Effect of packaging type and storage temperature on the quality characteristics of beef longissimus lumborum, gluteus medius, and triceps brachii muscles aged for extended storage postmortem

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Background
The most common method of improving meat quality within the industry is postmortem aging. Many studies have discussed the effects of postmortem aging on rib and short loin steaks, and those of high quality and palatability, but few have focused on those steaks with Slight or Small degrees of marbling. Currently, approximately 60 percent of all young beef marketed is between Slight^50 and Small^50 degrees of marbling (Cargill, 2011).

The purpose of this research was to determine ways to increase the palatability and consistency of strip loin, top sirloin butt, and the chuck clod heart steaks from carcasses with that level of marbling. All the factors utilized in this research project have been studied to some extent independently of one another. However, the combination of storage temperature, aging period, and storage environment have not been thoroughly evaluated, particularly not with product quality representing the bulk of the U.S. beef supply. Also, no work has evaluated the effect of location within the muscle on tenderness of beef sirloin steaks.

Thus, the objectives of this study were to examine the combination of packaging type, temperature and extended aging on palatability, color stability, and shear force of beef strip loin, center-cut sirloin, and shoulder steaks, and to evaluate the effect of steak location on tenderness and palatability of beef sirloin steaks.

Methodology
The carcasses selected had an average marbling score of approximately Small 10 ± 30 marbling units, positioning them within the center of the target population. All subprimals were shipped to UF then trimmed to a consistent level of external fatness prior to being allocated into treatment groups.

The strip loins were separated into three equal parts and then randomly assigned to both a packaging type and an aging period. The strip loin pieces were either placed in a traditional vacuum bag, a DryBag, a special vacuum bag made out of a material that forms a bond with the proteins on the surface of the beef intended to minimize yield loss, while allowing beef to develop a dry aged flavor, or no packaging for dry aging. Strip pieces were aged for 21, 32, or 42 days. After the allotted time the cuts were then fabricated into three steaks, two of which were frozen that day with one being used for trained sensory panel, and another for Warner-Bratzler shear force, an objective measurement of meat tenderness. The third steak was placed into a coffin style retail case for color stability evaluations.

Chuck clod hearts were assigned to the same packaging treatments and allotted to age for 21, 28 or 35 days. Three clod steaks per muscle were cut and treated as described earlier after their respective aging periods. Top butt sirloins were randomly assigned to one of six packaging x aging combinations utilizing traditional vacuum bags or DryBags for packaging. After the assigned aging period they were fabricated according to the diagram below.
All steaks used for shear testing and trained sensory evaluation were frozen on the day of cutting. The sensory analysis was performed by a 7 to 10 member sensory panel. They were each given 6 random samples to evaluate for juiciness, tenderness, beef flavor, connective tissue, and off-flavor. Warner-Bratzler shear force testing is used to determine the amount of force it takes to cut through a core sample of cooked meat. All the samples were cooked and allowed to cool for 12-18 hours, then cored parallel to the muscle fibers. For color stability, the steaks were set on Styrofoam trays, then wrapped with a clear PVC film and displayed in a coffin-style retail case for 5 days. Steaks were rotated daily to compensate for any uneven temperature changes within the case. Steaks were evaluated daily by trained panelists for lean color with 1 being extremely dark red, to 7 being extremely bright cherry red. Steaks were also evaluated objectively each day with a Hunter colorimeter with L* representing lightness, a* representing redness, and b* representing yellowness of the steak surface.

**Findings**

Not surprisingly, vacuum packaged subprimals had 10-15% less yield loss due to dehydration and discoloration than subprimals packaged in the DryBag or dry aged, which had very similar yield losses. Within each muscle, subprimals fabricated after the shortest aging period had 4-6% less yield loss than muscles aged for longer periods, which were similar. Temperature had minimal effect on yield loss.

Sirloin steaks from subprimals aged for 14 days were objectively lighter, more red, and more yellow throughout retail display than steaks from muscles aged for 28 or 42 days, which were similar throughout. Interestingly, sirloin steaks from subprimals aged for 42 d had greater subjective color scores than steaks from subprimals aged for 14 or 28 days. Packaging or storage temperature had little effect on the objective or subjective color of sirloin steaks during retail display and did not affect shear force values, or trained sensory panel values for juiciness, beef flavor, or off-flavor of sirloin steaks. Additionally, postmortem aging period did not affect trained sensory panel values for juiciness, beef flavor, or off-flavor of sirloin steaks. Steaks from subprimals aged for 42 days had lower shear force values than steaks from subprimals aged for 28 days, but surprisingly steaks from subprimals aged for 14 and 42 days had similar shear force values.

**Figure 1. Steak location for top butt sirloin steaks.**

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<th>Fabrication Diagram</th>
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<td>Color Stability (C)</td>
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<td><strong>Ventral</strong></td>
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<td>Shear force (E)</td>
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<td><strong>Anterior end</strong></td>
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Packaging or temperature did not affect objective lightness values of strip steaks during retail display. Strip steaks from muscles aged for 42 days were darker at the start of retail display than steaks from muscles aged for 21 or 32 days, which were similar. Interestingly, strip steaks from muscles aged for 42 days became lighter throughout display, compared with steaks from muscles aged for 21 or 32 days which became darker throughout retail display. Similar to sirloin steaks, strip steaks from muscles aged for 42 days surprisingly had greater subjective color scores than steaks given a shorter postmortem aging period.

Packaging or temperature did not affect shear force values, or trained sensory panel values for juiciness or connective tissue of strip steaks. Strip steaks from subprimals packaged in DryBags tended to have more beef flavor than steaks from muscles which were dry aged or stored in vacuum packages. Sensory panelists tended to find strip steaks from muscles stored at 4°C to be more tender, but also found them to have more off-flavors than steaks from muscles stored at 0°C. Aging length did not affect trained sensory panel values for juiciness, beef flavor, or off-flavor of strip steaks. Strip steaks from muscles aged for 42 days had lower shear force values than steaks from muscles aged for 21 days. Trained sensory panelists found strip steaks from muscles aged for 42 days were more tender than steaks aged for 21 days.

Packaging, temperature, and days of postmortem aging did not affect the objective redness or yellowness of clod steaks during retail display. Clod steaks from all aging periods had similar objective lightness values when retail display began. Steaks from muscles aged 21 and 28 days became lighter during retail display, but steaks from muscles aged 35 days became darker. Packaging, temperature, or days of postmortem aging had no effect on juiciness, flavor or sensory tenderness of clod steaks. Trained sensory panelists found clod steaks from subprimals aged the longest had more off flavors. Extended aging had little impact on shear force, however the vacuum packaged muscles stored for 35 days certainly did not have the same aging response as muscles stored in the other aging and packaging combinations. This is an anomaly and is speculated to be caused by muscles allocated to this subgroup just being innately tougher.

The second part of this study was to determine the effect of steak location on palatability and shear force of sirloin steaks. Results of Warner-Bratzler shear force testing determined that as the steaks progress from anterior to posterior, regardless of packaging and aging parameters, that steaks have a higher shear force value, meaning they become tougher. Trained sensory panel found no differences between steak locations.

**Implications**

Aging has always been considered the best way to tenderize and enhance the flavor of steaks and this research furthers that fact. It also shows that only a limited number of days are needed to be effective for tenderizing a lower valued cut, such as a clod heart. For sirloin steaks, there was no shear force difference between those steaks aged for 14 days and those aged for 42 days. Strip steaks did become more tender as the length of aging progressed, but the actual difference was marginal. Clod steaks remained nearly the same throughout the aging process, except for the one subgroup which was speculated to simply being innately tougher. Steaks from all three muscles generally had poorer lean color during retail display as days of aging increased. Additionally, this study found variation within the top butt sirloin for objective tenderness. Steaks on the
anterior of the muscle are more tender and therefore have greater potential value than those from the posterior end of the muscle.

Image 1. Strip steaks in retail case and during the aging process

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