Preliminary Analysis of Data from 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 tenderness in this data set was .04, and the phenotypic correlation between tenderness and marbling was -0.26. Steers with more intramuscular fat were more tender. The data set used to develop this heritability and correlation is very small. If additional data result in a low estimate, it may not be cost effective to progeny test sires for tenderness.

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,
4. improve Iowa producer knowledge.

Materials and Methods

In order to evaluate tenderness, 94 sire-identified steers were fed at a central test location. They were harvested in two groups and 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. Cattle were placed into contemporary groups based on farm of origin and harvest date. The MIXED procedure of SAS was used to find variance components, and heritabilities, and the GLM procedure of SAS was used to find phenotypic correlations.

Results and Discussion

Tables 1 through 7 show the overall and contemporary group means, standard deviations, minimums and maximums for tenderness, marbling, hot carcass weight, ribeye area, rib fat, percent retail product, and yield grade. In Table 8, heritabilities for the carcass traits are shown on the diagonal, and phenotypic correlations are on the off-diagonal. It should be noted that this is a very small data set. Values for heritabilities and correlations can be expected to change considerably as more data are collected and analyzed. This data set was used to get preliminary estimates that may indicate what the true population parameters are. More data need to be collected and analyzed to find heritabilities and correlations that are accurate. Tenderness, as measured by Warner-Bratzler shear force, had a heritability of .04. This means that approximately four 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. Again, it should be emphasized that this is a small data set, and the estimate of heritability can be expected to change as more information is collected. The heritabilities of marbling and ribeye area are .43 and .34, respectively. These estimates are similar to those reported by other researchers, although a little higher than those used by the American Angus Association in genetic evaluation (marbling h^2 = .37; ribeye area h^2 = .28). In this data set, there was very little sire variance for hot carcass weight and rib fat, which means the heritability estimates were extremely low. A possible explanation is that the steers were harvested as nearly as possible to equal rib fat and equal weight, reducing the variation in these traits. Percent retail product and yield grade showed no sire variance, and therefore, had heritability estimates of zero. Rib fat and hot carcass weight are major factors in calculating both of these values. The low sire variance for rib fat and hot carcass weight could cause the sire variance for percent retail product and yield grade to be very low as well.

The phenotypic correlations between the carcass traits are shown on the off-diagonal of Table 8. Perhaps the most interesting is the correlation of -.26 (P = .0130) between

tenderness and marbling. Because Warner-Bratzler shear force is measured in pounds of force needed to cut through a steak, a lower number (fewer pounds) is more tender. This means that as marbling went up, the pounds of force needed to cut through the steak went down. In other words, more highly marbled steaks were more tender. Percent retail product and yield grade showed significant relationships with hot carcass weight, ribeye area, and rib fat. This was expected, because hot carcass weight, ribeye area, and rib fat are major components in calculating percent retail product and yield grade. Heavier carcasses were associated with decreased retail product and increased yield grade. Larger ribeyes were associated with increased percent retail product and lower yield grade. Increased rib fat was associated with decreased percent retail product and increased yield grade. There was an extremely high negative correlation between percent retail product and yield grade. Increased percent retail product was associated with decreased yield grade. Another interesting relationship is between marbling and rib fat. In this study, there is no significant relationship between subcutaneous and intramuscular fat (see Table 8). This may be due partially to the fact that the steers were harvested at nearly equal levels of rib fat. It could also mean that steers that have greater levels of subcutaneous fat do not necessarily have increased marbling. The American Angus Sire Summary also reports a low phenotypic correlation (r = .16) between marbling and fat thickness.

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 .04. The correlation between shear force and marbling was negative. 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. However, if more data substantiate the low heritability for tenderness in Angus cattle, breeders may not be able to justify the expense associated with measuring this trait because genetic progress will be very slow.

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Table 1. Means, standard deviations, minimums and maximums by contemporary group and overall for Warner-Bratzler shear force (lbs).

Contemporary Group	n	mean	std dev	min	max
farm 1, harvest 1	52	6.17	1.08	4.38	8.49
farm 1, harvest 2	16	5.86	1.45	4.29	9.36
farm 2, harvest 1	7	5.75	.37	5.24	6.21
farm 2, harvest 2	9	4.97	.74	3.66	6.18
farm 3, harvest 1	8	5.37	1.01	3.86	6.60
farm 3, harvest 2	2	4.87	.30	4.66	5.08
overall	94	5.88	1.14	3.66	9.36

Table 2. Means, standard deviations, minimums and maximums by contemporary group and overall for marbling score.

Contemporary Group	n	mean	std dev	min	max
farm 1, harvest 1	52	940.77	90.79	820.00	1340.00
farm 1, harvest 2	16	979.38	76.37	850.00	1110.00
farm 2, harvest 1	7	882.86	69.69	830.00	1010.00
farm 2, harvest 2	9	943.33	51.23	900.00	1030.00
farm 3, harvest 1	8	936.25	60.22	850.00	1020.00
farm 3, harvest 2	2	955.00	63.64	910.00	1000.00
overall	94	943.19	82.62	820.00	1340.00

800s = select; 900s = choice-; 1000s = choice^{o}; 1100s = choice+; 1200s = prime-; 1300s = prime

Table 3. Means, standard deviations, minimums and maximums by contemporary group and overall for hot carcass weight (lbs).

Contemporary Group	n	mean	std dev	min	max
farm 1, harvest 1	52	736.46	59.10	609.00	857.00
farm 1, harvest 2	16	717.06	53.36	592.00	813.00
farm 2, harvest 1	7	714.00	29.06	685.00	752.00
farm 2, harvest 2	9	699.33	50.03	613.00	791.00
farm 3, harvest 1	8	766.13	65.83	684.00	875.00
farm 3, harvest 2	2	785.50	24.75	768.00	803.00
overall	94	731.50	57.58	592.00	875.00

Table 4. Means, standard deviations, minimums and maximums by contemporary group and overall for ribeye area (square inches).

Contemporary Group	n	mean	std dev	min	max
farm 1, harvest 1	52	12.20	.86	10.00	13.80
farm 1, harvest 2	16	11.71	1.02	9.80	13.50
farm 2, harvest 1	7	11.70	.77	10.60	12.70
farm 2, harvest 2	9	11.17	.75	9.80	12.40
farm 3, harvest 1	8	12.08	.85	10.90	13.60
farm 3, harvest 2	2	12.90	.42	12.60	13.20
overall	94	11.99	.92	9.80	13.80

Table 5. Means, standard deviations, minimums and maximums by contemporary group and overall for rib fat (inches).

Contemporary Group	n	mean	std dev	min	max
farm 1, harvest 1	52	.49	.14	.20	.85
farm 1, harvest 2	16	.51	.15	.20	.80
farm 2, harvest 1	7	.54	.10	.40	.70
farm 2, harvest 2	9	.44	.09	.30	.55
farm 3, harvest 1	8	.57	.19	.30	.90
farm 3, harvest 2	2	.50	.07	.45	.55
overall	94	.50	.14	.20	.90

Table 6. Means, standard deviations, minimums and maximums by contemporary group and overall for percent retail product (percent).

Contemporary Group	n	mean	std dev	min	max
farm 1, harvest 1	52	69.64	2.56	63.37	75.82
farm 1, harvest 2	16	69.24	2.62	63.87	73.99
farm 2, harvest 1	7	68.41	2.05	65.60	70.91
farm 2, harvest 2	9	69.93	1.48	68.21	72.82
farm 3, harvest 1	8	68.19	3.84	61.20	73.59
farm 3, harvest 2	2	70.14	1.48	69.09	71.19
overall	94	69.40	2.56	61.20	75.82

Table 7. Means, standard deviations, minimums and maximums by contemporary group and overall for yield grade.

Contemporary Group	n	mean	std dev	min	max
farm 1, harvest 1	52	3.06	.49	1.84	4.06
farm 1, harvest 2	16	3.16	.51	2.39	3.98
farm 2, harvest 1	7	3.27	.46	2.68	3.94
farm 2, harvest 2	9	3.13	.36	2.36	3.58
farm 3, harvest 1	8	3.41	.75	2.19	4.62
farm 3, harvest 2	2	3.01	.40	2.72	3.29
overall	94	3.12	.51	1.84	4.62

Table 8. Heritabilities (diagonal, bold) and phenotypic correlations with P-values (off-diagonal) for carcass traits.

	WB	MS	HCW	REA	FAT	PRP	YG
WB	**.04**						
MS	-.26 .0130**	**.43**					
HCW	-.18 .0966*	.20 .0607*	**.07**				
REA	-.11 .2995	.07 .5182	.34 .0013**	**.34**			
FAT	-.03 .8070	.08 .4600	.36 .0006**	-.03 .7612	**.05**		
PRP	.01 .9402	-.09 .4073	-.30 .0045**	.21 .0505*	-.97 .0001**	**0**	
YG	-.03 .7691	.11 .2925	.47 .0001**	-.41 .0001**	.85 .0001**	-.91 .0001	**0**

WB = Warner-Bratzler shear force
MS = marbling score
HCW = hot carcass weight
REA = ribeye area
FAT = rib fat
PRP = percent retail product
YG = yield grade
** There was a statistically significant relationship between the traits (P < .05).

* There tended to be a relationship between the traits (P < .1).