Kansas Agricultural Experiment Station Research Reports

Volume 0
Issue 1 *Cattleman's Day (1993-2014)*

Article 1564

2003

Mechanical Probes Used on Uncooked Steaks Can Predict Cooked Beef Longissimus Tenderness

J. W. Stephens
Kansas State University

J. A. Unruh
Kansas State University, Manhattan, junruh@k-state.edu

Michael E. Dikeman
Kansas State University, mdikeman@k-state.edu

See next page for additional authors

Recommended Citation

Stephens, J. W.; Unruh, J. A.; Dikeman, Michael E.; Hunt, M. C.; Lawrence, T. E.; and Loughin, T. M. (2003) "Mechanical Probes Used on Uncooked Steaks Can Predict Cooked Beef Longissimus Tenderness," *Kansas Agricultural Experiment Station Research Reports*: Vol. 0: Iss. 1. https://doi.org/10.4148/2378-5977.7512

Mechanical Probes Used on Uncooked Steaks Can Predict Cooked Beef Longissimus Tenderness

Abstract

We investigated five mechanical probes, used on uncooked strip loin steaks at 2 days postmortem, to predict trained sensory panel (TSP) tenderness and Warner-Bratzler shear force (WBSF) of steaks aged 14 days. Twenty-nine USDA Select strip loins were evaluated with sharp needle, blunt needle, sharp blade, and blunt blade probes in parallel and perpendicular orientations to the length of the strip loin. A steak from each loin was also measured with a plumb bob probe in a parallel orientation and with a Miniscan for instrumental color. None of the perpendicular orientation measurements were correlated (P>0.05) to TSP tenderness. The sharp blade and sharp needle probe values from the perpendicular orientation were correlated to WBSF (r=0.49 and 0.37, respectively). Parallel measurements by the sharp needle, blunt needle, sharp blade, blunt blade, and plumb bob probes were correlated with TSP tenderness (r=-0.77, -0.40, -0.52, -0.57, and -0.53, respectively) and WBSF (r=0.74, 0.38, 0.60, 0.41, and 0.46). Instrumental color variables were not correlated (P>0.05) with TSP tenderness or WBSF. A regression equation for predicting TSP tenderness using the sharp needle probe resulted in R2 of 0.74, while the equation predicting TSP tenderness from WBSF had an R2 of 0.69. Equations using the sharp blade and plumb bob probe values in addition to L* values resulted in R2 values of 0.45 and 0.56, respectively. The sharp needle, sharp blade, and plumb bob probes were successful in predicting trained sensory panel tenderness. However, the sharp needle probe was superior to the other mechanical probes.

Keywords

beef cattle

Authors

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

MECHANICAL PROBES USED ON UNCOOKED STEAKS CAN PREDICT COOKED 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 investigated five mechanical probes, used on uncooked strip loin steaks at 2 days postmortem, to predict trained sensory panel (TSP) tenderness and Warner-Bratzler shear force (WBSF) of steaks aged 14 days. Twenty-nine USDA Select strip loins were evaluated with sharp needle, blunt needle, sharp blade, and blunt blade probes in parallel and perpendicular orientations to the length of the strip loin. A steak from each loin was also measured with a plumb bob probe in a parallel orientation and with a Miniscan for instrumental color. None of the perpendicular orientation measurements were correlated (P>0.05) to TSP tenderness. The sharp blade and sharp needle probe values from the perpendicular orientation were correlated to WBSF (r=0.49 and 0.37, respectively). Parallel measurements by the sharp needle, blunt needle, sharp blade, blunt blade, and plumb bob probes were correlated with TSP tenderness (r=-0.77, -0.40, -0.52, -0.57, and -0.53, respectively) and WBSF (r=0.74, 0.38, 0.60, 0.41, and 0.46). Instrumental color variables were not correlated (P>0.05) with TSP tenderness or WBSF. A regression equation for predicting TSP tenderness using the sharp needle probe resulted in R^2 of 0.74, while the equation predicting TSP tenderness from WBSF had an R^2 of 0.69. Equations using the sharp blade and plumb bob probe values in addition to L* values resulted in R^2 values of 0.45 and 0.56, respectively. The sharp needle, sharp blade, and plumb bob probes were successful in predicting trained sensory panel tenderness. However, the sharp needle probe was superior to the other mechanical probes.

Introduction

Tenderness is considered the most important palatability attribute of beef, and consumers are willing to pay a premium for tender beef. Participants in the Beef Strategies Workshop of the National Beef Quality Audit identified two of the top ten issues in the beef industry as inconsistency of carcasses and inadequate tenderness. Generally, marbling has been the primary factor used to segregate young beef carcasses into tenderness groups, yet marbling only accounts for a small amount of the variation in tenderness.

Researchers have developed numerous methods to predict beef tenderness. These include the Warner-Bratzler shear force (WBSF), Armour Tenderometer, Meat Animal Research Center Tenderness Classification System, and BeefCam. These methods have not predicted tenderness in an inexpensive, timely, and sufficiently accurate manner. In a previous study (2002 Cattlemen's Day), the sharp needle and plumb bob probe measurements were compared to trained sensory panel (TSP) tenderness and WBSF. The sharp needle and plumb bob probes were highly corre-

[1] Department of Statistics.

lated to TSP tenderness (r=-0.71 and -0.74, respectively) and to WBSF (r=0.78 and 0.67, respectively). The objective of this study was to investigate the use of these and other mechanical measures as well as objective color to predict beef tenderness.

Experimental Procedures

The sharp needle probe contains six, sharp needles fixed to a plate in two rows of three. The plumb bob probe is cone shaped with a diameter ranging from zero to 1.38 inches. The three new probes we developed were the blunt needle probe (similar to the sharp needle probe, except that each needle has a rounded point), the blunt blade probe (stainless steel, 0.06-inch thick and 1.6-inch wide with a rounded edge), and the sharp blade probe (similar to the blunt blade probe except that the edge is sharp with a 22^o angle).

Twenty-nine USDA Select strip loins from a commercial packing facility were transported to Kansas State University. The exterior fat was removed from each strip loin before it was evaluated by the probes. Each loin was assigned a random order of treatments.

Each probe was attached to the Instron Universal Testing Machine. The sharp needle, blunt needle, sharp blade, and blunt blade measured strip loins perpendicular to the long axis of the loin, at 2 days postmortem. The strip loins were then fabricated into four 2.5-inch sections for the sharp needle, blunt needle, sharp blade, and blunt blade probes and into three 1-inch steaks for the plumb bob probe, trained sensory panel (TSP) tenderness, and Warner-Bratzler shear force (WBSF). The steaks for TSP and WBSF were vacuum packaged and stored to 14 days postmortem. The sharp needle, blunt needle, sharp blade, and blunt blade probes penetrated 1.5 inches into the 2.5 inch sections and were used at four locations, twice perpendicular and twice parallel. The plumb bob probe penetrated 2.7 inches through the steaks in three locations. For each measurement, the peak force (kilograms) and total energy (Joules) required to penetrate the steak were measured by the Instron. The product of peak force and total energy (cross product) was also calculated and used in analysis.

Steaks assigned to plumb bob probe determination were allowed to bloom for at least 80 minutes before instrumental color measurements were obtained. Lightness of the steaks was depicted by L* values, redness with a* values, and yellowness with b* values. Four measurements of pH were recorded for each loin and averaged for analysis. Steaks assigned to TSP and WBSF were cooked to 160^{o}F. A trained six-member panel analyzed the TSP steaks for myofibrillar tenderness, juiciness, connective tissue amount, and overall tenderness, but only overall tenderness was used in this analysis. The WBSF steaks were chilled overnight at 33^{o}F before six to eight cores were taken parallel to the muscle fiber direction and sheared with the Warner-Bratzler attachment of the Instron. Correlations were determined and regression equations were calculated from the best combinations of probe and color measurements.

Results and Discussion

The correlation coefficients of peak force, total energy, and cross product variables of the five probes in both perpendicular and parallel orientations with trained sensory panel (TSP) tenderness and Warner-Bratzler shear force (WBSF) are presented in Table 1. Perpendicular measurements by mechanical probes were weakly correlated (P>0.05) to TSP tenderness. Blunt blade and blunt needle probe perpendicular measurements were also weakly correlated (P>0.05) to WBSF. Perpendicular peak force, total energy, and cross product measurements of the sharp blade probe were correlated to WBSF (r=0.40, 0.49, and 0.45, respectively). The peak force perpendicular measurements of the sharp needle probe were correlated to WBSF (r=0.37). We concluded that probe measurements taken perpendicular to the length of the loin were not good predictors of tenderness and might be difficult to implement in plant operations.

In general, measurements taken parallel to the long axis of the loin were more consistently correlated to TSP tenderness and WBSF than the perpendicular orientation. In the parallel orientation, blunt blade, sharp blade, and sharp needle probes were all correlated ($P<0.05$) to TSP tenderness (Table 1). Total energy for the blunt needle probe was correlated ($r=-0.40$) to TSP tenderness, but its peak force and cross product were not ($P>0.05$). Eleven out of fifteen parallel probe variables were correlated ($P<0.05$) to WBSF. The blunt blade and blunt needle probes were weakly to moderately correlated (Table 1) to TSP tenderness and WBSF, and they were inferior to the sharp needle, sharp blade, and plumb bob probes in predicting TSP tenderness. The blunt needle and blunt blade probes were not good predictors of tenderness and were not considered further.

The correlation coefficients (Table 1) of the peak force, total energy, and cross product of the parallel sharp needle probe to TSP tenderness were r=-0.71, -0.71, and -0.77, respectively, and to WBSF were r=0.71, 0.74, and 0.74, respectively. The correlation coefficients of the peak force, total energy, and cross product of the parallel sharp blade probe to TSP tenderness were r=-0.38, -0.52, and -0.51, respectively, and to WBSF were r=0.35, 0.60, and 0.52, respectively. The correlation coefficients of the peak force, total energy, and cross product of the parallel plumb bob probe to TSP tenderness were r=-0.44, -0.53, and -0.50, respectively, and to WBSF were r=0.37, 0.46, and 0.44, respectively. The relationship of WBSF to TSP tenderness was r=-0.80. No color variable was correlated ($P>0.05$) to TSP tenderness or WBSF. Average pH values were correlated to TSP tenderness (r=-0.44) and WBSF (r=0.58).

Regression equations for predicting TSP tenderness from mechanical probe peak force, total energy, and cross product variables and L* values are presented in Table 2. For the sharp needle probe, the cross product was the most highly predictive as it accounted for 64% of the variation in TSP tenderness. The quadratic term of the cross product variable accounted for 74% of the variation in TSP tenderness, indicating that the sharp needle probe had a curvilinear relationship with TSP tenderness. The sharp needle probe regression equation had a R^2 (0.74) comparable to that of WBSF ($R^2=0.69$) for predicting TSP tenderness. The addition of instrumental color (L*) did not improve the predictive ability of the sharp needle probe equations. The sharp needle probe did not significantly alter the quality of the muscle during measurement.

A regression equation for predicting TSP tenderness from the total energy of the sharp blade probe had a R^2 value of 0.37, but the combination of total energy and L* values resulted in a R^2 of 0.43. The regression equation for predicting TSP tenderness from the quadratic term of the total energy resulted in an R^2 of 0.41, and L* accounted for an additional 4% of the variation in TSP tenderness. The sharp blade probe left marks on the uncooked steak, but these were not noticeable when the steaks were cooked.

A regression equation for predicting TSP tenderness from plumb bob probe total energy resulted in a R^2 of 0.52, and with the addition of L* values, the R^2 was 0.56. The plumb bob probe method leaves a steak unusable as a whole muscle product, but plumb bob steaks can still be used as cubed steaks or ground beef, retaining some value.

The sharp needle, sharp blade, and plumb bob probes have the potential to become online predictors of tenderness. In our study, the sharp needle probe was comparable to WBSF in predicting TSP tenderness. Although the sharp blade and plumb bob probes were not as successful at predicting tenderness as the sharp needle probe, they still deserve further attention. Addition of color (L*) improved the regression equations for the sharp blade and plumb bob probes. The sharp needle, sharp blade, and plumb bob probes are more easily applied than WBSF as a useful tenderness evaluation tool, as they are used on uncooked strip loins at 2 days postmortem, rather than after aging and cooking.

Table 1. Correlation Coefficients of Blunt Blade, Blunt Needle, Sharp Blade, Sharp Needle, and Plumb Bob Probe Peak Force, Total Energy, and Cross Product (Peak Force x Total Energy) in Perpendicular and Parallel Orientations, Color Values (L*, a* and b*), and Average pH with Trained Sensory Panel (TSP) Tenderness and Warner-Bratzler Shear Force (WBSF)

Orientation	Probe	Variable	TSP	WBSF
Perpendicular	Blunt blade	Peak force	0.15	-0.14
		Total energy	0.04	-0.08
		Cross product	0.09	-0.09
	Blunt needle	Peak force	0.06	-0.03
		Total energy	0.18	-0.09
		Cross product	0.11	-0.04
	Sharp blade	Peak force	-0.10	0.40[a]
		Total energy	-0.20	0.49[a]
		Cross product	-0.14	0.45[a]
	Sharp needle	Peak force	-0.24	0.37[a]
		Total energy	-0.16	0.33
		Cross product	-0.17	0.34
Parallel	Blunt blade	Peak force	-0.43[a]	0.30
		Total energy	-0.57[a]	0.41[a]
		Cross product	-0.53[a]	0.38[a]
	Blunt needle	Peak force	-0.20	0.11
		Total energy	-0.40[a]	0.38[a]
		Cross product	-0.28	0.26
	Sharp needle	Peak force	-0.71[a]	0.71[a]
		Total energy	-0.71[a]	0.74[a]
		Cross product	-0.77[a]	0.74[a]
	Sharp blade	Peak force	-0.38[a]	0.35
		Total energy	-0.52[a]	0.60[a]
		Cross product	-0.51[a]	0.52[a]
	Plumb bob	Peak force	-0.44[a]	0.37[a]
		Total energy	-0.53[a]	0.46[a]
		Cross product	-0.50[a]	0.44[a]
	WBSF	Peak force	-0.80[a]	---
		Total energy	-0.77[a]	---
		Cross product	-0.80[a]	---
	L*		0.32	-0.26
	a*		0.04	-0.10
	b*		0.00	-0.07
	Average pH		-0.44[a]	0.58[a]

[a]P<0.05.

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

R^2	Equation
0.64	6.84 - 0.014(sharp needle cross product)
0.74	6.23 - 0.00007(sharp needle cross product)^2
0.37	7.29 - 0.023(sharp blade total energy)
0.43	4.12 - 0.021(sharp blade total energy) + 0.067(L*)
0.39	6.48 - 0.0015(sharp blade total energy)^2
0.45	3.37 - 0.00014(sharp blade total energy)^2 + 0.068(L*)
0.52	7.91 - 0.019(plumb bob total energy)
0.56	4.29 - 0.017(plumb bob total energy) + 0.076(L*)
0.69	8.51 - 0.74(Warner-Bratzler shear force)

Figure 1. Sharp Needle Probe

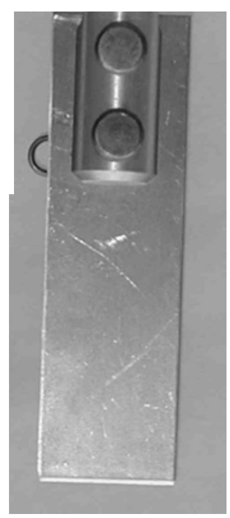

Figure 2. Sharp Blade Probe

Figure 3. Plumb Bob Probe