THE INFLUENCE OF PRODUCT HANDLING ON POSTMORTEM TENDERIZATION OF BEEF: POSTMORTEM TREATMENT INFLUENCES

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Background

Although many factors may have contributed to declining market share over the past two decades, recent consumer surveys have clearly indicated lack of consistency in product tenderness to be a major concern for most consumers. It is presently uncertain what the affect of postmortem processing, packaging, and handling has on the tenderization process during postmortem aging. This uncertainty has particular relevance, since the method utilized to process, package, distribute and merchandise beef has changed considerably, with advances in more efficient postmortem carcass chilling, boxed beef distribution and merchandising, and centralized preparation and packaging of display-ready retail cuts. Although these advancements have and will substantially improve beef's competitiveness in the marketplace, little is known regarding their impact on the tenderization produced by postmortem aging.

Objective

To provide the information required to optimize the balance between postmortem tenderization and achieving the most advantageous processing and marketing methods.

Methods

Wholesale ribs and shortloins from 16 beef carcasses were randomly allocated to four postmortem treatments [conventional carcass aging control (C), bone-in vacuum packaged aging (BIVP), boneless vacuum packaged aging (BOVP), and controlled atmosphere, boneless display-ready aging, (CADRP)], 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 BIVP were cut into retail-ready steaks and vacuum packaged. Cuts allocated to BOVP were boned, cut into retail-ready steaks and vacuum packaged. Cuts assigned to CADRP were boned, cut into retail-ready steaks placed on to hard plastic trays, overwrapped with an oxygen permeable film, placed into oxygen impermeable foil-laminate pouches, and masterpackaged 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°C± 1°C. The seven anterior steaks from each shortloin and 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 six 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. All steaks were grilled to 75°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, and sessions were conducted in partitioned, environmentally controlled booths under 580 lux of green incandescent light. Laboratory panelists were screened and trained according to AMSA guidelines 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 Instron Universal Testing Machine (Model 4301, Instron Corporation, Burlington, ON) and a crosshead spend of 100 mm/min. Data from the shear evaluations, sensory panel, and the profile panel denoting intensity of specific flavor and texture notes, order of appearance of specific flavor notes and amplitude ratings were analyzed using the general linear model of SAS (Statistical Analysis Systems Institue Inc., 1995), and a model containing postmortem treatment and postmortem aging interval and their interaction as main effects. Data from the profile panel denoting percentages of samples displaying certain texture and flavor notes were analyzed using the Chi-Square test. Linear regression was used to detect significant time trends in specific traits during postmortem storage. Two-way postmortem treatment x postmortem aging interval interactions were not detected. Consequently, the data were pooled and 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

CADRP cuts required the longest cooking times and sustained the greatest total cooking losses ($P < 0.05$), and BOVP cuts required longer cooking times and sustained greater total cooking losses ($P < 0.05$) than C and BIVP cuts,.

Shear Value and Palatability Attributes

BIVP cuts had lower Warner-Bratzler shear values than BOVP cuts CADRP cuts (4.09 vs. 4.58 and 4.24 respectively, $P<0.05$), and were also rated higher in initial and overall tenderness than C and CADRP (6.45 vs. 6.00 and 5.82 and. 6.80 vs. 6.33 and 6.18

respectively, P<0.05). In addition, BOVP cuts were rated higher in overall tenderness than CADRP cuts (6.52 vs. 6.18, P<0.05). BIVP cuts also were perceived to contain less connective tissue than C and CADRP cuts (6.71 vs. 6.39 and 6.30, respectively P< 0.05). Moreover, BIVP and BOVP cuts were rated higher in both juiciness and flavor desirability than C and CADRP cuts (6.48 and 6.42 vs. 6.08 and 5.96, and 6.70 and 6.69 vs. 6.30 and 6.49, respectively P<0.05). BIVP cuts also were perceived to have more intense beef flavor than cuts in any other postmortem treatment (P<0.05). Furthermore, BIVP and BOVP cuts were rated higher in overall palatability C and CADRP cuts (6.47 and 6.39 vs. 6.01 and 6.11, respectively P<0.05)

Flavor Profiles

A greater proportion of BOVP cuts had an inappropriate barny aromatic than BIVP cuts (4.4 vs. 0.0% P<0.05) and this inappropriate aromatic was absent only in BIVP cuts. A greater proportion of BOVP cuts displayed an inappropriate livery aromatic than CADRP cuts (92.2 vs. 70.9% P<0.05). An inappropriate, unidentifiable "off" aromatic was perceived more rapidly in C, BIVP and BOVP cuts than in a CADRP cuts (1.01, 1.00 and 1.02 vs. 1.07 P<0.05). An appropriate fatty aromatic was more intense in BOVP cuts than in C and CADRP cuts (1.67 vs. 1.58 and 1.50, P<0.05). This appropriate aromatic was also more intense in BIVP cuts than in CADRP cuts (1.63 vs. 1.50 P<0.05). An inappropriate livery aromatic was most intense in BOVP cuts (1.29) and least intense in CADRP cuts (0.72) (P<0.05), and, this inappropriate aromatic was more intense in BIVP cuts than in CADRP cuts (0.98 vs. 0.72 P<0.05). An inappropriate metallic aromatic was more intense in BOVP cuts than in cuts from any other treatment (P<0.05), and an inappropriate bitter taste was less intense in CADRP cuts than in cuts from any other treatment. An inappropriate livery aftertaste was more intense in BOVP cuts than in C and CADRP cuts (0.73 vs. 0.57 and 0.45, respectively P<0.05). This inappropriate aftertaste was also more intense in BIVP cuts than in CADRP cuts (0.61 vs. 0.45 P<0.05). These results indicate controlled atmosphere storage, can be effectively utilized to reduce the incidence and intensity of inappropriate character notes perceived with vacuum packaged storage, probably attributable to oxidative changes. However, the fact flavor amplitude ratings were not influenced (P>0.05) by postmortem treatment indicates cuts can be aged intact conventionally, under vacuum either bone-in or boneless, or in controlled atmosphere (100%. CO_2) as boneless, display-ready cuts without significantly influencing the overall flavor quality.

Texture Profiles

C and BOVP cuts were perceived to have more fat on the surface and during the first bite than CADRP cuts (1.04 and 1.09 vs. 0.94 and 1.44 and 1.48 vs. 1.35, respectively P<0.05). CADRP cuts released the least amount of moisture during the first bite (P<0.05). C cuts released more moisture during mastication than BIVP and CADRP cuts (3.06 vs. 2.92 and 2.79, respectively P<0.05). BOVP cuts also released more moisture during mastication than CADRP cuts (3.04 vs. 2.79, P<0.05). CADRP cuts absorbed the most moisture during mastication (P<0.05). BIVP cuts were perceived to contain the highest proportion of an appropriate, residual particle type, described as grainy, mealy, mushy, and crumbly, and C cuts were perceived to contain the lowest proportion of this appropriate, residual particle type (25.6 and 5.6% respectively P<0.05). CADRP cuts were perceived to contain a higher proportion of this appropriate, residual particle type than C cuts (14.4 vs. 5.6%, P<0.05). C cuts were perceived to contain a higher proportion of an inappropriate, residual particle type, described as grainy, mealy, mushy, crumbly, stringy and rubbery than BIVP cuts (20.0 vs. 7.8% P<0.05). However, these differences were not of sufficient magnitude to result in differences in the appropriateness, balance, and blend of the overall texture (texture amplitude). Consequently, postmortem handling of beef did not result in differences of major practical importance in textured properties.

Conclusions

The presence of bone in cuts reduced both cooking times and cooking losses, irrespective of postmortem handling treatment. Both BIVP and BOVP cuts were rated higher in overall palatability than C and CADRP cuts. However, detailed flavor and texture profile analyses indicated steaks could be aged up to four weeks, without influencing the overall quality of the flavor and texture, irrespective of postmortem handling treatment.

Pertinent References

Jeremiah, L.E., Gibson, L.L. and Burwash, K.L. 1997. Descriptive sensory analysis. The profiling approach. Agriculture and Agri-Food Canada Res. Br. Tech. Bull. No.1997-2E, Lacombe, AB.

Statistical Analysis Systems Institute, Inc. 1995. User's Guide: Statistics. Statistical Analysis Systems Institute, Inc., Cary, NC.