Effects of energy intake, implantation, and subcutaneous fat end point on feedlot steer performance and carcass composition[1]

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ABSTRACT: The purpose of this experiment was to evaluate the effects of energy intake, implantation, and fat end point on feedlot performance and carcass composition of steers. Three hundred eighty-four yearling crossbred steers (368 ± 23.1 kg) were allotted in a completely randomized design. Treatments were arranged in a 2 × 3 × 2 factorial experiment. Main effect factors were two levels of intake, three implant strategies, and two compositional fat end points at slaughter. The levels of intake were ad libitum (AL) and restricted (RS) intake (90% ad libitum). The three implant strategies were Revalor-S (REV) (120 mg trenbolone acetate, 24 mg estradiol), Synovex-Plus (SYN) (200 mg trenbolone acetate, 28 mg estradiol benzoate), and no implant (control). The compositional target end points were 1.0 and 1.4 cm s.c. fat cover over the 12th and 13th rib. Restricted-intake steers consumed 9.2% less ($P < .01$) DM than AL steers. Ad libitum-intake steers gained weight 15.5% more rapidly ($P < .01$) than RS-intake steers. Steers implanted with REV tended ($P < .07$) to gain faster than SYN steers, who in turn gained 15.2% more ($P < .01$) than control steers. Ad libitum-intake steers were 4.8% more ($P < .01$) efficient than RS steers. Steers fed to a targeted 1.4 cm s.c. backfat cover were 2.9% less ($P < .05$) efficient than steers fed to 1.0 cm, and steers implanted with either REV or SYN had similar ($P = .47$) feed efficiencies, whereas control steers had lower ($P < .01$) feed efficiencies. Steers fed to a targeted compositional fat end point of 1.4 cm had 1.3% higher ($P < .01$) dressing percentage (DP) than steers fed to 1.0 cm. Control and SYN steers had similar ($P = .13$) DP; however, REV steers had 6.1% greater ($P < .01$) DP than SYN steers. Steers fed to 1.4 cm s.c. fat end point had higher ($P < .01$) numerical yield grades than steers fed to 1.0 cm (3.34 vs 2.71). There was an interaction ($P < .01$) for intake level and implant for marbling score. Marbling scores were lower ($P < .05$) for RS × SYN and AL × REV than in other treatments. Steers on the RS × REV treatment were intermediate in marbling to all treatments except AL control, which was higher ($P < .01$) than RS × SYN, AL × REV, and RS × REV. No interaction for dry matter intake level and anabolic implants was observed for growth performance. The depression in carcass quality resulting from implanting is reduced as backfat increases from 1.0 to 1.4 cm at slaughter.

Key Words: Feedlots, Implantation, Restricted Feeding

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Introduction

Genetic potential for growth and environmental conditions are two factors that determine an animal's growth rate. Some environmental conditions that may affect growth are nutrition, climate, disease, and management practices (Ray et al., 1969). Acker et al. (1959) and Ray et al. (1969) reported a decrease in performance responses to growth promotants in the hot summer months. This reduced response to anabolic agents may be the result of decreased feed intake because of environmental temperature and(or) humidity.

The use of restricted intake as a management practice has the potential to reduce the cost of production. Feeding high-concentrate diets at less than ad libitum intake can reduce feed wastage and improve feed efficiency (Hicks et al., 1990; Sainz et al., 1995; Loerch and Fluharty, 1998).

It is commonly accepted that anabolic agents increase daily gains and improve feed efficiency when administered to cattle fed for ad libitum intake. However, when dry matter intakes are restricted, there is uncertainty whether the full response to anabolic agents is maintained. Trenbolone acetate has been shown to reduce protein degradation in muscle (Buttery and Sinnett-

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Smith, 1984). Therefore, trenbolone acetate-containing implants and restricted feeding may complement one another by reducing the energy required for maintenance (Eng, 1997).

Physiological end point at slaughter is another factor affecting performance. Daily gains and feed efficiencies decrease as animals approach, and then surpass, chemical maturity. However, feeding steers to a fatter physiological end point may decrease the negative effects of anabolic agents on carcass marbling.

The objective of this study was to evaluate the interactions among implant strategy, level of energy intake, and compositional fat end point on performance and carcass characteristics of feedlot steers.

Experimental Procedures

Three hundred eighty-four yearling crossbred steers (368 ± 23.1 kg) were allotted in a completely randomized design. Treatments were arranged in a 2 × 3 × 2 factorial experiment. Main effect factors were two levels of intake, three implant strategies, and two compositional fat end points at slaughter. The levels of intake were ad libitum and restricted intake (90% of ad libitum). The three implant strategies were Revalor-S (**REV**) (120 mg trenbolone acetate, 24 mg estradiol), Synovex-Plus (**SYN**) (200 mg trenbolone acetate, 28 mg estradiol benzoate), and no implant (control). The compositional target end points were 1.0 and 1.4 cm s.c. fat cover over the 12th and 13th rib.

Yearling steers previously on pasture were purchased and shipped to the Beef Research Unit at the University of Illinois. The steers were primarily Angus × Simmental and Angus × Charolais crosses. Upon arrival, the steers were offered grass hay for ad libitum consumption and .91 kg of supplement daily. Forty-eight hours after arrival, steers were ear-tagged, weighed, and vaccinated for infectious bovine rhinotracheitis (TSV-2, Smith Kline Beecham, West Chester, PA), parainfluenza (Bovishield-4, Smith Kline Beecham); clostridia (Vision-7, Miles, Shawnee, KS), *Haemophilus somnus* (Presponse, Langford, Lenexa, KS or One-Shot, Smith Kline Beecham), and *Moraxella bovis* (Boveye, Smith Kline Beecham). After 3 d, the steers were gradually adjusted to a 50% corn silage and 50% concentrate diet. Weights obtained were used to allot steers to pens so that the mean and standard deviation of pen weights were similar across treatments. Steer color was also used to allot steers to pens so that breed type was similar across treatments.

Initial weights were obtained by weighing steers on each of two consecutive days. Steers receiving an ear implant were implanted on d 1 of the experiment, at which time all steers were dewormed (Safe Guard, Hoechst Roussel Vet, Warren, NJ). After processing, steers were placed in feedlot pens (48 pens, eight steers/pen) and adapted to the 90% concentrate treatment diets (Tables 1 and 2). Thirty-six pens were solid-floor pens (4.3 × 12.2 m), which were bedded, and 12 pens (4.3 × 9.1 m) contained concrete slatted floors. Treatments were evenly distributed among pen types. Diet adaptation occurred over a 2-wk period using a sequence of diets in which the percentage of cracked dry corn was increased and that of corn silage was reduced. Restricted intake levels were calculated daily from the average ad libitum intake of contemporary groups from the previous day. Steers were weighed at 0800 at 28-d intervals prior to feeding throughout the trial.

Chromic oxide was fed to steers in the 12 concrete slatted pens as an external marker to estimate apparent digestibility, at a rate of 10 g·steer^{-1}·d^{-1} for a period of 10 d. On d 10, the pits under the slatted floor were cleaned and the scrapper system was turned off for a 24-h period. After 24 h, fecal samples were collected under each pen. Composited pen fecal samples and feed samples were air-dried at 55°C and ground through a 2-mm screen. The digestible energy of the diet was determined by analyzing feed and fecal samples by bomb calorimetry and comparing the concentrations of Cr in the feed and feces. The ad libitum diet was

Table 1. Ingredients of diets fed to yearling steers[a]

Item	Ad libitum	Restricted
Ingredient	% (DM basis)	
Corn silage	10	10
Cracked corn	73	71
Corn distillers solubles	5	5
Protein supplement[b]	10	12
Liquid fat	2	2
Diet composition		
Crude protein, %	13.5	15.0
Calcium, %	.60	.60
Phosphorus, %	.40	.40
Potassium, %	.70	.70

[a]Diets were balanced to meet or exceed the 1996 NRC requirements for minerals and vitamins.
[b]Composition given in Table 2.

Table 2. Ingredients of protein supplement fed to yearling steers

Ingredient	Ad libitum	Restricted
	% (DM basis)	
Soybean meal	54.82	64.47
Urea	7.37	7.44
Ground corn	22.95	15.76
Limestone	11.51	9.49
Trace mineralized salt[a]	2.95	2.48
Rumensin-80[b]	.17	.14
Tylan-40[c]	.13	.11
Vitamin premix[d]	.11	.11

[a]Composition (%): NaCl (93 to 98), Zn (≥.35), Mn (≥.28), Fe (≥.175), Cu (≥.035), I (≥.007), and Co (≥.007).
[b]Contains 176 g of monensin/kg.
[c]Contains 88 g of tylosin/kg.
[d]Composition (per gram): vitamin A (≥3,300 IU), vitamin D_3 (≥330 IU), vitamin E (≥44 IU), vitamin B_{12} (≥.0176 mg), riboflavin (≥4.4 mg), D-pantothenic acid (≥12.1 mg), niacin (≥16.5 mg), choline chloride (≥165.0 mg).

determined to supply 3.78 Mcal of DE/kg and the restricted diet was calculated to supply 3.71 Mcal of DE/kg. Net energy required for maintenance and gain were calculated using the equations of Garrett (1980) and assuming ME to be 82% of DE (NRC, 1984). A 5% increase for control steers and a 5% decrease for implanted steers for NE_g requirement was used to adjust NE available for gain (NRC, 1996). The ad libitum diet was calculated to supply 2.11 Mcal/ kg of NE_m and 1.44 Mcal/kg of NE_g, whereas the restricted diet was calculated to supply 2.01 and 1.40 Mcal/kg of NE_m and NE_g, respectively. The net energy system was used to calculate predicted gain of steers to compare to observed steer gains using digestible energy values, average pen feed intakes, and average pen body weights.

Steers were scanned by a real-time linear array ultrasound instrument (SSD-500V, Aloka Co., Wallingford, CT) to estimate s.c. fat cover between the 12th and 13th rib to predict slaughter time. When the average s.c. fat cover for a treatment group was estimated to be the desired amount, all treatment group pens were removed from the trial for slaughter. Although restricted-intake steers being fed to a compositional end point of 1.4 cm of s.c. backfat had not reached the desired backfat thickness, they were removed from trial with ad libitum-intake steers fed to a compositional end point of 1.4 cm. This was done because steers with ad libitum intakes were used to determine intakes of restrictively fed steers. Final weights were taken on each of two consecutive days, before steers were shipped to a commercial packing plant. Hot carcass weights were obtained at slaughter and carcass yield and quality data were obtained after carcasses were chilled for 24 h. Carcasses were evaluated by trained university personnel for longissimus muscle area at the 12th rib, s.c. fat thickness at the 12th rib, kidney, pelvic, and heart fat as a percentage of carcass weight, and marbling score at the 12th rib (USDA, 1975).

Data for growth performance and carcass characteristics were analyzed by the GLM procedures of SAS (1992). Model effects included intake level, implant type, s.c. fat end point, and their interactions as independent variables for growth performance and carcass characteristics of steers. Restricted-intake steers fed to a compositional end point of 1.4 cm of s.c. fat cover had less ($P < .01$) backfat than ad libitum-intake steers fed to 1.4 cm s.c. fat cover. Therefore, from observations of restricted intake × control steers (eight pens) a linear regression of daily gain and feed efficiency on backfat was used to estimate the regression coefficient of daily gain or feed efficiency on backfat. The predicted daily gain was the actual daily gain adjusted by the addition of the product of the regression coefficient times the actual backfat. In addition, from observations of restricted-intake × control steers (n = 64) a linear regression of carcass composition on backfat was used to predict carcass composition for unimplanted and implanted steers as described above.

Results and Discussion

Steer feedlot performance is shown in Table 3. Feeding to 1.4 cm of backfat had a much greater impact on final weight for implanted steers than for control steers and a greater effect on steers fed for ad libitum intake than on restricted-intake steers. Restricted-intake steers consumed 9.2% less ($P < .01$) DM than ad libitum-intake steers, because of experimental design. Unimplanted steers consumed less ($P < .01$) DM than implanted steers, and SYN steers tended ($P < .06$) to consumed less DM than REV steers. When DM intake was expressed as a percentage of body weight, REV steers consumed 2.10%, which was higher ($P < .01$) than control steers, which consumed 2.06%. Dry matter intakes as a percentage of body weight for steers implanted with SYN were intermediate ($P < .14$). Subcutaneous backfat end point had no effect ($P = .30$) on DM intake. However, when DM intakes were determined as a percentage of body weight, steers fed to 1.0 cm of backfat consumed 2.11% of body weight, which was higher ($P < .01$) than the 2.05% consumed by steers fed to 1.4 cm s.c. fat cover.

Steers fed for ad libitum intake gained 15.5% faster ($P < .01$, 1.84 vs 1.59 kg/d) than restricted-intake steers. In a review by Galyean (1999), unpublished data by Bachman and Armbruster showed that actual daily gains and daily gains adjusted for dressing percentage decreased linearly with increasing restriction. Unimplanted steers gained less ($P < .01$) than implanted steers, and steers implanted with SYN tended ($P < .07$) to gain less than REV steers. This is in contrast to findings by Herschler et al. (1995), who reported that implants containing a ratio of 1:10 estradiol:trenbolone acetate resulted in higher feedlot performance than implants containing a ratio of 1:5. Subcutaneous backfat end point had no effect ($P = .16$) on daily gains.

Restricted-fed steers were 4.8% less efficient ($P < .01$, .164 vs .172) than ad libitum-intake steers. This observed decrease in efficiency of restricted-intake steers is more a result of the high daily gains of ad libitum-intake steers and a more dramatic reduction in restricted-intake steer gains due to the 10% DM intake restriction than of a decrease in DM digestibility. This is in contrast to results from Hicks et al. (1990), who found control feeding throughout the finishing phase improved feed efficiencies 8.4%. Galyean (1999) stated that unpublished data by Bachman and Armbruster showed actual feed efficiency was numerically increased with restriction and adjusted feed efficiency increased linearly with increasing amounts of feed restriction.

Implanted steers were more efficient ($P < .01$, .175 vs .154) than unimplanted steers. These findings are similar to those of Foutz et al. (1997) and Herschler et al. (1995), who noted that steers with anabolic implants had improved feed efficiency, for the entire feeding period, relative to unimplanted steers. However, Johnson et al. (1996) reported that implants improved efficien-

Table 3. Effects of feed intake level and implantation on steer feedlot performance when fed to 1.0 or 1.4 cm of subcutaneous fat

	Control		Revalor-S		Synovex-Plus		
Item	1.0	1.4	1.0	1.4	1.0	1.4	SEM
Ad libitum intake							
On-trial wt, kg	368.1	367.9	369.9	367.2	368.0	367.2	
Off-trial wt, kg[ac]	586.1[ef]	608.2[hi]	603.3[ghi]	669.0[j]	589.7[efg]	654.3[j]	
Days on feed, d	134	151	117	151	117	151	
Daily intake, kg	10.32[g]	10.26[fg]	10.70[h]	11.08[i]	10.63[gh]	10.81[hi]	
Daily gain, kg[ab]	1.63[e]	1.59[e]	2.00[f]	2.00[f]	1.90[f]	1.90[f]	
Gain:feed[ab]	.158[de]	.155[d]	.187[h]	.180[gh]	.179[fgh]	.176[fgh]	
Restricted intake							
On-trial wt, kg	368.0	369.5	366.7	366.0	367.6	368.1	2.17
Off-trial wt, kg[ac]	562.9[d]	579.4[e]	594.5[efgh]	618.2[i]	595.7[fgh]	616.8[i]	5.57
Days on fed, d	134	151	134	151	134	151	—
Daily intake, kg	9.34[d]	9.30[d]	9.92[ef]	9.91[ef]	9.72[e]	9.74[e]	.127
Daily gain, kg[ab]	1.45[d]	1.38[d]	1.70[e]	1.67[e]	1.70[e]	1.64[e]	.040
Gain:feed[ab]	.156[d]	.148[d]	.171[fg]	.168[ef]	.175[fg]	.169[ef]	.0038

[a]Performance adjusted for a common dressing percentage of 62.5%.
[b]Performance predicted from regression equation for backfat vs feed intake treatment for restricted, control steers.
[c]Feed treatment × backfat treatment × implant interaction ($P < .05$).
[d,e,f,g,h,i,j]Means within an item row differ ($P < .05$).

cies 13.0% during the first 40 d of the feeding period and tended to improve efficiencies from d 41 to 115 but had no effect on feed efficiency during d 116 to 143. In this study, restricted-intake steers were slaughtered 134 to 151 d after implanting.

Steers fed to 1.4 cm s.c. backfat were 2.9% less ($P < .05$) efficient than steers fed to 1.0 cm. Van Koevering et al. (1995) reported that steers fed for 119 d were 7.4% ($P < .05$) more efficient than those fed for 147 d. During this same period backfat increased from .99 to 1.17 cm, which is less than the .50-cm increase in this trial. One difference between these trials is that steers in the Van Koevering study were implanted with 24 mg, of estradiol and did not receive an implant containing trenbolone acetate. Duckett et al. (1997) summarized over 30 trials that showed that 24 mg of estradiol had much less effect on feed efficiency than implants containing trenbolone acetate.

Using pen DM intake and average body weights for steers in the 12 pens on the concrete slatted floors, ad libitum- and restricted-intake steers were predicted to gain 1.45 and 1.26 kg/d, respectively. However, ad libitum-intake steers gained 124.8% and restricted-intake steers gained 130.2% above predicted daily gains. Unimplanted steers were predicted to gain 1.29 kg/d and implanted steers were predicted to gain 1.41 kg/d. Unimplanted and implanted steers gained 119.4 and 131.2%, respectively, above predicted gains.

Restricted-fed steers fed to 1.4 cm s.c. backfat had less ($P < .01$) backfat than ad libitum-intake steers fed to 1.4 cm; therefore, adjusted carcass data presented in Table 4 are predicted based on regression equations derived from restricted-intake × control. There was an interaction ($P < .05$) of intake level, s.c. fat end point, and implant type on hot carcass weight (**HCW**; Table 5). Similar to the interaction for final live weight, implanting resulted in a dramatic increase in HCW when feeding to 1.4 vs 1.0 cm of backfat compared to control steers, and the implant effect was more dramatic for ad libitum-intake than for restricted-fed steers. Steers fed for ad libitum intake and at restricted intakes had similar ($P = .68$) dressing percentages; however, steers fed to 1.4 cm s.c. backfat had a higher ($P < .01$) dressing percentage. May et al. (1992) found that dressing percentage increased with increased time on feed. Unimplanted steers had lower ($P < .01$) dressing percentages than REV, and SYN was intermediate. Bartle et al. (1992) reported an interaction between location and implant treatment for dressing percentage in a study conducted at three locations. They found dressing percentage to be lower for unimplanted than for implanted steers at one location; however, dressing percentage was similar for implanted and unimplanted at the other two locations.

An intake level and s.c. fat end point interaction ($P < .05$) occurred for longissimus muscle area and percentage kidney, pelvic, and heart fat (**KPH**). Restricted- and ad libitum-intake steers fed to 1.0 cm s.c. backfat had similar ($P = .28$) longissimus muscle areas; however, restricted-intake steers fed to 1.4 cm had smaller ($P < .01$) longissimus muscle areas than ad libitum-intake steers. Ad libitum-intake steers fed to 1.0 cm s.c. backfat were intermediate to restricted-intake steers fed to 1.0 cm and ad libitum-intake steers fed to 1.4 cm. Unimplanted steers had smaller ($P < .01$) longissimus muscle areas than implanted steers, and REV and SYN steers had similar ($P = .98$) longissimus muscle areas. The increase in longissimus muscle area is similar to results reported by Johnson et al. (1996) and Foutz et al. (1997). Bartle et al. (1992) found there

Table 4. Effects of feed intake level and implantation on steer carcass composition when fed to 1.0 or 1.4 cm of subcutaneous fat

Item	Control		Revalor-S		Synovex-Plus		SEM
	1.0	1.4	1.0	1.4	1.0	1.4	
Ad libitum intake							
Hot carcass wt, kg[ab]	366.2^{e}	381.7^{gh}	373.4^{fg}	417.8^{i}	367.1^{f}	410.7^{i}	
Dressing percentage[a]	61.88^{e}	62.65^{efgh}	62.38^{efg}	63.30^{hi}	62.16^{efg}	63.32^{hi}	
Fat thickness, cm	1.02^{ef}	1.33^{ij}	1.15^{fgh}	1.38^{j}	1.08^{efg}	1.32^{hij}	
Longissimus muscle area, cm^{2}[a]	86.33^{fgh}	84.53^{efg}	88.08^{ghi}	91.08^{ij}	88.63^{ghij}	92.68^{j}	
Kidney, pelvic, and heart fat, %[a]	2.45^{ghi}	2.64^{i}	2.13^{ef}	2.33^{fgh}	1.96^{e}	2.54^{hi}	
Yield grade[a]	2.76^{ef}	3.39^{g}	2.68^{ef}	3.30^{g}	2.57^{e}	3.23^{g}	
Yield grade 1, %	3.33^{ef}	0^{e}	0^{e}	0^{e}	9.38^{f}	0^{e}	
Yield grade 2, %	66.67^{g}	17.24^{ef}	75.00^{g}	33.33^{f}	68.75^{g}	32.26^{f}	
Yield grade 3, %	30.00^{e}	75.86^{fg}	25.00^{e}	56.67^{f}	21.88^{e}	61.29^{f}	
Yield grade 4, %	0^{e}	6.90^{ef}	0^{e}	10.00^{f}	0^{e}	6.45^{ef}	
Marbling score[ac]	1,078^{fgh}	1,166^{k}	1,030^{e}	1,107^{hij}	1,059^{efg}	1,154^{k}	
≥ Choice, %[d]	84.38^{fgh}	100.00^{h}	75.00^{efg}	100.00^{h}	87.50^{fgh}	90.32^{gh}	
≥ Average Choice, %[d]	43.75^{gh}	60.00^{h}	31.25^{fg}	54.84^{h}	28.13^{efg}	61.29^{h}	
Prime, %[d]	0^{e}	10.00^{f}	0^{e}	0^{e}	0^{e}	6.45^{ef}	
Restricted intake							
Hot carcass wt, kg[ab]	353.5^{e}	371.0^{fg}	375.2^{fg}	391.4^{h}	372.5^{fg}	391.0^{h}	4.51
Dressing percentage[a]	62.18^{efg}	62.53^{efgh}	62.80^{fghi}	63.57^{i}	62.05^{ef}	62.99^{ghi}	.317
Fat thickness, cm	.95^{e}	1.07^{efg}	.91^{e}	1.20^{ghi}	1.01^{ef}	1.16^{fgh}	.063
Longissimus muscle area, cm^{2}[a]	83.61^{ef}	81.74^{e}	89.07^{hij}	85.38^{efgh}	86.47^{fgh}	85.93^{fgh}	1.520
Kidney, pelvic, and heart fat, %[a]	2.44^{ghi}	2.30^{fgh}	2.24^{fg}	2.21^{fg}	2.28^{fg}	2.31^{fgh}	.093
Yield grade[a]	2.80^{f}	3.38^{g}	2.69^{ef}	3.36^{g}	2.79^{f}	3.40^{g}	.075
Yield grade 1, %	0^{e}	0^{e}	6.45^{f}	0^{e}	0^{e}	0^{e}	2.408
Yield grade 2, %	65.63^{g}	16.13^{ef}	64.52^{g}	6.45^{e}	70.97^{g}	18.52^{ef}	8.420
Yield grade 3, %	34.38^{e}	83.87^{g}	29.03^{e}	90.32^{g}	29.03^{e}	77.78^{fg}	8.507
Yield grade 4, %	0^{e}	0^{e}	0^{e}	3.23^{ef}	0^{e}	3.70^{ef}	2.954
Marbling score[ac]	1,055^{efg}	1,139^{jk}	1,039^{ef}	1,130^{ijk}	1,027^{e}	1,093^{ghi}	14.8
≥ Choice, %[d]	65.63^{e}	93.55^{h}	61.29^{e}	93.55^{h}	71.88^{ef}	96.55^{h}	6.339
≥ Average Choice, %[d]	28.13^{efg}	45.16^{gh}	19.35^{ef}	58.06^{h}	6.25^{e}	31.03^{fg}	8.623
Prime, %[d]	3.13^{ef}	6.45^{ef}	0^{e}	0^{e}	0^{e}	0^{e}	2.657

[a]Performance predicted from regression equation for backfat vs feed intake treatment for restricted, control steers.
[b]Feed treatment × backfat end point × implant interaction ($P < .05$).
[c]Marbling scores: 1,000 = small^{0}, 1,100 = modest^{0}, 1,200 = moderate^{0}.
[d]Percentages based on observed marbling scores.
[e,f,g,h,i,j,k]Means within an item row differ ($P < .05$).

Table 5. Three-way interactions for intake level, implant strategy, and subcutaneous fat end point

Off-trial weight[a]		Hot carcass weight	
Group[b]	kg	Group[b]	kg
RS × CON × 1.0	562.9^{c}	RS × CON × 1.0	353.5^{c}
RS × CON × 1.4	579.4^{d}	AL × CON × 1.0	366.2^{d}
AL × CON × 1.0	586.1^{de}	AL × SYN × 1.0	367.1^{d}
AL × SYN × 1.0	589.7^{def}	RS × CON × 1.4	371.0^{de}
RS × REV × 1.0	594.5^{defg}	RS × SYN × 1.0	372.5^{de}
RS × SYN × 1.0	595.7^{efg}	AL × REV × 1.0	373.4^{de}
AL × REV × 1.0	603.3^{fgh}	RS × REV × 1.0	375.2^{de}
AL × CON × 1.4	608.2^{gh}	AL × CON × 1.4	381.7^{ef}
RS × SYN × 1.4	616.8^{h}	RS × SYN × 1.4	391.0^{f}
RS × REV × 1.4	618.2^{h}	RS × REV × 1.4	391.4^{f}
AL × SYN × 1.4	654.3^{i}	AL × SYN × 1.4	410.7^{g}
AL × REV × 1.4	669.0^{i}	AL × REV × 1.4	417.8^{g}

[a]Off-trial weights adjusted for a common dressing percentage of 62.5%.
[b]Individual treatment groups: intake level (ad libitum [AL] and restricted [RS]), implant strategy (unimplanted [CON], Revalor-S [REV], and Synovex-Plus [SYN]), and compositional target end point (1.0 or 1.4 cm subcutaneous fat).
[c,d,e,f,g,h,i]Means within a column differ ($P < .05$).

was a linear increase in longissimus muscle area with increasing implant dosage; however, most of these differences were removed when differences in HCW were removed.

Ad libitum-intake steers fed to 1.0 cm s.c. backfat had KPH similar ($P = .21$) to that of restricted-intake steers fed to 1.4 cm and tended ($P < .06$) to have less KPH than restricted-intake steers fed to 1.0 cm. Ad libitum-intake steers fed to 1.4 cm s.c. backfat had the highest ($P < .05$) KPH. Implanted steers had less ($P < .01$) KPH than control steers. Steers fed restricted intakes had higher ($P < .05$) numerical yield grades than ad libitum-intake steers. In addition, steers fed to 1.4 cm s.c. backfat had 23.2% higher ($P < .01$) numerical yield grades than steers fed to 1.0 cm. These results are similar to results of Matulis et al. (1987), who found that cull cows' carcass weights, KPH, and yield grades increased with time on feed. Similar findings were also reported by Van Koevering et al. (1995), who found that steer HCW and KPH increased with increasing days on feed. Steers implanted with SYN tended ($P < .09$) to have improved carcass yield grades compared with controls; however, REV and control carcasses had similar (P = .13) yield grades. An intake level × implant type interaction (P < .05) occurred for percentage of carcass grading yield grade 1 (**YG1**). Percentage of carcasses grading YG1 was higher (P < .05) for restricted intake × REV and ad libitum intake × SYN than for all other treatments except ad libitum intake × control, which was intermediate. Ad libitum intake tended (P = .06) to increase the percentage of carcasses grading yield grade 2 (**YG2**); however, restricted steers had 27.2% more (P < .01) carcasses grading yield grade 3 (**YG3**) than ad libitum-intake steers. The percentage of steers grading yield grade 4 (**YG4**) tended (P = .09) to be higher for ad libitum-intake than for restricted-intake steers. More (P < .01) carcasses of steers fed to a composition end point of 1.0 cm of backfat than of steers fed to 1.4 cm backfat graded YG2; however, more carcasses of steers fed to 1.4 cm backfat than of steers fed to 1.0 cm graded YG3. In addition, 5.0% of the carcasses graded YG4 when fed to 1.4 cm of backfat, but no carcasses of steers fed to 1.0 cm backfat (P < .01) graded YG4. Implant treatment had no effect (P = .13) on percentage of carcasses grading YG 1, YG2, YG3, or YG4.

An intake level × implant type interaction (P < .01) occurred for carcass marbling score. Restricted-intake steers implanted with SYN and ad libitum-intake steers implanted with REV had marbling scores of Small^{60} and Small^{70}, respectively, which were lower (P < .05) than those of steers on all other treatments. All restricted-intake steers implanted with REV were intermediate except ad libitum-intake control steers, whose marbling score of Modest^{20} was higher (P < .01) than that of restricted × SYN, ad libitum × REV, and restricted × REV. Hicks et al. (1990) reported that marbling scores tended to be lower for steers with controlled intakes. Preston et al. (1996) reported that implants containing 30 mg of estradiol or a 1:10 ratio of estradiol and trenbolone acetate resulted in a 4% decrease in marbling score, which resulted in a reduction in the percentage of carcasses receiving a Choice grade. Herschler et al. (1995) reported that implants containing a 1:5 or 1:10 ratio of estradiol and trenbolone acetate decreased steer marbling score. However, Johnson et al. (1996) found that trenbolone acetate and estradiol in a combined implant had no effect on carcass marbling score.

The percentage of steers receiving a USDA Choice grade or better was determined from observed marbling scores. Ad libitum intakes resulted in an 11.35 and a 48.55% increase (P < .05) for percentage of carcasses receiving a Choice grade or better and an Average Choice grade or better, respectively. However, intake had no effect (P = .44) on percentage of carcasses receiving a Prime grade. Unpublished data by Bachman and Armbruster discussed in a review by Galyean (1999) showed the percentage of carcasses grading Choice decreased linearly as feed restriction increased. Feeding steers to a compositional target end point of 1.4 cm resulted in 28.79% more (P < .01) steers receiving a Choice grade or better and 97.88% more (P < .01) steers receiving an Average Choice grade or better, compared with steers fed to 1.0 cm backfat. Although 1.0 cm backfat has become a common target end point, these data show that, depending on the premiums available, the increased carcass quality and weight will more than offset the 2.9% reduction in feed efficiency resulting from delaying slaughter until the cattle reach 1.4 cm backfat. More (P < .05) control than SYN steers received a Choice grade or better, and REV steers were intermediate.

Implications

Implant responses in restricted-fed yearling steers are nearly as great as in those fed for ad libitum intake. A 9.2% reduction in feed intake is too severe for optimum performance and will reduce daily gains and may reduce efficiency. By feeding these steers the extra time to go from 1.0 to 1.4 cm backfat, feed efficiencies are further reduced; however, increases in carcass quality grade and weight may make it profitable. At 1.0 cm backfat, restricting intake 9.2% reduced the steers grading Choice or better by approximately 15 percentage units. Implants containing estrogen:trenbolone acetate ratios of 1:10 tended to be less efficacious than those containing ratios of 1:5.

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