Evaluating pH in Aubrac Cattle meat: Longissimus Dorsi & Semitendinosus at 0, 24, & 48 Hrs Postmortem

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Abstract
This study aimed to measure the pH of meat from both male and female Aubrac cattle. The study focused on the M. Semitendinosus and M. *Longissimus dorsi* muscles, comparing the pH values of the meat recorded at 0-, 24-, and 48-hours postmortem. Regarding the acidity of M. *Longissimus dorsi* in males, significant differences were observed between the average pH values at 0-, 24-, and 48-hours post-slaughter, with a slight decrease in the average from 6.05 at 0 hours to 5.5 at 48 hours. Similarly, significant differences were observed in females between the average pH values of M. *Longissimus dorsi* at 0-, 24-, and 48-hours post-slaughter. Analysing the acidity of M. *Semitendinosus*, significant differences were observed in both sexes between the average pH values at 0-, 24-, and 48-hours post-slaughter; for example, in males, average values ranging from 5.99 to 5.50 were obtained. In conclusion, these results highlight that the sex of the cattle influenced the average pH value at 0 hours for both muscle categories, collected from Aubrac cattle.

Keywords: Aubrac, *Longissimus dorsi*, meat, pH, *Semitendinosus*

1. Introduction

The Aubrac cattle breed is one of the most highly regarded meat breeds globally, with origins rooted in the mountainous Aubrac region in southern France. These cattle are known for their distinctive traits, which make them highly prized in the meat industry.
People recognize Aubrac for its adaptability to challenging environmental conditions, such as mountainous terrain and variable climates. These animals are robust and disease-resistant, making them ideal for rearing in diverse natural environments. Additionally, they are well-suited to grazing and grass-feeding, contributing to their superior meat quality. One of the most remarkable aspects of the Aubrac breed is its excellent meat quality. Aubrac meat is known for its fine texture, juiciness, and distinctive flavour. It is nutrient-rich, with a balanced amount of fats and proteins, making it both delicious and healthy.
Moreover, Aubrac meat stands out for its attractive colour and appealing appearance. It is often described as having a rosy hue with fine marbling and evenly distributed fat, contributing to its exceptional juiciness and flavour.
The Aubrac breed is renowned not only for its superior meat quality but also for its exceptional milk production. These cattle produce high-quality milk with a high fat and protein content, making them ideal for producing premium cheeses and dairy products [1,2].
The Aubrac breed distinguishes itself not only through its environmental resilience and

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adaptability but also through the excellent quality of its meat and milk. It is a valuable breed for both meat and dairy producers, providing products with exceptional taste and nutritional value.

Beef holds significant importance in the human diet, impacting health, economy, and culture. In the European Union, beef production experienced a decline in 2019 due to falling prices and reduced livestock numbers [3]. This trend intensified in 2020, exacerbated by the same factors and the COVID-19 pandemic, leading to reduced slaughter rates in the second quarter and constraining production and demand for higher-quality beef. However, a slight recovery is anticipated in the second half of 2020, with the global reduction in beef production estimated at 1.7% for the entire year.

Romania is well-positioned to capitalize on this trend due to its vast potential in pastureland and extensive beef cattle farming. Romanian farmers have the capacity to sustainably develop beef production to meet global demand. However, challenges persist in the beef industry, even within a more optimistic medium-term outlook. These include aspects related to production economics, potentially changing EU regulations, managing animal health and welfare standards, and environmental protection.

It is crucial for the industry to adapt and find sustainable solutions to address these challenges and ensure the sustainable development of the beef sector. Prospects for the beef industry are favourable amid the exponential growth of the world's population [4,5]. This demographic expansion will lead to increasing demand for beef, particularly in developing countries in the Far East.

The *Longissimus dorsi* muscle (Sirloin) is located on the dorsal side of cattle's back and is part of the group of back muscles. It is one of the most valuable meat muscles, being used in many culinary preparations due to its tender texture and rich taste. This muscle is usually cut into larger pieces, such as ribeye steak or filet mignon, and is considered one of the most delicious parts of the animal.

Figure 1. *Longissimus dorsi* muscle

The *Semitendinosus* is another important muscle located in the posterior part of the animal's thigh. It is part of a group of thigh muscles and is involved in leg movement and support. From a culinary perspective, the Semitendinosus is also a valuable source of meat, appreciated for its juicy taste and soft texture. It is used in a variety of preparations, such as roast beef or beef tenderloin, adding richness and flavour to different dishes.

Figure 2. *Semitendinosus* muscle

The quality of beef can be influenced by several factors, including the animal's breed, diet, age at slaughter, rearing methods, and meat processing. pH plays a crucial role in determining the quality of meat and can significantly affect its texture, taste, colour, and shelf life. Meat pH is a measure of its acidity or alkalinity and can vary depending on various factors, including the animal species, muscle type, slaughter method, and meat processing [6].

An adequate pH is essential for superior-quality meat. Generally, for fresh meats, the optimal pH falls within the range of 5.5 to 6.5. A higher pH may indicate lower-quality meat or meat that has begun to degrade, while a lower pH may indicate higher-quality meat but may affect its texture and shelf life.

Different pH values can also influence the aging and refrigeration processes of meat. For instance, a higher pH may slow down the aging process and increase the risk of microbial degradation, while a lower pH may accelerate aging and improve meat preservation. Thus, managing pH is essential in the meat industry to ensure product quality and safety [7,8].

In addition to its impact on meat quality, pH can also affect cooking processes and culinary experiences.

pH is an important indicator of meat quality and characteristics and must be carefully monitored and managed in the meat industry to ensure superior-quality products and food safety [9].

2. Materials and methods

At the moment of animal slaughter, the process of ending its life leads to the accumulation of lactic acid in the muscle fibres as a result of anaerobic metabolism, and the characteristic muscular pH level of a healthy and rested animal ranges between 7 and 7.3. After slaughter, the decrease in pH value is caused by ATP degradation, resulting in pH values between 5.4 and 5.5. The speed of this decline is influenced by species, muscle type, temperature, and various stressors. In this research, the potentiometric method was used to determine the pH of beef. The potentiometric method involves measuring the potential difference between a glass electrode and a reference electrode placed in the analysed sample, with this potential difference varying linearly with pH. The equipment used, called a pH meter, is equipped with a scale directly graduated in pH units (Figure 1). These devices use a single compound electrode, which is inserted into the analyzed solution and can be either fixed for laboratory use or portable for field analyses.

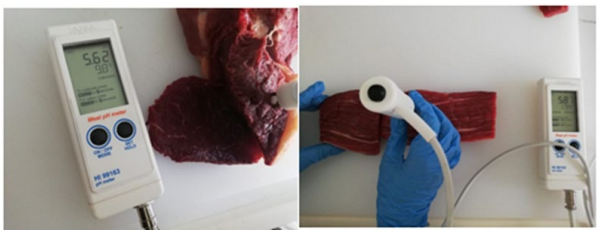

Figure 3. Laboratory pH meter, specially designed for the meat processing industry

The working method involves the use of actual meat or meat extract, with its preparation involving the cleaning of the meat from connective tissue and fat, followed by the fine chopping of the samples. Determining the pH with a special pH meter inserted into the meat sample is a straightforward yet precise process. Calibration is essential: before use, the pH meter must be calibrated using known pH buffer solutions to ensure measurement accuracy. Sample preparation involves taking a known quantity of meat and placing it in a suitable container, such as a laboratory glass or glass vessel. It's crucial to homogenize the sample to ensure accurate pH measurement. Electrode insertion follows: the pH meter electrodes, connected to the measuring device, are then inserted into the meat sample. One of the electrodes is a specialized glass electrode that detects pH variations in the sample. Measurement of pH: after the electrodes are placed in the sample, the measuring device displays the pH value on the screen. To obtain an accurate measurement, the electrodes must be stable and not exposed to external disturbances. Results interpretation: the pH value displayed on the screen represents the acidity or alkalinity of the meat sample. Depending on the obtained value and the pH range associated with meat quality, an assessment of the sample's quality and condition can be made. It's important to follow the manufacturer's instructions and perform measurements under appropriate conditions to ensure the accuracy and reliability of the results.
According to the specialized literature, the pH value interpretation range for beef is 5.5–6.0 for fresh meat and 6.0–6.7 for relatively fresh meat [3].

3. Results and discussion

In the present study, the pH of the Longissimus muscle (Sirloin) was determined in males and females at 0 h, 24 h, and 48 h. Subsequently, the comparison of the obtained means was conducted using the statistically analysed test, with a total of 30 samples analysed.

Tabel 1. Results regarding the pH of *Longissimus dorsi*

Maturation time	Gender	M. *Longissimus dorsi*		
		$\bar{X} \pm SD$	Min.	Max.
pH - 0 h	M	6.05 ± 0.04^{y}	5.99	6.12
	F	6.11 ± 0.05^{x}	6.03	6.18
pH – 24 h	M	5.60 ± 0.02^{x}	5.58	5.63
	F	5.61 ± 0.03^{x}	5.55	5.65
pH - 48 h	M	5.50 ± 0.02^{x}	5.47	5.53
	F	5.47 ± 0.02^{y}	5.45	5.51
OVERALL	M	5.72 ± 0.24^{x}	5.47	6.12
	F	5.73 ± 0.28^{x}	5.45	6.18

x & y: There are no significant differences (P > 0.05) between any two means within the same column indexed by the same letter. pH – the acidity of meat; M - males, F – females

According to the animals' sex, Table 1 highlights the obtained pH means for the Longissimus Dorsi muscle at 0 h, 24 h, and 48 h. Regarding the acidity of M. Longissimus dorsi in males, significant differences are observed between the average pH values at 0-, 24-, and 48-hours post-slaughter, with a slight decrease in the mean from 6.05 at 0 h to 5.5 at 48 h.
Additionally, significant differences are noted in females as well between the average pH values of M. Longissimus dorsi at 0-, 24-, and 48-hours post-slaughter. These results highlight that the sex of the cattle influenced the average pH value at 0 hours for the muscle group under study.
Sanudo C. et al. rigorously recorded a value of 5.59 for the pH levels of meat sourced from Aubrac cattle in their comprehensive study conducted in 1997 [10].

Tabel 2. Results regarding the pH of Semitendinosus muscle

Maturation time	Gender	M. Semitendinosus		
		$\bar{X} \pm SD$	Min.	Max.
pH - 0 h	M	5.99 ± 0.04^{y}	5.93	6.07
	F	6.05 ± 0.04^{x}	5.99	6.10
pH – 24 h	M	5.59 ± 0.02^{y}	5.56	5.62
	F	5.62 ± 0.12^{x}	5.56	5.96
pH - 48 h	M	5.50 ± 0.03^{x}	5.46	5.54
	F	5.46 ± 0.02^{y}	5.41	5.49
OVERALL	M	5.69 ± 0.22^{y}	5.46	6.07
	F	5.71 ± 0.26^{x}	5.41	6.10

x & y: There are no significant differences (P > 0.05) between any two means within the same column indexed by the same letter. pH – the acidity of meat; M - males, F - females

Analysing the acidity of the M. Semitendinosus, it is observed that, in both sexes, there are significant differences between the average pH values at 0-, 24-, and 48-hours post-slaughter. For example, in males, average values ranging between 5.99 and 5.50 were obtained.
Similarly, in the case of the M. Deltoid, it is observed that, in both sexes, there are significant differences between the average pH values at 0-, 24-, and 48-hours post-slaughter.
The results highlighted in Table 2 provide a detailed overview of the acidity dynamics in the Semitendinosus muscle, collected from carcasses of Aubrac cattle, with the average values falling within the ranges described in the specialized literature.

Conclusions

In conclusion, pH is a crucial parameter in meat quality assessment, influencing various aspects such as texture, taste, colour, and shelf life. Understanding pH dynamics in meat can provide valuable insights into the physiological changes occurring post-slaughter and during storage, aiding in the evaluation of meat freshness and quality. Monitoring and managing pH levels accurately are essential for ensuring the production of high-quality meat products that meet consumer expectations and safety standards.

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