Effect of Methionine Supplementation During Late Gestation in Beef Females

Landon F. Tadich
Jim R. Teichert
Kathryn J. Hanford
Jackie A. Musgrave
Rick N. Funston

Summary with Implications

Some amino acids are known to be essential to cattle and effect protein availability to the animal, especially during gestation when nutrient requirements are higher. Methionine is found to be one of the most limiting in low quality forage diets. Two 3- yr studies were performed to evaluate the impact of methionine supplementation during late gestation on intake, body weight, average daily gain, and subsequent calf performance in primiparous and multiparous females. In exp 1, 120 artificially inseminated pregnant heifers were placed in a Calan gate feeding system (n= 40/yr) and assigned 1 of 3 treatments during late gestation and fed ad libitum grass hay with either: no supplement, 2 lbs. distillers based supplement, or 2 lbs. distillers based supplement with 1 oz of rumen protected methionine. In exp 2, multiparous cows on upland winter range were fed 1 of 5 treatments: no supplement, ad libitum meadow hay, 1 lb. of a distiller's based cube, 2 lb. of a distiller's based cube, or 2 lb. of a distiller's based cube plus 1 oz of a rumen protected methionine. Body weight, body condition score, reproductive responses, and subsequent calf performance were recorded in both studies. No differences were observed in calving performance or progeny carcass characteristics in either experiment in response to methionine supplementation, so it may not be a necessary supplementation strategy.

Introduction

Gestational nutrition is crucial to both the dam and progeny during pregnancy, and the success that they have following parturition. While supplemental nutrient requirements may change drastically across production systems, it is important to both fulfill requirements while not over supplementing. A well balanced supplemental strategy must be well understood and utilized. Some research (*2023 Nebraska Beef Report*, pp. 13–15) has suggested that beef heifer development systems that developed heifers to lower body weights (BW) have little to no impact on reproduction, while reducing production cost for the producer. In the Nebraska Sandhills, low input development systems often involve wintering heifers post-weaning on native range preceding the breeding season. This often involves bringing heifers into a dry lot scenario to be synchronized, supplemented energy, and artificially inseminated before being placed with bulls on summer range. With methionine levels found to be low in most forage based diets; it is a combination of these factors that suggest rumen protected methionine supplementation may benefit growth in younger heifers. In addition to benefiting the immature dam, supplementation may also have the potential to influence both terminal progeny's quality and growth potential, and reproductive efficiency in female progeny entering the herd as replacements through epigenetic factors.

Procedure

Primiparous Heifers in Calan Gates

In experiment 1, 120 (n= 40/yr) randomly selected AI-pregnant Angus crossbred heifers were utilized at the West Central Research, Extension, and Education Center (WCREEC), North Platte, NE. Heifers were placed in 1 of 4 pens (10 headgates per pen) in a Calan Broadbent (American Calan, Northwood, NH) individual feeding system. Heifers were allowed a 20 d acclimation period before beginning the 90 d trial beginning at approximately 170 d of gestation. Following the acclimation period, heifers were stratified by age, AI sire, BW, and pen and assigned to 1 of 3 treatments from late October to early February: ad libitum grass hay with either no supplement (CON), 2lb distillers based supplement as is (DDG), or 2lb distillers based supplement with 1oz of a rumen protected methyl hydroxy analog as MFP (Novus, St Charles MO) (MET). Hay was offered twice daily with supplementation added once daily during the morning feeding. The amount of hay offered was recorded daily and based off previous feedings to allow for ad libitum intake. Feed refusals were collected once weekly and recorded. Dry matter intake was calculated by daily intake values and nutrient analysis conducted at Ward Laboratories (Kearney, NE).

After the feeding trial, all heifers were calved in a dry lot, pairs then grazed upland range in South Central Nebraska. At approximately 2 mo of age calves were branded, weighed, vaccinated, and males where castrated. Calves were limit fed a starter diet for 5 d at 2.0% BW before determining initial feedlot BW. There was a 21 day transition period on a backgrounding diet to a common feedlot diet. Backgrounding and finishing diets are shown in Table 1. Calves received a Synovex Choice (Zoetis; 200 mg of trenbolone acetate and 14mg of estradiol benzoate) at the start of the finishing period and were reimplanted with a Synovex Plus (Zoetis; 200mg trenbolone acetate and 24mg of estradiol benzoate) roughly 105 d later or 110 d before slaughter. Steers were weighed at the beginning of the finishing diet. Hot carcass weight was determined at slaughter and used to calculate final BW by using an average dressing percentage of 63%. Carcass characteristics were evaluated 24 h later.

Multiparous Cows on Upland Range

In experiment 2, 150 March calving multiparous cows (3/4 Red Angus, 1/4 Simmental) were utilized in a 3 yr study on upland winter range at the Gudmundsen Sandhills Laboratory, Whitman, NE.

Table 1. Composition of backgrounding and finishing diets of all calves in both experiment 1 and experiment 2

	DM, %	
Item	Backgrounding	Finishing
Dry rolled corn	15	48
Wet corn gluten feed	40	40
Hay	35	7
Supplement[1]	10	5
Nutrient analysis[2]		
CP, %	16.4	22.3
RUP, % CP	30.0	36.5
TDN	73.5	83.7
Crude fat, %	4.0	3.8

[1] Provided dietary concentration of .98 oz/ton of monensin and .35 oz/ton of tylosin (DM basis; Elanco Animal Health, Indianapolis, IN)

[2]Calculated values based on NRC estimated values and nutrient analysis of feed ingredients.

Table 2. Effect of methionine supplementation on intake, gain and calving performance in primiparous beef heifers (Exp 1)

Item	CON[1]	DDG[2]	MET[3]	SEM	*P*-value
N[4]	3	3	3		
Initial BW, lb	1021	1019	1027	19.79	0.78
Final BW[5], lb	1138[a]	1182[b]	1184[b]	32.54	<0.01
Treatment ADG, lb	1.24[a]	1.70[b]	1.70[b]	0.34	<0.01
Dry matter intake, lb	23.13	23.26	22.84	0.84	0.45
Gestation length, days	277	275	277	1.08	0.28
Birth Weight, lb	71	68	71	1.47	0.29
Calving ease[6] %	86	98	87	0.06	0.23
Calf Vigor[7]	84	78	76	0.07	0.72

[1]CON = heifers receiving ad libitum hay in a Calan gate individual feeding system twice daily with no added supplementation.

[2]DDG = heifers receiving 2 lb distillers based supplement once daily in the morning in addition to ad libitum hay in the Calan gate individual feeding system twice daily during the 90 d treatment period.

[3]MET = heifers receiving 2 lb distillers based supplement with 1oz of methionine as MFP once daily in the morning in addition to ad libitum hay in a Calan gate individual feeding system twice daily for the 90 d treatment period.

[4] Represents number of replications; 1 yr = 1 replication.

[5] Calculated from HCW and adjusted to a common dressing percent (63.0%).

[6] Percent of heifers with a calving score of 1. Calving ease scoring system: 1 = no assistance, 2 = easy pull, 3 = mechanical pull, 4 = hard mechanical pull, and 5 = Caesarean section.

[7] Percent of calves with a vigor score of 1. Calf vigor scoring system. 1 = nursed immediately, 2 = nurse on own, took some time, 3 = required some assistance to suckle, 4 = died shortly after birth, 5 = dead on arrival.

[a,b] Within each row, means without common superscripts differ ($P < 0.05$)

During late gestation over winter, cows were stratified by BW and age and then fed 1 of 5 treatments on 1 of 10 pastures that rotated annually : no supplement (NS), ad libitum meadow hay (HAY- average 7.4% CP, 58.4% TDN and 38.7% ADF), 1lb of a distillers based cube as is (DDG1), 2lb of a distillers based cube (DDG2), or 2lb of a distiller's based cube plus 1oz MFP (MET). The roughly 90 d treatment period began each year in early December and ended prior to calving in late February. Body condition score (BCS) and BW were recorded prior to the start of the treatment period in December, at the end of the treatment period prior to calving in late February, prior to breeding in May, and at weaning the first of November each year. Cows retained their treatment allocations each year of the study and were managed as a common group from calving until weaning each year. At the start of the breeding season each year, all cows were administered prostaglandin F2[a] (Lutalyse Highcon, Zoetis, Florham Park, NJ) 5 days after being placed on summer range with bulls at a bull to cow ratio of 1:17 for 45 days. Pregnancy determination was conducted via transrectal ultrasonography at weaning in early November each year. Calves were weighed within 24 hr of birth, prior to breeding and at weaning. Calves were vaccinated at birth, and at branding the beginning of May, bull calves were castrated and vaccinated. Following weaning, steer calves (yr 1, n = 62; yr 2, n = 62; yr 3, n = 48) remained in a dry lot with ad libitum hay for 2 weeks before being shipped 100 miles to a feedlot at the WREEC. Backgrounding and finishing diets are shown in Table 1. Weaned steer calves were treated the same as experiment 1.

Statistical Analysis

In Experiment 1, data were analyzed using the PROC GLIMMIX procedure in SAS 9.4 (Cary, NC USA). Variables were analyzed with a linear model that included the fixed effects of treatment and calf gender and random effects of yr, pen by yr and the residual Pre-treatment body weight was treated as a covariate when necessary. Pairwise differences were evaluated using the LSMEANS option in SAS. For Experiment 2, Data were analyzed with a repeated measures mixed-model analysis of variance using the PROC GLIMMIX procedure in SAS 9.4 (Cary, NC USA). Year and treatment were tested over the random yr by treatment effect. Cow post-treatment BW and BCS were analyzed with the same model with the addition of calf gender and December BW or BCS as a covariate. Pairwise differences were evaluated using the LSMEANS option in SAS using a Tukey's multiple comparison adjustment. Data were considered significant if $P \leq 0.05$ and tendency was considered if $P \leq 0.10$ but $P > 0.05$ for both studies.

Results

In Experiment 1, heifer BW, ADG, intake, and calving performance is summarized in Table 2. End of treatment BW and ADG was greater ($P < 0.01$) in DDG and MET heifers when compared to control. This was expected given the added protein and energy in DDG and MET diets. A lack of differences between these two groups

Table 3. Effect of methionine supplementation on subsequent calf performance in primiparous beef heifers (Exp 1)

Item	CON[1]	DDG[2]	MET[3]	SEM	*P*-value
N[4]	3	3	3		
Initial BW, lb	536[x]	538[x]	512[y]	10.25	0.09
Final BW, lb	1310	1290	1283	39.41	0.56
Finishing ADG, lb	3.50	3.42	3.50	0.20	0.45
Hot carcass weight[5], lb	825	811	806	25.20	0.56
Ribeye area, in^2	13.5	13.0	13.2	0.33	0.24
Marbling Score[6]	662	659	650	24.21	0.38
Yield grade	3.63	3.63	3.49	0.14	0.58
12[th] rib fat, in	0.73	0.71	0.67	0.03	0.43

[1]CON = calves whose dam's received ad libitum hay in a Calan gate individual feeding system twice daily with no added supplementation.

[2]DDG = calves whose dam's received 2 lb distillers based supplement once daily in the morning in addition to ad libitum hay in a Calan gate individual feeding system twice daily during the 90 d treatment period.

[3]MET = calves whose dam's received 2 lb distillers based supplement with 1oz of a methionine as MFP once daily in the morning in addition to ad libitum hay in a Calan gate individual feeding system twice daily for the 90 d treatment period.

[4]Represents number of replications; 1 yr = 1 replication.

[5]Calculated from HCW and adjusted to a common dressing percent (63.0%).

[6]500 = Small[0]

[x,y] Within each row, means without common superscripts differ ($P < 0.10$).

Table 4. Effect of Methionine supplementation on BW, body condition score, calving performance and pregnancy outcomes in multiparous beef cows (Exp 2)

Item	NS[1]	DDG1[2]	DDG2[3]	MET[4]	HAY[5]	SEM	*P*-value
N[6]	3	3	3	3	3		
Pretreatment BCS	5.21	5.19	5.22	5.04	5.27	0.07	0.26
Pretreatment BW, lb	1027	1043	1043	1014	1058	24.80	0.73
Precalving BCS	4.45[a]	5.00[b]	5.29[b]	5.18[b]	5.29[b]	0.07	<0.01
Precalving BW, lb	1012[a]	1091[b]	1118[b]	1118[b]	1157[c]	7.21	<0.01
Calf birth weight, lb	71	77	77	75	77	1.81	0.22
Prebreeding BCS	4.55	4.79	5.55	4.83	5.17	0.28	0.19
Prebreeding BW, lb	941[a]	974[b]	992[bc]	1003[bc]	1023[c]	7.36	<0.01
Pregnancy rate, %	81[a]	95[b]	94[b]	94[b]	94[b]	0.04	0.04
Weaning BCS	4.98	4.89	4.95	4.90	4.93	0.06	0.76
Weaning BW, lb	1087	1058	1118	1058	1098	26.63	0.48

[1]NS= cows that received no supplement while grazing dormant upland winter range in the Nebraska Sandhills.

[2]DDG1= cows grazing upland winter range that were supplemented 1 lb of a distillers based cube per hd/d throughout the treatment period.

[3]DDG2 = cows grazing upland winter range that were supplemented 2 lb of a distillers based cube per hd/d throughout the treatment period.

[4] MET= cows grazing upland winter range that were supplemented 2 lb of a distiller's based cube plus 1oz methyl hydroxy analog as MFP per hd/d.

[5]HAY= cows grazing upland winter range and provided ad libitum hay throughout the treatment period.

[6] Represents number of replications; 1 yr = 1 replication.

[x] Percent of heifers with a calving score of 1. Calving ease scoring system: 1 = no assistance, 2 = easy pull, 3 = mechanical pull, 4 = hard mechanical pull and 5 = Caesarean section.

[y] Percent of calves with a vigor score of 1. Calf vigor scoring system. 1 = nursed immediately, 2 = nurse on own, took some time, 3 = required some assistance to suckle, 4 = died shortly after birth, 5 = dead on arrival.

[a,b,c] Within each row, means without common superscripts differ ($P < 0.05$).

however may illustrate that sufficient levels of rumen degradable protein and rumen undegradable protein from the dried distiller's grain may be adequate supplementation. Methionine supplementation had no detectable impact on heifer ADG or BW during the prepartum treatment period. There were also no differences observed in DMI among heifers across the treatment period ($P = 0.38$). Length of gestation, calf birth weight, and calving performance data was also similar among treatment groups. Subsequent calf performance and carcass data is shown in Table 3. There was a tendency ($P = 0.09$) for MET calves to be lighter at the start of the finishing period (511 lb) compared to DDG (538 lb) and CON (536 lb) calves. Given that no other performance variables point to MET calves underperforming, there are two possible explanations for this response: a greater number of experimental units may lead to no observed differences between groups, or excess methionine led to hypermethylation and reduced growth during late gestation and early postnatal development. No differences were observed in final BW at time of slaughter, and carcass characteristics were similar among treatments.

In Experiment 2, cow BW and BCS were not different at the start of the treatment period. Prior to calving however, NS cows had significantly lower BCS and BW than all other groups ($P < 0.01$). Given the environmental challenges and low protein forages while grazing dormant winter range, this response is not surprising. No differences were observed in calving performance, nor calf birth weights. While pre-breeding BCS were not significantly different among groups, differences were observed in pre-breeding BW ($P < 0.01$). Pregnancy rates for HAY (94%), MET (94%), DDG2 (94%), and DDG1 (95%) were significantly higher ($P < 0.01$) than NS (81%) cows. At weaning, no differences were seen among cow BW and BCS (Table 4). Progeny performance and carcass data is available in Table 5. At weaning, calves from NS dams had lower BW compared to DDG2 and MET cows ($P = 0.03$). No differences were observed in initial and final finishing weights. This challenges the findings in experiment 1 that suggest MET calves may be lighter at feedlot entry. Additionally, carcass data were similar among groups. There was however a tendency for calves

Table 5. Effect of methionine supplementation on subsequent calf performance in multiparous beef cows (Exp 2)

Item	NS[1]	DDG1[2]	DDG2[3]	MET[4]	HAY[5]	SEM	*P*-value
N[6]	3	3	3	3	3		
BW at breeding, lb	139[a]	157[b]	161[b]	152[ab]	161[b]	3.88	0.01
Weaning Weight, lb	465[a]	494[ab]	507[b]	487[ab]	511[b]	8.99	0.03
Initial BW, lb	578	602	624	625	617	12.32	0.13
Final BW[7], lb	1250	1279	1266	1281	1302	26.39	0.68
Finishing ADG, lb	3.66	3.70	3.75	3.64	3.79	0.07	0.66
Hot carcass weight, lb	783	803	820	805	820	13.89	0.30
Ribeye area, in^2	14.0	14.0	14.5	14.3	14.3	0.18	0.30
Yield grade	2.47	2.75	2.72	2.56	2.69	0.10	0.34
Marbling score[8]	509[x]	537[xy]	540[xy]	522[xy]	586[y]	17.90	0.09
12[th] rib fat, in	0.45	0.52	0.55	0.49	0.51	0.02	0.16

[1]NS= cows that received no supplement while grazing dormant upland winter range in the Nebraska Sandhills.

[2]DDG1= cows grazing upland winter range that were supplemented 1 lb of a distiller's based cube per hd/d throughout the treatment period.

[3]DDG2 = cows grazing upland winter range that were supplemented 2 lb of a distiller's based cube per hd/d throughout the treatment period.

[4] MET= cows grazing upland winter range that were supplemented 2 lb of a distiller's based cube plus 1oz methyl hydroxy analog as MFP per hd/d.

[5]HAY= cows grazing upland winter range and provided ad libitum hay throughout the treatment period.

[6] Represents number of replications; 1 yr = 1 replication.

[7] Calculated from HCW and adjusted to a common dressing percent (63.0%).

[8] 500 = Small[0].

[a,b] Within each row, means without common superscripts differ ($P < 0.05$).

[x,y] Within each row, means without common superscripts differ ($P < 0.10$).

from HAY cows to have greater marbling scores than calves from NS cows.

Conclusions

Ultimately, late gestation supplementation had limited detectable impact on dam and subsequent progeny performance. There is no question that winter supplementation strategies change drastically with environment and cow requirements based on the timing of the production system. Based on the results of the current study, the addition of methionine to late gestation diets in primiparous heifers had no impact on DMI, but heifers receiving distillers based supplement did gain more throughout the treatment period. Likewise, in the second study, cows receiving greater supplementation while grazing winter range had greater BW and BCS at critical timepoints throughout the production year whether that supplementation was in the form of hay, DDG, or DDG with methionine. This suggest that some supplementation strategy is warranted, and these findings support the belief that gestational nutrition does have an impact on progeny performance, however, more research is needed to further elucidate mechanisms influencing this process.

Landon F. Tadich, graduate student.

Jim Teichert, research technician.

Jackie A. Musgrave, research technician.

Kathryn J. Hanford, professor, statistics, University of Nebraska- Lincoln.

Rick N. Funston, professor, animal science, University of Nebraska- Lincoln West Central Research and Extension Center, North Platte, NE.