Carcass EPDs for Yearling Angus Bulls Using Real-time Ultrasound Measures

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Summary

Real-time ultrasound (RTU) images from yearling Angus bulls were analyzed to determine adjustment factors and genetic parameter estimates. The traits analyzed included ribeye area, 12-13th rib fat thickness, rump fat thickness, and % intramuscular fat. The heritability estimates are higher than those calculated from the American Angus Association's carcass database. Expected progeny differences (EPD) for these traits were computed for the sires that produced the yearling bulls. The rank correlations for sires with both carcass EPD and RTU EPD from this study were developed. As accuracy for RTU EPD increases, the rank correlation with carcass EPD increases positively.

Introduction

This report summarizes an analysis of the real-time ultrasound images that were collected during the first year of the American Angus Association Centralized Ultrasound Processing (AAACUP) research project. This is a two-year project, ending December 30, 1999. The objectives of this project include:

(1) Developing a centralized processing center for expedient and quality controlled interpretation of real-time ultrasound (RTU) images collected from Angus yearling seed stock animals (bulls and heifers) and from Angus-sired steers involved in progeny testing programs with the American Angus Association, and
(2) Developing the structure that will allow for transitioning of the centralized processing center into an industry-operated organization that meets the objectives and criteria for beef cattle performance and carcass improvement programs.

There were 12 technicians that participated with ISU and the American Angus Association (AAA) in the collection of RTU images primarily from yearling bulls, replacement heifers, feedlot steers and feedlot heifers. Body composition measurements from these and future RTU images will be used by AAA to generate expected progeny differences (EPD) for carcass traits. The purpose of this paper is to summarize the measurements made from the yearling bull RTU images.

Materials and Methods

Description of Data

All of the images collected by the technician are stored on a ZIP™ disk and then sent to the AAACUP laboratory, Room 42, Kildee Hall, Iowa State University, Ames, IA. The technician is required to collect a rump fat image, a 12-13th rib cross-sectional image and 4 longitudinal images of the *longissimus dorsi (ld)* muscle without a standoff guide. The *ld* scans include the portion of the muscle over the 11, 12 and 13th ribs. Upon receipt by the laboratory, ISU technicians make a rump fat thickness measurement (RUMP), a 12-13th rib fat thickness measurement (FAT), a ribeye area (REA) measurement and a % intramuscular fat measurement (%IMF) from the images. The technician also sends a barn sheet with the images. This barn sheet contains the individual animal identification and other information required for contemporary grouping. AAACUP personnel merge the measurements for each animal with the barn sheet information, and they then electronically forward the combined set of information to AAA for further processing. Breeders receive the actual ultrasound measures, age-adjusted measurements and contemporary group ratios from the AAA. All images collected in 1998 were with the Aloka 500 and a 17cm transducer. All of the RTU measurements were made using ISU developed software.

There were 4,518 bull RTU measurements prior to edits available for use in this analysis. The summary statistics are given in Table 1 for bull age, weight, weight per day of age (WDA), and RTU measurements for the edited data. The weight measurement was recorded at time of scanning or within ± 7 days of when the scanning was done. The WDA trait was computed using the weight measurement divided by the age of the animal in days. The % retail product trait is a computed trait using an estimated carcass weight, an assumed KPH% (2%), REA and FAT. Carcass data existing on Angus bulls in the AAA database were used to develop a prediction formula for carcass weight using live weight and actual carcass measurements (R^2=.76). This formula is given by:

Carcass weight, lbs (CWT) = .16766*actual weight+29.205*REA+122.61*FAT.

The % retail product weight estimation is given by:

% Retail product, % = 65.69-3.91*(FAT*2.54)+.19*(REA*6.452)-.029*(CWT*.454)-1.29*KPH%.

There were 497 sires with yearling bull progeny in the RTU database. The Fall 1998 Angus Sire Evaluation Report listed 1,944 sires with progeny carcass data. Of the 497 sires, 193 have both RTU yearling bull measures and progeny carcass data (primarily steer).

Statistical Analysis

General linear model procedures were used to develop regression formulas that could be used to adjust all of the records to a common end point. Both regressions on age and on weight/day of age were developed. Each model included a herd-year-season fixed effect and a covariate for either age or weight/day of age. The data were edited to remove measurements taken at less than 250 days of age and greater than 450 days of age. This reduced the overall data set 4,422 observations per trait.

Genetic parameters were estimated for a multiple-trait model using Restricted Maximum Likelihood (REML) procedures. The REML software package uses a sire-maternal grandsire model including relationships. This program also computes EPD and actual prediction error variances that can be used to develop accuracy values for each EPD. This program is currently being used to calculate the AAA carcass EPD allowing for comparison of carcass EPD and ultrasound EPD using equivalent genetic prediction models. Individual yearly bull EPD can be obtained by back-solution using sire and maternal grandsire EPD and Mendelian sampling estimates.

Results and Discussion

Adjustment Factors

The linear model estimates for age and WDA are presented in Table 2. With the exception of % IMF, the WDA model accounts for more variation in the data. Future regressions for WDA need to also consider this trait computed from weaning age and weight to the scanning weight. The genetic parameters were computed using 365-day age adjusted carcass weight and % IMF and WDA adjusted ribeye area, rump fat, 12-13th rib fat, and % retail product. Linear and quadratic regressions are given in Table 3. The quadratic effects are quite small for all traits, but some are significant (Type I SS). The linear and quadratic models do not increase R^2 over the linear models. Contemporary group fixed effects were highly significant (Pr>F =.0001) for all traits.

It is important to point out that age regression models for the RTU traits being measured would be best fit using within-individual animal regressions rather than pooling the data as done here. However, this does require serial scans (30 day intervals over a period of 60-90 days) on each animal. It would be hard for breeders to justify this added expense and time. The pooling effect could partially account for the extremely flat regressions found in these data.

Genetic Parameter Estimates

Genetic parameter estimates for the RTU measurements and computed traits are given in Table 4. Heritability (h^2) estimates are given on the diagonal, genetic correlations above the diagonal, and phenotypic correlations below the diagonal. The h^2 estimates for all of the traits are higher than those estimated from steer progeny carcass traits in the AAA national sire evaluation database. For example, RTU-% IMF of .42 vs. carcass Marbling Score of .37, RTU-REA of .39 vs. carcass REA of.27, and RTU-FAT of .44 vs. carcass 12-13th rib fat thickness of .25. The moderately high RTU h^2 estimates would indicate that breeders can make significant genetic change in each of the compositional traits evaluated in this research project.

The RTU-rump fat h^2 estimate is .52. This estimate is considerably higher than the RTU rib fat thickness estimate of .44. From Table 1, it can be seen that mean values and variation of both traits are very similar. The higher h^2 estimate for the rump fat trait would indicate that a RTU measurement of fat in the rump region is a more repeatable measure than the RTU rib fat measurement. And for this reason, rump fat will continue to be measured on Angus cattle. The rump fat may become the most important component trait for a computed % retail product estimate in live cattle. The two external fat traits are very highly correlated (genetically) at .82, meaning that they are controlled genetically by most of the same genes.

There is a small positive genetic correlation between the RTU-% IMF trait and both the RTU rump fat and 12-13th rib fat thickness traits. These genetic correlations are .12 and .17, respectively. This is in contrast to the .00 genetic correlation reported between USDA Marbling Score and fat thickness in the AAA Fall 1998 Sire Evaluation Report. These positive genetic correlations are more consistent with literature-reported estimates between these two traits. It is hypothesized that the zero genetic correlation has more to do with our inability to accurately adjust Marbling Score and carcass fat thickness to a common end point for variance component estimation. There exists a wide age and compositional end point (fat thickness and quality grade) in the AAA steer-carcass database. This variation could contribute to a significant increase in error variance and a reduction in sire genetic variance. The age range on the RTU traits is very narrow and management of most of the yearly bulls involved in this study would be very similar.

RTU EPD and Carcass EPD Comparisons

Less than 40 % of the 497 sires evaluated for RTU traits have carcass EPD. This means that direct comparisons between RTU EPD and carcass EPD cannot be made because both systems have different bases. However, comparisons between EPD for the 193 sires that do have both types should provide some general tendencies as to whether the two systems are evaluating sires the same for compositional traits. Rank correlations between the RTU EPD and carcass EPD for the 193 sires having both is presented graphically in Figure 1. The rank correlations are plotted as a function of RTU EPD accuracy. For example, the first series of rank correlations (one for each trait) are based upon the ranks for sires with an RTU EPD accuracy of .40 and higher. There was no restriction placed on the carcass EPD accuracy. The second series of rank correlations are for sires with an RTU EPD accuracy of .50 and higher. These comparisons extend through RTU EPD accuracy of .80 and higher. The general trend from this figure is that as RTU EPD accuracy increases (increasing numbers of yearly bulls per sire measured), the rank correlation with these sires' carcass EPD increase.

Implications

The genetic parameter estimates for RTU measured compositional traits in yearling Angus bulls would indicate that breeders can make significant change in these traits through selection. The rank correlations obtained between RTU generated EPD from yearling bulls and those generated from steer carcass progeny records indicate that the traits being measured in the bulls are equivalent to those traits being measured in steer carcasses. Centralized processing of ultrasound images for beef cattle is a very positive step towards insuring that high standards in image capture and interpretation can be achieved.

Acknowledgments

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Table 1. Summary statistics for the 4,422 yearling Angus bulls scanned in 1998 as a part of the AAACUP research project.

Trait	Mean	SD	Low	High
Age, days	360	28	252	448
Weight, lbs	1080	131	452	1510
Weight/day of age, lbs/day	3.00	.31	.27	4.26
Rump fat, in.	.28	.10	.04	.83
12-13th rib fat, in.	.26	.10	.04	.80
Ribeye area, sq. in.	11.90	1.60	6.5	16.9
% Intramuscular fat, %	3.70	.80	1.12	8.57
% Retail Product, %	67.63	1.21	60.76	71.57

Table 2. Linear model estimates for age and WDA regressions for Angus yearling bull ultrasound measures and computed traits.

	Age			WDA		
Trait	Regression	R^2	Pr>F	Regression	R^2	Pr>F
Carcass wt, lbs/d	.84052	.63	.0001	117.396	.72	.0001
% IMF, %/d	.00563	.31	.0001	-.0657	.30	.0001
Ribeye area, sq. in./d	.01389	.55	.0001	1.7795	.59	.0001
Rump fat, in./d	.00063	.35	.0001	.0814	.37	.0001
12-13th rib fat, in./d	.000578	.42	.0001	.0924	.45	.0001
% Retail product, %/d	.000225	.25	.0001	-.282	.25	.0001

Table 3. Linear and quadratic model estimates for age regressions for Angus yearling bull ultrasound measures and computed traits.

Trait	Model R^2	Linear Regression	Linear Pr>F	Quadratic Regression	Quadratic Pr>F
Carcass wt, lbs/d	.62	3.369	.0001	-.003499	.0001
% IMF, %/d	.31	.00067	.0001	.00000686	.6270
Ribeye area, sq. in./d	.55	.05402	.0001	-.0000555	.0141
Rump fat, in./d	.35	.0043	.0001	-.00000509	.0024
12-13th rib fat, in./d	.42	.0038834	.0001	-.00000457	.0031
% Retail product, %/d	.25	-.016709	.7932	.00002324	.2929

Table 4. Genetic parameter estimates for RTU measures made on yearling Angus bulls.

Trait	CWT	MS	REA	FT	%RP	RF
Carcass Wt (CWT)	.43[a]	-.31	.48	.097	.49	.14
Marbling Score (MS)	.01	.42	-.12	.17	-.31	.12
Ribeye Area (REA)	.66	-.06	.39	.23	.45	.25
12-13th Rib Fat Thickness (FT)	.30	.17	.20	.44	-.71	.82
% Retail Product (%RP).	.45	-.17	.60	-.62	.42	-.53
Rump Fat (RF)	.17	.16	.13	.58	-.36	.52

[a] h^2 estimates on diagonal, genetic correlations above diagonal, and phenotypic correlations below diagonal.

Figure 1. Rank correlation between RTU EPD and carcass EPD as a function of RTU EPD accuracy.