Project Summary

Evaluation of Hyperspectral Near Infrared Spectroscopy and Imaging for Tenderness Determination in Cattle

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Study Completed
July 2004

Funded by The Beef Checkoff

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Background

Several researchers have explored possible methods of evaluating beef tenderness through objective methods at the point of harvest. In order to be viable on a commercial basis, an assessment system must be accurate, rapid, noninvasive and adaptable to on-line applications and speeds.

Near infrared spectroscopy (NIRS) is one technology that might be suitable for evaluating tenderness in beef carcasses. It has been used in several agricultural applications including evaluating poultry freshness and meat quality. The technology is highly sensitive to concentrations of fat, protein and moisture. The accuracy of NIRS assessment relies, in large part, on calibration with a reference database. In order to make the technology viable for tenderness assessment in beef, the database needs to include reference information for as many sources of variation as possible.

Current reference methods for tenderness in beef are Warner-Bratzler shear force (WBSF) values and sensory panel evaluations. One of the difficulties in developing instrument assessments for tenderness is the lack of precision in reference methods. The large variation in U.S. cattle populations due to an array of production conditions also complicates the ability to develop accurate reference models.

The objective of this study was two-part. Researchers first sought to determine if there is an adequate relationship between near infrared spectral analysis and tenderness evaluations using Warner Bratzler shear force and sensory panel evaluations to use NIRS as a method for predicting tenderness. Secondly, researchers evaluated hyperspectral imaging for its ability to make a combination analysis of tenderness, fat and connective tissue.

Methodology

Steer carcasses (n = 136) were sourced from a crossbreeding study with Angus, Brahman and Romosinuano (tropically adapted *Bos taurus* breed). The steers were harvested in a commercial processing facility. Routine carcass traits were collected 48 hours after harvest. Researchers obtained the strip loins (IMPS/NAMP 175) and shipped them to a university meats lab for further evaluation.

After the strip loins arrived at the research facility, investigators made a fresh cut between the 11^{th} and 12^{th} rib and were allowed to bloom for ten to 20 minutes. The face of the intersection was photographed with hyperspectral imaging. A quarter-inch section was sliced from the face of the loin and two one-inch cores were obtained (medial and lateral lobe) and were scanned by near infrared reflectance. After the initial data collection, the loins were packaged and stored at 2 to 4ºC (35.6ºF to 39.2ºF) for seven days. Subprimals were fabricated into steaks and were analyzed for Warner Bratzler shear force, sensory characteristics and collagen analysis.

Researchers also designed and constructed a hyperspectral imaging system to collect spectral and spatial images of beef. The imaging system was calibrated and a variety of images were collected from the steaks (dark current, 99 percent reflectance panel and 99 percent, 50 percent, 25 percent and 12 percent reflectance).

Findings

There was a low variation in Warner Bratzler shear force, which surprised the researchers as about 30 percent of the cattle were either purebred or F1 Brahman crosses. WBSF is an objective measurement of tenderness, but based on this research, there appeared to be considerable variability within a steak and among steaks that came from the same subprimal. In this study, shear force values between the medial and lateral lobes of each steak varied considerably. This variability in the reference method complicated the development of a predictive method of evaluation. The researchers determined that expanding the data set to include more variation (i.e. more tough steaks) should allow the development of a more accurate reference equation.

According to the researchers, the technique of using spectral imagery holds promise even though this project did not demonstrate a relationship between the spectral image and tenderness. Images collected during this project indicated a strong potential to delineate fat from lean and possibly identify marbled fat from external fat.

Table 1. Carcass traits, WBSF and sensory attributes for steaks from Angus, Brahman and Romosinuano (crossbred and purebred) steers (n = 136).

Trait	Mean	Std Deviation	Minimum	Maximum
Dressing Percent	63.2	7.43	52.4	66.0
Hot Carcass Wt	725	105	507	972
Adjusted PYG	3.36	0.51	2.3	5.0
REA	12.4	1.27	9	15.7
REA/CW	1.72	0.21	1.28	2.55
Marbling Score	510	103	270	830
Shear Force	4.05	0.79	2.67	7.71
Sensory				
Juiciness	4.89	0.56	3.67	6.78
BFI	5.4	0.43	4.44	6.44
Overall Tender	5.68	0.57	4.33	7.22
Connective Tissue	6.03	0.56	4.33	7.33
Off Flavor	5.51	0.40	3.89	6.13

Implications

The carcasses chosen for this study did not have enough variation (tough steaks) to adequately develop reference information for use of near infrared spectroscopy as a predictor of tenderness. However, a review of previous research indicates that the technology holds promise and should be investigated further.

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