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WARNER-BRATZLER SHEAR FORCE VALUES AND RANGES OF STEAKS FROM CATTLE OF KNOWN SIRES

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Summary

Carcass data and Warner-Bratzler shear force (WBSF) data on strip loin steaks were collected from nearly 8,500 cattle in contemporary groups of progeny from the more popular sires in 14 different beef cattle breeds in the Carcass Merit Traits project funded by Beef Checkoff dollars, the breed associations, and MMI Genomics. In addition, trained sensory panel evaluations were conducted on over 2,500 strip loin steaks from contemporary groups of progeny from five sires included in the DNA marker validation component of the project. The correlation between WBSF and tenderness scored by the trained sensory panel was -0.82, indicating that as WBSF increased, tenderness scored by the sensory panel decreased. Our results showed that a WBSF value of ≥ 11.0 lb generally results in a sensory score of slightly tough or tougher. In this study, 22.8% of the cattle had WBSF values ≥ 11.0 lb and 26.3% had sensory scores of slightly tough or tougher. The phenotypic range of WBSF means for sires within breeds ranged from 1.9 to 6.6 lb. The phenotypic range of WBSF means across breeds was 8.9 lb, whereas the range among sires across breeds was a dramatic 14.4 lb. The phenotypic range for flavor intensity scores among sires within and across breeds was much smaller than for tenderness, with juiciness scores being intermediate. The 40 widely used sires that produced progeny with steaks that were unacceptable in tenderness in this study might be expected to be sires of several thousand bulls used in commercial herds. This demonstrates that seedstock producers should aggressively utilize sires that have genetics for tender meat.

Introduction

Consumers eat beef primarily for its desired flavor, but when they have a complaint about the palatability of beef, it usually is because of unacceptable tenderness. The National Beef Tenderness Study published in 1998 found that, except for the tenderloin, considerable variability occurred in tenderness, and significant percentages of nearly all beef cuts were unacceptable in tenderness. Tenderness generally is measured on the longissimus muscle (the main muscle in rib and strip loin cuts) because it has the most total value, and almost always is cooked by dry heat with the expectation that it will be tender, juicy, and flavorful. Recent market studies have shown that consumers are willing to pay more for beef of known tenderness. Although consumers are the ultimate judges of whether beef is desirable or undesirable in tenderness, Warner-Bratzler shear force (WBSF) is used as a highly repeatable and more economical

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method for measuring tenderness. Reviews of published literature on the genetic control of tenderness show that the heritability of WBSF is moderately high (29%) and that of marbling is high (38%), indicating that progress can be made through selection. However, selecting for tenderness or other palatability traits is expensive. With the availability of Expected Progeny Differences (EPDs) and(or) DNA marker-assisted selection, the beef cattle industry could make significant progress toward improving meat palatability through genetic selection. The American Simmental Association has published EPDs for WBSF for 120 of the most widely used Simmental and Simbrah sires. The Carcass Merit Traits project was an extensive 3½-year research project involving four universities, 13 beef cattle breed associations (14 breeds), and MMI Genomics. The project was funded with Beef Checkoff dollars, by participating breed associations, and MMI Genomics, and it was coordinated by the National Cattlemen's Beef Association (NCBA). The objectives of the project reported here were to:

1. Collect information and develop guidelines to aid in the development of EPDs for carcass merit traits.

2. Measure *longissimus lumborum* (strip loin steak) Warner-Bratzler shear force of contemporary groups of progeny from multiple sires within each breed.

3. Measure *longissimus lumborum* sensory attributes on a sample of contemporary groups of progeny from sires included in DNA marker validation.

4. Validate markers for the carcass traits of tenderness, marbling, and composition in different beef breeds.

Experimental Procedures

The 13 breed associations (14 breeds) provided approximately 8,500 AI progeny of the most widely used sires within their respective breeds, primarily from commercial cowherds. One or more reference sires of each breed was used in each test herd (to tie contemporary groups together within breeds). Beef Improvement Federation guidelines for sire evaluation were followed. The numbers of progeny from each breed were determined by the proportional numbers of registrations of the respective cooperating breeds. Each breed association was responsible for providing leadership for selection of sires; coordinating progeny testing; costs of synchronizing and mating cows; blood sampling; selection of feedlots and feedlot regimen, slaughter endpoint, and beef processing plants; carcass data collection; and the development of EPDs for their respective breed. Consequently, the breed associations funded approximately 50% of the total costs of the research project. The Beef Checkoff Program provided funds for shear force and sensory panel evaluation, graduate student assistantships, travel for carcass data collection, and one-half of the DNA analyses. MMI Genomics funded the other one-half of the cost of DNA analyses. Sires were compared only within breed and not across breeds. Breed identity was coded to prevent associations or breeders from comparing breeds. Dan Moser was the facilitator and liaison to the breed associations.

Each breed association was allocated a minimum of 10 sires plus additional sires based on the number of registrations for each respective breed. The range for the number of allocated sires for the different breed associations was from 10 to 54. Ten sires within each breed were designated as DNA sires, with a target of 50 progeny/sire. For the other sires within each breed, the target number of progeny/sire was 15. Carcass data and WBSF data were obtained on all progeny from all sires. For five of the DNA sires within each breed that were selected by the respective breed associations, trained sensory panel evaluations were conducted on their progeny. Prior to, or upon entering the feedlot, blood was obtained and sent to both Clare Gill at Texas A&M University and to Tom Holm at MMI Genomics for analyses. Semen samples were also analyzed for the DNA sires. The DNA analyses were to validate the association of particular DNA markers with shear force, sensory panel traits, and carcass traits that were identified by Jerry Taylor and Scott Davis at Texas A&M University through the "Angleton" Genome Mapping project, which was funded by the Beef Checkoff, USDA-CSREES, and the Texas Agricultural Experiment Station.

A muscle sample from all progeny was obtained at slaughter for backup DNA analyses and verification of animal identity. Detailed carcass data were obtained. Additionally, one steak from the progeny of every sire and two steaks from DNA sires were obtained and shipped overnight to Michael Dikeman at Kansas State University for Warner-Bratzler shear force measurement. The extra steak from DNA sires was used for trained sensory panel evaluation. Steaks used to measure shear force were cooked at 14 days postmortem, whereas sensory panel steaks were frozen and later thawed for sensory panel evaluations.

The database maintained by John Pollak and researchers at Cornell University was secure and updated almost daily. The development of carcass, shear force, and sensory panel EPDs was the responsibility of the breed associations, although John Pollak conducted analyses for at least two breeds. The NCBA and breed associations own all carcass, shear force, and sensory panel data. The marker identities, genotypes produced by scoring the markers, and protocols for marker identification remain the property of Texas A&M University and NCBA. However, this information, as well as the phenotypic data, will be provided to the breed associations for their use in computing EPDs for related carcass merit traits.

Results and Discussion

The correlation between Warner-Bratzler shear force (WBSF) and trained sensory panel tenderness was -0.82, indicating that as WBSF increased (decreasing tenderness), there was a distinct corresponding decrease in sensory panel tenderness. This correlation is considerably higher than the average in the literature. Some research publications show that a WBSF value ≥10 lb results in a sensory panel score of slightly tough or tougher. However, our results show that a WBSF value of ≥11 lb generally resulted in a sensory panel tenderness score of slightly tough or tougher. Our analysis showed that 22.8% of the cattle in this study had WBSF values ≥11.0 lb and 26.3% had sensory panel tenderness scores of slightly tough or tougher. These steaks were aged to 14 days postmortem, were not mechanically tenderized, and were cooked to a medium degree of doneness (158°F). The steaks were from relatively young cattle that had been managed optimally. The phenotypic range of WBSF means for sires within breeds ranged from 1.9 lb in the least variable breed to 6.6 lb in the most variable breed (Table 1). Assuming a heritability estimate of 0.30 for tenderness, the genetic range for sires within breeds would be approximately 0.6 to 2.0 lb. The phenotypic range across breeds was large at 8.9 lb, whereas the range among all sires across all breeds was a dramatic 14.4 lb. These results indicate that there is considerable variation in WBSF of strip loin steaks from young cattle managed optimally.

On an 8-point scale with 8 being extremely tender and 1 being extremely tough, the range in sensory panel tenderness means for sires within breeds ranged from 0.56 in the breed with the least variation to 1.13 in the breed with the most variation (Table 2). The tenderness range across breeds was 2.55, whereas the range among all sires across all breeds was 3.03. The range for sensory panel flavor scores for sires within breeds were quite small except for one breed (Table 3). The range for sensory panel juiciness scores (Table 4) for sires within breeds was larger than for flavor, but not as large as for tenderness. The rankings of breeds for sensory panel tenderness, flavor, and juiciness were not well related (Tables 2, 3, and 4).

If each of the 40 sires in this study that produced progeny with steaks that were unacceptable in tenderness were to sire 150 commercial bulls per year, that would be 6,000 bulls per year, or 18,000 bulls over three years (Table 5). If each of these commercial bulls produced 25 progeny per year, that would be 150,000 progeny per year plus an estimated 4,000 cull bulls and heifers from the 40 sires, or 154,000 progeny per year. Because loin eye and rib eye steaks from each carcass that are unacceptably tough could result in a negative eating experience for more than 50 consumers, as many as 7.5 million consumers could be impacted negatively per year, or more than 22 million in three years, unless effective mechanical tenderization and/or longer aging was used. Seedstock producers could improve tenderness genetically by aggressive discrimination against sires that are inferior for tenderness.

Table 1. WBSF Sire Ranges Within Breeds Ranked from Lowest to Highest WBSF*

Breed #1	3.45 lb
Breed #2	5.20 lb
Breed #3	3.74 lb
Breed #4	2.29 lb
Breed #5	2.79 lb
Breed #6	2.66 lb
Breed #7	4.32 lb
Breed #8	3.68 lb.
Breed #9	1.90 lb
Breed #10	3.99 lb
Breed #11	2.33 lb
Breed #12	6.62 lb
Breed #13	4.49 lb
Breed #14	6.41 lb

*Breed range = 8.09 lb; Range among all sires across all breeds = 14.44 lb.

Table 2. Sire Ranges for Sensory Panel Tenderness Scores Within Breeds Ranked from Most to least Tender Breed*

Breed #2	0.75
Breed #3	0.56
Breed #4	0.84
Breed #7	1.11
Breed #9	0.80
Breed #6	1.11
Breed #8	0.52
Breed #11	0.55
Breed #10	0.81
Breed #13	1.13
Breed #14	1.05

*Breeds within ≥100 progeny; Average tenderness score = 5.63; Breed range = 2.55; Range among all sires across all breeds = 3.03. Scale: 8 = extremely tender, 7 = very tender, 6 = moderately tender, 5 = slightly tender, 4 = slightly tough, 3 = moderately tough, 2 = very tough, 1 = extremely tough.

Table 3. Sire Ranges for Flavor Scores Within Breeds Ranked from Most to Least Flavorful Breed*

Breed #8	0.25
Breed #11	0.17
Breed #3	0.23
Breed #6	0.24
Breed #4	0.14
Breed #2	0.58
Breed #9	0.24
Breed #12	0.14
Breed #13	0.14
Breed #7	0.13
Breed #14	0.28

*Breeds with ≥100 progeny; Average flavor score = 5.54; Breed range = 0.45; Range among all sires across all breeds = 0.69. Scale: 8 = extremely intense, 7 = very intense, 6 = moderately intense, 5 = slightly intense, 4 = slightly bland, 3 = moderately bland, 2 = very bland, 1 = extremely bland.

Table 4. Sire Ranges for Juiciness Scores Within Breeds Ranked 1st to 12th*

Breed #12	0.21
Breed #6	0.38
Breed #9	0.31
Breed #2	0.70
Breed #8	0.40
Breed #11	0.28
Breed #4	0.38
Breed #7	0.36
Breed #3	0.31
Breed #13	0.27
Breed #14	0.70

*Breeds with ≥100 progeny; Average juiciness score = 5.63; Breed range = 0.67; Sire range = 1.12.

Table 5. Impact of 40 Sires with WBSF Values > 11.0 lb

- 40 sires → ≈400 progeny/sire/year → ≈150 bulls/sire/year
- 40 sires X 150 bulls/year → 6,000 bulls
- 6,000 bulls/year X 25 progeny/bull → ≈150,000 progeny/year
- 40 sires X 100 cull bulls or heifers → ≈4,000 year
- ≈154,000 progeny/year X 50 consumers → ≈7.5 million undesirable eating experiences
- ≈7.5 million X 3 years → ≈22.5 million undesirable eating experiences and no genetic progress would have been made