Heritability and Correlation Estimates of Carcass Data from Angus-Sired Steers

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Jennifer A. Minick, graduate assistant
Doyle E. Wilson, professor
M.E. Dikeman, professor, Kansas State University
E.J. Pollak, professor, Cornell University

Summary

Carcass data including Warner-Bratzler shear force, marbling score, hot carcass weight, 12-13th rib fat, and ribeye area from 589 Angus-sired steers in the National Cattlemen's Beef Association Carcass Merit Project were analyzed to estimate heritabilities and genetic correlations. Genetic parameters were estimated using the sire/maternal-grandsire model with the relationship matrix. The heritabilities for tenderness, marbling, hot carcass weight, ribeye area and rib fat were .25, .29, .79, .59, and .07, respectively.

Introduction

The National Cattlemen's Beef Association initiated a project in 1998 to study carcass merit in 12 breeds. The objectives were to develop methodology and procedures for the collection of information necessary for further development of EPD for carcass merit traits, and to collect carcass data and measure tenderness of the longissimus thoracis by Warner-Bratzler shear force in contemporary groups of progeny of multiple sires within each breed. The data used in this study represent the Angus-sired steers from that project. The objective of this analysis was to estimate heritabilities and genetic correlations for Warner Bratzler shear force (WB), marbling score (MS), hot carcass weight (HCW), ribeye area (REA), and 12-13th rib fat (FAT).

Materials and Methods

There were 589 steers sired by 28 Angus bulls (after edits) in the National Cattlemen's Association Carcass Merit Project. Steers were removed from the analysis if they were missing observations for any of the carcass measurements, or if they were the only progeny of a sire. Number of progeny per sire ranged from five to 47. The effect of age as a covariate was tested for all of the carcass traits. Because age did not significantly affect any trait, none of the records were adjusted. Restricted maximum likelihood (REML) estimates of the genetic parameters were determined using a sire/maternal-grandsire model that incorporated the relationship matrix. This model accounted for contemporary groups, which were derived from farm of origin and slaughter date. Multiple-trait analyses, including all two-trait, three-trait, and four-trait combinations of the traits, as well as the full five-trait model, were run.

Results and Discussion

Table 1 shows the means, standard deviations, minimums and maximums for each of the carcass traits. Table 2 shows the genetic parameters (averaged over all analyses), with heritabilities ± standard errors on the diagonal, genetic correlations above the diagonal, and phenotypic correlations below the diagonal. Each of the two-, three-, four-, and five-trait analyses resulted in slightly different values for heritabilities and correlations. Table 3 shows the ranges for the genetic parameters with heritabilities on the diagonal, genetic correlations above the diagonal and phenotypic correlations below the diagonal.

The average heritability for tenderness was .25. This is within the range of .09 to .53 reported in the research literature. The heritability for marbling score was also within the range of literature reports and was similar to that used by the American Angus Association in genetic evaluation. However, the heritabilities for hot carcass weight and ribeye area were higher than expected, and the heritability for rib fat was lower than expected. It is possible that these steers were harvested at as nearly equal fat thickness as possible, which would decrease the variance and heritability. Because of the removal of the hide, rib fat is inaccurately measured in the packing plant. Also, this data set is relatively small, and these values can be expected to change as more information is added to the analysis. The genetic correlation between tenderness and marbling was slightly negative, and the phenotypic correlation was -.18. This means that as marbling went up, the amount of force needed to cut through the steak went down. Steaks with more marbling were more tender.

Implications

Heritability for tenderness, as measured by Warner-Bratzler shear force in the Angus-sired steers in the National Cattlemen's Beef Association Carcass Merit Project, was .25. This indicates that selection on shear force can improve tenderness.

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National Cattlemen's Beef Association
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Table 1. Means, standard deviations, minimums and maximum for Warner-Bratzler shear force in pounds (WB), marbling score (MS)[a], hot carcass weight in pounds (HCW), ribeye area in inches^2 (REA) and 12-13th rib fat (FAT) in inches.

	n	mean	std. dev.	minimum	maximum
WB	589	8.18	1.75	4.38	17.12
MS[a]	589	5.57	0.87	3.0	9.6
HCW	589	788.29	68.37	508	962
REA	589	12.67	1.19	8.4	16.0
FAT	589	0.55	0.14	0.08	1.08

[a] 3.0-3.9 = traces, 4.0-4.9 = slight, 5.0-5.9 = small, 6.0-6.9 = modest, 7.0-7.9 = moderate, 8.0-8.9 = slightly abundant, 9.0-10.0 = moderately abundant

Table 2. Heritabilities (diagonal), genetic correlations (above the diagonal) and phenotypic correlations (below the diagonal) for Warner-Bratzler shear force (WB), marbling score (MS), hot carcass weight (HCW), ribeye area (REA) and 12-13th rib fat (FAT).

	WB	MS	HCW	REA	FAT
WB	.25 ± .18	-.04	.64	.42	.21
MS	-.18	.29 ± .19	-.15	.23	-.51
HCW	.12	.19	.79 ± .29	.64	.07
REA	.19	0	.38	.59 ± .25	-.77
FAT	-.03	.19	.26	.19	.07 ± .11

Table 3. Ranges from all of the 2-, 3-, 4-, and 5-trait analyses for heritabilities (diagonal), genetic correlations (above the diagonal), and phenotypic correlations (below the diagonal) for Warner-Bratzler shear force (WB), marbling score (MS), hot carcass weight (HCW), ribeye area (REA) and 12-13th rib fat (FAT).

	WB	MS	HCW	REA	FAT
WB	.22 - .27	-.03 - -.06	.63 - .64	.40 - .44	.09 - .29
MS	-.18	.28 - .30	-.13 - -.17	.19 - .27	-.46 - -.55
HCW	.12	.19	.77 - .80	.61 - .67	.01 - .14
REA	.19	0 - -.01	.38-.39	.56 - .62	-.68 - -.86
FAT	-.03 - -.04	.19	.26	-.19	.04 - .10