Influence of aging time and technique (dry- vs. wet-aging) on tenderness, color and lipid stability of Belgian Blue beef

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Introduction

Postmortem aging is a process that occurs naturally in all muscle tissues which improves palatability attributes of meat such as flavor and tenderness. In the conversion of muscle to meat, natural enzymes breakdown proteins and lipids into smaller and more flavorful fragments. Furthermore, the hydrolysis of key muscle proteins by, mainly, calpains contributes to meat tenderization.
Two common approaches for beef aging are wet-aging and dry-aging. Wet-aging refers to meat aged in a sealed barrier package at refrigerated temperatures; while unpackaged wholesale cuts aged at controlled temperatures and relative humidity (RH) is defined as dry-aging. Dry-aging is an ancient process used nowadays to produce beef characterized by its unique flavor and superior quality, and mainly destined to high-end consumers (Bowker et al., 2010). Nevertheless, dry-aging is a costly procedure that requires hygiene in the chilling room (DeGeer et al., 2009).
Oxidative processes are the main non-microbiological factors implicated in quality of meat during chilled storage. The oxidation of myoglobin turns this pigment to metmyoglobin, which gives a brown color to meat. Furthermore, lipid oxidation results in formation of several products, some of them being often associated with the development of off-flavors even at low concentrations.
In this context, the present study was conducted to evaluate the potential effect of aging technique (wet-aging vs. dry-aging) and duration of aging (0, 21, 42 and 63 days) on the pH, tenderness, and color and lipid stability of Belgian Blue meat.

Materials and methods

Three *longissimus dorsi* (LD) from two Belgian Blue cows were supplied by a butcher shop located in the Walloon Region. Each LD was cut into two pieces. Three half-LD were cut in four pieces each, each piece was vacuum packaged and wet aged at 2 °C for up to 63 days. In parallel, the other three half-LD were dry-aged at the same temperature at 75 % RH for the same period of time. Analyses were performed each 21 days (d_0, d_{21}, d_{42} and d_{63}). Moreover, from d_{21}, each 21 days, a part of the samples was cut into steaks and repackaged in vacuum bags – 60 μm thick and oxygen permeability of 13 $cm^3/m^2 \cdot 24$ h at 23 °C and 0 % RH – or under shrinkable film (under atmospheric air) and stored during 4 days at 4 °C + 8 days at 8 °C (simulated retail display), and then analyzed (d_{21+12}, d_{42+12} and d_{63+12}). *pH measurement*: pH was measured using a pH meter Knick type 765 and a combined pH electrode (Ingold ref. 104063123), according to ISO (1999). Measurement was performed in five different zones of each sample and values were averaged. *Tenderness measurement*: samples were stored at –18 °C until analyses, then they were thawed at 4 °C for 24 h. Steaks were cooked in non sealed plastic bags in a water bath at 75 °C for 60 min. The open extremity of the bags was folded in order to avoid water leaking into them. After cooking, samples were chilled in an ice bath for 45 min, and cores, 1.25 cm in diameter, removed. Warner–Bratzler shear force (WBSF) was measured on 10 cores from each steak at room temperature using a Warner–Bratzler shear equipment (Lloyd LR5K), with a crosshead speed of 200 mm/min. *Color measurement*: instrumental evaluation of meat sample color was performed 1.5 h after removal from package and exposure to atmospheric air using a Minolta CM-600d spectrophotometer (11 mm aperture, D_{65} illuminant, 10° observation angle, color space CIE L*a*b*). The instrument was calibrated against air (zero) and a white calibration plate, as directed by the manufacturer. Ten measurements were made on the surface of each sample and the mean was calculated. Color measurement of dry aged samples was performed after trimming. *Myoglobin oxidation*: the accumulation of surface metmyoglobin was monitored using the ratio of the reflectance at 572 and 525 nm after K/S transformation (AMSA, 2012). A smaller ratio indicates more metmyoglobin, which gives the meat a brownish color. *Lipid oxidation*: to assess lipid oxidation, the

TBARS content was measured by spectrophotometric quantification of a complex formed with malondialdehyde (MDA). *Statistical analysis*: experimental data for each response variable was analyzed by ANOVA using the GLM procedure. Whenever a post-hoc test was suitable, Tukey test was performed.

Results and discussion

Initial pH value (d_0) was 5.55 ± 0.06. This parameter remained stable during 63 days of wet-aging. Conversely, an increase of pH was observed during dry-aging ($P < 0.05$). Aerobic conditions favor the growth of proteolytic spoilage bacteria such as *Pseudomonas*, and could have contributed to the higher pH measured at the end of dry-aging. After 63 days of aging and 12 days of display (d_{63+12}), wet aged samples presented lower pH than dry aged samples (5.48 ± 0.17 vs. 5.70 ± 0.33; $P < 0.05$). In absence of oxygen, the bacterial population consists mainly of lactic acid bacteria (LAB). The production of lactic acid by LAB could have contributed to the lower pH values observed in wet aged samples.
Initial WBSF value (d_0) was 99.3 ± 21.4 N. A decrease to 35.1 ± 6.7 N of WBSF was observed during the first 21 days of aging ($P < 0.05$). After this period, the tenderness of samples became stable. No significant differences were observed between the aging techniques. In the studied conditions, 21 days of aging was the minimum period necessary to achieve the lowest WBSF values.
Initial a* value (d_0) was 16.7 ± 2.3 and no significant loss of redness was observed during 63 days of aging. No influence of previous aging time or aging technique was observed during display. Conversely, an effect of the packaging during display was observed ($P < 0.05$). After 12 days of display a* values were 19.2 ± 1.8 and 10.8 ± 1.8 for vacuum packed and shrinkable film packed samples, respectively.
At d_0 K/S 572/525 ratio was 1.35 ± 0.01 and it remained stable during 63 days of aging. As for redness (a*), no influence of previous aging time or aging technique was observed during display, but an effect of packaging during display was observed ($P < 0.05$). After 12 days of display, K/S 572/525 ratio values were 1.33 ± 0.06 and 1.06 ± 0.11 for vacuum packed and shrinkable film packed samples.
TBARS value at d_0 was 0.13 ± 0.02 mg MDA-equivalent/kg and it increased ($P < 0.05$) to 0.55 ± 0.15 mg MDA-equivalent/kg after 63 days of aging (no effect of aging technique was observed). An effect of the previous aging time and packaging was observed during display ($P < 0.05$). After 12 days of display, TBARS values were 1.31 ± 0.86, 1.14 ± 0.94 and 1.88 ± 0.98 mg MDA-equivalent/kg for samples aged for 21, 42 and 63 days, respectively. TBARS values of 0.67 ± 0.50 and 2.22 ± 0.59 mg MDA-equivalent/kg were observed for vacuum packed and shrinkable film packed samples, respectively.

Conclusion

In this experiment, the sensitivity of samples to pigment oxidation was influenced by the packaging during display. Aging time and packaging during display influenced lipid oxidation.
Twenty-one days of aging allowed to achieve the maximum tenderness observed and would be compatible with a subsequent 12-day display under vacuum. A 12-day display period under shrinkable film is largely beyond the shelf life of meat under this condition.
This study contributes new knowledge about Belgian Blue beef behavior when it is wet or dry aged. Further research will be conducted to study the microbiological quality of these meats.

References

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