GENETIC EVALUATION OF TENDERNESS OF THE *LONGISSIMUS* IN MULTI-BREED POPULATIONS OF BEEF CATTLE AND THE IMPLICATIONS OF SELECTION

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INTRODUCTION

Tenderness of beef is a primary determinant of consumer satisfaction. Sixty-four percent of participants in a Canadian study (Jeremiah *et al.*, 1993) chose tenderness as the primary criterion of satisfaction versus 20% for flavour and 11% for leanness. Several studies have shown that a considerable proportion of beef steaks do not satisfy consumers, for example Roeber, *et al.* (2001). It is known that marbling level influences the juiciness and flavour of beef, and to a lesser extent, tenderness. However, there is considerable variation in tenderness that is independent of marbling. Quantifying and utilizing this variation to identify and select breeding stock with superior genetics for tenderness has the potential to improve customer satisfaction and increase beef market share.

The objectives of this study were to assess genetic variation of tenderness, quantify this variation by producing genetic evaluations, and to discuss the implications of selection for tenderness on consumer acceptability.

MATERIALS AND METHODS

Data. The study is based on Warner-Bratzler shear force measurements from three separate but related studies. The first data source was a detailed study of 200 steers fed together in a typical Ontario feedlot. These cattle were from 17 sires of 4 breeds (Angus, Charolais, Simmental, Limousin). The second data set was obtained from 600 commercially fed cattle of several breed crosses identified and tracked using Beef Improvement Ontario's BIO-LINK system. The third data source was from steer feeding trials conducted at the Elora Beef Research Centre feedlot, with steers originating from three research herds utilizing an Angus and Simmental rotational crossbreeding system. Eighty percent of the cattle were steers, with the remaining being heifers or bulls. Management groups were formed by combination of sex, herd of origin, feedlot location, and year.

Tenderness measurement. For all data sources, a primal rib cut consisting of ribs 6 to 12 from one side of each carcass were purchased and delivered to the Meat Laboratory at the University of Guelph. Five steaks were prepared from the *longissimus* muscle and allocated to postmortem aging times of 2, 7, 14, 21, and 28 days for subsequent measurements of tenderness using Warner-Bratzler shear.

This study is based on shear force of *longissimus* steaks aged for 7 days. The reported shear force is the average kilograms of force required to shear through eight one centimeter cores from each steak.

Analysis. Tenderness measurements were combined and analyzed using a single trait animal model with fixed effects of the mean, and random effects of animal, management group, and breed group using VCE4 (Groeneveld, 1994). Almost all of the animals in the study were crossbred, composed of varying levels of several different breeds. Breed group was formed by grouping animals of similar breed combinations based on sire and dam breed. The breed group effect accounts for the effect of each specific breed combination on shear force, rather than the effect of one breed over another. Across breed genetic evaluations were generated utilizing the individual animal solutions in combination with the breed group effect, allowing comparison of animals across several breeds and crosses. Accuracy was approximated from the standard error of prediction of the animal solutions..

RESULTS AND DISCUSSION

Initially, each of the three data sets were analyzed separately to examine the characteristics of each data source. As shown in table 1, the mean shear force was higher in the commercial cattle compared to the Rockwood and Elora feeding trials. This may be due to greater differences in management and age, since there were more sources of cattle, and the feedlot environment was not controlled as in the Rockwood or Elora feeding trials. Similar range and variation was found for each data set.

Table 1. Summary of *longissimus* shear force aged 7 days by data source

Data source	N	Mean (kg)	Std. Dev. (kg)	Min. (kg)	Max. (kg)
Commercial data	516	5.0	1.3	2.4	8.6
Rockwood feeding trial	173	4.4	1.2	2.5	8.6
Elora feeding trials	580	4.6	1.3	1.8	8.8
Overall	1269	4.7	1.3	1.8	8.8

Animals in this study were mostly sired by purebred bulls, with crossbred dams. Total proportions of each were counted to estimate the number of equivalent purebred animals of each breed: Angus (299), Simmental (246), Charolais (131), Limousin (88), Hereford (45), Other/ unknown (460). Breed of dam was unknown for a large number of the commercially sourced cattle. While there were common sires in all three data sources, the commercial data had more diversity of breeds and crosses.

Table 2 shows the results of variance component estimation. The heritability of 0.11 is lower than a pooled estimate of 12 studies of 0.29 reported by Koots *et al.* (1994).

Table 2. Variance components estimated for *longissimus* shear force aged 7 days

Variance Component	kg^2
Residual Variance (V_e)	1.083
Additive Genetic Variance (V_a)	0.171
Contemporary Group Variance (V_{cg})	0.268
Breed Group Variance (V_{bg})	0.012
Heritability (h^2)	0.111

Shear force measures the amount of force required to slice a section of steak, and lower values indicate more tender beef. Across breed genetic evaluations were computed to predict the difference in progeny average shear force due to the genetics of the animal. For example, steaks from progeny of a sire with a –0.20 genetic evaluation are expected to require 0.30 kg less force to shear than steaks from progeny of a sire with a +0.10 evaluation. The range of sire evaluations in this study ranged from –0.25 (most tender) to +0.24 (least tender) with accuracy ranging from 0.27 to 0.75.

There are no exact standards for connecting shear force to consumer acceptability. However, a meat tenderness study involving taste panels (Wheeler *et al.*, 2000) showed that in their sample of 310 carcasses, 20% were considered tender, 68% intermediate, and 11% tough. Assuming these proportions are also representative of the data that we have collected, tender would be 4.05 kg and under, and tough beef would be 5.64 kg and over. Steaks within these two levels would be considered intermediate in tenderness.

Table 3 shows the expected average shear force of progeny for three sires with different shear force evaluations when mated to the same set of cows. This suggests that substituting the 'Tender' for the 'Tough' sire would increase the percent of tender carcasses from 12% to 30%, while decreasing the proportion of tough carcasses from 18.5% to 6%.

Table 3. Example effect of sire shear force genetic evaluation on progeny tenderness category

	Tender Sire	Average Sire	Tough Sire
Genetic evaluation (kg)	-.25	0	+.24
Average progeny shear force (kg)	4.45	4.70	4.94
Tender (%)	30	20	12
Intermediate (%)	64	69	69.5
Tough (%)	6	11	18.5

The value of tenderness to the beef industry is great. Figure 1 shows the effect of changing the mean shear force of a group of cattle on the proportion of tender, intermediate, and tough steaks.

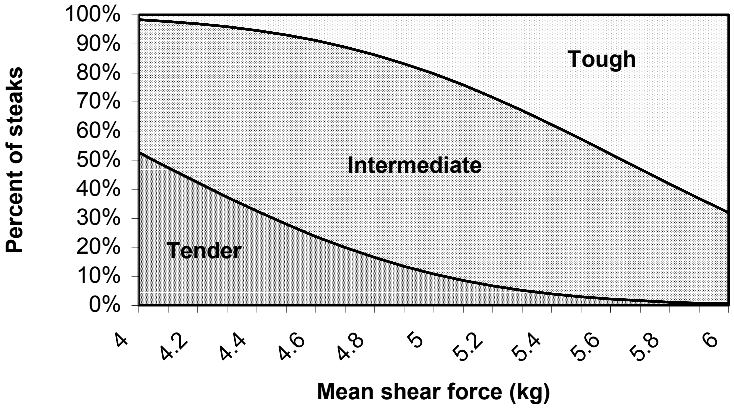

Figure 1. Effect of mean shear force on proportion of tender, intermediate, and tough steaks

CONCLUSION

There are many factors that influence the tenderness of beef, including genetics, age at slaughter, post-mortem aging, electrical stimulation, and cooking method. This research was able to quantify the variation due to genetics and produce genetic evaluations for individual animals of several breeds and crosses. It is clear that sufficient genetic variation exists to change the proportion of animals producing tender beef.

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