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Predicting Beef Carcass Retail Product Using Real-time Ultrasound and Live Animal Measures: Progress Report

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Abstract
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Predicting Beef Carcass Retail Product Using Real-time Ultrasound and Live Animal Measures: Progress Report

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Summary

Two-hundred-eighty-two crossbred steers were scanned with real-time ultrasound (RTU), slaughtered, and fabricated into retail cuts to determine the potential for a combination of live animal and ultrasound measures to predict carcass retail yield. Ultrasound measures of fat thickness, ribeye area, rump fat thickness, and body wall thickness, as well as live weight and visual muscle score were recorded three to five days prior to slaughter. Carcass measurements were taken, and one side of each carcass was fabricated into retail cuts with .3 inches fat. Stepwise regression analysis was used to compare possible models for prediction of either pounds or percent retail product from carcass measurements or a combination of live animal traits and ultrasound measures. Results indicate that possible prediction models for percent or pounds of retail product using live animal and RTU measures were similar in their predictive power and accuracy when compared to models derived from carcass measurements.

Introduction

Currently retail product yield in a beef carcass is predicted using ribeye area (REA), fat thickness, KHP, and carcass weight. Research at ISU and other institutions has demonstrated the potential for real-time ultrasound to accurately predict carcass traits (REA and external fat thickness) in the live animal. Consumer demand for a leaner end product and the move toward value based marketing has underlined the importance for beef producers to be concerned about the final products they produce. Ultrasonic measurements offer beef producers another tool for making genetic progress in carcass traits. Incorporation of ultrasound measurements into breed improvement program databases also offers promise for enhancing carcass expected progeny differences.

As the industry begins to produce leaner animals, external fat thickness will be less predictive of differences in retail product yield. Ribeye area has been the standard as an indicator of total muscle in the beef carcass. Other measures of muscle mass, however, would be helpful in determining carcass composition.

This study is a collaborative project between Iowa State University and the U.S. Meat Animal Research Center (MARC) in Clay Center, Nebraska. The objective is to determine the efficacy of using real-time ultrasound measurements and other live animal measures to predict retail product in the beef carcass. Prediction models can be compared to models derived using traditional carcass measures (yield grade parameters). Additionally, development of carcass retail product prediction equations applicable to the live animal would add another level of capability to genetic evaluation.

Materials and Methods

Two-hundred-eighty-two steers from Cycle V of the Germplasm Evaluation study at U.S. MARC were utilized in this study. Steers were scanned on one of four dates in the summer of 1994 (May to July), with approximately 70 animals per scanning date. Sire breeds consisted of Hereford, Angus, Brahman, Boran, Tuli, and Belgian Blue. Dam breeds were Hereford, Angus, and MARC III (Angus x Hereford x Pinzgauer x Red Poll).

Animals were measured four to five days prior to slaughter using an Aloka 500V real-time ultrasound machine with a 17 centimeter transducer. Three images per steer were collected. The first was a cross-sectional image using a wave guide taken between the 12th and 13th ribs to measure external fat thickness and REA. Body wall thickness was measured between the 12th and 13th ribs 1.5 inches ventral to the *longissimus dorsi* muscle, perpendicular to the external body surface. Rump fat measurements were taken at the Aus meat P8 site over the *gluteus medius* muscle on the rump. Visual muscle scores were assessed using a scale of 1 = light muscled to 9=heavy muscled (system developed by Bob Long, Texas Tech).

Cattle were slaughtered at a commercial packing facility and routine carcass measures were taken 24 hours postmortem. One side of each carcass was transported to MARC and fabricated into boneless retail cuts trimmed to .3 inches fat thickness. Retail product was calculated and expressed as a percentage of carcass weight or as total pounds.

Table 1. Means, standard deviations, minimum, and maximum values for live animal, carcass, and ultrasound measures.

Trait	Mean (std. dev.	Minimum	Maximum
Live weight, lb	1206 (140	780	1610
Carcass weight, lb	735 (89	472	991
Carcass fat thickness, in	.38 (.16	.10	1.0
Carcass REA, in^2	11.78 (1.24	9.1	15.5
Carcass KPH, %	2.78 (.60	1.0	4.5
Carcass yield grade	3.04 (.71	1.26	5.46
RTU fat thickness, in	.39 (.14	.09	.79
RTU REA, in^2	11.94 (1.16	9.18	15.84
RTU rump fat thickness, in	.41 (.13	.14	.90
RTU body wall thickness, in	2.05 (.29	1.32	2.94
Muscle score	4.49 (1.5	2.0	9.0
Carcass retail product, %	70.4 (3.8	60.6	79.9
Carcass retail product, lb	244.3 (29.3	170.0	323.0

Results and Discussion

Table 1 lists the means, standard deviations, and minimum and maximum values for live animal and carcass traits. The diversity of sire breeds used in this study resulted in a great deal of variation in carcass and live animal traits. Ultrasound measured traits of fat thickness and REA had smaller standard deviations and less variation than the same traits measured on the carcass.

Table 2 relates the accuracy of ultrasound measures compared to carcass measurements for fat thickness and ribeye area. The mean and absolute differences reflect bias when comparing the ultrasonic measurement to the carcass measurement. Both fat thickness and ribeye were over-predicted when measured ultrasonically compared to measurements taken on the carcass in the cooler. The mean absolute differences for both traits are larger than the mean differences, indicating that some images were interpreted to be larger and some smaller than actual carcass measurements. Ultrasound measurements of REA and fat thickness had positive correlations with carcass measures of the same traits (r=.91 for REA and r=.93 for fat thickness). Standard errors of prediction currently are being used as the standard to certify ultrasound technicians for accuracy. Current Beef Improvement Federation guidelines for certification allow maximum standard errors of prediction of .10 inches and 1.1 square inches for fat thickness and ribeye area, respectively. The low standard errors of prediction in this study are indicative of an experienced technician and reflect the ability to accurately rank animals when ultrasound measures are compared to carcass data.

Correlation coefficients between live animal and carcass traits with retail product percent or weight are reported in Table 3. Fat thickness, measured ultrasonically or in the carcass, has a strong negative correlation with percentage retail product but has no significant correlation with total pounds of retail product. Ribeye area is positively correlated with both pounds and percentage of retail product but has a stronger relationship to weight of retail product in the beef carcass. Correlations for carcass ribeye area were higher than those found for ultrasound-measured ribeye area, perhaps due in part to bias involved in ultrasound measurements. Muscle score correlations were similar to those found for ribeye area. Body wall thickness and rump fat were negatively related to percentage retail product and are thought to be additional indicators of carcass fat. Rump fat measures have been used in Australia and may be most useful in leaner cattle who have less 12th rib fat. Limited work has been done with body wall thickness in cattle; however, it is used to predict percentage of retail cuts in lamb carcasses.

Table 2. Accuracy of ultrasound measurements.

	Fat thickness, in	REA, in^2
Bias (carcass-ultrasound)	-.01	-.16
Mean absolute difference	.04	.42
Standard error of prediction	.06	.52

Table 3. Correlations between retail product and live animal, carcass, and ultrasound measures.

	Retail product, %	Retail product, lb
Live weight	-.28	.84
Carcass weight	-.24	.87
Carcass fat thickness	-.75	
Carcass REA	.38	.66
RTU fat thickness	-.76	
RTU REA	.27	.61
RTU rump fat thickness	-.66	
RTU body wall thickness	-.48	
Muscle score	.37	.53

$p < .001$

Results of stepwise regression analysis for predicting percent retail product using RTU and live animal measures or carcass measures are shown in Tables 4 and 5. Fat thickness (either measured on the carcass or with RTU) accounted for a large proportion of the variation found in percent retail product. This may be a function of the variation in fat thickness in the population of cattle used in this study. Comparison of the R^2 values for RTU vs. carcass fat thickness indicates that RTU fat thickness accounts for more of the variation found in percent retail product than carcass fat thickness. The lower R^2 for carcass fat thickness may be partially due to errors involved in taking carcass measures that result from hide pulls and other slaughter/chilling processes. Both RTU rump fat thickness and muscle score accounted for 3.7% of the variation found in percent retail product. Muscle score was a more important parameter in the prediction model than RTU REA (partial R^2 value .037 vs. .015, Table 4). Although body wall thickness is also a measure of fat thickness, it accounted for a very small proportion of the variation in percent retail product. Table 5 indicates that carcass measures account for 67.6% of the variation found in retail product. These carcass measures correspond with the USDA yield grading equation currently used by the industry to predict differences in carcass yield. Using live animal and RTU measured traits accounted for 68.0% of the variation in percent retail product (Table 4). Mean square errors (MSE) for possible prediction models using live animal and RTU measures compared to carcass measures alone were similar (MSE=2.16 lb for live animal/RTU measures and MSE=2.17 lb for carcass measures).

Table 6 shows the stepwise regression results for prediction of pounds of retail product using RTU and live animal measures. Final weight alone accounted for 70.5% of the variation found in pounds of retail product. Although muscle score and REA are both indicators of muscle content, muscle score was more

Table 4. Stepwise regression for prediction of percent retail product using real-time ultrasound and live animal measures.

	Model R^2	Partial R^2	MSE
RTU fat thickness	.575	.575	2.47
RTU rump fat thickness	.612	.037	2.37
Muscle score	.649	.037	2.26
Live weight	.660	.012	2.22
RTU REA	.675	.015	2.18
RTU body wall thickness	.680	.005	2.16

Table 5. Stepwise regression for prediction of percent retail product using carcass measures.

	Model R^2	Partial R^2	MSE
Carcass for thickness	.560	.560	2.52
Carcass REA	.609	.050	2.37
Carcass weight	.660	.051	2.22
Carcass KPH	.676	.016	2.17

Table 6. Stepwise regression for prediction of pounds of retail product using ultrasound and live animal measures.

	Model R^2	Partial R^2	MSE
Live weight	.705	.705	15.9
Muscle score	.799	.094	13.2
RTU fat thickness	.843	.044	11.6
RTU REA	.870	.026	10.6
RTU rump fat thickness	.875	.005	10.4

predictive of pounds of retail product than REA (R^2 =.094 vs. .026). Ultrasound fat thickness and rump fat were less predictive of pounds of retail product than percent retail product. Using live animal and RTU measures accounted for 87.5% of the variation in total pounds of retail product.

Table 7 lists possible regression models for predicting pounds of retail product from carcass measures. Carcass weight accounted for a large proportion of the variation found in pounds of retail product (R^2 = .766). Carcass weight is more indicative of pounds of retail product than live weight due to differences in dressing percentages. Carcass fat thickness accounted for an additional 10% of the variation in pounds of retail product, with REA and KPH accounting for 2.5% and .4% respectively. Using all four carcass traits accounted for 89.5% of the variation in pounds of retail product. Carcass measurements have more predictive power for pounds of retail product than a combination of live animal and RTU traits.

These preliminary results suggest that using a combination of live animal and RTU traits can be useful in predicting percent or pounds of retail product in the beef carcass. Possible prediction models for predicting percent or pounds of retail product using live animal and RTU measures were similar in their predictive power and accuracy as compared to models derived from carcass measurements alone. However, more of the variation in pounds of retail product may be accounted for than percent retail product.

Other measures such as rump muscle depth, ribeye depth, or fat area also may be added to investigate their potential predictive power. The diverse sire lines represented in this study may be looked at separately in order to determine the the potential accuracy of prediction within a group of cattle with less variation and more similar composition.

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Table 7. Stepwise regression for prediction of pounds of retail product using carcass measures.

	Model R^2	Partial R^2	MSE
Carcass weight	.766	.766	14.2
Carcass fat thickness	.866	.100	10.8
Carcass REA	.890	.025	9.7
Carcass KPH	.895	.004	9.6