Project Summary

Interaction of VISNIR Predicted Tenderness Class, Aging Time, and Blade Tenderization on Slice Shear Force of Longissimus and Gluteus Medius

Principal Investigators: Steven D. Shackelford, David A. King, & Tommy L. Wheeler,
USDA-ARS-US Meat Animal Research Center

Study Completed
May 2010

Funded by The Beef Checkoff

Interaction of VISNIR Predicted Tenderness Class, Aging Time, and Blade Tenderization on Slice Shear Force of Longissimus and Gluteus Medius: Project Summary

Background

Shackelford et al. (2011a) determined that application of the USMARC noninvasive tenderness prediction system, which is based on visible and near-infrared (**VISNIR**) spectroscopy, to the ribeye of beef carcasses online at the grading stand allows for identification of carcasses that excel in tenderness (lower slice shear force) of several beef muscles (*Longissimus*, *Semimembranosus*, *Gluteus medius*, *Biceps femoris*, *Adductor*, and *Semitendinosus*). Additionally, similar results were obtained with application of VISNIR directly to the exposed *Gluteus medius* on the anterior end of Top Sirloin subprimals either during carcass fabrication or after aging. This suggests that this technology could be utilized by virtually all segments of the industry to control variation in tenderness. As food service entities contemplate eliminating the use of blade tenderization due to perceived pathogen risk, one possible use for this technology is to identify cuts that would meet tenderness expectations without blade tenderization. Likewise, this technology might allow for stratification of carcasses or cuts into optimal aging-time groups.

Objective

The present experiments were conducted to determine if VISNIR spectroscopy can be used to optimize aging time and identify cuts that would meet tenderness expectations without blade tenderization and to field test the potential for VISNIR sorting during commercial steak cutting.

Methodology

Experiment 1

On each of seven selection trips over a nine-month long period, U.S. Select beef carcasses were evaluated, online immediately following USDA quality grading at a large-scale commercial beef harvesting facility, and tenderness was predicted as described by Shackelford et al. (2011b). Balanced equally among selection trips, carcasses were selected for inclusion in the study that equally represented each quartile of the distribution of predicted slice shear force values (SSF;n = 280 carcasses) observed in carcasses sampled previously in a variety of experiments (Shackelford et al., 2011b).

The Strip Loin (IMPS #180; USDA, 2010; NAMP 2010) was obtained from the left side and the Top Sirloin (IMPS #184) was obtained from both sides of each carcass and transported (0ºC) to the USMARC abattoir. The following day (i.e., approximately 48 hours postmortem), each Strip Loin was divided into two sections at a point approximately 14 cm posterior to the anterior end of the Strip Loin. Top Sirloins were processed into center-cut top sirloins by removing the cap (Biceps *femoris* and subcutaneous fat) and accessory muscles. One section from each strip and one *Gluteus medius* (GM) from each carcass was blade tenderized. Within each selection day, assignment of Strip Loin sections (anterior versus posterior) and sides (GM from left side of carcass versus GM from right side of carcass) to blade-tenderization was blocked equally among VISNIR predicted SSF quartiles.

Four LM steaks (2.54 cm thick) were obtained from each Strip Loin section beginning at the anterior end of the section and from each GM beginning at the posterior end. Steaks were blocked by

location within section/side and assigned to postmortem aging (1.5ºC) periods of 7, 14, 28 or 42 days postmortem. Fresh (never frozen) steaks were cooked (71ºC) with a belt grill and SSF was determined following the muscle specific procedures of Shackelford et al. (2009).

Experiment 2

At a commercial steak-portioning facility, vacuum-packaged Strip Loins (n = 200; IMPS #180) and center-cut Top Sirloins (n = 210; IMPS #184B) were unpackaged and pre-trimmed for steak cutting following the plant's conventional procedures. The exact number of days that subprimals were aged before steak cutting was not known; but, plant management indicated that steak cutting typically occurred at 7 to 10 days postmortem and steaks typically were retailed 3 to 5 days postmortem. The anterior cut surface of each cut (i.e., LM exposed by ribbing of the carcass side and GM exposed during fabrication by the shortloin-sirloin separation) was assessed at line speed by VISNIR to predict tenderness and cuts with predicted SSF less than the median for the muscle were classified as predicted tender. Muscles were cut into steaks following the plant's conventional procedures and one steak was obtained for this study from each cut. Steaks were identified and transported to USMARC and aged an additional 5 days to simulate the additional 3 to 5 days aging time the steaks normally go through during distribution from the steak portioning to retail sales. Steaks were cooked and LM and GM SSF was measured as above.

Statistical Analysis

For Experiment 1, the GLMMIX procedure of SAS was used to conduct ANOVA with fixed main effects of VISNIR predicted SSF class, blade tenderization treatment, aging time, all possible interactions, and the random effect of carcass within VISNIR predicted SSF class. Differences among least-squares means were determined with the diff and lines options of GLMMIX. For Experiment 2, the model only included the main effect of VISNIR predicted SSF class. Slice shear force data were analyzed independently for each muscle because measures of shear force do not accurately reflect tenderness differences between muscles (Shackelford et al., 1995; Rhee et al., 2004) and because shear force does not accurately represent the contribution of connective tissue to muscle tenderness (Bouton et al., 1978; Harris and Shorthose, 1988).

Findings

All main effects were highly significant for SSF for each muscle ($P < 0.0001$) and the order of means was consistent with expectations based on available literature for VISNIR prediction of beef tenderness, blade tenderization, and aging time. There was a highly significant ($P < 0.0001$) interaction of aging time and VISNIR predicted tenderness class on LM SSF but this two-way interaction was not significant for GM SSF). For LM, the SSF difference between the toughest VISNIR quadrant and the other quadrants was greatest at 7 d postmortem and diminished with increased length of postmortem storage. But, for both muscles, the toughest VISNIR quartile had higher ($P < 0.05$) SSF than the other quartiles at each aging period. For both muscles, the two most tender quadrants did not differ ($P > 0.05$) in SSF at any aging time suggesting that there would not be any advantage to differentiating those two quadrants. For LM and GM, SSF of the two toughest VISNIR quartiles improved ($P < 0.05$) between each successive aging period. But, the SSF of the two most tender VISNIR quartiles did not improve after 28 d ($P > 0.05$). The effect of blade tenderization on SSF of LM differed among VISNIR tenderness classes ($P < 0.05$). While blade tenderization reduced SSF of each class, the effect was greatest for the toughest VISNIR quartile. Likewise, the effect of blade tenderization on SSF of LM ($P < 0.05$) and GM ($P < 0.0001$) differed among aging periods, with the greatest effect at 7 d postmortem. These data show that in the

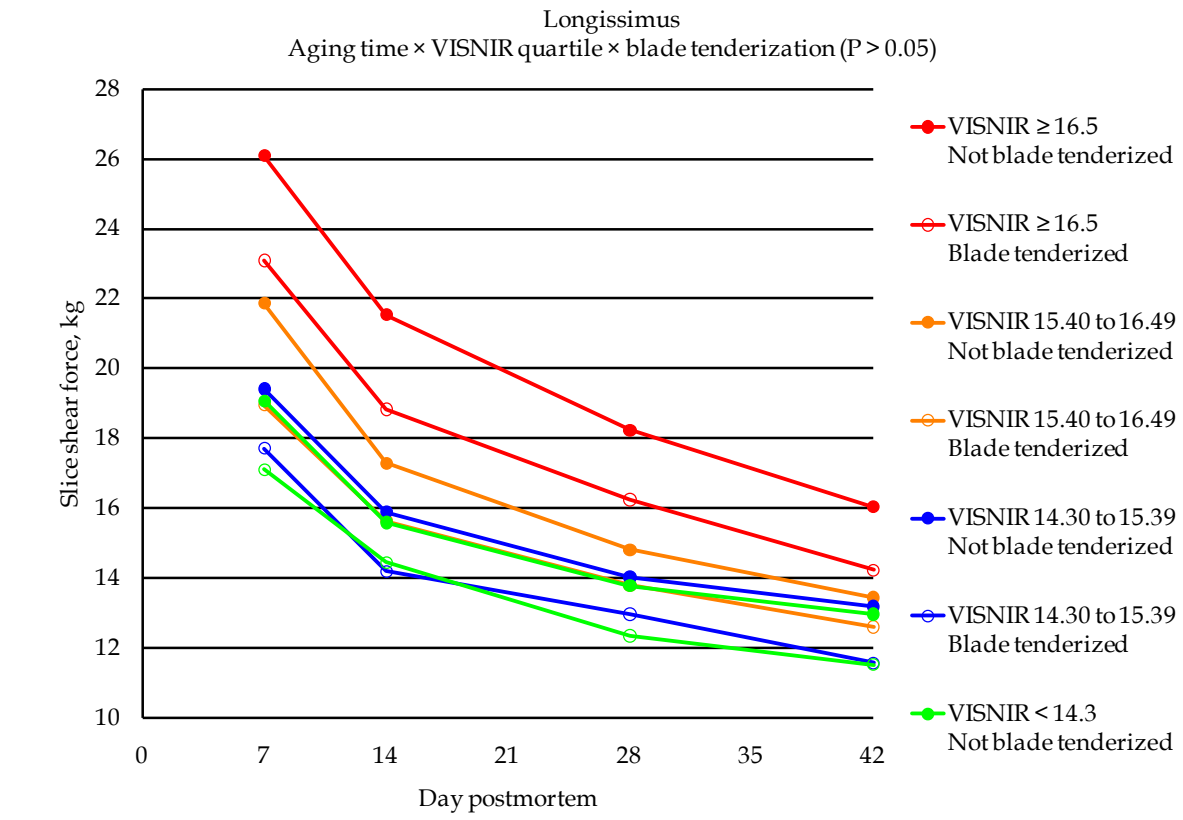
absence of lengthy postmortem storage or blade tenderization, there is a high degree of incentive to utilize cuts predicted to be tender by VISNIR.

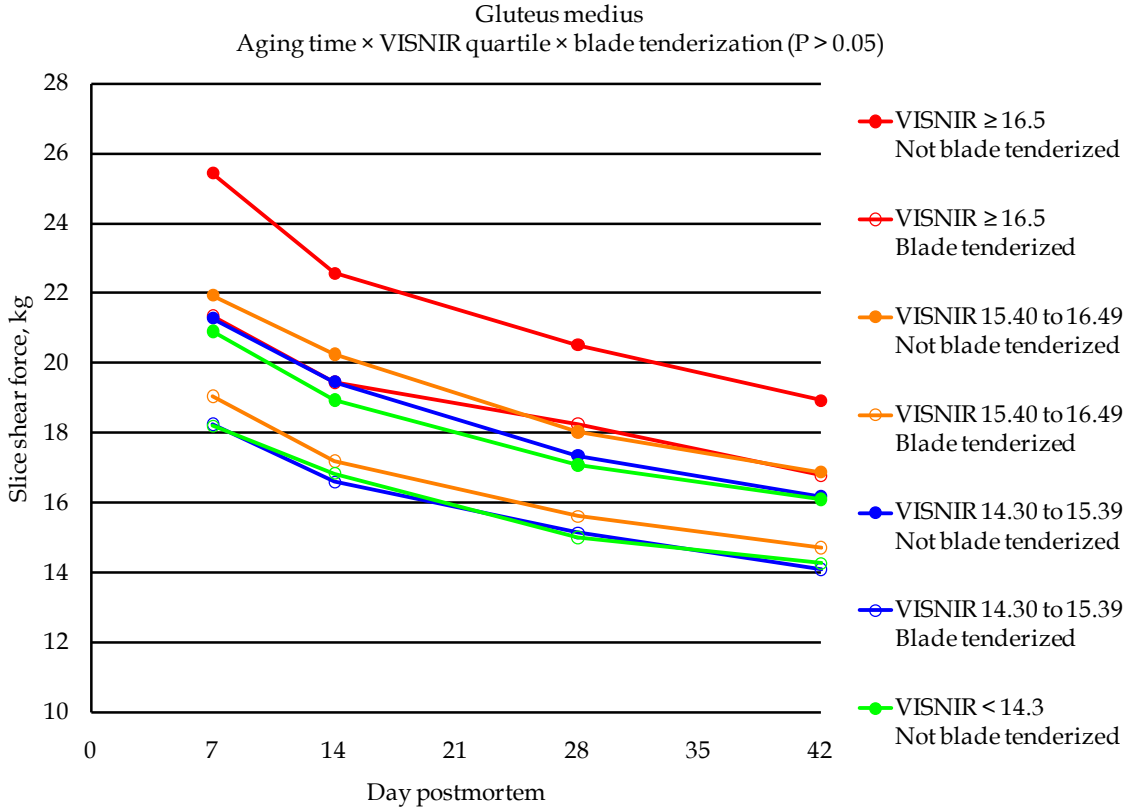
Implications

It was determined that optimal aging times differ greatly among VISNIR predicted tenderness (slice shear force) classes and are influenced strongly by blade tenderization. Cuts from carcasses in the least tender VISNIR predicted tenderness quartile require much more aging to reach acceptable tenderness than cuts from the other quartiles. This study will allow the beef industry to more effectively control variation in tenderness which should increase consumption of U.S. beef.

VISNIR sorted carcasses with cuts tagged and ready for fabrication and subsequent processing

Gluteus medius steaks


Longissimus
Aging time × VISNIR quartile × blade tenderization (P > 0.05)
Slice shear force, kg
28
26
24
22
20
18
16
14
12
10
0
7
14
21
28
35
42
Day postmortem
VISNIR ≥ 16.5
Not blade tenderized
VISNIR ≥ 16.5
Blade tenderized
VISNIR 15.40 to 16.49
Not blade tenderized
VISNIR 15.40 to 16.49
Blade tenderized
VISNIR 14.30 to 15.39
Not blade tenderized
VISNIR 14.30 to 15.39
Blade tenderized
VISNIR < 14.3
Not blade tenderized


Gluteus medius
Aging time × VISNIR quartile × blade tenderization (P > 0.05)
Slice shear force, kg
28
26
24
22
20
18
16
14
12
10
0
7
14
21
28
35
42
Day postmortem
VISNIR ≥ 16.5
Not blade tenderized
VISNIR ≥ 16.5
Blade tenderized
VISNIR 15.40 to 16.49
Not blade tenderized
VISNIR 15.40 to 16.49
Blade tenderized
VISNIR 14.30 to 15.39
Not blade tenderized
VISNIR 14.30 to 15.39
Blade tenderized
VISNIR < 14.3
Not blade tenderized

For more information contact:
National Cattlemen's Beef Association
9110 East Nichols Avenue
Centennial, Colorado 80112-3450
(303) 694-0305