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Association of Inactive Myostatin in Piedmontese-Influenced Steers and Heifers on Performance and Carcass Traits at Different Endpoints

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Summary

Performance and carcass traits were evaluated using Piedmontese-influenced calf-fed steers and yearling heifers genotyped for zero, one, or two copies (homozygous active, heterozygous, or homozygous inactive, respectively) of the inactive myostatin allele. Steers and heifers had similar responses across genotypes in performance and carcass traits evaluated at different endpoints. Inactive myostatin decreased DMI, final BW (live), and ADG (live). Increased dressing percentage resulted in increased carcass-adjusted ADG and improved feed conversion for cattle with inactive myostatin. Cattle with inactive myostatin are leaner with larger LM area when finished to equal carcass weight.

Introduction

Myostatin regulates the development and maturation of skeletal muscle mass. Mutations found within this gene produce inactive myostatin (IM) protein which leads to dramatic increases in muscle development through hyperplasia and hypertrophy of muscle fibers (i.e., double muscling). The objective was to investigate the potential association of inactive myostatin on the performance and carcass traits of Piedmontese-influenced steers and heifers.

Procedure

Two years of Piedmontese-influenced calf-fed steers (n = 117; 590 ± 66 lb) and yearling heifers (n = 119; 776 ± 119 lb) on an all-natural program were fed common finishing diets for an average of 211 and 153 days, respectively. Animal genotypes were confirmed by DNA testing as having zero, one, or two copies of the inactive myostatin allele, which corresponds to homozygous active (ACTIVE), heterozygous (HET), and homozygous inactive (INACTIVE), respectively. Calf-fed steers included 39 ACTIVE, 50 HET, and 28 INACTIVE. Yearling heifers included 44 ACTIVE, 46 HET, and 29 INACTIVE.

Cattle were individually-fed using Calan electronic gates in groups of 60 steers (calf-feds) or 60 heifers (yearlings). Common finishing diets consisted of 35% wet distillers grains plus solubles, 52% high-moisture:dry-rolled corn blend, 8% grass hay, and 5% supplement (year 1; DM basis); and 20% *Sweet Bran*®, 20% modified distillers grains plus soluble, 48% high-moisture:dry-rolled corn blend, 8% grass hay, and 4% supplement (year 2; DM basis). Cattle received no implants and diet supplements contained no feed additives.

Cattle were limit fed for 5 days on a diet with a 1:1 ratio of alfalfa hay:*Sweet Bran*® and 5% supplement (DM) at 2% BW which was then followed by three consecutive days BW collection for an average initial BW. Limit feeding followed three to four weeks of training to the Calan gates. Steers and heifers were serially weighed and scanned by a certified ultrasound technician at initiation and 28-day intervals throughout each feeding period. Carcass ultrasound measurements collected included LM muscle area, 12th rib fat thickness (uRIBF), rump fat thickness and intramuscular fat percentage.

Animal final BW were calculated as 1) a live final BW basis with two days consecutive BW shrunk 4% prior to shipment for harvest, and 2) a carcass-adjusted final BW basis at a common dressing percentage of 63%. Cattle were harvested at a commercial packing plant where HCW was collected and used to determine dressing percentage and carcass-adjusted final BW. After a 60-hour chill, LM area, USDA marbling, 12th rib fat thickness, and estimated KPH were recorded. A calculated USDA yield grade was determined from HCW, LM area, 12th rib fat thickness, and estimated KPH. Average daily gain and feed conversions were calculated for both live final BW and carcass-adjusted final BW.

Statistical Analysis

Within group, serial ultrasound data and BW were used to develop regression equations within genotype class. Regression equations were used to adjust individual animals to common endpoints determined by the overall mean of animals within gender for age, live BW, and uRIBF. Evaluations of endpoint adjustments demonstrate the dramatic differences between genotypes at a common age, BW, or fatness. All traits were analyzed using orthogonal contrasts based on genotype (HET vs average of ACTIVE and INACTIVE to test for a dominance effect, and ACTIVE

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vs INACTIVE to test for an additive genetic effect) in the MIXED procedure of SAS (SAS Inst., INC., Cary, N.C.). Individual animal was the experimental unit, with genotype was treated as a fixed effect. Year was considered a random effect. Steer age was used as a covariate in the model for performance, carcass, and carcass-adjusted performance (Table 1) due to differences in age at the start. No covariate was used in heifer analysis (Table 2) due to lack of significance.

Results

Steers

Steers with inactive myostatin were younger calves ($P < 0.01$). There was a quadratic response ($P = 0.04$) in initial BW with HET and ACTIVE being heavier than INACTIVE steers. Homozygous inactive steers had lower ($P < 0.01$) live final BW, live ADG and DMI than ACTIVE with HET intermediate. Homozygous inactive steers had the lowest ADG but the decrease in DMI resulted in a quadratic tendency, or dominance effect, ($P = 0.07$) for improved F:G for INACTIVE steers, with HET more similar to ACTIVE. Hot carcass weights were similar ($P = 0.18$) between all genotypes, although numerically lower for INACTIVE.

Regardless, dressing percentage was dramatically increased for INACTIVE steers (67.3%) compared to HET (63.7%) and ACTIVE (63.0%). LM area responded quadratically ($P = 0.05$) with IM presence, which was greatest for INACTIVE, intermediate for HET, and smallest for ACTIVE. Rib fat thickness, marbling and calculated yield grade linearly decreased ($P < 0.01$) with increasing inactive myostatin. Due to similar HCW between genotypes, ADG calculated from carcass-adjusted final BW responded quadratically ($P = 0.05$) with greatest gains for INACTIVE, followed by ACTIVE, and the lowest gains for HET. Carcass-adjusted feed conversion improved quadratically ($P < 0.01$) with

Table 1. Steers live BW performance, carcass-adjusted BW performance, and carcass traits.

	Myostatin[1]				*P*-value[2]	
Performance traits	ACTIVE	HET	INACTIVE	SEM	Lin.	Quad.
Age, day	480	472	464	29	< 0.01	0.96
Initial BW, lb	591	601	544	98	0.04	0.04
DMI, lb/day	18.9	17.1	15.0	0.9	< 0.01	0.69
Live BW[3]						
Final BW, lb	1132	1099	1015	22	< 0.01	0.27
ADG, lb/day	2.56	2.35	2.26	0.07	< 0.01	0.43
F:G[7]	7.30	7.25	6.67	—	< 0.01	0.07
Carcass-adjusted BW[4]						
Final BW, lb	1131	1110	1085	23	0.18	0.93
ADG, lb/day	2.53	2.39	2.58	0.08	0.72	0.05
F:G[7]	7.41	7.09	5.88	—	< 0.01	< 0.01
Carcass traits						
HCW, lb	712	699	684	15	0.18	0.93
Dress, %	62.98	63.69	67.26	1.43	< 0.01	< 0.01
Marbling[5]	597	453	283	34	< 0.01	0.57
LM area, in^2	12.42	14.55	15.51	2.21	< 0.01	0.05
12th rib Fat, in	0.51	0.28	0.13	0.03	< 0.01	0.26
CYG[6]	2.98	1.68	0.71	0.58	< 0.01	0.31

[1]Myostatin: homozygous active (ACTIVE), heterozygous (HET), and homozygous inactive (INACTIVE)
[2]*P*-value: Lin. = linear response to inactive myostatin and Quad. = quadratic response to inactive myostatin
[3]Live BW collected on two consecutive days prior to shipment, shrunk 4%
[4]Carcass-adjusted BW calculated at 63% dressing
[5]Marbling score: 500 = SM, 400 = SL, 300 = TR, 200 = PD
[6]Calculated Yield Grade = 2.5 + (2.5*12th rib fat, in.) + (0.0038*HCW, lb.) – (0.32*LM area, in.^{2}) $^+$ + (0.2*estimated KPH, %)
[7]F:G calculated as 1/(G:F)

Table 2. Heifers live BW performance, carcass-adjusted BW performance, and carcass traits.

	Myostatin[1]				*P*-value[2]	
Performance traits	ACTIVE	HET	INACTIVE	SEM	Lin.	Quad.
Age, day	629	622	626	33	0.59	0.13
Initial BW, lb	780	775	769	94	0.52	0.95
DMI, lb/day	21.1	19.5	16.7	0.7	< 0.01	0.06
Live BW[3]						
Final BW, lb	1177	1121	1041	28	< 0.01	0.48
ADG, lb/day	2.54	2.23	1.79	0.21	< 0.01	0.27
F:G[7]	8.30	8.77	9.35	—	< 0.01	0.75
Carcass-adjusted BW[4]						
Final BW, lb	1193	1157	1138	53	0.03	0.67
ADG, lb/day	2.59	2.43	2.41	0.31	0.08	0.41
F:G[7]	8.20	8.06	6.94	—	< 0.01	< 0.01
Carcass traits						
HCW, lb	751	729	717	33	0.03	0.67
Dress, %	63.80	64.95	68.92	1.39	< 0.01	< 0.01
Marbling[5]	585	495	368	43	< 0.01	0.28
LM area, in^2	13.59	15.18	18.05	0.95	< 0.01	0.04
12th rib Fat, in	0.56	0.31	0.16	0.07	< 0.01	0.10
CYG[6]	2.84	1.63	0.23	0.13	< 0.01	0.49

[1]Myostatin: homozygous active (ACTIVE), heterozygous (HET), and homozygous inactive (INACTIVE).
[2]*P*-value: Lin. = linear response to inactive myostatin and Quad. = quadratic response to inactive myostatin.
[3]Live BW collected on two consecutive days prior to shipment, shrunk 4%.
[4]Carcass-adjusted BW calculated at 63% dressing.
[5]Marbling score: 500 = SM, 400 = SL, 300 = TR, 200 = PD.
[6]Calculated Yield Grade = 2.5 + (2.5*12th rib fat, in.) + (0.0038*HCW, lb.) – (0.32*LM area, in.^{2}) $^+$ + (0.2*estimated KPH, %).
[7]F:G calculated as 1/(G:F).

INACTIVE being lowest, and HET more similar to ACTIVE.

Heifers

Heifers were similar in age and initial BW ($P = 0.13$ and 0.52, respectively) across genotypes. Similar to steers, INACTIVE heifers had decreased ($P < 0.01$) live final BW, live ADG, and DMI. Feed conversions linearly increased ($P < 0.01$) as IM presence increased with ACTIVE heifers having the lowest F:G. Heifers HCW linearly decreased ($P = 0.03$) for ACTIVE to INACTIVE. Carcass-adjusted ADG was slightly ($P = 0.08$) decreased for INACTIVE compared to ACTIVE. Interestingly, F:G based on carcass growth was dramatically improved ($P < 0.01$) for INACTIVE heifers compared to ACTIVE and HET heifers, which were more similar. Heifers had a quadratic increase ($P < 0.01$) in dressing percentage with INACTIVE heifers greater than HET and ACTIVE, similar to steers. There was a quadratic response in LM area ($P = 0.04$) with INACTIVE heifers increased relative to ACTIVE and HET. Marbling, 12th rib fat, and calculated yield grade linearly decreased ($P < 0.01$) for heifers with IM presence.

Being on an all-natural program, liver abscesses were recorded at 30.8 and 27.7% (steers and heifers, respectively), and were not influenced by genotype ($P > 0.33$). At common finishing endpoints, the influence of IM was similar for steers and heifers. Cattle with 1 or 2 copies of IM, at a common finishing age, had lighter live BW and leaner carcasses, but had increased LM area compared to their ACTIVE counterparts. To reach a common finishing fat thickness, a significant increase in days fed for increased live BW will be necessary for cattle with IM. Homozygous inactive cattle that are finished at a common live BW or fat thickness will have an even larger difference in LM area when compared to the HET or ACTIVE cattle.

Inactive myostatin effects on performance and carcass characteristics were generally similar between Piedmontese-influenced steers and heifers. Cattle with IM are lighter in live BW and have decreased DMI with leaner carcasses across all fat depots. Inactive myostatin increased LM area, dressing percentage, carcass-adjusted ADG and, when evaluated on a carcass-adjusted basis, improved F:G. When comparing cattle with IM influence, differences in performance evaluations are best to be considered on carcass weight, carcass-adjusted basis, or at the same finishing endpoints.

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