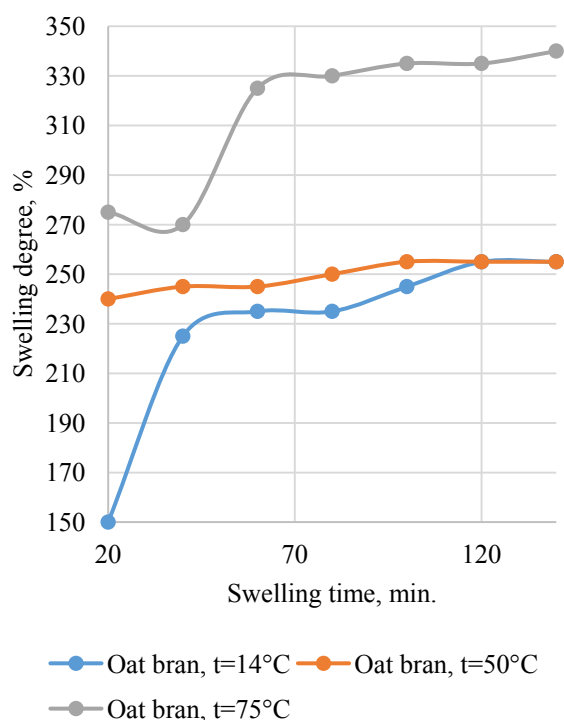


Fig. 2 - Dependence of the swelling degree and swelling time of oat bran

The minced system consists of chicken meat (muscle tissue and chicken skin) and water, while their amount is: water 5%, skin 10% and muscle tissue 85%. The content of the additive in mince systems less than 5% has not been studied, since such an amount does not provide the semi-finished product with a sufficient content of dietary fiber. In accordance with the FAO/WHO recommendations, a product containing 6.4 g of dietary fiber per 100 g is considered as a source of this functional ingredient. However, more than 15% was also not studied, since the taste of the finished product changes, in addition, the mass fraction of muscle tissue in the recipe will be 55%, thus the semi-finished product will be classified as meat-containing category B. All studied samples belong to meat semi-finished products category B, except for sample 1 - category A with a mass fraction of muscle tissue in the formulation of more than 80.0% [21].

For all types of minced meat, the following were studied: pH, water-binding and water-retaining capacity, as well as organoleptic indicators of finished cutlets with vegetable additives. The research data are given in table 2 and Fig. 3-4.

There are no significant deviations in organoleptic parameters, the samples have almost the same characteristics, except for the sample with the addition of 15% oat bran, where inclusions of flakes and a slightly bitter aftertaste are noticeable.

Table 2 - Organoleptic characteristics of cutlets with vegetable additives

Samples	Organoleptic characteristic
Control	Cut color is white. Smooth consistency, not crumbly
Sample 1	The color on the cut is white, characteristic of chicken meat. Consistency is smooth, not crumbly. The sample has a pronounced smell and taste of chicken
Sample 2	
Sample 3	Cut color is white. Small inclusions of herbal supplements are visible. The sample has a pronounced smell of chicken, a slightly bitter aftertaste.

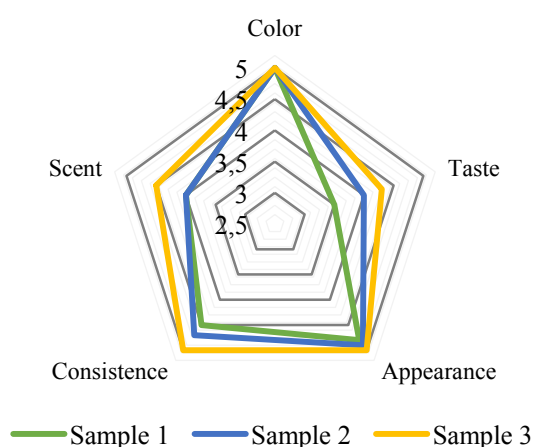


Fig. 3 – Profilogram of sensory quality indicators of chicken cutlets

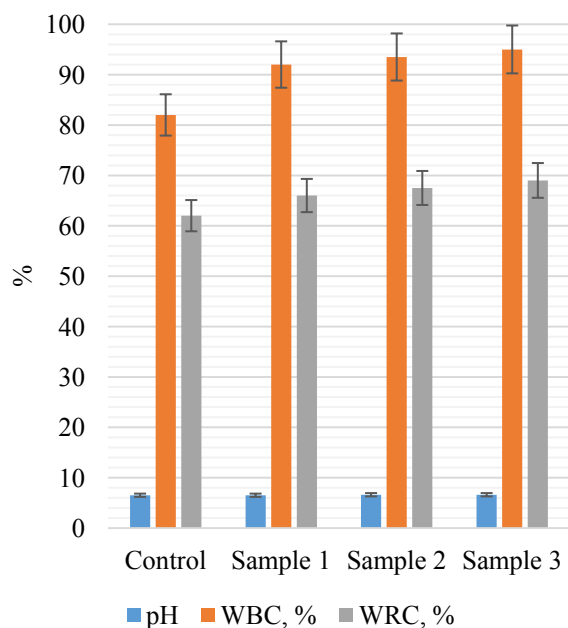


Fig. 4 - Functional and technological properties of mince systems with vegetable additives

The active acidity of the control sample is 6.52 units, the introduction of the additive changes the active reaction of the minced meat medium by 0.02-0.09 units to the alkaline side. Changing the pH of the medium to the alkaline side entails changes in the moisture-binding capacity by 12-16%. The water-retaining capacity is from 62 to 69%. Experimental studies have shown that an increase in the dose of the additive leads to an improvement in the technological properties of minced meat, but the amount of the additive more than 10% is undesirable due to changes in organoleptic indicators.

Thus, as a result of the research, taking into account the functional, technological and organoleptic properties of various mince models, the most optimal dose of the herbal supplement "Oat Bran" is 10% of the mass of meat, which made it possible to propose a recipe for a new product - chicken cutlets with dietary fiber. The recipe for cutlets is presented in Table. 3, the molding of semi-finished products is possible with any mass in accordance with the ratio of the components of the recipe.

Table 3 - Recipe for cutlets from broiler meat with dietary fiber

Name of raw materials	Amount of raw materials, g
Broiler chicken meat	77,0
Herbal supplement "Oat bran"	8,0
Water for swelling herbal supplement	25
Water	4,0
Food salt	1,0
Ground black pepper	0,03
Breadcrumbs	10,0
Semi-finished product weight	125

The parameters of the heat treatment of the product were selected, which included heat treatment and cold preservation. Heat treatment was carried out in a steam convection oven in a combined mode with a temperature in the chamber of 160 °C, at a humidity of 45%, for 10 minutes.

To preserve the product for a long time, "shock" freezing was used at a temperature of minus 35 °C and an air velocity in the chamber of 9.4 m/s. Shock freezing modes are mainly developed for semi-finished products and raw products, but there are no recommendations for finished products, which will differ in thermophysical characteristics depending on the properties and composition of food products. Since the finished product additionally contains dietary fiber, the following indicators were studied:

thermal conductivity coefficient 1.0 W/(mK), cryoscopic temperature -1.5 °C, product moisture 0.656 kg moisture/kg.

The freezing time was calculated using the Planck formula [19], which is included in the recommendations of the International Institute of Refrigeration. The estimated freezing time for chicken cutlets was 15 minutes. The calculated and experimental data on the freezing time coincide with an error of less than 10%. The final recommended freezing time for the finished product from poultry meat with a high content of dietary fiber is 17 minutes at a temperature of -35 °C with an air exchange rate of 9.4 m/s.

Conclusions

As a result, we selected raw materials for the production of the finished product, developed a recipe, selected heat treatment parameters and developed a technology for a quick-frozen finished product. The developed ready-made poultry meat dish has an increased nutritional value due to the content of dietary fiber. Keep in mind that dietary fiber should be a mandatory part of the diet. Their total content in one serving is 8 g per 125 g of the finished product, which satisfies the daily requirement for this indicator by 40%.

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Відомості про авторів (About authors)

Zhang Feng – master student of the faculty of food technologies, Research Institute of Food Science and Engineering Technology, College of Food and Bioengineering, Hezhou University, China; Sumy National Agrarian University, Sumy, Ukraine; e-mail: 2211528915@qq.com

Джан Фен – магістрант факультету харчових технологій, Науково-дослідний інститут харчової науки та інженерних технологій, Коледж харчової та біоінженерії, Університет Хечжоу, Китай; Сумський національний аграрний університет, Суми, Україна; e-mail: 2211528915@qq.com

Tatyana Stepanova – Ph.D., Associate Profesor of the department of food technology, Sumy National Agrarian University, Sumy, Ukraine; ORCID <https://orcid.org/0000-0002-9392-3773>; e-mail: eshkina97@gmail.com

Степанова Тетяна Михайлівна – к.т.н., доцент кафедри харчових технологій, Сумський національний аграрний університет, Суми, Україна; ORCID <https://orcid.org/0000-0002-9392-3773>; e-mail: eshkina97@gmail.com

Tatyana Golovko – Doctor of technical science, Professor of the department of meat technology, State Biotechnological University, Kharkiv, Ukraine; ORCID <https://orcid.org/0000-0001-7059-3620>; e-mail: Golovko.tatyana@gmail.com

Головко Тетяна Михайлівна – доктор технічних наук, професор кафедри технології м'яса, Державний біотехнологічний університет, Харків, Україна; ORCID <https://orcid.org/0000-0001-7059-3620>; e-mail: Golovko.tatyana@gmail.com

Mykola Golovko – Doctor of technical science, Professor of the department of chemistry, biochemistry, microbiology and food hygiene, State Biotechnological University, Kharkiv, Ukraine; ORCID <https://orcid.org/0000-0002-1778-4847>; e-mail: Golovko.pal@gmail.com

Головко Микола Петрович – доктор технічних наук, професор кафедри хімії, біохімії, мікробіології та гігієни харчування, Державний біотехнологічний університет, Харків, Україна; ORCID <https://orcid.org/0000-0002-1778-4847>; e-mail: Golovko.pal@gmail.com

Fedir Pertsevoi – Doctor of technical science, Professor of the department of food technology, Sumy National Agrarian University, Sumy, Ukraine; ORCID <https://orcid.org/0000-0002-3111-5017>; e-mail: kaf_th@meta.ua

Перцевой Фодір Всеволодович – доктор технічних наук, доцент кафедри харчових технологій, Сумський національний аграрний університет, Суми, Україна; ORCID <https://orcid.org/0000-0002-3111-5017>; e-mail: kaf_th@meta.ua

Olha Vasylenko – Ph.D., Associate Professor of the department of occupation safety and physics, Sumy National Agrarian University, Sumy, Ukraine; ORCID <https://orcid.org/0000-0003-1643-0702>; e-mail: vasylenko.sumy@gmail.com

Василенко Ольга Олександрівна – к.т.н., доцент кафедри охорони праці та фізики, Сумський національний аграрний університет, Суми, Україна; ORCID <https://orcid.org/0000-0003-1643-0702>; e-mail: vasylenko.sumy@gmail.com

Vladyslav Prymenko – Ph.D., Associate Professor of the department of management and administrating, Dnipro Faculty of Management and Business of Kyiv University of Culture, Dnipro, Ukraine; ORCID <https://orcid.org/0000-0001-7856-6678>; e-mail: primenkovlad@gmail.com

Применко Владислав Геннадійович – к.т.н., доцент кафедри менеджменту та адміністрування, Дніпровський факультет менеджменту та бізнесу Київського університету культури, Дніпро, Україна; ORCID <https://orcid.org/0000-0001-7856-6678>; e-mail: primenkovlad@gmail.com

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