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QUALITY ASSESSMENT OF *Longissimus dorsi* IN AUBRAC CATTLE: IMPLICATIONS FOR MEAT NUTRITION AND SUSTAINABILITY

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Abstract

The Aubrac cattle breed is renowned for its adaptability to mountainous environments, growth performance, and notably favorable nutritional properties of its meat. This study investigated the biochemical composition of the longissimus dorsi muscle in male (n = 28) and female (n = 10) Aubrac cattle, focusing on amino acid and fatty acid profiles. Males exhibited higher concentrations of essential amino acids (15.05% vs. 12.68% in females), suggesting superior protein quality, while fatty acid analysis revealed higher saturated fatty acids (48.96% vs. 46.82%) and polyunsaturated fatty acids (3.96% vs. 2.66%) in males, whereas females showed higher monounsaturated fatty acids (44.45% vs. 39.11%). These results indicate that sex significantly influences muscle composition, impacting both nutritional value and meat quality. The findings highlight the genetic potential of Aubrac cattle to produce protein- and lipid-rich beef with favorable health-related traits, making this breed particularly suitable for extensive and sustainable production systems. Such insights can guide breeders, meat producers, and researchers in implementing targeted management, selection, and breeding strategies to optimize beef quality and consumer benefits.

Key words*: Aubrac, meat, nutrition, quality, sustainability.*

INTRODUCTION

Cattle and beef production hold considerable importance for human society from nutritional, economic, and cultural perspectives. From a nutritional standpoint, beef represents a valuable source of high-quality proteins, essential for tissue development, maintenance of physiological functions, and proper functioning of the immune system. Regular consumption contributes to an adequate intake of essential amino acids required for maintaining a balanced diet (Poroșnicu et al., 2026). In addition, beef provides important micronutrients, including vitamin B12, iron, zinc, and selenium, which are critical for metabolic processes and overall human health. The presence of heme iron, a highly bioavailable form, further enhances its nutritional value by supporting hemoglobin synthesis and efficient oxygen transport within the body.

Beyond its dietary significance, the cattle and beef industry plays a vital role in the economy of many countries. It generates employment opportunities and contributes to income across multiple sectors, including farming, processing, and distribution. At the same time, beef occupies a central place in numerous culinary traditions, being a key ingredient in a wide variety of traditional dishes, appreciated for its distinctive flavor and versatility (Maysonnave et al., 2020). In this context, increasing attention has been directed toward specialized beef breeds, such as the Aubrac cattle breed (Bakharev et al., 2018).Originating from the Aubrac region in southern France, this breed is recognized for its long-standing history and its capacity to produce high-quality meat. Aubrac cattle are characterized by a robust and compact conformation, with medium to large body size, a well-developed frame, a broad and strong chest, and strong limbs (Mădescu et al., 2021). Their coat typically ranges from light grey to reddish tones, sometimes accompanied by darker pigmentation around the facial area. Despite their solid appearance, these animals exhibit notable agility.

A defining characteristic of the Aubrac breed is its remarkable adaptability to diverse environmental conditions (Matei et al., 2022). Traditionally raised in mountainous and hilly areas, these cattle demonstrate resilience to

harsh climates and the ability to efficiently utilize marginal grazing lands. This adaptability has facilitated their successful expansion into various regions, including lowland areas, where they continue to perform well under different production systems (Aviles et al., 2015).

The meat obtained from Aubrac cattle is widely appreciated for its superior sensory qualities, including fine texture, juiciness, and rich flavor profile. A key attribute is its excellent marbling, characterized by the uniform distribution of intramuscular fat, which enhances tenderness and palatability. As a result, Aubrac beef is highly valued on both local and international markets, meeting the growing consumer demand for premium-quality products (Mădescu et al., 2025).

Furthermore, beyond meat production, Aubrac cattle may also serve additional roles in certain regions, such as animal traction or participation in agricultural exhibitions, reflecting their multifunctional value within rural systems. The expansion of this breed in countries such as Romania illustrates a broader trend of agricultural diversification and alignment with evolving market requirements, offering benefits to both producers and consumers (Mădescu et al., 2025).

The chemical composition of beef is a key determinant of its nutritional value, with particular emphasis on lipid and protein fractions (Wu et al., 2016). Among these, fatty acids play a central role, as their profile directly influences both the technological properties of meat and its implications for human health (Bostami et al., 2023). Beef lipids consist of a complex mixture of saturated and unsaturated fatty acids, the relative proportions of which are influenced by genetic factors, feeding strategies, and production systems (Listrat et al., 2016). While saturated fatty acids are generally present in higher amounts, increasing attention has been directed toward the beneficial effects of unsaturated fatty acids, which are associated with improved lipid metabolism and a reduced risk of cardiovascular diseases (Davis et al., 2022; Davidescu et al., 2024). Consequently, the characterization of fatty acid composition has become an important criterion in the evaluation of meat quality (Mădescu et al., 2025).

In addition to lipids, the protein fraction of beef is of major nutritional importance, being defined by its amino acid composition (Ucar et al., 2024). Beef provides a complete profile of essential amino acids, which cannot be synthesized by the human body and must be obtained through dietary intake, thus playing a fundamental role in protein synthesis, tissue development, and metabolic regulation (Alekseeva et al., 2019). Furthermore, non-essential amino acids contribute to maintaining physiological balance and supporting various biochemical processes. The variability of amino acid composition, influenced by factors such as breed and feeding conditions, makes its assessment a valuable indicator of the biological quality of meat (Emery, 2013).

Within this context, the integrated evaluation of fatty acid and amino acid profiles offers a comprehensive approach to assessing beef quality (Lee et al., 2020). Such analyses are particularly relevant in the case of specialized beef breeds, including Aubrac cattle, where both genetic background and production conditions may contribute to the development of meat with enhanced nutritional and sensory attributes (O.M. Sheveleva et al., 2021).

MATERIALS AND METHODS

The study used 38 Aubrac beef cattle (28 males and 10 females), aged 15-18 months, raised in a semi-intensive system on a farm in southeastern Romania. The Aubrac cattle included in the study were slaughtered at 18 months of age in the farm's own slaughterhouse, which complies with the regulations set forth by Regulation (EC) No. 1099/2009 on the protection of animals at the time of slaughter, also adhering to hygiene and food safety standards. Meat samples were taken from the Longissimus dorsi muscle at the 13th rib (sirloin area), following ISO 3100-1:1991 guidelines for representative sampling. Each sample weighed 300-500 g and was prepared and stored for laboratory analysis.

The fatty acid profile of beef samples was determined using gas chromatography–mass spectrometry (GC-MS) following conversion to fatty acid methyl esters (FAME). Lipids were extracted with a chloroform-methanol mixture, after which transmethylation was performed using boron trifluoride (BF_3) in methanol at 60 °C for 30 min (AOAC, 1990).

FAME separation was carried out on a polar capillary column (30 m × 0.25 mm,

polyethylene glycol), using a temperature program from 100°C to 250°C. Helium was employed as the carrier gas (1.5 mL/min), with a split ratio of 40:1. Identification of compounds was achieved by mass spectrometry based on characteristic fragmentation patterns, while quantification was performed using a certified reference standard (FAME Supelco 37 Mix). Results were expressed as percentages of total identified fatty acids (FAO, 1991).

The analysis enabled the determination of major saturated, monounsaturated, and polyunsaturated fatty acids, including specific trans isomers. Based on these data, lipid quality indices were calculated, such as total saturated (ΣSFA), monounsaturated (ΣMUFA), polyunsaturated (ΣPUFA), and unsaturated fatty acids (ΣUFA), as well as omega-3 (Ω3), omega-6 (Ω6), and total trans fatty acids (TFA) (Simeanu et al., 2022; FAO, 1991).

The amino acid composition of beef samples was determined using an automatic amino acid analyzer (Mikrotechna AAA 881, Model 118/119 CL, CR). Prior to analysis, samples were subjected to acid hydrolysis with 6 M HCl at 110°C for 24 h to release free amino acids. Under these conditions, cysteine and methionine were converted into their oxidized forms (cysteic acid and methionine sulfone), allowing for their reliable quantification (Simeanu et al., 2022; FAO, 1991).

Tryptophan content was assessed separately following alkaline hydrolysis with NaOH at 110°C for 22 h, in accordance with standardized analytical procedures. Amino acid concentrations were expressed as g/16 g nitrogen (equivalent to g/100 g protein), enabling accurate evaluation of protein quality and nutritional value (Simeanu et al., 2022; FAO, 1991).

The collected data were first organized in a Microsoft Excel database for efficient handling and subsequently analyzed using SPSS (Statistical Package for the Social Sciences). Descriptive statistical analysis was applied, and the obtained results were expressed as percentages according to gender distribution. No inferential statistical tests were reported in the present study. The results are presented in tables as percentage distributions by gender.

RESULTS AND DISCUSSIONS

The fatty acid composition and the calculated lipid quality indices are summarized in Table 1. Analyses were performed on the M. Longissimus Dorsi, with samples collected from both male and female animals. The fatty acids in beef are an important aspect of the meat's chemical composition. We classify them into saturated and unsaturated fatty acids, and their proportion and type can influence the quality and nutritional characteristics of the meat.

Table 1.The content of saturated, monounsaturated, and polyunsaturated fatty acids in the *Longissimus dorsi* muscle

Specification	Gender	
	Male (n = 28)	**Female** (n = 10)
[1]SFA %	**48.96 %**	**46.82 %**
C10:0	0.40	0.10
C12:0	0.40	0.12
C14:0	3.28	3.36
C15:0	0.48	0.50
C16:0	23.43	28.23
C17:0	1.02	0.98
C18:0	19.86	13.45
C20:0	0.09	0.09
[2]MUFA %	**39.11 %**	**44.45 %**
C14:1	0.63	0.64
C16:1	2.92	4.38
C18:1	35.41	39.31
C20:1	0.16	0.12
[3]PUFA %	**3.96 %**	**2.66 %**
C18:2:cis	**3.49**	**2.10**
C18:3:cis:ω3	**0.47**	**0.56**

1 = saturated fatty acids (SFA); 2 = monounsaturated fatty acids (MUFA); 3 = polyunsaturated fatty acids (PUFA); n = number of samples.

Table 1 presents the fatty acid composition of the *Longissimus dorsi* muscle, highlighting differences between male and female Aubrac cattle. Saturated fatty acids (SFA) represented the predominant fraction in both sexes, accounting for 48.96% in males and 46.82% in females. Among individual SFAs, palmitic acid (C16:0) was notably higher in females (28.23%) compared to males (23.43%), whereas stearic acid (C18:0) was more abundant in males (19.86%) than in females (13.45%). Minor saturated fatty acids, including capric (C10:0), lauric (C12:0), myristic (C14:0), pentadecanoic (C15:0), heptadecanoic (C17:0), and arachidic acid (C20:0), were present in low concentrations with minimal sex-related variation.

Monounsaturated fatty acids (MUFA) were more prevalent in females (44.45%) than in males (39.11%). Oleic acid (C18:1) was the major MUFA, contributing 39.31% in females and 35.41% in males, while palmitoleic acid (C16:1) and myristoleic acid (C14:1) showed modest increases in females, reflecting an overall higher MUFA content in female beef. Eicosenoic acid (C20:1) remained minor in both sexes.

Polyunsaturated fatty acids (PUFA) constituted the smallest fraction, with males exhibiting 3.96% and females 2.66%. Linoleic acid (C18:2 cis) was predominant among PUFAs, particularly in males (3.49%), whereas alpha-linolenic acid (C18:3 cis, ω-3) was slightly higher in females (0.56% vs. 0.47% in males). Overall, male beef was characterized by higher total SFA and slightly elevated PUFA content, while female beef showed greater MUFA proportions, particularly oleic and palmitoleic acids, which may enhance nutritional quality and influence meat sensory attributes. These results underline sex-related differences in fatty acid composition that could inform breeding and dietary strategies aimed at optimizing meat quality.

Amino acids constitute the building blocks of proteins and their composition can be influenced by species, breed, and dietary factors (Albracht-Schulte et al., 2021). Assessing the amino acid profile provides valuable insights into the nutritional quality and biological value of meat. Table 2 summarizes the amino acid composition of the M. Longissimus dorsi muscle, including relevant indices, with samples obtained from both male and female animals.

Table 2. The content of essential and non-essential amino acids in the *Longissimus dorsi* muscle

Specification	Gender	
	Male (n = 28)	**Female** (n = 10)
[1]EAA %	**15.05 %**	**12.68 %**
Phenylalanine	1.12	0.93
Isoleucine	1.33	1.12
Histidine	1.17	0.95
Leucine	2.35	1.89
Lysine	2.60	2.15
Methionine	0.75	0.61
Threonine	1.30	1.09
Total tryptophan	3.06	2.85
Valine	1.38	1.11
[2]NEAA %	**15.56 %**	**13.28 %**
Aspartic acid	2.67	2.24
Glutamic acid	4.31	3.72
Alanine	1.61	1.42
Arginine	2.12	1.86
Cystine+Cysteine	0.29	0.27
Glycine	1.19	1.00
Hydroxyproline	0.01	0.01
Proline	1.10	0.87
Serine	1.21	1.02
Tyrosine	1.04	0.88

1 = essential amino acids (EAA); 2 = non-essential amino acids (NEAA);
n = number of samples.

The data presented in Table 2 highlight notable differences between male and female Longissimus dorsi muscles in terms of both essential (EAA) and non-essential amino acid (NEAA) content. Males consistently exhibit higher concentrations of all measured amino acids, with total EAA content reaching 15.05% compared to 12.68% in females, and total NEAA content of 15.56% versus 13.28% in females. Among essential amino acids, leucine and lysine were particularly abundant in males (2.35% and 2.60%, respectively), compared to females (1.89% and 2.15%). This trend is mirrored in non-essential amino acids, with glutamic acid and aspartic acid showing higher levels in males (4.31% and 2.67%) relative to females (3.72% and 2.24%).

These differences in amino acid composition may be linked to physiological and metabolic distinctions between genders. The higher EAA content in males suggests a greater capacity for protein synthesis and muscle growth, potentially reflecting the influence of anabolic hormones such as testosterone. Similarly, the elevated NEAA levels, particularly of glutamic acid and aspartic acid, indicate a higher availability of substrates for energy metabolism, nitrogen transport, and biosynthetic processes in male muscle tissue.

Moreover, the overall profile suggests that male *Longissimus dorsi* muscles may provide a more complete source of dietary protein in terms of both essential and non-essential amino acids. From a nutritional perspective, these findings underscore the importance of considering gender-specific differences when evaluating meat quality and protein value. The higher content of both EAA and NEAA in males could contribute to improved functional properties in processed meat products, such as enhanced texture and water-holding capacity, which are influenced by protein composition.

The observed differences between males and females in the *Longissimus dorsi* muscle amino acid profile reflect underlying biological variations in muscle metabolism, growth potential, and protein utilization.

CONCLUSIONS

The present study highlights clear sex-related differences in the fatty acid and amino acid composition of the *Longissimus dorsi* muscle in Aubrac cattle. Male muscles exhibited higher concentrations of both essential and non-essential amino acids, indicating greater protein quality and a higher potential for muscle growth. In contrast, female muscles were characterized by a higher content of monounsaturated fatty acids, particularly oleic and palmitoleic acids, which may contribute to improved meat flavor, tenderness, and nutritional value. Saturated fatty acids were predominant in both sexes, whereas polyunsaturated fatty acids were present in smaller proportions, with males showing slightly higher levels. These compositional differences have important implications for meat nutritional quality, sensory attributes, and processing characteristics, suggesting that sex should be considered when evaluating meat quality and developing breeding or feeding strategies aimed at optimizing both protein and lipid profiles. Overall, the findings provide valuable insights into the biological and nutritional distinctions between male and female Aubrac cattle, supporting targeted approaches to enhance meat quality and functional properties.

As a consequence of the reduced number of cows but an increased milk yield, milk production has continuously increased, except the year 1995 when it recorded the lowest level.

The North Eastern region is traditionally suitable for cow rearing, due to its pastures and meadows, the important number of cow livestock and possibilities to produce ecological milk.

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