Use of belt grill cookery and slice shear force for assessment of pork longissimus tenderness

S. D. Shackelford[1], T. L. Wheeler, and M. Koohmaraie

USDA-ARS, U.S. Meat Animal Research Center, P.O. Box 166, Clay Center, NE 68933

Introduction

Traditional meat tenderness research techniques are labor intensive and, thus, make evaluating tenderness of large numbers of samples very expensive. We found shear force data from beef samples to be more repeatable using the slice shear force (SSF) protocol developed for beef tenderness classification (Shackelford et al., 1999a), than the traditional WBSF protocol (Shackelford et al., 1999b). Therefore, experiments were conducted to determine if these procedures could be adapted for use in pork tenderness research. Three experiments were conducted to: 1) determine the effect of belt grill (BG) cookery on repeatability of pork shear force data; 2) compare the correlation of WBSF and SSF with trained sensory panel tenderness ratings; and 3) estimate the repeatability of pork longissimus SSF for chops cooked using a BG.

Materials and Methods

Experiment 1: Comparison of cooking methods

At 1 d postmortem, eight longissimus chops were obtained from each of 25 pork carcasses. Chops were cooked to a constant endpoint temperature using open-hearth (OH) broilers or cooked for a constant amount of time using a belt grill (BG), Warner-Bratzler shear force (WBSF) was measured in duplicate.

Belt grill cooking was conducted with a Magigrill (model TBG-60; MagiKitch'n Inc., Quakertown, PA) using settings designed to achieve a final internal temperature of 71°C for 2.54-cm thick longissimus chops. Electric broiler cooking was conducted with an Open Hearth electric broiler (model 450N; Farberware, Bronx, NY). Chops were turned after reaching 40°C, then removed from the grill after reaching 71°C internal temperature.

[1]For more information: phone: 402-762-4223; fax: 402-762-4149; e-mail: shackelford@email.marc.usda.gov.

Three 1.27-cm diameter cores from each chop were sheared with a WBSF attachment using an electronic testing machine (model 4411; Instron Corp., Canton, MA). Repeatability of WBSF was calculated as the proportion of the total variance that could be attributed to animal variation.

Experiment 2: Comparison of shear force methods

At 1 d postmortem, seven longissimus chops were removed from 23 pork carcasses. Two chops were used for WBSF measurement, four chops were used for trained sensory panel tenderness assessment (Wheeler et al., 2000), and one chop was used for measurement of slice shear force (SSF). Immediately after cooking, SSF was determined using the protocol developed for beef tenderness assessment (Shackelford et al., 1999a,b). Simple correlations were calculated using SAS.

Experiment 3: Repeatability of slice shear force for belt grill cooked chops

The right loin was obtained from 372 pork carcasses. At 2 d postmortem, the loins were divided at the 10th rib. Anterior and posterior sections were frozen at 2 and 10 d postmortem, respectively. Two adjacent chops were obtained from each section. Chops were cooked with BG as described for Exp. 1. Slice shear force was measured as described for Exp. 2. Repeatability of SSF was calculated as the proportion of the total variance that could be attributed to sample (a given carcass at a given number of days postmortem) variation.

Results

Experiment 1: Comparison of cooking methods

Estimates of the repeatability of WBSF were similar for chops cooked with OH and BG (Table 1). Differences in WBSF between cooking methods accounted for less than 5% of the total variation in WBSF. This suggests that replacement of OH cookery with the less labor intensive BG method will have little impact on the magnitude or repeatability of pork longissimus WBSF values.

Experiment 2: Comparison of shear force methods

The correlation of pork longissimus SSF with sensory panel tenderness rating was slightly stronger than the correlation of WBSF with tenderness rating (Table 1). Additionally,

the coefficient of variation of SSF (32%) was larger than the coefficient of variation of WBSF (19%).

Experiment 3: Repeatability of slice shear force

This experiment was conducted to obtain an accurate estimate of the repeatability of SSF using a large (n = 744) data set that contained a substantial amount of variation in tenderness. Although this data set contained less variation (SD = 5.0 kg) in SSF than the data sets that we used to evaluate this technique in beef (SD = 7.5 kg) and lamb (SD = 13.4 kg), the estimated repeatability (0.90; Figure 1) was comparable to repeatability estimates that we have obtained for SSF for beef and lamb (0.91 and 0.95, respectively; Shackelford et al., 1999b, 2004).

Implications

Belt grill cookery and the slice shear force technique can be used to accurately assess pork longissimus tenderness. Use of these technologies could reduce the amount of labor required for pork tenderness research, and facilitate tenderness evaluation in experiments with a large number of samples. Thus, use of belt grill cookery and the slice shear force technique should reduce research costs and permit in-depth evaluation of the sources of genetic variation in pork tenderness.

Literature Cited

Shackelford, S. D., T. L. Wheeler, and M. Koohmaraie. 1999a. Tenderness classification of beef. II: Design and analysis of a system to measure beef longissimus shear force under commercial processing conditions. J. Anim. Sci. 77:1474-1481.

Shackelford, S. D., T. L. Wheeler, and M. Koohmaraie. 1999b. Evaluation of slice shear force as an objective method of assessing beef longissimus tenderness. J. Anim. Sci. 77:2693–2699.

Shackelford, S. D., T. L. Wheeler, and M. Koohmaraie. 2004. Evaluation of sampling, cookery, and shear force protocols for objective evaluation of lamb longissimus tenderness. J. Anim. Sci. 82:802-807.

Wheeler, T. L., S. D. Shackelford, and M. Koohmaraie. 2000. Variation in proteolysis, sarcomere length, collagen content, and tenderness among major pork muscles. J. Anim. Sci. 78:958-965.

Figure 1. Repeatability of slice shear force of pork longissimus chops cooked with belt grill.

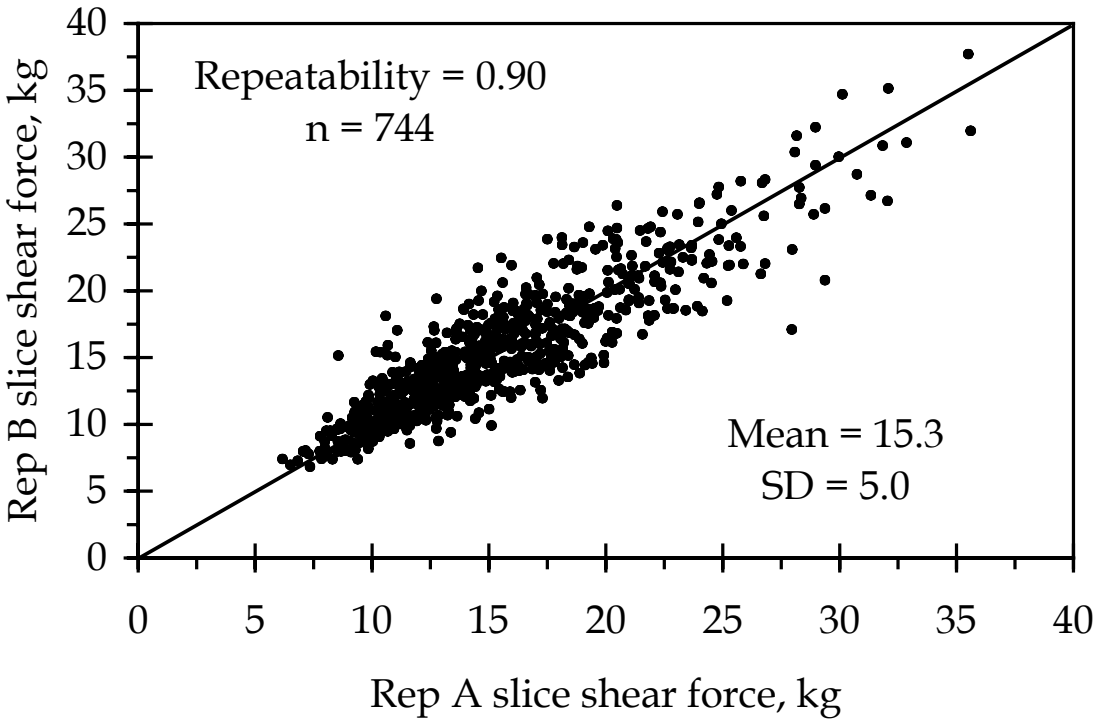

Table 1. Simple statistics, repeatabilities, and correlations for Experiments 1 and 2.

Trait	Cooking method	n	Mean	SD	Minimum	Maximum	Repeatability	Correlation to tenderness rating
---------- Experiment 1 ----------								
Cooked temperature, C	Belt grill	25	71.1[b]	2.1	67.3	75.4		
Cooked temperature, C	Open Hearth	25	71.0[b]	0.0	71.0	71.0		
Cooking loss, %	Belt grill	25	23.2[c]	1.7	19.1	25.6	0.51	
Cooking loss, %	Open Hearth	25	27.6[b]	3.0	22.1	34.1	0.00	
Warner-Bratzler shear force, kg	Belt grill	25	3.9[c]	0.6	2.6	5.0	0.59	
Warner-Bratzler shear force, kg	Open Hearth	25	4.1[b]	0.7	2.3	6.3	0.61	
---------- Experiment 2 ----------								
Warner-Bratzler shear force, kg	Belt grill	23	3.5	0.7	2.5	5.6		-0.66
Slice shear force, kg	Belt grill	23	18.9	6.0	10.6	36.8		-0.72
Tenderness rating [a]	Belt grill	23	6.4	1.1	3.4	7.5		

[a] 1 = extremely tough and 8 = extremely tender.

[bc] Within a trait, means not sharing a common superscript letter differ.