EFFECT OF BEEF ULTIMATE pH ON MEAT TENDERNESS AND COLOR OF FEEDLOT FINISHED NELLORE CATTLE

Cátia A. Martins[1], Mariane Beline[2*], Rosana R. P. S. Corte[2], Daniel S. Antonelo[2], Juan F. M. Gómez[2], Henrique B. Silva[2], Bruna Pavan[2], Laura B. Toseti[2] and Saulo L. Silva[2]

[1]College of Zootechnical Engineering. Higher Institute of Agronomy, Lisbon, 1349-017, Portugal;

[2]College of Animal Science and Food Engineering, University of Sao Paulo, Pirassununga, 13635-900, Brazil;

*Corresponding author email: marianebeline@gmail.com

I. INTRODUCTION

The extent of postmortem pH decline dictates the development of important meat quality traits, such as tenderness, cooking loss, and color [1]. Insufficient postmortem pH decline increases the development of dark-cutting, which affects the appearance and the eating quality traits of meat and leads to a huge impact on consumers' purchasing decisions, affecting the beef industry [2]. Thus, this study was carried out to evaluate the effect of different ultimate pH (pH_u) ranges on meat tenderness and color of feedlot Nellore cattle.

II. MATERIALS AND METHODS

A total of 110 Nellore bulls (535 ± 50 kg body weight and 24 mo old) were slaughtered and after 24 hours chilling, the meat ultimate pH (pH_u) was measured in the longissimus muscle (LM), between the 12ª and 13ª ribs, using an electrode probe attached to a portable pH meter (Hanna Instruments model HI99163, Sao Paulo, Brazil). Forty-nine out of 110 carcasses were selected by their pH_u and split into three different treatments: pH_u < 5.7 (low pH_u; n = 25), 5.8 < pH_u > 6.1 (intermediate pH_u; n = 14) and pH_u > 6.1 (high pH_u; n = 10). Afterward, 2.5 cm thick LM steaks were sampled, identified, individually vacuum packed, and aged (0 to 4 °C) during seven days. After ageing time, samples were allowed to bloom by environment exposition for 20 minutes at 4 °C to 6 °C and then lightness (L*), redness (a*) and yellowness (b*) of the meat was performed using a portable spectrophotometer model CM2500d (Konica Minolta Brazil, Sao Paulo, Brazil) with standard illuminant D65, observation angle of 10° and aperture of 30 mm. Sarcomere length was performed by laser diffraction (Helium Neon Laser - Model 05-LHR-021; Melles Griot, Carlsbad, CA, USA). To determine cooking loss and shear force, samples were weighed and roasted in an oven (Model F130 / L – Electric Furnaces Golden Arrow Ind. and Com. Ltda, São Paulo, Brazil) equipped with a thermostat adjusted to 170°C. After cooking, samples were cooled to 22°C and weighed again, thus obtaining the value for cooking loss. After that, six cylinders (1.27 cm diameter) were taken from the samples to determine shear force by using a TMS-Pro texture analyzer (Food Technology Corporation, Sterling, VA, USA) with a Warner–Bratzler shear device and a crosshead speed set at 200 mm/min. The effect of the pH ranges on the meat characteristics was evaluated as a completely randomized design using the MIXED procedure of SAS 9.3 software (SAS Institute Inc., Cary, NC, USA). pH range was used as fixed effect and the animal was used as experimental unit. The least squares means statement was used to calculate the adjusted means for treatment. Differences were considered statistically significant when $P \leq 0.05$.

.

III. RESULTS AND DISCUSSION

High beef pH_u showed the lowest meat color values, whereas the low beef pH_u had the higher values of meat color values (Table 1), which can be explained by the higher water-holding capacity in high pH_u beef, resulting in a small amount of free water and low amount of lost proteins, such as myoglobin, and consequently lower L* values. On the other hand, as pH_u decreases close to the isoelectric point, free water increases and water-binding muscle proteins are lost and consequently the light scatters more, favoring the coloring of the meat [3].

Moreover, meat from intermediate pH_u group had the highest shear force value, whereas the lowest shear force was observed in the high pH_u meat (Table 1), which could be explained because pH may lead to improvements in tenderness through changes in proteolytic activity, as the calcium-activated proteases have a pH optimum close to 7.0 as reported by Greaser [4]. In the present study, although there were significant differences in shear force between treatments, sarcomere length was not affected by different pH_u ranges. According to Purchas [5], sarcomere length can explain only 50% of the variation in shear force.

Cooking loss was affected by pH_u. High pH_u group showed 24.7% lower value of cooking loss than intermediate pH_u group. Yu & Lee [6] stated that improvements in water-holding capacity and consequently lower cooking loss appears to be related to improved tenderness as pH_u increases above 6.1. In this study, samples that presented lower cooking loss (pH_u > 6.1, high pH group) showed better tenderness than samples that presented higher cooking loss (5.8 < pH_u > 6.0, intermediate pH group). It can be explained because lower cooking losses will allow cross-sectional areas of meat sample contain more water and less structural components [5], thus improving meat tenderness.

Table 1 Mean and standard error for low, intermediate and high pHu of shear force, cooking loss and sarcomere length from LM

Item	Treatments			p
	pHu < 5.7	5.8 < pHu > 6.0	pHu > 6.1	
Shear force, N	40.7 ± 4.3 b	52.7 ± 4.7 a	32.1 ± 5.0 b	0.0008
Cooking loss, %	24.0 ± 4.21 ab	24.7 ± 4.21 a	20.8 ± 4.22 b	0.0247
Sarcomere length, µm	1.8 ± 0.06	1.7 ± 0.06	1.7 ± 0.06	0.0774
L*	39.61 ± 0.55a	37.44 ± 0.65b	34.94 ± 0.73c	<0.0001
a*	18.46 ± 2.47a	16.29 ± 2.47ab	14.34 ± 2.48c	<0.0001
b*	15.96 ± 1.36a	12.57 ± 1.37b	10.10 ± 1.39c	<0.0001
Hue angle	39.92 ± 1.28a	38.35 ± 1.32ab	35.95 ± 1.36c	0.0137
Chroma	24.33 ± 2.80a	20.66 ± 2.81b	17.60 ± 2.82c	0.0001

Values within a row with different lowercase letters differ significantly at P < 0.05.
Hue angle = $\tan^{-1}(b^*/a^*)*(180°/\pi)$;
Chroma = $(a^{*2}+b^{*2})^{1/2}$

IV. CONCLUSION

Ultimate pH affects meat quality from Nellore beef. High pHu (pHu > 6.1) promotes dark-cutting, but it has higher tenderness than others pH_u ranges.

ACKNOWLEDGEMENTS

The authors wish to thank Laboratory of Animal Evolution and Meat Quality (LAAQC) for financing this project.

REFERENCES

1. Matarneh, S. K.; England, E. M.; Scheffler, T. L.; Gerrard, D. E. (2017).The conversion of muscle to meat. In F. Toldrá, Lawrie's meat science (p. 159-185), Cambridge: Woodhead Publishing.
2. JOO, S. T., Kim, G. D., Hwang, Y. H., Ryu, Y. C. (2013). Control of fresh meat quality through manipulation of muscle fiber characteristics. Meat Science, 95, (2013), p. 828-836.
3. Brewer, M. S., Zhu, L. G., Bidner, B., Meisinger, D. J., McKeith, F. K. (2001). Measuring pork color: effects of bloom time, muscle, pH and relationship to instrumental parameters. Meat Science, 57 (2001), p. 169-176.
4. Greaser, M. L. (1986). Conversion of muscle to meat. In P. J. Bechtel, Muscle as Meat (p. 37-102), Orlando: Academic Press.
5. Purchas, R. W. (1990). An assessment of the role of pH differences in determining the relative tenderness of meat from bulls and steers. Meat Science, 27 (1990), p. 129-140.
6. Yu, L. P., Lee, Y. B. (1986). Effects of postmortem pH and temperature on bovine muscle structure and meat tenderness. Journal of Food Science, 51 (1986), p. 774-780.