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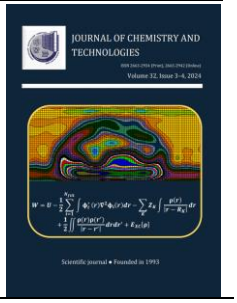

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CRAFT TECHNOLOGIES OF MARINATING SEMI-FINISHED MEAT OF WILD ANIMALS – THE POTENTIAL OF THE MARKET OF ORGANIC PRODUCTS IN UKRAINE

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Abstract

Modern approaches to the development of high-quality pickled game semi-finished products are based on a deep understanding of the chemical and biochemical processes that occur during pickling. The use of vegetable ingredients with a high content of organic acids, such as kiwi, in the technology of marinating game meat allows to significantly improve the structural, mechanical and taste qualities of the finished products. Studies have shown that optimal results are achieved when marinating wild boar meat for 24–27 hours using a marinade containing 20–30 % kiwifruit. This concentration is able to ensure the maximum quality and profitability of meat semi-finished products, as indicated by the results of the product yield study after pickling, heat treatment and organoleptic evaluation. The conducted structural and mechanical studies testify to the effectiveness of the developed marinades for improving the texture and juiciness of game meat, as well as emphasizing its unique flavor and aroma profile. It has been studied that the use of fermented pickles from cucumbers and cabbage as marinades for small pieces of semi-finished products from wild boar meat leads to high yields of finished products after heat treatment, which emphasizes their economic suitability for commercial production. Conducted research on the content of essential amino acids in the developed products showed a high balance of marinated semi-finished products from wild boar meat, and proved that a successful selection of components for marinating meat can positively affect the biological value of finished products. Thus, modern pickling methods, including the use of natural enzymes and organic acids, make it possible to create high-quality, safe and economically competitive pickled game semi-finished products. This opens up new opportunities for producers of meat products, contributing to the expansion of the assortment and satisfaction of the growing needs of consumers for healthy and organoleptically high-quality food.

Keywords: organic acids; kiwi; pickling; wild boar meat; experimental samples; semi-finished products; quality.

КРАФТОВІ ТЕХНОЛОГІЇ МАРИНУВАННЯ НАПІВФАБРИКАТІВ З М'ЯСА ДИКИХ ТВАРИН – ПОТЕНЦІАЛ РИНКУ ОРГАНІЧНИХ ПРОДУКТІВ В УКРАЇНІ

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Анотація

Сучасні підходи до розробки високоякісних маринованих напівфабрикатів з дичини базуються на розумінні хімічних та біохімічних процесів, що відбуваються під час маринування. Використання рослинних інгредієнтів з високим вмістом органічних кислот, таких як ківі, у технології маринування м'яса дичини дозволяє суттєво покращити структурно-механічні та смакові якості готових виробів. Оптимальні результати досягаються в ході маринування м'яса дикого кабана протягом 24–27 годин з використанням маринаду, що містить 20–30 % ківі, на що вказують результати дослідження виходу продукту після маринування, термічної обробки та органолептичної оцінки. Структурно-механічні дослідження свідчать про ефективність розроблених маринадів для покращення текстури та соковитості м'яса дичини, а також підкреслення його унікального смако-ароматичного профілю. Використання ферментованих розсолів з огірків та капусти в якості маринадів для дрібношматкових напівфабрикатів з м'яса дикого кабана зумовлює високі показники виходу готових виробів після теплової обробки, що підкреслює їх економічну придатність для комерційного виробництва. Дослідження вмісту незамінних амінокислот у розроблених продуктах показали високу збалансованість маринованих напівфабрикатів з м'яса дикого кабана та довели, що вдалий підбір компонентів для маринування м'яса здатен позитивно вплинути на біологічну цінність готових виробів.

Ключові слова: органічні кислоти; ківі; маринування; м'ясо дикого кабана; дослідні зразки; напівфабрикати, якість.

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Introduction

One of the most promising directions for expanding the range of meat products is the production of semi-finished products, which is dynamically developing in the conditions of the modern rhythm of life. An analysis of the world food structure shows a stable increase in the consumption of semi-finished products and fast food, among which marinated meat products occupy the first positions in the market [1]. A wide range of semi-finished products allows rational use of raw materials, fully satisfying the purchasing demand of various social strata of the population. The production of small pieces of semi-finished meat requires the solution of issues related to implementation, extension of shelf life and provision of stable indicators of their quality during storage [2].

The use of marinades gives traditional meat products a unique taste and aroma, making ready-made dishes more attractive to consumers, which allows creating various taste profiles thanks to the expansion of marinade technologies and marinating methods [3]. Marinating inevitably contributes to the preservation of meat quality, helps to ensure its juiciness and attractive texture for the consumer during long-term storage, slowing down microbial spoilage due to the content of natural preservatives, spices and organic acids [4].

Currently, in the meat sector of the food industry, there is a decrease in the production of meat from farm animals. This phenomenon is associated with the reduction of the livestock of large and small cattle, as well as pigs. Additional factors are the high cost of meat and meat products and the growing distrust of consumers in products obtained from industrially raised animals [5]. Consumers are raising concerns about the use of various chemical additives, antibiotics, growth promoters and hormones in livestock feed. This leads to an increase in demand for alternative sources of protein, such as plant-based meat substitutes and game meat products, and also stimulates the development of natural and organic farming methods [6].

Traditionally, in most countries of the world, meat products are made from beef, pork and poultry. However, this raw material is often inferior to the meat of wild animals, which has always been considered a healthy and chemically complete food. Wild animals eat natural food and instinctively choose the most necessary and useful of them. Many plants contain essential substances that accumulate in the meat of wild animals, enriching it with vitamins and minerals. In addition, wild animals live at a considerable distance from industrial zones and lead a mobile lifestyle, which positively affects the consistency of their meat – it is dense and contains a small amount of fat. Due to these factors, the meat of wild animals has high nutritional and dietary properties, which makes it a valuable source of protein for a healthy diet [7].

Analysis of livestock in Ukraine reflects complex dynamics and trends in the country's agriculture. At the end of the last decade, there was a significant decrease in the resources of traditional animal husbandry. In recent years, statistical data show that the number of wild animals in Ukraine shows a progressive increase. This mostly applies to hunting species, mainly wild boars. In Ukraine, wild boars were common inhabitants of the forests of Volhynia and Podillia as early as the 1930s. Currently, they are most common in the lowland areas of Western Ukraine, in particular in Zakarpattia, Chernivtsi, Lviv, and Ternopil regions. In the Odesa region, wild boars live in the floodplains of the Dnieper, and in smaller numbers they are also found in the Zhytomyr, Kirovohrad, Kyiv, Poltava, Cherkasy, and Sumy regions, which determines the feasibility of choosing this type of meat for further research.

The expansion of the assortment of marinated game semi-finished products corresponds to the modern trends of rational nutrition and the growing demand for natural products. Today, a wide range of new types of marinades, methods of their application, as well as ready-to-cook pickled semi-finished products are available on the world and Ukrainian markets. However, there is a need for further development of pickling technologies, aimed at extending the shelf life of products, increasing their output and improving organoleptic and technological characteristics. The development of new marinades will help increase the quality and competitiveness of meat products on the market, meeting the demands of modern consumers and meeting their expectations regarding the quality and safety of food products, both from traditional meat raw materials and from wild animal meat [8].

It is common knowledge that the composition of the marinade necessarily includes organic acids. Among food acids, acetic acid is the most well-known in the technology of meat products [9]. However, recently, studies on the use of food acids contained in vegetable and animal raw materials have become widespread [10]. This

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makes it possible to improve the pickling technology with the expansion of the range of pickled semi-finished products. The use of various organic acids, such as lactic, apple, lemon, wine, amber allows to improve the taste and sensory characteristics of products and to provide more variety in the choice of taste profiles of meat products [11]. These innovations contribute to meeting the needs of various categories of consumers, in particular those who are looking for convenient ways to prepare food with a large assortment of varieties, without losing the quality of ready meals and products.

The first marinades appeared in Ancient Rome and consisted of sea water, in which meat, fish and game were soaked to soften or add flavor. In Southern Europe, where winemaking was developed, vinegar from sour wine was used instead of salt. Various national cuisines, especially French and Eastern, have created complex marinades using spices: pepper, onion, garlic, cloves and cinnamon. Today there are hundreds of recipes for marinades, which are divided into two categories: for preparing meat, poultry and game before heat treatment and for fish, vegetables and mushrooms [12].

Marinating has been used in the meat industry for many decades, but this process is constantly being improved through careful selection of marinade ingredients, optimization of process control, and the introduction of modern technological approaches to improve the final quality characteristics of meat products. The use of the latest methods allows you to significantly preserve the useful properties of meat, improve its taste, texture and aroma, as well as extend the shelf life without loss of quality [13].

The use of fruit and berry crops in marinating meat is an innovative approach that opens up new opportunities for expanding the technology and assortment of high-quality meat products [14]. Thanks to the natural acidity of fruits and berries, marinades based on them effectively soften meat, preserving its juiciness and tenderness [15]. Such marinades expand the segment of healthy and natural food products, thanks to the content of a wide range of vitamins, minerals, phenolic compounds and antioxidants in the composition of fruit and berry raw materials [16]. Plant exogenous proteolytic enzymes, such as papain, bromelain and ficin, play a key role in the process of meat softening, which is extremely important in the production of game semi-finished products. Differences in the quality of ready-made marinated semi-finished products from different types of meat arise from the quantitative and qualitative variety of enzyme types in the selected fruit and berry raw materials [17]. For example, papain, one of the most common plant enzymes, is capable of actively cleaving both myofibrillar and connective tissue proteins, which allows for effective meat softening [18]. On the other hand, bromelain exhibits a more pronounced hydrolytic activity on collagen, which makes it especially useful for softening tough meat, such as game, improving its texture, taste, as well as methods and terms of heat treatment [19].

In addition, the introduction of the latest technologies in marinating meat includes the use of brines from fermented products, such as pickled cabbage and cucumbers. This approach not only gives the meat unique taste properties, but also provides numerous benefits for the health of consumers. Fermented products, thanks to the process of natural fermentation, are enriched with useful bacteria that support the health of intestinal microflora, increase immunity and promote better assimilation of nutrients [20]. For the meat processing industry, the use of such brines is an economically beneficial method of extending the shelf life of meat semi-finished products, replacing artificial preservatives or more expensive raw materials for pickling with brines, which are actually secondary products of processing vegetable raw materials - however, in the long-term fermentation process, natural enzymes and acids accumulate , which have unconditional prospects for their use as natural preservatives in the technology of meat products [21]. Thus, the introduction of this raw material into the recipes of marinades for meat products corresponds to modern trends in healthy nutrition and trends in sustainable, waste-free production [22].

Research material and methods

The development of the technology of marinated semi-finished products from wild boar meat required a new methodical approach to the study of not only the finished product, but also the raw materials. A comprehensive study of various pickling mixtures and pickled semi-finished products from wild boar meat allowed us to formulate an experimentally based idea about the formation of physico-chemical and functional-technological properties of the product.

Based on a systematic analytical approach, native raw materials for marinades were selected, as a result of which the optimal concentration of marinade components, meat: marinade ratio,

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duration of the marinating process were determined.

During the research, the following methods were used: generally accepted, organoleptic, physico-chemical, experimental-statistical, analytical.

For the production of experimental samples of marinated semi-finished products from wild boar meat, the marinade was prepared according to the selected recipes and the meat was kept in the marinade for 3–72 hours. The resulting pickled semi-finished products were used for further research. The finished samples were compared with the control sample «Shashlyk extra» according to «GOST 52675 – 2006 Semi-finished meat and meat-containing products», according to organoleptic, physico-chemical and structural-mechanical indicators.

The selection of samples of marinated semi-finished products from wild boar meat for further research and their preparation for analysis was carried out in accordance with the requirements of DSTU 4823:2007 «Meat products. Organoleptic assessment of quality indicators».

Results and their discussion

Marinating wild boar meat is an important stage in the process of making this delicacy. Wild boar has a specific taste and texture, which, with classic cooking methods, can be significantly different from the pork used by the general public [23]. Thus, a properly selected marinade not only helps to soften the meat, but also enriches it with unique taste and aroma properties. Pickling helps to neutralize the peculiar taste of game (natural bitterness) and the specific characteristic smell of game, giving meat products a touch of sophistication, thereby attracting consumers [24]. A well-chosen set of ingredients in the marinade helps reveal the best taste qualities of wild boar meat, emphasizing the uniqueness of this delicacy among traditional types of meat [25] (Fig. 1).

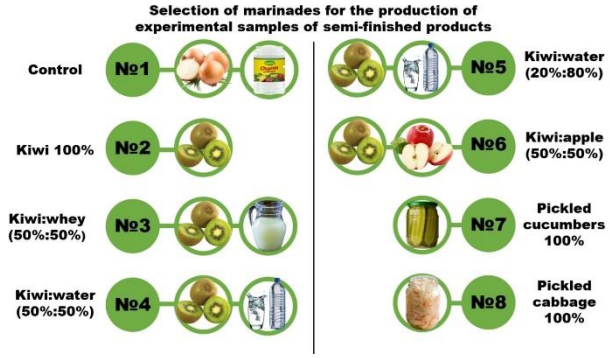

Fig. 1. Selection of components for marinating semi-finished products from wild boar meat

After the preparation of marinades according to the given recipes for the further production of semi-finished products from game, the initial acidity of the selected marinade mixtures was investigated (Fig. 2). According to the obtained data, it can be seen that the highest acidity is characteristic of sample №7 (pickle-based marinade from cucumbers), other marinades had identical pH values, at the level of 3.2–3.7. The lowest acidity is characteristic of the control sample - a marinade made according to a traditional recipe using acetic acid.

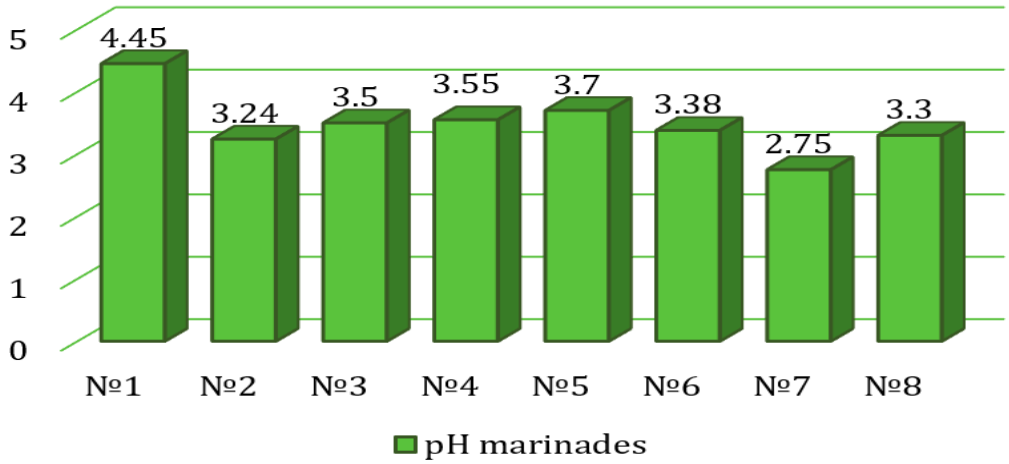

Fig. 2. Initial acidity of marinades before the start of marinating meat

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Selection of the optimal ratio of wild boar meat and marinade is an important stage for achieving the best taste and structural and mechanical properties of the finished product. That is why, in the course of the study, a comparison of meat semi-finished products marinated according to different ratios of meat: marinade was carried out. The obtained results (Table 1) prove that the 1 : 1 ratio is the best, so we choose it for the development of marinated semi-finished products from wild boar meat.

Table 1

Determination of the optimal ratio for marinating meat

Meat : marinade	Characteristic
1 : 0,1	It is impractical, since the marinade covers only the surface of the product and does not give the desired effect
1 : 0,25	It is impractical, since the marinade covers the lower part of the product, which does not give the desired effect
1 : 0,5	It is impractical, since the marinade covers half of the product, which does not give the desired effect
1 : 0,75	It is impractical, since the marinade does not completely cover the product, which does not give the desired effect
1 : 1	It is appropriate, since the marinade completely covers the product, which ensures uniform diffusion of the components of the pickling mixture into the product
1 : 2	It is impractical, as it excessively covers the product and leads to an increase in the cost of the product

At the next stage of the research, eight samples of pickled semi-finished products were developed (Fig. 3), using the selected pickling mixtures.

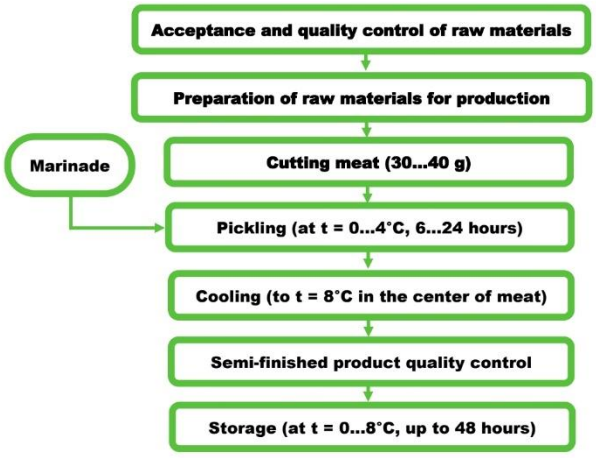

Fig. 3. Technological scheme of production of marinated meat semi-finished products

Determining the structural and mechanical characteristics of marinated game semi-finished products is an extremely important stage in ensuring the quality indicators of the finished product. Wild boar meat has unique properties that require careful analysis and control. Structural and mechanical assessment allows to determine the optimal marinating parameters that affect the texture, tenderness and juiciness of the meat. This not only helps to create a product with attractive organoleptic properties, but also ensures its safety and long shelf life.

All samples were marinated for 3 hours, according to the classic technology. The analysis was carried out both immediately after the end of pickling and after heat treatment. This made it possible to assess changes in the structural-mechanical and organoleptic properties of meat, to ensure the complex effect of marinating on the final quality of the product.

The duration of marinating can significantly change the weight of meat due to the absorption of liquid and its loss during heat treatment. We conducted a study of the yield of semi-finished products depending on the exposure time in the marinade (Fig. 4). Determining the optimal exposure time will help to find a balance between achieving the desired taste and texture characteristics and minimizing losses, which is important to ensure high quality of the finished product and profitability of production.

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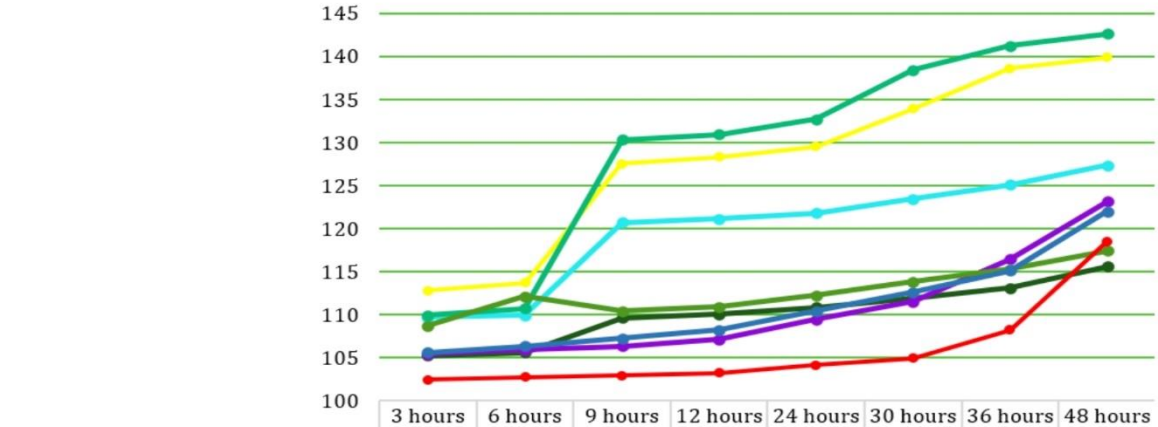

	3 hours	6 hours	9 hours	12 hours	24 hours	30 hours	36 hours	48 hours
№1 (control)	105.2	105.6	109.6	110	110.8	111.9	113.1	115.6
№2 (100 % kiwi)	109.7	109.9	120.7	121.1	121.8	123.4	125.1	127.3
№3 (50% kiwi : 50% whey)	112.8	113.7	127.5	128.3	129.5	133.9	138.6	139.9
№4 (50% kiwi : 50% water)	109.9	110.7	130.3	130.9	132.7	138.4	141.2	142.6
№5 (20% kiwi : 80% water)	105.4	105.9	106.3	107.1	109.4	111.5	116.4	123.1
№6 (50% kiwi : 50% apple)	108.7	112.1	110.4	110.9	112.2	113.8	115.3	117.4
№7 (100% pickled cucumbers)	102.4	102.7	102.9	103.2	104.1	104.9	108.2	118.5
№8 (100 % pickled cabbage)	105.6	106.3	107.2	108.2	110.4	112.6	115.1	122

Fig. 4. Yield of semi-finished products depending on the exposure time in the marinade, %

It can be seen from the presented data that the highest yield of semi-finished products was observed when marinating meat in the following ratios: 50 % kiwi and 50 % water (sample №4), 50 % kiwi and 50 % whey (sample №3), 100 % kiwi (sample №2), as well as 20 % kiwi and 80 % water (sample №5). These combinations ensured optimal absorption of the marinade by the meat, which contributed to an increase in the yield of the product.

At the next stage, a study was conducted to determine the acidity (pH value) of marinades and marinated game meat semi-finished products (Fig. 5, Fig. 6). Measuring pH allows you to assess the level of acidity, which affects the marinating process, in particular, the softening of meat, its saturation with flavor and aromatic substances from the marinade, and the reduction of microbial contamination during the storage of marinated semi-finished products.

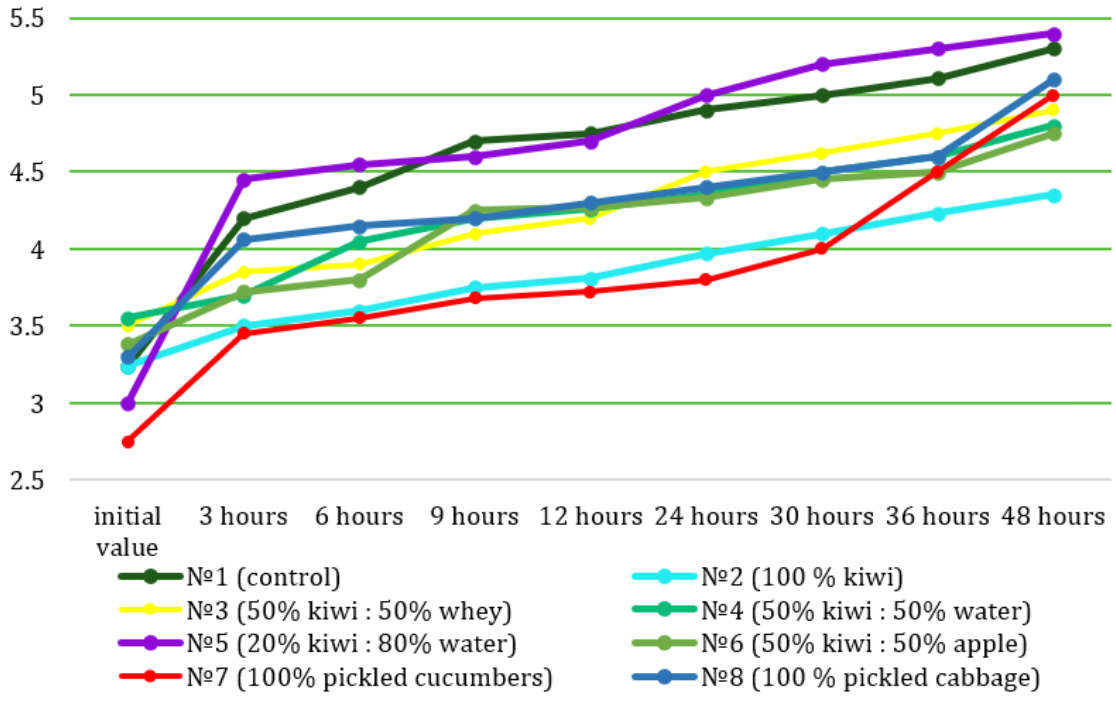

Fig. 5. Change in the pH of the marinade as a result of the marinating time

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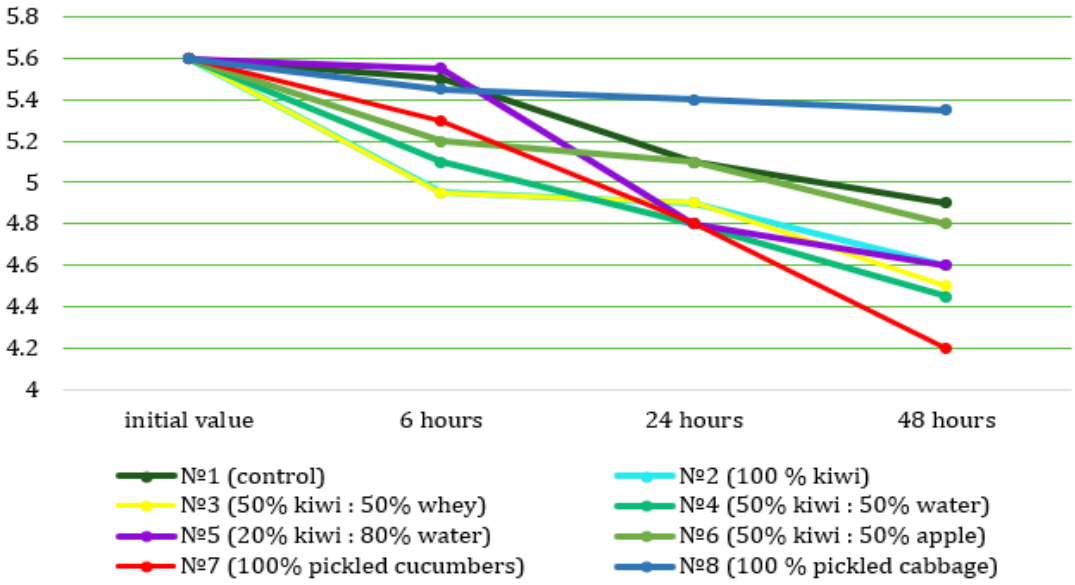

Fig.6. Change in the pH of wild boar meat during pickling

The obtained results indicate that the acidic environment, characteristic of all marinades, gradually changes to a more neutral one during the aging process with meat. This is explained by the diffusion exchange between the moisture contained in the meat and the marinade. Such an exchange is confirmed by a decrease in the pH level of the meat compared to the initial values. This process provides a more balanced acidity in the finished product, which contributes to the desired taste and texture characteristics.

The next stage was a study on the ultimate shear stress of marinated semi-finished products from wild boar meat (Fig. 7). This made it possible to determine how pickling affects the mechanical properties of meat, in particular, its strength and ability to deform.

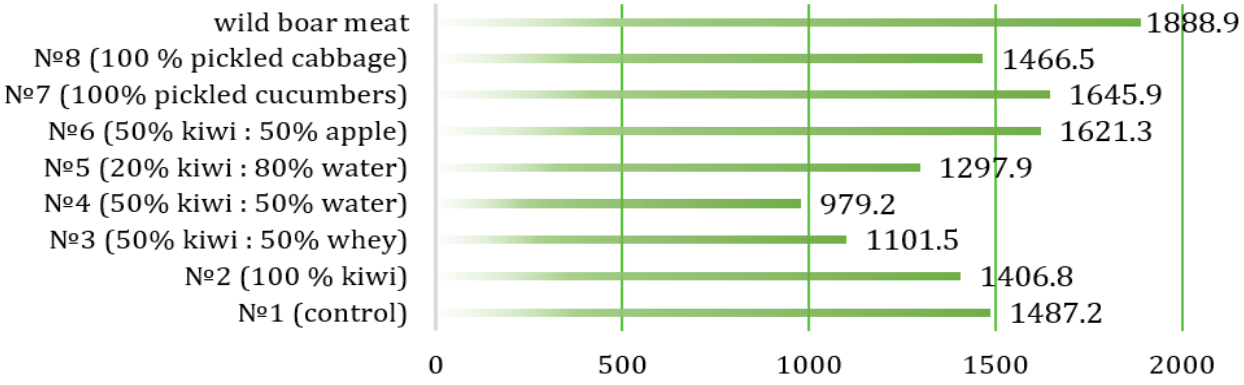

Fig. 7. The value of the ultimate shear stress for pickled semi-finished products, Pa

Ultimate shear stress characterizes the consistency of the product and the strength of the structure, marinating the meat for 48 hours gives the semi-finished product juiciness and tenderness, which proves the feasibility of marinating. In a marinade with a proportion of 50 % kiwi and 50 % water (sample №4), the meat becomes twice as tender compared to unmarinated meat and 35 % tenderer than the control sample. In addition, marinades in ratios of 50 % kiwi and 50 % whey (sample №3) and 20 % kiwi and 80 % water (sample №5) showed a high softening effect.

The next step was to conduct research on how different marinades and marinating conditions affect the yield of the product after cooking, since the yield of the finished product is an important indicator that reflects the effectiveness of marinating and the ability of meat to retain moisture and volume during heat treatment. The results of the study showed that the best yield of semi-finished products after heat treatment is characteristic of samples of kebabs marinated in pickles made of cucumbers and cabbage. This indicates the positive effect of enzymes on the preservation of moisture in meat during

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marinating, thereby obtaining a juicy product after cooking.

After that, an organoleptic evaluation of the prepared samples of marinated semi-finished products from wild boar meat was carried out (according to DSTU 4823:2007). As part of the study, the appearance, consistency, color, taste and aroma of the finished product were evaluated in order to find out its general suitability for consumption and sale (Fig. 8).

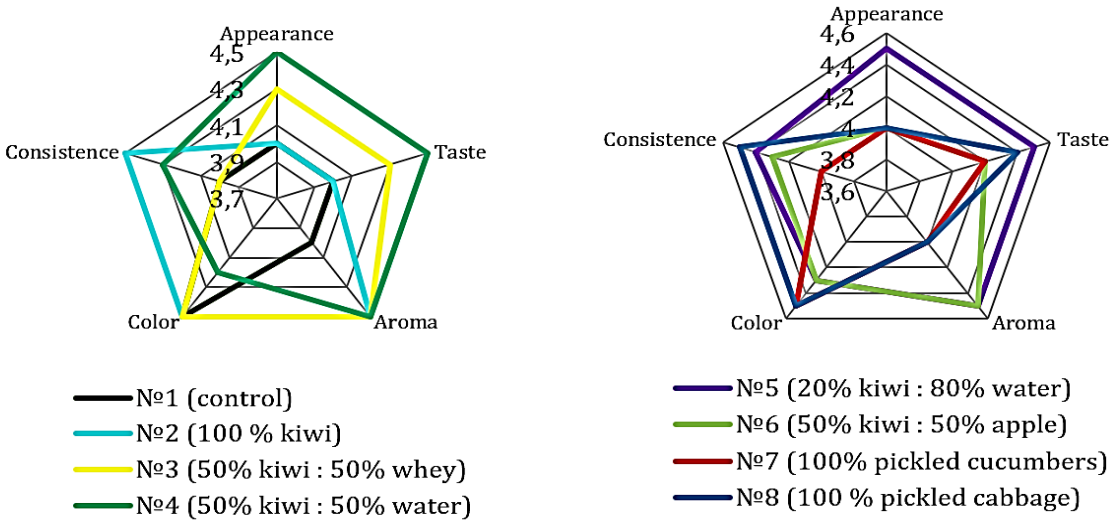

Fig. 8. Indicators of organoleptic evaluation of experimental samples

According to the results of the organoleptic evaluation, samples №3, 4 and 5, which contain kiwi in proportions of 50 % and 20 %, were the best. These studies confirmed that the meat, which was treated with marinades with the addition of kiwi juice or puree, has the most optimal quality characteristics. Thus, further research was conducted using a marinade that included kiwi both in boiled and fresh form.

Different varieties of kiwi were used to make marinades, including Actinidia grown in Crimea, Spain and Chile, as these species are available for purchase and use within Ukraine. For a detailed study of the effect of these marinades on organoleptic and structural-mechanical indicators, wild boar meat was marinated using kiwifruit of different ripeness. Research results have shown that the ripe kiwi has the best properties for softening meat, which is especially important when making semi-finished game products. This confirmed the effectiveness of ripe kiwifruit in improving the texture and taste of wild boar meat products.

The optimal pickling time was established based on the results of organoleptic and structural-mechanical assessment of pickled semi-finished products and products after heat treatment. The study included exposures lasting 3, 6, 21, 24, 27, 48 and 72 hours from the moment of pickling (Fig. 9). These data made it possible to determine the optimal time required to achieve the best quality and taste characteristics of the finished product after heat treatment.

According to the graph, it can be seen that the best indicators of the yield of finished products were observed after 24–27 hours of marinating, and according to the organoleptic evaluation, sample №3, which contains a marinade of 20 % kiwi and 80 % water, was the best. The highest product yield was recorded for the control sample and the sample with heat-treated kiwi, which were 69 % and 65 %, respectively.

Next, the ultimate shear stresses were determined for marinated semi-finished products and ready-to-eat kebabs from wild boar meat, comparing the effect of marinating time on the structural and mechanical properties of the products (Fig. 10, Fig. 11, Fig. 12).

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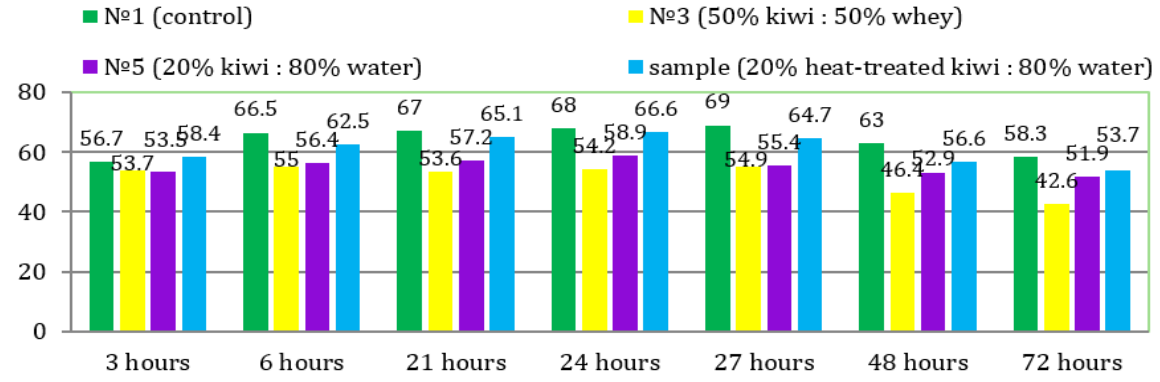

Fig.9. Output of finished products after heat treatment depending on the time of pickling

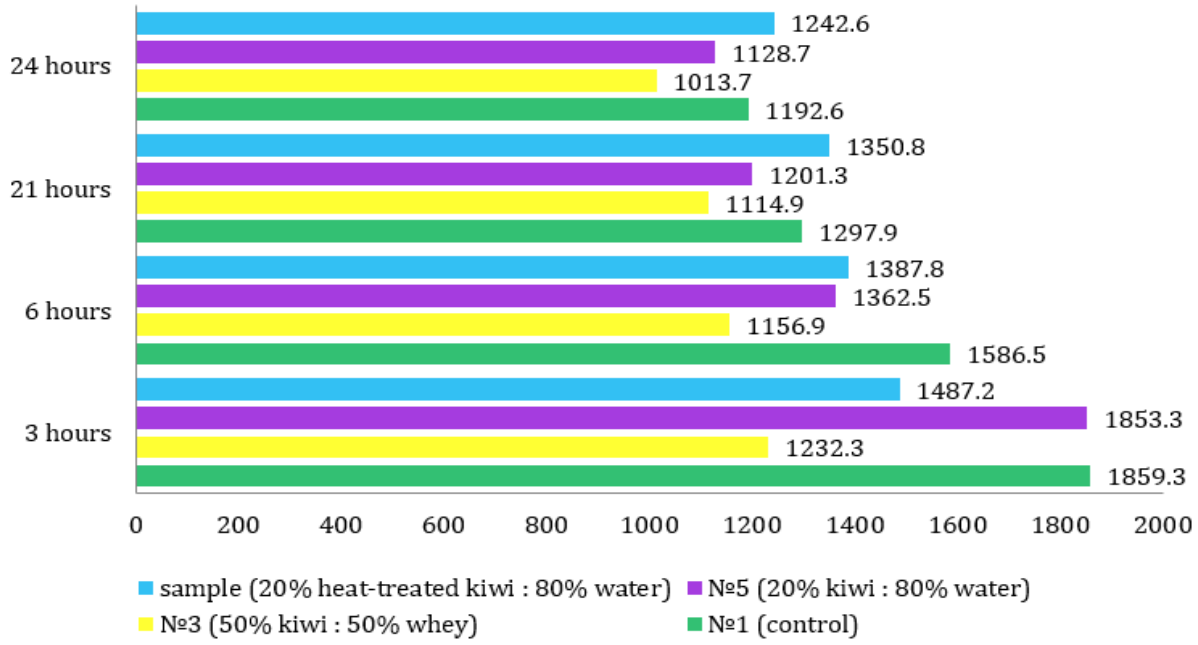

Fig. 10. Ultimate shear stress of semi-finished products after pickling (3–24 hours), Pa

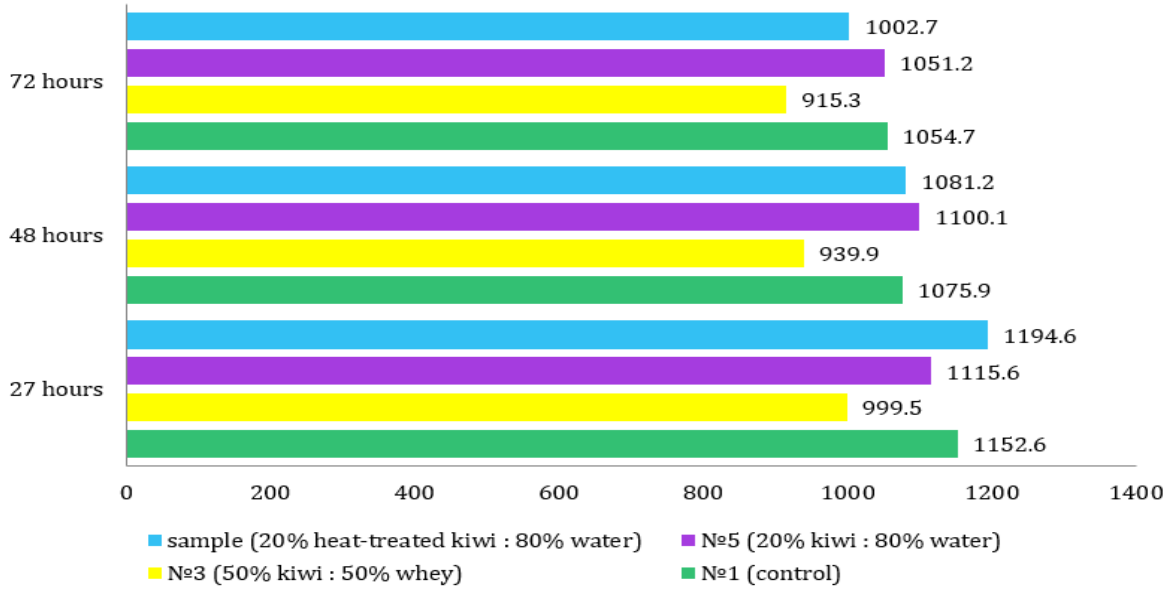

Fig. 11. Ultimate shear stress of semi-finished products after pickling (27–72 hours), Pa

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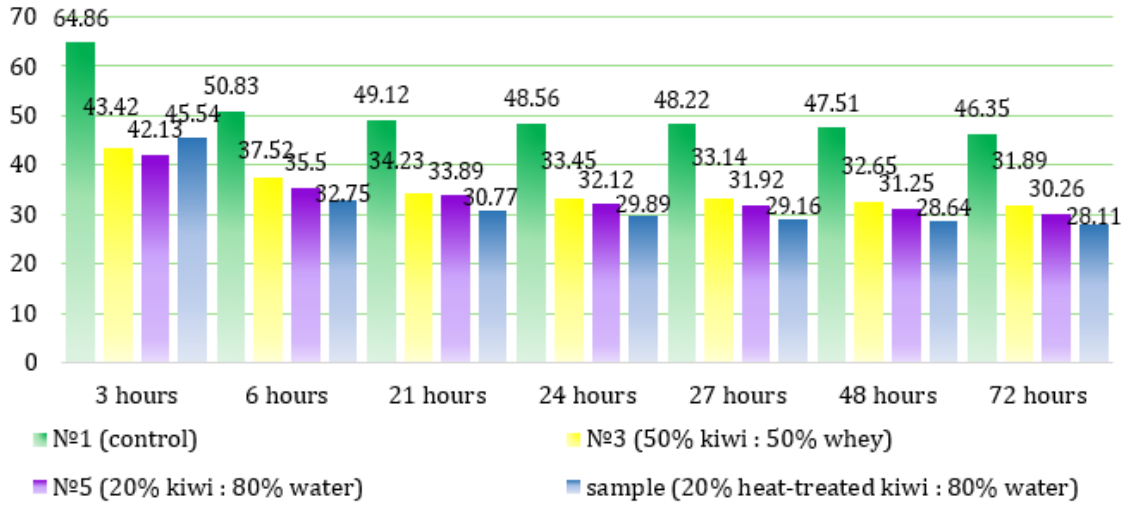

Fig. 12. Ultimate shear stress of products after heat treatment, kPa

It can be seen from the figure that the ultimate shear stress of semi-finished products gradually decreases with increasing duration of exposure to the components of the pickling mixture. The most pronounced softening effect is observed in samples that were marinated in a marinade with a ratio of 50 % kiwi and 50 % whey (sample №3), as well as with a marinade in which 20 % of the kiwi was pre-heated, and the rest consisted of water.

According to the general results of the study, the optimal concentration of kiwi in the pickling mixture for semi-finished products from wild boar meat was determined, the results are shown in Table 2.

Table 2

Determining the optimal concentration of kiwifruit for marinating small pieces of meat semi-finished products

Kiwi concentration in the marinade,%	Yield of the product after pickling	Characteristics of the finished product
10	108.8	The pickling effect is not pronounced enough
20	111.8	The pickling effect is sufficient, the product is tender and soft
30	112.2	The pickling effect is sufficient
50	113.2	The marinating effect is sufficient, but the meat has a slight flouriness
100	121.8	The effect of marinating is too pronounced – the meat has a mealy texture

According to organoleptic indicators, the best results were observed in samples with kiwi content in the marinade at the level of 20–30 %. Since one of the main goals was to reduce costs and maximize the yield of the finished product, studies have shown that the most appropriate concentration of kiwi for marinating small pieces of semi-finished meat is 20 % of both fresh kiwi and cooked puree.

Since the main component of meat products is protein, and its quality is determined by the balance of the amino acid composition, we therefore conducted a study of the amino acid rate (the content of essential amino acids in the product) for samples with the best organoleptic indicators (table 3).

Table 3

The content of essential amino acids in experimental samples of marinated semi-finished products from wild boar meat

Amino acid	FAO/WHO g/100 g of protein (2011)	Sample №1 (control)		Sample №3 (50% kiwi : 50% whey)		Sample №5 (20% kiwi : 80% water)	
		g/100 g	Amino acid rate, %	g/100 g	Amino acid rate	g/100 g	Amino acid rate
Valine	4.0	3.64	91.0	3.74	93.5	3.70	92.5
Isoleucine	3.0	3.84	128.0	3.93	131.0	3.90	130.0
Leucine	6.1	6.48	106.2	6.61	108.4	6.54	107.2

Continue from Table 3

Lysine	4.8	5.92	123.4	6.05	126.1	5.98	124.6
Methionine+ cystine	2.3	1.77	77.0	1.85	80.4	1.82	79.1
Threonine	2.5	4.17	166.8	4.27	170.8	4.22	168.8
Tryptophan	1.0	1.03	103.0	1.07	107.0	1.05	105.0
Phenylalanine+ tyrosine	4.1	2.71	66.1	2.83	69.0	2.79	68.1
Biological value, %		87.4		87.3		87.4	
Coefficient of imbalance of amino acid composition		62.2		63.2		63.1	
Coefficient of imbalance of amino acid composition		12.6		12.7		12.6	
Index of essential amino acids		1.04		1.07		1.05	

The results of the study of the amino acid composition of the developed wild boar meat products showed that the research samples have a high biological value and balance of essential amino acids in comparison with the protein standard according to FAO/WHO (2011). Among the pickled semi-finished products, sample №3 (50 % kiwi : 50 % whey) has the highest values, since the amino acids contained in the milk whey additionally affected the general indicators of protein balance. Thus, the results prove that marinated semi-finished products from wild boar meat are high-value products, both in terms of organoleptic and structural-mechanical indicators, respectively, in terms of biological value – in terms of the content of essential amino acids.

One of the criteria for evaluating the quality of food products is the microbiological state of the product, that is, the presence of general and pathogenic microflora. Studies of the developed marinated semi-finished products from wild boar meat have shown that when the control and experimental samples are stored at a temperature of 0–8 °C, for 24–48 hours, the microbiological indicators correspond to the norm and indicate the safety of using the manufactured meat products.

Conclusions

Marinating has been used in the meat industry for many decades, but this process is constantly being improved due to the careful selection of ingredients for the preparation of the marinade, optimization of process control and the introduction of modern technological approaches to improve the quality characteristics of the final meat products. The use of the latest methods allows you to preserve more useful properties of meat, improve its taste, texture and aroma, as well as extend the shelf life without losing quality. Wild animals eat natural feed rich in useful substances that accumulate in their meat, enriching it with vitamins and minerals. In addition, they live far from industrial zones and lead an active lifestyle, which positively affects the consistency of their meat, which is dense and contains a small amount of fat. Due to these factors, the meat of wild animals has high nutritional and dietary properties, which makes it a valuable source of protein for a healthy diet.

The use of vegetable ingredients with a high content of organic acids, such as kiwi, in the technology of marinating game meat, allows you to significantly improve the textural and taste qualities of the finished products. Conducted studies indicate that optimal results are achieved when marinating wild boar meat for 24–27 hours using a marinade containing 20–30 % kiwi.

According to the structural and mechanical indicators, the appropriateness and effectiveness of the developed pickling mixtures have been established, which improve the texture, tenderness, juiciness, giving piquancy to wild boar meat, emphasizing its unique taste and aroma profile. The use of fermented pickles from cucumbers and cabbage as marinades for small pieces of semi-finished products from wild boar meat is characterized by higher than other pickling mixtures, indicators of the yield of finished products after heat treatment, which emphasizes their economic feasibility for commercial production in the food industry or restaurant production. Analysis of the content of essential amino acids in the developed products showed a high protein balance of marinated semi-finished products from wild boar meat, confirming that well-chosen pickling components have a positive effect on the biological value of the finished products. In addition, the marinades developed during the research have further prospects for their use in the technology of marinating meat of other species of wild animals, for example, rabbits, venison, roe deer, etc. This can become a strong basis for the expansion of the

market for game meat products, which today are very popular between the foreign consumers, thanks to their unique taste and desire for organic. The results of the obtained studies prove that modern pickling methods, the use of organic acids and enzymes, allow creating high-quality, safe and economically profitable pickled semi-finished products, both from traditional types of meat and game.

References

[1] Zavistanaviciute, P., Klementaviciute, J., Klupsaite, D., Zokaityte, E., Ruzauskas, M., Buckiuniene, V., Viskelis, P., Bartkiene, E. (2023). Effects of Marinades Prepared from Food Industry By-Products on Quality and Biosafety Parameters of Lamb Meat. *Foods*, *12*, 1391. https://doi.org/10.3390/foods12071391

[2] Peshuk, L., Kyrylov, Y., Shtyk, I., Chernushenko, O. (2022). Technology of marined game semi-finished meat with an accent of elegance and functionality. *Journal of Chemistry and Technologies*, *30*(4), 639–651. https://doi.org/10.15421/jchemtech.v30i4.268176

[3] Peshuk, L. V., Prykhodko, D. Y., Shtyk, I. I. (2024). [The influence of coffee marinade on the optimization of quality indicators of semi-finished game meat]. *Taurida Scientific Herald. Series: Technical Sciences*, (5), 131–139 (in Ukrainian). https://doi.org/10.32782/tnv-tech.2023.5.15

[4] Latoch, A., Czarniecka-Skubina, E., Moczkowska-Wyrwisz, M. (2023). Marinades Based on Natural Ingredients as a Way to Improve the Quality and Shelf Life of Meat: A Review. *Foods*, *12*(19), 3638. https://doi.org/10.3390/foods12193638

[5] Font-i-Furnols, M. (2023). Meat Consumption, Sustainability and Alternatives: An Overview of Motives and Barriers. *Foods*, *12,* 2144. https://doi.org/10.3390/foods12112144

[6] Czarniecka-Skubina, E., Stasiak, D. M., Latoch, A., Owczarek, T., Hamulka, J. (2022). Consumers' Perception and Preference for the Consumption of Wild Game Meat among Adults in Poland. *Foods*, *11*(6), 830. https://doi.org/10.3390/foods11060830

[7] Niewiadomska, K., Kosicka-Gębska, M., Gębski, J., Gutkowska, K., Jeżewska-Zychowicz, M., Sułek, M. (2020). Game Meat Consumption—Conscious Choice or Just a Game? *Foods*, 9, 1357. https://doi.org/10.3390/foods9101357

[8] Tkacz, K., Modzelewska-Kapituła, M. (2022). Marinating and Grilling as Methods of Sensory Enhancement of Sous Vide Beef from Holstein-Friesian Bulls. *Applied Sciences*, *12*(20), 10411. https://doi.org/10.3390/app122010411

[9] Syed Md Ehsanur, R., Sharmeen, I., Junyu, P., Dewei, K., Qian, X., Qijing, D., Yongxin, Y., Jun Wang, Deog-Hwan, O., Rongwei, H. (2023). Marination ingredients on meat quality and safety – a review. *Food Quality and Safety*, 7, 1–17. https://doi.org/10.1093/fqsafe/fyad027

[10] 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]. *Naukovij visnik LNUVMBT im. Gzhickogo, Scientific Bulletin of LNUVMBT named after Gzhitskyi*, Vol.16, 2(59), 164–169 (in Ukrainian).

[11] Birk, T., Gronlund, A., Christensen, B., Knöchel, S., Lohse, K., Rosenquist, H. (2010). Effect of Organic Acids and Marination Ingredients on the Survival of Campylobacter jejuni on Meat. *Journal of food protection*, 73, 258–265. https://doi.org/10.4315/0362-028X-73.2.258

[12] Vişan, V. G., Chiș, M. S., Păucean, A., Mureșan, V., Pușcaș, A., Stan, L., Vodnar, D. C., Dulf, F. V., Țibulcă, D., Vlaic, B. A., Rusu, I. E., Kadar, C. B., Vlaic, A. (2021). Influence of Marination with Aromatic Herbs and Cold Pressed Oils on Black Angus Beef Meat. *Foods*, *10*(9), 2012. https://doi.org/10.3390/foods10092012

[13] Meneses, R., Teixeira, P. (2022). Marination as a Hurdle to Microbial Pathogens and Spoilers in Poultry Meat Products: A Brief Review. *Applied Sciences*, *12*, 11774. https://doi.org/10.3390/app122211774

[14] Sengun, I. Y., Turp, G. Y., Cicek, S. N., Avci, T., Ozturk, B., Kilic, G. (2021). Assessment of the effect of marination with organic fruit vinegars on safety and quality of beef. *International Journal of Food Microbiology*, *336*, 108904. https://doi.org/10.1016/j.ijfoodmicro.2020.108904

[15] Klementaviciute, J., Zavistanaviciute, P., Klupsaite, D., Rocha, J. M., Gruzauskas, R., Viskelis, P., El Aouad, N., Bartkiene, E. (2024). Valorization of Dairy and Fruit/Berry Industry By-Products to Sustainable Marinades for Broilers' Wooden Breast Meat Quality Improvement. *Foods*, 13, 1367. https://doi.org/10.3390/foods13091367

[16] Simonova, I., Peshuk, L. (2023). Organic acids of berry raw materials in the physiology of human nutrition. *International scientific journal grail of science*, *25*, 163–168. https://doi.org/10.36074/grail-of-science.17.03.2023.026

[17] Bekhit, A. A., Hopkins, D. L., Geesink, G., Franks, P. (2014). Exogenous proteases for meat tenderization. Crit. Rev. *Food Science & Nutrition*, *54*, 1012–1031. https://doi.org/10.1080/10408398.2011.623247

[18] Barekat, S., Soltanizadeh, N. (2017). Improvement of meat tenderness by simultaneous application of high-intensity ultrasonic radiation and papain treatment. I*nnovative Food Science & Emerging Technologies*, *39*, 223–229. https://doi.org/10.1016/j.ifset.2016.12.009

[19] Shin, H., Kim, H. T., Choi, M. J., Ko, E. Y. (2019). Effects of Bromelain and Double Emulsion on the Physicochemical Properties of Pork Loin. *Food Science of Animal Resources*, 39(6), 888–902. https://doi.org/10.5851/kosfa.2019.e70

[20] Tan, X., Cui, F., Wang, D., Lv, X., Li, X., Li, J. (2024). Fermented Vegetables: Health Benefits, Defects, and Current Technological Solutions. *Foods*, *13*, 38. https://doi.org/10.3390/foods13010038

[21] Jinap, S., Hasnol, N., Sanny, M., Jahurul, M. (2018). Effect of organic acid ingredients in marinades containing different types of sugar on the formation of heterocyclic amines in grilled chicken. *Food Control*, *84*, 478–484. https://doi.org/10.1016/j.foodcont.2017.08.025

[22] Herman, A., Matulewicz, O., Korzeniowska, E., Herman, A. P. (2024). Determination of Post-Fermentation Waste from Fermented Vegetables as Potential Substitutes or Preservatives in o/w Emulsion. *International Journal of Molecular Sciences*, 25, 5510. https://doi.org/10.3390/ijms25105510

[23] Peshuk, L. V., Yancheva, M. O., Haschuk, O. I., Kyrychenko, S. G. (2017). [Technology of meat products from non-traditional meat raw materials. Textbook]. Center for Educational Literature", Kyiv. (in Ukrainian).

[24] Peshuk, L. V., Shtyk, I. I., Kryvobyk, R. A., Novikova, N. V. (2023). [Safety and quality of meat and meat products.

Production control in the context of HACCP: training. manual for universities]. Odesa: Oldi+. (in Ukrainian).

[25] Peshuk, L. V., Ishchenko, V. M., Shtyk, I. I., Ivanova, T. M. (2016). [Prescription composition of semi-finished small-piece chilled wild boar meat: pat. for the invention 110564 of Ukraine IPC A 23 L 1/31]. Applicant and the patent owner of the NUHT – №a 201409764, application 05.09.14, publ. 12.01.16,. Bul. №1. 4 p. (in Ukrainian).