RECIPROCATION SESSION

MARC Beef Classification System

Tommy L. Wheeler*, Steven D. Shackelford* and Mohammad Koohmaraie

Introduction

The development of technologies that could be used by the U.S. beef packing industry to accurately characterize beef for tenderness has been a major focus of this laboratory. Because longissimus comprises a higher proportion of total carcass value than any other muscle and there is more carcass-to-carcass tenderness variation in longissimus than any other major beef muscle (Shackelford et al., 1995, 1997a), the need for tenderness classification is greatest for longissimus.

Ideally, the beef industry would prefer to be able to measure (predict) meat tenderness with a rapid, automated, tamper-proof, noninvasive, accurate instrument. It is highly unlikely that indirect measurements will ever be sufficiently accurate, and more importantly, amenable to industry application. Therefore, we have focused on methodology for direct measurement of tenderness. The best direct measure of tenderness with the best chance to be successfully adapted for automated, on-line tenderness measurement was Warner-Bratzler shear force, an objective measurement of meat tenderness routinely used by meat scientists. Shackelford et al. (1997b) determined that a high proportion of the variation in longissimus Warner-Bratzler shear force at 14 days after slaughter could be predicted by measuring shear force at 1 or 2 days after slaughter. Although there is a large amount of variation in the extent to which carcasses tenderize during the aging period, a large portion of that variation could be predicted by measuring shear force at 1 or 2 days after slaughter (Shackelford et al., 1997b). Thus, Warner-Bratzler shear force measurement was adapted for commercial use (Shackelford et al., 1999).

Beef Classification System

After chilling 24 to 72 hours after slaughter, a 1 inch thick rib steak is removed from the right side of each carcass at the time of carcass ribbing. Using off-the-shelf technology, an image of the untrimmed steak is captured, image analysis is conducted, retail product yield is estimated (R^2 = .89), and data are outputted to a computer database in less than 7 seconds. The steak is trimmed of fat and bone and the ribeye is rapidly (7.33 min) cooked to a medium degree of doneness (160°F). A 5-cm long, 1-cm thick slice is removed from the cooked steak parallel to the muscle fibers. The slice is sheared by a flat, blunt-edge blade attached to an electronic testing machine and the slice shear force (SSF) value is determined. If automated, the tenderness and yield classification process could be completed during the 10 minutes that the carcasses are typically held to allow the ribeye to brighten for quality grading. Thus, classification would not interfere with production rates.

Tenderness Classification System

Shackelford et al. (1999) classified a carcass as "Tender," "Intermediate," or "Tough" if its slice shear force value at 3 d postmortem was less than 23 kg, 23 to 40 kg, or greater than 40 kg, respectively. Although statistical analysis of data from several studies was used to establish the slice shear force values defining each class, those values are largely arbitrary and have not been evaluated with consumer research. Those values were established to analyze the potential efficacy of the tenderness classification system and should not be interpreted as definitive cut-offs representing consumer acceptability.

In that experiment (Shackelford et al., 1999), 47%, 48%, and 5% of the carcasses were classified as "Tender," "Intermediate," and "Tough," respectively. The relative frequency of the various tenderness classes should be considered when interpreting the results. However, those frequencies may not be representative of national averages because that experiment was limited to cattle raised under one production scenario and slaughtered in one packing plant. It is highly likely that those percentages will vary among packing plants due to differences in postmortem carcass handling practices, cattle types, and management regimes. Even if this experiment were replicated, the results might differ because of the large contribution (~70%) of environmental and non-additive genetic factors to variation in beef longissimus tenderness.

For 94.4% of the samples evaluated at 3 d postmortem, tenderness classification accurately predicted whether or not the trained sensory panel would rate the sample as "Slightly Tender" or higher at 14 d postmortem (Figure 1).

T. L. Wheeler
USDA-ARS, U.S. Meat Animal Research Center
P. O. Box 166
Clay Center, NE 68933
wheeler@email.marc.usda.gov
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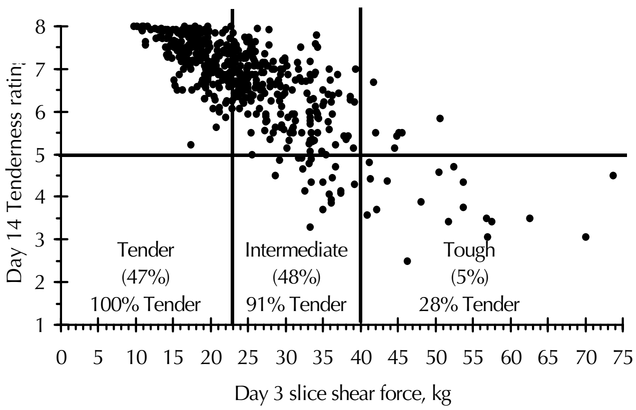
FIGURE 1.



Use of manual tenderness classification at 3 d postmortem to predict longissimus tenderness ratings at 14 d postmortem (r=-.81). Parenthetical values below the class names indicate the percentage of the total population in each class. Adapted from Shackelford et al. (1999).

All of the samples in the "Tender" class were rated "Slightly Tender" or higher, most (91%) of the samples in the "Intermediate" class were rated "Slightly Tender" or higher, and few (28%) of the samples in the "Tough" class were rated "Slightly Tender" or higher by the trained sensory panel at 14 d postmortem. Although the level of tenderness difference between "Tender" and "Intermediate" steaks was small relative to the level of tenderness difference between "Intermediate" and "Tough" steaks, it is likely "Tender" steaks would result in greater consumer satisfaction, particularly for those consumers who prefer their steaks well done (Wheeler et al., 1999a). In a series of experiments designed to determine the value of tenderness to consumers, it has been found that consumers are willing to pay a premium for steaks that were tested and known to be tender. Thus, "Tender" steaks could probably be marketed at a premium similar to that now commanded by "Prime" steaks.

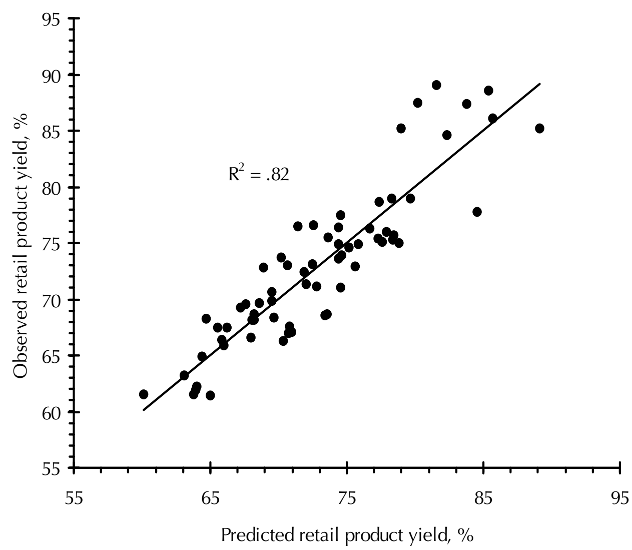
Tenderness classification has been evaluated based on segregation of carcasses into three groups. However, it is not known how many different tenderness classes should be used to maximize carcass value and consumer satisfaction. When longissimus steaks were cooked well done, trained sensory panel ratings for juiciness and beef flavor intensity were higher for "Tender" Top choice carcasses compared to "Tender" Low Select carcasses (Wheeler et al., 1999b). Those results suggested there may be merit to augmenting the present grading system with tenderness classification rather than simply replacing the current grading system with tenderness classification. We are in the process of comparing the effects of tenderness classification and marbling-based classification and their interaction on consumer satisfaction. Additional research is needed to test the feasibility and accuracy of this system under commercial processing conditions.

Image Analysis

Image analysis has been shown to accurately predict 9-10-11 rib (r = .90) and carcass composition (r = .94) under controlled conditions. However, application of image analysis in high-speed beef processing plants (r = .72 and .74) has been less successful because it is difficult to consistently position a video camera in a manner to record an image of the entire ribeye muscle and its surrounding fat cover (J. W. Wise, personal communication). Thus, erroneous readings are often recorded with little or no opportunity for re-evaluation. As with yield grading, a limitation of conventional image analysis is that when carcasses are ribbed, the angle at which the ribeye is transected is highly variable. As the angle of the cut deviates from 90°, the area of the ribeye muscle increases and thus overestimates the muscularity of the carcass.

Because tenderness classification requires that a 12th rib cross section be removed from each carcass, it provides an easy opportunity to assess carcass composition by analyzing

FIGURE 2.



Ability of image analysis to predict percentage retail product yield. Adapted from Shackelford et al. (1998).

the composition of the cross section. Using off-the-shelf equipment and software, Shackelford et al. (1998) have developed an easy, automated technique for evaluating percentage retail product yield (R^2 = .89; Figure 2), retail product weight (R^2 = .95), and longissimus area (R^2 = .88). Thus, it would appear that there would be merit to combining image analysis with tenderness classification to fully evaluate carcass merit.

References

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Names are necessary to report factually on available data; however, the USDA neither guarantees nor warrants the standard of the product, and the use of the name by USDA implies no approval of the product to the exclusion of other products that may also be suitable.