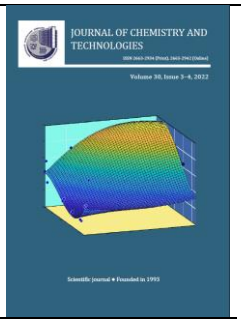
Journal of Chemistry and Technologies, 2022, *30*(4), 639-651

Journal of Chemistry and Technologies

pISSN 2663-2934 (Print), ISSN 2663-2942 (Online).

journal homepage: http://chemistry.dnu.dp.ua



UDC 663.81:634.51

TECHNOLOGY OF MARINED GAME SEMI-FINISHED MEAT WITH AN ACCENT OF ELEGANCE AND FUNCTIONALITY

Lyudmyla V. Peshuk[1], Yury E. Kyrylov[2], Iryna I. Shtyk[3], Olena A. Chernushenko[1]

[1]Oles Honchar Dnipro National University, 72 Gagarin ave., Dnipro, 49010, Ukraine

[2]Kherson State Agrarian and Economic University

[3]TOV "Tulchyn meat processing plant", Ukraine

Received 1 December 2022; accepted 6 January 2023; available online 26 January 2023

Abstract

The aim of the work was to theoretically substantiate and experimentally establish the influence of the marinating process of small pieces of semi-finished products from animal meat of various species using different methods of heat treatment on a complex of technological, microbiological and organoleptic indicators of the quality of the finished product. The aim of the work was to theoretically justify and experimentally establish the influence of the marinating process of small pieces of semi-finished products from animal meat of various species with the use of various methods of heat treatment on a complex of technological, microbiological and organoleptic indicators of the quality of finished products. To achieve the goal, the task was set: to analyze the chemical composition of the meat of wild animals in comparison with the traditional meat of agricultural animals; choose raw materials for making marinades, determine physico-chemical and functional-technological indicators of small semi-finished products after marinating; to study the effect of heat treatment on the quality of ready-made small semi-finished products, to determine the safety indicators of semi-finished products during storage. The main goal of the research was to improve the production technology of small semi-finished products from wild boar meat; choose raw materials for making marinades that soften meat; to determine the physico-chemical and functional-technological indicators of semi-finished products; to investigate the impact of the possibility of using different methods of heat treatment in the technology of marinated semi-finished products from traditional raw materials of beef and pork meat in comparison with the meat of wild animals; set processing modes; to determine the safety indicators of the developed small semi-finished products in the storage process. Analytical and experimental methods of analysis were used to conduct research: organoleptic, physico-chemical, functional-technological, microbiological and instrumental with the use of modern computer technology equipment. In the work, the chemical composition and functional and technological indicators of wild boar meat were investigated in comparison with traditional raw materials and its advantages were established, raw materials were selected for the production of marinades; the physico-chemical and functional-technological indicators of semi-finished products are determined; the influence of the main methods of heat treatment on the quality of finished products is studied. Based on the analysis and generalization of theoretical data, the results of comprehensive research, it was established that in terms of chemical composition and functional and technological properties, wild boar meat is superior to farm animal meat. The best organoleptic characteristics of the finished product were obtained on the basis of successfully selected optimal recipes of the marinade, due to which certain properties (taste, color, aroma) were given to small-sized semi-finished products. The main task of the technology is the maximum preservation of valuable components of raw materials while bringing the product to culinary readiness, during the research it was found that the best result was obtained when processing small-sized semi-finished products in a combi oven at t = 220–260^{0}C, φ=15% for 8–10 minutes. According to the results of the conducted research, microbiological stability was established - the conditions for the growth of beneficial microflora and its influence on the ripening processes due to the organic acids of the marinades - increased stability of the small semi-finished product, which ensures the preservation of the product quality for 15 days in vacuum packaging.

Key words: wild boar meat, venison; beef; pork; semi-finished products; marinade; heat treatment; quality of food products.

ТЕХНОЛОГІЯ М'ЯСНИХ МАРИНОВАНИХ НАПІВФАБРИКАТІВ З ДИЧИНИ З АКЦЕНТОМ ВИШУКАНОСТІ ТА ФУНКЦІОНАЛЬНОСТІ

Людмила В. Пешук[1], Юрій Є. Кирилов[2], Ірина І. Штик[3], Олена О. Чернушенко[1]

[1]Дніпровський національний університет імені Олеся Гончара, пр. Гагаріна, 72, Дніпро, 49010, Україна,

[2]Херсонський державний аграрно-економічний університет

[3]ТОВ «Тульчинський м'ясокомбінат», Україна.

**Corresponding author: e-mail address: linechern@gmail.com*

© 2022 Oles Honchar Dnipro National University;

doi: 10.15421/jchemtech.v30i4.268176

Journal of Chemistry and Technologies, 2022, *30*(4), 639-651

Анотація
Метою роботи було теоретично обґрунтувати та експериментально встановити вплив процесу маринування дрібношматкових напівфабрикатів з м'яса тварин різних видів з використанням різних способів термічного обробляння на комплекс технологічних, мікробіологічних та органолептичних показників якості готового продукту. Основною метою при проведенні досліджень було удосконалити технологію виробництва дрібношматкових напівфабрикатів з м'яса дикого кабана; підібрати сировину для виготовлення маринадів, що пом'якшують м'ясо; визначити фізико-хімічні та функціонально-технологічні показники напівфабрикатів; дослідити вплив можливості використання різних способів термічного обробляння в технології маринованих напівфабрикатів з традиційної сировини м'яса яловичини та свинини в порівнянні з м'ясом диких тварин; встановити режими обробки; визначити показники безпечності розроблених дрібношматкових напівфабрикатів в процесі зберігання. Для проведення досліджень використовували аналітичні та експериментальні методи аналізу: органолептичні, фізико-хімічні, функціонально-технологічні, мікробіологічні та інструментальні з використанням сучасного устаткування комп'ютерних технологій. У роботі досліджено хімічний склад та функціонально-технологічні показники м'яса дикого кабана в порівнянні з традиційною сировиною та встановлено його переваги, підібрано сировину для виготовлення маринадів; визначено фізико-хімічні та функціонально-технологічні показники напівфабрикатів вивчено вплив основних способів теплового обробляння на якість готової продукції. На основі аналізу та узагальнення теоретичних даних, результатів комплексних досліджень встановлено, що за хімічним складом та функціонально-технологічними властивостями м'ясо дикого кабана переважає м'ясо сільськогосподарських тварин. На основі вдало підібраних оптимальних рецептур маринаду, за рахунок яких було надано певних властивостей (смаку, кольору, аромату) дрібношматковим напівфабрикатам, отримано найкращі органолептичні характеристики готового продукту. Головним завданням технології є максимальне збереження цінних компонентів сировини при доведенні продукту до кулінарної готовності, при проведенні досліджень встановлено, що найкращий результат отримано при обробці дрібношматкового напівфабрикату в пароконвектоматі за t = 220–260 ˚С, φ = 15 % протягом 8–10 хвилин. За результатами проведених досліджень встановлено мікробіологічну стабільність – умови зростання корисної мікрофлори та її вплив на процеси дозрівання за рахунок органічних кислот маринадів – підвищення стабільності дрібношматкового напівфабрикату, що забезпечує збереження якості продукту протягом 15 діб у вакуумній упаковці.
Ключові слова: м'ясо дикого кабана; оленина, яловичина; свинина; дрібношматковий напівфабрикат; маринад; термічна обробка; якість харчових продуктів.

Introduction

The market of meat products needs expansion and innovation. Advantages are given to the renewal of the assortment, the development of new types of delicate meat products with a touch of sophistication, both for gourmets and for the general population [1]. It is relevant to involve the meat of wild animals in the technological process, as it allows you to obtain high-quality, safe, and in some cases functional food products, in addition, it is an interesting market niche, since game is usually sold at high prices directly to restaurants and is bought by consumers with relatively high income [2]. Breeding of wild boars and deer is common for EU countries, the main game exporters are Belgium and the Netherlands [3]. Given Ukraine's proximity to the EU market and its rich nature, it may have great potential to export farmed game or "original" premium game for supply to the EU market. Yes, this industry can be an interesting alternative for the future specialization of some Ukrainian enterprises [4].

The meat of wild animals is a potential source of complete protein, minerals, vitamins, but the presence of a significant amount of collagen fibers in the raw material limits its use in the production of food products due to its hardness, which complicates the process of chewing food and the insufficient saturation of such meat with digestive enzymes [5–8]. One of the ways to improve the functional-technological properties of game, namely the moisture-binding capacity and tenderness to give the product sophistication, is marinating the meat and a type of heat treatment, which significantly affects the quality of the finished product. Sanitary safety, organoleptic indicators, nutritional value, and product yield depend on the method, heating regime, and its duration.

By applying different marinades, you can expand the range of meat semi-finished products. The composition of the marinade necessarily includes food acids that participate in the metabolism – the connecting link between the exchange of proteins, fats and carbohydrates. Acetic acid has gained the most popularity in the pickling process. In addition to food acids, the marinade includes spices, herbs, salt, enzymes, various additives, vegetable oil, means for preserving freshness.

The stability of product quality is largely determined by the level of technological process control. In this regard, the study of the technology of pickling and heat treatment of small pieces of meat semi-finished products and

the study of their quality characteristics is of scientific interest.

The aim of the study. The aim of the work was to theoretically substantiate and experimentally establish the influence of the marinating process of small pieces of semi-finished products from animal meat of various species using different methods of heat treatment on a complex of technological, microbiological and organoleptic indicators of the quality of the finished product.

To achieve the goal, the task was set: to analyze the chemical composition of the meat of wild animals in comparison with the traditional meat of agricultural animals; choose raw materials for making marinades, determine physico-chemical and functional-technological indicators of small semi-finished products after marinating; to study the effect of heat treatment on the quality of finished small semi-finished products, to determine safety indicators of semi-finished products in the storage process.

Research material and methods

For research, samples of meat from farm and wild animals were taken for a comparative assessment of chemical composition and functional properties. Analytical and experimental methods of research are used in the work: organoleptic, physico-chemical, functional-technological, instrumental for establishing structural-mechanical properties, experimental statistical, analytical with the use of modern computer technology equipment. The classic technology of small-piece semi-finished products was taken as control in accordance with GOST R 52675-2006 "Meat and meat-containing semi-finished products. General technical conditions". Evaluation of organoleptic indicators of raw materials was determined according to DSTU 4823:2007.

For the production of experimental samples of small pieces of marinated semi-finished products, the marinade was prepared according to the recipe and kept in the marinade for 24 hours in accordance with the previous research conducted by the authors. The obtained semi-finished products were used for further research. The finished samples were compared among themselves according to organoleptic, physico-chemical and structural-mechanical indicators. The ultimate shear stress was determined on a penetrometer MP-984 PC, indicators of active acidity were determined by the potentiometric method on a laboratory pH-meter pH 340. Heat treatment of small pieces of semi-finished products was carried out by various methods: frying, steam treatment, in a ultra high frequency radiation and a combi oven in an interval of 5−10 minutes at a temperature of 220–260 ^{0}C.

Results and their discussion

Today, meat products of healthy food made from natural unrefined, unmodified agricultural raw materials are becoming popular. To replenish the volume of non-traditional raw materials in Ukraine, there is enough game, namely hare, wild boar, roe deer, spotted deer [9].

Heat treatment is the main technique in the technological process of production of various meat products. Most often, heat treatment is used at the final stage of cooking and is used to bring the product to a state of culinary readiness, as well as to destroy potentially toxic microorganisms. According to literature data, methods of heat treatment using a combi steamer, ultra-high frequency (UHF) heating, that is, the use of an ultra-high frequency electromagnetic field, infrared radiation (IR), steam, UHF compatible with IR, have become widespread [10, 11]. Along with this, the heat treatment of meat products affects the change of initial physicochemical and biochemical indicators, the value of which depends on the temperature, the method of carrying out the technological process and its duration. Therefore, the improvement and rationalization of heat treatment processes is an important direction in the way of improving the quality of meat semi-finished products.

At the first stage of the research, qualitative indicators of various types of raw materials selected for research were analyzed. The nutritional value of the meat of wild animals was evaluated according to physical and chemical parameters. For comparison, table 1 shows the results of studies of similar characteristics of wild boar meat, deer meat, pork and beef.

Table 2 shows the functional and technological indicators of the meat of farm animals in comparison with game.

Thus, in terms of its properties. the meat of wild animals is somewhat superior to the meat of farm animals (tables 1, 2).

Table 1

Physico-chemical indicators and energy value of meat

Type of raw material	The mass fraction, %				Energy value, kcal/100 g
	Moisture	Protein	Fat	Ash	
Wild boar[1]	72.52±0.45	18.65±0.17	7.68±0.18	1.15±0.01	143.72
Wild boar[2]	62.15±0.53	18.24±0.16	17.8±0.16	0.9±0.02	215.00
Semi-fat pork[1]	69.68±0.51	15.08±0.25	14.29±0.21	0.95±0.02	188.93
Pork[2]	51.5±0.56	14.3±0.18	33.3±0.11	0.6±0.02	357.00
Venison[1]	70.12±0.49	21.87±0.14	7.01±0.15	1.0±0.01	123.41
Venison[2]	72.1±0.57	21.4±0.15	5.0±0.15	1.2±0.02	115.60
Beef[1]	76.59±0.55	18.9±0.28	3.41±0.22	1.1±0.02	106.29
Category II beef[2]	69.2±0.55	20.0±0.12	9.8±0.22	0.5±0.02	168.00

[1]– Own research
[2] – [12].

Table 2

A comparison of functional and technological parameters of meat was made

Type of raw material	pH	MBC_a, %	MBC_m, %	Plasticity, cm^2/g
Boar	6.0±0.05	78.9±1.3	57.21±1.1	7.53±0.45
Pork	5.9±0.06	79.08±1.6	55.11±1.4	7.16±0.49
Venison	6.2±0.04	82.91±1.4	57.78±1.3	8.3±0.41
Beef	5.8±0.05	75.86±1.4	57.87±1.6	7.75±0.55

In particular, wild boar meat has a higher moisture-binding capacity compared to pork, thanks to which it is possible to achieve an increase in the yield of the finished product. Since wild game has a slightly higher collagen content compared to farm animals, we marinated the meat to give the product piquancy and sophistication by choosing different marinade fillings. The softening of meat is connected simultaneously with the breakdown of bonds in muscle fibers, mainly under the influence of enzymes, and with a decrease in the stiffness of connective tissue, especially collagen. Collagen in raw meat is usually softened as a result of prolonged exposure to the enzyme collagenase, but the value of this process is small, since the changes in the meat proceed very slowly, and the product undergoes microbiological spoilage before the stiffness of the collagen is significantly reduced. Another method of softening collagen is marinating meat in an acidic solution containing wine or vinegar at low positive temperatures for 24–48 hours. Collagen in an acidic environment begins to swell, absorbing moisture, and as a result, its structure softens.

Marinade is a mixture of spices, salt and acid on a liquid basis or in dry form. The difference between marinated meat semi-finished products and ordinary natural ones lies not only in their appearance, but also in their taste properties [13].

We conducted an analysis of the chemical composition of plant raw materials exotic to Ukraine, rich in food acids as an alternative to traditional acetic acid in the marinade filling (Table 3).

Table 3

The chemical composition of the raw materials included in the marinade

Indicator	Grapefruit	Kiwi	Ginger	Pomegranate
Proteins. g/100 g	0.9	1.0	7.28	0.7
Carbohydrates. g/100 g	7.3	10.3	63.08	14.5
Fiber. g/100 g	0.7	3.5	5.9	0.9
Organic acids. g/100 g	1.5	2.5	0.9	1.8
Mineral substances. mg/100 g				
Potassium	13	295	1.34	2
Calcium	184	38	116	150
Sodium	23	4.0	32	10
Magnesium	10	24	184	2
Phosphorus	0.5	31	148	8
Vitamins. mg/100 g				
B_1	0.04	0.02	0.03	0.04
B_2	0.02	0.05	0.03	0.01
C	0.20	71.0	12	0.5
PP	60	0.4	0.95	4
Energy value. kcal/kJ 100 g	35/147	48/201	80	72

After researching the chemical composition of plant raw materials and using them as marinades for meat of various types of animals, we came to the conclusion that kiwi has the best property from the point of view of technology. Kiwi contains a unique actinidin enzyme that breaks down fats and proteins contained in red meat, fish and dairy products, has a beneficial effect on blood vessels, and strengthens capillary walls. The actinidin enzyme is similar to papain and bromelain enzymes found in pineapples [14]. Kiwi fruits contain the largest amount of ascorbic acid, vitamins of group B. In addition to vitamins, kiwi contains macroelements, which are represented in large quantities by potassium, calcium and phosphorus, and trace elements: iron, zinc, iodine, manganese, as well as sugars (4.4–7.6 %), carotene (0.06–0.10 mg %), catechins (20.0–26.2 mg %), anthocyanins (37.2–125.0 mg %) [15; 16].

Ginger is a promising raw material for making marinade. Its composition includes zingiberene, which belongs to the class of terpenes and gives a burning taste to the root, sugar and fat. The root contains essential amino acids: threonine, tryptophan, lysine, phenylalanine, methionine and valine. K, Ca, Fe, Mg, F, K, Na, Zn, Cu, Mn are available among micro- and macroelements. The root of ginger is a source of water-soluble vitamins, such as C, B_2, it also includes vitamins A, E. Ginger has an antimicrobial, antifungal effect [17]. Ginger extracts help extend the shelf life of products due to the presence of a large number of natural preservatives and antioxidants.

Whey is important in nutrition, it contains more than 50 % of dry matter, including 30 % of proteins, more than 200 microelements, vitamins and vital substances, which, with daily use, compensate for 2/3 of the body's daily need for Calcium, 1/2 – in Potassium, 80 % – in vitamin B_2, 1/3 – in vitamins B_1, B_6, B_{12} [18].

In the conditions of a market economy, the leading place in the production of food products of animal origin should be occupied by resource-saving technologies.

According to statistical studies [19], the volume of whey in the world is about 140 million tons, in particular in Ukraine – 2 million tons. Taking into account the fact that in today's conditions there is a constant lack of protein and mineral substances, and a significant amount of whey by enterprises processed, we decided to include whey, which contains a significant amount of organic acids, in the marinade. Tables 4 and 5 show data on the chemical composition of whey of various types.

Table 4

Chemical composition of different types of serum

Constituent part (component)	Podsirna	3-for sour milk cheese
Water.%	95.00±2.50	94.00±2.50
White.%	1.01±0.05	1.21±0.05
Fat. g	0.41±0.02	0.22±0.02
Carbohydrates (lactose). g	4.00±0.20	4.90±0.20
Organic acids. g	0.261±0.013	0.282±0.013
Zola. g	0.56±0.03	0.92±0.03

Table 5

The content of vitamins and minerals in whey

Constituent part (component)	Podsirna	3-for sour milk cheese
Macroelements. mkg		
Sodium	43±2	42±2
Potassium	128±6	130±6
Calcium	56±3	65±3
Magnesium	5.5±0.3	6.5±0.3
Phosphorus	61±4	80±4
Microelements. mkg		
Iron	65±4	70±4
Manganese	5.5±0.3	5.5±0.3
Cobalt	0.82±0.04	0.74±0.04
Nickel	1.2±0.1	0.15±0.1
Chrome	1.5±0.1	1.5±0.1
Zinc	300±21	310±21
Copper	1.02±0.05	1.15±0.05
Vitamins. mkg/kg		
β-carotene	13±3	75±3
A	22±4	110±4
B_1	315±16	263±16
B_2	1389±95	1107±95

Continuation of the table 5

B_6	524±25	478±25
PP	140±7	140±7
C	500±25	500±25
E	227±15	315±15

Scientists, together with technologists, conduct research on the prospects of using milk whey in various branches of the food industry. A diverse range of products for direct consumption is produced from whey, and it is also produced as a semi-finished product for use in various industries [20]. To give the product tenderness, vegetable oil is often used as a marinade, taking into account that Ukraine is the world leader in the production of sunflower oil, the composition of which is rich in useful substances, it can be used not only in the process of cooking, but also in marinating meat, it was taken – rich in vitamin E – an antioxidant capable of protecting the human body from atherosclerosis, strengthening the immune system, normalizing liver function, participating in the metabolism of carbohydrates and proteins in the body, and improving memory. An important component of sunflower oil is unsaturated fatty acids (vitamin F), which are necessary for the full activity of nerve fibers, blood vessels and liver cells [21].

Table 6 shows the fatty acid composition of sunflower oil.

Table 6

Fatty acid composition of sunflower oil

The name of the acid	Sunflower oil
Saturated fatty acids:	
Miristinova $C_{14:0}$	0.1
Palmytynova $C_{16:0}$	3.5 – 4.6
Stearinova $C_{18:0}$	1.6 – 4.6
Monounsaturated fatty acids:	
Oleinova $C_{18:1}$	24 – 40
Polyunsaturated fatty acids:	
Linoleum $C_{18:2}$	46 – 62
Linolenova $C_{18:3}$	1
Arakhidonova $C_{20:4}$	0.7 – 0.9

According to the data given in table 6, sunflower oil contains valuable fatty acids, such as linolenic, oleic, arachidonic, linoleic and phosphorus-containing substances, tocopherols, wax, volatile substances, the amount of which depends on the method of obtaining and further processing of the oil [22] and which affect the process of marinating meat, saturating the semi-finished product with them.

According to indicators of chemical composition and functional and technological properties, raw materials were selected for the development of further technological operations – marinating meat for 24 hours and further research.

For control, the classical technology of small-piece semi-finished products was taken in accordance with GOST R 52675-2006 "Meat and meat-containing semi-finished products General technical requirements", after the analysis of the raw materials, four recipes of marinated small-piece semi-finished products were developed, which are listed in table 7. So in marinade №1 used 100% milk whey, in marinade № 2 the ratio of milk whey to kiwi juice was 1:1, marinade № 3 includes kiwi juice, and marinade № 4 includes sunflower oil and ginger (Table 7).

Table 7

The ratio of recipe components of marinated small pieces of semi-finished products has been developed

Raw materials	Small semi-finished product "Extra" Control	Small piece semi-finished product in marinade №1	Small piece semi-finished product in marinade №2	Small piece semi-finished product in marinade №3	Small piece semi-finished product in marinade №4
	kg per 100 kg	kg per 100 kg	kg per 100 kg	kg per 100 kg	kg per 100 kg
Meat	75.0	75.0	75.0	75.0	63.5
Onion	12.0	12.0	12.0	12.0	-
Vinegar 9 %	6.5	-	-	-	-
Serum	-	6.5	3.25	-	-
Kiwi	-	-	3.25	6.5	-
Sunflower oil	-	-	-	-	20.0

Journal of Chemistry and Technologies, 2022, *30*(4), 639-651

Continuation of the table 7

Egg white	-	-	-	-	8.5
Ginger juice	-	-	-	-	1.5
Salt	1.4	1.4	1.4	1.4	1.4
Ground black pepper	0.1	0.1	0.1	0.1	0.1
Water	5.0	5.0	5.0	5.0	5.0

Figures 1 – 3 show the yield of small semi-finished products after the marinating process for 24 hours from different types of meat. From the given data, it can be seen that the highest indicators of marinated semi-finished products were obtained: from beef meat in marinade №1 with 100 % whey content, and in marinades № 2 where the ratio of whey to kiwi juice was 1:1 and № 3 containing 100 % kiwi juice, almost identical yield indicators 113–114 (Fig. 2.); from pork - a semi-finished product in marinade №1 has a yield value of 112%, and in marinade № 2 the yield was 110 % (Fig. 1).

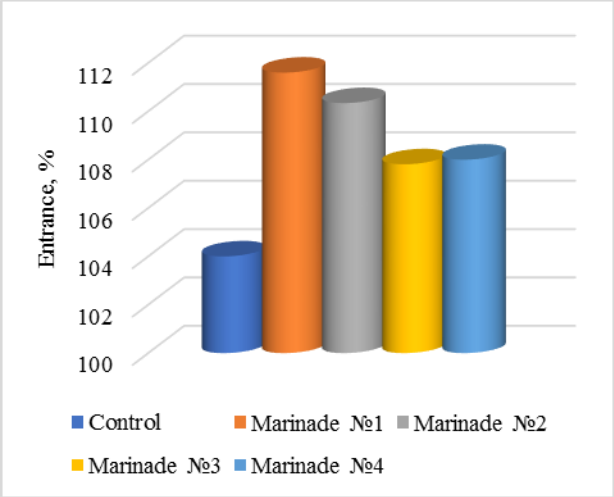


Fig. 1. Yield of semi-finished pork in the process of marinating. depending on the recipe of the marinade. %.

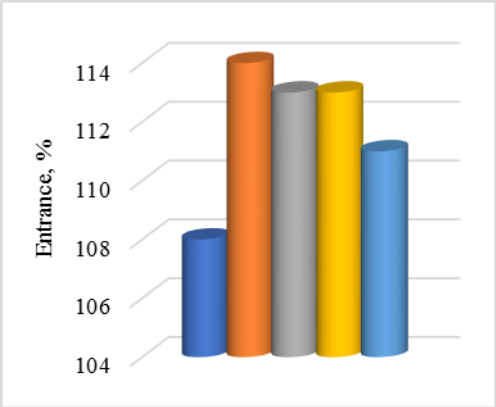


Fig. 2. Yield of semi-finished beef in the process of marinating, depending on the recipe of the marinade, %.

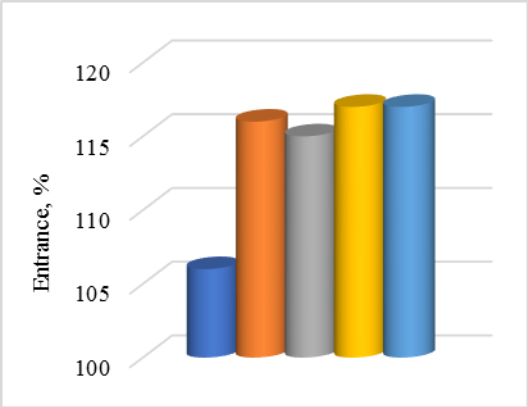


Fig. 3. Yield of semi-finished product from wild boar meat in the process of marinating. depending on the recipe of the marinade, %.

Quite the opposite indicators were obtained when marinating wild boar meat. The whole process of pickling has a positive effect on the output of small semi-finished products compared to farm animals: the output is much higher; the best results were recorded when marinating the semi-finished product in marinade № 3 containing kiwi and marinade № 4 containing oil and ginger; a slightly smaller, but somewhat lower indicator was obtained when marinating game in marinade № 1 with 100 % whey content (yield 116 %) and № 2, where the ratio of whey to kiwi juice was 1 : 1 (yield 115 %). (Fig. 3).

The main mass of raw materials when used at food industry enterprises is subjected to heat treatment, which significantly affects the quality of finished products. The main technique for bringing most meat products to a state of culinary readiness is heat treatment of the semi-finished product by various methods. In the technological

process of production of various meat products, the methods of heat treatment using steam, IR, combi steamer, UHF, combination of UHF and IR, which significantly affect the change of physico-chemical, functional-technological, biochemical and organoleptic indicators and depend on the main parameters of the technological process, namely the temperature, method and duration of heat treatment. Sanitary safety, organoleptic indicators, nutritional value, and yield of products depend on the method, heating regime, and its duration.

A comparative assessment of the effect of different methods of heat treatment on the output of shish kebab revealed the advantages of using a steamer and a UHF over traditional frying and steaming. The reduction of moisture loss in the finished product after processing in a combi oven is the reason for the increase in the output of small pieces of semi-finished. The loss of mass of culinary products during UHF-heating is also reduced compared to frying.

The increase in the output of finished products during heat treatment in a combi oven is explained by more moderate temperature modes of heating the samples than with the traditional method. This causes less profound physicochemical changes in the protein system of products, which leads to a decrease in mass loss. An important indicator that characterizes the change in the mass of meat products during heat treatment, their juiciness and consistency is MBC (moisture binding capacity).

Table 8

Losses of mass and VZZ of the finished product after heat treatment in various ways [24]

Method of heat treatment	Entrance, %	Entrance,%	MBC_a, %	MBC_m, %	pH
Roasting	50.0±1.2	50.0	55.3±1.8	23.4±0.9	5.7±0.09
UHF	54.2±0.9	45.8	66.8±1.7	26.34±1.2	5.55±0.04
Steam	51.2±1.6	48.8	58.7±1.5	25.3±0.7	5.75±0.07
Steam convective	68.0±0.75	32.0	75.0±1.2	49.7±1.4	5.65±0.03

The data shown in table 8 indicate differences in the moisture binding capacity (MBC) of the finished product processed by different methods. The best indicators were obtained when using UHF and steam-convective processing, the rest of the thermal processing methods do not lead to a significant increase in MBC.

Potentiometric determination of the active acidity of the finished samples did not reveal noticeable differences in the dynamics of this indicator depending on the applied method of heat treatment of the product.

Reduction of mass loss. increase of MBC lead to improvement of tenderness and juiciness of the finished product. Food is cooked in a combi steamer thanks to the convection of hot air generated by heating electric heaters or gas. The constant circulation of hot air ensures uniform baking of products in the oven and the speed of their preparation.

Table 9 shows the data of the study of the finished small piece semi-finished product during heat treatment in a combi steamer at different temperature regimes.

Table 9

Comparative characteristics of the functional and technological properties of small semi-finished products processed at different temperature regimes.

Processing temperature	Entrance, %	Entrance, %	MBC_a, %	MBC_m, %	pH
220 ^{0}C	67.1±1.1	32.9	67.9±1.1	55.0±1.1	5.6±0.08
240 ^{0}C	69.0±0.5	31.0	68.9±0.4	54.1±0.4	5.65±0.05
260 ^{0}C	61.5±1.2	38.5	59.7±0.9	35.8±1.2	5.7±0.09

Analyzing the data in table 9, it can be seen that the highest functional and technological indicators, MBC, and, therefore, the organoleptic evaluation of the finished product were obtained when processing small pieces of semi-finished products in a steam oven at a temperature of 2400C, while the losses are significantly lower by 31 % and the output is higher (69 %) compared to the temperature regime within ±20 ^{0}C. Mass changes during heat treatment of meat products are mainly related to the loss of moisture, water-soluble organic and mineral substances and are caused by high temperature, which causes denaturation of protein substances and significantly affects the moisture-retaining capacity of the finished product.

According to the requirements of current regulatory documents, the quality indicators of the finished 15 samples of small semi-finished products from different types of meat and using different marinades after heat treatment were evaluated by the tasting committee first on the uncut and then on the cut product in the following sequence: appearance, color and

Journal of Chemistry and Technologies, 2022, *30*(4), 639-651

surface condition; smell, aroma, taste and juiciness of meat products cut into pieces. Profilograms of organoleptic evaluation of ready-made semi-finished products are shown in (Fig. 4).

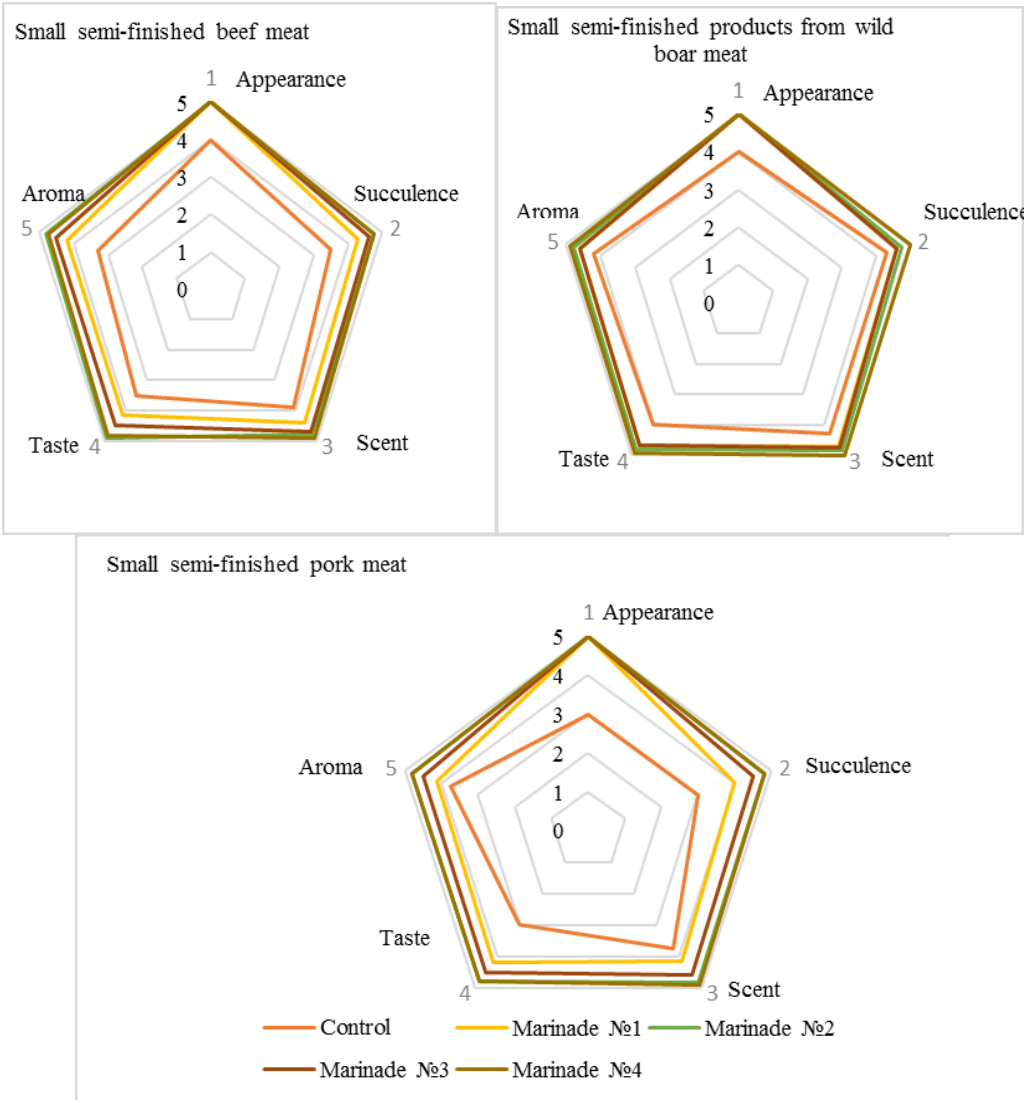


Fig. 4. Organoleptic evaluation of ready small pieces of semi-finished products

Analyzing the data obtained from the tasting evaluation of small-sized semi-finished products, it can be concluded that all samples met the requirements of the current regulatory documentation, but the highest rating from the tasting commission was given to small-sized semi-finished products prepared in a steam oven and UHF using marinade № 3, which contains kiwi juice and № 4 in the composition which includes sunflower oil and ginger.

Table 10 shows the physico-chemical composition of small semi-finished products heat-treated in a combi oven for various types of meat.

Table 10

Physico-chemical composition of small pieces of semi-finished products

Type of marinade	The mass fraction, %		
	Moisture	Fat	Zola
From beef			
Control	44.6±0.55	30.47±0.29	1.12±0.03
Marinade №1	52.9±0.48	17.99±0.14	1.15±0.02
Marinade №2	58.5±0.43	18.7±0.25	1.15±0.01
Marinade №3	59.7±0.47	20.7±0.23	1.14±0.02
Marinade №4	43.4±0.41	39.45±0.19	1.16±0.01
From wild boar meat			
Control	57.5±0.59	27.14±0.3	1.1±0.02

Continuation of the table 10

Marinade №1	61.8±0.57	32.34±0.26	1.21±0.01
Marinade №2	62.4±0.41	22.1±0.22	1.23±0.01
Marinade №3	69.6±0.38	28.3±0.29	1.22±0.01
Marinade №4	71.3±0.53	36.94±0.31	1.1±0.02
From pork meat			
Control	36.67±0.45	4.18±0.25	0.99±0.01
Marinade №3	37.01±0.35	5.64±0.2	1.07±0.03
Marinade №4	44.23±0.41	10.51±0.22	1.02±0.02

Small piece of semi-finished products with marinade № 4 is characterized by a slightly higher fat content and reduced moisture content, this feature is explained by the presence of sunflower oil in the marinade

Table 11 shows the data obtained during the study of the functional and technological properties of small semi-finished products from various types of meat that underwent heat treatment in a steam oven.

Table 11

Functional and technological properties of small semi-finished products after heat treatment in a combi oven.

Type of marinade	pH	MBC $_a$, %	MBC$_m$, %	Plasticity, cm^2/g
From pork meat				
Control	5.65±0.06	87.0±1.6	57.82±1.5	7.8±0.57
Marinade №1	5.90±0.05	87.95±1.3	59.88±1.1	6.54±0.41
Marinade №2	5.85±0.04	88.52±1.2	61.60±1.2	6.28±0.53
Marinade №3	5.80±0.05	88.79±1.1	60.20±1.4	6.0±0.38
Marinade №4	6.0±0.05	98.7±1.05	61.73±1.0	7.87±0.6
From beef				
Control	5.30±0.05	76.1±1.8	32.6±1.5	6.7±0.61
Marinade №1	5.85±0.04	81.0±1.4	38.88±1.3	5.37±0.48
Marinade №2	5.65±0.05	85.2±1.1	48.02±1.1	5.74±0.55
Marinade №3	5.50±0.06	86.0±1.5	48.84±1.2	5.77±0.35
Marinade №4	5.55±0.03	79.4±1.1	37.94±0.95	3.97±0.51
From wild boar meat				
Control	5.35±0.05	69.0±1.5	25.32±1.4	2.88±0.5
Marinade №1	5.45±0.04	73.2±1.4	24.59±1.1	3.0±0.32
Marinade №2	5.35±0.05	79.6±1.2	36.58±1.2	3.3±0.78
Marinade №3	5.45±0.05	65.8±1.3	22.29±1.3	2.9±0.31
Marinade №4	5.40±0.06	77.4±1.6	31.97±1.1	5.2±0.56

From the data given in table. 11, it can be seen that samples of small piece of semi-finished products aged in marinades № 2, № 3 and № 4 have higher indicators of MBC$_a$ and MBC$_m$. It is well known that these indicators have a positive effect on the output of the product after heat treatment.

Table 12 shows the data obtained during the study of functional and technological indicators of small piece of semi-finished products that underwent heat treatment by the UHF oven method.

Table 12

Functional and technological indicators of small pieces of semi-finished products from pork

Type of marinade	pH	MBC$_a$. %	MBC$_m$. %	Plasticity. cm^2/g
Control	5.45±0.05	99.8±1.7	26.34±1.5	12.1±0.6
Marinade №3	5.40±0.04	99.6±1.5	37.60±1.4	10.18±0.4
Marinade №4	5.90±0.07	99.7±1.6	29.58±1.0	10.51±0.6

From the given data in table 12, it can be seen that the test samples small piece of semi-finished products subjected to heat treatment in UHF ovens are characterized by a high rate of MBC$_a$, which reaches up to 99.8 %, and this, in turn, is positively reflected in the output of the finished product.

In the process of heat treatment, the product reaches a state of culinary readiness, which is characterized by certain organoleptic quality indicators and ensures the destruction of most bacteria, including those potentially dangerous for humans, as well as changes in the yield of the product.

In fig. 5–8 shows the yield of the finished product depending on the method of heat treatment and the type of raw material.

Journal of Chemistry and Technologies, 2022, *30*(4), 639-651

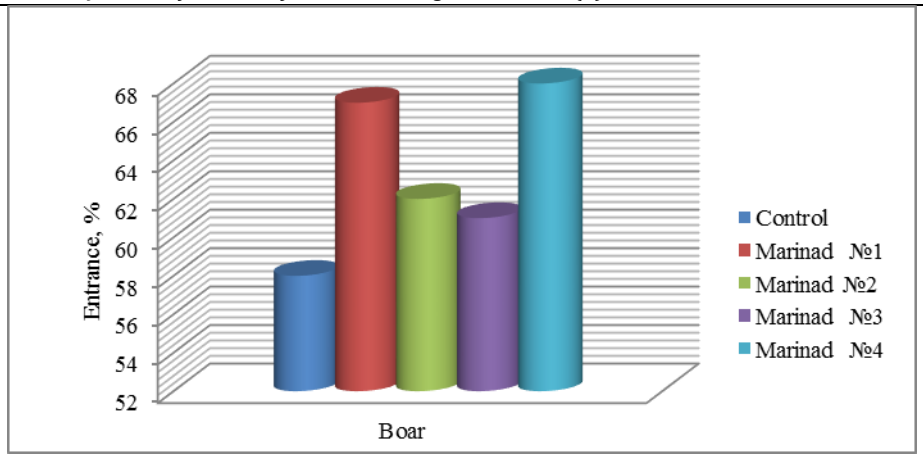


Fig. 5. Output of small-sized semi-finished product from wild boar meat after heat treatment in a combi oven

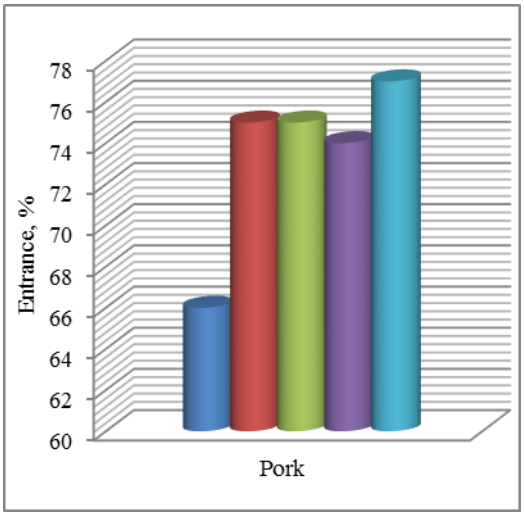


Fig. 6. Output of small-sized semi-finished product from wild boar meat after heat treatment in a combi oven

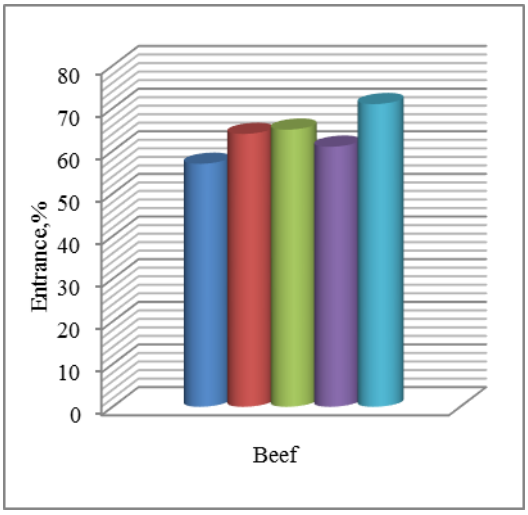


Fig. 7. Output of small-sized semi-finished beef products after heat treatment in a combi oven

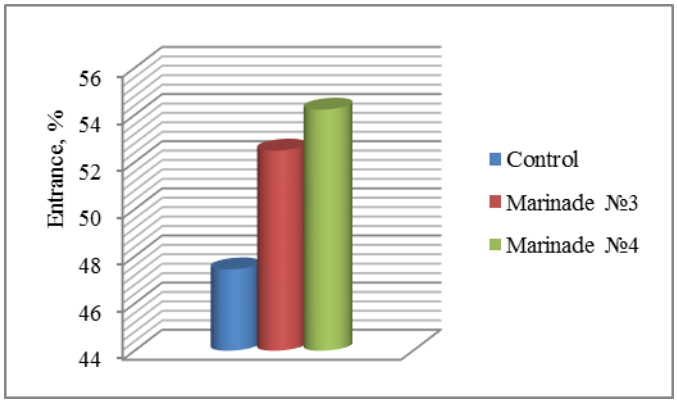


Fig. 8. Output of small pieces of semi-finished products from boar meat processed by the microwave method

Analyzing the results of Figures 5 and 6, we can conclude that the output small pieces of semi-finished products that have undergone heat treatment are influenced by such factors as the type of meat, recipe ingredients of the marinade, the type of equipment used and the use of the type of heat treatment (boiling, baking, frying, steam treatment, ultra-high-frequency heating treatment throughout the product, where electromagnetic energy is converted into heat. Therefore, the product heats up quickly and there is practically no temperature gradient). The obtained data confirm the results of studies carried out earlier [23], where various methods of thermal processing of special-purpose meat products, their advantages and disadvantages are given, and attention is focused on gentle methods of processing meat semi-finished products, which allow to preserve the essential substances in the finished product as much as possible.

Analyzing the data after the research, it was found that the optimal recipes for obtaining a tender juicy semi-finished product from wild boar meat are the use of kiwi fruit juice marinade № 3 and sunflower oil in combination with ginger juice marinade № 4 as marinades, after heat treatment in a combi steamer. Due to the components of marinades, exquisite organoleptic characteristics (taste and aroma) were provided and quite good functional and technological indicators of the finished product were obtained.

When developing the technology for the production of marinated small-piece semi-finished products, vacuum packaging of semi-finished products from wild boar meat was provided. After packaging, small semi-finished products were sent for storage in a refrigerating chamber at a temperature of 0 + 6 ^{0}C for a specified period. The studied samples were examined according to microbiological indicators: the number of mesophilic aerobic and facultatively anaerobic microorganisms (MAFAM), BECG (bacteria of the Escherichia coli group coli-forms), pathogenic microorganisms, including the genus Salmonella, sulfite-reducing clostridia, pathogenic microorganisms, including *L. monocytogenes* during storage. The results of the obtained studies are presented in table 13.

The amount of MAFAM both in the control sample and in the experimental meat samples small pieces of semi-finished products, were within the normative parameters. In none of the studied samples were found BECG (coli-forms), sulfite-reducing clostridia and pathogenic microorganisms, including the genera *Salmonella* and *L. monocytogenes* (Table 13).

Table 13

Microbiological indicators of pickled semi-finished products

Indicators. samples	Norm	Results of the study				
		At the beginning of the storage	In 7 days	In 10 days	In 12 days	In 15 days
MAFAM. CFU/g						
sample 1- control	$5 \cdot 10^6$ by DSTU ISO 4833:2006 GOST 1044.15-94	$1.96 \cdot 10^3$	$4.8 \cdot 10^4$	$5.6 \cdot 10^6$	$6.1 \cdot 10^6$	$7.3 \cdot 10^6$
sample 2 (in marinade №1)		$2.9 \cdot 10^3$	$5.6 \cdot 10^4$	$9.4 \cdot 10^4$	$6.1 \cdot 10^5$	$5.6 \cdot 10^6$
sample 3 (in marinade №2)		$2.1 \cdot 10^3$	$5.9 \cdot 10^4$	$3.4 \cdot 10^5$	$1.1 \cdot 10^5$	$4.8 \cdot 10^6$
sample 4 (in marinade №3)		$1.9 \cdot 10^3$	$5.6 \cdot 10^4$	$9.4 \cdot 10^4$	$2.4 \cdot 10^5$	$4.7 \cdot 10^5$
sample 5 (in marinade №4)		$7.6 \cdot 10^3$	$1.0 \cdot 10^4$	$5.8 \cdot 10^4$	$1.8 \cdot 10^5$	$3.2 \cdot 10^5$
BECG (coli forms) in 1 g	not allowed by GOST 9225-84	not found	not found	not found	not found	not found
Sulfite-reducing clostridia in 0.01 g	not allowed by GOST 30518-97	not found	not found	not found	not found	not found
Pathogenic microorganisms. including *Salmonella* in 25 g	is not allowed by DSTU EN 12824:2004	not found	not found	not found	not found	not found
Pathogenic microorganisms. including *L.monocy-togenes* in 25 g	is not allowed by DSTU ISO 11290-1:2003	not found	not found	not found	not found	not found

According to the results of the microbiological evaluation of the experimental semi-finished products, the shelf life of samples in marinade № 3 and № 4 was established for 15 days.

Conclusions

Based on the analysis and generalization of theoretical data. the results of comprehensive research. it was established that in terms of chemical composition and functional and technological properties. wild boar meat is superior to farm animal meat. On the basis of successfully selected optimal recipes of the marinade. due to which certain properties (taste. color. aroma) were given to the finished product. the best organoleptic characteristics of small pieces of semi-finished products were obtained.

The main task of the technology is the maximum preservation of valuable components of raw materials while bringing the product to readiness. in the course of research it was found that the best result was obtained when

processing small pieces of semi-finished products in a steam oven at t = 220–260 ^{0}C, φ = 15 %, 8–10 min. According to the results of the conducted research. microbiological stability was established – the conditions for the growth of beneficial microflora and its influence on ripening processes due to organic acids containing marinade № 3 from kiwi and marinade № 4 from ginger in combination with sunflower oil – increasing the stability of small pieces of semi-finished products. which ensures the preservation of quality product within 15 days in vacuum packaging.

References

[1] Savekin A. V. (2012).Technical innovations in the field of heat treatment. *Meat industry, 9*, 26–27.

[2] Horlov, I. V., Shalymova, O. A., Tsykin, S. S. (2009). Prospects for expanding sources of raw materials of animal origin by using non-traditional meat raw materials *Vestnyk Orel GAU*, 6, 53–56.

[3] Peshuk, L., Melnyk, O., Radzievska, I., Galenko, O. (2018). Investigatio of vegetable oils to oxidative degradation of varying degrees of saturation with tocopherol [AUT.] *Carpathian journal of food science and technology, 10*(3), 163–170.

[4] Hess, S., Voget, B., Kuznetsova A. (2009). *European meat markets: real opportunities for Ukraine?: Consultative work No. [AƨPP No. 24].* Kyiv: Institute of Economic Research and Political Consultations.

[5] Peshuk, L. V., Ishchenko, V. M., Shtyk, I. I., Ivanova, T. M. (2014). The use of marinades based on food acids for the preparation of semi-finished products from wild boar meat. *Scientific Bulletin of LNUVMBT named after S.Z. Gzhitskoho*, *16*(2), 4, 164–170.

[6] Shtyk, I., Ivanova, T., Dydyuk O. (2013). Quality indicators and biological value of wild animal meat. *Ukrainian food journal*, *2*(2).157–162.

[7] Avramenko, N. O. (2017). Meat of wild animals: features and composition. *Bulletin of the Poltava State Agrarian Academy*. 3. 108–109.

[8] Sales, J., Kotrba, R. (2013). Meat from wild boar. *Meat Science*. *94*(2). 187–201. https://doi.org/10.1016/j.meatsci.2013.01.012

[9] Peshuk L. V., Yancheva, M. O., Haschuk, O. I., Kyrychenko, S. G. (2017). *Technology of meat products from non-traditional meat raw materials extbook.* National University of Food of Technologies, Kharkiv. state University of Food and trade. Kyiv: TsUL.

[10] Chizoba Ekezie, F. G., Sun, D. W., Han, Z., Cheng, J. H. (2017). Microwave-assisted food processing technologies for enhancing product quality and process efficiency: a review of recent developments. *Trends in Food Science & Technology, 67*, 58–69. https://doi.org/10.1016/J.TIFS.2017.05.014

[11] Hassoun, A., Ojha, Sh., Tiwari, B., Rustad, T., Nilsen, H., Heia, K., Cozzolino, D., El-Din Bekhit, A., Wold, A. B. J. P. (2020). Monitoring Thermal and Non-Thermal Treatments during Processing of Muscle Foods: A Comprehensive Review of Recent Technological Advances. *Applied Sciences*. *10*, 6802; doi:10.3390/app10196802

[12] Tsykin, S. S., Shalymova, O.A . (2011). Development of the technology of natural frozen semi-finished products from the meat of wild animals for the restaurant business. *Technology and product development of innovative food products.* 6. 33–38.

[13] Khomych, G. P., Oliynyk, L. B., Nakonechna Y. G. (2021). Optimizing the technological characteristics of marinated meat semi-finished products. *LTEU Bulletin. Technical sciences 25*(5/11). 127–135. https://doi.org/10.36477/2522-1221-2021-25-17.

[14] Nishiyama, I. (2007) Fruits of the actinidia genus. *Advances in food and nutrition research*. 52. 293 – 324 doi: 10.1016/S1043-4526(06)52006-6.

[15] Richardson, D. P., Lynley J. A., Drummond N. (2018). The nutritional and health attributes of kiwifruit: a review. *European Journal of Nutrition*. 57, 2659–2676. doi:10.1007/s00394-018-1627-z.

[16] Robles, L. R., de la Maza, B. P., García, J T., Vieitez, J. J. G., Gómez, M. J. F., Mellado, I. B., Poma M. D. B. (2019). Laura Redondo Robles. Nutritional profile of multiple sclerosis. *Nutricion Hospitalaria*. 10; *36*(2) 340–349. doi: 10.20960/nh.2023.

[17] Rubanka, K. V., Terletska, V. A., Abramova, A. G. (2017). Research on the quality of dry ginger root extract. Economic strategy and prospects for the development of trade and services: coll. of science Ave. *Khark. state University of Food and Trade*, 302–310.

[18] Mehraa, R., Kumara, H., Kumara, N., Ranvirb, S., Janac, A., Buttard, H. S., Telessye, I. G. (2021). Whey proteins processing and emergent derivatives: An insight perspective from constituents, bioactivities, functionalities to therapeutic applications *Journal of Functional Foods* 87, 104760 https://doi.org/10.1016/j.jff.2021.104760

[19] Grajales-Lagunes, A., Rivera-Bautista, C., Ruiz-Cabrera, M., Gonzalez-Garcia, R., Ramirez-Telles, J., Abud-Archila, M.(2012). Effect of lactic acid on the meat quality properties and the taste of pork Serratus ventralis muscle. *Agric. Food Sci*. 21.171–181. doi: 10.23986/afsci.6082.

[20] Simitzis, P., Zikou, F., Progoulakis, D., Theodorou, G., Politis, I. (2021) A Note on the Effects of Yoghurt Acid Whey Marination on the Tenderness and Oxidative Stability of Different Meat Types *Foods. 10*(11), 2557. doi:10.3390/foods10112557.

[21] Zhou, Y., Zhao, W., Lai, Y., Zhang, B., Zhang, D. (2020) Edible Plant Oil: Global Status, Health Issues, and Perspectives. *Front Plant Sci*. 11, 1315. doi: 10.3389/fpls.2020.01315.

[22] Peshuk L. V. Nosenco T. T., Kichshenko V. A., Levchuk I. V., Radzievska I. G (2011). *Comparison of biological value of some animal fat.* IUFoST Proceeding of Conference 21-23.06.2011, Shangai, China

[23] Peshuk, L. V., Ivanova T. M., (2015). Analysis of thermal processing methods for quality indicators of special purpose meat products. Scientific. *Bulletin of the LNUVMBT named after S.Z. Gzhitskoho, 17*. 4 (64).