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"ORGANIC AND FUNCTIONAL FOOD WITH RURAL TOURISM - SUSTAINABILITY AND FUTURE OF MACEDONIA AND THE REGION OF SOUTHEASTERN EUROPE"

ПРВА МЕЃУНАРОДНА НАУЧНО АГРО-БИЗНИС КОНФЕРЕНЦИЈА "АГРО МАК" 2025

"ОРГАНСКА И ФУНКЦИОНАЛНА ХРАНА СО РУРАЛЕН ТУРИЗАМ - ОДРЖЛИВОСТ И ИДНИНА НА МАКЕДОНИЈА И РЕГИОНОТ НА ЈУГОИСТОЧНА ЕВРОПА"

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FIRST INTERNATIONAL SCIENTIFIC AGRI-BUSINESS CONFERENCE
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INVITED SPEAKERS

PLENARY PRESENTATIONS

SESSION A

INFLUENCE OF ORGANIC VERSUS CONVETIONAL PIG PRODUCTION ON MEAT QUALITY AND FATTY ACID COMPOSITION

ВЛИЈАНИЕ НА ОРГАНСКОТО НАСПРОТИ КОНВЕНЦИОНАЛНОТО ПРОИЗВОДСТВО НА СВИЊИ ВРЗ КВАЛИТЕТОТ НА МЕСОТО И СОСТАВОТ НА МАСНАТА КИСЕЛИНА

Aco Kuzelov, Full Professor[38]
Nadica Bajraktarova, Assistant Lecturer[39]
Dimitar Nakov, Full Professor[40]

***Abstract**: Studies have shown that organic rearing systems can enhance certain meat quality parameters. To investigate the nutritional processing quality of pork meat from conventional pig farms, the standard physical-chemical analysis was performed. Intramuscular fat content was 4.28%, water content 76.71%, protein 24%, pH=6.02, water binding ability 16.10%, and the brightness L=32.32, redness a=7.76, yellowness b=7.81. The interplay of genetics, nutrition, and production practices ultimately shapes the functional food properties of pork, influencing consumer preferences and market trends.*

***Key words:** pork, nutritional quality, production system*

***Апстракт:** Истражувањата покажаа дека системите за органско одгледување можат да ги подобрат одредени параметри за квалитет на месото. За да се испита квалитетот на нутриционистичката обработка на свинското месо од конвенционалните свињарски фарми, беше извршена стандардна физичко-хемиска анализа. Интрамускулната содржина на маснотии беше 4,28%, содржина на вода 76,71%, протеини 24%, pH=6,02, способност за врзување вода 16,10%, а осветленоста L=32,32, црвенило a=7,76, жолтило b=7,81. Интеракцијата на генетиката, исхраната и производствените практики на крајот ги обликува функционалните прехранбени својства на свинското месо, влијаејќи на преференциите на потрошувачите и трендовите на пазарот.*

***Клучни зборови:** свинско месо, квалитет на исхрана, систем на производство*

1. INTRODUCTION

The influence of organic versus conventional pig production on meat quality and fatty acid composition as a functional food is a significant area of research, particularly as consumer

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demand for healthier and more sustainable food options increases. It is a multifaceted topic encompassing various aspects of animal husbandry, nutritional strategies, and consumer preferences. The differences in production systems significantly affect the physiological and biochemical properties of pork, which in turn influence its quality and health benefits.

Organic pig production is often associated with improved animal welfare and sustainability, as it typically involves outdoor access and a diet free from synthetic additives and antibiotics. Studies have shown that organic rearing systems can enhance certain meat quality parameters, such as oxidative stability and intramuscular fat content, which are crucial for flavor and tenderness. For instance, Martino et al. found that organic crossbred pigs exhibited a different oxidative status compared to conventional breeds, suggesting potential benefits in meat quality attributes like tenderness and flavor (Martino et al., 2014). Furthermore, the inclusion of organic trace elements in pig diets has been linked to enhanced antioxidant capacity, which can reduce lipid peroxidation and improve meat quality (Xu et al., 2024). This is particularly relevant as oxidative stability is a key factor in determining the shelf life and sensory attributes of meat products. This approach often results in pork with higher levels of beneficial fatty acids. For instance, studies have shown that pork from organically raised pigs tends to have a higher concentration of polyunsaturated fatty acids (PUFAs) and a more favorable omega-6 to omega-3 fatty acid ratio compared to conventionally raised pork (Abdullah et al., 2023). This is attributed to the diets of organic pigs, which often include foraged plants and grains that are richer in omega-3 fatty acids. Additionally, the higher lean meat percentage associated with organic production systems can lead to improved fatty acid profiles, enhancing the nutritional quality of the meat (Abdullah et al., 2023).

In contrast, conventional pig production often prioritizes growth rate and feed efficiency, which can lead to differences in meat quality traits with a higher content of saturated fatty acids and lower levels of beneficial unsaturated fatty acids. For example, research indicates that pigs raised in conventional systems may have higher muscle glycogen levels, which can negatively impact meat quality by leading to lower pH and increased susceptibility to spoilage (Liu et al., 2019). Additionally, conventional systems may result in a higher prevalence of certain health issues, which can affect meat quality. Alban et al. (2015) reported that lesions found during meat inspections were more common in pigs raised under conventional conditions, potentially reflecting the stress and health challenges associated with intensive farming practices. Conventional pork typically exhibits higher levels of n-6 fatty acids, which, while essential, can contribute to an imbalanced fatty acid profile when not countered by sufficient omega-3 intake (Almeida et al., 2014). This imbalance is concerning as excessive consumption of n-6 fatty acids relative to n-3 fatty acids has been linked to various health issues, including inflammation and cardiovascular diseases (Da et al., 2021).

Moreover, the nutritional strategies employed in organic versus conventional systems play a critical role in determining meat quality. Organic pigs often receive diets that promote higher intramuscular fat content, which is essential for flavor and tenderness. This is supported by findings that indicate organic systems can lead to a more favorable fatty acid profile in pork, enhancing its nutritional value (Abdullah, 2023). Conversely, conventional systems may focus on maximizing lean meat production, which can compromise flavor and tenderness due to lower intramuscular fat levels (Abdullah et al., 2023).

The genetic background of the pigs also contributes significantly to meat quality. Liu (2023) performed research in which highlighted that different pig breeds exhibit varying meat quality traits, with indigenous breeds often preferred for their superior flavor and tenderness compared to conventional hybrids. Research indicates that certain breeds, such as Duroc, are associated with higher intramuscular fat content, which is positively correlated with desirable sensory traits such as flavor and tenderness (Jiang et al., 2011). The genetic selection for higher intramuscular fat content in organic systems can further enhance the quality of pork, making it not only more palatable but also nutritionally superior due to its higher monounsaturated fatty acid content, particularly oleic acid, which has been shown to have antioxidant properties and potential health benefits (Ros-Freixedes et al., 2016; Da et al., 2021).

2. MATERIALS AND METHODS

Hind leg meat from finisher pigs reared in commercial pig farms was obtained for analysis of physical-chemical meat composition. Surface tendons, membranes and fats were removed, and some of them were used for quality determination such as pH, tenderness, water binding ability, and meat color, and some of them were prepared into dry samples to determine nutritional indicators such as moisture, protein and fatty acids content. Mixed standards of 33 fatty acids were used for chromatographic detection of fatty acids. Before the assay was performed, fat extract was prepared. A test sample of 0.03 g was transferred into a 50 mL centrifuge tube, add 143 mg pyrogallic acid and 2 mL 95% ethanol solution, mixed well, added 10 mL hydrochloric acid solution, and placed in a water bath at 70-80°C for 40 min for hydrolysis. Then the sample was cooled to room temperature, added 10 mL of 95% ethanol solution and 50 mL of petroleum, shakeed for 5 min, transfered to a separating funnel and allowed to stand for 10 min, collected the ether layer extracted into a 100 mL Erlenmeyer flask, repeated the extraction three times. The extract was left to volatilize overnight to obtain the fat extract, which was dissolved by adding 4 mL of n-hexane, shaken for 30 sec. and allowed to stand until clear, about 1 g of sodium bisulfate was added, shaken to neutralize potassium hydroxide, and after salt precipitation, filtered with a 0.22 µm filter membrane and measured using gas chromatography-mass spectrometer.

3. RESULTS AND DISCUSSION

This study analyzes the nutritional and physical characteristics of pork meat from the hind leg. Table 1 presents the results, showing that this cut has a relatively low fat content of 4.28% and a high water content of 76.71%, contributing to its tenderness. The fat content is lower than what is typically reported in other studies (Pinchen et al., 2020), suggesting variability influenced by factors such as cut type and processing methods. The slightly higher water content compared to some previous research may be due to differences in handling or meat sources. The measured value for water content was 76.71%, which is slightly higher than the 72% water content observed in the study conducted by Pinchen et al. (2020), indicating that variability depends on factors such as processing and cut type.

Table 1. Nutritional quality of pork meat from hind leg parts

Parameter	**Pork meat from the hind legs part**
Fat	4.28
Water	76.71
Ash	1.45
Protein (%)	24.00
pH	6.02
Water bind ability (WBA)	16.10
Color L	32.32
Color a	7.76
Color b	7.81
RGB_red	91.00
RGB_green	71.00
RGB_blue	64.00

Regarding the ash content, the recorded value of 1.45% in this study is consistent with the general understanding that pork, especially lean cuts, tends to have minimal ash content. However, specific ash values for hind leg cuts were not directly mentioned in the available literature. Protein makes up 24% of the meat's composition, reinforcing its nutritional value as a high-quality protein source. Similarly, the measured protein content aligns with the characterization of pork as a rich source of high-quality protein, as noted in various studies on meat composition (Vicente, Pereira, 2024).

The pH level of 6.02 indicates near-neutral acidity, while color measurements reveal a moderately bright, slightly reddish hue, characteristic of this cut. These pH and color values align with general expectations for pork. While the pH value of pork meat can vary depending on breed, diet, and processing methods, detailed pH values for the hind leg part were not explicitly addressed in the literature's sources reviewed. The color parameters obtained, with L = 32.32, a = 7.76, and b = 7.81, are indicative of typical pork color, though specific values for the hind leg part were not directly reported in recent studies. Pork color is influenced by muscle type, pH, and processing methods, which can contribute to some variation. The water binding ability of 16.10% in this study also falls within a typical range for meat, although specific data for hind leg cuts were not readily available in the literature.
Overall, these findings provide insight into the key nutritional and physical properties of pork from the hind leg.

In Table 2, the fatty acid composition of pork meat from the hind leg part is shown. The results show that the major fatty acids in the sample were oleic acid (C18:1), palmitic acid (C16:0), and stearic acid (C18:0), with oleic acid being the predominant monounsaturated fatty acid. These findings are consistent with previous studies, which report that oleic acid is typically one of the most abundant fatty acids in pork fat (Covaciu et al., 2024).

Table 2. Fatty acids content in pork meat

Parameter	**Pork meat from the hind legs part**
Saturated fatty acid (SFA)	1.46
Caproic acid (C6:0)	0.02
Caprylic acid (C8:0)	0.02
Capric acid (C10:0)	0.02
Undecanoic acid (C11:0)	0.02
Lauric acid (C12:0)	0.02
Tridecanoic acid (C13:0)	0.02
Myristic acid (C14:0)	0.05
Myristoleic acid (C14:1)	0.02
Pentadecanoic acid (C15:0)	0.02
Pentadecenoic acid (C15:1)	0.02
Palmitic acid (C16:0)	0.97
Palmitoleic acid (C16:1)	0.13
Heptadecanoic acid (C17:0)	0.02
Heptadecanoic acid (C17:1)	0.02
Stearic acid (C18:0)	0.44
Oleic acid (C18:1)	2.34
Linoleic acid (C18:2)	0.29
Linolenic acid (C18:3)	0.02

Arachidic acid (C20:0)	0.02
Gondoic acid (C20:1)	0.04
Eicosadienoic acid (C20:2)	0.02
Eicosatrienoic acid (C20:3)	0.02
Arachidonic acid (C20:4)	0.02
Eicosapentaenoic acid (C20:5)	0.02
Heneicosanoic acid (C21:0)	0.02
Behenic acid (C22:0)	0.02
Erucic acid (C22:1)	0.02
Docosadienoic acid (C22:2)	0.02
Docosahexaenoic acid (C22:6)	0.02
Tricosanoic acid (C23:0)	0.02
Lignoceric acid (C24:0)	0.02
Nervonic acid (C24:1)	0.02

The meat contains a variety of both saturated and unsaturated fatty acids, with palmitic acid (C16:0) being the most prevalent saturated fatty acid at 0.97%. Oleic acid (C18:1), a monounsaturated fatty acid, stands out with a higher concentration of 2.34%, which is known for its beneficial health properties. Other fatty acids, like stearic acid (C18:0) and linoleic acid (C18:2), were measured in smaller amounts, contributing to the overall fat profile. This diverse range of fatty acids reflects the complex nutritional content of the pork meat from this specific cut. The concentration of palmitic acid in the current sample was 0.97 g/100g, which is in line with other studies that report palmitic acid as a major saturated fatty acid in pork, constituting approximately 30-35% of the total fatty acids (Covaciu et al., 2024). The level of stearic acid (0.44 g/100g) also falls within the range observed in other studies, where it typically contributes around 10-15% of the total fatty acids in pork fat (Covaciu et al., 2024).

Regarding polyunsaturated fatty acids, linoleic acid (C18:2) was present at 0.29 g/100g, a value that aligns with findings from Fernández et al. (2003), who reported linoleic acid levels in pork ranging from 0.2 to 0.5 g/100g. Interestingly, the concentrations of omega-3 fatty acids, such as linolenic acid (C18:3), were found to be minimal in our sample, which is consistent with the low levels typically observed in conventional pork fat (Covaciu et al., 2024).

In general, the fatty acid profile of pork meat from the hind leg in this study is consistent with existing literature, particularly concerning the dominance of oleic acid and palmitic acid. The observed concentrations of stearic acid and linoleic acid also align with previous reports, while the minimal presence of omega-3 fatty acids supports the general finding that conventional pork fat contains low levels of polyunsaturated fats. Overall, the findings from this study are in line with existing literature, confirming the nutritional value and typical fatty acid profile of pork from the hind leg, while also revealing slight variations that may result from different meat processing techniques.

4. CONCLUSION

Comparison between organic and conventional pig production reveals that while organic systems may enhance certain quality traits through improved welfare and dietary practices, conventional systems often focus on efficiency and growth rates, which can lead to trade-offs in meat quality. Organic production tends to yield pork with a more favorable fatty acid profile, enhanced nutritional benefits, and superior sensory qualities, while conventional methods may lead to less desirable health outcomes due to an imbalance in fatty acid composition. The interplay of genetics, nutrition, and production practices ultimately shapes the functional food properties of pork, influencing consumer preferences and market trends. As consumer awareness of health and sustainability continues to grow, these factors will likely play an increasingly important role in meat purchasing decisions.

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