EFFECT OF AGEING TIME ON QUALITY PARAMETERS OF FOAL MEAT DURING DISPLAY

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Abstract - The effect of ageing time on the quality parameters of the *Longissimus dorsi* muscle from 16-month-old foals was assessed. For this study, eight samples were vacuum packaged and aged for 7 (A7) and 14 (A14) days at 5 ºC. After each ageing time, the samples were cut into steaks and packaged directly by sealing the film upon the tray. The visual color, metmyoglobin content, color parameters and lipid oxidation were evaluated at 0, 1, 2, 3 and 4 days during display at 2 ºC. From the sensory point of view, the color of A14 group turned from "characteristic" to "anomalous" at day 2 of storage time, whereas samples from A7 batch kept color stability during the whole display. On the other hand, the ageing time had a significantly influence on lipid oxidation, since the highest TBA values were found in longer ageing times (14 days). Therefore, it seems that longer ageing affected negatively color and lipid stability and, consequently, reduced the shelf file of foal meat.

Key Words – Color stability, Lipid oxidation, Metmyoglobin content, Storage time

I. INTRODUCTION

Foal meat is known by its nutritional properties [1]. This kind of meat is very recommended, above all, for children and elderly people with a high content of vitamins and minerals, principally, iron [2]. On the one hand, the ageing is an important process, which has not been stablished in foal meat yet and it is linked to meat properties. In general, foal meat quality and shelf life are determined by different characteristics including color, odor, appearance, lipid and protein oxidative status and microbial quality [3]. Among those, meat purchasing decisions are influenced by color more than by any other of those quality factors [4].

Vacuum packaging is the most commonly used ageing system by the meat industry. When the air is removed, its oxidizing effect is also eliminated, which allows higher ageing times delaying meat discoloration and lipid oxidation. The surface color of fresh meat changes from bright red to purplish red due to deoxymyoglobin formation [5]. Then, upon exposure to oxygen, bright-red oxymioglobin is rapidly formed on surface, allowing meat to bloom to the characteristic color of fresh meat. On the other hand, the high myoglobin content in foal meat and its susceptibility to oxidation result in early color degradation [6]. Furthermore, the meat industry needs to find the best compromise between the improvement in meat tenderness using vacuum ageing and the subsequent minimum loss in color and lipid stability of foal meat during retail display. Thus, the aim of this work was to study the effect of different ageing time in vacuum (7 and 14 days) on quality parameters of foal meat overwrap packaging during display (0, 1, 2, 3 and 4 days) at 2 ºC.

II. MATERIALS AND METHODS

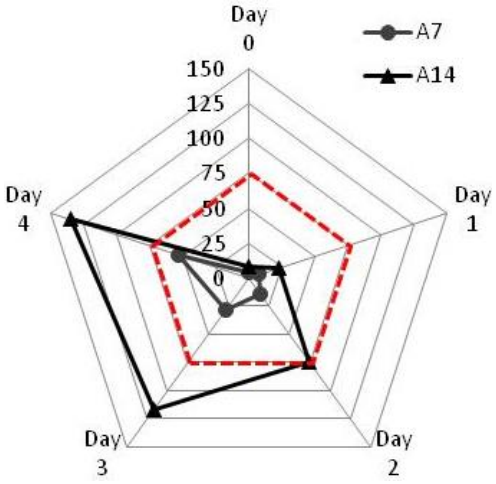
For this study, eight meat samples from the *Longissimus dorsi* (LD) muscle from the left half of carcass from 16-months-old foals of Burguete breed were used. The loin was divided in two equal parts, vacuum packaging and aged at 5 ºC for 7 (A7) and 14 (A14) days, respectively. After this ageing time, the samples were cut and the steaks were randomly placed in polyethylene trays covered with an oxygen permeable film (overwrap). The trays were then stored under simulated retail display conditions: at 2 °C for 4 days. At days 0, 1, 2, 3 and 4 of display one of the steaks was sampled. The color stability was analyzed based on metmyoglobin quantification over the meat surface (%MMb)

[7], whereas instrumental color coordinates, L*, a*, b* were determined using a Minolta CM-2002 spectrophotometer. For the evolution of the visual color, a quantitative analyses followed the methodology proposed by Gómez *et al.* [8] with some modifications were used. A trained 10-member sensory panel assessed the degradation of this attributes. A 150 mm unstructured line scale was used. It was indicated: on the left edge (minimum value, 0 mm) "characteristic color" and, on the right edge (maximum value, 150 mm) "anomalous color", respectively. The midpoint 75 marked the threshold between "characteristic" and "anomalous" ($0< 75 \leq 150$ mm). Lipid oxidation was determined in A7 and A14 just in days 0 and 4 of display. Finally, the thiobarbituric acid value (TBA) was calculated as described Tarladgis *et al.* [9]. The results were calculated from a standard curve of malonaldehyde with 1,1-3,3 tetraetoxipropane and expressed as mg MDA/kg sample. The effect of ageing time on visual color, metmyoglobin content, color parameters and lipid oxidation was examined using a mixed-model ANOVA, where these parameters were set as dependent variables, ageing time and storage period as fixed effect, and animals as random effect. The pairwise differences between least-square means were evaluated by Tukey's method. Differences were considered significant if $P<0.05$. The values were given in terms of mean values and standard deviation. All statistical analysis was performed using IBM SPSS Statistics 21 software.

III. RESULTS AND DISCUSSION

Figure 1 shows the effect of ageing time on the visual color of foal meat during the storage time. According to the scale used, values lower than 75 mm indicated a positive acceptance of color and, on the contrary, those higher than 75 mm indicated disapproval. The samples from A14 group were worse evaluated than those from the other one. In this line, foal samples aged for 14 days overcame the threshold point (75 mm) after 2 days of storage period, what means that the visual color changed from "characteristic" to "anomalous" just after 2 days of display. On the other hand, samples from A7 group were evaluated below the limit during the whole storage time (54 mm); so, the color was correctly preserved. These outcomes are in agreement with those reported by Vitale *et al.* [10] who observed that steaks aged for 14 and 21 days discolored at a relatively faster rate and to a greater extent than steaks aged for shorter times.

Figure 1. Effect of ageing time on the visual color of foal meat during the whole display

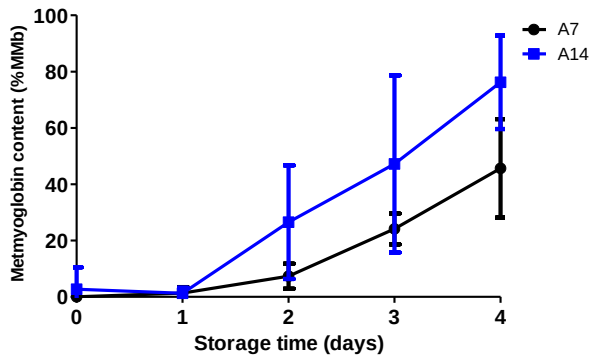


A7: Loins aged during 7 days
A14: Loins aged during 14 days

However, Ponnampalam *et al.* [11] noticed that vacuum ageing could improve consumer (color) acceptability of lamb over three days of display. These observed differences in the visual color between ageing times could be related to the results obtained from the lipid oxidation (data not shown). At day 0, both groups presented similar results (0.13 *vs*. 0.19 mg MDA/kg for A7 and A14 batches, respectively). However, after 4 days of storage, significantly ($P<0.001$) highest TBA values were observed in samples from A14 group (1.05 *vs*. 0.32 mg MDA/kg for A14 and A7 treatments, respectively), what means a higher degradation of the foal meat aged for 14 days. This result is in agreement with those noticed by Ismail *et al.* [12] who found that ageing influenced lipid oxidation at 0, 3, and 7 days of storage where both 2 and 3 week aged beef had higher TBARS values than 1 week aged beef. Therefore, it seems that longer ageing process conduces to fast and early color degradation.

The effect of ageing time on metmyoglobin content (%MMb) of foal meat during display is shown in Figure 2. No significant differences were observed between treatments till day 1 of storage. Nevertheless, after this period, a significantly higher increased in %MMb was noticed in A14 group compared to the other one.

Figure 2. Effect of ageing time on the metmyoglobin content of foal meat during the whole display

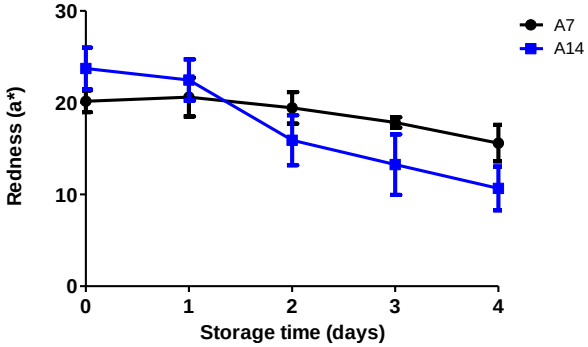


A7: Loins aged during 7 days
A14: Loins aged during 14 days

Several works related the metmyoglobin content to the sensory evaluation of the visual color. McDougall [13] affirmed that when the %MMb in the surface is over than 20%, the 50% of the consumers would reject the meat. Van den Oord *et al.* [14] established that when the %MMb in the surface is over than 40%, the 100% of the consumers would reject the meat. According to these statements, the meat aged 7 days would be only accepted by the 50% of the consumers after 3 days of display (24.1%) and rejected by the total of them after 4 days of display (45.7%). Nevertheless, the meat aged 14 days would be rejected by this 50% of the consumers just after 2 days (26.5%) and rejected by the total of them after 3 days of display (44.2%). These values are different from those described by Ruiz *et al.* [15], who found %MMb in non-aged foal meat higher than 40% after 3 days of storage time. Significant and positive correlations support the connection between the %MMb and the sensory evaluation (P<0.001) (r = 0.91 and r = 0.90, for A7 and A14 groups, respectively).

Initial foal lightness (L*) (0 days of display) did not differ between the two different ageing times (A7 and A14) (data not shown). This finding is in agreement with the data reported by Franco *et al.* [16], who found no significant changes in redness, yellowness and chroma values of meat using long vacuum ageing times, explaining these results with low myoglobin oxidation in vacuum packaged meat. However, Lindahl *et al.* [17] noticed more pronounced increase in L*, a* and b* values in samples aged for 1 day compared to 8 days of ageing. With regard to redness (a*), significant differences were observed between the two different ageing times (A7 and A14) at 0 days of storage (Fig. 3). This outcome is in disagreement with those reported by Vitale *et al.* [10] who found no significant differences in redness among samples from different ageing times.

Figure 3. Effect of ageing time on the redness of foal meat during the whole display



A7: Loins aged during 7 days
A14: Loins aged during 14 days

On the other hand, the highest decrease on a* values over the time were observed in foal samples from A14 group. This finding is in agreement with those noticed by Lindahl [18] who found the highest reduction in meat samples for the longer ageing times. To this regards, Sarriés *et al.* [19] observed that with ageing, there is a reduction in the oxygen consumption rate of the meat and an increase in the thickness of the oxymyoglobin layer resulting in a redder appearance. In addition, Zakrys *et al.* [20] noticed that a* values had a negative correlation while L* values had a positive correlation with

days of display, indicating that samples became less red and lighter over the duration of retail display. The difference in color stability between foal samples from short and long ageing times was also evident from other color parameters as indicated by chroma variations during display since the decrease in chroma has been related to the appearance of brown color in meat [21].

IV. CONCLUSION

The effect of ageing time on the visual color, metmyoglobin content, color parameters and lipid oxidation of foal meat has been assessed. Foal samples aged during 14 days showed an acceptable color only for up to two days of storage; whereas samples aged during 7 days was scores as "characteristic" color during the whole display. Longer ageing times (14 days) may achieve further improvements in tenderness but foal meat shelf life is reduced significantly as indicated by the poorer color stability evaluated by trained panelists at the end of storage.

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