Increasing Protein Supply to Pregnant Beef Cows When Energy Is Limited Does Not Improve Cow or Calf Performance

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Introduction

Pre- and postpartum deficiencies of metabolizable protein have been identified as potentially limiting to productivity of beef cows and calves. Pre-partum supplementation of forage-based diets with ruminally undegraded protein has increased weight gain and breeding performance in prior studies, but the level of ruminally degraded protein fed was not known. Feeding adequate ruminally degraded protein to beef cows maximizes the productivity of microbes in the rumen, so any benefits shown in prior work could have been attributed to increased ruminal fermentation.

Our objectives were (1) to determine the value of supplementing ruminally undegraded protein when dietary ruminally degraded protein supply was estimated to be adequate to support normal ruminal fermentation, and (2) to monitor the changes in intake and digestion that precede parturition in beef cows fed low-quality, warm-season forage.

Experimental Procedures

Pregnant Angus × Hereford cows were used in 2 experiments that measured intake, digestion, and performance of beef cows and calves when provided ruminally undegraded protein in addition to ruminally degraded protein needed for optimal ruminal fermentation. Cows used in both experiments were fed 1 of 3 supplements daily that supplied similar amounts of ruminally degraded protein (0.09% of body weight) and increasing amounts of ruminally undegraded protein: 0.05% (LOW), 0.07% (MOD), or 0.09% of body weight (HI). Supplement composition is shown in Table 1.

Experiment 1

Late-gestation cows (n = 18; body weight = 940 lb; body condition score = 4.5 [1 = thin, 9 = very fat]) were used in a 3-treatment, randomized complete block experiment. Cows were housed individually and assigned to be fed 1 of the 3 supplements described previously. Each cow had free-choice access to low-quality prairie hay (2.1% crude protein) and supplements were fed daily. Fecal grab samples were collected daily at 8:00 a.m. Sample collection corresponded to the period spanning 14 through 5 weeks pre-partum. Hay intakes by individual animals were summarized as 10 weekly means. Proportional intakes (percentage of body weight) were expressed using individual animals' average body weight for each month of the trial.

Experiment 2

Pregnant Angus × Hereford cows (n = 17; body weight = 1,160 lb; body condition score = 5.2) were used in a randomized complete block experiment. Cows were stratified by weight and body condition score and assigned to receive 1 of the 3 supplements evaluated in Experiment 1.

Within treatment, cows were assigned randomly to graze 1 of 3 native tallgrass pastures. Cows were gathered from the pastures each morning and sorted into treatment groups. Supplements were group-fed. This process was repeated daily from November 25 until all cows had calved (average calving date = March 7 $\pm$ 13 days). Treatments were discontinued when calving occurred. Cows were weighed and assigned a body condition score at 4-week intervals until calving was complete. Performance of calves was monitored from birth until weaning the following fall.

Results and Discussion

Experiment 1

Effects of supplemental ruminally undegraded protein on forage intake and digestion are shown in Table 2. Effects of advancing digestion on forage intake are shown in Table 3. Forage dry matter intake, total dry matter intake, and total digestible dry matter intake of cows fed LOW was greater ($P < 0.01$; Table 1) than that of cows fed MOD or HI. Total tract dry matter digestibility did not differ ($P > 0.10$) between treatments. The likelihood of an intake response to supplemental ruminally undegraded protein seems dependent upon adequacy of ruminally degraded protein supply and the total amount of supplement provided. At high levels of supplement intake, forage intake will decrease due to limits in overall intake of nutrients by cattle.

Forage dry matter intake, total dry matter intake, and total digestible dry matter intake increased ($P \leq 0.03$) cubically between 14 and 4 weeks pre-partum, whereas total tract dry matter and neutral detergent fiber digestibilities decreased ($P \leq 0.03$) linearly over time (Table 3). Previous research has noted that increased body weight and nutrient requirements coincident with advancing gestation stimulated dietary intake until fetal tissues reach sufficient size to begin to compress the rumen. Approximately 50% of fetal growth occurs during the final trimester, with a concurrent decrease in ruminal digesta content and capacity. The cattle used in this experiment appear to have compensated for decreased rumen capacity by increasing the rate of passage of nutrients through the digestive system, which led to the decrease in dry matter and neutral detergent fiber digestibility noted above.

Experiment 2

Cow average daily gain and body condition score change did not differ ($P \geq 0.13$) among treatments during the pre-partum period (Table 4). This differs from previous work on the subject. A possible explanation for discrepancies in response to ruminally undegraded protein supplementation is variation in metabolizable protein balance. A positive response to ruminally undegraded protein supplementation is more likely when metabolizable protein supply is inadequate to support the level of performance allowed by the dietary energy provided. In our trial, metabolizable protein supply appeared sufficient to maximize performance within the constraints of energy supply.

Subsequent Julian calving date, pregnancy rate, and calving interval were not different ($P \geq 0.62$) among treatments (Table 4). Pregnancy rate has not usually been influenced by ruminally undegraded protein supplementation, but postpartum interval has been reduced by supplemental ruminally undegraded protein in some cases. In those cases, supplemental ruminally undegraded protein likely increased energy status of the animals by providing the protein necessary for maximal ruminal fermentation. Cows in

our study likely were not lacking in protein needed to maximize ruminal fermentation, so no increase in energy status occurred when additional ruminally undegraded protein was provided. Pre-partum supplementation with ruminally undegraded protein did not affect ($P \geq 0.55$) calf birth weight, average daily gain, or weaning weight (Table 4).

Implications

Pregnant cows consuming low-quality tallgrass forage and supplemented with common feeds to provide ruminally degraded protein at 0.09% of body weight daily appeared to have been fed sufficient protein to maximize performance within the constraints of energy supply. Therefore, altering supplemental protein composition to provide additional ruminally undegraded protein under such conditions is not warranted.

Table 1. Ruminally undegraded protein supplement composition (Experiment 1 and 2)

	Ruminally undegraded protein [1]		
Ingredient	LOW	MOD	HI
Dry matter, %	90.8	91.5	93.4
Feed composition, % of dry matter			
Blood meal	0.1	4.7	9.3
Corn gluten meal	0.2	6.5	12.9
Soybean meal	71.5	63.3	55.1
Sorghum grain	23.8	21.1	18.3
Molasses	4.4	4.4	4.4
Protein composition, % of crude protein			
Ruminally degraded protein	63.4	57.4	52.4
Ruminally undegraded protein	36.6	42.6	47.6

[1] Ruminally undegraded protein: 0.05% (LOW), 0.07% (MOD), or 0.09% of body weight (HI).

Table 2. Effects of ruminally undegraded protein supplementation on intake and digestibility by pregnant beef cows fed low-quality forage (Experiment 1)

	Ruminally undegraded protein[1]			
Item	LOW	MOD	HI	SEM
Total-tract dry matter digestibility, %	51.8	51.8	52.4	0.27
Total-tract neutral detergent fiber digestibility, %	58.4[a]	57.6[b]	58.4[a]	0.24
Forage dry matter intake, % body weight	2.31[a]	2.14[b]	2.10[b]	0.02
Total dry matter intake, % body weight	2.61[a]	2.45[b]	2.42[b]	0.02
Total digestible dry matter intake, % body weight	1.36[a]	1.27[b]	1.26[b]	0.01

[1] Ruminally undegraded protein: 0.05% (LOW), 0.07% (MOD), or 0.09% of body weight (HI).
[ab] Means within rows having common superscripts do not differ ($P < 0.05$).

Table 3. Effects of decreasing time to parturition on intake and digestibility by beef cows fed low-quality forage (Exp. 1)

	Week relative to average calving date											*P*-value		
Item	-14	-13	-12	-11	-10	-9	-8	-7	-6	-5	SEM	Linear	Quadratic	Cubic
Total tract digestibility, %														
Dry matter	54.0	53.0	52.6	52.1	52.1	51.8	51.6	50.8	51.1	50.5	0.48	0.01	0.36	0.39
Neutral detergent fiber	58.7	58.5	58.4	58.0	58.3	58.3	58.3	57.2	57.9	57.5	0.51	0.03	0.81	0.88
Intake, % of body weight														
Forage	1.7	2.0	2.1	2.1	2.2	2.3	2.4	2.2	2.4	2.5	0.04	0.01	0.01	0.01
Total	2.0	2.3	2.4	2.4	2.5	2.6	2.7	2.5	2.8	2.8	0.04	0.01	0.01	0.01

Table 4. Effects of of ruminally undegraded protein supplementation on cow and calf performance (Exp. 2)

	Ruminally undegraded protein [1]			
Item	LOW	MOD	HI	SEM
Cow				
Average daily gain (ADG), lb/day	0.22	0.15	0.04	0.072
Body condition score change	-0.19	-0.20	-0.39	0.094
Julian calving date	68	66	64	2.2
Pregnancy rate, %	95	95	92	4.4
Calving interval, day	364	368	366	3.6
Calf				
Birth weight, lb	90	86	86	2.0
Weaning weight, lb	538	540	536	12.6
ADG (birth to weaning), lb/day	2.18	2.18	2.14	0.02

[1] Ruminally undegraded protein: 0.05% (LOW), 0.07% (MOD), or 0.09% of body weight (HI).