Journal of Animal and Veterinary Advances 3 (1): 13-18, 2004

Aggressive Implant Strategies do not Negatively Impact Beef Tenderness

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Abstract: We proposed that aggressive treatment with anabolic steroids (Synovex® implants) would have no effect on meat tenderness when cattle of similar genetic background were fed as weanling calves and slaughtered at a constant fat thickness. A total of 416 Angus crossbred steer and heifer calves of similar genetic makeup were randomly assigned to five treatments. Treatments consisted of: (1) no implant, (2) no implant at branding (6 wk of age) + Synovex S® or H® at weaning (8 mo of age) + Synovex S® or H® 90 d later, (3) no implant at branding + Synovex S® or H® at weaning + Synovex Plus® 90 d later, (4) Synovex C® at branding + Synovex S® or H® at weaning + Synovex S® or H® 90 d later, and (5) Synovex C® at branding + Synovex S® or H® at weaning + Synovex Plus® 90 d later. Calves were produced on two different ranches and were transported to a growing yard at weaning (206 ± 29 kg). When calves reached 341 kg BW, they were transported to a feedlot where they were fed a finishing ration for approximately 90 d, prior to harvesting. USDA quality and yield grade factors were obtained and samples of *m. longissimus thoracis* were taken from each carcass. Meat samples were aged for 2 wk at 2°C before being frozen until they could be shear tested. The meat was prepared and sheared following established guidelines for the determination of Warner Bratzler shear force. There was no difference ($P > 0.05$) in shear force among the five treatment groups. Differences ($P < 0.05$) were detected in shear force due to ranch, sex, and slaughter group. Regardless of implant treatment, sex, or ranch of origin, more than 98% of the steaks required less than 4.55 kg of shear force. We conclude that treatment with the Synovex family of implants has no effect on meat tenderness in cattle of this breed type when calves are fed a growing/finishing diet immediately after weaning and harvested at a constant fat thickness.

Key words: Tenderness, implants, carcass composition, beef cattle

Introduction

Growth promotants have been used for over 40 years in the beef industry of the United States. They have proved to increase efficiency and optimize animal performance thereby bringing a higher return for the producer (Raun *et al.*, 1997; Johnson *et al.*, 1996 and Trenkle, 1987). Gill and Trapp (1997) estimated that retail beef sales would be diminished by $1.4 billion due to a loss in cost competitiveness if producers were unable to implement implant strategies. There is disagreement, however, as to the effects of anabolic implants on beef tenderness. A recent study (Gerkin *et al.*, 1995) utilized genetically identical steers to compare the effects of single implantation with anabolic implants on meat tenderness. Implanting with estradiol or trenbolone acetate had little appreciable effect on meat tenderness. In contrast, Morgan (1997) found that aggressively implanted cattle with combination androgenic/estrogenic implants did have a higher shear force rating, but after aging for 21 days, the shear values were comparable to the non-implanted controls that had been aged for only 7 days.

In the present investigation, we hypothesized that implant strategy would not adversely affect beef tenderness when cattle of similar genetic background were fed as weanling calves and slaughtered at a constant fat thickness. To address our hypothesis, we compared five implant strategies: (1) no implants, (2) no implant at branding (6 weeks of age) + Synovex S or H® at weaning (8 mo of age) + Synovex S or H® 90 d later, (3) no implant at branding + Synovex S or H® at weaning + Synovex Plus® 90 d later, (4) Synovex C® at branding + Synovex S or H® at weaning + Synovex S or H® 90 d later, (5) Synovex C® at branding + Synovex S or H® at weaning + Synovex Plus® 90 d later.

Materials and Methods

Animals: All procedures and protocols involved in the present study conformed to the guidelines delineated in Guide for Care and Use of Agricultural Animals in Agricultural Research and Teaching (Consortium, 1988). A commercial cooperator owned all cattle, the ranches where calves were reared to weaning, and the feedlot.

A total of 416 Angus crossbred steer and heifer calves of similar genetic makeup were randomly assigned to five treatments to determine the effect of anabolic implants on meat tenderness. Dams of all calves were produced at Deseret Citrus and Livestock, Inc. near Orlando, Florida. Dams were sired by Angus bulls and out of cows that were part of a three-breed rotational crossbreeding system (Simbrah, Beefmaster and Red Brangus). These cows were artificially inseminated to Angus sires. Therefore, the calves in the present investigation were approximately ¾ Angus and 1/8 Brahman. Calves were reared until weaning on two different ranches: Geyser Ranch near Ely, Nevada and Vernon Livestock Project near Vernon, Utah. Calves were weaned at approximately 8 mo of age and transported to Deseret Feedlot near Elberta, Utah for processing (53 km from Vernon; 342 km from Ely). Treatments consisted of: (1) no implant, (2) no implant at branding (6 wk of age) + Synovex™ S or H at weaning (8 mo of age) + Synovex™ S or H 90 d later, (3) no implant at branding + Synovex™ S or H at weaning + Synovex™ Plus 90 d later, (4) Synovex™ C at branding + Synovex™ S or H at weaning + Synovex™ S or H 90 d later, and (5) Synovex™ C at branding + Synovex™ S or H at weaning + Synovex™ Plus 90 d later. Treatments are illustrated in Table 1.

Management During Feedlot Growing and Finishing Phases: Upon arrival at the feedlot, calves were weighed, administered vaccines against viral and clostridial pathogens, injected with selenium, and received implants according to the experimental protocol given above. Vitamin A and D injectable and Ivomec® anthelmintic were also administered to all calves according to label instructions. Approximately 45 days later, all calves were transported 66 km to a commercial growing yard near American Fork, Utah where they were fed a corn silage and alfalfa hay diet (composition and analysis of diet not available). All calves were re-implanted 120 days after weaning, regardless of whether they were ready to be placed on the finishing ration at that time. When calves reached 341 kg, they were transported back to Deseret Feedlot where they were placed on a finishing ration (Table 2) for approximately 90 d, after which they were slaughtered.

Carcass Evaluation: Cattle were slaughtered under USDA inspection at a commercial abattoir in accordance with an approved HACCP protocol. Carcasses were chilled in a 2°C chiller and for 24 h prior to grading. A single trained grader obtained USDA quality and yield grade factors.

Sample Analyses: Samples of *m. longissimus thoracis* from the 10^{th}-12^{th} rib area were taken from each carcass. Each sample was aged for 2 wk at 2°C before being frozen until they could be shear tested. Steaks were transported to Texas A&M University for analysis. Steaks were broiled on a Farberware Open Hearth grill (model 450N, Kidde, Inc., Bronx, NY) to an internal temperature of 70°C. Steaks were turned once during cooking at an internal temperature of 35°C. Internal temperatures were monitored using a continuous recording device (RD4031 Hybrid Recorder, Omega Engineering, Inc., Stamford, CT) with type T copper/constantan thermocouples (Omega Engineering, Inc., Stamford, CT) inserted in the geometric center of each steak. Raw and cooked weight of each steak was recorded during cooking. Percent cooked yield was determined by dividing the cooked weight by the uncooked, raw weight and multiplying by 100. Total cooking time also was recorded (cooked yield and cooking time data not reported). Steaks were cooled to an ambient temperature (25°C) before removal of six cores (1.27 cm diameter) by machine drill coring (E.H. Sargent and Co., US) parallel to the longitudinal orientation of the muscle fibers. Cores were sheared parallel to muscle fiber orientation using Warner-Bratzler Shear force machine (Mod. SD-50; Chatillon, New York, NY). The mean of the shear force of the six cores was reported as the Warner-Bratzler shear force (kg) for each steak.

Statistical Analyses: Data were analyzed using SAS statistical analysis (SAS Inst. Inc, Cary, NC). Multivariate regression using a mixed model method was used to determine treatment and ranch effects by calf gender. Slaughter group was treated as a random effect because it reflected feedlot pen placement. Means for overall average daily gain were calculated based on three measurements per calf (initial implant-to-weaning implant, weaning implant-to-final implant, final implant-to-slaughter) using ranch, slaughter group, and treatment as fixed effects and the individual calf as a random effect. All data are expressed as least square means ± SEM; P-values < 0.05 were considered significant, although trends ($P < 0.10$) are discussed.

Results

Growth: Means for growth traits of heifers and steers are shown in Table 3. Weaning weight, weight at the time of re-implant, and final weight are given for descriptive purposes. As expected, non-implanted heifers tended to be lighter at each weigh period than treated heifers. A significant treatment effect for steers was determined for overall average daily (3 measurements per calf). All implant treatments for steers increased average daily gain over non-implanted controls. Overall average daily gain was higher for heifers that received Synovex Plus® (terminal implant) than for non-implanted heifers or CSS heifers. Cattle of all treatment groups were slaughtered at the same weight.

Carcass Composition: Treatment with Synovex caused differences in marbling and maturity scores (Tables 4 and 5). Calfhood implants either reduced or tended to reduce marbling in heifers and Synovex Plus® implants reduced

Table 1: Implant Treatments

Treatment[a]	Branding	Weaning	Re-implant
NNN	None	None	None
NSS	None	Synovex S® or H®	Synovex S® or H®
NSP	None	Synovex S® or H®	Synovex Plus®
CSS	Synovex C®	Synovex S® or H®	Synovex S® or H®
CSP	Synovex C®	Synovex S® or H®	Synovex Plus®

[a]Treatment: (NNN) no implant; (NSS) no implant at branding (6 wk of age) + Synovex S® or H® at weaning (8 mo of age) + Synovex S® or H® 90 d later; (NSP) no implant at branding + Synovex S® or H® at weaning + Synovex Plus® 90 d later; (CSS) Synovex C® at branding + Synovex S® or H® at weaning + Synovex S® or H® 90 d later; (CSP) Synovex C® at branding + Synovex S® or H® at weaning + Synovex Plus® 90 d later

Table 2: Composition and Proximate Analysis of Finishing Diet[a]

Ingredient	
Wheat Straw	9.0
Corn	46.0
Potato Waste	37.0
Supplementb8.0	
Total	100.0
Proximate Analysis	
DM %	72.0
CP %	10.2
Fat %	4.8
ADF %	7.5
NDF %	12.7
Ca %	0.6
P %	0.4

[a]Dry matter basis.
[b]Composition of supplement: DM = 59.94%; Protein = 25.26%; NPN = 19.69%; Ca = 6.32%; P = 1.33%; NaCl = 3.26%; K = 1.18%; S = .09%; Mg = .30%; Zn = 960.30ppm; Fe = 45.67ppm; Cu = 242.55ppm; Mn = 252.45ppm; Co = 14.35ppm; Se = 9.90ppm; Vit. A = 16,290.79 IU kg^{-1}; Vit. D = 4,104.09 IU kg^{-1}; Vit. E = 20.79 IU kg^{-1}.

Table 3: Analysis of variance of growth traits for heifers and steers

	Treatment[1]						
Dependent variable	NNN	NSS	NSP	CSS	CSP	SE	p-value[2]
Heifers							
Initial wt, kg	77	79	79	80	76	6.9	0.89
Weaning wt, kg	197[b]	207[ab]	213[a]	205[ab]	212[a]	10.4	0.02
Re-implant wt, kg	259[c]	283[a]	292[a]	271[b]	282[a]	5.3	0.0002
Final live wt, kg	513	488	507	516	518	19.0	0.74
Overall ADG,[3] kg	0.90[b]	0.94[ab]	0.97[a]	0.91[b]	0.96[a]	0.021	0.06
Steers							
Initial wt, kg	73[b]	75[b]	84[a]	88[a]	87[a]	8.6	0.0007
Weaning wt, kg	217	214	228	220	222	14.2	0.27
Re-implant wt, kg	276[b]	286[a]	299[a]	294[a]	293[a]	5.9	0.05
Final live wt, kg	539	540	560	571	546	24.6	0.83
Overall ADG,[3] kg	0.90[b]	1.01[a]	1.04[a]	1.02[a]	1.04[a]	0.024	0.0001

[1]Treatment: (NNN) no implant, (NSS) no implant at branding (6 wk of age) + Synovex S® or H® at weaning (8 mo of age) + Synovex S® or H® 90 d later, (NSP) no implant at branding + Synovex S® or H® at weaning + Synovex Plus® 90 d later, (CSS) Synovex C® at branding + Synovex S® or H® at weaning + Synovex S® or H® 90 d later, and (CSP) Synovex C® at branding + Synovex S® or H® at weaning + Synovex Plus® 90 d later.
[2]p-values are for treatment effects in the model; any time $p < 0.10$ for treatment, means were separated using $P < 0.05$.
[a,b,c]Means with the different superscripts are different $P < 0.05$.
[3]ADG = average daily gain

Table 4: Analysis of variance of carcass traits for heifers

	Treatment[1]						
Dependent variable	NNN	NSS	NSP	CSS	CSP	SE	p-value[2]
Carcass weight, kg	308	299	307	311	310	10.90	0.95
Dressing percentage	59.8^{b}	61.3^{a}	60.6^{ab}	59.9^{b}	60.0^{b}	0.57	0.09
Adjusted fat thickness, mm	11.5^{ab}	12.6^{a}	12.7^{a}	10.9^{b}	11.1^{b}	0.82	0.085
Ribeye area, sq cm	77.8^{b}	82.1^{a}	81.6^{a}	78.8^{ab}	80.4^{ab}	2.36	0.072
Kidney, pelvic, and heart fat,%	2.45^{ab}	2.60^{a}	2.34^{abc}	2.10^{c}	2.16^{bc}	0.17	0.017
USDA yield grade	2.68	2.70	2.69	2.53	2.53	0.09	0.34
Marbling scores[3]	4.15^{ab}	4.13^{ab}	4.20^{a}	3.80^{c}	3.86^{bc}	0.15	0.04
Maturity[4]	1.50^{b}	1.63^{a}	1.59^{a}	1.62^{a}	1.65^{a}	0.03	0.008
Warner Bratzler shear force, kg	2.74	2.94	2.98	2.94	2.88	0.09	0.31

[1]Treatment: (NNN) no implant, (NSS) no implant at branding (6 wk of age) + Synovex S® or H® at weaning (8 mo of age) + Synovex S® or H® 90 d later, (NSP) no implant at branding + Synovex S® or H® at weaning + Synovex Plus® 90 d later, (CSS) Synovex C® at branding + Synovex S® or H® at weaning + Synovex S® or H® 90 d later, and (CSP) Synovex C® at branding + Synovex S® or H® at weaning + Synovex Plus® 90 d later.

[2]p-values are for treatment effects in the model; any time $P<0.10$ for treatment, means were separated using $P<0.05$.

[a,b,c]Means with the different superscripts are different $P<0.05$.

[3]3 = USDA Slight, 4 = USDA Small

[4]1 = USDA A maturity

Table 5: Analysis of variance of carcass traits for steers

	Treatment[1]						
Dependent variable	NNN	NSS	NSP	CSS	CSP	SE	p-value[2]
Carcass weight, kg	325	331	341	345	332	14.90	0.85
Dressing percentage	60.3	61.3	60.9	60.6	60.7	0.32	0.23
Adjusted fat thickness, mm	10.0	10.6	10.5	11.6	11.4	0.74	0.21
Ribeye area, cm^2	76.6^{b}	81.0^{a}	82.6^{a}	79.2^{ab}	79.3^{ab}	1.49	0.02
Kidney, pelvic, and heart fat,%	2.54	2.32	2.46	2.41	2.24	0.29	0.25
USDA yield grade	2.69	2.68	2.61	2.85	2.81	0.13	0.27
Marbling scores[3]	4.20^{a}	4.07^{ab}	3.80^{b}	3.97^{ab}	3.77^{b}	0.20	0.08
Maturity[4]	1.47^{b}	1.53^{a}	1.55^{a}	1.55^{a}	1.57^{a}	0.06	0.005
Warner Bratzler shear force, kg	3.01	3.08	2.94	3.10	3.13	0.13	0.70

[1]Treatment: (NNN) no implant, (NSS) no implant at branding (6 wk of age) + Synovex S® or H® at weaning (8 mo of age) + Synovex S® or H® 90 d later, (NSP) no implant at branding + Synovex S® or H® at weaning + Synovex Plus® 90 d later, (CSS) Synovex C® at branding + Synovex S® or H® at weaning + Synovex S® or H® 90 d later, and (CSP) Synovex C® at branding + Synovex S® or H® at weaning + Synovex Plus® 90 d later.

[2]p-values are for treatment effects in the model; any time $p < 0.10$ for treatment, means were separated using $P<0.05$.

[a,b,c]Means with different superscripts are different $p < 0.05$.

[3]3 = USDA Slight, 4 = USDA Small

[4]1 = USDA A maturity

marbling in steers. All implants increased USDA maturity score in both heifers and steers.

Warner Bratzler Shear Force: There was no difference ($P> 0.05$) in shear force among the five treatment groups for steers or heifers. Differences ($P< 0.05$) were detected in shear force due to ranch, sex, and slaughter group. Over 98% of the strip steaks, regardless of implant treatment, sex, or ranch of origin, required less than 4.55 kg of shear force.

Discussion

There has been controversy as to how implants affect carcass quality, and tenderness of beef (Morgan *et al.*, 1991b and Smith *et al.*, 1992). Tenderness has been identified as the most important palatability trait that consumers attach to meat, and thus a good determinant of meat quality (Morgan, 1997; Miller *et al.*, 1995 and Morgan *et al.*, 1991a). Morgan (1997) goes on to explain that one tough beef carcass could negatively impact

542 consumers, and most of the consumers who have a bad eating experience don't complain, they just don't come back. It has been shown that a reason for meat becoming less tender as an animal ages is the collagen in meat becomes less soluble (Gerrard *et al.*, 1987). Shackelford *et al.* (1995) found a 10-fold increase in variation of tenderness within an age group of cattle than between cattle of differing ages, suggesting other factors may affect meat tenderness more strongly. At the Wyoming Beef Symposium (1997), nine different factors were identified that are associated with tenderness of meat. Of these nine, three are directly or could be indirectly affected by anabolic implant usage. It was suggested that implant use may affect meat tenderness, and multiple implant usage was implicated as having a more detrimental affect on tenderness. They further suggested that physiological age of the animal or maturity could affect the palatability of meat. The age of a beef carcass is estimated primarily by the degree of bone ossification in the vertebrae. It was stated at the symposium that younger cattle are generally more tender than their older counterparts. Hardt *et al.* (1995) showed that carcass maturities were adversely affected by the implants resulting in more "B" and "C" maturity carcasses, and when multiple implants were administered, the bones of the carcasses realized greater breaking loads. It was stated at the Wyoming Beef Symposium (1997) that there is a small positive relationship marbling degree and beef tenderness. Hardt *et al.* (1995) noted that marbling score were slightly decreased ($P<.08$) when multiple implants were administered. Vanderwater *et al.* (1986) found that Zeranol implanted at weaning tended to increase Warner Bratzler Shear values, but the implant had no effect on taste panel evaluation palatability traits. In a study using intact bulls, Shackelford *et al.* (1992) saw no difference in tenderness when comparing synovex implanted treatment groups to control groups.

Miller *et al.* (1993) reported consumers accept steaks that were less than 3 kg of shear force in a restaurant setting, and less than 5 kg of shear force for steaks consumed in the home. A later study performed by Miller *et al.* (1998) showed that consumer acceptance is diminished and a transition occurs from tender to tough steaks between 4.3 and 4.9 kg of Warner-Bratzler shear.

In a recent study performed using genetically identical steers to determine the effects of single implantation with estrogenic and androgenic implants on meat tenderness, implanting with estradiol or trenbolone acetate had little appreciable affect on meat tenderness (Gerkin *et al.*, 1995). Morgan (1997) found that aggressively implanted cattle with combination androgenic/estrogenic implants did have a higher shear rating, but after aging 21 days post slaughter, the shear values were comparable to the non-implanted controls that had been aged for only 7 days post slaughter. In other words, implanted cattle will respond to post-mortem aging; but it takes a longer amount of time for steaks to become as tender as the non-implanted or conservatively implanted cattle. We did not observe any effect of implants on tenderness in the present study.

We conclude that aggressive treatment with the Synovex family of anabolic steroids has no effect on meat tenderness when cattle of similar genetic background are fed as weanling calves and slaughtered at a constant fat thickness.

Implications: We had hypothesized that implant treatments ranging from conservative to moderately aggressive would not impact meat tenderness. These data indicate that Synovex® implants do not negatively affect tenderness in genetically similar cattle finished as weanlings.

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