# Colour Dynamics in Aubrac Cattle Meat: Longissimus Dorsi Analysis at 0-, 24-, and 48-Hours Postmortem

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**Abstract**
The objective of this study was to assess the changes in meat colour over time in Aubrac cattle of both genders. Specifically, the study concentrated on Longissimus Dorsi muscles, examining the colour values of the meat at 0, 24, and 48 hours after death. The development of the CIE Lab* colour space allows for the expression of colours in a three-dimensional system. The L*, a*, and b* values represent lightness, the red-green colour component, and the yellow-blue colour component, respectively. These values enable the evaluation and description of the colour of a meat sample. Taking into account the overall obtained results (example: the meat colour saturation recorded an average value of 14.28 ± 1.11 in males, and 17.72 ± 2.76 in females), we can appreciate that in the Aubrac cattle breed, there are significant differences between males and females, concerning all analysed parameters regarding colour (brightness, hue intensity, colour intensity of the meat, colour saturation, and Hue index) observed in the anatomical region under study.

**Keywords**: Aubrac cattle, colour, meat, quality.

## 1. Introduction

Cattle and their meat have significant importance for humans from several perspectives. Beef is an important source of high-quality protein, which is essential for the development and maintenance of healthy tissues, the immune system, and other vital human functions. Regular consumption of beef can ensure an adequate intake of proteins and amino acids necessary for balanced nutrition.
The breeding and marketing of cattle and beef play an important role in the economies of many countries. This industry provides employment opportunities and generates income for farmers, processors, and distributors.
Additionally, beef holds significant importance in many culinary cultures and traditions. It is a primary ingredient in numerous traditional dishes and recipes, bringing a distinct taste and aroma to the kitchen.
The Aubrac cattle breed is one of the most well-known and appreciated beef cattle breeds. This breed, known for its superior meat quality, has a long history and originates from the Aubrac region in southern France [1]. Aubrac cattle have a robust and compact appearance, with a medium to large stature. They have well-defined waists, broad and strong chests, and sturdy limbs. Their fur is usually light grey to reddish, and some individuals may have a black mask on their faces. Despite

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their massive appearance, they are agile and graceful [2].
Aubrac cattle's adaptability to different growing conditions is one of their strengths. These animals are accustomed to grazing in mountainous and hilly areas, which gives them good resistance to harsh climates and difficult terrains.
People appreciate the fine texture, juiciness, and rich flavour of the meat from Aubrac cattle. Excellent marbling, which evenly distributes fat within the muscle tissue, contributes to the meat's tendency to be tender and juicy. Their meat is valued both locally and internationally and sought after for its quality and distinct taste.
In addition to meat production, Aubrac cattle are also used for other purposes, such as animal traction in some regions, as well as participating in exhibitions and agricultural events [3].
The Longissimus dorsi muscle (Sirloin) represents an exceptionally valuable muscle in beef processing, renowned for its remarkable organoleptic qualities such as tender texture and intense flavour [4, 5]. This muscle is used for obtaining highly popular and appreciated meat cuts, such as T-bone, porterhouse, New York strip steak, and striploin roast.
The colour of meat is assessed by observing it externally and in cross-section. Initially, it is determined whether it is characteristic of the respective species. The colour of meat can vary from pale pink to dark red, depending on the type of muscle. The intensity and shade of the colour are determined by the content of myoglobin, haemoglobin, and the chemical state of the pigment in the muscle [6,7]. Within the same species, the colour of the meat can be influenced by various factors, such as age, health status, physiological condition of the animal before slaughter, and meat storage conditions [8].

## 2. Materials and methods

The research was initiated by forming a herd of Aubrac cattle, including both males and females. After slaughter, 30 samples were collected from the carcasses obtained from Aubrac breed animals, and the colour analysis of the Longissimus Dorsi muscle (Sirloin) was conducted.
In the process of perceiving the colour of meat, all these parameters are objectively expressed through the light emitted by the muscle tissue towards the viewing object, which describes the colour through five coordinates: L, a, b, C, and h°.
The determination of the colour of beef samples was performed using the Konica Minolta Chroma Meter CR-410. The device is a reflection spectrophotometer capable of measuring the colour of the sample using colorimetric scales such as XYZ, Yxy, Lab*, Hunter Lab, L Ch, and Munsell.
The development of the CIE Lab* colour space allows for expressing colours in a three-dimensional system. The values L*, a*, and b* represent brightness, the red-green colour component, and the yellow-blue colour component, respectively. These values enable the evaluation and description of a meat sample's colour. The L* value determines the level of brightness, while the a* and b* values determine the hue and intensity of the colour. By interpreting these parameters, we can obtain information about the colour of the meat and compare different samples in terms of visual appearance [9].
The chroma (C*) represents the colour's intensity or saturation and indicates how vibrant or intense a particular hue is. The higher the chroma value, the more intense and vibrant the colour is. Chroma values can range from zero (neutral or grey) to a maximum value (pure and intense colour).
Hue angle (H*), or hue, determines where a particular hue falls on the colour spectrum. It indicates whether the colour is red, green, blue, yellow, etc. The hue angle is measured in degrees and can range from 0° (red) to 360° (red, returning to the same hue).
The Chroma Meter CR-410 is equipped with a 50 mm measurement surface and is used for evaluating reflected colour and colour difference in a wide range of industries [10].
The procedure for determining colour consists of the following steps: the device was turned on and set to PC mode, then the SpectraMagicTM NX program was opened, and the device was connected to the computer to check the connection. The device was calibrated using the white calibration plate, and the samples were prepared for analysis. For colour reading, the device's tube was placed on the meat surface in a way that avoids external light from entering the device's light lamp [11].
The data were automatically stored in the program, and at the end of the determination, the document was saved with the desired name.

Subsequently, for the interpretation and understanding of the results, the SPSS (Statistical Package for the Social Sciences) analysis software was used by applying statistical methods.

## 3. Results and discussion

Colour is a parameter that refers to the physical characteristics of meat and can influence the consumption experience and, implicitly, the overall quality. It varies depending on the species, breed, and level of fattening of the animals. Ranging from pale pink to dark red, colour is influenced by the myoglobin content and other chemical compounds in the muscles.

In the course of the conducted research, Table 1 illustrates that the brightness level recorded in the M. *Longissimus dorsi* muscle in males exhibits significant differences between 0 ($32.99\pm0.81^{y}$) hours and 48 ($34.73\pm0.59^{x}$) hours post-slaughter, while in females, the differences are non-significant regarding the brightness level recorded at 0 ($35.94\pm 0.94^{x}$), 24 ($35.61\pm0.33^{x}$), and 48 hours ($35.35 \pm 0.41^{x}$).

**Table 1**. Results regarding the brightness of the meat

| Maturation time | Gender | M. *Longissimus Dorsi* | | |
|---|---|---|---|---|
| | | $\bar{X} \pm SD$ | Min. | Max. |
| L* - 0 h | M | $32.99 \pm 0.81^{y}$ | 31.94 | 34.51 |
| | F | $35.94\pm 0.94^{x}$ | 34.85 | 37.45 |
| L* – 24 h | M | $33.73 \pm 0.66^{y}$ | 32.78 | 34.78 |
| | F | $35.61 \pm 0.33^{x}$ | 35.25 | 36.34 |
| L* - 48 h | M | $34.73 \pm 0.59^{x}$ | 33.71 | 35.64 |
| | F | $35.35 \pm 0.41^{x}$ | 34.83 | 36.18 |
| **OVERALL** | M | $33.82 \pm 0.99^{y}$ | 31.94 | 35.64 |
| | F | $35.63 \pm 0.65^{x}$ | 34.83 | 37.45 |

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

Regarding the overall, significant differences were recorded between the meat colour obtained from males ($33.82\pm0.99^{y}$) compared to that obtained from females (35.63±0.65x). Sanudo et al. reported a value of 38.90±1.71 for the brightness of the meat obtained from Aubrac cattle in 1997 [12].

**Table 2.** Results regarding the hue of the meat

| Maturation time | Gender | M. *Longissimus Dorsi* | | |
|---|---|---|---|---|
| | | $\bar{X} \pm SD$ | Min. | Max. |
| a* - 0 h | M | $12.25 \pm 0.63^{y}$ | 11.11 | 13.83 |
| | F | $14.23\pm 0.41^{x}$ | 13.69 | 15.75 |
| a* – 24 h | M | $13.83 \pm 0.42^{y}$ | 13.09 | 14.55 |
| | F | $15.75 \pm 0.29^{x}$ | 15.24 | 16.24 |
| a* - 48 h | M | $13.83 \pm 0.47^{y}$ | 13.00 | 14.56 |
| | F | $19.73 \pm 0.76^{x}$ | 18.36 | 20.90 |
| **OVERALL** | M | $13.31 \pm 0.91^{y}$ | 11.11 | 14.56 |
| | F | $16.57 \pm 2.41^{x}$ | 13.69 | 20.90 |

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

Regarding the hue (a*) of the meat obtained from the Aubrac breed (Table 2), it is noted that the mean values recorded in the M. *Longissimus dorsi* muscle in males exhibit significant differences between 0 ($12.25 \pm 0.63^{y}$) hours and 48 hours post-slaughter ($13.83 \pm 0.47^{y}$), while in females, the differences are significant regarding the hue recorded at 0 ($14.23\pm 0.41^{x}$), 24 ($15.75 \pm 0.29^{x}$), and 48 hours ($35.35 \pm 0.41^{x}$). Additionally, significant differences were observed in the overall comparison of meat colour obtained from males versus females. Sanudo C. et al. reported a value of 14.12±1.22 for the hue of the meat obtained from Aubrac cattle in 1997 [12].

**Table 3.** Results regarding the colour intensity of the meat

| Maturation time | Gender | M. *Longissimus Dorsi* | | |
|---|---|---|---|---|
| | | $\bar{X} \pm SD$ | Min. | Max. |
| b* - 0 h | M | $4.04 \pm 0.78^{y}$ | 2.68 | 5.29 |
| | F | $5.32 \pm 0.28^{x}$ | 4.86 | 5.67 |
| b* – 24 h | M | $6.42 \pm 0.28^{x}$ | 6.06 | 7.02 |
| | F | $5.17 \pm 0.20^{y}$ | 4.99 | 5.52 |
| b* - 48 h | M | $4.81 \pm 0.40^{y}$ | 4.05 | 5.46 |
| | F | $8.28 \pm 0.53^{x}$ | 7.52 | 9.22 |
| **OVERALL** | M | $5.09 \pm 1.13^{y}$ | 2.68 | 7.02 |
| | F | $6.26 \pm 1.50^{x}$ | 4.86 | 9.22 |

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

Regarding the colour intensity (b*) of the meat obtained from the Aubrac breed (Table 3), it is observed that the average values recorded in the M. *Longissimus dorsi* muscle in males show significant differences between 0-, 24-, and 48-hours post-slaughter, while in females, the differences are significant regarding the colour intensity at 48 hours compared to 0 and 24 hours. Taking into account the overall obtained result, we can appreciate that in the Aubrac cattle breed, there are significant differences between males and females regarding the observed colour intensity. Sanudo C. et al. documented a colour intensity value of 10.02±0.93 for the meat obtained from Aubrac cattle in 1997 [12].

**Table 4.** Results regarding the colour saturation (Chroma) of the meat

| Maturation time | Gender | M. *Longissimus Dorsi* | | |
|---|---|---|---|---|
| | | $\bar{X} \pm SD$ | Min. | Max. |
| C* - 0 h | M | $12.92 \pm 0.61^{y}$ | 11.54 | 14.12 |
| | F | $15.19 \pm 0.46^{x}$ | 14.61 | 15.83 |
| C* – 24 h | M | $15.26 \pm 0.41^{y}$ | 14.57 | 15.86 |
| | F | $16.57 \pm 0.30^{x}$ | 16.04 | 17.12 |
| C* - 48 h | M | $14.65 \pm 0.47^{y}$ | 13.68 | 15.26 |
| | F | $21.40 \pm 0.75^{x}$ | 20.01 | 22.48 |
| **OVERALL** | M | $14.28 \pm 1.11^{y}$ | 11.54 | 15.86 |
| | F | $17.72 \pm 2.76^{x}$ | 14.61 | 22.48 |

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

Regarding the colour saturation (C*) of the meat obtained from the Aubrac breed (Table 4), it is observed that the average values recorded in the M. *Longissimus dorsi* muscle, regardless of sex, show significant differences between 0-, 24-, and 48-hours post-slaughter.

**Tabel 5.** Results regarding the hue of meat colour (Hue index)

| Maturation time | Gender | M. *Longissimus Dorsi* | | |
|---|---|---|---|---|
| | | $\bar{X} \pm SD$ | Min. | Max. |
| H° - 0 h | M | $71.74 \pm 3.49^{x}$ | 66.36 | 78.16 |
| | F | $69.50 \pm 0.70^{y}$ | 68.29 | 70.63 |
| H° – 24 h | M | $65.09 \pm 1.15^{y}$ | 63.15 | 67.12 |
| | F | $71.82 \pm 0.62^{x}$ | 70.55 | 72.76 |
| H° - 48 h | M | $70.83 \pm 1.57^{x}$ | 68.25 | 73.95 |
| | F | $67.23 \pm 1.43^{y}$ | 64.91 | 69.43 |
| **OVERALL** | M | $69.22 \pm 3.73^{x}$ | 63.15 | 78.16 |
| | F | $69.52 \pm 2.13^{x}$ | 64.91 | 72.76 |

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

Taking into account the overall obtained result, we can appreciate that in the Aubrac cattle breed, there are significant differences between males and females regarding the saturation of the colour observed in the studied muscle. The results regarding colour saturation in Aubrac cattle can provide important information about the quality and visual appearance of the meat, contributing to its characterization and evaluation within the beef industry.

Regarding the hue (H°) of the meat colour obtained from the Aubrac breed (Table 5), it is observed that the average values recorded in the M. *Longissimus dorsi* muscle in females show significant differences at 0-, 24-, and 48-hours post-slaughter. In males, significant differences are observed between the average values obtained at 24 hours (65.09°), compared to those recorded at 0 hours (71.74°) and 48 hours (70.83°).

## 4. Conclusions

In the process of perceiving meat colour, all these parameters are objectively expressed through the light reflected by the muscular tissue to the human eye. This allows for the description of colour using various metrics, including brightness (L), hue (a and b), saturation (C), and tone (h).

It is important to recognize the economic and nutritional value of cattle and beef, as well as to promote sustainability and food safety in this industry. Thus, the Aubrac cattle breed can be the best option for beef producers, considering the specificity of consumer demand.

My study fills a relatively unexplored research area regarding the quality of meat from Aubrac cattle. The findings are useful for researchers seeking a better understanding of these aspects. Additionally, they bring new perspectives on the subject, enriching existing knowledge.

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