RELATIONSHIPS BETWEEN LIVE ANIMAL ULTRASOUND PREDICTED INTRAMUSCULAR FAT AND SHEAR FORCE IN FED CATTLE

L. D. Keenan, D. W. Moser, D. R. Eborn, and T. T. Marston

Summary

Approximately 280 Simmental- and Hereford-sired feedlot steers were ultrasonically evaluated for intramuscular fat deposition using CPEC and Critical Vision, Inc. (CVI) ultrasound systems. Warner-Bratzler shear force measurements were taken on steaks from the 13th rib region. Differences between CPEC and CVI ultrasound and actual marbling measurements were corrected for bias and identified as CPEC deviation and CVI deviation. Correlation coefficients and linear models were used to determine if shear force values were associated with amount of intramuscular fat predicted by the ultrasound systems. Correlation coefficients of CPEC deviation and CVI deviation with shear force were 0.18 and 0.15, respectively. This indicates that animals overestimated for marbling by ultrasonic measures had a tendency to have higher shear force values. However, when the data were evaluated with linear models, which take many variables into account, we found that animals with ultrasound marbling predictions higher than the actual carcass marbling score were not associated with higher shear force values. Thus, animals with a higher marbling prediction are not associated with an unfavorable increase in shear force values. Selecting animals for increased marbling through ultrasound evaluation should have neither a favorable nor unfavorable effect on tenderness.

Introduction

Real-time ultrasound has proven to be an accurate tool in the prediction of intramuscular fat in beef cattle. This information can be used in the selection and genetic evaluation of breeding animals. Ultrasonic evaluation of carcass traits in breeding animals can be used to reduce the cost of sire progeny testing programs or eliminate the bias associated with feeding only culled animals for carcass data collection.

Consumers have identified tenderness as the foremost characteristic in determining meat acceptability. Marbling and tenderness are not highly related. Intramuscular fat often explains only 5% of the variation in tenderness. It has yet to be determined whether ultrasound systems used to predict intramuscular fat can distinguish between connective tissue and intramuscular fat. It would be detrimental to consumer acceptance of beef to mistakenly identify connective tissue as intramuscular fat through ultrasound evaluation and to classify those individuals as being superior. The objective of our study was to determine if tenderness is negatively affected in animals with higher amounts of intramuscular fat determined through ultrasound.

Experimental Procedures

Ultrasound measurements were taken on one group of Simmental-sired (n=136) and one group of Hereford-sired (n=148) feedlot steers. Two commercially available ultrasound systems were used to scan the cattle for intramuscular fat. The two systems used were CPEC, Oakley, KS (developed by Kansas State University, Hays) and Critical Vision, Inc., Atlanta, GA (developed by Iowa State University). Ultrasound images were taken with an Aloka 500V system outfitted with a 17-cm, 3.5-MHz transducer. An ultrasound technician scanned each steer with both systems over the 12th to 13th rib site. The CPEC system estimated the marbling score on-site. Images from the Critical Vision machine were sent to the Centralized Ultrasound Processing lab in Ames, IA for analysis of intramuscular fat.

Visual evaluation of fat thickness was utilized to determine harvest date, which was used to define contemporary groups. The Simmental-sired cattle were harvested at IBP, Inc., in Emporia, KS on 29, 35, 69, 75, 79, and 85 days after scanning. The Hereford cattle were harvested at Excel Corp. in Ft. Morgan, CO in one group 17 days after scanning. Each carcass was evaluated for 12th rib fat thickness, longissimus muscle area, weight, and marbling score by a commercial data collector. Steaks were removed from the 13th rib region of the hindquarter from each carcass and promptly shipped to Kansas State University where the standard protocol for aging and shear force evaluation was followed to determine tenderness of the steaks.

CVI's prediction for percent intramuscular fat (%IMF) was converted to the standard USDA marbling score using:

Marbling score = [(749.81 + 67.197 * %IMF – 1.172 * %IMF^2) /100]-5 where Slight^{40} = 4.4; Slight^{50} = 4.5; Small^{00} = 5.0; Modest^{10} = 6.1; etc. CPEC predicts actual marbling score directly, so no conversion was needed. CPEC and CVI deviation from actual marbling (CPEC deviation and CVI deviation) were calculated by subtracting marbling score from CPEC or CVI then mathematically correcting for bias due to unknown error.

Pearson correlation coefficients were calculated among all variables (CPEC, CVI, CPEC deviation, CVI deviation, contemporary group, fat thickness, longissimus muscle area, marbling score, shear force, and weight). Two linear models accounting for breed, CPEC deviation or CVI deviation, marbling score, shear force, and the interaction of breed with shear force were developed using the GLM procedure of SAS.

To evaluate the utility of including both systems in determining actual marbling score, three linear models were developed, each accounting for contemporary group. Two models consisting of variables CVI, contemporary group, and their interaction, or CPEC, contemporary group, and their interaction were developed to compare to a model consisting of contemporary group, CVI, CPEC, contemporary group x CVI interaction, and contemporary group x CPEC interaction.

Results and Discussion

Simple descriptive statistics are presented in Table 1. The correlation for CPEC with shear force was the only correlation of interest that was not significantly different from zero (Table 2). The correlation for CVI with shear force was negative. Thus, as predicted marbling increased, there was a decrease in shear force. The two most noteworthy statistics in Table 2 are the positive correlations of CPEC deviation and CVI deviation with shear force ($P<0.01$). This indicates that animals that were overestimated for intramuscular fat with CPEC and CVI were associated with an increase in shear force. To further evaluate these relationships, other factors were taken into account by using the GLM procedure of SAS. When marbling score, shear force, breed, and breed x shear force interaction effects were accounted for in their relationship with CPEC deviation and CVI deviation, shear force and breed x shear force did not significantly affect ($P>0.05$) CPEC deviation or CVI deviation. All other effects were significant ($P<0.001$). Thus, animals that were evaluated as having a higher percentage of intramuscular fat were not associated with an unfavorable increase in shear force values. Therefore, it appears that selecting for increased intramuscular fat in cattle through ultrasound evaluation should have neither a favorable nor unfavorable effect on tenderness.

Our data are not sufficient to accurately compare the two ultrasound systems because ether extractable fat data were not collected. Previous studies found that the two ultrasound systems did not differ in predicting ether extractable fat. R^2 values, which describe the percent of variation in marbling that can be explained by the ultrasound estimate of marbling, were evaluated on models in order to compare the accuracy of predicting marbling score using one ultrasound system as compared to both ultrasound systems. We found that using both systems (R^2=0.47) as opposed to one (R^2=0.44 and 0.42, for CPEC and CVI, respectively) does not increase the accuracy of predicting marbling score enough to justify the additional costs and time of using both ultrasound systems to predict intramuscular fat.

Table 1. Descriptive Statistics

Variable	Average	Standard Deviation	Minimum	Maximum
Warner-Bratzler shear force	9.51	1.47	6.47	13.86
Fat thickness, inch	0.53	0.22	0.08	1.20
Longissimus muscle area, inch²	13.15	1.36	9.90	16.60
Marbling score	5.07	0.73	3.70	8.00
CPEC	4.53	0.56	3.21	6.21
CVI	4.52	0.39	3.70	5.72
CPEC Deviation	-0.54	0.84	-2.96	1.44
CVI Deviation	-0.55	0.64	-2.75	0.85

Table 2. Pearson Correlation Coefficients and Statistical Significance of Variables

	Fat Thickness	Longissimus Muscle Area	Marbling Score	CPEC	CVI	CPEC Deviation	CVI Deviation
Warner-Bratzler	0.17	-0.2	-0.25	-0.06	-0.23	0.18	0.15
Shear Force	<0.01	<0.01	<0.01	0.31	<0.01	<0.01	<0.01
Fat		-0.28	-0.12	0.18	-0.22	0.23	-0.002
Thickness		<0.01	0.04	<0.01	<0.01	0.97	0.97
Longissimus			0.24	-0.09	0.23	-0.27	-0.14
Muscle Area			<0.01	<0.01	<0.01	<0.01	0.02
Marbling				0.18	0.48	-0.75	-0.84
Score				<0.01	<0.01	<0.01	<0.01
CPEC					0.35	0.52	0.02
					<0.01	<0.01	0.72
CVI						-0.18	0.07
						<0.01	0.27
CPEC							0.75
Deviation							<0.01