Impact of Days Fed on Holstein Bull and Steer Performance and Cutability of Cattle Pen-Fed Organic Diets

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Summary with Implications

Performance, carcass characteristics, and total meat yield of Holstein bulls and steers were compared in a simulated organic production system with the goal of producing ground beef. Holstein bulls (n = 120, initial BW = 487 lb) and steers (n = 120, initial BW = 471 lb) of the same age were blocked by BW and assigned randomly to be harvested at 308, 343, 378, and 413 days on feed. After harvest, all meat off the carcass was considered trim and was collected and weighed to calculate total trim yield. Bulls gained faster and had greater live body weight, carcass weight, and trim yield than steers. Steers showed greater linear increases in marbling scores and fat composition of trim yield as days on feed increased than bulls. Increasing days on feed linearly increased feed intake, live body weight, carcass weight, and trim yield. Bulls had greater feed costs per animal than steers but castration had no effect on feed cost of gain. Feed cost per pound of trim yield increased linearly as days on feed increased. Feeding bulls may increase profitability in a ground beef production system that is not penalized for low quality beef.

Introduction

The use of steroidal hormones in beef cattle production has been approved since the 1950s. Use of a hormonal implant can increase average daily gain (ADG) and feed efficiency by up to 20% and 13.5%, respectively. This is due to the anabolic effect steroidal hormones like estrogen and testosterone or synthetic analogues of those compounds have on muscle tissue. However, use of hormonal implants and other growth promoting technologies are banned in an organic beef production system. To compensate for the loss of technology and therefore a loss in performance, one option may be to leave male calves intact. When compared to steers, bulls have greater hot carcass weight (HCW) and longissimus muscle (LM) area but less tender meat and reduced marbling scores.

The hypothesis was that bull calves would have increased muscle mass thereby increasing body weight (BW), ADG, and LM area compared to steers and that both steers and bulls would have increased final live BW, hot carcass weight (HCW), and LM area as the length of the feeding period increased. The objective of this study was to compare the performance, carcass characteristics, and total meat yield of Holstein bulls and steers fed an increasing number of days in a simulated organic production system.

Table 1. Diets fed to Holstein bulls and steers in five phases to simulate an organic production system

	Feeding Phase				
Ingredient, %DM	d 1 to d 63	d 64 to d 126	d 127 to d 189	d 190 to d 252	d 253 to Harvest
Dry Rolled Corn	31.0	40.0	53.0	60.2	65.0
Alfalfa Haylage	30.0	30.0	30.0	30.0	30.0
Fish Meal	4.0	3.0	2.0	0.8	0.0
Field Peas	30.0	22.0	10.0	4.0	0.0
Supplement[1]	5.0	5.0	5.0	5.0	5.0

[1]Supplement consisted of fine ground corn carrier with trace minerals, vitamins A-D-E, and limestone

Procedure

Holstein bulls (*n* = 120, initial BW = 487 lb, SD = 35.3) and steers (*n* = 120, initial BW = 471 lb, SD = 26.5) were fed at the research feedlot at the Eastern Nebraska Research, Extension, and Education Center (ENREEC) located near Mead, NE. All calves were born at dairies in IA, were similar in age, and were grown at the same facility in South Dakota after weaning until study initiation. Calves were assigned to be castrated or left intact by the preweaning facility that raised them by castrating every other animal in the group. Calves assigned to castration were castrated using elastic bands at 4 wk of age and were weaned off of milk at 8 wk of age. Cattle were processed upon arrival and were given an individual identification number. Calves were vaccinated with the combination intranasal vaccine Inforce 3 (Zoetis), One Shot BVD (Zoetis), Ultrabac-7/Somubac (Zoetis), and injectable doramectin (Dectomax, Zoetis).

Bulls and steers were blocked by BW into three blocks and assigned randomly to be harvested at 308, 343, 378, and 413 days on feed (DOF). The initial harvest date of 308 DOF was selected to achieve a minimum live BW of 1100 lb, and successive harvest dates were spaced at 35 d intervals. Cattle were housed in earthen pens with 10 calves per pen. Treatments were arranged in a 2 × 4 factorial with castration status and DOF, with each of the three BW blocks represented once for bulls and steers within each assigned harvest date.

Before trial initiation, cattle were limit-fed a diet of 50% alfalfa hayage and 50% Sweet Bran (Cargill) at 2% of BW from d -4 to d 0 to reduce variation in gut fill. Cattle were then weighed on d 0 and d 1 of the study in the morning before feeding and those weights were averaged to determine initial BW. Final live BW was collected

Table 2. Simple effects of castration and days on feed on performance and carcass characteristics of Holstein bulls and steers fed a common diet for different days

	Steers				Bulls					*P*-Value[2]				
Item	308[1]	343	378	413	308	343	378	413	SEM	CAST	L	Q	L int	Q int
No. of animals (pens)	30(3)	30(3)	28(3)	30(3)	28(3)	26(3)	28(3)	30(3)	-	-	-	-	-	-
Initial BW, lb	474	472	473	472	484	490	485	488	3.6	<0.01	0.78	0.87	0.61	0.77
DMI, lb/d	20.1	19.7	20.3	20.6	20.9	20.8	21.4	22.6	0.58	<0.01	0.05	0.25	0.36	0.73
DMI, % of average BW[3]	2.49	2.42	2.40	2.33	2.49	2.40	2.40	2.41	0.041	0.44	<0.01	0.16	0.24	0.52
Live Performance														
Final BW, lb	1138	1153	1253	1301	1188	1250	1310	1383	25.5	<0.01	<0.01	0.55	0.73	0.77
ADG, lb/d	2.16	1.98	2.06	2.01	2.29	2.22	2.19	2.17	0.066	<0.01	0.09	0.38	0.97	0.81
F:G	9.26	9.90	9.80	10.31	9.09	9.35	9.80	10.42	-	0.31	<0.01	0.97	0.35	0.52
Carcass Characteristics														
Hot Carcass Weight, lb	638	659	727	754	685	725	738	796	20.3	0.01	<0.01	0.68	0.60	0.86
Dressing Percentage, %	56.1	57.1	58.0	58.0	57.6	58.0	56.3	57.5	0.81	0.96	0.37	0.91	0.12	0.44
Marbling Score[4]	433	485	479	549	336	345	342	357	15.2	<0.01	<0.01	0.59	0.01	0.81
Fat Depth, in	0.17	0.16	0.19	0.20	0.08	0.06	0.06	0.07	0.014	<0.01	0.24	0.19	0.17	0.73
LM Area, in^2	9.3	9.4	10.4	10.4	11.5	12.1	12.3	12	0.36	<0.01	0.01	0.37	0.26	0.45
Calculated Yield Grade	2.7	2.7	2.7	2.8	1.9	1.8	1.8	2.1	0.09	<0.01	0.11	0.07	0.53	0.25
Trim Yield, lb/animal	460.5	460.1	513.5	532.5	483.5	527.6	530.1	584.8	18.05	<0.01	<0.01	0.56	0.75	0.86
Trim Yield, % of HCW	72.2	69.7	70.6	70.6	70.8	72.7	71.8	73.4	0.91	0.05	0.61	0.46	0.09	0.31
Trim Fat, %	8.8	12.0	15.8	15.2	8.1	7.5	7.8	5.7	1.60	<0.01	0.35	0.19	0.01	0.77
Trim Lean, %	91.2	88.0	84.2	84.8	92.0	92.5	92.2	94.3	1.60	<0.01	0.35	0.19	0.01	0.77
Trim Fat, lb/animal	40.4	57.8	81.0	80.2	37.3	40.3	40.0	33.0	10.49	<0.01	0.05	0.29	0.02	0.75
Trim Lean, lb/animal	428.3	402.3	432.5	452.3	433.7	487.3	490.1	551.9	25.93	<0.01	<0.01	0.41	0.10	0.55

[1]Average days on feed

[2] CAST = castration status; L = linear response for main effect of days on feed (DOF), Q = quadratic response for main effect of DOF, L int = linear interaction between castration status and linear DOF, Q int = quadratic interaction between castration and quadratic DOF

[3]This was calculated as the average lb of DMI over the feeding period divided by the average Live BW over the feeding period

[4]Marbling Score: 300 = Slight^{00}, 400 = Small^{00}, 500 = Modest^{00}

using a pen scale, shrunk 4%, and averaged over the number of animals in the pen. Final live BW was calculated only using the weights of the pens that were scheduled to harvest in that event. Final BW was used to calculate average daily gain (ADG).

All cattle were fed a common diet with 30% alfalfa haylage and 5% supplement with dry rolled corn, field peas, and fish meal included at differing proportions to meet metabolizable protein requirements as BW increased over time (Table 1). The supplement was a dry meal with fine ground corn as a carrier and contained limestone, salt, vitamins A-D-E, and trace minerals. Feeds were conventionally grown and processed; however, the diet was designed to mimic the requirement of organic beef production where grazed forage needs to be a minimum of 30% of diet dry matter during the grazing season. In this study, cattle were fed in pens and forage maintained at 30% of diet DM to represent a worst-case scenario of cattle requiring delivered feed year-round. Feed was delivered once daily and feed refusals were collected as needed, weighed, and a subsample was dried in a forced-air oven at 60°C for 48 h to calculate dry matter refusals and accurately estimate dry matter intake (DMI).

Table 3. Simple effects of castration and days on feed on feed cost of gain of Holstein bulls and steers fed a common diet for different days

	Steers				Bulls					*P*-Value[2]				
Item	308[1]	343	378	413	308	343	378	413	SEM	CAST	L	Q	L int	Q int
Total Feed Cost, $/animal[3]	1295	1396	1622	1724	1358	1641	1738	1886	47.3	<0.01	<0.01	0.33	0.59	0.33
Total BWG, lb/animal	665.0	681.0	779.7	828.7	704.3	760.3	825.7	894.7	23.81	<0.01	<0.01	0.51	0.76	0.77
Trim Yield, lb/animal	460.5	460.1	513.5	532.5	483.5	527.6	530.1	584.8	18.05	<0.01	<0.01	0.56	0.75	0.86
Feed COG, $/lb BWG	1.95	2.06	2.09	2.08	1.93	2.16	2.10	2.10	0.048	0.40	<0.01	0.02	0.90	0.40
Feed Cost, $/lb TY	2.82	3.04	3.16	3.24	2.81	3.11	3.28	3.23	0.097	0.55	<0.01	0.09	0.95	0.48

[1]Average days on feed

[2] CAST = castration status; L = linear response for main effect of days on feed (DOF), Q = quadratic response for main effect of DOF, L int = linear interaction between castration status and linear DOF, Q int = quadratic interaction between castration and quadratic DOF

[3]Prices used for calculation on a DM basis: fish meal = $1933.80/ton after a 5% shrink; field peas = $622.40/ton after a 5% shrink; dry rolled corn = $403.68/ton after a 2% shrink; alfalfa haylage = $290.74/ton after a 15% shrink

Cattle were harvested at JBS in Omaha, NE over a period of 3 days for each harvest event in the order of heavy block, middle block, and light block so that identification of individual carcasses could be preserved through fabrication. Individual HCW was collected at harvest. Dressing percentage (DP) was calculated using the pen average of HCW and final live BW. Following a 24-h chill, 12th-rib fat depth, longissimus muscle (LM) area, and marbling score were collected. Kidney-pelvic-heart (KPH) fat was assumed to be 1.5% for all animals in all harvest events, and yield grade was calculated. Preliminary yield grade was used to calculate 12th-rib fat thickness. At fabrication, carcasses from each pen were deboned and all meat was treated as boneless trim, collected in combo bins, and weighed to obtain trim yield. Samples of each combo bin of trim were collected by JBS employees and were used to measure fat and lean composition of the trim, which was also used to calculate yields of fat trim and lean trim.

A feed cost of gain analysis was conducted using the prices of organic feed applied to the DMI to calculate total feed costs for each treatment group. Prices used for calculation on a DM basis were as follows: fish meal = $1933.80/ton after a 5% shrink; field peas = $622.40/ton after a 5% shrink; dry rolled corn = $403.68/ton after a 2% shrink; alfalfa haylage = $290.74/ton after a 15% shrink. Feed costs were expressed on a per animal basis. Total live BW gain (BWG) and trim yield in lb/animal were used to calculate feed cost of gain per lb of BWG or feed cost per lb trim yield. Data such as yardage, veterinary costs, and death loss were not included in this analysis.

Data were analyzed as a randomized complete block design using the GLIMMIX procedure of SAS (9.3, SAS Institute Inc., Cary, NC) and means were estimated using the LSMEANS option of SAS. Pen was the experimental unit and block was considered a fixed effect. Linear and quadratic interactions between DOF and castration and linear, quadratic, and cubic effect of DOF were examined using contrasts.

Results

Bulls had heavier initial BW and 6.0% greater final BW than steers ($P < 0.01$). Compared to steers, bulls had 7.5% greater ADG ($P < 0.01$) and greater DMI in lb/d ($P < 0.01$). However, no difference was observed in DMI between bulls and steers when expressed as a percent of average BW ($P = 0.44$). No difference in F:G was observed for castration status ($P = 0.31$).

Bulls had 5.9% greater HCW than steers ($P = 0.01$); however, dressing percentage was not different between bulls and steers ($P = 0.96$). Bulls had 21.1% greater LM area and 8.1% greater trim yield in lb/animal than steers ($P < 0.01$). Bulls also had greater trim yield as a percent of HCW than steers ($P \leq 0.05$). Steers had greater 12th-rib fat depth than bulls ($P < 0.01$). Trim lean in lb/animal was 14.4% greater for bulls than for steers ($P < 0.01$). A tendency for an interaction between castration status and DOF was observed for trim yield as a percent of HCW ($P = 0.09$) as bulls tended to increase in trim yield as a percent of HCW over time while steers did not. A tendency for an interaction was also observed for trim lean in lb/animal ($P = 0.10$) as bulls tended to increase in trim lean at a greater rate than steers as DOF increased. There was a linear interaction between castration status and DOF for marbling score, with both steers and bulls increasing in marbling score over time but steers increasing at a greater rate ($P < 0.01$). Linear interactions between castration status and DOF were observed for trim lean percentage, trim fat percentage, and trim fat in lb/animal ($P \leq 0.02$) because steers increased in fat content of trim yield as DOF increased, while bulls appeared to maintain or decrease in trim fat content while trim lean percentage increased as DOF increased. Bulls had lower YG than steers ($P < 0.01$), which was driven by bulls having greater LM area and HCW and decreased 12th-rib fat depth compared to steers.

Final BW and DMI in lb/d increased linearly for both bulls and steers across days on feed ($P \leq 0.05$). A linear increase in F:G and a linear decrease in DMI as a percent of average BW was observed with increasing DOF ($P < 0.01$). A tendency for a linear decrease in ADG was observed as DOF increased ($P = 0.09$).

Carcass weights increased linearly as DOF increased ($P < 0.01$), but no change in DP ($P = 0.37$) or YG ($P = 0.11$) was observed over time. Longissimus muscle area increased as DOF increased ($P = 0.01$). Trim yield as a percent of HCW did not change as DOF increased ($P = 0.61$); however, trim yield in lb/animal increased as DOF increased ($P < 0.01$). No change in 12^{th}-rib fat depth was observed over DOF ($P = 0.24$). Lean trim in lb/animal increased as DOF increased ($P < 0.05$). The interaction of DOF and castration observed for fat content of the trim was likely influenced by the increase in marbling scores in steers and the increase in LM area observed in bulls as DOF increased.

Total feed cost increased as DOF increased, and bulls had higher total feed costs than steers ($P < 0.01$; Table 3). No difference due to castration status was observed for cost of BWG or feed cost per lb trim yield ($P \geq 0.40$). Feed cost of BWG increased in both a linear and quadratic fashion as DOF increased ($P \leq 0.02$). Feed cost of trim yield increased linearly as DOF increased ($P < 0.01$). A tendency for a quadratic increase in cost of trim yield was also observed ($P = 0.09$). This indicates that feed cost of trim yield increases as DOF increases, while the feed cost of BWG increases at a decreasing rate as DOF increases. No linear or quadratic interactions between castration status and DOF were observed for any variable examined in the cost of gain analysis ($P \geq 0.33$).

Conclusion

Bulls had greater live BW, HCW, and trim yield than steers when fed the same number of days. Steers showed greater linear increase in marbling scores and proportion of trim fat as DOF increased compared to bulls. Bulls had leaner carcass composition over time. Increasing DOF linearly increased live BW, HCW, and trim yield. Feeding bulls in an organic production system may result in an increase in saleable product but did not impact feed cost of gain. However, meat quality is significantly influenced. Feeding bulls may increase profitability in a ground beef production system that is not penalized for low quality beef.

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