Project Title: Using Near-Infrared (NIR) System to Sort Middle and End Muscle Cuts into Tenderness Categories

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Background

Tenderness is a primary consideration in consumer satisfaction for beef products; however, producers and processors are not necessarily directly rewarded for producing a more tender product. Currently, the primary method used today to classify carcasses into various palatability groups is U.S. Department of Agriculture (USDA) quality grading, as it is nondestructive and can be implemented in a commercial setting.

Instrument grading has the potential to improve prediction of palatability by employing technology to sort carcasses into more finite quality groups. According to the 2000 National Beef Quality Audit, 83 percent of fed steer and heifer carcasses fell into the Low Choice or Select quality grades. Since the majority of fed beef falls into such a narrow range of marbling scores, it is difficult to accurately reward producers that provide a more tender product. As a result, more precise methods for evaluating the palatability of beef should be developed.

The objectives of this study were to 1) determine the effectiveness of a near infrared (NIR) system to predict the tenderness rating of longissimus, triceps brachii, rectus femoris, gluteus medius, semimembranosus and semitendinosus muscles from the U.S. Choice and U.S. Select quality grading carcasses, 2) conclude if a relationship exists between predicted longissimus shear force value and muscle tenderness of "short-term" muscle cuts, and 3) determine consumer perceptions of beef longissimus steaks which were categorized using the same NIR system as being "tender, intermediate, or tough."

Methodology

Beef carcasses were scanned with an NIR spectrometer in one of two processing facilities. A longissimus tenderness grid was developed and the 768 carcasses were categorized, based on sliced shear force value, as being tender (<16 kg), intermediate (16.0-25 kg) or tough (>25 kg).

Carcass grade data factors such as ribeye area, lean maturity, skeletal maturity, marbling score, and quality grade as evaluated by a USDA grader were collected. Researchers also collected hot carcass weights.

Longissimus, triceps brachii, rectus femoris, gluteus medius, semimembranosus and *semitendinosus* were individually identified. At approximately 72 hours after harvest, all subprimals were fabricated into one-inch steaks, individually identified and allowed to "bloom" for 30 minutes. The center steak from each of the subprimals was scanned using an NIR spectrometer and designated for a three-day Warner-Bratzler shear force (WBSF) analysis. All remaining steaks were aged for 14 days and frozen for further analysis.

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Shear Force Measurement
Center subprimal steaks were randomly distributed across each cooking date so that all quality grade and aging times were represented. Steaks were broiled at 180°C to an internal temperature of 65°C. Raw and cooked weights were recorded for each steak and used to calculate cook loss. A minimum of six cores were removed parallel to muscle fiber orientation and analyzed for Warner-Bratzler shear force.

Traditionally, Warner-Bratzler shear force values have been used as a tenderness reference. This procedure involves coring steaks parallel to muscle fibers to collect cylindrical samples for shearing, however coring angle and location of core samples were not standardized, leading to limited repeatability. Precision of reference values is critical in developing reliable models. A new tenderness reference method known as "slice shear" force (SSF) has been developed by the U.S. Meat Animal Research Center. In this method, a larger sample is sliced at a fixed location on the ribeye, at a 45-degree angle. This procedure produces better repeatability than the WBSF method and was used as the tenderness reference in this study.

Consumer Survey Testing
Ribeyes (IMPS/NAMP 112A) were cut into one-inch steaks and were individually vacuum-packaged, aged for 14 days, frozen and stored at -20°C. Center steaks from each of the captured subprimals were scanned using the NIR spectrometer and a predicted 14-day classification value was obtained.

Two participating adults from each household recruited for the study were given three weeks to prepare and evaluate each steak as they wished. Steaks were color coded as to their tenderness classification based on their NIR reading, so that consumers associated their likes and dislikes with a particular color coding category. Consumers based their evaluations on a 23-point scale developed by the National Livestock and Meat Board.

Findings

All of the carcasses had Small or Slight marbling scores that would qualify them for U.S. Low Choice and U.S. Select quality grades. Of the 100 ribeyes classified in-plant (two days after harvest), 27 were tender, 45 were intermediate and 28 were tough based on the NIR spectrometer readings. The mean slice shear force values (day 14) were 15.4, 19.2 and 33.4 kg, respectively for the tender, intermediate and tough groups, which translated to a low correlation between the actual and predicted slice shear-force values. The NIR spectrometer did not predict specific tenderness values with high accuracy for the tender or intermediate classifications, however identifying carcasses that are tough is a higher priority.

Consumer Evaluations
Overall satisfaction and tenderness was highest for the steaks classified as tender (red group) or intermediate (white group) steaks when compared to the steaks classified by the NIR system as being the toughest (blue group). These data correlate with the findings that the NIR systems was better at identifying the tough steaks than identifying differences between the tender and intermediate groups. The evaluation form completed by each consumer provided information concerning thawing methods, preparation methods and degree of doneness, however no attempt was made to determine how these preparation methods may have influenced consumer satisfaction.

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Implications

The ability to more accurately sort carcasses based on predicted consumer satisfaction rates will be helpful in giving cattle producers and beef processors clear market signals, and will hopefully lead to their being rewarded on a more accurate basis for generating a product that meets consumers' demands.

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