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BIOCHEMICAL, FUNCTIONAL, AND TECHNOLOGICAL EVALUATION OF WILD BOAR MEAT PREPARED BY DIFFERENT CULINARY METHODS

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Abstract

Aim. The purpose of the work is to study the functional, technological, and culinary properties of wild boar meat and to establish the influence of different heat treatment methods on sensory parameters and product yield. Methods. The study focused on wild boar meat obtained through traditional hunting in the hunting grounds of the Sumy region, Ukraine. Results. The protein content was 21.56–22.68 %, fat – 2.25–2.64 %, which affected the energy value of the meat: 112–118 kcal/100 g. It was found that the meat of female wild boars under the age of one year has a slightly lower nutritional value (112 kcal/100 g) compared to the meat of males, which is due to the lower protein and fat content and higher moisture content. When comparing the functional and technological parameters of raw meat between male and female wild boar, no significant differences were found, indicating a lack of special strategies for processing or marketing meat of animals of different sexes. Cooking wild boar meat by frying (180 °C for 5–10 min) proved to be the most effective heat treatment method for preserving optimal quality characteristics, particularly in terms of sensory and textural characteristics preferred by consumers. Conclusion. Based on the results of the study of the functional, technological, and culinary properties of wild boar meat of both sexes and the establishment of the influence of various heat treatment methods on sensory indicators and losses during cooking, it can be concluded that wild boar meat has high nutritional value, sufficient functional indicators, and has a favorable sensory assessment during culinary processing.

Keywords: wild boar meat; functional properties; culinary processing; cooking methods.

БІОХІМІЧНА, ФУНКЦІОНАЛЬНА ТА ТЕХНОЛОГІЧНА ОЦІНКА М'ЯСА ДИКОГО КАБАНА, ПРИГОТОВАНОГО РІЗНИМИ КУЛІНАРНИМИ МЕТОДАМИ

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Анотація

Мета роботи – дослідити функціональні, технологічні та кулінарні властивості м’яса дикого кабана та визначити вплив різних методів термічної обробки на органолептичні показники та вихід продукту. Дослідження проводили на м’ясі дикого кабана, здобутому в результаті традиційного полювання на мисливських угіддях Сумської області, Україна. Вміст білка становив 21.56–22.68 %, жиру – 2.25–2.64 %, що вплинуло на енергетичну цінність м’яса: 112–118 ккал/100 г. Встановлено, що м’ясо самок дикого кабана віком до одного року має дещо нижчу харчову цінність (112 ккал/100 г) порівняно з м’ясом самців, що зумовлено нижчим вмістом білка та жиру й вищим вмістом вологи. Порівняння функціональних та технологічних параметрів сирого м’яса самців та самок дикого кабана істотних відмінностей не виявило, що вказує на відсутність особливих стратегій щодо переробки чи збуту м’яса тварин різної статі. Приготування м’яса дикого кабана смаженням (180 °С, 5–10 хв) виявилося найкращим методом термічної обробки для збереження оптимальних якісних характеристик, зокрема щодо органолептичних та текстурних властивостей, що є пріоритетними для споживачів. На основі результатів дослідження функціональних, технологічних та кулінарних властивостей м’яса дикого кабана обох статей та встановлення впливу різних методів термічної обробки на органолептичні показники та втрати під час приготування можна зробити висновок, що м’ясо дикого кабана має високу харчову цінність, достатні функціональні показники та отримує позитивну органолептичну оцінку під час кулінарної обробки.

Ключові слова: м’ясо дикого кабана; функціональні властивості; кулінарна обробка; методи приготування.

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Introduction

In recent years, game meat has increasingly been recognized as a prestigious and refined food product, serving as a high-quality alternative to conventional farm animal meat, as evidenced by numerous scientific studies.

According to a survey [1] on the frequency and popularity of different types of meat among consumers, it was found that 5 % of respondents considered game to be the most popular type of meat, and 6 % indicated it as the most frequently consumed. However, the game market is still difficult for consumers to access, generally only in fine restaurants.

Game meat is considered a valuable product due to its high digestibility, which is attributed to its low-fat content and high levels of complete proteins, vitamins, and certain minerals, particularly calcium, iron, and phosphorus. Compared to farmed animal meat, game meat is characterized by a darker color, less tenderness [2–3], and a higher content of proteins and extractives, which give it a characteristic taste and aroma [4–5]. However, it is well known that significant climatic differences between hunting regions affect the functional-technological and sensory properties of harvested game meat, as well as its microbiological safety [6–7].

The processes of obtaining and utilizing game meat remain insufficiently studied, as confirmed by several systematic reviews [8–9]. Among the positive aspects is the proven potential [10] to manage wild animal populations for ensuring the availability of game meat as a prospective contribution to food security. At the same time, several challenges remain, particularly those related to the safe integration of high-quality game meat into the commercial market and the development of a reliable and profitable production chain.

Numerous questions arise regarding hunting methods and the quality of the resulting game meat. Research [11–12] has confirmed that various hunting practices, which cause stress and intense physical exertion before death, negatively affect meat quality, particularly its pH value. Typically, an elevated meat pH is observed due to glycogen depletion, leading to the occurrence of DFD (dark, firm, dry) meat. As a result, the product becomes hard, dry, and dark, making it less appealing to consumers; moreover, such meat tends to spoil more rapidly.

According to several researchers [13–14], more detailed studies are needed to assess the potential impact of hunting methods, particularly in the case of wild boar meat, on its technological and consumer properties. Further evaluation is also required for other quality parameters, such as water-holding capacity and moisture loss during different stages of thermal processing [15].

The wild boar is one of the most widespread large mammals, with populations showing a tendency to increase both in Ukraine and EU countries according to [16–17]. This trend contributes to the growing availability of wild boar meat for both domestic consumption and industrial use [18].

Different cooking methods of wild boar meat can alter its sensory perception due to variations in juiciness and tenderness, which are critical factors in consumer evaluation of meat quality. Several studies [19–20] examining the effects of cooking methods (boiling, grilling, and sous vide) on the texture and sensory characteristics of wild boar meat have demonstrated the potential for adapting game meat to consumer acceptance and enhancing the eating experience. This, in turn, opens up opportunities for the production of more economically viable organic food products, but requires a more detailed study of the technological and culinary characteristics of wild boar meat hunted in different geographical areas.

During meat processing, structural modifications occur to varying extents, depending on the applied time–temperature parameters and technological treatments. Heat exposure, in particular, induces pronounced alterations in the principal protein fractions, primarily manifested through denaturation, amino acid oxidation, and aggregation [21–22].

Meat and meat products are considered cooked if an internal temperature of 65–70 °C is maintained for 10 minutes, which is accompanied by protein coagulation and a tenderizing effect of the meat due to partial hydrolysis of collagen [23]. According to Choi et al. [24], prolonged heat treatment of meat at temperatures above 80 °C can cause an off-flavor, resulting from complex physicochemical processes in muscle tissue. Enhanced moisture retention during cooking contributes to a juicier texture and a more pleasant sensory experience for the consumer. On the other hand, when tough meat is cooked, it becomes hard, dry, and less tasty, which makes chewing and digestion difficult. Hardness and dryness occur due to significant fluid loss during the cooking of tough meat.

Rapid cooking of meat in a microwave oven results in a reduction of flavor and aroma in the final product, which is associated with the lack of non-enzymatic browning reactions, such as those involved in the Maillard reaction, according to [25–26]. During rapid heating, many volatile compounds remain in the food matrix without the opportunity to manifest themselves.

This study aimed to evaluate the effects of different cooking methods for wild boar meat – namely boiling, grilling, and microwaving – on the texture, sensory attributes, and yield of the final product.

Materials and methods

Sample Collection

The material used in the experiment consisted of muscle tissue cuts obtained from the carcasses of both female and male wild boars, hunted using traditional methods in the game management areas of the Polissya region of Ukraine, specifically in the Sumy Oblast. The animals were approximately 9–10 months old, with a live weight of 36–38 kg.

Muscle tissue cuts weighing 300–350 g each were taken from the inner part of the hind leg (ham) and the longissimus dorsi muscle. These cuts were then further processed into 2-cm-thick steaks weighing 150 g each, as well as into patties for burgers (Fig. 1.).

Wild boar meat is tougher than regular pork and may have a specific taste, so it is advisable to soak it in a marinade, brine, weak (2 %) vinegar solution or whey. To prepare marinades, Joshta fruits (from German Johannisbeere - currant and German Stachelbeere - gooseberry) were used, which have a sweet and sour taste, with a pleasant nutmeg flavor. On the day of the experiment, the berries were squeezed to extract juice using a household juicer (Tefal Easy Fruit ZE610D38, China, 800 W). The resulting juice was filtered through two layers of gauze and used to prepare a marinade. In order to disinfect pathogenic microflora, the squeezed juice was pasteurized at a temperature of 80 °C for 10 minutes. Marinades were prepared by mixing juice, water, and salt (in a ratio of 60 : 37 : 3 %). The source of sodium chloride was first-grind sea salt manufactured in accordance with TU U 82.9 -345607700-002:2021. Before use, the marinades were cooled to 4°C. Marinating was carried out by immersion for 24 hours, in a ratio of 1 : 1 (meat: marinade) at an ambient temperature of 2–4 °C.

To make burger cutlets, we used muscle tissue from the inner part of the ham, which was ground using a Moulinex HV3 ME307832 household meat grinder with a grate hole diameter of 2–3 mm. 2 % table salt and 0.06 % black pepper were added to the minced meat. The finished minced meat was shaped into patties with a diameter of 100–110 mm and a weight of 85–90 g each. The thickness of the patties was 15 mm.

a b

Fig. 1. Samples of meat used in the experiment: a – portioned semi-finished products (steak); b- semi-finished products from chopped meat (burgers).

Muscle tissue samples were analyzed for their chemical composition, functional and technological properties, and culinary properties after heat treatment [27–30]. In all cases, tissue samples were collected during slaughter and processing. Physicochemical analyses were performed in triplicate in each experiment.

The effects of various cooking methods on the sensory and technological characteristics of cooked products were investigated across three experimental variants.

Table 1 provides information about the cooking methods.

For microwave cooking, samples (portioned semi-finished products – steaks; semi-finished products from minced mass – burger patties) were placed in a ceramic container at the center of the carousel in a Whirlpool microwave oven (EMEA, Wrocław, Poland). Cook for 4 min on each side in a microwave oven until an internal temperature of 75 °C.

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Table 1

Cooking process of cooked portioned semi-finished products (steaks) and semi-finished products from chopped meat (burger cutlets).

Cooking methods	Cooking time (min)	Addition ingredient	Cooking equipment
Frying with oil	6–8	Sunflower oil 5 ml	Electric frying pan with thermostat and fixed heating (PP 3401, Clatronic, China)
Frying on an electric grill	8	-	Induction range Electric folding grill with thermostat (Multigrill, Silex, Germany)
Microwave cooking	4×2	-	Whirlpool microwave oven (EMEA, Wrocław, Poland).

Losses during cooking were calculated as weight loss divided by the initial weight, expressed as a percentage. After heating, the samples were blotted with a paper towel and weighed to determine the cook loss. It is calculated by measuring the weight of a sample before and after cooking and inputting the measurements into the following equation.

$$\text{Cooking loss (\%)} = \frac{Wr - Wc}{Wr} \times 100, \quad (1)$$

where Wr – weight before cooking, g;
Wc – weight after cooking, g.

The mass changes were expressed as a percentage of the initial mass [31].

The sensory properties of products prepared by various heat treatment methods were evaluated on a five-point scale by 11 tasters, considering appearance, texture, taste, juiciness, aroma, and color [32].

Determination of moisture content

Moisture content was determined using the gravimetric method [33]. A glass container was filled with sand at 2–3 times the weight of the product, a glass rod was added, and the container was dried in a drying oven at (150 ± 2) °C for 30 minutes. The container was then cooled to room temperature in a desiccator and weighed. A 3 g portion of the minced meat sample was subsequently added to the container with sand, mixed thoroughly using the glass rod, and dried in an open container in the drying oven at (150± 2) °C for 1 hour. After cooling to room temperature in a desiccator, the container was weighed again. Moisture content was calculated from the difference in weight before and after drying and expressed as a percentage.

Determination of raw protein content

Protein content of meat and cooked products was determined using the Kjeldahl method [34]. 5 g of sample were mixed with 20 ml of concentrated sulfuric acid and 8 g of catalyst, and heated at 350 °C for 30 minutes. The mineralized sample was then neutralized with 33 % NaOH and steam-distilled. The resulting distillate was titrated with 0.01 N sulfuric acid using Tashiro indicator to determine the nitrogen content, from which protein content was calculated.

Determination of raw fat content

Fat content of meat and cooked products was determined using the Soxhlet method [27]. Four grams of the dried sample, placed in a paper cartridge, were loaded into the extraction flask of a Soxhlet apparatus (Simax, Czech Republic). Petroleum ether (boiling point 45 °C) was used as the extraction solvent. After several extraction cycles, the cartridge was dried to a constant weight. The difference between the initial and final weight was used to calculate the fat content as a percentage.

Determination of ash content

The mass fraction of mineral substances of meat was determined using the dry ash method. Porcelain crucibles were first pre-calcined in a muffle furnace (MLW, Germany) at 520 °C for 1 hour and cooled in a desiccator. A 1 g portion of minced meat was then weighed, placed in a crucible, and ashed in the muffle furnace at 520 °C until a constant mass was achieved. After cooling, the crucible with ash was weighed, and the difference in weight before and after ashing was used to calculate the mineral content.

Determination of the energy value

The calorie content of meat was calculated using Atwater values [35].

Methods of measuring functional indicators

The water-binding capacity (WBC) of minced meat was determined using the method [36]. 0.3 g portion of minced meat was pressed under a 1 kg load for 10 minutes. The moisture-binding capacity was calculated as the fraction of moisture (relative to the total moisture content in the sample) retained in the sample after pressing. The moisture content of minced meat was then determined as the difference between the total moisture fraction and the moisture released during heat treatment.

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pH measurement

The pH value of meat was determined using a digital pH meter pH-150MI according to the method [36].

Pigments content

Pigment content was determined using the spectrophotometric method [26], which involves extracting pigments from meat and meat products with an aqueous acetone solution, followed by measurement of the optical density (D) of the extract. Color intensity was measured using a Spekol-11 spectrophotometer (Germany) at a wavelength of 540 nm, with a control solution in which the sample was replaced with 15 ml of water. The optical density was directly proportional to the pigment's concentration.

Retention factor

Since nutritional analysis measures nutrients in samples of a fixed weight, and cooking alters the product's weight, the concentration of nutrients per unit of mass is not the same in the raw and cooked food. Therefore, the following equation [37] needs to be applied in consideration of the different weights before and after cooking. An over-100 retention factor is given as 100.

$$TR = \frac{N2 \times M2}{N1 \times M1} \times 100 \qquad (2)$$

TR – True retention, %;

N_2 – nutrient after cooking, g/100 g;

N_1 - nutrient before cooking, g/100 g;

M_2 – mass of sample after cooking, g;

M_1 – mass of sample before cooking, g.

Table 2

Weights before and after cooking for samples for which true retentions are calculated

Sample	Weight after cooking (g)		Weight before cooking (g)	
	males	females	males	females
Steak (Frying with oil)	111	108	150	150
Steak (Frying on an electric grill)	106	105	150	150
Steak (Microwave cooking)	108	105	150	150
Burger cutlet (Frying with oil)	64	63	90	90
Burger cutlet (Frying on an electric grill)	62	61	90	90
Burger cutlet (Microwave cooking)	63	61	90	90

Statistical analysis

Statistical analysis of the results was performed using the standard Microsoft Excel package (USA), using Student's t-test. A difference was considered significant if the p-value was < 0.05.

Results and discussion

Analysis of the chemical composition of wild boar meat

The results of the study of the chemical composition of wild boar meat (male and female), obtained in late November 2024 from a hunting enterprise in the Sumy region (Ukraine), are presented in Table 3.

Table 3

Comparative analysis of the chemical composition of wild boar (Sus scrofa) meat in relation to sex

Indexes	Males (n=7)	Females (n=5)
Moisture content, %	74.16±1.27	74.96±1.83
Protein, %	22.68±0.46	21.56±1.38
Fat, %	2.64±0.13	2.25±0.21
Ash, %	0.87±0.061	0.52±0.045
pH	5.78±0.13	5.63 ±0.27
Total pigments, mg/sm^3	10.37±0,37	9.89±0.03
Calorie content, kcal/100 g	118	112

Usually, wild boar meat is considered a dietary food product due to its fat content being below 3% [38; 39; 40]. However, analysis of the literature shows variations in the chemical composition of this meat, largely due to differences in the age, body weight, sex, and habitat of the animals [41; 42]. Moreover, the vast majority of studies on wild boar meat have revealed differences in its physicochemical properties that affect its technological suitability for food use, primarily associated with sex-related differences and the region of harvest.

In terms of chemical composition, the meat of male and female wild boars (Sus scrofa) shows no significant differences and is characterized by high quality. However, it has been established that the meat of female wild boars under one year of age has a slightly lower nutritional value (112 kcal/100 g) compared to that of males. This is due to its lower protein content (21.56 ±

1.38 %) and fat content (2.25 ± 0.21 %), as well as a higher moisture level.

At the same time, in the study by Żmijewski et al., a higher fat content was observed in the carcasses of females across all age groups (yearlings and adults [42]. Moreover, the proportion of fat in females increased with age, which, according to the authors, may be related to the role of adipose tissue in the production of female hormones that serve as an energy source during pregnancy and lactation [43].

The results also showed that the meat of young yearling wild boars had an optimal pH value 24 hours post-mortem, which is typical for game meat [40]. Based on pH values, the studied samples corresponded to the quality class NOR meat, suitable for the production of both whole-muscle and comminuted meat products. Similar pH values were reported for wild boar meat in the study by Tomljanović et al. [12].

A darker color characterized the muscle tissue of young male wild boars compared to that of females, which was associated with a higher myoglobin concentration. A darker color was also observed in muscle samples taken from the inner part of the ham, regardless of sex. This is explained by the higher myoglobin concentration resulting from the more intensive physical activity of limb muscles compared to the back muscles. At the same time, Modzelewska-Kapituła et al. [42] noted that age has a greater effect than sex on meat quality, particularly on color.

Functional and technological properties of wild boar meat

Figure 2 shows the results for moisture content and water-binding capacity in the muscle tissue of female and male wild boars.

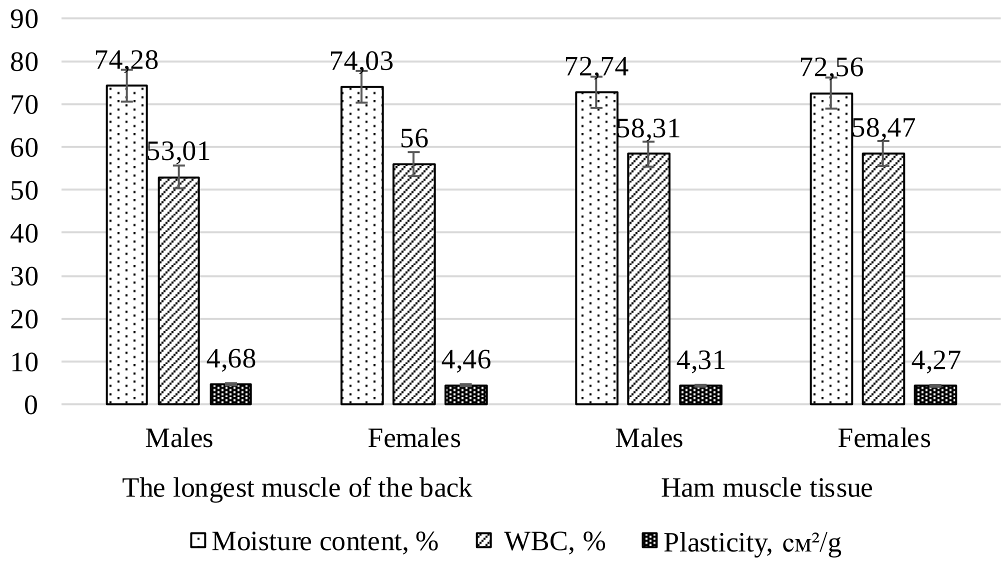

Fig. 2. Functional properties of wild boar meat

Meat quality is influenced by numerous factors, such as the animals' growth rate and age, pre-slaughter stress, as well as the stages of processing and production [44]. These factors can alter the distribution and mobility of water in the meat.

Consequently, the conducted studies did not reveal significant differences in the same meat parameters between male and female wild boars in their raw form. This indicates that there is no need for separate processing or marketing strategies for meat from animals of different sexes.

Cooking loss and organoleptic properties of wild boar meat depending on culinary preparations

To the best of our knowledge, this study represents the first comprehensive assessment of the culinary properties of wild boar meat harvested in the hunting grounds of the Polesia region of Ukraine. In the available literature from EU countries, research has primarily focused on the nutritional value of wild boar meat in relation to age, sex, or harvesting location [40; 41; 45; 46], as well as on issues of meat safety [47–48].

An analysis of the existing scientific literature indicates that most studies focus on the effects of temperature and processing time on the physical, chemical, microbiological, and organoleptic properties of the product. Microwave heating has attracted considerable interest from both researchers and industry due to its high heating rate and short processing time. Several studies [49–50] have reported that the efficiency of microwave heating surpasses that of traditional heating methods. However, it is well known that uneven temperature distribution is one of the primary drawbacks associated with the use of microwave ovens.

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Traditional thermal processing methods (e.g., boiling, frying, roasting, grilling, and smoking) produce organoleptically acceptable and flavorful products, but they have several drawbacks, including limited heat penetration, long processing times due to slow heat transfer, and uneven heat distribution, which can result in overheating or underheating.

Table 4 and 5 present the results of the study on the quality parameters of wild boar meat depending on the type of culinary processing.

Table 4

Quality parameters of finished products made from wild boar meat

Indexes	Steak	
	Males	Females
Frying on an electric grill		
Cooking loss, %	29.17±0,51	30.09±0.33
pH	5.67±0.03	5.83±0.09
Total pigments, mg/sm^3	6.13±0.11	5.36±0.13
Frying with oil		
Cooking loss, %	26.03±0.11	28.01±0.41
pH	5.88±0.17	5,94±0.13
Total pigments, mg/sm^3	7.16±0.13	6.52±0.13
Microwave cooking		
Cooking loss, %	28.27±0.31	29.97±0.11
pH	5.85±0.11	5.96±0.11
Total pigments, mg/sm^3	6.77±0.31	6.41±0.61

Table 5

Quality parameters of finished products made from wild boar meat

Indexes	Burger cutlet	
	Males	Females
Frying on an electric grill		
Cooking loss, %	31.63±0.37	32.57±0.11
pH	5.81±0.13	5.97±0.11
Total pigments, mg/sm^3	5.33±0.71	5.16±0.33
Frying in oil		
Cooking loss, %	28.69±0.21	30.19±0.11
pH	5.89±0.07	5.88±0.09
Total pigments, mg/sm^3	6.73±0.11	6.33±0.13
Microwave cooking		
Cooking loss, %	30.07±0.33	32.16±0.27
pH	5.83±0.19	5.91±0.11
Total pigments, mg/sm^3	6.43±0.11	6.39±0.11

Cooking loss primarily depends on the cooking temperature and the target internal temperature of the sample. However, in our study, a certain tendency was observed for cooking loss to vary according to the sex of the meat. Specifically, products made from the meat of female wild boars, prepared using various thermal processing methods, showed slightly lower yields.

A key feature of meat preparation is water loss, which leads to a reduction in the product's weight. This, in turn, concentrates the non-volatile nutrients (protein, fat) in the residual mass. The results of the study on the protein and fat content in ready-made semi-finished products and their relative concentrations are presented in Tables 6 and 7.

Analysis of the data in Table 6 shows that in all samples, the protein concentration in 100 g of finished steak (20.06–22.05 g/100 g) is higher compared to raw meat (typically 18–20 g/100 g). This indicates dehydration of the product during heat treatment. Despite the high concentration, the actual total amount of protein remaining in the steak is only 62.5–70.25 %. This means that 30–37.5 % of protein (or protein components) is lost together with juices during heat treatment. When comparing cooking methods, it was found that the best protein preservation is demonstrated by microwave processing (about 70 %).

This is probably due to faster heating, which minimizes liquid leakage and the duration of thermal exposure to protein structures. The worst protein preservation is observed when frying on an electric grill (on average 63.9 %). High temperatures, direct contact with a heated surface, and long cooking times can lead to greater drying and moisture loss.

Table 6

Effect of different cooking methods on the content of protein and fat and true retention in steak depending on sex

Sample	Cooking method	Protein		Fat	
	Male	CW*(g/100 g)	TR**(%)	CW*(g/100 g)	TR**(%)
Steak	Frying in oil	21.03	68.61	3.47	97.27
	Frying on an electric grill	20.06	62.50	3.42	91.55
	Microwave cooking	22.05	70.00	3.45	94.09
	Female				
Steak	Frying in oil	20.73	69.22	3.69	118.08
	Frying on an electric grill	20.12	65.32	3.48	108.27
	Microwave cooking	21.64	70.25	3.61	112.31

*CW cooked weight
**TR(%) True retention

The TR of fat of male steaks is below 100 % (from 91.55 % to 97.27 %). According to the fact that in these steaks more of their own fat melted and was lost than was absorbed (even when frying in oil). These steaks probably had a better ability to melt fat. For steaks prepared from pig meat, the TR of fat is above 100 % (108.27–118.08 %). This means that the total amount of fat in the finished product increased (especially during oil frying), which is explained by oil absorption during frying and by the fact that steaks from female meat have a lower ability to melt, leading to a net increase in fat after cooking.

Table 7

Effect of different cooking methods on the content of protein and fat and true retention in burger cutlet depending on sex

Sample	Cooking method	Protein		Fat	
	Male	CW*(g/100 g)	TR**(%)	CW*(g/100 g)	TR**(%)
Burger cutlet	Frying in oil	20.97	65.74	4.21	113.4
	Frying on an electric grill	20.85	63.33	4.18	109.7
	Microwave cooking	20.78	64.13	4.20	111.36
	Female				
Burger cutlet	Frying in oil	20.01	64.96	4.97	154.62
	Frying on an electric grill	20.03	62.96	4.87	146.70
	Microwave cooking	20.14	63.31	4.81	144.89

*CW cooked weight
**TR (%) True retention

According to Table 7, the protein content of the finished burger patties (around 20–21 g/100 g for "Male" and 20 g/100 g for "Female") is higher or almost unchanged compared to the initial content of the raw meat (which is usually around 18–20 g/100 g for pork). This is due to the water loss during cooking, which concentrates the protein in the residual mass. Although the protein concentration (CW) may be high due to water loss, the actual total amount of protein retained in the finished portion is only 63–66 % of the initial amount. The rest (34–37 %) is losses (mainly juice/fat leakage with water) during cooking. The fat content of the finished product is around 4.18–4.21 g/100 g for "Male" and 4.8–4.9 g/100 g for "Female". For fat, the TR is significantly higher than 100 % (ranging from 109.7 to 154.62 %) for all cooking methods. A good retention of more than 100 % indicates net absorption of the nutrient (in this case, fat) by the product during cooking.

The results of the organoleptic evaluation of the products prepared using different thermal processing methods are presented in Figures 3–5.

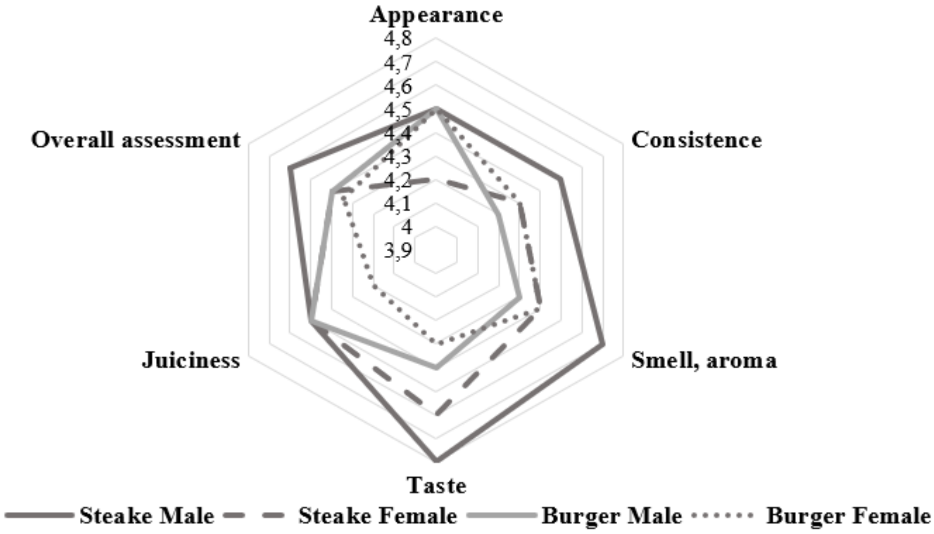

Fig. 3. Sensory evaluation profilogram of steaks and burger patties pan-cooked with oil

When preparing steaks and patties from wild boar meat by pan-frying with oil, the cooked products received the highest scores for both male and female meat. The average score for steaks ranged from 4.40 to 4.60, while for burgers it ranged from 4.34 to 4.40. This can be attributed to the use of added fat in the form of oil, which positively influenced the sensory evaluation by the panelists.

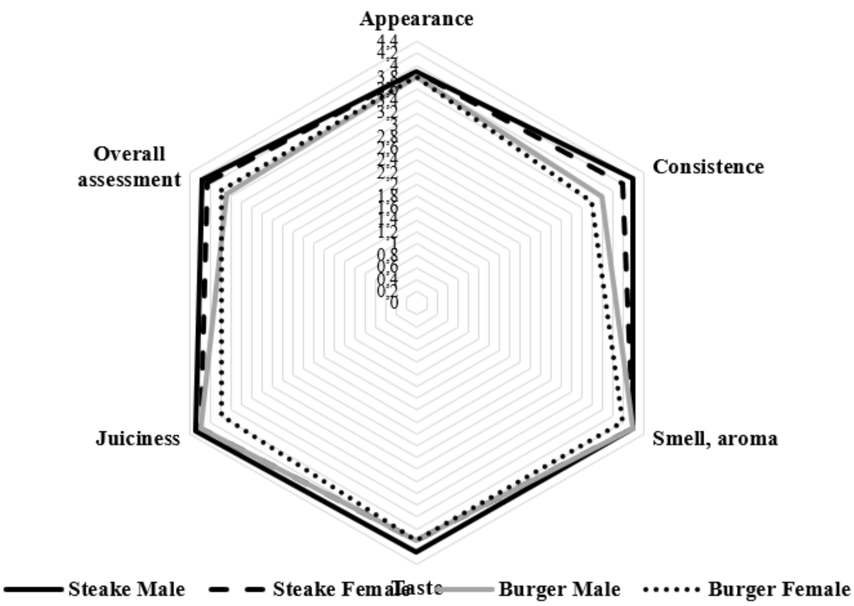

Fig. 4. Sensory evaluation profilogram of steaks and burger patties grilled on an electric grill

When grilling wild boar meat, steaks from both males and females received higher organoleptic scores compared to burgers. The overall score for steaks was 4.16 for males and 4.06 for females. High scores were given for texture, taste, and aroma. In contrast, when preparing patties, the texture quality decreased, receiving scores of 3.4–3.6, which is 15–19 % lower than the texture scores of the steaks.

The sensory evaluation of steaks and patties made from wild boar meat in a microwave oven showed that this cooking method reduces the expression of the meat's organoleptic properties compared to the two previous methods. The average scores for steaks ranged from 3.98 to 4.06, and for burgers from 4.20 to 4.24. In terms of taste, aroma, and juiciness, steaks and burgers cooked in a microwave oven scored slightly lower than those pan-fried with added oil. Specifically, pan-fried steaks received 12.5–13.04 % higher scores for taste and 11.11–13.33 % higher scores for juiciness compared to microwave-cooked steaks.

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However, scores for aroma and smell were nearly identical. The reduced taste of microwave-cooked steaks and burgers can be explained by the absence of non-enzymatic browning reactions and the low content of Maillard reaction products [25].

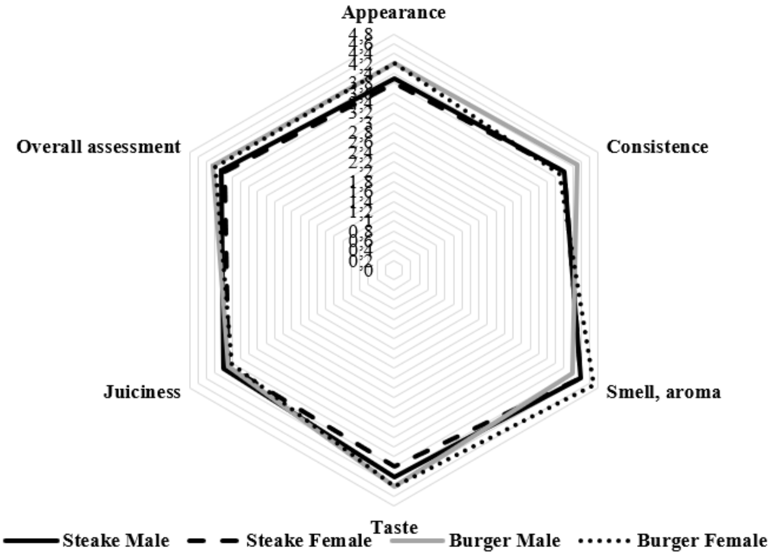

Fig. 5. Sensory evaluation profilogram of steaks and patties for burger processing in a microwave oven

Conclusion

Based on the results of the study of the functional-technological and culinary properties of male and female wild boar meat, and the assessment of the effects of different thermal processing methods on sensory attributes and cooking losses, it can be concluded that wild boar meat has high nutritional value, adequate functional properties, and favorable sensory characteristics when subjected to culinary processing.

The protein content ranged from 21.56 to 22.68 %, and fat content from 2.25 to 2.64 %, which affected the meat's energy value, ranging from 112 to 118 kcal/100 g. It was found that the meat of female wild boars under one year of age has a slightly lower nutritional value (112 kcal/100 g) compared to that of males, due to lower protein and fat content and higher moisture content.

Comparison of the functional-technological parameters of raw meat from male and female wild boars revealed no significant differences, indicating that there is no need for separate processing or marketing strategies based on sex.

Pan-frying wild boar meat (at 180 °C for 6–8 minutes) proved to be the most effective thermal processing method for preserving optimal quality characteristics, particularly sensory and textural attributes that are preferred by consumers. This cooking method also minimizes cooking losses, which is a key factor in reducing potential financial losses depending on the chosen preparation process.

It was found that the best protein preservation occurs when using microwave processing (about 70 %) for portioned semi-finished products. When heat treating burger cutlets, the best method for preserving protein is frying in oil (64.96–65.74 %). It was determined that with all cooking methods, the relative fat content increases due to moisture loss, especially for products made from minced meat.

Thus, when processing wild boar meat, the peculiarities of changes in meat during cooking should be taken into account. When manufacturing portioned semi-finished products, it is more expedient to use the microwave cooking method for heat treatment, while for emulsified products such as burger cutlets, frying with a small amount of oil in a frying pan. When preparing both portioned and chopped semi-finished products from female wild boar meat, it is recommended to reduce the amount of oil during cooking, as it has a higher fat melting point compared to male wild boar meat and the ability to absorb fat during cooking.

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