Influence of Hide Thickness on the Ability to Predict Percent Intramuscular Fat with Real-time Ultrasound in Beef Cattle

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Summary and Implications

Seven hundred forty (740) head of cattle were scanned with real-time ultrasound. Models developed by Iowa State University were used to predict percent intramuscular fat on these cattle. Hide thickness was also measured on each animal and the relationship between hide thickness and accuracy of predicting percent intramuscular fat with ultrasound was evaluated. Overall, hide thickness has little effect on accuracy of ultrasound to predict percent intramuscular fat. However some particular groups (i.e. thick hided cattle scanned with Aloka technology) may be prone to underestimation of percent intramuscular fat with ultrasound.

Introduction

Real-time ultrasound is being widely used throughout the beef cattle seedstock industry to predict percent intramuscular fat within the *longissimus dorsi* muscle of potential breeding stock. The objective of this study was to evaluate whether the hide thickness that the ultrasound waves have to penetrate has an adverse impact on the accuracy of ultrasound predictions of chemical percent intramuscular fat. In essence, does a thicker hide cause a loss of gain or attenuation?

Materials and Methods

Four (4) longitudinal real-time ultrasound images were collected on each of 740 cattle to predict percent intramuscular fat. Predictions of percent intramuscular fat were made on each individual image from Iowa State University developed software. These four measures were subsequently averaged to provide ultrasound predicted percent intramuscular fat (UPFAT) measures for each animal. Images were collected with either Aloka 500 (Aloka USA, Wallingford, CT) (n = 245) or Classic Scanner 200 (Classic Medical Supply, Tequesta, FL) (n = 495) ultrasound machines with beef cattle animal science (17 or 18 cm linear array) transducers attached.

Thickness of the hide on each animal was determined by measuring the first image collected on each animal. Animals were also categorized into thin hide (<= 0.15 in) or thick hide (> 0.15 in) groups. Percent intramuscular fat (PFAT) was determined by chemical extraction on a *longissimus dorsi* sample from each animal. A miss (MISS) was calculated for each animal as UPFAT - PFAT. Analysis of the relationship between hide thickness and MISS would indicate whether a linear trend was present between hide thickness and the error of prediction. Also of interest is whether there is a relationship between hide thickness and general inaccuracy of UPFAT. This was evaluated through an analysis of the relationship between hide thickness and the absolute value of MISS (|MISS|).

Results and Discussion

Summaries of this data and various subsets are given in Table 1. Overall UPFAT had a bias of -0.01%. The correlation between PFAT and UPFAT was 0.63.

Hide thickness was not a significant predictor of MISS (P = 0.13) or |MISS| (P = 0.57). When the data were subdivided by ultrasound technology hide thickness was a significant predictor of MISS (P < 0.01) for both technologies. However, a different trend was established for each technology (Table 2). The Aloka 500 underpredicted PFAT as hide thickness increased, and the Classic Scanner 200 overpredicted PFAT as hide thickness increased. While these trends were statistically significant (P < 0.01) they only accounted for a small proportion of the errors observed in predicting PFAT with UPFAT (R^2 <= 0.06, for either technology). For both technologies the estimate of MISS is closer to 0.00% in a thin hided animal (i.e. 0.10 in.; 0.183% and 0.033% for Aloka and Classic, respectively) than a thick hided animal (i.e. 0.20 in.; -0.834% and 0.574% for Aloka and Classic, respectively).

Hide thickness was not associated with the general inaccuracy of ultrasound (|MISS|) to predict PFAT with either ultrasound technology (P > 0.10 for either technology).

Analysis was also conducted to identify the machine by hide thickness classification interactions and their impacts on general abilities to predict PFAT (Table 3). It was observed that the technology by hide thickness class interaction was a significant (P < 0.01) predictor of MISS. The largest impact observed on an interaction class was the effect of ultrasound underpredicting PFAT by 0.668% in the thick hided cattle scanned with Aloka technology. Conversely, ultrasound overpredicted PFAT by 0.436% in thick hided cattle scanned with Classic technology. Ultrasound technology by hide thickness classification interaction, ultrasound technology, and hide thickness classification were all not significant (P > 0.10) at predicting |MISS|.

Traditional measures associated with ultrasound certification status (i.e. bias, correlation, and standard error of prediciton) were also calculated for each technology by hide thickness class subset of data and are reported in Table 4. Correlations and standard errors of prediction are similar across the subsets of data. However there are large differences in the bias (-0.67% to 0.43%) depending on technology by hide thickness classification.

Implications

Overall it appears that hide thickness does not impact the ability of ultrasound technology to predict percent intamuscular fat in beef cattle. It is possible that hide thickness will have different impact on differing ultrasound technologies' abilities to predict percent intramuscular fat in beef cattle. Aloka technology being applied to thick hided cattle appears to be the most adverse situation in terms of accurately estimating PFAT with ultrasound. While it is probably not necessary to incorporate hide thickness into the development of a prediction model for UPFAT, it becomes obvious that some ultrasound technologies may have more difficulties predicting PFAT in thick hided cattle.

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Table 1. Summary statistics for hide thickness impact on ultrasound prediction of intramuscular fat by groups.

	Mean	Std. Dev.	Min	Max
All Cattle (n = 740)				
Ether Extract, %	4.58	1.65	1.15	11.38
Marbling Score*	5.26	0.88	3.00	9.20
Ultrasound Pfat, %	4.57	1.30	1.50	9.90
Hide Thickness, in	0.15	0.03	0.09	0.26
MISS, %	-0.01	1.31	-6.02	4.03
|MISS|, %	0.99	0.84	0.00	6.02
Aloka Data (n = 245)				
Ether Extract, %	4.77	1.60	1.77	11.21
Marbling Score*	5.17	0.67	3.70	8.10
Ultrasound Pfat, %	4.29	1.25	1.50	8.28
Hide Thickness, in	0.16	0.03	0.11	0.25
MISS, %	-0.48	1.25	-6.02	4.00
|MISS|, %	0.99	0.89	0.00	6.02
Classic Data (n = 495)				
Ether Extract, %	4.49	1.66	1.15	11.38
Marbling Score*	5.30	0.97	3.00	9.20
Ultrasound Pfat, %	4.71	1.30	1.96	9.90
Hide Thickness, in	0.14	0.03	0.09	0.26
MISS, %	0.22	1.28	-4.59	4.03
|MISS|, %	0.99	0.83	0.00	4.59
Thin Hide (<= 0.15 in) (n = 364)				
Ether Extract, %	4.70	1.73	1.55	11.38
Marbling Score*	5.27	0.98	3.00	9.20
Ultrasound Pfat, %	4.76	1.39	1.96	9.90
Hide Thickness, in	0.12	0.01	0.09	0.14
MISS, %	0.06	1.28	-4.59	4.03
|MISS|, %	0.97	0.84	0.00	4.59
Thick Hide (> 0.15 in) (n = 376)				
Ether Extract, %	4.46	1.55	1.15	11.21
Marbling Score*	5.24	0.78	3.20	8.60
Ultrasound Pfat, %	4.39	1.17	1.50	7.95
Hide Thickness, in	0.18	0.02	0.16	0.26
MISS, %	-0.07	1.33	-6.02	3.00
|MISS|, %	1.02	0.86	0.00	6.02

Table 1. (Cont.)

	Mean	Std. Dev.	Min	Max
Aloka * Thin Hide (n = 71)				
Ether Extract, %	4.83	1.56	1.82	10.38
Marbling Score*	5.15	0.70	3.70	7.80
Ultrasound Pfat, %	4.83	1.35	2.11	8.28
Hide Thickness, in	0.13	0.01	0.11	0.14
MISS, %	-0.00	1.19	-2.45	4.00
|MISS|, %	0.89	0.77	0.01	4.00
Aloka * Thick Hide (n = 174)				
Ether Extract, %	4.75	1.62	1.77	11.21
Marbling Score*	5.18	0.66	3.70	8.10
Ultrasound Pfat, %	4.08	1.13	1.50	7.25
Hide Thickness, in	0.18	0.02	0.16	0.25
MISS, %	-0.67	1.22	-6.02	1.97
|MISS|, %	1.03	0.93	0.00	6.02
Classic * Thin Hide (n = 293)				
Ether Extract, %	4.67	1.77	1.55	11.38
Marbling Score*	5.30	1.04	3.00	9.20
Ultrasound Pfat, %	4.74	1.40	1.96	9.90
Hide Thickness, in	0.12	0.01	0.09	0.14
MISS, %	0.07	1.31	-4.59	4.03
|MISS|, %	0.99	0.86	0.00	4.59
Classic * Thick Hide (n = 202)				
Ether Extract, %	4.22	1.46	1.15	9.06
Marbling Score*	5.29	0.86	3.20	8.60
Ultrasound Pfat, %	4.65	1.15	2.08	7.95
Hide Thickness, in	0.17	0.02	0.16	0.26
MISS, %	0.44	1.20	-3.98	3.00
|MISS|, %	1.00	0.79	0.01	3.98

* Slight 0 = 4.0, Small 0 = 5.0, Modest 0 = 6.0, Moderate 0 = 7.0

Table 2. Linear prediction of MISS and |MISS| with hide thickness.

	R^2	P-Value	Intercept	Slope
All Data (n = 740)				
MISS	<0.01	0.13	...	...
|MISS|	<0.01	0.57	...	...
Aloka Data (n = 245)				
MISS	0.06	<0.01	1.20	-10.17
|MISS|	<0.01	0.32	...	...
Classic Data (n = 495)				
MISS	0.02	<0.01	-0.64	6.07
|MISS|	<0.01	0.95	...	...

Table 3. Least squares means estimates of effect of technology and hide thickness interaction on MISS and |MISS|.

	Hide Thickness Class		
	Thin (P-Value)	Thick (P-Value)	Both Hide Classes (P-Value)
Technology			
MISS			
Aloka	-0.005 (<0.01)	-0.668 (<0.01)	-0.34 (<0.01)
Classic	0.072 (<0.01)	0.436 (<0.01)	0.25 (<0.01)
Both Technologies	0.03 (0.15)	-0.12 (0.15)	
|MISS|			
Aloka	0.892 (0.36)	1.034 (0.36)	0.96 (0.65)
Classic	0.989 (0.36)	1.001 (0.36)	1.00 (0.65)
Both Technologies	0.94 (0.28)	1.02 (0.28)	

Table 4. Accuracy statistics for each ultrasound technology by hide thickness class.

	All Data	Aloka * Thin (within class)	Aloka * Thick (within class)	Classic * Thin (within class)	Classic * Thick (within class)
N	740	71	174	293	202
MISS (Bias), %	-0.01	-0.00	-0.67	0.07	0.43
|MISS|	0.99	0.89	1.03	0.99	1.00
Correlation, (PFAT vs. UPFAT)	0.63	0.68	0.66	0.68	0.60
Std. Error of Prediction	1.31	1.19	1.22	1.31	1.20