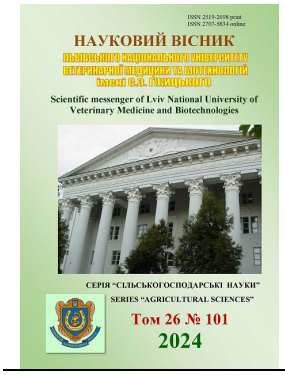

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The fatty acid composition of lamb makes it a valuable raw material for the meat processing industry

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Lamb holds a significant position in the food industry due to its nutritional properties and diverse flavour profiles. It serves as a source of high-quality protein, vitamins, and minerals, making it a valuable food product. In recent years, there has been a growing interest in the fatty acid composition of meat, particularly concerning their impact on human health. The primary aim of this study was to evaluate the fatty acid composition of lamb meat produced from the crossbreeding of Romanov sheep with Hisar rams. To achieve this, the research involved producing ram lambs of two genotypes: Romanov × Romanov (control group) and Romanov × Hisar (experimental group). The fatty acid profiles of the meat were analysed using gas chromatography following standard extraction and methylation procedures. The study revealed that the meat of crossbred lambs contains a higher level of unsaturated fatty acids compared to purebred lambs. Specifically, the crossbred lambs showed an increase in oleic acid by 1.79 % (24.59 % vs. 22.80 %), linoleic acid by 0.54 % (3.63 % vs. 3.09 %), and gondoic acid by 0.32 % (0.76 % vs. 0.44 %) ($P < 0.05$). This enhancement contributes to improved meat quality. Among saturated fatty acids, the content of palmitic acid increased by 0.85 % (24.20 % vs. 23.35 %), while stearic acid rose by 0.34 % (21.55 % vs. 21.21 %) in crossbred lambs. The ratio of saturated to unsaturated fatty acids in the control group was 1.66, indicating a predominance of saturated fatty acids, whereas in the experimental group, this ratio was 1.55, suggesting an improvement in favour of unsaturated fatty acids. Moreover, the ratio of omega-6 to omega-3 fatty acids was 3.75 in the control group and 3.50 in the experimental group. Although both values are within the normal range, the slight decrease in the experimental group indicates a better balance between these fatty acids, which may be beneficial for health. These results highlight the significance of selective breeding strategies for enhancing the nutritional value of meat, which is crucial for both producers and consumers. Future research could focus on further optimising crossbreeding methods to increase the beneficial fatty acid profiles in lamb meat, exploring the impact of different diets on fatty acid composition, and assessing consumer preferences related to meat quality attributes.

Key words: *crossbreeding of sheep, lamb meat, fatty acids, omega-6/omega-3 ratio, meat quality.*

Introduction

Lamb meat is highly valued for its nutritional properties, particularly its unique fatty acid profile, which plays a key role in human health. The fatty acid composition of lamb meat is influenced by several factors, including breed, diet, and environmental conditions (Skliarov et al., 2020). Recent research has shown that genetic factors, such as breed, have a significant impact on the concentration of saturated (SFA), monounsaturated (MUFA), and polyunsaturated fatty acids (PUFA) in lamb meat, which in turn affects the meat's nutritional and organoleptic qualities (Lu et al., 2022).

Breed-specific differences are particularly important when optimizing lamb meat production for both local and global markets (Fernandez-Turren et al., 2020; Ding et al., 2024). Studies over the past five years have highlighted

the role of traditional and indigenous breeds in maintaining a higher PUFA content compared to commercial breeds, which are often selected for faster growth and higher carcass yield. For example, Mercan et al. (2022) reported that native Mediterranean breeds exhibit a higher concentration of omega-3 fatty acids compared to crossbred or intensively reared lambs. Similar findings have been observed in breeds from other regions, where local adaptation to grazing systems leads to differences in intramuscular fat composition (Ke et al., 2023).

Moreover, the growing demand for high-quality, sustainable meat products has brought attention to the importance of breed selection in lamb farming. With increasing consumer awareness of the health benefits of omega-3 and omega-6 fatty acids, breeds that naturally produce meat with a favourable fatty acid profile are becoming more attractive for niche markets. Recent studies support this trend, suggesting that certain breeds are better suited for producing healthier meat products without compromising on yield or meat quality (Skliarov et al., 2021; Ponnampalam et al., 2024).

Studies have confirmed that an effective method for increasing lamb production volumes, as well as improving its quality indicators, is the use of two-breed and three-breed commercial crossbreeding of ewes of different breeds with rams of intensive meat breeds. Crossbred animals, produced as a result of such crossbreeding, generally show higher meat performance due to the heterosis effect compared to their purebred counterparts (Vargas Jurado et al., 2022). Additionally, crossbred young animals tend to grow more intensively, and their live weight is usually greater (Esfandyari et al., 2015; Assan et al., 2024).

The aim of the study

Thus, the study of the fatty acid composition of meat of Romanov lambs and meat of lambs obtained from crossing the Romanov breed with the Hisar breed was the aim of our research.

Materials and Methods

The study on the crossbreeding of Romanov ewes with Hisar breed rams was conducted at Terra Rich LLC in the Pology district, Zaporizhzhia region. Ram lambs of two genotypes were produced: Romanov × Romanov (control group) and Romanov × Hisar (experimental group). Meat productivity was evaluated through the control slaughter of 8-month-old ram lambs (five from each group), following standard procedures (Pokhyl & Mykolajchuk, 2020).

The fatty acid composition of muscle tissue was determined using gas chromatography, based on the methodology described by Mylostyvyi et al. (2021). Lipids were extracted using a chloroform-methanol solution (2:1, v/v), followed by methylation of the fatty acids to form fatty acid methyl esters (FAMEs). FAMEs were analyzed using gas chromatography (GC) with a flame ionization detector (FID) on a DB-23 capillary column. The injector and detector were set to 250°C, with the column temperature programmed to rise from 130°C to 230°C at 2°C per minute, using helium as the carrier gas. Fatty acids were identified by comparing retention times with known standards, and their concentrations were calculated from peak areas. This method enabled the identification and quantification of saturated, monounsaturated, and polyunsaturated fatty acids.

Results

When evaluating the nutritional value of meat, a crucial indicator is the fatty acid composition of its lipid fraction. Fat affects the energy value and taste properties of meat, contributing to its tenderness and juiciness. At the same time, the quality of fat depends on the ratio of individual fatty acids and the degree of their saturation. Disruption of the optimal ratio between saturated and unsaturated fatty acids leads to metabolic changes, which subsequently deteriorate the quality of the product.

The presence and ratio of fatty acids in muscle tissue primarily determine the flavour and aroma of the meat and significantly influence its organoleptic properties and technological qualities as a raw material. The results of the fatty acid composition analysis of muscle tissue from ram lambs of different genotypes are presented in Table 1.

The analysis of the fatty acid composition shows that the amount of unsaturated fatty acids in the meat of crossbred lambs exceeds that of Romanov purebred lambs by 3.25 %. Additionally, the meat of the crossbred lambs contains 1.79 %, 0.54 %, and 0.32 % more oleic, linoleic, and gondoic acids ($P < 0.05$), respectively. The increased content of unsaturated fatty acids indicates an improvement in the meat quality of the crossbred lambs.

Among the saturated fatty acids, the major components in both genotypes were stearic and palmitic acids, which play a key role in meat consistency. Their content in crossbred lambs was 21.55 % and 24.20 %, compared to 21.21 % and 23.35 % in purebred Romanov lambs. Crossbreeding Romanov ewes with Hisar breed rams resulted in an increase in palmitic acid content by 0.85 % ($P < 0.05$) and stearic acid content by 0.34 %. This crossbreeding approach contributed to an overall improvement in the quality of meat in the crossbred lambs.

The results indicate that the ratio of saturated to unsaturated fatty acids in the control group was approximately 1.66, reflecting a higher content of saturated fatty acids compared to unsaturated ones. In contrast, the experimental group exhibited a ratio of 1.55, suggesting a slight improvement in favour of unsaturated fatty acids. This lower ratio in the experimental group may indicate an enhancement in meat quality, as unsaturated fatty acids are generally regarded as more beneficial for health. Regarding the ratio of omega-6 to omega-3 fatty acids, it was 3.72 in the control group and 3.50 in the experimental group. Although both values are low, indicating a dominance of omega-6 fatty acids, the slight increase in the experimental group suggests a better balance between these fatty acids.

Table 1
Fatty acid composition of the muscle tissue of lambs of different genotypes, %

Fatty acid	Group	
	control	experimental
Unsaturated fatty acids		
Myristoleic acid (C14:1)	0.19 ± 0.01	0.20 ± 0.02
Palmitoleic acid (C16:1)	1.58 ± 0.17	1.92 ± 0.21
Heptadecenoic acid (C17:1)	0.57 ± 0.05	0.61 ± 0.07
Oleic acid (C18:1)	22.80 ± 0.19	24.59 ± 0.23*
Linoleic acid (C18:2 ω6)	3.09 ± 0.10	3.63 ± 0.12*
Linolenic acid (C18:3 ω3)	0.78 ± 0.07	0.97 ± 0.09
Arachidonic acid (C20:4 ω6)	0.40 ± 0.06	0.40 ± 0.05
Eicosapentaenoic acid (C20:5 ω3)	0.20 ± 0.01	0.23 ± 0.02
Eicosadienoic acid (C20:2 ω6)	0.16 ± 0,01	0.17 ± 0.01
Gondoic acid (C20:1 ω9)	0.44 ± 0.06	0.76 ± 0.09*
Erucic acid (C22:1 ω9)	0.11 ± 0.03	0.09 ± 0.02
Total unsaturated FA	30.32	33.57
Saturated fatty acids		
Arachidic acid (C20:0)	0.22 ± 0.04	0.20 ± 0.03
Capric acid (C10:0)	0.17 ± 0.06	0.19 ± 0.10
Lauric acid (C12:0)	0.36 ± 0.11	0.38 ± 0.13
Myristic acid (C14:0)	2.29 ± 0.07	2.51 ± 0.11*
Pentadecanoic acid (C15:0)	0.67 ± 0.09	0.77 ± 0.10
Palmitic acid (C16:0)	23.35 ± 0.13	24.20 ± 0.16*
Margaric acid (C17:0)	2.19 ± 0.13	2.37 ± 0.14
Stearic acid (C18:0)	21.21 ± 0.24	21.55 ± 0.26
Total saturated FA	50.46	52.17

Note: * P < 0.05

An optimal ratio of omega-3 to omega-6 is essential for human health, as excess omega-6 can contribute to inflammatory processes. Therefore, the findings suggest that crossbreeding Romanov ewes with Hisar breed rams can lead to improved meat quality by increasing the proportion of unsaturated fatty acids and improving the omega-6 to omega-3 ratio.

Discussion

The results of this study demonstrate significant differences in the fatty acid composition of meat from Romanov lambs compared to crossbred lambs obtained from the Romanov and Hisar breeds. The increased concentration of unsaturated fatty acids in the meat of crossbred lambs (30.32 % in the control group versus 33.57 % in the experimental group) indicates an enhancement in the nutritional quality of the meat. This finding aligns with recent research emphasizing the health benefits associated with higher levels of unsaturated fatty acids, particularly oleic, linoleic, and gondoic acids, which have been shown to improve cardiovascular health and reduce inflammation (Kim et al., 2023; Jackson et al., 2024).

Moreover, the ratio of saturated to unsaturated fatty acids is a critical aspect of meat quality. The observed ratios of 1.66 for the control group and 1.55 for the experimental group suggest a shift towards a healthier profile in the crossbred lambs, where a lower ratio is often associated with better nutritional quality (Belhaj et al., 2020). These findings are supported by recent studies that indicate the importance of breed selection in enhancing meat quality traits, specifically in relation to fatty acid composition (Zhou et al., 2022).

The omega-6 to omega-3 fatty acid ratio also reflects the nutritional potential of the meat. The slight decrease from 3.72 in the control group to 3.50 in the experimental group is noteworthy, considering that a lower ratio between these fatty acids is beneficial for reducing the risk of chronic diseases associated with excessive omega-6 consumption (Jackson et al., 2024). While both ratios are still considered low, the trend towards improvement is promising and suggests that crossbreeding may help address the growing consumer demand for healthier meat options.

In addition, the improvement in the fatty acid profile as a result of crossbreeding can be attributed to the genetic diversity introduced by incorporating the Hisar breed. This aligns with previous research that highlights the benefits of hybrid vigour and the positive impacts of crossbreeding on growth performance and meat quality (Wang et al., 2021; Song et al., 2022). The findings support the hypothesis that selective breeding strategies can play a pivotal role in enhancing the overall quality of lamb meat.

Overall, the study underscores the importance of fatty acid composition in determining the nutritional value of lamb meat and suggests that crossbreeding Romanov ewes with Hisar breed rams may yield not only higher quantities but also improved quality of meat, making it a valuable strategy for lamb producers looking to meet evolving market demands.

Conclusion

The study of the fatty acid composition of Romanov lambs and hybrids with Hisar breed sheep demonstrated that the meat of the hybrids has a higher content of

unsaturated fatty acids, enhancing its nutritional properties. The hybrid group exhibited a more favourable saturated-to-unsaturated fatty acid ratio, indicating a healthier fat profile. Additionally, there was a slight improvement in the omega-6 to omega-3 fatty acid ratio, which further contributes to the meat's nutritional quality. These findings underscore the significance of genetic selection and crossbreeding in improving the quality characteristics of meat products, meeting the growing demand for healthier and more nutritious options in the meat industry. Therefore, developing effective breeding strategies could significantly enhance the competitiveness of meat producers in the market.

Conflict of interest

The authors declare no conflict of interest.

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