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SOUTH DAKOTA STATE UNIVERSITY

Department of Animal Science

Meats & Human Nutrition

Determining the efficacy of predicting beef tenderness using proteins from purge

M. Jia, B. Bowker, S. Zuelly, A. Blair, K. Underwood

Objective

To determine if proteins from purge can predict tenderness at different aging points as a non-destructive method.

Study Description

Ninety strip loins were characterized for Warner-Bratzler shear force, collagen content and solubility and sarcomere length. Forty five strip loins were selected from this population to represent the variation in tenderness of the population. Purge was collected from each of the 45 selected strip loins and utilized for sodium dodecyl sulfate polyacrylamide (SDS-PAGE) gel electrophoresis. Protein bands were quanitified and utilized to determine predictive models of tenderness using stepwise regression in SAS.

Take home points

Analysis of SDS-PAGE revealed proteins from purge at 3 days postmortem can account for 35.3% of the variation in tenderness of 3-day aged steaks with and 24.5% of the variation in tenderness of 7-day aged steaks. In addition, purge proteins can account for 45.8% of the tenderness variation of steaks with WBSF values higher than 4.4 kg or classified as tough.

Keywords: beef, proteolysis, purge, tenderness

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Abstract

Tenderness is an important palatability trait that influences consumers' perception of beef quality. It is influenced primarily by three mechanisms, including sarcomere length (structural unit of muscle), connective tissue, and postmortem proteolysis (postmortem aging). Previous studies have investigated myofibrillar proteins, which can be indicators of tenderness. However, extraction of myofibrillar proteins requires removing meat samples, and therefore damages and reduces the amount of the final meat products. Therefore, the objective of this study was to determine if proteins from purge can predict tenderness at different aging points as a non-destructive method. Analysis of sodium dodecyl sulfate polyacrylamide (SDS-PAGE) gel electrophoresis revealed proteins from purge at 3 days postmortem can account for 35.3% of the variation in tenderness of 3-day aged steaks with and 24.5% of the variation in tenderness of 7-day aged steaks. In addition, purge proteins can account for 45.8% of the tenderness variation of steaks with WBSF values higher than 4.4 kg. Results of this study indicate that proteins from purge can be used as potential indicators for predicting tenderness without damaging the final product.

Introduction

Meat quality is determined by a number of palatability traits including tenderness, flavor, and juiciness. However, tenderness is considered the most important attribute that affects consumers' satisfaction of beef products (Morgan et al., 1991; Brooks et al., 2000). Although tenderness has generally improved during the past decades (Guelker et al., 2013), variations in beef tenderness and tough steaks remain an issue in the beef industry (Howard et al., 2013). Three mechanisms influence tenderness, including connective tissue content, sarcomere length and proteolysis of myofibrils during aging; and the cumulative effects of these mechanisms can explain most of the variation in beef tenderness (Koohmaraie, 1996). Savage et al. (1990) indicated that approximately 112 mg of protein per mL of fluid on average was contained in the purge, or the drip from meat, and that most of the compounds present were water-soluble, sarcoplasmic proteins. Therefore, purge collection and analysis could be an alternative method to collect proteins without damaging meat products.

Experimental Procedures

Ninety USDA Select strip loins were selected from Tyson, Dakota City, NE, vacuum packaged at 2 days postmortem, and transported back to the South Dakota State University meat lab under refrigeration. Purge samples were collected from vacuum bags after removing strip loins. Three 1-inch steaks were fabricated from the anterior portion of each loin and aged to 3, 7, and 14 days postmortem for Warner-Bratzler shear force (WBSF) analysis. Two additional steaks were cut from strip loins and aged to 3 days postmortem for measurement of sarcomere length and collagen analysis. All steaks were vacuum packaged and frozen at each aging point at -20°C to prevent further proteolysis. A subset of 45 samples of the original 90 samples was selected for further analysis based on WBSF at 14 days postmortems to show the maximum variation of tenderness in samples. The 45 selected samples were subjected to sodium dodecyl sulfate

polyacrylamide gel electrophoresis (SDS-PAGE) to separate purge proteins based on molecular weight (Figure 1). Sarcomere lengths were determined to account for muscle shortening related variations in tenderness in this research. Collagen content and solubility were determined to account for connective tissue related variations in tenderness. Data were analyzed using regression procedures (PROC REG) of SAS 9.3 (SAS Inc., Cary, N.C.) to determine if sarcomere lengths, collagen content, meat color and proteins from the purge were related with tenderness at different days postmortem at significance level of 0.05. A stepwise regression procedure (PROC STEPWISE, forward) of SAS was also used to find the models that best predict tenderness.

Results and Discussion

Mean sarcomere lengths were 1.78 ± 0.15 µm and there was no relationship between sarcomere length and 3, 7, and 14 days WBSF values ($P > 0.05$). No correlation was found between 3, 7 and 14 day shear force values and L*, a*, and b* values ($P > 0.05$). Prediction equations from stepwise regression accounted for 35.3%, 24.5% and 5.7% of the variation in tenderness for 3, 7 and 14 days. Intensities of purge proteins were the only variables included in the stepwise regression model, while collagen content, objective color measurements and sarcomere lengths were not included in the models. This data indicates that purge proteins from 3 days postmortem can account for partial variation of tenderness for 3 days ($R^2 = 0.353$, $P = 0.0013$) and 7 days ($R^2 = 0.245$, $P = 0.0098$) postmortem (Table 1). However, proteins collected at 3 days postmortem are not predictive of 14-day postmortem beef tenderness since a significant model was not determined ($R^2 = 0.057$, $P = 0.1133$, Table 1). Purge proteins can account for 45.8% of the tenderness variation of steaks with WBSF values higher than 4.4 kg (Table 1).

Implications

This study provides evidence that analyzing proteins from purge could be a potential methodology to predict beef tenderness without damaging the carcass. Further studies are needed to determine the changes in protein composition from purge at different aging points.

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Table 1. **Stepwise regression equations used to predict Warner-Bratzler shear force (WBSF) values.**

Predicted equations Regression using Warner-Bratzler shear force	C(p)	R^2	P-value
3DSF[1] = 4.472 + 0.019*Band4[a] + 0.031*Band7[a] - 0.036*Band10[a] -0.010*Band15[a]	-6.803	**0.353**	0.0013
7DSF[2] = 3.639 - 0.007*Band1[a] + 0.034*Band9[a] - 0.025*Band10[a]	-9.828	**0.245**	0.0098
14DSF[3] = 2.490 + 0.008*Band2[a]	-5.199	0.057	0.1133
3TDSF[4] = 4.595 -0.031*Band11[a] + 0.036*Band12[a]	-6.656	**0.458**	<0.0001

[1] 3DSF = WBSF at 3 days postmortem; [2] 7DSF = WBSF at 7 days postmortem;

[3] 14DSF = WBSF at 14 days postmortem.

[4] 3TDSF = WBSF of tough group (>4.4kg) at 3 day postmortem

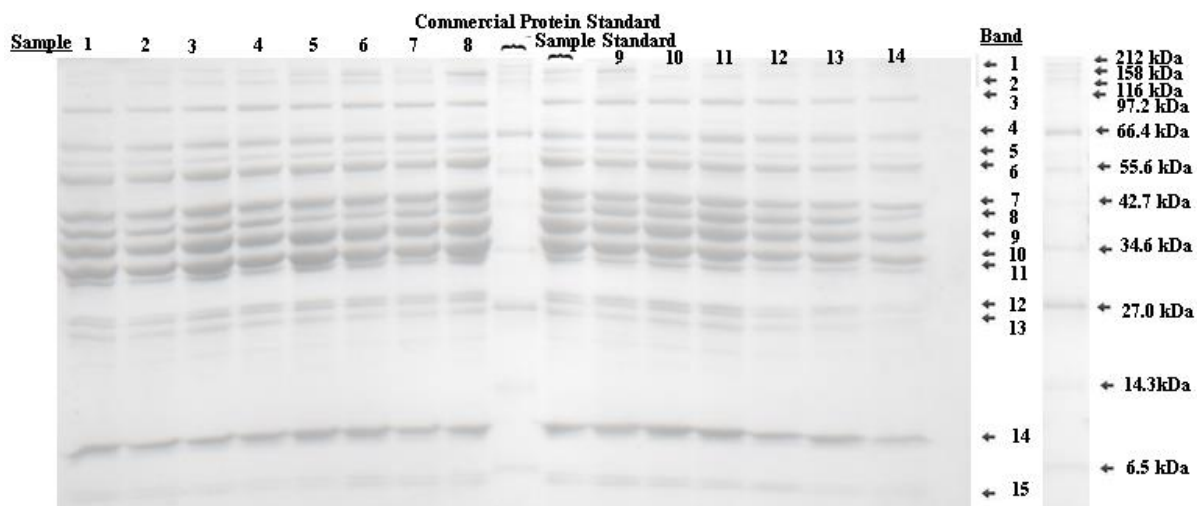[a] Molecular weight of bands are determined based on the commercial protein standards.

Band 1: 212 kDa to 158 kDa; Band 2: 158 kDa;

Band 4: 66.4 kDa; Band 7: 55.6 kDa to 42.7 kDa;

Band 9: 42.7 kDa to 34.6 kDa; Band 10: 42.7 kDa to 34.6 kDa;

Band 11: 34.6 kDa to 27.0 kDa; Band 12: 34.6 kDa to 27.0 kDa;

Band 15: smaller than 6.5 kDa;

Figure 1. Images of purge proteins in SDS-PAGE gels stained with Coomassie Blue.