Usefulness of Cross-Sectional Image to Predict Intramuscular Fat for Feedlot Application Using Real-Time Ultrasound

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Summary

The purpose of this project was to determine if it is possible to accurately calculate both %IMF and 12th-13th subcutaneous fat from the cross-sectional ribeye image with a guide in place, therefore eliminating the need for four %IMF images. This would make this technology less time consuming and more efficient. The correlation between the traditional longitudinal %IMF and the %IMF from the ribeye image was moderate and in both the case of ether extract %fat and marbling score, the traditional longitudinal %IMF was more highly correlated than the ribeye image %IMF. From this analysis, it can be concluded that the cross-sectional ribeye image would not be as good of a predictor of %IMF as the longitudinal image currently utilized. The accuracy that would be sacrificed may not be worth the time that would be saved by only taking the one cross-sectional ribeye image as compared to the four longitudinal %IMF images and the one cross-sectional ribeye image. A more likely solution would be to collect one cross-sectional ribeye image for a subcutaneous fat measurement and one longitudinal image for a %IMF measurement.

Introduction

Ultrasound has become an important tool in genetic evaluation of body composition of beef cattle in the past few years. Six images are currently collected to produce the results needed to evaluate body composition traits. These are predictors of carcass traits, which are of economic value to the producer. The first image taken is of the *Gluteus Medius* muscle on the rump of the animal, where a subcutaneous fat measurement is collected. The second image is a cross-sectional image of the *Longissimus Dorsi* muscle (ribeye) between the 12th-13th ribs, where a carcass would be split. This is used to collect a ribeye area measurement (an indicator of total carcass muscle content) and a 12th-13th rib subcutaneous fat measurement. The remaining four images collected are longitudinal images of the *Longissimus Dorsi* muscle over the 11th, 12th, and 13th ribs. Percent intramuscular fat (%IMF) is calculated from these images, and the individual calculations are averaged, which results in a more accurate measure of %IMF. Percent intramuscular fat is a predictor of carcass marbling score, an economically relevant carcass trait to the producer.

This technology is widely used for genetic evaluation of prospective breeding animals. There is potential application for this technology in the feedlot. Producers could scan animals in order to identify appropriate feeding and marketing strategies for each individual. Many cattle are priced according to two measures of carcass merit: quality grade and yield grade. Quality grade is based on the amount of marbling in the ribeye, and yield grade is based on subcutaneous fat and muscle. Due to time constraints, it is not currently efficient to ultrasound feedlot animals when six (one cross-sectional ribeye, four %IMF and one rump) images have to be collected. Another time consideration is that online interpretation is necessary in a feedlot setting. The four longitudinal images could be eliminated if %IMF could be calculated with acceptable accuracy from the cross-sectional image with a guide in place.

The primary objective of this project was to determine if it is possible to accurately calculate both %IMF and 12th-13th subcutaneous fat from the cross-sectional ribeye image with a guide in place, thereby eliminating the need for four %IMF images. This would save producers time and money.

Materials and Methods

In order to evaluate the cross-sectional ribeye image for its accuracy in predicting %IMF, previously collected research data (1998-2001) was evaluated. The data that included ether extract %IMF was chosen for the project. Ether extract %IMF is a chemical analysis of a ¼" facing of the *Longissimus Dorsi* muscle removed at the 13th rib from the carcass. This is an objective measure of %IMF in the muscle. There were fourteen scan groups evaluated in the project with a total of 809 head of cattle, including 148 bulls and 661 steers.

The cross-sectional ribeye image was tested for its usefulness in predicting percent intramuscular fat by first interpreting %IMF from the cross-sectional image using the same %IMF software model used to interpret %IMF from the longitudinal image. This software varies depending on the machine used to collect the ultrasound images. Two ultrasound machines are currently used to collect the images for beef genetic evaluation, the Aloka 500V® (Corometrics Medical Systems, Inc., Wallingford, CT, USA) and the Classic Scanner 200 (Classic Medical Supply, Inc., Tequesta, FL, USA). These machines will be referred to as

Aloka and Classic, respectively. Each technology was evaluated separately. All of the software uses a 100x100 pixel box to define the area on the image to be evaluated. Percent intramuscular fat was calculated from the cross-sectional ribeye images and this data was compared to data from the traditional longitudinal %IMF interpretation as well as from ether extract %IMF. Simple statistics, as well as product-moment (r_p) and Spearman rank (r_s) correlation, were developed for the animals and used for the comparison. This was done both across and within sex to evaluate possible differences between sexes.

The location on the image that the interpretation was taken from was also evaluated. Two locations were sampled for this purpose. The box was placed to the extreme lateral end of the image (position 1), as well as directly under the acorn on the medial side of the image (position 2).

Results and Discussion

Table 1 shows the number of observations, mean, standard deviation, minimum and maximum for each of the methods observed across both sexes.

Table 2 represents the product-moment (r_p) and Spearman rank (r_s) correlation developed for the overall group of animals. Product-moment (r_p) correlation is below the diagonal, while Spearman rank correlation is above the diagonal. The relationship between all variables in this table is statistically significant (P<.01). As can be seen in Table 2, the correlation of Aloka %IMF at either position on the ribeye image and the Aloka %IMF on the longitudinal image is moderate. This is also observed with the Classic machine. The correlation of Aloka %IMF at either position on the ribeye image and ether extract %IMF is substantially lower than the correlation between the Aloka %IMF on the traditional longitudinal image and ether extract %IMF. Again, this pattern is noticed with the Classic machine as well. The longitudinal image %IMF data also correlate better with marbling score than the data does for %IMF from the cross-sectional ribeye image. This is true for both Aloka and Classic technologies.

From this analysis, it can be concluded that the cross-sectional ribeye image would not be as good of a predictor of %IMF as the longitudinal image currently utilized. The accuracy that would be sacrificed may not be worth the time that would be saved by only taking the one cross-sectional ribeye image as compared to the four longitudinal %IMF images and the one cross-sectional ribeye image. A more realistic approach may be to collect one cross-sectional ribeye image for a subcutaneous fat measurement and one longitudinal image for a %IMF measurement, thereby lowering the collection and interpretation process from six images to two images.

Table 1. Means, standard deviations, minimums and maximums for methods of % intramuscular fat prediction.

Variable	N	Mean	Std Dev	Min	Max
Aloka %IMF at position 1 on REA image	314	3.41	1.02	1.08	8.94
Aloka %IMF at position 2 on REA image	314	4.88	1.38	2.41	11.77
Aloka %IMF on longitudinal image	545	4.38	1.12	1.50	8.28
Classic %IMF at position 1 on REA image	495	2.95	0.76	1.02	5.23
Classic %IMF at position 2 on REA image	495	4.10	1.23	1.11	8.83
Classic %IMF on longitudinal image	563	4.77	1.35	1.96	9.90
Marbling Score*	809	5.24	0.87	3.00	9.20
Ether Extract %IMF	809	4.60	1.65	1.15	11.38

*5.0=small 0, 6.0=modest 0

Table 2. Product-moment correlation (below-diagonal) and Spearman rank correlation (above-diagonal) for methods of % intramuscular fat prediction.**

	apos 1	apos 2	apfat	cpos 1	cpos 2	cpfat	ms	ee
apos 1	1.00000	0.46256	0.54878	NA*	NA*	0.63245	0.44529	0.52521
apos 2	0.55527	1.00000	0.37657	NA*	NA*	0.43774	0.33038	0.31834
apfat	0.47326	0.34172	1.00000	0.34553	0.38607	0.71397	0.58424	0.61083
cpos 1	NA*	NA*	0.31206	1.00000	0.33530	0.47445	0.45489	0.40550
cpos 2	NA*	NA*	0.38630	0.34670	1.00000	0.44596	0.46156	0.46960
cpfat	0.56648	0.31338	0.70538	0.48394	0.46509	1.00000	0.63483	0.65713
ms	0.41660	0.34061	0.56210	0.42525	0.44613	0.61622	1.00000	0.67690
ee	0.48034	0.33915	0.60260	0.39931	0.51551	0.65335	0.68990	1.00000

apos1 = Aloka %IMF at position 1 on REA image
apos2 = Aloka %IMF at position 2 on REA image
apfat = Aloka %IMF on longitudinal image
cpos1 = Classic %IMF at position 1 on REA image
cpos2 = Classic %IMF at position 2 on REA image
cpfat = Classic %IMF on longitudinal image
ms = Marbling score
ee = Ether extract %IMF
**There was a statistically significant relationship between all variable in the table ($P<.01$).
*NA – Comparison between these methods was not possible because interpretation of %IMF on the REA image was done in Aloka or Classic, but not both.

Implications

The cross-sectional ribeye image is not as good of a predictor of %IMF as the traditional longitudinal %IMF image. The data reflects that the time saved by taking only the cross-sectional image may not be a sufficient trade off to the accuracy lost. Other areas of this technology must be explored to increase the efficiency of this technology in the feedlot.