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Effects of Prepartum Metabolizable Protein Supplementation on Wagyu- and Angus-Sired Offspring

Abstract

To test the effects of maternal prepartum protein supplementation on growth and carcass characteristics, cows bred to Angus and Wagyu bulls were supplemented with metabolizable protein for 60 days prepartum. Supplemented cows were fed 108% of the NRC recommendation for metabolizable protein, while control cows received 85% of the NRC recommendation. Supplementation resulted in increased 205-day weaning weights for Wagyu-sired calves compared to control Wagyu-sired calves. Maternal pre-partum supplementation did not have a great effect on carcass quality. Breed appeared to have the greatest impact on carcass quality of the calves. Wagyu-sired calves had increased marbling scores and USDA quality grades, compared to calves from Angus sires.

Introduction

In Part 1 of the *Feeding Beef Cattle* series, the challenges and benefits of feeding low quality forages are explored (Llewellyn et al., 2012). In *Feeding Beef Cattle* Part 2 (Llewellyn et al., 2012), fetal programming in cow-calf production schemes are introduced. The reader is encouraged to refer to these for background information relating to the methods described in this publication. In the Pacific Northwest, cow-calf operations typically rely on low quality forages to feed their pregnant cattle, which often does not contain enough protein to fully support the nutrient requirements. Changing maternal diets impacts the nutrition available to the fetus, potentially creating important nutrigenomic influences on fetal calves. Nutrigenomics has been defined as how diet influences the genome, through nutrients acting as signals for certain gene expressions, which then results in phenotypic changes (Muller and Kersten, 2003; Neibergs and Johnson, 2015). Nutrigenomics lies within the epigenetic landscape, whereas epigenetics is a broader term for changes in gene expression which are heritable, though they do not cause changes in DNA sequences (Alam et al., 2019). One effect of limited gestational protein is decreased meat quality, muscle development and adipogenesis in subsequent offspring (Du et al., 2013). In a recent study conducted at Washington State University, the effects of maternal late gestational metabolizable protein on subsequent offspring was examined.

Materials and Methods

In a study conducted by Liu et al. (2021) and Moffett-Hemmer et al. (2019) at Washington State University (WSU), the effects of late gestational fetal programming through maternal nutritional changes were explored. The WSU Institutional Animal Care and Use Committee approved all procedures used in this study (WSU Protocol 04790-001).

Forty-two mature, multiparous Angus cows (1369 +/- 161 lbs) were bred to either Angus or Wagyu sires. The cows were randomly allocated into groups and were fed for 60 days, with the control group receiving a diet typical of cow-calf production diets in the Pacific Northwest (85% of the 2016 NRC recommendation for metabolizable protein [MP]) and a supplemented group receiving a diet containing 108% of the 2016 NRC recommendation for metabolizable protein from the addition of heat-treated soybean meal (46.5 - 48% crude protein). Metabolizable energy requirements of the cows was calculated using the NRC (2016) model. The values of the supplemented diet equaled +0.1lbs /d MP and a ruminal nitrogen balance of 0.04lb N /d. Calves from supplemented cows will be referred to as SUPP calves and calves from control cows will be CON calves.

After calving, cow-calf pairs were grazed together on pasture sufficient to meet 100% of the pairs NRC (2016) nutrient requirements. Calves were weaned early due to pasture conditions with an average age at weaning 157 +/- 4.5 d. Calves consumed mid-bloom alfalfa hay for 101 d, then a backgrounding diet of 54.0 % alfalfa hay, 37 % corn, 5.7 % French fries and 3.3 % supplement, until a pen reached approximately 632.5 +/- 14.61 lbs body weight (BW). Pens were then fed two equally spaced, step-up diets (each for 1 week), then a final finisher diet of 71.1 % steam rolled corn, 2.6 % yellow grease, 8.8 % potatoes, 2.1 % French fries, 10.4 % alfalfa hay and 5.0 % supplement. Pens of calves were harvested at a final body weight of 1268.5 +- 36.5 lbs. Data were analyzed as a completely randomized design with a 2x2x2 factorial arrangement of treatments. Main effects were sire breed (Angus vs Wagyu), gestational protein intake (85 vs 108 % of 2016 NRC metabolizable protein requirement) and calf sex (heifer vs steer). Calf was the experimental unit except for feed intake, which was a pen with an average of 5 calves.

Table 1. Nutrient analysis of grass hay on a dry matter (DM) basis.

Nutrient	**Amount (%DM)**
Crude Protein (CP)	6.6
Available Protein (AP)	5.5
ADF[1]	37.8
aNDF[2]	60
Lignin	5.6
Ash	4.7
Total Digestible Nutrients (TDN)	61
NEM, (Mcal/kg)	0.91
NEG, (Mcal/kg)	0.5
RFV[3]	92
Ca	0.38
P	0.16

[1] ADF: Acid detergent fiber.
[2] aNDF: Amylase-treated neutral detergent fiber.
[3] RFV: Relative feed value. *averages of grass hay analyses from Dairy One and Cumberland Valley Analytical Services.

Table 2. Control and supplemented late gestation diet contents.

Nutrient analysis estimated from NRC Original Beef Cattle Nutrient Requirements Model (2016, Version 1.0.37.6); [a] 96 % NaCl, 0.009 % Se, 0.006 % Co, 0.01 % P, 0.035 % Cu, 0.20 % Fe, 0.18% Mn, 0.037 % Mg, 0.35 % Zn; [b] 30,000 IU

Ingredient	Control (% DM)	Supplemented (% DM)
Grass hay	98.9	91.2
Pelleted soybean meal mix	N/A*	8.8
Mineral mix[a]	1.14	

Nutrient Analysis	Control (% DM)	Supplemented (% DM)
Crude Protein (CP)	5.93	9.67
ADF	36.15	35.03
NDF	57.31	54.54
Crude fat	1.9	2.4
NEm (Mcal/kg)	1.1	1.15
Neg (Mcal/kg)	0.55	0.6

Ingredient	Control Mineral mix (%AF)	Supplemented Pelleted soybean meal mix (%AF)
Trace Mineral Salt[a]	82.5	10.3
Monosodium Phosphate[c]	16.5	2.1
Vitamin A Premix[b]	1.0	0.1
SBM	N/A	82.5
Urea	N/A	2.1
Molasses	N/A	2.9

vitamin A- acetate /g; [c] 26% P, .001% F, 19.3% Na. *N/A: Not applicable

Results

Supplementation did not impact cow body condition scores or subsequent reproductive performances. Data were averaged over sex of calf because they performed typically. Steers were heavier, eat more, gained faster and reached market weight in fewer days than heifers (Table 3.3). Angus calves had greater gains from birth to weaning ($P < 0.02$) compared to Wagyu sired calves, averaging 2.23 vs 2.17 +/- 0.04 lbs/d for Angus and Wagyu calves, respectively. Diet and breed interacted ($P < 0.05$) for 205 d weaning weight (WW). Weaning weight was increased ($P < 0.01$) by 22lbs for SUPP Wagyu-sired calves compared to CON.

During the backgrounding phase, feed intake was lower ($P<0.05$) for SUPP calves compared to CON calves. Feed to gain ratio was increased ($P < 0.01$) for Angus-sired calves, averaging 12.8 +/- 0.52, where Wagyu sired calves averaged 11.15 +/- 0.52.

Feed intake was higher (P < 0.01) for Angus-sired calves compared to Wagyu-sired calves.

Table 3. Influence of prepartum dietary protein supplementation and sire breed on calf growth traits.

		Treatment[a]				
	Item	Angus CON	Angus SUPP	Wagyu CON	Wagyu SUPP	SE
Birth to Weaning	Birth Weight, lbs	72.9	72.1	67.7	70.1	3.34
	ADG, lbs/d [b]	2.24	2.22	2.20	2.14	0.06
	205d WW, lbs [c]	430.3	426.7	380.0	402.1	11.12
Backgrounding phase	Feed Intake, lbs/d [d,e]	17.8	17.2	16.3	15.8	0.14
	ADG, lbs/d [f]	1.43	1.33	1.47	1.47	0.06
	Feed:Gain [d]	12.7	13.2	11.3	11.0	0.73
	Final BW, lbs	655.1	639.4	608.4	627.1	14.61
Finishing phase	Feed Intake, lbs/d [c]	20.7	21.0	16.3	15.2	0.18
	ADG, lbs/d [d]	3.54	3.44	3.16	3.06	0.12
	Feed:Gain	5.29	5.81	5.75	5.35	0.20
	Harvest Weight, lbs [d]	1181.0	1177.3	1147.9	1150.9	6.08
	Days on Feed [d]	124.9	138.8	174.1	165.6	7.71

[a] 85 or 108 % of NRC metabolizable protein requirement; ADG = Average daily gain; WW = Weaning weight; BW = Body weight
[b] Effect of breed (P < 0.05)
[c] Breed x Diet interaction (P < 0.05)
[d] Effect of breed (P < 0.01)
[e] Effect of diet (P < 0.01)
[f] Effect of diet (P < 0.05)

In the finishing phase, a breed and diet interaction was detected (P < 0.05) for DM intake, with maternal supplementation increasing DM intake for Angus-sired calves (+ 0.3 lbs/d) but decreasing DM intake for Wagyu-sired calves (-1.1 lbs/d). Angus-sired calves had greater (P < 0.01) ADG compared to Wagyu-sired calves. In contrast to the results of the backgrounding phase, finishing feed to gain ratios were not affected by treatment. Angus-sired calves were heavier (P < 0.01) than Wagyu-sired calves at harvest and fed for fewer (P < 0.001) days on feed. SUPP Wagyu-sired calves had fewer days on feed (P < 0.01) compared to Angus-sired calves and lower (P < 0.05) feed intake compared to CON Wagyu-sired calves. SUPP Angus-sired calves had more days on feed (P < 0.01) compared to CON Angus-sired calves.

Breed had the greatest effect on carcass characteristics, with Angus-sired calves having higher slaughter weights (P < 0.01; Table 4). Hot carcass weight (HCW) tended to be influenced (P < 0.10) by breed with Angus-sired calves having heavier HCW compared to Wagyu-sired. Dressing percent tended to be influenced (P < 0.10) by diet, with SUPP calves averaging higher dressing percentages compared to CON calves. The 12th rib fat was greater (P < 0.002) in Angus-sired vs. Wagyu-sired calves. Rib eye area (REA) was influenced by a breed x diet interaction (P < 0.10), with Angus-sired calves having numerically smaller average REA compared to Wagyu-sired calves and SUPP decreased REA with Wagyu-sired calves only. Yield grades were greater (P < 0.01) for Angus-sired calves compared to Wagyu-sired calves. Marbling scores were greater (P < 0.01) for Wagyu-sired calves which had an average score of 857.65 +/- 26.67, while Angus-sired calves averaged 676.9 +/- 26.67. Quality grades were similarly affected by breed (P < 0.01) with Wagyu-sired calves graded higher than Angus-sired calves.

Table 4. Influence of prepartum dietary protein supplementation and sire breed on carcass traits

	Treatment[a]				
Item	Angus CON	Angus SUPP	Wagyu CON	Wagyu SUPP	SE
Slaughter weight, lbs [b]	1181.0	1177.3	1147.9	1150.9	6.08
Hot carcass weight, lbs [c]	770.7	784.0	752.2	763.7	6.05
Dressing % [d]	59.8	61.0	60.0	60.8	0.42
12th-rib fat, in^2 [b]	0.80	0.85	0.51	0.60	0.05
Rib eye area, in^2 [e]	11.8	12.1	13.0	11.9	0.27
Kidney, pelvic and heart fat %	2.9	3.3	3.4	3.5	0.25
Yield grade[b]	4.2	4.4	3.2	3.8	0.19
Marbling score [b,f]	690.2	663.6	846.5	868.8	37.71
Quality grade [b,g]	5.6	5.3	7.0	7.5	0.37
Maturity	155.3	160.7	168.0	161.2	3.25

[a] ANG: Angus-sired calves; WAG: Wagyu-sired calves; CON: Cows fed 85% NRC MP requirement; SUPP: Cows fed 108% NRC MP requirement.
[b] Effect of Breed (P < 0.01)
[c] Effect of Breed (P < 0.10)
[d] Effect of Prepartum Diet (P < 0.10)
[e] Breed x Diet Interaction (P < 0.10)
[f] Modest: 600-699; Moderate: 700-799; Slightly abundant: 800-899
[g] Average Choice: 5; High choice: 6; Low Prime: 7; Average Prime: 8

Discussion

Breed and diet interacted (P < 0.05) for 205 d WW and for Wagyu-sired calves, WW increased (P < 0.01) by 22 lbs from maternal supplementation. The cost of the additional feedstuffs and feed processing for the SUPP cows in this study was a total of $615.92 for 60 days of supplementation or $0.49 /head/d, with each SUPP cow consuming 2.19 lbs/d of additional supplement (Pelleted soybean meal, molasses and urea) compared to CON cows. Each pound of additional Wagyu-sired calf weaning weight cost $1.34 with calves currently valued at $ 1.80/ lb for a $ 10.12/ calf greater return if sold at weaning.

Calf breed positively impacted marbling and quality grades. For Wagyu-sired calves, carcasses had USDA quality grades of low prime, 3.5 average yield grade and on average weighed 757.95 lbs HCW. With carcass value at $312.12/ cwt (AMS USDA, 2020, c) and premiums and discounts (AAA, 2020), Wagyu-sired calf carcasses were valued at $3.10/ lb HCW. Angus-sired calves had USDA quality grades of average choice, 4.3 average yield grade and on average weighed 777.35 lbs HCW. With a carcass value of $288.80 /cwt (AMS USDA, 2020) along with premiums and discounts (AAA, 2020), Angus-sired calf carcasses were valued at $2.37/ lb HCW. Overall, carcasses from Wagyu-sired cattle would return $507.32/ carcass or $0.73/ lb HCW more compared to Angus-sired calves.

Conclusions

Feeding metabolizable protein pregnant cows 60 days prepartum may help subsequent Wagyu-sired calves increase weaning weights, feed efficiency during backgrounding and decrease feed intake during finishing while maintaining marbling and quality grades. For Angus-sired calves from supplemented dams, feed intake and ADG and feed efficiency decreased. In this case, pre-partum MP protein supplementation may be more advantageous for the growth of Wagyu x Angus cattle, compared to purebred Angus. Additionally, the differences not observed between treatments may indicate the adaptability of Angus cattle to lower quality PNW dietary conditions. Maternal supplementation did not have a significant effect on carcass characteristics, but breed did, with Wagyu-sired calves having higher marbling scores and quality grades compared to Angus-sired calves. The improved carcass composition for Wagyu-sired calves has the potential to improve returns to producers at slaughter. Crossing Wagyu cattle with Angus can potentially increase the carcass quality of offspring compared to pure Angus while still allowing producers to take advantage of the American Angus Association premiums.

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