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J.W. Stephens

Melvin C. Hunt

T.E. Lawrence

See next page for additional authors

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Abstract

We pooled the mechanical probe data from two experiments to develop regression equations to predict beef longissimus tenderness. Fifty-three USDA Select strip loins were evaluated at 2 days postmortem with three mechanical probes to predict trained sensory panel (TSP) tenderness and Warner-Bratzler shear force (WBSF) of cooked steaks aged 14 days. The sharp needle, sharp blade, and plumb bob probes were correlated to TSP tenderness (r=-0.51, -0.45, and -0.35, respectively)and WBSF (r=0.56, 0.53, and 0.36, respectively). Regression equations developed from sharp needle, sharp blade, and plumb bob probe measurements and L* (lightness) values accounted for 49, 50, and 47% of the variation in TSP tenderness. The predicted values of equations were also used to classify the strips as tough or tender, and this classification was compared to the actual TSP tenderness classification. Of the steaks predicted to be tender by the equations using the sharp needle, sharp blade, and plumb bob probes and WBSF 88, 88, 84, and 87%, respectively, were actually tender according to TSP. The sharp needle, sharp blade, and plumb bob probe prediction equations were comparable to WBSF in classifying carcasses into sensory panel determined tenderness groups, and they were superior to WBSF in simplicity and cost.

Keywords

Cattlemen's Day, 2003; Kansas Agricultural Experiment Station contribution; no. 03-272-S; Report of progress (Kansas State University. Agricultural Experiment Station and Cooperative Extension Service); 908; Beef; Uncooked steaks; Longissimus tenderness

Authors

J.W. Stephens, Melvin C. Hunt, T.E. Lawrence, T.M. Loughin, John A. Unruh, and Michael E. Dikeman

EVALUATION OF MECHANICAL PROBES USED ON UNCOOKED STEAKS TO CLASSIFY BEEF LONGISSIMUS TENDERNESS

J. W. Stephens, J. A. Unruh, M. E. Dikeman, M. C. Hunt, T. E. Lawrence, and T. M. Loughin [1]

Summary

We pooled the mechanical probe data from two experiments to develop regression equations to predict beef longissimus tenderness. Fifty-three USDA Select strip loins were evaluated at 2 days postmortem with three mechanical probes to predict trained sensory panel (TSP) tenderness and Warner-Bratzler shear force (WBSF) of cooked steaks aged 14 days. The sharp needle, sharp blade, and plumb bob probes were correlated to TSP tenderness (r=-0.51, -0.45, and -0.35, respectively) and WBSF (r=0.56, 0.53, and 0.36, respectively). Regression equations developed from sharp needle, sharp blade, and plumb bob probe measurements and L* (lightness) values accounted for 49, 50, and 47% of the variation in TSP tenderness. The predicted values of equations were also used to classify the strips as tough or tender, and this classification was compared to the actual TSP tenderness classification. Of the steaks predicted to be tender by the equations using the sharp needle, sharp blade, and plumb bob probes and WBSF 88, 88, 84, and 87%, respectively, were actually tender according to TSP. The sharp needle, sharp blade, and plumb bob probe prediction equations were comparable to WBSF in classifying carcasses into sensory panel determined tenderness groups, and they were superior to WBSF in simplicity and cost.

Introduction

The beef industry needs to sort and market carcasses based on assurance of tenderness. Currently, marbling strongly influences industry marketing of carcasses due to its presumed influence on palatability, but the relationship of marbling to tenderness is low. Warner-Bratzler shear force (WBSF) is the most used objective method to measure tenderness, but is costly, time consuming, and difficult to fit into industry operations because it must be performed on cooked steaks. Sharp needle, sharp blade, and plumb bob probes were developed and evaluated in a previous study to predict cooked tenderness on uncooked, strip loin sections at 2 days postmortem. This study increased the number of observations relating sharp needle, sharp blade, and plumb bob probes and color variables to TSP tenderness.

Experimental Procedures

Fifty-three USDA Select strip loins were selected from a commercial processing facility and transported to Kansas State University. The exterior fat was removed from the strips before they were fabricated into two 2.5-inch sections and three 1-inch steaks. Two steaks were vacuum packaged and stored until 14 days postmortem for WBSF measurement and TSP evaluation.

[1]Department of Statistics.

The 2.5-inch sections were evaluated with the sharp needle and sharp blade probes attached to the Instron Universal Testing Machine. Each probe was used to penetrate the cut surface of the loineye section in medial and lateral locations, and the values were averaged for analysis. The Instron measured the peak force in kilograms and measured total energy required to penetrate the muscle in Joules. The product of peak force and total energy (cross product) was also studied as a variable to account for both peak force and total energy measurements. The remaining steak was used to measure instrumental color values of L* (lightness), a* (redness), and b* (yellowness) before evaluation with the plumb bob probe. The plumb bob probe was also attached to the Instron and was tested on each steak in three locations. A Sentron probe was used to measure pH on each loin.

The data were used to calculate the relationship of the probe measurements, color variables, and pH to trained sensory panel (TSP) tenderness and Warner-Bratzler shear force (WBSF). The best combinations of probe measurements and color values were used to calculate the regression equations and classify strips into tenderness groups. The predicted tenderness scores of 4.5 or higher were classified as tender and tenderness scores below 4.5 were classified as tough. These were compared to actual TSP scores, which were also used to classify the strips as tough or tender. When these agreed, the carcass was classified correctly.

Results and Discussion

The sharp needle probe peak force, total energy, and cross product were correlated to TSP tenderness ($r=-0.53$, -0.51, and -0.54, respectively) and WBSF ($r=0.55$, 0.56, and 0.56, respectively; Table 1). The sharp blade probe correlation coefficients of peak force, total energy, and cross product to TSP tenderness were -0.37, -0.45, and -0.45, respectively, and to WBSF were 0.33, 0.53, and 0.47, respectively. The correlation coefficients of the plumb bob probe peak force, total energy, and cross product to TSP tenderness were -0.44, -0.53, and -0.50, respectively, and to WBSF were 0.37, 0.46, and 0.44, respectively. No color variable was meaningfully correlated ($P>0.05$) to TSP tenderness or WBSF. Average pH values were correlated to TSP tenderness ($r=-0.43$) and WBSF ($r=0.40$). The correlation coefficient of TSP tenderness to WBSF was –0.69.

Sharp Needle Probe: The regression equation (Table 2) using the sharp needle cross product value (peak force x total energy) alone only accounted for 38% of the variation in TSP tenderness, while L* in combination with sharp needle cross product accounted for 49% of the variation in TSP tenderness. Of the loins that were predicted to be tender (tenderness>4.5) by the sharp needle probe and L* equation, 42 out of 48 (88%) were actually tender according to the TSP (Figure 1). However, of the loins predicted to be tough (tenderness<4.5), 3 out of 5 (60%) were actually tough. When the tenderness threshold of 5.5 was used to classify the loins, 25 of the 26 loins (96%) predicted to be tender were tender according to the TSP (tenderness>4.5).

Sharp Blade Probe: The equation from the pooled data using the sharp blade total energy alone accounted for 37% of the variation in TSP tenderness, while L* accounted for an additional 13% of the variation in TSP tenderness. Of the loins that were predicted to be tender (tenderness>4.5) by the sharp blade probe and L* equation, 44 out of 50 (88%) were actually tender according to the TSP (Figure 2). However, of the loins predicted to be tough (tenderness<4.5), 100% (3 out of 3) were actually tough. When the tenderness threshold of 5.5 was used to classify the loins, 21 of the 22 loins (95%) predicted to be tender were tender according to the TSP (tenderness>4.5).

Plumb Bob Probe: The equation from the pooled data calculated with the quadratic term of plumb bob total energy and L* accounted for 47% of the variation in TSP tenderness, and the equation using the linear term of the plumb bob total energy and L* accounted for 44% of the variation in TSP tenderness. Of the loins that were predicted to be tender (tenderness>4.5) by the plumb bob probe and L* equation, 43 out of 51 (84%) were actually tender according to the TSP (Figure 3). However, 1 of the 2 loins (50%) predicted to be tough (tenderness<4.5) was actually tough. When the tenderness threshold of 5.5 was used to classify the loins, 25 of the 26 loins (96%) predicted to be tender were tender according to the TSP (tenderness>4.5).

Warner-Bratzler Shear Force (WBSF): A regression equation using WBSF to predict TSP tenderness accounted for 58% of the variation in TSP tenderness. Of the loins that were predicted to be tender (tenderness>4.5) by the WBSF equation, 41 out of 47 (87%) were actually tender according to the TSP (Figure 4). However, of the loins predicted to be tough (tenderness<4.5), 3 of the 6 (50%) were actually tough. When the tenderness threshold of 5.5 was used to classify the loins, 20 of the 21 loins (95%) predicted to be tender were tender according to the TSP (tenderness>4.5).

The regression equations from the sharp needle, sharp blade, and plumb bob probes and L* values were comparable to those using WBSF at classifying carcasses into tenderness groups. The mechanical probes, which were superior to WBSF in simplicity and cost, have potential as on-line predictors of tenderness.

Table 1. Correlation Coefficients of the Sharp Needle, Sharp Blade and Plumb Bob Peak Force, Total Energy, and Cross Product (Product of Peak Force and Total Energy) Instrumental Color, and Average pH Values to Trained Sensory Panel (TSP) Tenderness and Warner-Bratzler Shear Force (WBSF) in the Pooled Data

Probe	Variable	TSP Tenderness	WBSF
Sharp needle	Peak force	-0.53[a]	0.55[a]
	Total energy	-0.51[a]	0.56[a]
	Cross product	-0.54[a]	0.56[a]
Sharp blade	Peak force	-0.37[a]	0.33[a]
	Total energy	-0.45[a]	0.53[a]
	Cross product	-0.45[a]	0.47[a]
Plumb bob	Peak force	-0.24	0.24
	Total energy	-0.35[a]	0.36[a]
	Cross product	-0.32[a]	0.33[a]
L*		0.43[a]	-0.15
a*		0.06	-0.08
b*		0.13	-0.06
Average pH		-0.43[a]	0.40[a]
WBSF		-0.69[a]	---

[a]$P<0.05$

Table 2. Regression Equations for Predicting Trained Sensory Panel Tenderness from the Sharp Needle, Sharp Blade, and Plumb Bob Probes and L* (Lightness) and Warner-Bratzler Shear Force

R^2	Intercept
0.38	6.25 - 0.0098 (sharp needle cross product)
0.49	1.92 - 0.0087 (sharp needle cross product) + 0.096(L*)
0.37	6.99 - 0.0216 (sharp blade total energy)
0.50	2.14 - 0.0196 (sharp blade total energy) + 0.106(L*)
0.47	0.82 - 0.00004 (plumb bob total energy) + 0.119(L*)
0.58	8.51 - 0.74 (Warner-Bratzler shear force)

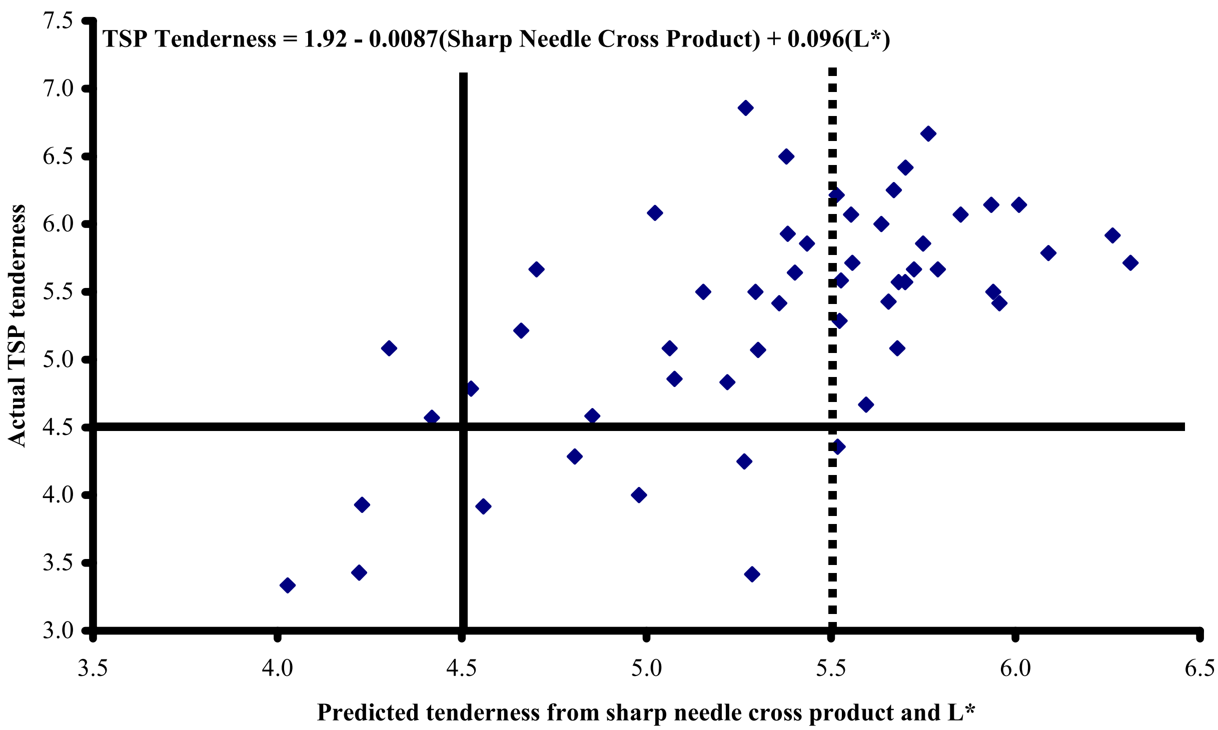

Figure 1. Classification of Longissimus Tenderness Based on 2-Day Postmortem Sharp Needle Probe and L* Prediction Equation Thresholds of 4.5 and 5.5 (4.0 = slightly tender, and 6.0 = moderately tender). Accuracy of Classification was Based Trained Sensory Panel (TSP) Ratings on Day 14 Postmortem.

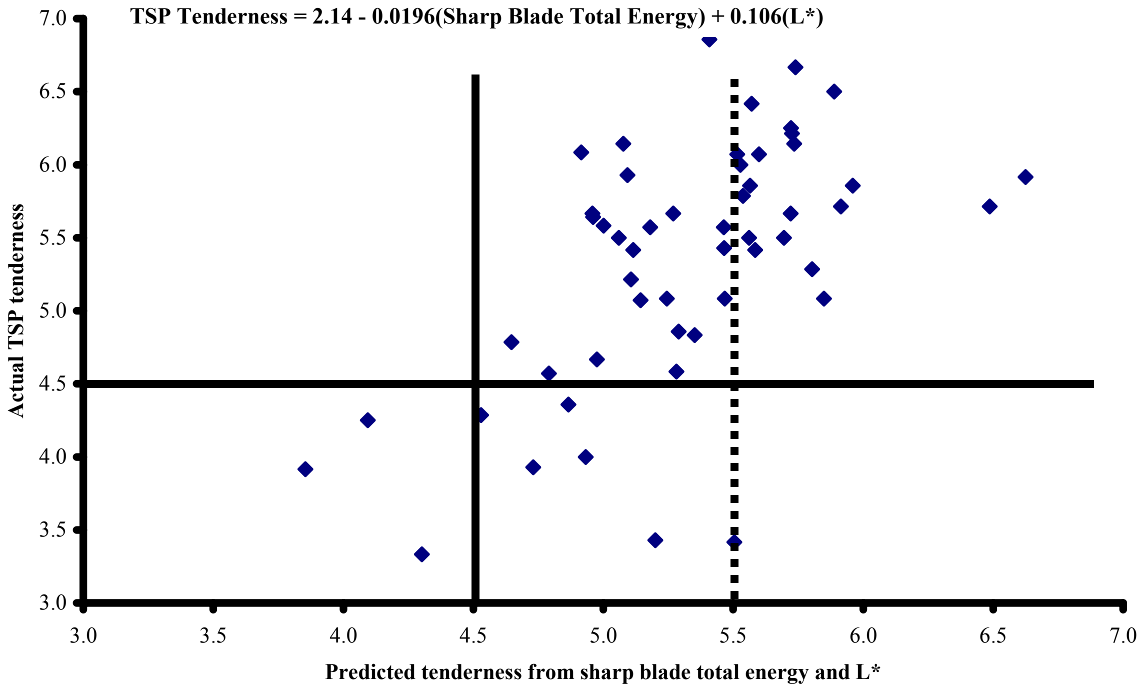

Figure 2. Classification of Longissimus Tenderness Based on 2-Day Postmortem Sharp Blade Probe and L* Prediction Equation Thresholds of 4.5 and 5.5 (4.0 = slightly tough, 5.0 = slightly tender, and 6.0 = moderately tender). Accuracy of Classification was Based Trained Sensory Panel (TSP) Ratings on Day 14 Postmortem.

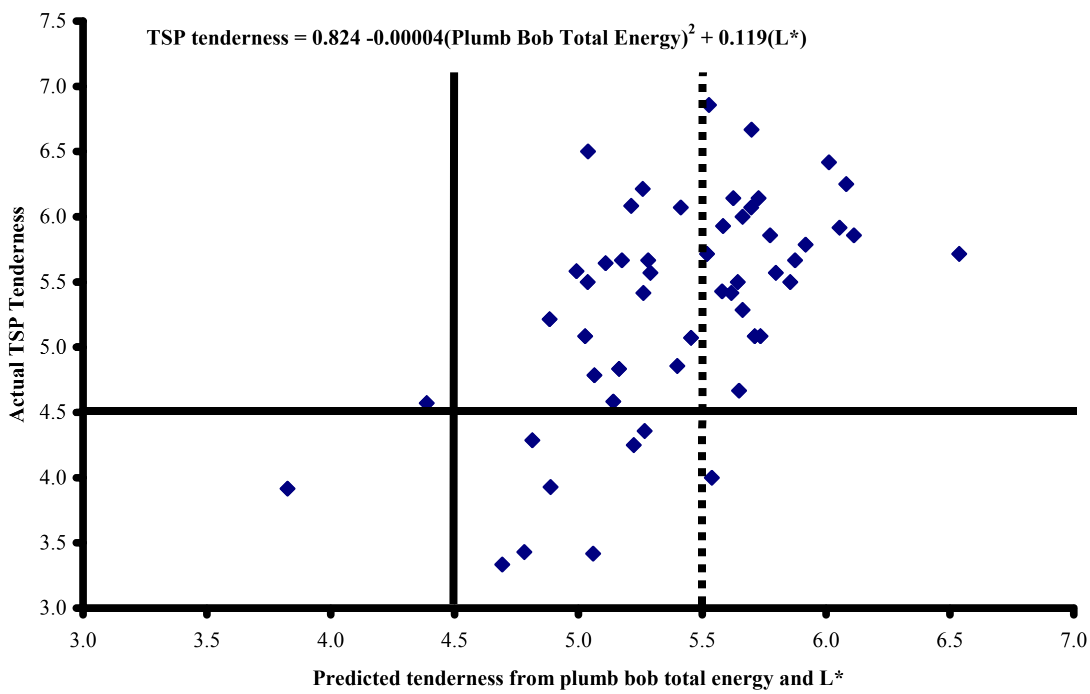

Figure 3. Classification of Longissimus Tenderness Based on 2-Day Postmortem Plumb Bob Probe and L* Prediction Equation Thresholds of 4.5 and 5.5 (4.0 = slightly tough, 5.0 = slightly tender, and 6.0 = moderately tender). Accuracy of Classification was Based Trained Sensory Panel (TSP) Ratings on Day 14 Postmortem.

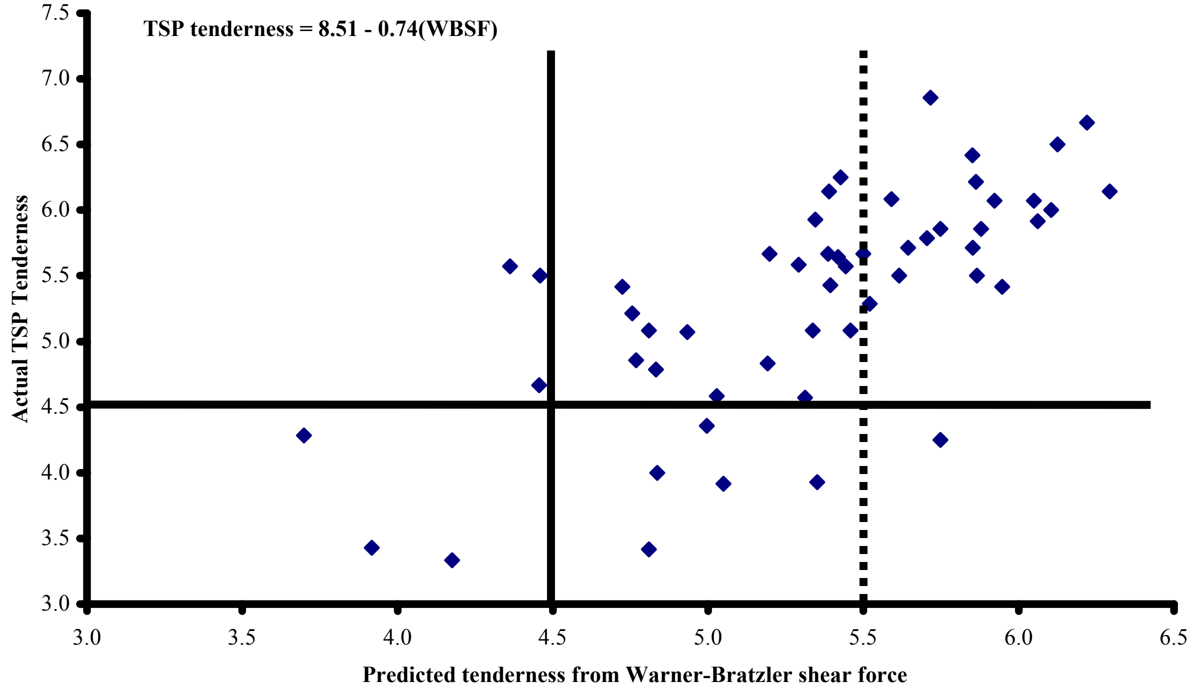

Figure 4. Classification of Longissimus Tenderness Based on 2-Day Postmortem Warner-Bratzler Shear Force (WBSF) Prediction Equation Thresholds of 4.5 and 5.5 (4.0 = slightly tough tough, 5.0 = slightly tender, and 6.0 = moderately tender). Accuracy of Classification was Based Trained Sensory Panel (TSP) Ratings on Day 14 Postmortem.