Association of Myostatin on Performance and Carcass Traits in Crossbred Cattle

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Summary

Calf-fed steers and yearling heifers genotyped as homozygous active, heterozygous, or homozygous inactive for myostatin were used to evaluate performance and carcass traits from Piedmontese influenced cattle. Homozygous inactive steers had similar ADG, lower DMI and lower F:G when compared to steers influenced by active myostatin. Steers and heifers with inactive myostatin showed similar trends in carcass traits producing larger LM area, greater dressing percentages and leaner carcasses. Similar ADG, lower DMI, and improved F:G were observed for homozygous inactive compared to homozygous active steers. Cattle with inactive myostatin require more days on feed than homozygous active cattle to reach similar live BW and 12th rib fat endpoints.

Introduction

Mutations within the myostatin gene produce inactive myostatin that leads to the overgrowth of muscle tissue associated with the double-muscling phenotype found in Piedmontese cattle. Cattle with inactive myostatin have shown increased muscle mass due to an increase in muscle fiber numbers without increasing fat deposition. Cattle associated with the double-muscled phenotype have greater muscle mass with leaner carcasses, lower DMI, and improved F:G (*Journal of Animal Science*, 76:468). The objective of this study was to investigate the potential association of inactive myostatin from Piedmontese influence on performance and carcass traits in crossbred cattle.

Procedure

The current study included two groups, crossbred calf-fed steers (n = 59; 609 ± 61 lb) and yearling heifers (n = 60; 869 ± 60 lb). Cattle genotypes were confirmed by DNA test results as homozygous active (ACTIVE), heterozygous (HET), or homozygous inactive (INACTIVE) for myostatin. Calf-fed steers included 19 ACTIVE, 28 HET, and 12 INACTIVE. Yearling heifers included 25 ACTIVE, 26 HET, and 9 INACTIVE.

Calf-fed steers and yearling heifers were trained and fed individually using Calan electronic gates located at the University of Nebraska–Lincoln Agricultural Research and Development Center Research Feedlot. Feed refusals were collected 1-2 days each week and DM of refused feed was determined for individual total DMI. Steers and heifers were adapted to a common finishing diet that consisted of 52% high moisture: dry-rolled corn blend, 35% wet distillers grains plus solubles, 8% hay, and 5% supplement (DM) for 190 days and 114 days, respectively. Cattle received no implants or feed additives as part of the market protocol for the all natural program.

Cattle were limit fed a common diet with a 1:1 ratio of alfalfa hay and wet corn gluten feed and 5 % supplement (DM) at 2 % BW for 5 days followed by a collection of 3 consecutive days weight average to minimize variation in gut fill. Cattle were weighed and serially scanned via a certified ultrasound technician at 28-day intervals for LM area, 12th rib fat thickness, rump fat thickness, and intramuscular fat percentage. Intermediate BW were shrunk 4% to account for gut fill. After a 60-hour chill, USDA marbling, 12th rib fat thickness, LM area and estimated KPH were collected. Yield grade was calculated with LM area, HCW, 12th rib fat thickness, and estimated KPH data. Individual animal final BW were calculated on 1) a two consecutive day live weight average shrunk 4% prior to slaughter, and 2) a carcass adjusted at 63% HCW. Average daily gain and F:G were determined on both a live final BW and carcass adjusted final BW.

Within sex, individual animal performance and ultrasound data were used to determine the group means of age, BW, ultrasound 12th rib fat and rump fat measurements collected prior to slaughter. Serial BW and ultrasound data were used to develop within genotype class regression equations to adjust individual animals to group means (common end points). Performance, carcass, and adjusted traits were analyzed using the MIXED procedure of SAS (Version 9.2, SAS Inst., Inc., Cary, N.C.). Steer age was significantly different ($P = 0.05$) and was used as a covariate in the MIXED procedure of SAS in analysis of unadjusted performance and carcass data.

Results

Steers

A linear decrease in age, initial BW, live final BW, and DMI were observed with increased number of inactive myostatin alleles($P \leq 0.05$; Table 1). Live final BW calculated ADG tended to linearly decrease ($P = 0.12$) with increased number of inactive myostatin alleles. However, feed conversion decreased linearly ($P < 0.01$) such that INACTIVE steers had significantly lower F:G when compared to steers with active myostatin. Dressing percentage

Table 1. Steers performance and carcass traits.

	Myostatin[1]					
Performance traits	ACTIVE	HET	INACTIVE	SEM	Linear	Quadratic
Age, day	448[a]	445[ab]	436[b]	5	0.05	0.50
Initial BW, lb	636[a]	618[a]	546[b]	20	< 0.01	0.16
DMI, lb/day	18.30[a]	16.76[a]	14.74[b]	0.75	< 0.01	0.74
Live BW avg.						
Final BW, lb	1136[a]	1085[a]	998[b]	32	< 0.01	0.59
ADG, lb/day	2.63	2.45	2.38	0.11	0.12	0.66
F:G	6.99[a]	6.85[a]	6.22[b]	0.18	0.01	0.18
Carcass adjusted BW						
Final BW, lb	1098	1063	1042	32	0.22	0.84
ADG, lb/day	2.43	2.34	2.61	0.12	0.29	0.16
F:G	7.57[a]	7.25[a]	5.58[b]	0.30	< 0.01	0.03
Carcass traits						
HCW, lb	692	670	657	20	0.22	0.84
Dress, %	60.9[b]	61.7[b]	65.9[a]	0.75	< 0.01	0.04
Marbling[2]	473[a]	415[b]	225[c]	21	< 0.01	< 0.01
LM area, in^2	11.6[b]	13.1[a]	13.7[a]	0.34	< 0.01	0.22
12th rib Fat, in	0.42[a]	0.27[b]	0.14[c]	0.05	< 0.01	0.89
CYG[3]	2.90[a]	1.96[b]	1.29[c]	0.23	< 0.01	0.56
					Chi-square	
Liver, %	32.2	47.5	20.3	—	0.11	

[a,b,c]Means without a common superscript differ ($P < 0.05$).
[1]Myostatin: homozygous active (ACTIVE), heterozygous (HET), homozygous inactive (INACTIVE).
[2]Marbling score: 400 = select high, 300 = select low, 200 = standard.
[3]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, %) ·

Table 2. Steer traits adjusted to common endpoints.

		Myostatin[1]					
Traits	Endpoint[2]	ACTIVE	HET	INACTIVE	SEM	Linear	Quadratic
LM area, in^2	live BW	12.03[c]	13.24[b]	16.07[a]	0.29	< 0.01	< 0.01
12th rib Fat, in	live BW	0.36[a]	0.28[b]	0.15[c]	0.02	< 0.01	0.35
Live BW, lb	age	1098[a]	1074[a]	990[b]	22	< 0.01	0.17
Age, day	live BW	425[b]	433[b]	465[a]	8	< 0.01	0.09
Age, day	rib fat	407[c]	454[b]	592[a]	10	< 0.01	< 0.01

[a,b,c] Means without a common superscript differ ($P < 0.05$).
[1]Myostatin: homozygous active (ACTIVE), heterozygous (HET), homozygous inactive (INACTIVE).
[2]Common endpoint based on group means: age 436 days; live BW 1063 lb; and rib fat 0.29 in.

increased quadratically ($P = 0.04$), and LM area linearly increased ($P < 0.01$) with INACTIVE steers being greatest. A linear ($P < 0.01$) and quadratic decrease ($P < 0.01$) was observed for 12th rib fat and marbling, respectively, with INACTIVE having leaner carcasses compared to HET and ACTIVE steers. There was no difference (P = 0.22) in hot carcass weight between genotypes (P = 0.22). Therefore, final BW was not different ($P = 0.22$) when adjusted to 63% HCW. There was no statistical difference ($P = 0.29$) among genotypes with carcass adjusted ADG; however, INACTIVE steers had numerically greater ADG than both HET and ACTIVE. Carcass adjusted F:G decreased quadratically ($P = 0.03$) where INACTIVE steers had the lowest feed conversion. There was no significant difference ($P = 0.11$) in liver abscesses between genotypes; however, 51% of steers had liver abscesses, which is not uncommon with all natural programs.

Live BW adjusted to common age decreased linearly ($P < 0.01$) with inactive myostatin allele presence with no difference between ACTIVE and HET steers (Table 2). A quadratic increase ($P < 0.01$) was observed in LM area adjusted to a common live BW where INACTIVE had larger LM area than ACTIVE with HET steers intermediate. Fat depth decreased linearly ($P < 0.01$) with INACTIVE steers being leaner at common live BW than ACTIVE with HET steers intermediate. Homozygous inactive steers require an average of 36 more days than HET and ACTIVE steers to reach a common live BW. Age adjusted to a common 12th rib fat quadratically increased ($P < 0.01$) with increasing copies of inactive myostatin alleles.

Heifers

There was no significant difference ($P = 0.48$) in age between heifers differing in myostatin genotype (Table 3). Initial BW, live final BW, DMI, and ADG linearly decreased ($P < 0.01$) as number of inactive myostatin alleles increased. Feed conversion increased ($P = 0.03$) where INACTIVE heifers had the greatest F:G. Dressing percentage and LM area increased quadratically ($P < 0.02$) with increased number of inactive myostatin alleles. A linear and quadratic decrease ($P < 0.03$) in 12th rib fat and marbling, respectively, were observed, with INACTIVE heifers being leaner than HET and ACTIVE heifers. There was no difference ($P = 0.40$) in carcass adjusted final BW, since no difference was observed ($P = 0.40$) in HCW between all genotypes. Carcass adjusted ADG did not differ ($P = 0.12$) between genotypes where INACTIVE heifers now had numerically greater ADG than both HET and ACTIVE. Carcass adjusted feed conversion decreased linearly ($P < 0.02$) where INACTIVE heifers showed the lowest F:G. On an all- natural program, heifers had 30% liver abscesses; however, there was no significant difference ($P = 0.90$) among genotypes.

Live BW adjusted to age decreased linearly ($P < 0.01$) with the presence of inactive myostatin alleles (Table 4). A quadratic response ($P < 0.01$) was observed whereby age adjusted LM

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increased from ACTIVE to INACTIVE. At a common weight, 12th rib fat linearly decreased ($P < 0.01$) with inactive myostatin. Age increased linearly ($P < 0.01$) and quadratically ($P = 0.05$) when adjusted to live BW and 12th ribfat, respectively, among heifers with increased presence of inactive myostatin alleles.

In conclusion, INACTIVE steers had similar gains, lower DMI and improved F:G when compared to steers with active myostatin allele(s). Observed data for steers and heifers suggested that INACTIVE animals had lighter initial and live final BW than ACTIVE. Homozygous inactive steers and heifers require more days on feed to reach a common live BW and 12th rib fat thickness than homozygous active steers and heifers. On a carcass adjusted final BW basis, homozygous inactive steers and heifers had improved F:G when compared to HET and ACTIVE steers and heifers. Steers and heifers with inactive myostatin allele presence had similar trends in carcass traits producing larger LM area, leaner carcasses, with greater dressing percentages, and producing similar HCW.

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Table 3. Heifer performance and carcass traits.

	Myostatin[1]					
Performance traits	ACTIVE	HET	INACTIVE	SEM	Linear	Quadratic
Age, day	595	591	591	5	0.48	0.60
Initial BW, lb	892[a]	861[ab]	829[b]	19	< 0.01	0.95
DMI, lb/day	20.05[a]	19.12[a]	16.51[b]	0.75	< 0.01	0.74
Live BW avg.						
Final BW, lb	1149[a]	1100[b]	1020[c]	26	< 0.01	0.49
ADG, lb/day	2.25[a]	2.09[a]	1.68[b]	0.13	< 0.01	0.24
F:G	8.93[a]	9.17[ab]	10.0[b]	0.472	0.03	0.45
Carcass adjusted BW						
Final BW, lb	1135	1107	1107	18	0.40	0.52
ADG, lb/day	2.16	2.16	2.44	0.15	0.12	0.28
F:G	10.13[a]	9.23[ab]	6.92[b]	1.10	0.02	0.44
Carcass traits						
HCW, lb	716	697	698	18	0.40	0.52
Dress, %	62.4[b]	63.4[b]	68.4[a]	0.69	< 0.01	< 0.01
Marbling[2]	421[a]	380[a]	219[b]	33	< 0.01	0.03
LM area, in^2	13.1[c]	14.1[b]	16.4[a]	0.32	< 0.01	0.02
12th rib Fat, in	0.42[a]	0.31[b]	0.16[c]	0.05	< 0.01	0.64
CYG[3]	2.49[a]	1.79[b]	0.64[c]	0.19	< 0.01	0.15
						Chi-square
Liver, %	32.0	26.9	33.3	—		0.90

[a,b,c] Means without a common superscript differ ($P < 0.05$).
[1]Myostatin: homozygous active (ACTIVE), heterozygous (HET), homozygous inactive (INACTIVE).
[2]Marbling score: 400 = select high, 300 = select low, 200 = standard.
[3]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, %) ·

Table 4. Heifer traits adjusted to common endpoints.

		Myostatin[1]					
Traits	Endpoint[2]	ACTIVE	HET	INACTIVE	SEM	Linear	Quadratic
LM area, in^2	age	14.02[c]	14.69[b]	17.12[a]	0.40	< 0.01	< 0.01
12th rib Fat, in	live BW	0.41[a]	0.29[b]	0.18[c]	0.04	< 0.01	0.83
Live BW, lb	age	1115[a]	1069[b]	997[c]	25	< 0.01	0.52
Age, day	live BW	579[b]	587[b]	605[a]	6	< 0.01	0.32
Age, day	rib fat	568[c]	596[b]	652[a]	9	< 0.01	0.05

[a,b,c] Means without a common superscript differ ($P < 0.05$).
[1]Myostatin: homozygous active (ACTIVE), heterozygous (HET), homozygous inactive (INACTIVE).
[2]Common endpoint based on group means: age 584 d; live BW 1077 lb; and rib fat 0.33 in.