Genetic Analysis of the Iowa Beef Tenderness and Carcass Evaluation Project

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Summary

Steers from the Iowa Beef Tenderness and Carcass Evaluation Project were harvested and carcass data, including Warner-Bratzler shear force values, were collected. The heritability estimate of Warner-Bratzler shear force in this data set was 0.45, and the genetic correlation between tenderness and marbling score was -0.40. Steers with more marbling were more tender. Heritabilities for feed consumed per pound of gain and for feed consumed per day were 0.25 and 0.26 respectively. These traits were highly correlated with gain, but had no relationship to each other. The heritability of dressing percentage was 0.52. These preliminary estimates can be expected to change as more data are collected.

Introduction

Tenderness of a steak is one of the critical components of a good eating experience. As beef producers strive to produce a more consistent, higher quality product, much industry and research attention has been focused on this trait. One of the difficulties in studying tenderness is that it can only be measured after the animal has been harvested. This makes data collection to evaluate sires very expensive and time consuming for individual producers. The Iowa Beef Tenderness and Carcass Evaluation Project was initiated to:

1. assist Iowans in evaluating and identifying sires that produce progeny highly desirable in tenderness,
2. establish Iowa producers as a source of reference genetics,
3. create better producer awareness, and
4. improve Iowa producer knowledge.

Materials and Methods

In order to evaluate tenderness, 238 sire-identified steers by Angus bulls were fed at a central test location in 2001 and 2002. At harvest, carcass measurements including marbling score, hot carcass weight, percentage retail product, yield grade, ribeye area and 12-13th rib fat were taken. A ribeye steak was taken from each carcass, aged for 14 days, cooked, and evaluated for Warner-Bratzler shear force, which is a measurement of tenderness. The Cornell model was used to estimate individual feed consumption for all steers. This model uses body composition, growth rate, breed composition, pen intakes, and ration energy to predict feed consumption. Cattle were placed into contemporary groups based on year, farm of origin, and harvest date. Restricted maximum likelihood (REML) with a sire-maternal grandsire relationship matrix was used to estimate variance components.

Results and Discussion

Tables 1 through 3 show the overall and yearly means, standard deviations, minimums and maximums for kill age, average daily gain, hot carcass weight, dressing percentage, 12-13th rib fat, ribeye area, yield grade, percent retail product, marbling score, Warner-Bratzler shear force, days on feed, feed consumed per day, and feed consumed per pound of gain. In Table 4, 5, and 6, heritabilities are shown on the diagonal, genetic correlations are above the diagonal, and phenotypic correlations are below the-diagonal. It should be noted that this is a very small data set for estimating variance components. Values for heritabilities and correlations can be expected to change as more data are collected and analyzed.

Tenderness, as measured by Warner-Bratzler shear force, had a heritability of 0.45. This means that approximately forty-five percent of the difference in tenderness between animals in this data set is due to genetic differences, with the remainder due to environment. Literature estimates of this heritability range from about .09 to .53, with an average of approximately .2. The heritability of marbling score was 0.82. This is considerable higher than most literature estimates. The American Angus Association (AAA) Fall 2002 Sire Evaluation reports the heritability of marbling score as 0.36 and of ultrasound intramuscular fat as 0.31. The genetic correlation between shear force and marbling was –0.40. Steaks that had more marbling had less shear force (were more tender). This indicates that producers can improve tenderness by selecting for marbling.

The heritability of feedlot average daily gain (ADG) was 0.56, which is higher that that of 0.20 reported by the AAA for post-weaning growth of bulls and heifers. The heritabilities of feed consumed per day (F/D) and feed consumed per pound of gain (F:G) were 0.26 and 0.25, respectively. The genetic correlation between ADG and F/D was 0.74. Cattle that gained faster ate more feed. The genetic correlation between ADG and F:G was –0.67. Cattle that gained faster used less feed per pound of gain. These large correlations agree with literature estimates. There was no relationship between F/D and F:G. The amount of feed consumed did not affect how efficiently this feed was utilized.

The heritability of 12-13th rib fat and dressing percentage were 0.44 and 0.52 respectively. The heritability

of fat agrees well with the AAA estimates of 0.24 for carcass rib fat, 0.37 for ultrasound rib fat, and 0.41 for ultrasound rump fat. The large heritability for dressing percentage indicates that there may be a genetic component for this trait. However, it is important to remember that the standard error is very large, and makes the estimate not significantly different from zero. More data is needed to more accurately estimate the genetic component of dressing percentage.

Implications

Results from the Iowa Beef Tenderness and Carcass Evaluation Project showed that, in this small data set, tenderness, as measured by Warner-Bratzler shear force, had a heritability estimate of 0.45. The correlation between shear force and marbling was negative and moderate. This means that more highly marbled beef was more tender. To raise cattle that will produce steaks with increased tenderness, producers can select for tenderness from bulls that have been progeny tested, or select for the correlated trait of marbling. There also appears to be a genetic component for feed consumed per day, pounds of feed consumed per pound of gain, and dressing percentage, and these traits should be further researched.

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Table 1. Means, standard deviations, minimums and maximums for kill age (days), average daily gain (lbs/day), hot carcass weight (lbs) dressing percentage, 12-13th rib fat (in), ribeye area (in^2), yield grade, percent retail product, marbling score[a], Warner-Bratzler shear force (lbs), days on feed, feed consumed per day (lbs) and feed:gain (lbs/lb) for 2001 and 2002 data.

	n	mean	std dev	min	max
Kill age	238	417.88	26.42	347	510
Average daily gain	238	3.16	0.44	1.86	4.16
Hot carcass weight	238	695.10	54.42	534	929
Dressing percentage	238	61.41	1.85	55.12	68.16
12-13th rib fat	238	0.48	0.11	0.20	0.85
Ribeye area	238	11.82	1.00	9.1	15.4
Yield grade	238	2.97	0.51	1.56	4.26
Percent retail product	238	63.62	2.02	58.34	69.34
Marbling score	238	572.23	87.47	410	810
Warner-Bratzler shear force	238	5.52	1.00	3.51	8.69
Days on feed	238	147.94	27.12	105	189
Feed consumed/day	238	25.92	4.95	14.23	42.79
Feed : gain	238	7.05	0.81	5.41	10.15

[a] 400s = select, 500s = low choice, 600s = average choice, 700s = high choice, 800s = low prime

Table 2. Means, standard deviations, minimums and maximums for kill age (days), average daily gain (lbs/day), hot carcass weight (lbs) dressing percentage, 12-13th rib fat (in), ribeye area (in^2), yield grade, percent retail product, marbling score[a], Warner-Bratzler shear force (lbs), days on feed, feed consumed per day (lbs) and feed:gain (lbs/lb) for 2001 data.

	n	mean	std dev	min	max
Kill age	136	422.73	29.97	347	510
Average daily gain	136	2.98	0.43	1.86	4.16
Hot carcass weight	136	679.21	48.03	534	806
Dressing percentage	136	61.51	1.73	56.35	66.42
12-13th rib fat	136	0.45	0.11	0.20	0.85
Ribeye area	136	11.83	1.02	9.2	14.4
Yield grade	136	2.81	0.50	1.56	3.88
Percent retail product	136	64.28	1.94	60.07	69.34
Marbling score	136	565.59	84.96	410	810
Warner-Bratzler shear force	136	5.13	0.84	3.51	7.84
Days on feed	136	132.84	23.08	105	167
Feed consumed/day	136	28.83	4.40	19.94	42.79
Feed : gain	136	7.46	0.77	5.72	10.15

[a] 400s = select, 500s = low choice, 600s = average choice, 700s = high choice, 800s = low prime

Table 3. Means, standard deviations, minimums and maximums for kill age (days), average daily gain (lbs/day), hot carcass weight (lbs) dressing percentage, 12-13th rib fat (in), ribeye area (in^2), yield grade, percent retail product, marbling score[a], Warner-Bratzler shear force (lbs), days on feed, feed consumed per day (lbs) and feed:gain (lbs/lb) for 2002 data.

	n	mean	std dev	min	max
Kill age	102	411.41	19.06	359	456
Average daily gain	102	3.39	0.34	2.50	4.09
Hot carcass weight	102	716.27	55.44	558	929
Dressing percentage	102	61.27	1.98	55.12	68.16
12-13th rib fat	102	0.52	0.10	0.25	0.75
Ribeye area	102	11.80	0.98	9.1	15.4
Yield grade	102	3.18	0.45	1.76	4.26
Percent retail product	102	62.74	1.78	58.34	68.17
Marbling score	102	581.08	90.38	420	810
Warner-Bratzler shear force	102	6.03	0.95	4.28	8.69
Days on feed	102	168.07	17.25	154	189
Feed consumed/day	102	22.04	2.27	14.23	27.45
Feed : gain	102	6.51	0.47	5.41	7.64

[a] 400s = select, 500s = low choice, 600s = average choice, 700s = high choice, 800s = low prime

Table 4. Heritabilies (diagonal), genetic correlation (above diagonal), and phenotypic correlation (below diagonal) for Warner-Bratzler shear force (WB) and marbling score(MS).

	WB	MS
WB	0.45 ± 0.57	-0.40
MS	-0.22	0.82 ± 0.67

Table 5. Heritabilies (diagonal), genetic correlations (above diagonal), and phenotypic correlations (below diagonal) for average daily gain (ADG), feed consumed per day (F/D), and feed consumed per pound of gain (F:G).

	ADG	F/D	F:G
ADG	0.56 ± 0.61	0.74	-0.67
F/D	0.67	0.26 ± 0.49	-0.04
F:G	-0.56	0.16	0.25 ± 0.49

Table 6. Heritabilies (diagonal), genetic correlation (above diagonal), and phenotypic correlation (below diagonal) for 12-13th rib fat (FAT) and dressing percentage (DP).

	FAT	DP
FAT	0.44 ± 0.57	-0.57
DP	0.02	0.52 ± 0.60