Lifetime Implant Strategies: Effects on Beef Carcass Quality Characteristics

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SUMMARY

This study compared the effects of 10 different lifetime implant treatments and a non-implanted control on beef quality and carcass traits of crossbred steer calves (n=550). Carcasses of steers in the control group had higher marbling scores ($P<.05$) than did carcasses from steers in all other treatment groups. Implanting at branding, weaning, or backgrounding did not affect marbling scores. The number of implants administered during the lifetime of steers affected ($P<.05$) marbling score. Treatment of steers with only 2 implants resulted in carcasses that had higher mean marbling scores compared with marbling scores for carcasses of steers treated with 4 or 5 implants. Administering implants to steers in this study increased ($P<.05$) average daily gain by 11.8 to 20.5% from weaning to harvest when compared to the non-implanted controls. All implant strategies increased ($P<.05$) hot carcass weight of steers compared to the control group. Similar increases in carcass weight were observed for all lifetime implant protocols with three or more implants. Implanting steers increased ($P<.05$) REA and decreased ($P<.05$) the estimated percentage of kidney/pelvic/heart fat. Implant strategy did not affect dressing percentage or adjusted fat thickness. Implanting steers had a tendency to decrease calculated USDA yield grade as implanting steers with 9 out of 10 implant strategies decreased yield grades.

KEY WORDS: Beef, Implants, Quality, Carcass Traits

INTRODUCTION

The production benefits of using implants to improve growth performance of cattle are well documented. However, both the 1991 and 2000 National Beef Quality Audits identified "reduced quality of beef due to implants" as one of the packing industry's top six quality challenges facing the beef industry (Smith et al., 1992; Roeber et al., 2000). This study was designed to examine the additive effects of repetitive implant use throughout a beef animal's lifetime on beef carcass quality traits.

MATERIALS AND METHODS

Animals

Crossbred steer calves (n=550) obtained from 5 ranches (in different geographical regions of the U.S and representing a variety of breeds and breed crosses) were used in this study. The experimental design is presented in Table 1. Steers were allocated either to one of ten different lifetime implant treatments or to an untreated negative control group in a randomized, complete-block experimental design with ranch serving as the block effect and individual animals as the experimental unit. Cattle were implanted, according to their respective treatments, at any or all of five phases of production (branding, weaning, backgrounding, feedlot entry and re-implanting in the finishing phase). In addition to the individual treatment comparisons, the experimental design of this study allowed for contrasts of treatments that differed only by their respective implant protocols (receiving implants or not receiving implants) at each of the branding, weaning, and backgrounding phases of production. The design of this study also provided an opportunity to analyze the effects of the number of implants (0, 2, 3, 4, or 5 implants) administered throughout the lifetime of steers, independently, regardless of timing of implanting.

Cattle Management

Steers at each ranch were castrated at branding and remained with their dams until weaning at approximately 240 days of age. Within two weeks after weaning, steers from each ranch were transported to the same commercial feedlot in Eastern Colorado for growing and finishing. Steers from each ranch were placed in large pens (one pen per ranch) and started on a 25% concentrate grower diet (15% crude protein) for the weaning (45 to 48 days) and backgrounding phases (64 to 102 days) of production. Dates for the initiation of the finishing phase (termination of the backgrounding phase) for each pen were determined by back-calculating 150 days from a projected slaughter date for all of the steers derived from each ranch. At the initiation of the finishing phase steers were started on a 6-level "step-up" diet in which the concentrate level of the grower diet was gradually increased, over a two-week period, resulting in a finishing diet (13.1% crude protein) that consisted of 67% dry rolled corn, 15% distiller's grain (wet), 10% beet pulp, 5% liquid supplement and 2.5% ground alfalfa hay. Dates for re-implanting during the finishing phase were determined for steers from each ranch by back-calculating 80 days from a projected slaughter date for all steers derived from each ranch.

Steers were harvested when they attained 12 to 16 mm of fat thickness over the longissimus muscle at the 12^{th} rib (measured using real time ultrasound). Because of the difference in age and biological type of the steers obtained from each ranch not all ranches were represented at each harvest date. However, harvest groups from each ranch consisted of steers from all eleven treatment groups.

Carcass Evaluation

On each harvest date, steers in each harvest group were transported to a commercial beef packing plant and harvested using conventional procedures. Following a 36 hr carcass-chilling period, a panel of three Colorado State University personnel independently obtained carcass grade data. Each evaluator recorded measurement/assessments of fat thickness, ribeye area, percentage of kidney, pelvic and heart fat, lean maturity and marbling score for each carcass. Values for each trait from the three evaluators were averaged, resulting in a single value for each factor for each carcass.

Statistical Analysis

Analyses of carcass data were conducted using the least squares mixed model procedure of SAS (1998). In all analyses, individual animals were used as the experimental units. The statistical model included Treatment as the independent fixed effect and Ranch (a block effect) and Ranch by Treatment, Harvest date (Date), Date within Ranch and Treatment by Date within Ranch as random effects. When *F*-tests were significant ($P < .05$), multiple comparisons of treatment means were performed using paired comparison t-tests. Frequency distributions of USDA quality grades (Choice and Prime and upper two-thirds Choice and Prime) among control and treatment groups were compared using the Chi-square test of SAS (1998). If the overall Chi-square analysis was significant, Fisher's exact test of SAS was used to separate the percentages. Contrasts comparing the effects of implanting at branding, weaning, and backgrounding were performed using the contrast statement in the mixed model analysis of SAS (1998).

RESULTS

Carcass Quality Traits

Mean marbling scores and USDA quality grade distributions for each treatment group are presented in Table 1. Carcasses of steers in the control group had higher (P<.05) marbling scores than did carcasses of steers in all other treatment groups. Steers in treatment 2, which were not implanted prior to the finishing phase, produced carcasses that had higher (P<.05) marbling scores when compared to steers that received some of the more aggressive lifetime implants strategies such as treatments 6, 7, and 11. The number of implants administered during the lifetime of steers affected (P<.05) marbling score. Steers receiving only 2 implants produced carcasses that had higher marbling scores than did steers treated with 4 or 5 implants (Table 2). Implanting at branding at branding, weaning or backgrounding did not affect marbling scores (Table 3).

The percentage of carcasses grading Choice and Prime (range 56 to 82%) did not differ among treatments (Table 1). However, the frequency distribution of USDA quality grades within the Choice and Prime grades was shifted slightly as a result of the administration of some implant strategies. Within the control group, 54% of the steers produced carcasses that graded upper two-thirds Choice and Prime which was higher than the percentage of carcasses with the same grade classifications in treatments 3, 7, 9, and 11 (Table 1). Steers in treatment 2 produced a higher (P<.05) percentage of carcasses grading upper two-thirds Choice and Prime when compared to steers subjected to treatment 11 (36 versus 14%; Table 1).

The percentage of carcasses grading Choice and Prime was higher (P<.05) for non-implanted steers when compared to carcasses of steers implanted four or five times (Table 2). Similarly, the percentage of carcasses grading upper two-thirds Choice and Prime was higher (P<.05) for non-implanted steers when compared to carcasses of steers implanted three, four, or fives times (Table 2). Implanting steers 5 times decreased (P <.05) the percentage of carcasses grading upper two-thirds Choice and Prime when compared to implanting steers two times (Table 2; 21.4% verses 36%).

Production and Carcass Traits

Least squares means for carcass traits by treatment are presented in Table 4. Administering implants to steers in this study increased (P<.05) average daily gain (ADG) by 13.0 to 22.2% from weaning to harvest when compared to the non-implanted controls. All treatment groups receiving implants had heavier (P <.05) hot carcass weights (adjusted to a common fat thickness) than did the control group. Branding implants had no effects on hot carcass weight; however, weaning implants increased (P<.05) and backgrounding implants tended (P=.078) to increase hot carcass weights (Table 3). Administering 5 implants throughout a steer's lifetime increased (P<.05) hot carcass weight compared to the use of only two implants (Table 2). Implanting steers increased (P<.05) REA and decreased (P<.05) the estimated percentage of kidney/pelvic/heart fat (Table 4). Implant strategy did not affect dressing percentage or adjusted fat thickness. Steers in the non-implanted group had higher (P<.05) calculated USDA yield grades than steers for all other treatments except for those in treatment 5 (Table 4).

IMPLICATIONS

In this study, the most appreciable reduction in intramuscular fat deposition was associated with the use of implants during the finishing phase of production. Results of this study suggest that administration of implants before feedlot entry results in only marginal effects on beef carcass quality. However, aggressive lifetime implant protocols, requiring four or five implants, may be detrimental to beef carcass quality. These findings emphasize the need for the development of lifetime implant protocols that enhance cattle performance without adversely affecting beef carcass quality.

LITERATURE CITED

Smith, G.C., J.W. Savell, R.P. Clayton, T.G. Field, D. B. Griffin, D.S. Hale, M.F. Miller, T.H. Montgomery, J. B. Morgan, J. D. Tatum and J.W. Wise. 1992. Improving the consistency and competitiveness of beef. The Final Report of the National Beef Quality Audit – 1991. National Cattlemen's Association, Englewood, CO.

Roeber, D.L., D.R. McKenna, P.K. Bates, T.B. Schmidt and K.E. Belk. 2000. Producer, packer, retailer and restaurateur responses to questionnaires. In: Final Report: The National Beef Quality Audit-2000. National Cattlemen's Association, Englewood, CO.

Table 1. Experimental design and adjusted (to the mean external fat thickness) least squares means of expert marbling scores and USDA Quality Grade distribution

	Lifetime Implant Protocol[a]							Frequency of Quality Grade	
Treatment	BRAND	WEAN	BACK	ENTRY	RI	N	MARB[b]	% Choice and Prime	% Premium Choice[c] and Prime
1	N	N	N	N	N	50	538^{w}	82^{w}	54^{w}
2	N	N	N	S	REV	50	485^{x}	70^{w}	36^{wx}
3	N	N	RA	S	REV	50	465^{xy}	74^{w}	24^{xy}
4	N	N	S	S	REV	50	454^{xyz}	64^{w}	26^{wxy}
5	C	N	S	N	REV	50	464^{xyz}	68^{w}	26^{wxy}
6	N	RA	S	S	REV	50	439^{yz}	56^{w}	26^{wxy}
7	C	N	RA	S	REV	50	442^{yz}	60^{w}	22^{xy}
8	C	N	S	S	REV	50	457^{xyz}	62^{w}	26^{wxy}
9	C	RA	RA	S	REV	50	460^{xyz}	72^{w}	22^{xy}
10	C	RA	S	S	REV	50	453^{xyz}	64^{w}	28^{wxy}
11	C	RA	S	REV	REV	50	430^{z}	60^{w}	14^{y}

[a]Implant protocol with respect to phase of production and product administered. Abbreviations used: BRAND = branding; WEAN =weaning; BACK = backgrounding; ENTRY = feedlot entry; RI = re-implant; N = no implant; C = Synovex-C®; RA = Ralgro®; S = Synovex-S®; REV = Revalor-S®.

[b]MARB = expert marbling score, adjusted to a common fat thickness. Unadjusted expert marbling scores were: 541, 481, 464, 454, 462, 435, 443, 453, 461, 451 and 431 for treatments 1, 2, 3, 4, 5, 6, 7, 8, 9, 10 and 11, respectively. 400 = small, 500 = modest.

[b]Average and high Choice

[wxyz]Means in the same row lacking a common superscript letter differ (P <.05).

Table 2. Least squares means of implant strategies differing by number of implants administered

	Means by number of implants administered				
Trait	0	2	3	4	5
Marbling score[a]	538^{x}	485^{y}	461^{yz}	447^{z}	447^{z}
% Choice and Prime	82.0^{x}	70.0^{xy}	68.7^{xy}	59.3^{y}	65.3^{y}
% Upper 2/3 Choice and Prime	54.0^{x}	36.0^{xy}	25.3^{yz}	24.7^{yz}	21.4^{z}
Adj. HCW, lbs	716^{z}	785^{y}	802^{xy}	804^{xy}	811^{x}

[a] Adjusted to a common fat thickness; 300 = slight, 400 = small, 500 = modest.

[b]Adj. HCW = hot carcass weight (adjusted to a common fat thickness).

[xyz]Means in the same row lacking a common superscript letter differ (P < .05).

Table 3. Probabilities of significance of contrasts for means of implant strategies differing by phase of production									
	Least squares means						*P* of contrasts		
Trait	Branding		Weaning		Backgrounding		Branding	Weaning	Backgrounding
	No	Yes	No	Yes	No	Yes	Yes/No	Yes/No	Yes/No
Adj. Marbling score[a]	453	451	451	451	485	460	.825	.936	.087
Adj. HCW[b], lbs	809	801	795	812	784	804	.302	.022	.078

[a]Adjusted to a common fat thickness; 300 = slight, 400 = small, 500 = modest
[b]HCW = hot carcass weight (adjusted to a common fat thickness).

Table 4. Least squares means for carcass traits												
	Experimental treatment group[a]											
Trait[b]	1	2	3	4	5	6	7	8	9	10	11	SEM
ADG[c], WW to FW (lb^{-1}/day^{-1})	2.61[y]	2.95[x]	3.15[vw]	3.13[vw]	3.09[vw]	3.19[v]	3.06[wx]	3.04[wx]	3.09[vw]	3.11[vw]	3.06[wx]	.108
HCW[c], lbs	716[y]	784[x]	808[vwx]	799[vwx]	793[wx]	819[v]	795[vwx]	790[x]	800[vwx]	817[vw]	806[vwx]	10.7
Dressing %[c]	62.4[v]	63.0[v]	62.8[v]	62.9[v]	62.2[v]	63.1[v]	62.8[v]	62.5[v]	62.8[v]	63.0[v]	63.2[v]	.270
FT, in	.64[v]	.59[v]	.60[v]	.60[v]	.58[v]	.58[v]	.60[v]	.58[v]	.61[v]	.59[v]	.61[v]	.031
REA[c], in^2	11.7[z]	12.9[xy]	13.2[vwx]	13.0[vwxy]	12.6[y]	13.4[v]	13.2[vwx]	12.8[xy]	12.9[wxy]	13.1[vwx]	13.3[vw]	.188
KPH %[c]	2.52[v]	2.29[w]	2.16[wxy]	2.12[xy]	2.26[wx]	2.18[wxy]	2.15[wxy]	2.17[wxy]	2.13[xy]	2.07[y]	2.15[wxy]	.058
YG[c]	3.43[v]	3.27[wx]	3.24[x]	3.25[x]	3.38[vw]	3.22[x]	3.19[x]	3.30[wx]	3.28[wx]	3.27[wx]	3.19[x]	.120

[a]Implant strategy with respect to products administered: 1 = no/no/no/no/no (control); 2 = no/no/no/Synovex-S®/Revalor-S®; 3 = no/no/Ralgro®/Synovex-S®/Revalor-S®; 4 = no/no/Synovex-S®/ Synovex-S®/ Revalor-S®; 5 = Synovex-C®/no/ Synovex-S®/no/ Revalor-S®; 6 = no/ Ralgro®/Synovex-S®/ Synovex-S®/Revalor-S®; 7 = Synovex-C®/no/ Ralgro®/Synovex-S®/Revalor-S®; 8 = Synovex-C®/no/ Synovex-S®/ Synovex-S®/Revalor-S®; 9 = Synovex-C®/ Ralgro®/ Ralgro®/ Synovex-S®/ Revalor-S®; 10 = Synovex-C®/ Ralgro®/ Synovex-S®/ Synovex-S®/Revalor-S®; 11 = Synovex-C®/ Ralgro®/ Synovex-S®/ Revalor-S®/ Revalor-S®.
[b]Abbreviations used: ADG , average daily gain (weaning to final weight); HCW, hot carcass weight; FT, adjusted fat thickness; REA, ribeye area (longissimus muscle); KPH, estimated kidney, pelvic and heart fat; YG, calculated Yield Grade.
[c]Adjusted to a common fat thickness
[vwxyz]Means in the same row lacking a common superscript letter differ ($P < .05$).