Evaluation of Implant Strategies in Angus-sired Steers with High and Low Genetic Potential for Marbling and Gain

D.N. Black[1], B.W. Neville[2], M.R. Crosswhite[1] and C.R. Dahlen[1]
[1]Department of Animal Sciences, NDSU; [2]CGREC, NDSU

The purpose of this project was to access how implant strategies influence cattle with different genetic potential. Implant strategies can affect feedlot performance and carcass characteristics at different points throughout the feeding period. Marbling in steers of high genetic potential appears to be more sensitive to implant strategy than marbling in steers of low genetic potential.

Summary

Sixty-nine Angus-sired steer calves (initial BW = 732.7 pounds) were used to determine the effects of moderate and aggressive implant strategies on steers of high and low genetic potential (GP) using the GeneMax (Zoetis, Florham Park, N.J.) genetic profiling test. Steers were assigned to treatments in a 2 x 2 factorial design with factors of 1) composite GP score [high (HI), mean score of 86.5, n = 35, or low (LO), mean score of 25.3, n = 34]; and 2) implant strategy [aggressive (AGG) or moderate (MOD)].

All steers were given the same implant (Revalor-S, Merck Animal Health, Summit, N.J.) with the AGG group implanted on day 0 and day 70, and the MOD group only on day 70. A high-concentrate (84.5 percent) diet was fed *ad libitum* once daily. Ultrasound was used to measure body composition characteristics on day 0. Steers were harvested after 140 days on feed. On day 0, HI steers had a greater ($P < 0.001$) percent of intramuscular fat than LO steers.

Throughout the entire 140-day feeding period, we found no differences ($P \geq 0.6$) in body weight (BW), average daily gain (ADG), dry matter intake (DMI) or gain-to-feed ratio (G:F) between GP groups; however, AGG steers had greater ($P = 0.03$) ADG, compared with MOD steers, while still having similar ($P \geq 0.12$) DMI and G:F. The marbling score tended ($P = 0.06$) to be impacted by a GP x implant strategy interaction (492.9, 538.3, 481.1, 463.7 for HI AGG, HI MOD, LO AGG and LO MOD, respectively). No differences ($P \geq 0.7$) were observed between GP groups for hot carcass weight (HCW); longissimus muscle (LM) area; rib fat thickness; kidney, pelvic, and heart fat (KPH); or yield grade.

Steers in the MOD group had less ($P = 0.003$) rib fat thickness than AGG steers, but similar ($P \geq 0.14$) HCW, marbling, LM area, KPH and yield grade. Steers in the HI GP group were more likely ($P = 0.03$) to grade choice (100 percent) than LO steers (88 percent).

Results of this study indicate that genetic potential tests, specifically GeneMax, may be indicative of marbling potential and quality grades. The overall quality grades observed indicates that managing cattle with poor genetic potential to achieve acceptable performance may be possible.

Introduction

Hormone implants have been used since the 1950s (Preston, 1999) in beef production to improve performance and lower the cost of production (Duckett *et al*. 1997; Wileman *et al*. 2009). A variety of implants are available, with varying potencies, depending on their active ingredient and dosage (Montgomery *et al*. 2001).

Elevated circulating concentrations of hormones and subsequent growth promotion occur soon after implant placement and decline as the implant dissolves (Reinhardt 2007). To offset the decline in growth promotion, cattle can be placed on an aggressive implant regime whereby an additional implant can be applied to foster additional growth and feed efficiency (Samber *et al*. 1996; Parr *et al*. 2011). Unfortunately, aggressive implant strategies can result in decreased marbling scores, compared with more moderate implant strategies (Samber *et al*. 1996; Duckett *et al*. 1997; Platter *et al*. 2003; Parr *et al*. 2011).

As our knowledge of the bovine genome expands, a larger variety of genetic tests have become available to predict an animal's genetic potential to express economically important traits. Although DeVuyst *et al*. (2011) found a positive correlation between Igenity (Neogen, Lansing, Mich.) marbling markers and actual quality grade of feedlot steers, further evaluations of observed phenotype in animals with different genotypes are needed. In addition, a paucity of information is available regarding the feedlot performance and carcass characteristics of cattle with varying genetic potential when exposed to different implant strategies.

Perhaps the early indication of genetic potential for growth and marbling available via genetic testing can be paired with an optimal implant strategy to maximize feedlot profitability. This study was conducted to evaluate the effects of moderate and aggressive implant strategies in Angus-sired steers with varying genetic potentials for gain and marbling using the GeneMax test (Zoetis, Florham Park, N.J.).

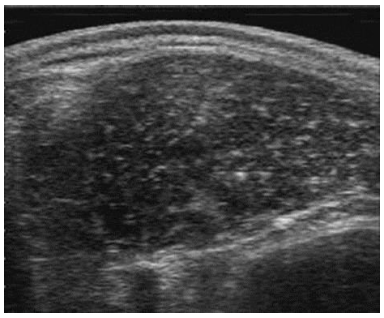
Procedures

All procedures were conducted within the guidelines and approval of the North Dakota State University Institutional Animal Care and Use Committee.

Animals and treatments. At the time of weaning, blood samples were collected via jugular venipuncture from 114 Angus-sired steers originating from North Dakota State University's Central Grasslands Research Extension Center in Streeter, N.D., and submitted to Angus Genetics Inc. (St. Joseph, Mo.) for determination of GeneMax score. GeneMax scores represent the genetic potential (GP) for post-weaning gain and marbling in Angus-based calves. Individual scores for gain and marbling (each reported in quintiles; 1 to 5) are used to calculate a composite score ranging from 1 to 100, with 1 being the least and 100 being the greatest GP. Sixty-nine steers (average age = 10 months, initial BW = 732.7 pounds) representing the highest (HI, n = 35) and lowest (LO, n = 34) composite GP scores were selected from the original population and assigned to treatments in a 2×2 factorial arrangement with factors of GP and implant strategy (moderate, MOD, or aggressive, AGG). Steers were paired according to composite GP and BW and pairs were assigned randomly to each of two implant treatments.

The four treatment groups were as follows: 1) HI with AGG implant (HI AGG, n = 17), 2) HI with MOD implant (HI MOD, n = 18), 3) LO with an AGG implant (LO AGG, n = 18), and 4) LO with MOD implant (LO MOD, n = 16). Implants administered in all instances contained 120 milligrams (mg) of trenbolone acetate (TBA) and 24 mg of estradiol (E_2) (Revalor-S, Merck Animal Health, Summit, N.J.). Steers in the AGG group were implanted on days 0 and 70, whereas steers in the MOD group were implanted only on day 70.

Steers were fed individually once daily at 6:30 a.m. using a Calan gate feeding system (American Calan, Northwood, N.H.) and had continual access to water. The finishing diet was 85 percent concentrate, contained 1.25 megacalories per kilogram (MCal/kg) for net energy gain (NEg) and 17.2 percent crude protein, and was fed ad libitum. Orts were collected weekly and weighed for determination of DMI.



The start weight of the steers was the average of two consecutive days' weights. The percentage of intramuscular fat (IMF) was determined at the initiation of the experiment (day 0) using ultrasonography (Aloka 500V equipped with a 3.5-MHz, 17 centimeter [cm] linear array transducer, Wallingford, Conn.; Wall *et al*. 2004).

After 140 days on feed, all steers were transported and processed in a commercial abattoir. After routine processing procedures, HCW was collected and carcasses were chilled for 24 hours (35° F) before determining LM area, 12th rib fat depth (RF), yield grade (YG), quality grade, marbling number and KPH. Final BW was calculated using the HCW adjusted to a common dressing percent of 63.4 percent. All ADG and G:F calculations were made using the carcass-adjusted final weight.

Statistical analysis. The GLM procedure of SAS (SAS Inst. Inc., Cary, N.C.) was used to analyze all continuous data, whereas the GEN MOD procedure was used for binomial data. The models contained GP group (HI or LO), implant strategy (MOD or AGG) and the respective interaction, with steer being the experimental unit. Means were separated with the least significant difference procedure and were considered significant at $P \leq 0.05$.

Results and Discussion

Genetic potential scores. By design, composite GP scores for HI steers (86.5 ± 1.7) were higher ($P < 0.001$) than LO steers (25.3 ± 1.7). In addition, marbling score was higher ($P < 0.001$) for HI steers (3.7± 0.1) than LO steers (1.4 ± 0.1), and gain scores were higher ($P < 0.001$) for HI steers (3.83 ± 0.2) than LO steers (2.88± 0.2).

Ultrasound intramuscular fat. At the start of the experiment, HI steers had a higher percentage of intramuscular fat ($P = 0.001$) than LO steers (Table 1). We have found no other reports of diverging IMF percentage being observed in steers of differing genetic potentials before they are placed onto finishing diets.

Table 1. Effect of genetic potential and implant strategy on feedlot performance of Angus based steers.

	Genetic Potential[1]		Implant Group[2]		
Item	**Low**	**High**	**Moderate**	**Aggressive**	**SE**
Day 0 Intramuscular fat, %	3.26[x]	3.83[y]	3.58	3.52	0.09
Start BW, lbs	730.3	721.0	726.5	725.0	9.83
Final BW, lbs[3]	1281.5	1273.8	1261.5	1293.5	15.08
ADG, lbs/day	3.92	3.95	3.81[x]	4.06[y]	0.009
DMI, lbs/day	21.23	21.12	20.95	21.43	0.24
G:F	0.19	0.19	0.18	0.19	0.003

[1]Low = mean genetic potential score, 86.5; High = mean genetic potential score, 25.3. Determined using GeneMax, Zoetis, Florham Park, NJ
[2]Moderate = steers implanted on day 70; Aggressive = steers implanted day 0 and day 70, all implants contained 120 mg of TBA and 24 mg of E_2 (Revalor-S, Merck Animal Health, Summit, NJ)
[3]Calculated as HCW divided by 0.634 (average dressing percentage)
[xy]Means within factor and row differ ($P < 0.05$)

Overall, 25 percent of steers had IMF of ≥ 4 percent (the anticipated value needed to be considered for a choice carcass), with a greater proportion ($P = 0.01$) of steers in the HI group (36.8 percent) having IMF of ≥ 4 percent, compared with LO steers (11.8 percent). These observations support the concept that IMF deposition is a lifetime event (Bruns *et al*. 2004; Wall *et al*. 2004; Rhoades *et al*. 2009). The observation of differing IMF percentages between GP groups before being placed on feed may foreshadow potential differences in marbling at the conclusion of the finishing period.

Feedlot Performance. No differences ($P \geq 0.60$) were observed between GP groups in final BW, ADG, DMI or G:F (Table 1) in spite of the HI steers having greater genetic potential for gain than LO steers (3.8 and 2.9 for HI and LO, respectively). DeVuyst *et al*. (2011) also failed to observe a phenotype effect in steer gain with different Igenity (Merial Ltd.) panel scores. Taken together, three possibilities exist: 1) genetic evaluations do not accurately separate cattle into distinct gain groups, 2) greater divergence in GP scores for gain are required to observe a phenotypic gain response or 3) greater experimental power is required to observe a phenotypic gain response.

No differences ($P \geq 0.12$) were observed in final BW, DMI or G:F between MOD and AGG implant strategies. Guiroy *et al*. (2002) also did not observe a difference in feed efficiency between implant treatments when steers were given a delayed implant (Revalor-S) on day 90 or an implant on days 0 and 90.

Table 2. Effect of genetic potential and implant strategy on carcass composition of Angus based steers after 140 days on feed.

	Genetic Potential[1]		Implant Group[2]		
Item	**Low**	**High**	**Moderate**	**Aggressive**	**SE**
HCW, lbs	818.9	814.1	799.8	820.3	9.59
LM Area, in^2	13.7	13.6	13.7	13.6	0.17
RF[3], in	0.54	0.53	0.47[x]	0.60[y]	0.03
KPH, %	2.35	2.34	2.33	2.37	0.05
Yield Grade	3.35	3.33	3.19[x]	3.50[y]	0.07
Quality Grade, % Choice	87.8[x]	100[y]	90.6	97.2	0.04

[1]Low = mean genetic potential score, 86.5; High = mean genetic potential score, 25.3. Determined using GeneMax, Zoetis, Florham Park, NJ
[2]Moderate = steers implanted on day 70; Aggressive = steers implanted day 0 and day 70, all implants contained 120 mg of TBA and 24 mg of E_2 (Revalor-S, Merck Animal Health, Summit, NJ)
[3]Carcass rib fat thickness
[xy]Means within factor and row differ ($P < 0.05$)

Table 3. Effect of genetic potential[1] × implant strategy[2] interaction on marbling score and carcasses qualifying for Certified Angus Beef of Angus based steers after 140 day on feed.[3]

	Treatment group[4]				
Item	**HIAGG**	**HIMOD**	**LOAGG**	**LOMOD**	**SE**
Marbling Score[4]	492.9^{x}	538.3^{y}	481.1^{x}	463.8^{x}	16.7
Certified Angus Beef, %	35.3^{x}	66.7^{y}	33.3^{x}	25.0^{x}	0.11

[1]Genetic potential (GP) determined using GeneMax, Zoetis, Florham Park, NJ
[2]Moderate = steers implanted on day 70; Aggressive = steers implanted day 0 and day 70, all implants contained 120 mg of TBA and 24 mg of E_2 (Revalor-S, Merck Animal Health, Summit, NJ)
[3] Marbling score GP × Implant strategy ($P = 0.08$); % Certified Angus Beef GP × Implant strategy ($P = 0.06$)
[4]HIAGG: Average GP score of 86.4, received implant on day 0 and day 70; HIMOD: Average GP score of 86.5, received implant on day 70; LOAGG: Average GP score of 25.8, received implant on day 0 and day 70; LOMOD: Average GP score of 24.8, received implant on day 70
[4]Marbling Score based on $Small^{00} = 400$
^{xy}Means in the same row lacking a common superscript differ ($P \leq 0.05$)

In the current study, steers in the AGG group had greater overall ADG ($P = 0.03$) than MOD steers; however, this appears to be strictly a result of increased ADG during the first 70 days (data not shown) when MOD steers did not have the growth-promoting benefits of an implant. The observed difference in ADG is similar to findings of Guiroy *et al*. (2002), who reported steers given two implants gained more per day than those given one delayed implant.

Carcass characteristics. No differences ($P \geq 0.28$) were observed between GP groups in HCW, LM area, RF, KPH percent or YG. (Table 2). A greater proportion ($P = 0.03$) of steers in the HI group had choice carcasses (100 percent), compared with LO steers (87.8 percent). Interestingly, a tendency for an interaction ($P \leq 0.08$) between GP and implant factors was present for marbling score and proportion of carcasses qualifying for the Certified Angus Beef (CAB) program (Table 3).

Marbling score and percent of CAB were reduced by the AGG implant strategy in HI steers but the same effect was not present in LO steers. Previous research has reported a further reduction in marbling score when re-implanting or using a more aggressive implant, compared with more moderate regimens (Samber *et al*. 1996; Duckett *et al*. 1997; Platter *et al*. 2003). Duckett *et al*. (1997) reported a 2.5 percent reduction in marbling when implanting with a combination TBA/E_2 implant rather than a single estrogen, and a 4.3 percent reduction when utilizing two combination implants, compared with a single combination implant.

DeVuyst *et al*. (2011) reported that greater Igenity marbling panel scores correlated with improved quality grades. Contrary to our results, Johnston and Graser (2010) did not find association between GeneSTAR (Zoetis) marbling markers and carcass marbling score.

Results from the current study would indicate that cattle of differing GP may be managed differently to attain desirable quality grades. Steers with greater GP, based on GeneMax score, achieve greater marbling scores when implanted once, compared with receiving two implants. Cattle of lesser GP can be given two implants to reap full benefits of an implants growth potential without negatively impacting marbling scores. Steers in the AGG group had thicker ($P = 0.003$) RF and greater ($P = 0.003$) yield grades than MOD steers, and no differences ($P \geq 0.14$) were observed in HCW, marbling, LM area or KPH.

Considerable variability exists in other reports of carcass characteristics of cattle managed under moderate and aggressive implant strategies (Duckett *et al*. 1997; Scaglia *et al*. 2004). The thicker RF seen in the AGG treatment is something not expected because previous work reported that more aggressive implants result in thinner RF (Parr *et al*. 2011).

In the current study, all cattle were harvested on a common date. In a commercial setting where cattle are marketed at a certain degree of finish, however, the AGG steers would be market-ready before the MOD steers, resulting in fewer overall days on feed. Perry *et al*. (1991) compared steers implanted with Revalor-S with non-implanted controls and found that when slaughtering on an individual basis (when ultrasound predicted a small degree of marbling), implanted cattle had fewer days on feed than non-implanted steers.

After cattle have reached physiological maturity, caloric intake above maintenance requirements will be partitioned in the form of adipose tissue rather than protein (Andrews 1958), at least partly explaining the greater amount of RF observed in the AGG implant group, compared with the MOD implant group.

Conclusion

Results of this study indicate that commercially available predictions of genetic potential can be indicative of marbling potential and quality grades. Steers with high genetic potential had a higher percentage of intramuscular fat before consuming high-concentrate diets and improved marbling scores and quality grade at slaughter compared with low genetic potential steers. The difference in intramuscular fat on day 0 between genetic potential groups indicates that marbling accretion occurs before steers are being fed high-concentrate diets.

The overall quality of carcasses in the current study indicates that producers may be able to adopt management strategies that result in acceptable performance of cattle with poor genetic potential. More aggressive implant strategies can affect feedlot performance and carcass characteristics at different points throughout the feeding period, but carcass marbling in steers of greater genetic potential appears to be more sensitive to implant strategy than that of steers with lesser genetic potential for marbling.

Literature Cited

Andrews, F.N. 1958. Fifty years of progress in animal physiology. J. Anim. Sci. 17:1064-1078.

Bruns, K.W., R.H. Pritchard and D.L. Boggs. 2004. The relationships among body weight, body composition, and intramuscular fat content in steers. J. Anim. Sci. 82:1315-1322.

DeVuyst, J.T. Biermacher, J.L. Lusk, R.G. Mateescu, J.B. Blanton Jr., J.S. Swigert, B.J. Cook and R.R. Reuter. 2011. Relationships between fed cattle traits and Igenity panel scores. J. Anim. Sci. 89:1260-1269.

Duckett, S.K., F.N. Owens and J.G. Andrae. 1997. Effects of implants on performance and carcass traits of feedlot steers and heifers. Pages 63-82 in Impacts of Implants on Performance and Carcass Value of Beef Cattle Symposium. Oklahoma Agric. Exp. Stn. P-957. Tulsa, Okla.

Guiroy, P.J., L.O. Tedeschi, D.G. Fox and J.P. Hutcheson. 2002. The effects of implants strategy on finishing body weight of beef cattle. J. Anim. Sci. 80:1791-1800.

Johnston, D.J., and H.-U. Graser. 2010. Estimated gene frequencies of GeneSTAR markers and their size of effects on meat tenderness, marbling, and feed efficiency in temperate and tropical beef cattle breeds across a range of production systems. J. Anim. Sci. 88:1917-1935.

Montgomery, T.H., P.-F. Dew and M.S. Brown. 2001. Optimizing carcass value and the use of anabolic implants in beef cattle. J. Anim. Sci. 79:E296-E306.

Parr, S.L., K.Y. Chung, J.P. Hutcheson, W.T. Nichols, D.A. Yates, M.N. Streeter, R.S. Swingle, M.L. Galyean and B.J. Johnson. 2011. Dose and release pattern of anabolic implants affects growth of finishing beef steers across days on feed. J. Anim. Sci. 89:863-873.

Perry, T.C., D.G. Fox and D.H. Beermann. 1991. Effect of an implant of trenbolone acetate and estradiol on growth, feed efficiency, and carcass composition of Holstein and beef steers. J. Anim. Sci. 69:4696-4702.

Platter, W.J., J.D. Tatum, K.E. Belk, J.A. Scanga and G.C. Smith. 2003. Effects of repetitive use of hormonal implants on beef carcass quality, tenderness, and consumer ratings of beef palatability. J. Anim. Sci. 81:984-996.

Preston, R.L. 1999. Hormone containing growth promoting implants in farmed livestock. Adv. Drug Deliv. Rev. 38:123-138.

Reinhardt, C. 2007. Growth-promotant implant: Managing the tools. Vet. Clin. Food Anim. 23:309-319.

Rhoades, R.D., C.H. Ponce, S.B. Smith, A.D. Herring, L.O. Tedeschi, D.K. Lunt, D.T. Dean, F.R. Ribeiro, C.W. Choi, D.G. Riley and J.E. Sawyer. 2009. Evaluation of growth-based predictions of carcass fat and marbling at slaughter using ultrasound measurements. Professional Animal Scientist 25:434-442.

Samber, J.A., J.D. Tatum, M.I. Wray, W.T. Nichols, J.B. Morgan and G.C. Smith. 1996. Implant program effects on performance and carcass quality of steer calves finished for 212 days. J. Anim. Sci. 74:1470-1476.

Scaglia, G., L.W. Greene, F.T. McCollum, N.A. Cole and T.H. Montgomery. 2004. Effects of delaying implant and programmed rate of gain on performance and carcass characteristics of yearling beef steers. Professional Animal Scientist. 20:170-177.

Wall, P.B., G.H. Rouse, D.E. Wilson, R.G. Tait Jr. and W.D. Busby. 2004. Use of ultrasound to predict body composition changes in steers at 100 and 65 days before slaughter. J. Anim. Sci. 82:1621-1629.

Wileman, B.W., D.U. Thomson, C.D. Reinhardt and D.G. Renter. 2009. Analysis of modern technologies commonly used in beef cattle production: Conventional beef production versus nonconventional production using meta-analysis. J. Anim. Sci. 87:3418-3426.

Photos by Carl Dahlen