Effect of Glucogenic Feed Additive on Reproductive Performance in Young Postpartum Range Cows

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Summary with Implications

Performance of young March-calving range cows receiving a protein supplement with the addition of either monensin or propionate salt were compared to evaluate the effect of feed additive on overall production in the postpartum stage. Cow body weight and body condition were not impacted by postpartum supplementation throughout the study. Calf body weights were not impacted by type of feed additive at birth, weaning, or 205-d. Twenty-four-hour milk production was not impacted by the type of feed additive. Conception rates for cows receiving postpartum supplementation containing propionate salt were greater than cows receiving monensin. This implies that the addition of propionate salt when supplementing young range cows in the postpartum period can increase pregnancy rate resulting in an increase in marginal revenue compared to cows fed monensin.

Introduction

Increased nutrient demands are observed in young cows due to lactation and continued growth which can result in negative energy balance and decreased reproductive performance when grazing native range. Providing an additional or increasing source of energy can allow cows to repartition energy during this time of lactational demand and reproductive repair post-calving. Furthermore, increasing post-ruminal supply of glucose from the diet through increase ruminal propionate supply has been shown to partition nutrients away from milk production while increasing reproductive performance. Therefore, increasing ruminal propionate supply to young cows consuming low-quality forage-based diets may increase energy metabolism and reproductive performance. Supplementation with the inclusion of either monensin or propionate salts have been shown to decrease days to resumption of estrus and increase pregnancy rates in young range cows. Understanding the efficacy of differing glucogenic precursor feed additives can provide insight to develop supplementation strategies to optimize reproductive performance in young cows.

The objective of this study was to determine the impact of addition of either monensin (Rumensin 90, Elanco Animal Health) or propionate salt (NutroCal 100, Kemin Industries) in protein supplements on body weight (BW) change, body condition score (BCS), energy metabolism, reproduction, milk production, and calf weaning BW in young postpartum range cows.

Procedure

This study was conducted over a 3-year period (2019–2021) at Gudmundsen Sandhills Laboratory (GSL) located near Whitman, NE utilizing Red Angus/Simmental composite cows in their first or second parity (n = 189). Cows were stratified at calving by BW (1036 ± 103 lbs) and assigned randomly to a supplementation treatment. A 30% crude protein (CP) supplement (Table 1) was provided at a rate of 2 lb/d with the addition of either: 1) 160 mg/cow daily of monensin (MON; Elanco Animal Health) or 2) 40 g/cow daily of propionate salt (CAP; NutroCal 100, Kemin Animal Nutrition and Health). Supplementation was individually fed and offered for an average of 70 d postpartum after calving. Cows were individually supplemented daily by Super SmartFeed (C-Lock Inc., Rapid City, SD) electronic pasture feeding system.

Table 1. Nutrient composition of postpartum protein supplements for 2- and 3-yr-old range cows

	Supplement[1]	
Item	MON	CAP
Dry matter, %	90.4	90.4
Crude protein, %	29.8	29.8
NutroCal[2], %	0	4.4
Rumensin[3], mg/d	160	0
RUP, % of CP	39.7	39.7
RDP, % of CP	60.4	60.4
Crude fat, %	4.64	4.5
Crude fiber, %	6.01	7.0
Zinc, mg/kg	147	147
Copper, mg/kg	32.7	32.0
Manganese, mg/kg	86.1	86.0
Vitamin A, IU/kg	22,750	22,026

[1]Supplement: 2.0 lb/d with a 30 % crude protein supplement with the addition of either: 1) 160 mg/cow daily of monensin (Rumensin 90, Elanco Animal Health; MON) or 2) 40 g/cow daily of propionate salt (NutroCal 100, Kemin Industries; CAP).

Cows were offered ad libitum access to meadow hay averaging 6.8% CP and 69.6% NDF throughout the study.

Cow BW and BCS (1 = emaciated, 9 = obese) were recorded once weekly upon placement onto trial. Cow BW was taken at 0830 h, prior to hay being provided. Cows were exposed to fertile bulls (1:17 bull to cow ratio) for a 45-d breeding season starting in June of each year. Pregnancy was detected via transrectal ultrasonography in October to determine reproductive performance of cows. Calving distribution in 21-d intervals was calculated with the start of the calving season coinciding with the first day that 2 or more heifers calved.

Calf BW was taken at birth within the first 24 h, pre-breeding, and weaning. Calves were vaccinated with Alpha 7 (Boehringer/Ingelheim) at birth and Vista Once and Vision 7 (Merck) were administered at branding (late April). Bull calves were castrated at branding. Calves were weaned in

October with calf BW adjusted to a 205-d age constant BW without adjusting for age of dam and sex of calf.

Blood samples were taken weekly beginning 45-d postpartum via coccygeal venipuncture into serum separator vacuum tubes and analyzed for metabolites. A commercial enzyme-linked immunoassay kit (DGR International, Inc., Springfield, NJ) was used with a 96-well microplate spectrophotometer (Epoch, BioTek, Winooski, VT) to determine circulating serum progesterone concentrations. Cows were considered cycling before the start of the breeding season if two consecutive samples were ≥ 1.0 ng/mL. In years 1 and 2, milk production was determined using a modified weigh-suckle-weigh method around d 60 postpartum. Cows were milked with a machine after a separation from calves and 24-h milk production was calculated.

A hypothetical partial budget model was developed to compare the economic marginal returns due to supplementation strategy of two 100-cow herds in a 2-yr partial budget using the results. A 2-yr budget was utilized to show the potential impact of supplemental treatments in the year of supplemented and the subsequent year to capture difference in reproductive responses from the first year. Two separate herds are assumed, one consisting of young range cows consuming MON and one consuming CAP. Performance parameters of the partial budget were derived from the results of the current study. Calf prices were estimated using an average price for steers and heifers over a 10-yr period combined from auctions in Nebraska and calf crop was adjusted with an average calf loss. Supplement cost was the average 3-yr cost for the study.

Statistical Analysis

Data were analyzed as a randomized block design using the MIXED procedure of SAS. Cow served as experimental unit with supplemental treatment, year, cow age, and their interactions set as fixed effects. Interactions which were not significant were removed from the model. Cow BW, BCS, and serum metabolite concentrations were analyzed as repeated measures with date of collection serving as a repeated factor with an autoregressive covariate structure. Significance level was set at $P \leq 0.05$.

Table 2. Postpartum supplement effects on cow body weight, body condition score, and reproductive performance for 2- and 3-yr-old postpartum cows.

	Supplement[1]			
Measurement	MON	CAP	SEM	*P*-value
Cow body weight, lb				
Precalving	1020	1010	11	0.50
Calving	933	923	11	0.51
Prebreeding	926	906	11	0.19
Begin of Breeding	917	897	11	0.17
Nadir	882	864	11	0.23
Weaning	933	911	11	0.15
Cow body weight change, lb				
Calving to Prebreeding	-4	-15	4	0.04
Calving to Breeding	13	15	4	0.91
Calving to Weaning	0	-13	7	0.12
Body Condition Score				
Precalving	5.6	5.5	0.04	0.25
Calving	5.3	5.3	0.04	0.69
Prebreeding	5.3	5.2	0.03	0.26
Breeding	5.3	5.2	0.03	0.38
Weaning	5.3	5.2	0.04	0.11
Reproductive Measurements				
Cycling prior to breeding, %	45	58	4	0.03
Pregnancy rate, %	80	89	3	0.04
Calved in first 21 d, %	43	52	3	0.02

[1]Supplement: 2.0 lb/d with a 30 % crude protein supplement with the addition of either: 1) 160 mg/cow daily of monensin (Rumensin 90, Elanco Animal Health; MON) or 2) 40 g/cow daily of propionate salt (NutroCal 100, Kemin Industries; CAP).

Results

Difference in cow BW was not influenced ($P \geq 0.55$; Table 2) by postpartum supplemental treatments at all measurement points from calving to weaning. However, cows consuming CAP did lose more ($P = 0.04$) BW from calving to pre-breeding than their counterparts. Cow body weight change from calving to breeding and to weaning were not influenced ($P \geq 0.12$) by postpartum supplementation strategies. Like cow BW, BCS was not influenced ($P \geq 0.11$) by postpartum supplementation at each measurement time. Calf BW was not influenced ($P \geq 0.68$) by supplemental treatments of dam at birth, weaning, and 205-d adjusted BW. Calves averaged 68, 462, and 418 lbs at birth, weaning, and 205-d respectively.

Reproduction in young breeding females plays a critical role in overall ranch profitability, therefore, shortening the length of the postpartum interval in young range cows can increase overall profitability through improved reproductive efficiency due to more opportunities for conception in the given breeding season. Though no change in BW or BCS was observed, a greater percentage of cows were cycling at the beginning of the breeding season ($P = 0.03$; Table 2) when consuming CAP. Overall pregnancy rates were greater ($P = 0.04$) with cows receiving CAP compared to their counterparts. The increased percentage of cows cycling prior to the start of the breeding season in the CAP supplemental group may have allowed increased opportunities for cows to conceive, which positively impacted pregnancy success. In addition, percentage of calves born in the first 21-d of the calving season were increased ($P = 0.02$) from dams fed CAP.

Serum non-esterified fatty acids (NEFA), urea nitrogen, and glucose concentrations were not influenced ($P \geq 0.47$) by postpartum supplementation strategy. Beta-hydroxybutyrate (BHB) concentration was lower ($P = 0.01$) in cows fed CAP

Table 3. Effect of postpartum supplementation on milk production and milk components for 2- and 3-yr-old range cows

	Supplement[1]			
Measurement	MON	CAP	SEM	*P*-value
24-h Production[2], lb/d	10.00	9.94	0.49	0.94
Milk Components				
Protein, %	2.68	2.56	0.04	0.06
Fat, %	2.79	2.64	0.12	0.42
Lactose, %	5.31	5.40	0.03	0.04
Solids-not-fat, %	8.87	8.86	0.06	0.88
Urea nitrogen, mg/dL	17.93	17.06	0.45	0.06

[1]Supplement: 2.0 lb/d with a 30 % crude protein supplement with the addition of either: 1) 160 mg/cow daily of monensin (Rumensin 90, Elanco Animal Health; MON) or 2) 40 g/cow daily of propionate salt (NutroCal 100, Kemin Industries; CAP).

[2]Millk production measured ~d 60 postpartum.

Table 4. A partial budget model comparing cost and net revenue for 2 postpartum supplementation strategies for two 100-cow herds for 2 consecutive years[1]

	Supplement[2]	
Item	MON	CAP
Year 1		
No. of cows	100	100
Cost of supplement, $/t	345	374
Days of postpartum supplementation	70	70
Supplement cost, $/d	0.345	0.374
Postpartum supplement cost, $/cow	24.15	26.18
Days of postpartum supplementation	209	210
Price of calves, $/lb	1.684	1.684
Weaned calf value, $	774.14	777.84
Minus feed cost, $	749.99	751.66
Total Revenue per cow herd, $	74,998.60	75,166.00
Difference from MON, $	—	167.40
Pregnancy rates, %	80	89
Calving death loss based on exposed females, %	2.8	2.8
Calf crop, %	77.2	86.2
Year 2		
No. of Cows	77	86
Cost of supplement, $/t	345	374
Days of postpartum supplementation	70	70
Supplement cost, $/d	0.345	0.374
Postpartum supplement cost, $/cow	24.15	26.18
Calf weaning weight, kg	209	210
Price of calves, $/kg	1.684	1.684
Weaned calf value, $	774.14	777.84
Minus Feed Cost, $	749.99	751.66
Total Revenue per cow herd, $	57,748.92	64,642.76
Difference from MON, $	—	6,893.84

[1]Data from the current study were used to construct the 2-yr partial budget.

[2]Supplement: 2.0 lb/d with a 30 % crude protein supplement with the addition of either: 1) 160 mg/cow daily of monensin (Rumensin 90, Elanco Animal Health; MON) or 2) 40 g/cow daily of propionate salt (NutroCal 100, Kemin Industries; CAP).

compared to MON. Circulating NEFA and BHB concentrations can be used to identify negative energy balance as they indicate the mobilization of fat stores. The decrease in BHB in cows fed CAP compared to MON suggests that the addition of CAP in the supplementation strategy helped to prevent a metabolic imbalance during the postpartum period.

Milk production was not influenced ($P = 0.94$; Table 3) by supplementation strategy. Milk fat, protein, and solids-not-fat (SNF) were not impacted ($P > 0.05$) by supplementation strategy. Cows fed CAP had greater ($P = 0.04$) lactose percentage compared to MON. Milk urea nitrogen (MUN) concentration, which is associated with the ratio of protein and energy intake, tended ($P = 0.06$) to be lower in cows receiving CAP. This suggests that the addition of CAP improved protein utilization.

An evaluation of potential revenue from two 100-cow herds was conducted with a 2-yr partial budget of the 2 postpartum supplements using results from the study (Table 4). Total supplemental feed costs for the supplemental period were $21.56 and 28.56/cow for MON and CAP, respectively. In year 1, net revenue was $167.40/cow more for cows receiving CAP, respectively, compared with MON. Increased net revenue in year 1 was due to a numerical increase in calf weaning BW. Pregnancy rates across the 3-yr averaged for the supplement year (yr 1) were 80 and 89% for MON and CAP, respectively. Consequently, young range cows fed CAP in year 1 had an increase in net revenue in year 2 of 10.6% compared with MON-fed young range cows. This increase in revenue is the sum of an increase in pregnancy rates and to a lesser extent a decrease in days to first estrus, which offset the greater postpartum feed costs for the year. The increase in revenue did not account for income from cull cows or the cost of developing additional heifers to replace culled open cows.

Conclusion

Although, postpartum supplementation strategies did not influence cow BW or BCS after calving, supplementing young range cows with 40 g of calcium propionate increased the number of cows cycling prior to the initiation of breeding and increased pregnancy rate. In addition, a greater percentage of cows calved in the first 21-d of the calving season the subsequent year, allowing for the potential to wean older, heavier calves. Addition of calcium propionate to a protein supplement resulted in a decrease of BHB concentration indicating lower fat store mobilization suggesting improved energy efficiency, which may have allowed for decreased days from calving to resumption of estrus and overall increased pregnancy rates. Even with the increased cost of supplementation, feeding young range cows 40 g per day of calcium propionate increased marginal revenue compared to feeding cows monensin.

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