Interactions in postweaning production of F_1 cattle from Hereford, Limousin, or Piedmontese sires[1,2]

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ABSTRACT: A 2-yr study was conducted to evaluate the interactions of castration, feeding length, and dietary CP on growth and carcass characteristics of male cattle (bulls and steers) that vary in expression of muscular hypertrophy. Crossbred cows were bred by AI to Hereford, Limousin, or Piedmontese bulls, which represented genotypes with normal, moderate, and hypermuscularity, respectively, but with similar mature weights. Male calves (131 in yr 1 and 120 in yr 2) were placed in pens with individual electronic feeding gates. Calves were fed growing diets until they reached 386 kg BW and then were individually switched to finishing diets for 90 or 132 d. Interactions were observed among sire breed, gender, and feeding length on carcass composition. Bulls were more efficient than steers in producing live weight gain. Length of finishing period accounted for a larger source of variation than gender for weight characteristics, whereas gender was the larger source of variation for carcass composition. Concentration or degradability of dietary CP influenced rate of gain from weaning to 386 kg. Interactions resulting from varying management on carcass characteristics among calves of different sire breeds indicate that unique strategies may be beneficial for the production of meat from these breeds.

Key Words: Breeds, Carcass Quality, Cattle, Growth, Muscle weight

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Introduction

Use of cattle breeds that express various degrees of muscle hypertrophy may be a way to increase production of a lean product. This trait can dramatically increase muscle size and decrease carcass fat. Hot carcass weight, dressing percentage, and longissimus muscle area have been reported to be greater in cattle heterozygous for a major gene causing muscle hypertrophy than for normal cattle (Baker and Lunt, 1990), but effects on carcass fat have varied. Several researchers have reported that meat from cattle heterozygous for this major gene is more tender than that from cattle that do not have this gene (West et al., 1973; Carroll et al., 1978; Tatum et al., 1990). Information is needed on the production characteristics of cattle with the genetic potential for muscular hypertrophy and their interaction with other management strategies.

Increased muscle mass could influence dietary protein requirements. Boucque et al. (1984) suggested that the protein requirement of Belgian Blue bulls was greater than that of other cattle. Burgher et al. (1990, 1991a,b) reported no interactions between breed and dietary protein concentration on growth or carcass characteristics of Belgian Blue × Holstein and Holstein steers. Because several studies in cattle without muscular hypertrophy have shown increased fat deposition with increased dietary CP (Martin et al., 1978; Anderson et al., 1988), the effect of altering dietary CP concentration and source should be evaluated with cattle heterozygous at the myostatin locus.

Gender can also greatly influence carcass traits. Intact males produce a carcass with less fat and more edible product than castrated males (Seideman et al., 1982). The objective of this study was to evaluate the interactions of castration, dietary CP, and feeding length on growth and carcass characteristics of male cattle that vary in degree of muscularity.

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Materials and Methods

Crossbred cows were bred by AI for 2 yr to normally muscled Line 1 Hereford sires (sire n = 22), moderately muscled Limousin sires (sire n = 24), or hypermuscular Piedmontese sires (sire n = 23). Sire breeds were chosen for their potential differences in muscling but similarities in size and growth rate. The crossbred cows were mainly ½ Red Angus, ¼ Charolais, and ¼ Tarentaise, but some also included Angus, Hereford, Simmental, and other Continental breeds in their genetic background. Male calves were randomly assigned within sire to be left intact or castrated at approximately 2 mo of age. Calves remained with their dams until approximately 6 mo of age. During this time, all cows were managed together and grazed either improved, irrigated pastures or native rangeland.

After weaning, male (bulls and steers) calves were placed into covered pens with individual electronic feeding gates (American Calan, Northwood, NH) with six animals per pen. In yr 1, 131 calves were used, and in yr 2, 121 calves were used. Bulls and steers were penned separately.

Calves were fed growing diets from weaning to 386 kg and were then individually switched to finishing diets for 90 or 132 d. Cattle were fed once each morning. Cattle were fed diets containing moderate or low protein (yr 1) or moderately or lowly degradable protein (yr 2) throughout both the growing and finishing periods (Table 1). Degradable protein concentrations for feeds were based on published values (NRC, 1989). Crude protein concentrations of alfalfa hay and corn silage in yr 1 were less than expected, resulting in dietary CP concentrations below the formulated concentrations. Low CP could limit response to dietary differences. Because of the low dietary protein concentrations associated with the diet fed in yr 1, a different diet was fed in yr 2. The moderate protein diet fed in yr 1 was formulated to have similar degradable protein concentration but higher undegradable protein concentration compared to the low-protein diet (Table 1). In yr 2, the two diets were similar in CP concentration, but the diets were formulated so that a greater proportion of protein in the diet containing blood meal was undegradable protein compared with the diet that did not contain blood meal.

Representative feed samples were collected monthly in yr 1 and weekly in yr 2. Samples were weighed, air-dried, and reweighed to determine a DM at air temperature. Samples were then ground to pass a 1-mm mesh screen in a Wiley mill and analyzed for DM, ADF (both AOAC, 1990), CP (Hach, 1987), and NDF (Robertson and Van Soest, 1977).

Cattle were weighed unshrunk every 28 d except when they approached 386 kg, at which time they were weighed weekly to determine the appropriate time to switch diets. Weighing was done in the morning approximately 24 h after feeding.

Longissimus muscle area and backfat thickness were determined by ultrasound scanning within 10 d of reaching 386 kg to determine the effect of growing diet on these characteristics. Measurements were made by one of two trained technicians using an Aloka 500V realtime ultrasound unit (Corometrics Medical Systems, Wallingford, CT) equipped with a 17-cm scanning width, 3.5-MHz linear array transducer. The transducer was placed across the longissimus muscle between the 12th and 13th ribs. Images were recorded in a computer and later measured for longissimus muscle area and backfat thickness with the AUSKey 2.0 (Animal Ultrasound Systems, Howell, MI) computer software package by one of the two technicians.

Cattle were slaughtered at a commercial abattoir using standard industry procedures. Hot carcass weight was measured the day of slaughter and other carcass measures were taken after 48 h of storage at 2°C.

Dressing percentage was calculated as 100 times the ratio of hot carcass weight to live weight taken 1 d before slaughter. Longissimus muscle area between the 12th and 13th sternal ribs was measured using a planar grid. Fat thickness over the longissimus muscle was taken at the 12th rib. The kidney, pelvic, and heart fat was estimated and recorded as a percentage of carcass weight. Marbling was evaluated by subjective comparison of the amount of fat within the longissimus muscle between the 12th and 13th ribs with photographic standards (National Livestock and Meat Board, 1981). Primal cuts of one-half of the carcass were weighed and included chuck, rib, short loin, sirloin, and round. Meat tenderness was determined on the longissimus muscle taken at the 12th rib on the left side of the carcass. After aging for 14 d, freezing, and storage, steaks were thawed at 5°C for 40 to 48 h and cooked to a 70°C internal temperature. After cooling for a minimum of 2 h, five cores, 1.27 cm in diameter, were taken parallel to the muscle fibers and Warner-Bratzler shear force was determined.

In yr 1, 36 additional bulls were used to evaluate the effect of sire breed on serum IGF concentrations during the growing phase. Twelve bulls of each sire breed were allotted to one of two diets. Diets were similar to the growing diet for yr 1 (Table 1), with the exception that no urea was included in the low-CP diet, and both diets contained monensin (Elanco Animal Health, Indianapolis, IN) at a rate of 22 mg/kg of diet on an as-fed basis. Bulls were housed without sheds in two pens, and one diet was fed in each pen. At approximately 290 kg, bulls were placed into metabolism crates. Bulls were fed once daily and feed intake was adjusted to 95% of ad libitum consumption. Feed intake averaged 69% of that of bulls not in metabolism crates.

On d 7, 9, and 11 a blood sample was collected via venipuncture of the tail vein of bulls in the metabolism crates. Blood was allowed to clot and serum was collected after 24 h and frozen until analysis for IGF-I. Insulin-like growth factor I analysis was conducted as

Table 1. Ingredient and chemical composition of diets fed to steers and bulls during the growing and finishing phases. Diets varied in crude protein (CP) in yr 1 and in undegradable intake protein in yr 2

	Year 1				Year 2			
	Growing diet		Finishing diet		Growing diet		Finishing diet	
Item	Low CP	Moderate CP	Low CP	Moderate CP	Low UIP	Moderate UIP	Low UIP	Moderate UIP
	% of							
Ingredient								
Corn silage	54.3	54.3	44.7	44.7	49.7	49.7	42.8	42.8
Rolled barley	33.4	30.7	54.0	51.5	30.9	28.8	56.1	55.6
Chopped alfalfa hay	10.4	10.4	—	—	14.1	14.1	—	—
Blood meal	—	1.9	—	—	—	2.9	—	0.7
Corn gluten meal	0.4	1.4	—	2.6	—	—	—	—
Soybean meal	—	—	—	—	3.8	3.8	—	—
Urea	0.2	—	0.1	—	0.8	—	0.2	—
Salt	0.6	0.6	0.5	0.5	0.2	0.2	0.2	0.2
Dicalcium phosphate	0.4	0.4	0.1	0.1	—	—	—	—
Limestone	0.2	0.2	0.5	0.5	0.4	0.4	0.6	0.6
Trace mineral mix[a]	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Chemical composition[b]								
DM	47.4	48.1	51.2	51.2	44.5	41.3	46.3	46.7
CP	10.2	12.1	9.5	10.1	12.8	13.4	11.8	11.5
NDF	40.5	39.5	37.9	37.9	—	—	—	—
ADF	20.1	19.6	18.0	17.9	17.2	21.5	14.8	15.5
Estimated DIP[c]	7.6	7.7	6.9	6.9	9.8	8.8	8.7	8.0
Estimated UIP[c]	2.6	4.4	2.6	3.2	3.0	4.9	3.1	3.5

[a]Trace mineral mix contained 20.0% Mg, 6.0% Zn, 5% Fe, 4% Mn, 2.7% S, 1.5% Cu, 0.11% I, 0.01% Co, and 0.01% Se.
[b]Measured values, DM basis.
[c]DIP = degradable intake protein, UIP = undegradable intake protein, estimated based on published values for individual feed ingredients (NRC, 1989).

described by Bramble et al. (1998). Intra- and interassay CV were 8.52 and 13.24%, respectively.

Data were analyzed using the General Linear Models procedure of SAS (SAS Inst. Inc., Cary, NC). Individual animal was the experimental unit used to test effects of gender, length of feeding, year, and all interactions. Sire breed was included in the model to allow for testing of interaction of sire breed with management. Length of feeding was not included in the model for measures collected during the growing phase. Diet within year was included in the model to account for the different diets fed in the 2 yr. If a significant effect of diet within year was observed, an analysis was run within year that included the interactions with other management factors. The model for analysis of IGF data included sire breed, dietary CP concentration, and the interaction with day of sampling as a repeated measure. For all analysis, effects were considered significant when $P < 0.05$ with a tendency toward significant differences when $P < 0.10$. Mean separation was by least significant difference when a significant F-test was observed.

Results and Discussion

In yr 1, cattle fed the moderate CP diet gained faster, ate more feed, and had greater feed conversion efficiencies than cattle on the lower-protein diet during the period from weaning to 386 kg (Table 2). This resulted in a decreased number of days required to reach 386 kg. This occurred even though CP concentrations for yr 1 were lower than anticipated and below estimated requirements (NRC, 1996). In yr 2, cattle fed the moderate UIP diet gained faster and had greater feed efficiencies during the growing period than cattle fed the low UIP diet. The number of days to reach 386 kg did not differ between treatments in yr 2 because of a tendency for a heavier initial weight in the group fed moderate UIP (232 kg) than in cattle fed low UIP (240 kg). Results for the 2 ys were consistent, indicating that a higher concentration of undegradable protein in the diet improved weight gain during the growing period from weaning to 386 kg. In yr 2, the cattle fed the moderate UIP diet tended to have a larger longissimus muscle area than cattle fed the low UIP diet when measured by ultrasonography at 386 kg. Backfat thickness at 386 kg did not differ with dietary protein treatment.

There were no interactions between dietary CP concentration and sire breed on growth of cattle up to 386 kg. Whereas research with purebred hypermuscular breeds of cattle has shown an increased protein requirement (Boucque et al., 1984; Fiems et al., 1995), research with crossbred cattle of these breeds has not (Burgher et al., 1990, 1991a).

There was no effect of dietary CP concentration within year on weight gains during the finishing phase or on carcass characteristics. Dietary compositional differences during this phase were less than during the

Table 2. Effects of dietary protein treatment within years on growth and ultrasound compositional measurements during the growing period (weaning to 386 kg) for male cattle

	Year 1		Year 2[a]			
Variable	Low protein	Moderate protein	Low UIP	Moderate UIP	SE	ANOVA *P*-value for treatment within year
ADG, kg/d	1.11	1.35	1.34	1.41	0.01	0.001
DM intake, kg/d	5.8	6.4	7.2	7.1	0.03	0.001
Feed efficiency, g gain/kg DMI	190	210	189	199	1.5	0.001
Days to reach 386 kg	143	119	99	99	1.3	0.001
Longissimus muscle area at 386 kg, cm^2	66.0	67.8	67.3	70.5	0.47	0.06
Backfat thickness at 386 kg, mm	2.8	1.4	6.6	3.3	0.65	0.27

[a]Protein supplement was based either on soybean meal + urea (low UIP) or blood meal + soybean meal (moderate UIP). UIP = undegraded intake protein.

growing phase. Due to unexpectedly low CP concentrations for yr 1, the ability to draw conclusions about CP effects during the finishing phase in this study is limited.

Steers gained 0.09 kg/d less and required 12 more days to reach 386 kg than bulls (Table 3). Feed efficiency averaged 14 g more live weight gain per kg DMI for bulls compared with steers, whereas DMI did not differ between the two. No interactions occurred between breed and gender during the growing period for growth characteristics. There was a tendency ($P = 0.06$) toward decreased backfat thickness in bulls compared to steers as measured by ultrasonography. Decreased fat deposition for bulls compared with steers is consistent with other research (Seideman et al., 1982).

Gender and length of finishing period accounted for most of the variation in carcass traits (Table 4), but some interactions occurred. Length of finishing period accounted for a larger source of variation than gender, as evidenced by the larger mean squares, for weight characteristics such as slaughter weight, hot carcass weight, and dressing percentage, whereas gender was the larger source of variation for the individual carcass components. The interaction of sire breed with length of finishing period and with gender for several carcass traits indicates a potential advantage to tailoring postweaning management to animal genotype for the production of meat, even for cattle of similar mature weight.

A three-way interaction among sire breed, gender, and length of finishing period occurred for hot carcass weight and shear force, and there was a tendency for this three-way interaction for slaughter weight and fat depth (Tables 4 and 5). Piedmontese-sired bulls finished for 132 d tended to be lighter than Hereford- or Limousin-sired bulls finished for the same length of time (Table 5). This difference averaged 30 kg. There were no differences in slaughter weight among other gender-finishing length combinations.

Due to differences in dressing percentage among breed-gender combinations (Table 6), the patterns for hot carcass weight were different from those for slaughter weight (Table 5). Hot carcass weight of steers was less for Hereford- than for Limousin- or Piedmontese-sired steers, which did not differ from one another, whether finished for 90 or 132 d. For bulls, length of finishing period affected the difference in hot carcass

Table 3. Main effects of gender and years on growth and ultrasound compositional measurements during the growing period (weaning to 386 kg) for male cattle

	Gender		Year			ANOVA *P*-value	
Variable	Bull	Steer	1	2	SE	Gender	Year
ADG, kg/d	1.35	1.26	1.23	1.37	0.01	0.001	0.001
DM intake, kg/d	6.6	6.6	6.2	7.1	0.03	0.94	0.001
Feed efficiency, g gain/kg DMI	204	190	200	194	1.5	0.001	0.11
Days to reach 386 kg	109	121	131	99	1.3	0.001	0.001
Longissimus muscle area at 386 kg, cm^2	68.5	67.3	66.9	68.9	0.47	0.23	0.11
Backfat thickness at 386 kg, mm	2.2	4.9	2.1	5.0	0.65	0.06	0.10

Table 4. Analysis of variance for growth during the finishing phase and carcass composition for bulls and steers (gender, G) sired by Hereford, Limousin, or Piedmontese bulls (sire breed, SB) and finished for 90- or 132-d (length of finishing period, LF)

Component	df	ADG, kg/d	DM intake, kg/d	Feed efficiency, g gain/kg DMI	Slaughter wt, kg	Hot carcass wt, kg	Dressing %	LMA[a], cm^2	Fat depth, mm	Marbling score	Wt of primal cuts, kg	KPH[b], %	Yield grade	Shear force, kg
		Mean square												
Yr	1	0.18*	1.20	736.9	2,514.2*	2,456.7**	14.8*	170.0†	6.6	1.1	163.0**	0.06	0.29	0.60
Sire breed	2	0.28**	1.82	5,996.5**	3,199.6*	1,585.8**	109.8**	3,477.4**	324.5**	74.3**	634.6*	2.54**	21.9**	0.25
SB × Yr	2	0.02	0.41	57.6	179.0	8.4	3.8	45.6	0.9	1.9	8.10	0.23	0.09	1.06
Gender	1	2.26**	0.002	31,812.9**	27,511.2**	13,746.1**	13.2*	3,083.4**	539.7**	432.9**	4,061.1**	23.72**	25.3**	0.02
G × Yr	1	0.19*	0.06	1,949.3†	2457.6*	408.9	4.2	151.7†	2.5	4.0	46.9	0.06	0.3	1.37
G × SB	2	0.09	0.71	2,300.2*	1,550.3†	264.5	6.9†	296.6**	58.3**	26.3**	21.4	0.93*	2.0**	0.87
G × SB × Yr	2	0.12†	0.004	1,589.8†	1,563.7†	628.8*	0.05	63.4	1.9	3.3	19.2	0.09	0.006	1.79*
Length of finishing period	1	0.35*	1.64	8,359.3**	93,248.2**	48,409.8**	55.4**	1,341.0**	78.6**	87.8**	3,270.4**	0.01	0.83*	2.45*
LF × Yr	1	0.18*	0.20	1,645.1†	3,047.4*	394.6	6.4	234.3*	2.0	4.1	5.1	0.14	0.65†	1.51†
LF × SB	2	0.03	1.12	1,186.6	882.9	613.4*	1.7	33.0	10.4†	5.6	77.2*	0.12	0.18	1.37†
LF × SB × Yr	2	0.01	1.17	1,025.3	150.9	99.1	0.8	80.7	0.3	1.6	14.7	0.18	0.22	0.04
LF × G	1	0.01	0.02	304.9	159.1	284.8	1.9	46.2	14.4†	6.5	108.7*	0.85†	0.006	0.64
LF × G × Yr	1	0.004	0.004	147.1	578.4	41.5	2.0	93.1	0.08	0.4	5.9	0.43	0.07	0.97
LF × G × SB	2	0.07	0.35	951.7	1,314.7†	673.3*	5.5	20.5	10.5†	6.5	34.4	0.38	0.21	1.99*
LF × G × SB × Yr	2	0.005	1.12	78.4	147.1	97.6	4.1	23.7	5.2	1.1	30.8	0.09	0.08	0.04
Diet within year	2	0.01	1.10	533.5	419.8	36.8	1.3	5.5	0.7	0.8	18.5	0.45	0.07	0.69
Sire within breed	66	0.05	0.86	788.7†	743.1*	266.4*	3.2	51.3	6.9**	4.8*	29.7**	0.19	0.18	0.54
Error MS	159	0.044	0.84	596.2	531.56	190.56	2.60	50.0	4.28	3.25	18.62	0.247	0.196	0.535

[a]LMA = longissimus muscle area.
[b]KPH = Kidney, pelvic, and heart fat.
*, **, †Significant at the 0.05, 0.01, and 0.10 levels, respectively.

Table 5. Interaction of gender, sire breed, and length of finishing period on performance and carcass characteristics of bulls and steers sired by Hereford, Limousin, or Piedmontese bulls and finished for 90 or 132 d

Item and length of finishing period	Hereford		Limousin		Piedmontese		
	Bull	Steer	Bull	Steer	Bull	Steer	SE
Slaughter wt[a], kg							
90 d	529	503	525	508	520	498	1.45
132 d	576	538	587	553	551	547	
Hot carcass wt[b], kg							
90 d	307	286	302	297	314	296	0.87
132 d	336	313	351	327	340	329	
Shear force[b], kg							
90 d	3.49	4.12	3.44	3.63	3.71	3.18	0.05
132 d	3.41	3.04	3.48	3.51	3.40	3.34	
Fat depth[a], mm							
90 d	5.4	9.4	5.3	8.0	2.9	4.4	0.13
132 d	6.2	13.1	6.2	8.4	3.4	5.9	
Primal cuts[e], kg[cd]							
90 d	81.5	73.1	80.9	76.1	87.7	78.2	0.27
132 d	89.6	78.1	94.9	84.1	95.5	86.0	

[a]Gender × sire breed × length of finishing period interaction, $P < 0.10$.
[b]Gender × sire breed × length of finishing period interaction, $P < 0.05$.
[c]Sire breed × length of finish interaction, $P < 0.05$.
[d]Gender × length of finishing period interaction, $P < 0.05$.
[e]Primal cuts = weight of chuck, rib, shortloin, sirloin, and round for one-half of the carcass.

weight among sire breeds. When fed for 90 d, hot carcass weight of Piedmontese-sired bulls was greater than that of Hereford- and Limousin-sired bulls. When finished for 132 d, Hereford- and Piedmontese-sired bulls did not differ in hot carcass weight, but both had lighter carcasses than Limousin-sired bulls.

Extending the length of finishing period from 90 to 132 d had the largest impact on shear force of Hereford-sired steers, decreasing it 26% (Table 5). Piedmontese-sired bulls also had a decrease in shear force with increasing length of finishing period. Increasing length of finishing period did not decrease shear force in other gender-sire breed combinations. Other researchers have shown decreased shear force values with increasing time on feed (Aalhus et al., 1992). Aberle et al. (1981) found improved tenderness with increasing time on a high-energy diet up to 70 d, but only very minor improvement after this time.

The comparison of the effect of sire breed on weight of primal cuts was affected by length of finishing period (Table 5). After 90 d on the finishing diet, Hereford- and Limousin-sired cattle did not differ in primal cut weights, whereas at 132 d Limousin-sired cattle had greater weight of primal cuts than Hereford-sired cattle. Piedmontese-sired cattle had greater primal cut weight than the other sire breeds at both finishing lengths. There was also a length of finishing period × gender interaction for primal cut (Table 5) due to a

Table 6. Performance and carcass characteristics affected by an interaction of gender (bull vs steers) and sire breed (Hereford-, Limousin-, or Piedmontese-sired) during the finishing period

Item	Hereford		Limousin		Piedmontese		
	Bull	Steer	Bull	Steer	Bull	Steer	SE
ADG, kg/d	1.46	1.18	1.49	1.27	1.32	1.18	0.01
Feed efficiency[ab], g gain/kg DMI	168	132	178	150	151	138	1.5
Longissimus muscle area[c], cm^2	86.7	74.0	88.6	82.2	92.4	97.1	0.45
Dressing percentage	58.1	57.7	58.6	58.7	61.0	59.8	0.10
Marbling score[cd]	9.8	13.5	9.9	11.4	7.7	11.4	0.11
Kidney, pelvic and heart fat[a], %	1.9	2.5	2.1	2.6	1.5	2.6	0.03
Yield grade[c]	1.8	3.0	1.8	2.4	1.0	1.5	0.03

[a]Gender × sire breed interaction, $P < 0.05$.
[b]Tendency for gender × sire breed × year interaction, $P < 0.10$.
[c]Gender × sire breed interaction, $P < 0.01$.
[d]Marbling score, 1 = devoid to 28 = abundant.

Table 7. Effect of length of finishing period on performance during the finishing phase and carcass characteristics of bulls and steers sired by Hereford, Limousin, or Piedmontese bulls and finished for 90 or 132 d

Item	Length of finishing period, d		
	90	132	SE
ADG[a], kg/d	1.36	1.27	0.01
Feed efficiency[b], g gain/kg DMI	160	146	1.5
Dressing percentage[b]	58.5	59.6	0.10
Longissimus muscle area[b], cm^2	84.1	89.5	0.45
Marbling score[bc]	9.9	11.3	0.11
Yield grade[a]	1.9	2.0	0.03

[a]Effect of length of finishing period, $P < 0.05$.
[b]Effect of length of finishing period, $P < 0.01$.
[c]Marbling score, 1 = devoid to 28 = abundant.

greater increase in primal weight between 90 and 132 d of finish for bulls (10 kg) than for steers (6.9 kg).

Piedmontese-sired bulls had less backfat than any other gender-sire breed combination, whether finished for 90 or 132 d (Table 5). Piedmontese- and Hereford-sired steers increased backfat thickness between 90 and 132 d, whereas Limousin-sired steers did not. The greatest increase in backfat thickness was for Hereford-sired steers, with an increase of 3.7 mm over 42 d.

Several researchers have reported little improvement in palatability of beef once backfat thickness over the 12th rib has reached 7.6 to 10 mm for both bulls and steers (Dolezal et al., 1982; Riley et al., 1983; May et al., 1992). This effect of backfat thickness on palatability may be related to carcass cooling time due to a potential decrease in cold shortening (Smith et al., 1976). Hereford- and Limousin-sired steers were beyond this quantity of backfat by 90 d of finishing in this system. Piedmontese-sired steers did not reach 7.6 mm of backfat by 132 d. Wheeler et al. (1996), however, found Piedmontese-sired steers to have a more desirable combination of palatability traits compared to several other breeds, even though fat thickness was less than in some breeds, including Hereford-Angus. Hereford and Limousin-sired bulls reached 6.2 mm of backfat by 132 d of feeding, whereas Piedmontese-sired bulls averaged only 3.3 mm of backfat after 132 d of feeding a finishing diet.

Other fat measures showed gender × sire breed interactions (Table 6) but not a three-way interaction that included length of finishing period. Marbling score was lower in bulls than in steers, but within gender, the ranking of sire breeds differed. For bulls, marbling score did not differ between Hereford- and Limousin-sired bulls, but these sire breeds had greater marbling than Piedmontese-sired bulls. Limousin- and Piedmontese-sired steers had less marbling than Hereford-sired steers.

Kidney, pelvic, and heart fat of bulls averaged about 71% that of steers, with a gender × sire breed interaction (Table 6). The kidney, pelvic, and heart fat did not differ among sire breeds in steers, but Limousin-sired bulls had greater kidney, pelvic, and heart fat than Hereford-sired bulls, which had greater kidney, pelvic, and heart fat than Piedmontese-sired bulls. The influence of gender on fat characteristics differed from those reported by Steen and Kilpatrick (1995), who found gender effects to be greater for internal fat measures than for carcass fat. We found gender effects on backfat depth to be greater than those for either marbling or kidney, pelvic, and heart fat.

There was also a tendency for a gender × length of finishing period interaction for kidney, pelvic, and heart fat; there was a greater difference between bulls and steers at 132 d (0.83%) than at 90 d (0.56%) on the finishing diet.

Bulls had larger longissimus muscle area than steers, but the rankings of sire breed within gender differed (Table 6). Piedmontese-sired cattle had larger longissimus muscle area than other sire breeds, whether bulls or steers. Between Limousin- and Hereford-sired cattle, longissimus muscle area did not differ in bulls but was greater in Limousin- than in Hereford-sired steers.

A combination of differences in fat and muscle characteristics resulted in a breed × gender interaction for yield grade (Table 6). Piedmontese-sired cattle had the lowest yield grade, whether fed as bulls or steers. Limousin-sired bulls did not differ in yield grade from Hereford-sired bulls, but Limousin-sired steers had lower yield grades than Hereford-sired steers.

Average daily gain decreased with increasing time on feed (Table 7). This resulted in a decrease in efficiency of utilization of feed for BW gain during the last 42 d on feed. Length of finishing period had direct effects on dressing percentage, longissimus muscle area, marbling score, and yield grade; all values increased with increasing length of finishing period (Table 7). In contrast, Tatum et al. (1990) did not observe any effect of increasing time on feed on dressing percentage, and they found a length of finishing period × sire breed interaction on marbling score.

Serum IGF-I values of bulls differed due to sire breed. Serum IGF-I concentrations were lower for Limousin-sired bulls (165 ± 1.3 ng/mL) than for Hereford-sired (268 ± 1.6 ng/mL) or Piedmontese-sired (215 ± 1.5 ng/mL) bulls. Hereford-sired bulls tended to have higher serum IGF-I concentrations than Piedmontese-sired bulls. Bulls fed high or low dietary CP did not differ in IGF-I concentrations. This is consistent with research indicating little effect of moderate changes in diet quality on circulating IGF-I (McGuire et al., 1992), including work by Fiems et al. (1995), who did not report any differences in IGF-I concentrations for Belgian Blue bulls fed three concentrations of dietary CP.

Implications

Crossbred cattle with potential for muscular hypertrophy can be used to produce a large quantity of a lean, tender product. Cattle produced from some sire breeds with this trait may be less efficient at gaining live weight. Interactions among sire breed, gender, and length of finishing period for production traits requires careful evaluation of the growing and finishing strategies used in producing carcasses from various types of cattle. Interactions among sire breed and sex were the most common. The interaction of sire breed with length of finishing period and with sex for several carcass traits indicates a potential advantage to tailoring postweaning management to animal genotype for the production of meat, even for cattle of similar mature weight.

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