# THE INFLUENCE OF PRODUCT HANDLING ON POSTMORTEM TENDERIZATION OF BEEF: DURATION OF AGING INFLUENCES

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**Background**

A problem confronting the beef industry for the past two decades has been declining market share. Recent consumer surveys have clearly indicated lack of consistency in product tenderness to be a major concern for most consumers. Although postmortem storage (aging) has been clearly documented to improve tenderness per se and the consistency of tenderness of most beef carcasses and cuts, it is presently uncertain how postmortem tenderization progresses and the duration of aging required to produce a consistently tender product.

**Objective**

To determine how postmortem tenderization progresses and the duration of postmortem storage required to provide a consistently tender product.

**Methods**

The wholesale ribs and shortloins from 16 beef carcasses were randomly allocated to four postmortem treatments (conventional carcass aging (control), bone-in vacuum packaged aging, boneless vacuum packaged aging, and controlled atmosphere, display-ready aging), and aged for weekly intervals up to 28 days. Each treatment was applied to each anatomical location (left rib, right rib, left shortloin, right shortloin,) at each aging period to remove any location effect. Cuts assigned to conventional carcass aging were suspended aerobically for the designated aging interval and then were cut into steaks. Cuts assigned to bone-in vacuum packaging were cut into retail-ready steaks and vacuum packaged. Cuts allocated to boneless vacuum packaging were boned, cut into retail-ready steaks and vacuum packaged. Cuts assigned to controlled atmosphere, display-ready aging were boned, cut into retail-ready steaks placed on to hard plastic trays, overwrapped with oxygen permeable film, placed into oxygen impermeable foil-laminate pouches, and masterpacked in two liters of carbon dioxide per kilogram of product. All cuts were aged for their designated storage interval in the same cooler at $1^{\circ} \pm 1^{\circ}C$. The seven anterior steaks from each shortloin and the seven posterior steaks from each rib were utilized and the entire experiment was replicated four times. The most anterior steak from each shortloin and the most posterior steak from each rib were evaluated by a 6-member sensory panel for initial and overall tenderness, amount of perceptible connective tissue, juiciness, flavor intensity, flavor desirability and overall palatability. The two steaks adjacent to the panel steaks were used for Warner-Bratzler shear analyses. The remaining four steaks, from each subgroup, were used to obtain complete flavor and texture profiles, using a highly trained, professional, flavor/texture profile panel (Jeremiah et al., 1997). All steaks were grilled to $75^{\circ}C$ on an electric grill and then subsampled by removing all subcutaneous and intermuscular fat and epimysium, and cutting into cubes (1.9 x 1.9 x 1.9 cm). Steaks were weighed before freezing and after thawing to obtain thaw-drip losses and before and after grilling to obtain total cooking losses. Cooking times were recorded. Panel sessions were conducted in partitional environmentally controlled booths under 580 lux of green incandescent light. Laboratory panelists were screened and trained according to AMSA guideline (American Meat Science Association and National Live Stock and Meat Board 1995) and profile panelists were screened and trained according to procedures outlined by (Jeremiah et al., 1997). Distilled water and unsalted soda crackers were provided for removal of flavor residues between sample evaluations. After cooking, shear steaks were refrigerated overnight and then cored, using a hand held 19 mm cork borer to remove six cores from each steak, parallel to the longitudinal axis of the muscle fibers. Cores were then sheared perpendicular to the longitudinal axis of the fibers using the Warner-Bratzler cell of the Instrom Universal Testing Machine (Model 4301) and a crosshead spend of 100 mm/min. Data from the shear evaluation and sensory panel were analyzed using the general linear model of SAS (Statistical Analysis Systems Institute Inc., 1995), and a model containing postmortem treatment and postmortem aging interval and their interaction as main effects. Data from the profile panel denoting intensity of specific flavor notes and amplitude ratings were also analyzed by analysis of variance using the general linear model of SAS and the previously described model. Data from the profile panel denoting percentages of samples displaying certain texture and flavor notes were analyzed using the Chi-Square test (Puri and Mullen, 1980). Linear regression was used to detect significant time trends in specific traits during postmortem storage (Puri and Mullen, 1980). Two-way postmortem treatment x postmortem aging interval interactions were not detected. Consequently the main effects of postmortem treatment and postmortem aging interval were examined independently and are being reported separately.

**Results and Discussion**

Yields and Cooking Times

Cuts stored for one week required less time to cook than unstored cuts (43.9 vs. 48.3 min/kg, $P<0.05$). Differences attributable to postmortem aging interval were not observed in either thaw-drip or total cooking losses ($P<0.05$).

Shear Values and Palatability Attributes

Warner-Bratzler shear force values decreased progressively ($r^2 = 0.70$, $P< 0.05$), and initial and overall tenderness ratings increased progressively ($r^2 = 0.69$ and 0.68, respectively $P< 0.05$) during postmortem aging. Scores for amount of perceptible

connective tissue also increased progressively ( $r^2 = 0.69$ $P<0.05$), during postmortem aging, indicating intramuscular connective tissue became progressively less perceptible as postmortem aging was prolonged. Beef flavor intensity increased during four weeks of aging ($r^2 = .88$, $P<0.01$), as did flavor desirability ($r^2 = 0.72$, $P<0.05$). However, only a positive trend approaching statistical significance was observed in overall palatability ($r^2 = 0.64$, $P<0.05$). Despite this fact, postmortem aging up to four weeks appeared to be beneficial to all palatability attributes, except juiciness, which was not, influenced by postmortem aging.

Flavor Profiles

An inappropriate livery aromatic and aftertaste became progressively more intense ($r^2 = 0.67$ and 0.73, respectively, $P<0.05$) as postmortem storage was prolonged. However, these trends were not of sufficient magnitude to influence flavor amplitude. Consequently, beef steaks can be aged for up to four weeks without significantly influencing the overall quality of beef flavor.

Texture Profiles

Cuts became less elastic ($r^2 = 0.88$, $P<0.01$) during four weeks of postmortem aging. Cuts also became easier to compress and less cohesive on the first bite during four weeks of postmortem aging ($r^2 = 0.89$ and 0.88 respectively, $P<0.01$). Cuts became less chewy ($r^2 = 0.81$, $P<0.05$) and required fewer chews during mastication, as postmortem aging was prolonged. The proportion of fine + fibers during mastication decreased progressively as postmortem aging was prolonged ( $r^2 = 0.77$, $P<0.01$). Cuts also became more uniform ($r^2 = 0.98$ $P<0.01$) and less dense and cohesive during mastication as postmortem aging was prolonged. ($r^2 = 0.88$, $P<0.01$ and 0.82, $P<0.05$, respectively). Progressively less connective tissue was perceived as postmortem storage was extended ($r^2 = 0.93$ $P<0.01$) and the connective tissue contained a progressively lower proportion of gristle ($r^2 = 0.73$ $P<0.05$) as postmortem storage was prolonged. Progressively greater proportions of the connective tissue were described as being webbed fibers and webbed fibers and soft gristle as postmortem aging was extended ($r^2 = 0.84$ and 0.89, respectively, $P<0.01$), and a progressively lower proportion of the connective tissue was described as being webbed fibers and soft and hard gristle as postmortem storage was extended ($r^2 = 0.92$, $P<0.01$). A progressively greater proportion of the particles during mastication were described as being grainy, mealy, mushy, crumbly and stringy ($r^2 = 0.87$, $P<0.01$), and a progressively lower proportion of the mastication particles were described as being grainy,mealy, mushy, crumbly, stringy, gristle and rubbery ($r^2 = 0.82$,$P<0.05$) as postmortem storage was prolonged. Consequently, there was a shift to more appropriate mastication particles as postmortem aging was extended. The amount of mouthcoating, after swallowing, increased progressively as postmortem aging was extended ($r^2 = 0.67$, $P<0.05$). There was also a shift in residual particle types during postmortem aging. The proportions of an appropriate residual particle type, described as being grainy, mealy, mushy, crumbly, and stringy increased progressively as postmortem aging was extended ($r^2 = 0.94$, $P<0.01$), and the proportion of an inappropriate residual particle type described as being grainy,mealy, mushy, crumbly, stringy, gristle, and rubbery decreased progressively as postmortem aging was prolonged ($r^2 = 0.88$ $P<0.05$). These changes were of sufficient magnitude to result in a progressive improvement in the appropriateness, balance, and blend of the overall texture (texture amplitude) ($r^2 = 0.75$, $P<0.05$) as postmortem aging was extended to four weeks.

**Conclusions**

Both initial and overall tenderness improved progressively and Warner-Bratzler shear values and the amount of perceived connective tissue decreased progressively as postmortem storage were extended. In addition, both flavor intensity and desirability increased progressively with the extension of postmortem aging. Consequently, postmortem aging appears to be beneficial to all palatability attributes except juiciness. Therefore, steaks can be aged for up to four weeks to obtain substantial improvements in overall texture, without adversely affecting overall flavor quality. In fact, significant improvements in flavor desirability appear possible by extending postmortem aging to four weeks.

**Pertinent References**

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