QUALITY AND PALATABILITY OF FOODSERVICE BEEF AGED AS VACUUM-PACKAGED SUBPRIMALS OR VACUUM-PACKAGED STEAKS

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Abstract – This study evaluated potential differences in quality attributes of beef aged as subprimals versus as steaks. Paired subprimals (*n* = 25 pairs) were selected and assigned randomly to a treatment group: (1) aging as vacuum-packaged steaks, or (2) aging as vacuum-packaged subprimals. Subprimals destined for aging as steaks were portioned 7 d postmortem. Remaining subprimals were aged intact and portioned into steaks after aging period. Product aging times were determined by subprimal type: 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/tenderness, shelf life, and consumer sensory analyses were conducted. A few differences between aging treatments were observed in odor and purge, but these attributes did not impact consumer panelist ratings. Overall, findings from this study support the practice of portioning subprimals into steaks before aging.

Key Words – aging, beef, steak, subprimal

I. INTRODUCTION

To meet consumer expectations for high quality beef products and exceptional eating experiences, aging of fresh beef for retail and foodservice has become a 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 [1]. 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.

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. This study was conducted to identify potential differences in quality attributes of beef derived from aged subprimals versus products aged as steaks.

II. MATERIALS AND METHODS

A. Product collection

Five subprimal types, fabricated to comply with Institutional Meat Purchase Specifications (IMPS), as described by the North American Meat Association [2], were removed from selected U.S. Choice 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.

B. 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 or (2) aging as vacuum-packaged steaks. Subprimals destined for aging as steaks were weighed for purge evaluation, cut into steaks 7 d postmortem, and vacuum packaged. 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 Texas A&M University 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).

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

C. Color, odor, and purge evaluations

On each of the evaluation days (Table 1), a 6-member trained panel performed color, odor, and purge evaluations [3]. Visual assessments of lean color, purge quantification/characterization, fat color, and bone marrow color (where applicable) were conducted before each package was opened. Immediately after packages were opened, trained panelists scored odors using a 5-point scale [3]. 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, fat color, and bone marrow color (where applicable) were again evaluated. Instrumental color measurements also were taken using a Hunter MiniScan EZ (HunterLab, Reston, VA) colorimeter after the 30-min bloom time.

D. Shear Force and Consumer Sensory

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). Before cooking, steaks were weighed and initial internal temperatures were recorded. All steaks were flipped over upon reaching an internal temperature of 35 °C, and removed from the griddle upon reaching a final internal temperature of 70 °C. Internal temperatures were monitored with thermocouples and thermocouple readers (Omega™ HH506A, Stamford, CT) using 0.02 cm diameter, copper constantan Type-T thermocouple wires. After steaks were removed from the griddles, thermocouples were removed from each steak, and cooked steak weights were obtained.

Steaks for shear force analyses were cooled for 16 to 18 h. 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 was recorded, and the mean peak shear force of the cores was used for statistical analysis.

Steaks for consumer sensory panel evaluation were cut into cubes (approximately 1.27 cm) and served warm in individual booths equipped with red theater gel lights. Samples were served in a random order and identified with random three-digit codes. Unsalted saltine crackers and double distilled, deionized water were served to panelists to cleanse their palate between samples.

Consumer panelists (n = 80) were recruited from the Bryan/College Station area using an existing consumer database. Panelists were asked to evaluate steak attributes based on 10-point scales: overall liking (1=dislike extremely; 10=like extremely), flavor liking (1=dislike extremely; 10=like extremely), tenderness liking (1=dislike extremely; 10=like extremely), level of tenderness (1=dislike extremely; 10=like extremely), juiciness liking (1=dislike extremely; 10=like extremely).

E. Statistical analysis

Data were analyzed using SAS (SAS Institute Inc., Cary, NC). Descriptive statistics and frequency distributions were generated using the PROC

FREQ procedure. Frequency distributions for trained color and odor panel were tested for significance ($P < 0.05$) using χ^2 analysis. All other data were analyzed using PROC GLM where main effects and significant two-way interactions were included in the model. Data were analyzed to evaluate aging differences between vacuum-packaged subprimals and vacuum-packaged steaks. Least squares means were calculated; where ANOVA testing indicated significance, means were separated using the PDIFF procedure and an $\alpha < 0.05$.

III. RESULTS AND DISCUSSION

A. Color, odor, and purge evaluations

Among subprimal types, tenderloins had lower ($P < 0.05$) *L** values when compared to other subprimals. Further, steaks from strip loins and tenderloins had lower ($P < 0.05$) *a** values when compared to ribeyes and top sirloins butts. When comparing treatments, there were no differences ($P > 0.05$) between steak and subprimal aging for *L** values. Across all subprimal types and aging treatment combinations, tenderloin steaks had the lowest ($P < 0.05$) *b** values. This outcome coincides with results published by McKenna, Mies, Baird, Pfeiffer, Ellebracht and Savell [4], who found the *M. psoas major* to have the lowest *b** values of 19 beef muscles. In the same study, McKenna, Mies, Baird, Pfeiffer, Ellebracht and Savell [4] concluded that those muscles with low *b** values also possessed "low" or "very low" color stability traits. Muscles utilized in our study fit the color stability categories as follows: rib and loin steaks (*M. longissimus thoracis* and *M. longissimus lumborum*) have "high" color stability, the primary sirloin muscle (*M. gluteus medius*) has "intermediate" color stability, and the major tenderloin steak muscle (*M. psoas major*) has "very low" color stability [4]. While many factors may influence overall color stability of beef muscles, both color stability [4] and bloom capacity [5] decrease during storage.

Table 2
Least squares means of panelist responses for combined treatment off-odor scores [a] by subprimal.

Subprimal	Off-odor
Ribeye	1.25ab
Strip loin	1.04b
T-bone/porterhouse	1.32ab
Tenderloin	1.28ab
Top sirloin butt	1.51a

Means lacking a common letter (a-b) differ ($P < 0.05$).
[a] Off-odor was determined using the following scale: 1 = no off-odor; 2 = slight off-odor; 3 = small off-odor; 4 = moderate off-odor; 5 = extreme off-odor.

There were no treatment effects for the presence of off odors; however, subprimal type significantly influenced off odors detected by trained panelists (Table 2). For combined aging treatments, panelist off-odor scores were higher for top sirloin butt steaks ($P < 0.05$) when compared to strip loin steaks (Table 2). Of 300 panelist odor evaluations, off-odors were observed 66 times (22%) — 41 from steak-aged and 25 from subprimal-aged products. Of the 41 steak-aged product off-odor characterizations, 15 (36.6%) were for top sirloin butt, 12 (29.3%) T-bone/porterhouse, 7 (17.1%) ribeye, 7 (17.1%) tenderloin, and 0 strip loin steaks. For the 25 subprimal-aged product off-odor characterizations, 13 (52.0%) were for T-bone/porterhouse, 6 (24.0%) top sirloin butt, 4 (16.0%) ribeye, 2 (8.0%) tenderloin, and 0 strip loin steaks. While three of the steak-aged cuts were characterized as sour (ribeye 42.9%, 3 out of 7 responses; T-bone/porterhouse 58.3%, 7 out of 12 responses; top sirloin butt 6.7%, 1 out of 15 responses), the only subprimal-aged cut with a sour off-odor characterization was the T-bone/porterhouse (46.2%; 6 out of 13 responses).

When comparing treatments for both numeric purge score and purge weight (g) of whole subprimals, steak-aged products had lower ($P < 0.05$) values than subprimal-aged products. Differences between treatments were expected, as subprimals assigned to the steak-aging treatment were evaluated for purge at the beginning of the aging period, while subprimal-aged products were evaluated after the aging period. Ribeye and tenderloin steaks both had higher ($P < 0.05$) purge values for subprimal-aged cuts when compared to

their steak-aged counterparts. However, strip loin and top sirloin butt steaks did not differ ($P > 0.05$) in purge values for either treatment. Chi-square analyses comparing purge quantification between aging treatments within subprimal were performed (data not shown in tabular form). Trained panelists noted greater amounts of visual purge for ribeye (chi-square = 0.0086) and top sirloin butt steaks (chi-square = 0.0009) that were subjected to steak aging, when compared to subprimal-aged products. Notable differences in panelist responses between treatments also were seen for purge characterization (chi-square = 0.0078) and bone marrow color (chi-square = 0.0418) of T-bone/porterhouse steaks. Panelists described the purge associated with subprimal-aged steaks as either "clear," "light red" or "dark red/purple." However, the purge associated with steak-aged products was most commonly characterized as "light red," with some "dark red/purple" scores. Differences seen between treatments for T-bones/porterhouses were likely due to the presence of the bone in these steaks. Gill [6] hypothesized that bone darkening in stored meats is a result of disrupted red blood cells in marrow accumulating at the surface of cut bones. When exposed to air, hemoglobin in bone marrow will turn from red, to dark brown, to black [6]. Although some bone discoloration was noted in our study, the use of vacuum packaging prevented the severe bone blackening documented in previous studies.

B. Shear Force and Consumer Sensory

No differences in tenderness ($P > 0.05$) were seen between aging treatments for steaks derived from ribeyes, strip loins, T-bone/porterhouses, or tenderloins. However, steaks cut from traditionally aged top sirloins butts were more tender ($P = 0.0358$) than top sirloin steaks that were portioned before aging. Based on these findings tenderness was not impacted by aging treatment.

A significant difference between treatments for four palatability attributes was apparent for those steaks derived from strip loins. Strip steaks cut prior to aging received higher ($P < 0.05$) scores for overall liking, flavor liking, juiciness liking, and tenderness liking than their subprimal-aged counterparts. Palatability differences between treatments for the other subprimals were not reflected in consumer panelist responses. Based on these data, we conclude that cutting subprimals into steaks before aging does not negatively impact consumer perception of beef quality and may actually improve palatability attributes of strip steaks.

IV. CONCLUSION

Aging of individual steaks is a potential option for achieving desired palatability characteristics while utilizing less storage space than traditional aging of subprimals. A few differences between aging treatments were observed in odor and purge, but these attributes did not impact consumer panelist ratings. Overall, findings from this study can be used to support the practice of portioning subprimals into steaks before aging for those processors interested in exploring additional options for aging beef.

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