Meat Science 110 (2015) 32–39

Contents lists available at ScienceDirect

Meat Science

journal homepage: www.elsevier.com/locate/meatsci

Influence of extended aging on beef quality characteristics and sensory perception of steaks from the *gluteus medius* and *longissimus lumborum*

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ARTICLE INFO

Article history:
Received 17 November 2014
Received in revised form 24 June 2015
Accepted 25 June 2015
Available online 2 July 2015

Keywords:
Beef
Aging
Shelf-life
Tenderness
Consumer panel

ABSTRACT

The objective was to determine the influence of post-fabrication aging (2, 14, 21, 42, and 63 days) on beef quality characteristics and consumer sensory perception of *gluteus medius* (GM) and *longissimus lumborum* (LL) steaks. Lipid oxidation and aerobic plate counts increased ($P < 0.05$) with longer aging periods and retail display times. An aging period by day of retail display interaction ($P < 0.05$) was observed for a* and b* values for both muscles and L* values for the LL. Warner–Bratzler shear force values decreased ($P < 0.05$) with longer aging for the LL, while no difference was observed for the GM. Consumer panel results demonstrated that longer aging periods increased ($P < 0.05$) tenderness of both muscles. Our results indicate that extended aging reduces retail color stability yet has positive effects on consumer perception of tenderness of beef loin muscles.

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1. Introduction

The 2010/2011 National Beef Tenderness Survey revealed that post-fabrication aging times for subprimal cuts in cold storage facilities ranged from 1 to 358 days and 9 to 67 days for retail and foodservice subprimals, respectively (Guelker et al., 2013). Effects of aging on beef tenderness have been well-documented (Bratcher, Johnson, Littell, & Gwartney, 2005; Dixon et al., 2012; Eilers, Tatum, Morgan, & Smith, 1996; Gruber et al., 2006). Bratcher et al. (2005) concluded that USDA Select muscles should be aged at least 14 days postmortem, whereas beef from carcasses in the upper two-thirds of USDA Choice was tender by 7 days postmortem. Gruber et al. (2006) also demonstrated that most USDA Select muscles require longer aging times than those from carcasses grading in the upper two-thirds of Choice. To date, most research on beef tenderness, including the work cited above, has focused on the effects of relatively short term aging (28 days or less) on Warner–Bratzler shear force. Consequently, little is known about the effects of extended aging of beef on shear force or consumer acceptability.

In addition to the paucity of information regarding the effects of extended aging on beef tenderness, relatively little is known about the effects of extended aging on beef color and flavor development. McKenna et al. (2005) demonstrated that beef muscles can be classified based on color stability. Interestingly, Lee, Apple, Yancey, Sawyer, and Johnson (2008a) observed no interaction between aging up to 35 days and bloom development of beef *longissimus thoracis*. However, these researchers reported that *gluteus medius* (GM) from top sirloin butts aged 14 days or less had more vivid color and a greater proportion of oxymyoglobin compared with GM steaks aged 28 to 35 days (Lee, Apple, Yancey, Sawyer, & Johnson, 2008b). Additionally, color of beef *longissimus lumborum* (LL) was more stable than the *psoas major* (PM) when product was stored from 8 h to 21 days prior to steak fabrication (Madhavi & Carpenter, 1993). The retail display time to 20% metmyoglobin accumulation was similar across storage times for LL steaks, despite a decrease in metmyoglobin reducing activity with increasing storage time (Madhavi & Carpenter, 1993).

Aging influences numerous volatile compounds in beef muscles, and positive flavor compounds generally decrease while negative compounds increase with aging from 7 to 14 days (Stetzer, Cadwallader, Singh, McKeith, & Brewer, 2008). Likewise, Yancey, Dikeman, Hachmeister, Chambers, and Milliken (2005) reported that wet-aging of GM, *supraspinatus*, or PM steaks for 21 or 35 days tended to increase metallic or rancid flavors detected by a trained panel. Little is known regarding the effects of aging longer than 35 days on consumer perception of beef flavor.

Gluteus medius and LL steaks derived from USDA Select carcasses have been shown to exhibit moderate to high aging responses, respectively, with potential to continue tenderizing beyond 28 days of aging (Gruber et al., 2006). Consequently, peptides and amino acids generated by proteolysis may contribute to flavor development in these muscles

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http://dx.doi.org/10.1016/j.meatsci.2015.06.013
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during extended aging. Additionally, the GM and LL were categorized as "intermediate" and "high" color stability muscles, respectively, when aged for 3 days and subjected to 5 days of retail display (McKenna et al., 2005). The effect of aging beef for longer than 28 days is unclear. Our specific objective was to determine the influence of wet aging for 2, 14, 21, 42, and 63 days on retail color stability, microbial growth, lipid oxidation, Warner–Bratzler shear force, soluble and insoluble collagen levels, and consumer acceptability of beef GM and LL steaks.

2. Materials and methods

2.1. Human subject participation in consumer panel

The University of Idaho Institutional Review Board certified this project as Exempt.

2.2. Product procurement

At 48 h post mortem (fabrication = day 0), beef top sirloin butt [Institutional Meat Purchase Specifications (IMPS) 184; NAMP, 2011] and strip loin (IMPS 180; NAMP, 2011) from the left side of USDA Select carcasses (n = 12 of each wholesale cut) were purchased from AB Foods (Toppenish, WA) and transported to the University of Idaho Meat Science Laboratory.

2.3. Preparation of product

The *gluteus medius* (GM) and *longissimus lumborum* (LL) were removed from their respective wholesale cuts for aging and subsequent analysis. The muscles were cut into five sections at least 5.1 cm-thick (Fig. 1). Each section was randomly assigned to one of the five aging periods (2, 14, 21, 42, and 63 days post-fabrication). Sections were vacuum shrink packaged (7 × 12 in. Durashrink bags, Winpak Films, Senoia, GA) and subsequently aged for the pre-determined time period at 0 °C.

At the end of each aging period, designated sections were cut into two 2.54 cm-thick steaks, which were randomly assigned to determine either consumer acceptability or retail shelf-life followed by Warner–Bratzler shear force (WBSF) and collagen analysis. Steaks used for retail display were weighed, swabbed (3 M Quick Swab) for microbial analysis, sampled for thiobarbituric acid reactive substances (TBARS) analysis, placed in white Styrofoam trays, and overwrapped with an oxygen permeable PVC film (Koch Industries, Inc. #7500-3815; Wichita, KS) with the freshly cut surface exposed to oxygen. Steaks were displayed in a glass-fronted retail display case (Model GDM-69, True Manufacturing Co., O'Fallon, MO) at 3 °C for 4 days. The display case was equipped with natural white Hg 40 W lights, and the average light intensity was 409 lx. Following retail display, steaks were weighed, swabbed for microbial analysis, sampled for TBARS analysis, cooked, measured for tenderness (WBSF), and frozen for collagen analysis. Steaks designated for consumer acceptability were weighed and exposed to retail display conditions as described above for 1 day, then reweighed, swabbed for microbial analysis, sampled for TBARS analysis, vacuum packaged, and frozen at −20 °C to stop the aging process, until completion of all aging periods when consumer panels were conducted.

2.4. Fluid loss

Each section was weighed prior to vacuum packaging and after aging to determine percent purge. Steaks were weighed prior to and following 4 days of retail display to determine percent retail fluid loss.

2.5. Retail color

Steaks were allowed to bloom for at least 60 min, then two instrumental color measurements per steak were taken using a Hunter MiniScan EZ (Restin, Virginia). Each point was selected avoiding large marbling flecks, connective tissue, and the product edge. This represented day 0 of retail display, and subsequent color measurements were taken on days 1, 2, 3, and 4. The Hunter MiniScan was equipped with a 25 mm-diameter measuring area and a 10° standard observer. The instrument was set to illuminant A, and Commission International de l'Eclairage (CIE) L* (lightness), a* (redness), and b* (yellowness) values were recorded. Calibration of the machine was carried out each day by measuring against black and white calibration tiles.

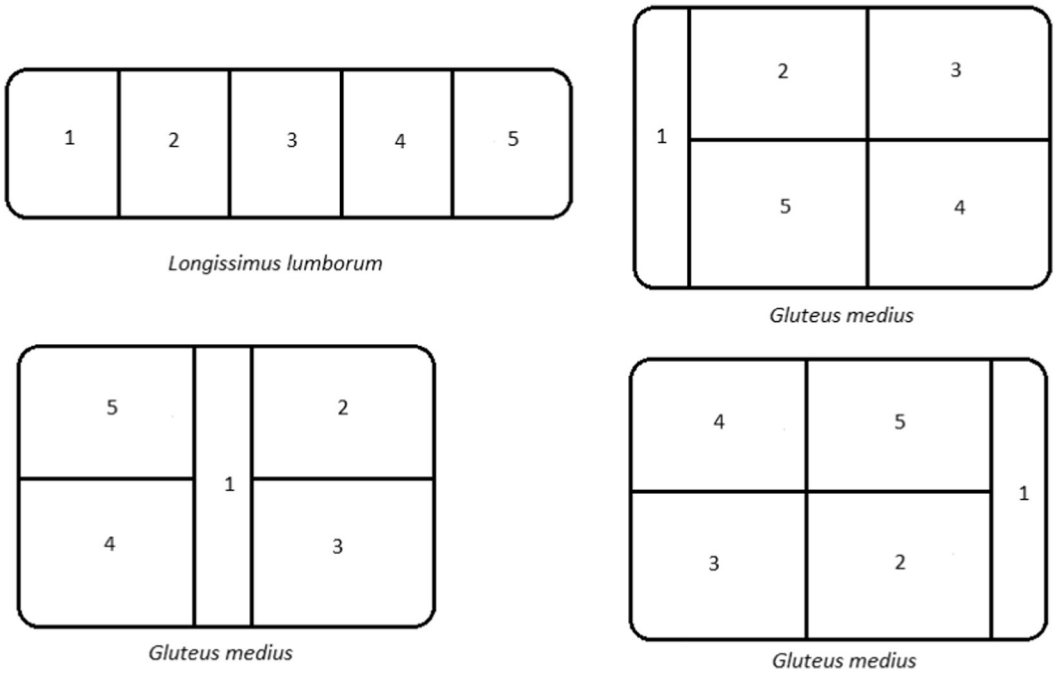

Fig. 1. Sectioning example of one *longissimus lumborum* (top left) and three *gluteus medius* (top right, bottom left, bottom right) muscles. Diagrams represent anterior to posterior and medial to lateral from left to right and top to bottom, respectively. Due to the size of the *gluteus medius*, the first aging period sample was cut steak thickness as shown above, while the remaining sections were at least 5.1 cm-thick and assigned so that each aging period was represented at each location.

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