HERITABILITY AND CORRELATION ESTIMATES OF WARNER-BRATZLER SHEAR FORCE AND MARBLING SCORE FROM ANGUS-, CHAROLAIS-, HEREFORD-, AND SIMMENTAL-SIRED CATTLE

J. A. Minick[1], M. E. Dikeman, E. J. Pollak[2], D. E. Wilson, and E. W. Dressler[3]

Summary

The objective of this study was to estimate heritabilities and genetic correlations for Warner-Bratzler shear force and marbling score of longissimus steaks from Angus-, Charolais-, Hereford-, and Simmental-sired cattle in the National Cattlemen's Beef Association (NCBA) coordinated Carcass Merit Traits Project funded with Beef Checkoff dollars. There were 700 Angus-sired steers, 691 Charolais-sired steers and heifers, 938 Hereford-sired steers, and 1,167 Simmental-sired steers and heifers in the study. Restricted maximum likelihood estimates of the genetic parameters were determined using a sire model with a sire/maternal grandsire relationship matrix. The heritabilities for Warner-Bratzler shear force and marbling score, respectively, were 0.35 and 0.36 for Angus, 0.43 and 0.26 for Charolais, 0.12 and 0.59 for Hereford, and 0.13 and 0.42 for Simmental. The genetic and phenotypic correlations between Warner-Bratzler shear force and marbling score, respectively, were -0.19 and -0.18 for Angus; -0.36 and -0.19 for Charolais; -0.47 and -0.23 for Hereford; and +0.64 and -0.11 for Simmental. The high positive genetic correlation between Warner-Bratlzer shear force and marbling score for Simmental sires indicates that as marbling increased Warner-Bratzler shear force increased (decreased tenderness). These results suggest that selection for increased marbling in the Simmental breed would actually have a detrimental effect on tenderness. Selection for Warner-Bratzler shear force in Angus and Charolais could result in improved in tenderness, but little progress would be expected in Hereford sired cattle. In general, selection for marbling score in these breeds would improve tenderness only minimally.

Introduction

Beef tenderness is a critical component of a good eating experience. Much recent research has focused on understanding tenderness. The literature reports heritabilities for Warner-Bratzler shear force that range from 0.02 to 0.53. The genetic and phenotypic correlations between Warner-Bratzler shear force and marbling score range from –1.00 to 0.45 and from -0.96 to -0.11, respectively. The National Cattlemen's Beef Association initiated a project in 1998 to study carcass merit in 15 breeds. The project was funded with Beef Checkoff dollars, the breed associations, and MMI Genomics. The objectives included developing methodology and procedures for collection of information for further development of expected progeny differences (EPDs) for carcass merit traits and measuring tenderness of the longissimus lumborum muscle (strip loin steaks) by Warner-Bratlzer shear force in contemporary groups of progeny of multiple

[1]Iowa State University, Ames, IA.
[2]Cornell University, Ithaca, NY.
[3]National Cattlemen's Beef Association, Centennial, CO.

sires within each breed. The data used in this study represent the Angus-, Charolais-, Hereford-, and Simmental-sired steers and heifers from that project. The objective of this analysis was to estimate heritabilities and genetic correlations for Warner-Bratzler shear force and marbling score in the four breeds.

Experimental Procedures

This study encompassed 700 yearling steers sired by 31 Angus bulls; 691 yearling steers and heifers sired by 32 Charolais bulls; 938 yearling steers sired by 47 Hereford bulls; and 1,167 yearling steers and heifers sired by 85 Simmental bulls. All were in the NCBA-coordinated Carcass Merit Traits project. The breed associations provided progeny of the more widely used sires within their respective breeds, primarily from commercial cowherds. One or more reference sires of each breed were used in a test herd, and 1996 Beef Improvement Federation guidelines for sire evaluation were followed. The selection of test herds, sires, feedlots and feedlot regimen, slaughter endpoint, and beef processing plants was at the discretion of each breed association.

Yield grade and quality grade data were collected by USDA personnel at 24 to 48 hours postmortem. A 1-inch thick steak was obtained from the longissimus lumborum muscle (strip loin steak) at the 13th rib region and shipped overnight to the Kansas State University Meat Laboratory. Steaks were vacuum packaged and aged for 14 days at 34°F.

Steaks were cooked at 325°F to an internal temperature of 158°F in a Blodget forced-air convection, gas oven and then cooled overnight before ½-inch diameter cores were removed and measured on an Instron Universal Testing Machine. The Warner-Bratzler shear force values for eight cores were averaged and used in statistical analyses.

In all breeds, age had an effect on marbling score ($P<0.02$) and these records were adjusted accordingly. Restricted maximum likelihood estimates of the genetic parameters were determined using a sire model that incorporated a sire/maternal grandsire relationship matrix. This model accounted for contemporary groups, which were derived from farm of origin, gender, and harvest date. Contemporary groups formed this way also accounted for season of birth and breed of dam. A two-trait analysis of Warner-Bratzler shear force and marbling score was performed.

Results and Discussion

The number of animals used and the genetic parameters for Warner-Bratzler shear force and marbling score are shown in Table 1. The heritabilities for Warner-Bratzler shear force were low to moderate and fell within the range of literature estimates. Heritabilities of Warner-Bratzler shear force in Hereford and Simmental were similar (0.12 and 0.13, respectively), whereas Angus and Charolais heritabilities for Warner-Bratzler shear force were somewhat higher (0.35 and 0.43, respectively). The spring 2002 Sire Summaries for the four breeds show heritabilities for marbling score and/or ultrasound percentage of intramuscular fat of 0.35 marbling score and 0.31% intramuscular fat for Angus; 0.30 marbling score for Charolais; 0.35% intramuscular fat for Hereford; and 0.35 marbling score for Simmental. The heritability for marbling score in our study for Hereford was somewhat higher than expected. This could be partially due to the fact that the American Hereford Association does not publish a marbling score EPD, but uses % intramuscular fat instead.

The genetic correlation between Warner-Bratzler shear force and marbling score in Charolais- and Hereford-sired cattle (–0.36 and –0.47, respectively) is similar to literature estimates of –0.25 to –0.55. The negative correlation indicates that more marbling is associated with less force required to shear steaks.

This correlation in Angus was somewhat smaller than expected (–0.19). Unlike the other breeds and most literature estimates, the genetic correlation between Warner-Bratlzer shear force and marbling score in Simmental was large and positive. The biological explanation for this is unknown; however, there is one published paper reporting a large positive genetic correlation (0.45) between Warner-Bratzler shear force and marbling score. The phenotypic correlation between Warner-Bratzler shear force and marbling score was similar for all breeds (–0.11 to –0.23) and agrees with literature estimates of –0.11. Direct selection could improve *longissimus* shear force-evaluated tenderness in Angus and Charolais. In Angus-, Charolais-, and Hereford –sired cattle, selection for increased marbling would be expected to result in a small improvement in tenderness, but in Simmental-sired cattle would be expected to result in decreased tenderness.

Table 1. Number of Animals, Heritability (h^2) for Warner-Bratzler Shear Force and Marbling Score[a], and Genetic Correlation (r_g) and Phenotypic Correlation (r_p) Between these Traits for Angus-, Charolais-, Hereford-, and Simmental-Sired Cattle

Item	Angus	Charolais	Hereford	Simmental
No. of cattle	700	691	938	1,167
Warner-Bratzler shear force h^2	0.35	0.43	0.12	0.13
Marbling score h^2	0.36	0.26	0.59	0.42
r_g	-0.19	-0.36	-0.47	0.64
r_p	-0.18	-0.19	-0.23	-0.11

[a]400 = slight, 500 = small.