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Performance and Carcass Characteristics of Bulls as Influenced by Exogenous Hormones

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ABSTRACT

One-hundred and forty-four weanling bulls of Angus (A, n = 48), Simmental × Hereford (SH, n = 48) and Simmental (S, n = 48) breeding were either castrated, left intact, left intact and implanted with Ralgro or left intact and implanted with Synovex S. Cattle were slaughtered after 190, 246 or 315 days of high-energy feeding. The right side of each carcass was electrically stimulated. Steers were inferior to intact treatments for most performance and carcass cutability traits, but steers were superior in marbling and lean quality (P < 0·05). There were no differences (P > 0·05) in dressing percentage or ribeye area per 100 kg of carcass weight among treatments. Relative to intact bulls, Ralgro and Synovex S increased carcass masculinity. Implanted intact treatments did not differ from nonimplanted intacts for feed conversion, average daily gain, yield grade characteristics, percent longissimus dorsi *chemical fat and 9–10–11th rib composition (P > 0·05).*

INTRODUCTION

Seideman *et al.* (1982) reviewed the literature and concluded that implantation of bulls with synthetic estrogen increases carcass fatness. This

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effect is in contrast to the result obtained in steers, and suggests that synthetic estrogen may improve the quality of young bull carcasses. Bailey *et al.* (1966) and Harte (1969) found that hormone treatment increased fat deposition in bulls but decreased fat deposition in steers. Losses associated with sexual aggression have been a major concern with feeding intact males. Gregory & Ford (1983) showed no effect on testicular growth, behavioural characteristics and degree of development of secondary sex characteristics when the anabolic agent zeranol was implanted in intact males at one year of age. When implanted in intact males at a young age (preweaning) and continued at approximately 106 day intervals until slaughter, Ralgro has been reported to decrease testicle size, aggressive male behavior and development of secondary sex characteristics (Greathouse *et al.*, 1983), and to increase docility of bulls (Price & Makarechian, 1982).

With increased consumer demand for lean beef and the advent of 0·64-cm subprimal trimming by the packing industry, the need exists for the production of lean, palatable beef. Therefore, this study investigated the effects of implanting young intact bulls with synthetic steroid hormone implants on performance and carcass characteristics.

MATERIALS AND METHODS

One-hundred and forty-four fall-born weanling bulls of Angus (A, $n = 48$), Simmental × Hereford (SH, $n = 48$) and Simmental (S, $n = 48$) breeding were either castrated, left intact, left intact and implanted with Ralgro (International Minerals and Chemical Corp., PO Box 207, Terre Haute, IN 47808, USA) or left intact and implanted with Synovex S (Syntex Agribusiness Inc., PO Box 653, Des Moines, IA 50303, USA). At weaning (approximately 200 kg live weight), cattle within each breed were assigned randomly to treatment (castrate, intact, intact + Ralgro, intact + Synovex S) within one of three slaughter groups (12, 14 or 16 months of age). Cattle were fed in 48 pens where each pen contained one animal of each breed and served as one replicate of one treatment within one slaughter group.

The length of the feeding period was 190, 246 and 315 days for slaughter groups 1, 2 and 3, respectively. Cattle were fed a growing diet for 84 days, and then the energy content of the diet was gradually increased over a two week period (Table 1). Slaughter groups 1, 2 and 3 were fed the finishing diet for 90, 146 and 215 days, respectively.

At slaughter, ending weight, hot carcass weight and dressing percentage were recorded. Testicle weights were recorded on all intact treatments. The right side of each carcass was electrically stimulated and the degree of contraction of each stimulated side was scored on a one- to five-point scale (one = no contraction and five = extreme contraction). The electrical

TABLE 1
Composition of Diets on an As-fed Basis[a]

	1	*2*	*3*	*4*	*5*
Corn silage	89·4	81·9	71·3	58·8	43·1
High moisture corn	5·1	12·1	24·3	37·9	53·5
Soybean meal	2·8	2·8	1·7	—	—
Mineral premix	2·7	3·2	2·7	3·3	3·4

[a] Diets 1, 2, 3 and 4 were fed for 84, 4, 6 and 6 days, respectively. Slaughter groups 1, 2 and 3 were fed diet 5 for 90, 146 and 215 days, respectively.

stimulation consisted of 17 pulses at 550 V (AC), 2–2·5 amps and 60 Hz, for a 1·8-s duration with a 1·8-s pause between impulses. Carcasses were chilled for 24 h at −1·5°C.

Both sides of each carcass were ribbed between the 12th and 13th ribs at 24 h postmortem for determination of USDA quality and yield grade data (USDA, 1989). For each carcass side, skeletal maturity, lean maturity, overall maturity, marbling, lead color and lean texture scores were recorded. Actual fat thickness, adjusted fat thickness, ribeye area, percentage kidney, pelvic and heart fat, USDA yield grade, and carcass masculinity (degree of development of secondary sex characteristics such as crests, thickly fleshed chucks and heavy development of the round) were recorded for the right side of each carcass. The scoring system used for lean color, lean texture and carcass masculinity was a one- to eight-point scale (8 = bleached, fine or masculine and 1 = dark, coarse or nonmasculine).

At 24 h postmortem, 9–10–11th rib sections were removed from the right side of each carcass according to Hankins & Howe (1946). Rib sections were dissected and separated into (1) subcutaneous fat, (2) seam fat, (3) bone, cartilage and connective tissue and (4) lean. All soft tissues were ground, homogenized and analyzed for moisture and fat (ether extractable component) content according to AOAC (1980). One steak was removed opposite the 12th thoracic vertebra of the right side of each carcass for determination of *longissimus dorsi* (LD) chemical composition. Moisture and fat were determined as above.

An analysis of variance (Steel & Torrie, 1980) for a 3 (slaughter endpoint) × 4 treatment randomized block design was used to analyze feed conversion data according to SAS (1985). For all other traits, excluding carcass quality traits, the following model (T = treatment; S = slaughter endpoint; B = breed) was used:

$$Y_{ijkl} = \mu + T_i + S_j + (TS)_{ij} + B_k + (TB)_{ik} + (SB)_{jk} + \text{Animals}(T_i S_j B_k)$$

Animals $(T_iS_jB_k)$ served as the error term for T_i, S_j, $(TS)_{ij}$, B_k, $(TB)_{ik}$ and $(SB)_{jk}$. For carcass quality traits, electrical stimulation (E) also was included in the designs as a split-plot:

$$Y_{ijkl} = \mu + T_i + S_j + TS_{ij} + B_k + (TB)_{ik} + (SB)_{jk} + \text{Animals}(T_iS_jB_k) + E_l + (TE)_{il} + (SE)_{jl} + (BE)_{kl} + (TSBE)_{ijkl}$$

$TSBE_{ijkl}$ served as the error term for E_l, $(TE)_{il}$, $(SE)_{jl}$ and $(BE)_{kl}$. None of the interactions were significant. When the main effect or interaction was significant, mean separation was accomplished using least-squares procedures (Montgomery, 1984). The predetermined level of significance was $P < 0{\cdot}05$.

RESULTS AND DISCUSSION

Steers were inferior ($P < 0{\cdot}05$) to all intact treatments for average daily gain, feed conversion, ending weight, hot carcass weight, actual and adjusted fat thickness, ribeye area, percentage kidney, pelvic and heart fat and yield grade (Table 2). Also, percentage total separable fat, percentage separable seam fat, percentage soft tissue chemical fat, and percentage LD chemical fat were higher for steers. Steer carcasses had higher marbling scores and were more youthful with brighter, finer textured lean ($P < 0{\cdot}05$). These data are in agreement with previous findings, as reported by the reviews of Field (1971) and Seideman *et al.* (1982).

Treatment did not affect dressing percentage, ribeye area per 100 kg of carcass weight, percentage separable subcutaneous fat and percentage separable bone, cartilage and connective tissue. Carcasses from bulls implanted with Ralgro or Synovex S were more masculine than those from nonimplanted bulls. Synovex S implantation resulted in higher lean color scores than Ralgro. Ralgro increased lean, skeletal and overall maturity scores and decreased marbling scores. Concomitantly, longissimus percentage chemical fat was lower, and percentage moisture was higher for carcasses from bulls implanted with Ralgro than those from bulls implanted with Synovex S. Implantation of bulls with Ralgro or Synovex S did not affect testicle weights or performance and carcass cutability traits. Johnson *et al.* (1984) reported that implantation of intact bulls with Synovex increased actual and adjusted fat thickness and USDA yield grade, while all other carcass characteristics were not affected. In the same study, implantation of intact bulls with Compudose (Elanco Products Co., 740 S. Alabama St., Indianapolis, IN 46285, USA) was reported to increase adjusted fat thickness. Percentage ether extractable fat of 9–10–11th rib sections, ribeye

TABLE 2
Effect of Treatment on Performance and Carcass Traits

	Steer	*Intact*	*Intact Ralgro*	*Intact Synovex S*	*SEM*
Average daily gain (kg)	1·1^{f}	1·3^{e}	1·3^{e}	1·3^{e}	0·02
Feed conversion (F/G)	12·9^{e}	11·4^{g}	12·1^{f}	11·7^{fg}	0·2
Ending weight (kg)	469^{f}	526^{e}	525^{e}	532^{e}	8·2
Hot carcass weight (kg)	287^{f}	322^{e}	328^{e}	330^{e}	6·0
Dressing percentage	61·1	61·2	62·3	61·8	0·5
Testicle weight (kg)	—	0·78	0·75	0·70	0·02
Degree of contraction[a]	4·5^{ef}	4·3^{f}	4·7^{e}	4·6^{ef}	0·1
Actual fat thickness (cm)	0·90^{e}	0·75^{f}	0·72^{f}	0·73^{f}	0·04
Adjusted fat thickness (cm)	0·81^{e}	0·65^{f}	0·62^{f}	0·75^{ef}	0·04
Ribeye area (cm^2)	74·7^{f}	83·0^{e}	84·5^{e}	84·5^{e}	1·4
Ribeye area per 100 kg of carcass (cm^2)	26·3	26·1	26·1	25·8	0·4
Kidney, pelvic and heart fat (%)	2·8^{e}	2·3^{f}	2·1^{f}	2·2^{f}	0·1
Yield grade	2·6^{e}	2·2^{f}	2·1^{f}	2·3^{f}	0·1
Masculinity[b]	1·7^{g}	5·0^{f}	6·0^{e}	5·9^{e}	0·25
Lean color[b]	5·5^{e}	4·8^{fg}	4·6^{g}	4·9^{f}	0·1
Lean texture[b]	5·0^{e}	4·1^{f}	4·1^{f}	4·3^{f}	0·1
Lean maturity[c]	138^{g}	142^{f}	146^{e}	141^{f}	0·1
Skeletal maturity[c]	135^{g}	142^{f}	143^{e}	142^{f}	0·2
Overall maturity[c]	136^{g}	142^{f}	144^{e}	141^{f}	0·4
Marbling score[d]	390^{e}	313^{f}	298^{g}	323^{f}	4·8
Longissimus dorsi moisture (%)	72·3^{g}	73·6^{f}	74·2^{e}	73·5^{f}	0·2
Longissimus dorsi fat (%)	5·6^{e}	4·0^{fg}	3·6^{g}	4·5^{f}	0·2
9–10–11th rib section composition					
Total separable fat (%)	29·1^{e}	25·2^{f}	24·9^{f}	26·5^{f}	0·7
Separable subcutaneous fat (%)	12·2	11·0	11·0	11·7	0·4
Separable seam fat (%)	16·9^{e}	14·2^{f}	14·0^{f}	14·8^{f}	0·5
Separable bone, cartilage and connective tissue (%)	19·2	20·0	19·2	18·8	0·4
Separable lean (%)	50·9^{f}	54·2^{e}	55·1^{e}	54·0^{e}	0·6
Soft tissue moisture (%)	51·5^{f}	55·0^{e}	55·2^{e}	53·9^{e}	0·6
Soft tissue fat (%)	33·8^{e}	29·3^{f}	28·9^{f}	30·6^{f}	0·8

[a] Degree of contraction is the degree of side contraction during electrical stimulation scored on a one- to five-point scale (1 = no contraction and 5 = extreme contraction).
[b] Scored on a one- to eight-point scale (8 = masculine, bleached or fine and 1 = nonmasculine, dark or coarse).
[c] 130 = A^{30} and 150 = A^{50}. Cattle slaughtered at chronological ages of 9–30 months generally produce carcasses with physiological maturity indicators (skeletal or lean) described as A^{00} to A^{100}, respectively, in USDA (1989) Standards for grades of carcass beef. A carcass with a maturity score of A^{38} would have less ossification of vertebral cartilage (skeletal maturity), brighter colored and/or finer textured muscle (lean maturity) or both (overal maturity) than would a carcass with a maturity score of A^{46}.
[d] 200 = Traces^{00}, 300 = Slight^{00} and 400 = Small^{00}. A carcass with a marbling score of Slight^{90} has more visible intramuscular fat than does a carcass with a marbling score of Slight^{13}. A marbling score of Traces^{100} would be congruent to a marbling score of Slight^{00}.
[e f g] Means in the same row with superscripts that do not have a common superscript letter differ ($P < 0·05$).

area, percentages kidney, pelvic and heart fat and carcass quality characteristics have been previously reported not to differ between nonimplanted and Ralgro-implanted bulls, while Ralgro increased adjusted fat thickness and yield grade in bulls (Greathouse *et al.*, 1983). Ford & Gregory (1983) reported no differences in cutability or carcass traits between intacts, intacts

TABLE 3
Effect of Slaughter Endpoint on Performance and Carcass Traits

	Days on feed			*SEM*
	190	*246*	*315*	
Average daily gain (kg)	1·27^{f}	1·33^{e}	1·19^{g}	0·02
Feed conversion (F/G)	12·5^{e}	11·4^{f}	12·2^{e}	0·2
Ending weight (kg)	437^{g}	523^{f}	579^{e}	6·9
Hot carcass weight (kg)	267^{g}	326^{f}	356^{e}	5·2
Dressing percentage	61·0	62·2	61·6	0·4
Testicle weight (kg)	0·63^{f}	0·80^{e}	0·81^{e}	0·02
Degree of contraction[a]	4·9^{e}	4·6^{e}	4·2^{f}	0·1
Actual fat thickness (cm)	0·58^{f}	0·82^{e}	0·92^{e}	0·04
Adjusted fat thickness (cm)	0·52^{f}	0·77^{e}	0·84^{e}	0·04
Ribeye area (cm^2)	75·3^{f}	84·0^{e}	85·8^{e}	1·2
Ribeye area per 100 kg of carcass (cm^2)	28·3^{e}	25·8^{f}	24·1^{g}	0·3
Kidney, pelvic and heart fat (%)	2·1^{f}	2·5^{e}	2·6^{e}	0·1
Yield grade	1·9^{g}	2·3^{f}	2·6^{e}	0·1
Masculinity[b]	4·6	4·9	4·5	0·2
Lean color[b]	4·7^{f}	5·1^{e}	5·1^{e}	0·1
Lean texture[b]	4·1^{g}	4·7^{e}	4·4^{f}	0·1
Lean maturity[c]	139^{f}	139^{f}	147^{e}	0·6
Skeletal maturity[c]	134^{g}	138^{f}	150^{e}	0·2
Overall maturity[c]	136^{g}	139^{f}	148^{e}	0·3
Marbling[d]	259^{g}	356^{f}	377^{e}	4·1
Longissimus moisture (%)	74·8^{e}	73·2^{f}	72·2^{g}	0·2
Longissimus fat (%)	3·4^{g}	4·4^{f}	5·7^{e}	0·2
9–10–11th rib section composition				
Total separable fat (%)	23·8^{f}	27·4^{e}	28·1^{e}	0·6
Separable subcutaneous fat (%)	10·3^{f}	11·2^{f}	12·9^{e}	0·4
Separable seam fat (%)	13·5^{f}	16·2^{e}	15·2^{e}	0·4
Separable bone, cartilage and connective tissue (%)	19·9^{e}	18·6^{f}	19·5^{ef}	0·4
Separable lean (%)	55·7^{e}	53·3^{f}	51·7^{g}	0·5
Soft tissue moisture (%)	57·4^{e}	52·7^{f}	51·6^{f}	0·5
Soft tissue fat (%)	26·7^{g}	31·6^{f}	33·7^{e}	0·7

^{abcdefg} See Table 2 for explanation of superscripts.

implanted with zeranol in the scrotum or intacts implanted with zeranol in the ear.

Average daily gain was highest for the second slaughter group and lowest for the third slaughter group, while the second slaughter group had the lowest feed to gain ratio (Table 3). Ending weight, hot carcass weight, testicle weight, actual fat thickness, adjusted fat thickness, ribeye area, percentage kidney, pelvic and heart fat, yield grade, percentage total separable fat,

TABLE 4
Effect of Breed on Performance and Carcass Traits

	Angus	*Simmental-Hereford*	*Simmental*	*SEM*
Average daily gain (kg)	1·2^{f}	1·3^{e}	1·3^{e}	0·02
Ending weight (kg)	486^{g}	513^{f}	541^{e}	7
Hot carcass weight (kg)	301^{f}	314^{f}	333^{e}	5·2
Dressing percentage	62·1	61·2	61·6	0·4
Testicle weight (kg)	0·70	0·73	0·80	0·02
Degree of contraction[a]	4·6^{ef}	4·7^{e}	4·3^{f}	0·1
Actual fat thickness (cm)	1·08^{e}	0·72^{f}	0·53^{g}	0·04
Adjusted fat thickness (cm)	1·03^{e}	0·66^{f}	0·44^{g}	0·04
Ribeye area (cm^2)	76·9^{f}	81·0^{f}	87·1^{e}	1·2
Ribeye area per 100 kg of carcass (cm^2)	25·8	26·0	26·4	0·3
Kidney, pelvic and heart fat (%)	2·7^{e}	2·3^{f}	2·1^{g}	0·1
Yield grade	2·8^{e}	2·2^{f}	2·1^{g}	0·1
Masculinity[b]	4·0^{f}	4·5^{f}	5·5^{e}	0·2
Lean color[b]	5·5^{e}	4·8^{f}	4·5^{g}	0·1
Lean texture[b]	4·8^{e}	4·4^{f}	4·0^{g}	0·1
Lean maturity[c]	137^{g}	142^{f}	146^{e}	0·6
Skeletal maturity[c]	138^{g}	141^{f}	143^{e}	0·2
Overall maturity[c]	138^{g}	141^{f}	144^{e}	0·3
Marbling[d]	380^{e}	317^{f}	296^{g}	4·1
Longissimus moisture (%)	72·7^{f}	73·2^{f}	74·2^{e}	0·2
Longissimus fat (%)	5·5^{e}	4·4^{f}	3·6^{g}	0·2
9–10–11th rib section composition				
Total separable fat (%)	31·2^{e}	26·2^{f}	21·9^{g}	0·6
Separable subcutaneous fat (%)	13·4^{e}	11·8^{f}	9·2^{g}	0·4
Separable seam fat (%)	17·7^{e}	14·4^{f}	12·8^{g}	0·4
Separable bone, cartilage and connective tissue (%)	18·5^{f}	19·5^{e}	19·9^{e}	0·4
Separable lean (%)	49·6^{g}	53·6^{f}	57·4^{e}	0·5
Soft tissue moisture (%)	49·6^{g}	53·9^{f}	58·2^{e}	0·5
Soft tissue fat (%)	36·6^{e}	30·5^{f}	24·9^{g}	0·7

[abcdefg] See Table 2 for explanation of superscripts.

percentage separable subcutaneous fat, percentage separable seam fat, percentage soft tissue fat and percentage LD fat all increased as time on feed increased ($P < 0.05$). Concomitantly, ribeye area per 100 kg of carcass weight and percentage separable lean decreased with increased time on feed. Masculinity and dressing percentage were not affected by slaughter endpoint ($P > 0.05$). Greathouse *et al.* (1983) showed increased 9–10–11th rib section percentage ether extractable fat for bulls fed to 499 kg live weight, as compared to bulls fed to 454 kg.

Angus had the lowest average daily gain and ending weight while S had the highest ending weight and hot carcass weight (Table 4). Actual and adjusted fat thickness, percentage kidney, pelvic and heart fat and yield grade were highest for A, intermediate for SH and lowest for S ($P < 0.05$) while S had the highest ribeye area. This was evidenced further by the rib dissection data which showed that A had the highest percentage of total separable fat, percentage separable subcutaneous fat, percentage separable seam fat and percentage soft tissue chemical fat, while S possessed the least. Ribeye area per 100 kg of carcass weight was not affected ($P > 0.05$) by breed but tended to favor S versus A. Also, percentage separable lean was highest for S, intermediate for SH and lowest for A. Lean color, lean texture, marbling and chemical fat content of the LD were highest for A, intermediate for SH and lowest for S ($P < 0.05$). Lean, skeletal and overall maturity scores were most youthful for A and most mature for S.

Marbling, lean color and lean texture scores were increased by electrical stimulation (Table 5). Moreover, electrical stimulation improved lean and overall maturity scores while not affecting skeletal maturity. These data agree with those previously reported for young bulls and steers (Crouse *et al.*, 1983; Cross *et al.*, 1984).

TABLE 5
Effect of Electrical Stimulation on Carcass Quality Traits

	Stimulated	*Nonstimulated*	*SEM*
Lean color[a]	5·5[e]	4·4[f]	0·1
Lean texture[a]	4·7[e]	4·0[f]	0·1
Lean maturity[c]	138[f]	146[e]	0·5
Skeletal maturity[c]	140[e]	141[e]	0·2
Overall maturity[c]	139[f]	143[e]	0·3
Marbling[d]	340[e]	321[f]	3·4

[a] Scored on a one- to eight-point scale (eight = bleached or fine and one = dark red or coarse).
[cdef] See Table 2 for explanation of superscripts.

CONCLUSIONS

Both implanted and nonimplanted bulls were superior to steers in terms of performance and carcass cutability, but inferior to steers in marbling and lean quality. Performance and carcass traits of bulls were not improved by implantation of exogenous hormones.

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