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Novel approach to aging beef: Vacuum-packaged foodservice steaks versus vacuum-packaged subprimals

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ABSTRACT

This study evaluated quality attributes of beef aged as subprimals versus as steaks. Paired subprimals ($n = 5$ pairs of five subprimal types) were selected and assigned to a treatment: (1) aging as vacuum-packaged steaks (portioned 7 d postmortem), or (2) aging as vacuum-packaged subprimals (portioned into steaks after each aging period: ribeye, 28 d; strip loin, 28 d; top sirloin butt, 35 d; tenderloin, 21 d; and short loin, 28 d). To simulate typical U.S. handling and distribution, all steaks were held an additional 14 d before color, shelf life, Warner–Bratzler shear force (WBSF), and consumer sensory analyses were conducted. Aging subprimals tended to result in a lower WBSF for the strip loin and significantly lower WBSF for top sirloin butts. Although consumer panelists preferred the strip loin aged as steaks, they had no preference for aging method for the other muscles. Overall, findings from this study show the potential for portioning subprimals into steaks before aging.

1. Introduction

In an effort to meet consumer expectations for high quality beef products and exceptional eating experiences, aging of fresh beef for retail and foodservice has become a standard U.S. industry practice. The process of wet aging is described as the refrigerated storage of vacuum-packaged subprimals for a period of time necessary to maximize tenderness, juiciness, and flavor (Campbell, Hunt, Levis, & Chambers, 2001; Oreskovich, McKeith, Carr, Novakofski, & Bechtel, 1988; Parrish, Boles, Rust, & Olson, 1991; Sitz, Calkins, Feuz, Umberger, & Eskridge, 2006). Tenderness is one of the leading factors influencing consumer perception of palatability (Gruber et al., 2006; Savell et al., 1987, 1989). Appreciating the beef industry's struggle to provide consumers with high quality beef products at reasonable prices, researchers continue to explore new, cost-effective processing methods, such as modifying conventional aging practices to reduce needed storage space. This conventional aging method could be modified to reduce needed storage space.

To date, no data are available to draw quality attribute comparisons between wet-aged steaks and steaks derived from wet-aged subprimals. Cutting steaks from subprimals before the aging process may allow the industry to realize economic advantages without negatively impacting beef quality. For example, processors may benefit from the faster and more efficient use of lean trimmings produced by cutting steaks before aging. Furthermore, storage of large boxed subprimals would be largely reduced, lessening the burden on cooler storage capacity. Processors would still have to accommodate storage of the vacuum-packaged steaks during aging, but the smaller product units should allow commercial processors added storage flexibility with smaller packages and fewer boxes. In an effort to assist processors interested in exploring novel aging methods, this study was conducted to identify potential differences in quality attributes of beef derived from five aged subprimal types versus products aged as steaks.

2. Material and methods

2.1. Product collection

A-maturity, yield grade 2 or 3 carcasses with small or modest marbling (USDA, 1997) and carcass weights ranging from 364.7 to 397.4 kg ($n = 5$) were selected at a commercial beef harvest and processing facility for use in this study. Five subprimal types fabricated to comply with Institutional Meat Purchase Specifications (IMPS), as described by the North American Meat Processors Association (2010), were removed from selected carcasses. All subprimals were selected in pairs ($n = 5$ pairs each): beef rib, ribeye, lip-on (IMPS 112A); beef loin, strip loin, boneless (IMPS 180); beef loin, tenderloin, full (IMPS 189); beef loin, short loin, short-cut (IMPS 174); and beef loin, top sirloin butt, boneless (IMPS 184). Once packaged, subprimals were boxed and transported via refrigerated truck to a commercial further processing facility to be aged. The pack date was identified as day 0 for all aging periods. However, subprimals assigned to the steak aging treatment were not cut until day 7.

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2.2. Treatment design

Upon arrival at a commercial further processing facility, each subprimal within a pair was assigned randomly to one of two treatment groups: (1) aging as vacuum-packaged subprimals (as outlined previously), or (2) aging as vacuum-packaged steaks: beef rib, ribeye steak, lip-on, short-cut, boneless (IMPS 1112B); beef loin, strip loin steak, boneless (IMPS 1180); beef loin, tenderloin steak, side muscle off, skinned (IMPS 1190A); beef loin, porterhouse steak (IMPS 1173) or beef loin, T-bone steak (IMPS 1174); and beef loin, top sirloin butt steak, semicenter-cut, boneless (IMPS 1184A). Subprimals destined for aging as steaks were swabbed for baseline microbiological analyses (lactic acid bacteria and aerobic plate count), weighed for purge evaluation, cut into steaks 7 d postmortem, and vacuum packaged (Model R-140; Multivac, Kansas City, MO). Vacuum-packaged steaks and subprimals were aged based on the scheme outlined in Table 1.

At the conclusion of each assigned aging period, aged subprimals were cut into steaks and vacuum packaged. Steaks from both treatment groups were transported to the Rosenthal Meat Science and Technology Center at Texas A&M University (College Station) following their respective aging periods. To simulate typical U.S. handling and distribution, steaks then were held an additional 14 d under refrigerated conditions (approximately 4 °C) in boxes. Within a subprimal, both subprimal-aged and steak-aged products were aged for the same length of time.

2.3. Microbiological analyses

Swab samples were collected on day 7 from surfaces of subprimals destined for aging as steaks. Swabs also were taken from steak surfaces of both treatment groups on each evaluation day outlined in Table 1. Before sample collection, all sponges (3M, St. Paul, MN) were hydrated with 25 ml of buffered peptone water (BPW; Difco, BD Diagnostics, Sparks, MD). Sponges then were wrung-out in the bag to remove excess BPW, removed from the bag, and used to swab two 100-cm^2 areas of each sample surface using a template. Samples were taken by making five horizontal passes with a sponge, flipping the sponge over, and utilizing the opposite side of the sponge to make an additional five vertical passes over the sample surface. Non-sterile latex gloves were worn at all times. Samples were stored at refrigerated conditions (approximately 4 °C) until arrival at the Food Microbiology Laboratory at Texas A&M University (College Station).

Upon arrival, samples were hand-pummeled for 1 min. To accommodate both aerobic plate count (APC) and lactic acid bacteria (LAB) analyses, pummeled samples obtained on day 7, and each evaluation day, were plated in duplicate onto APC Petrifilm plates (3M, St. Paul, MN) by using appropriate serial dilutions and pipetting 1 ml of sample onto the center of the bottom film. For LAB determination, serial dilutions were performed onto one-half of the APC Petrifilm plates using Lactobacilli de Man, Rogosa, Sharpe broth (MRS; Difco, BD Diagnostics, Sparks, MD) in place of BPW. Pummeled samples obtained on evaluation days also were plated onto Yeast and Mold Petrifilm plates (3M, St. Paul, MN) by using appropriate serial dilutions and pipetting 1 ml of sample onto the center of the bottom film. When necessary, a spreader was used over the top film of the Petrifilm plates to distribute the inoculum over the circular area before gel formed. APC plates were incubated aerobically for 48 h at 35 °C, LAB plates were incubated anaerobically for 48 h at 35 °C, and Yeast and Mold plates were incubated aerobically at 25 °C for 3 to 5 d. Following incubation, plates were counted.

Table 1
Aging period (days) by subprimal type.

Subprimal type	Aging period (days)	Evaluation day
Tenderloin	21	35
Ribeye	28	42
Strip loin	28	42
Shortloin	28	42
Top butt	35	49

2.4. Color, odor, and purge evaluations

On each of the evaluation days identified in Table 1, a 6-member trained panel performed color, odor, and purge evaluations. Scales outlined by the American Meat Science Association (AMSA, 2012) were utilized for purge characterization, off-odor quantification, and all color attributes. Scales for purge quantification and off-odor characterization were not detailed by AMSA (2012) and were developed internally. Visual assessments of lean color (1 = pale purple-red; 8 = extremely dark purple-red), purge quantification (1 = none; 5 = excessive), purge characterization (1 = other; 6 = dark red or purple), fat color (1 = white; 5 = yellow), and bone marrow color when applicable (1 = bright reddish-pink to red; 7 = black discoloration), were conducted before each package was opened. Immediately after packages were opened, trained panelists scored off odors using a 5-point scale (1 = no off-odor; 5 = extreme off-odor). When off odors were identified, panelists characterized the odors as: bloody/serumy, acidic, sour, putrid/spoiled, or other. Following a 30-min bloom time, lean color (1 = pale red; 8 = very dark red), fat color (1 = white; 5 = yellow), and bone marrow color when applicable (1 = bright reddish-pink to red; 7 = black discoloration), were again evaluated. Instrumental color measurements also were taken, after the 30-min bloom time, using a calibrated Hunter MiniScan EZ (Model 4500L; HunterLab, Reston, VA) colorimeter with a 3.18 cm aperture, 10° observation angle and D65 illuminant. Calibration of the Hunter MiniScan EZ was conducted using the "standardization" function of the device and placing black and white calibration tiles at the aperture when prompted on the device screen. Three instrumental color measurements were taken on the cut surface of each steak to produce mean L^*, a^*, and b^* color space values. Steaks opened for evaluation were re-packaged and frozen (approximately 0 °C) until Warner–Bratzler shear force (WBSF) analyses were performed. While steaks destined for sensory panel evaluations remained unopened, they were placed in frozen storage at the same time as those designated for WBSF.

2.5. Warner–Bratzler shear force evaluation

Steaks were thawed under refrigerated conditions (approximately 4 °C) for 48 h before cooking. Steaks were cooked on Presto® non-stick electric griddles (National Presto Industries, Inc., Eau Claire, WI). Griddles were pre-heated for 15 min to an approximate temperature of 177 °C. Before cooking, steaks were weighed and initial internal temperatures were recorded. Internal temperatures were monitored using thermocouple readers (Omega™ HH506A, Stamford, CT) and 0.2 cm diameter copper-constantan Type-T thermocouple wires (Omega) inserted into the geometric center of each steak. Once each steak reached an internal temperature of 35 °C, they were flipped to the opposite side and cooked to a final temperature of 70 °C. After steaks were removed from the griddles, thermocouples were removed from each steak, and cooked steak weights were obtained. Steaks then were cooled for 16 to 18 h at approximately 4 °C.

Cooled steaks were allowed to equilibrate to room temperature before being trimmed of visible fat and heavy connective tissue to expose muscle fiber orientation. At least six 1.3 cm cores were removed from the medial, middle, and lateral portions of each steak. Cores were removed parallel to the muscle fibers and sheared once, perpendicular to the muscle fibers, on a United Testing machine (United SSTM-500, Huntington Beach, CA) at a cross-head speed of 500 mm/min using an 226.8 kg load cell, and a 1.02 cm thick V-shape blade with a 60° angle and a half-round peak. The peak force (N) needed to shear each core