Reproductive Efficiency of Range Beef Cows Fed Different Quantities of Ruminally Undegradable Protein Before Breeding[1,2]

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ABSTRACT: Two studies, using 128 crossbred, multiparous beef cows grazing native winter and spring rangeland, were conducted to determine effects of protein supplementation on nutrient status and subsequent calf and reproductive performance. Postparturient cows (body condition score [BC] = 3.9) were fed 1.82 kg of one of two supplements (54% CP at 490 g of CP/d) per cow on alternate days. Supplements were formulated to contain 50% (245/490 g of CP) ruminally undegradable (UD) CP (RU50) or 25% (119/490 g of CP) UD CP (RU25) and were fed until breeding (BC = 4.2). Late-calving cows (Study 1) were individually fed supplement while grazing native range. Early-calving cows (Study 2) were group-fed supplement on alternate days while grazing native range and were daily fed approximately 5.4 kg of medium-quality grass hay (10.5% CP). Late-calving cows had similar ($P > .22$) BW losses postpartum, whereas early-calving cows fed RU50 lost 39 kg less ($P < .01$) BW than did cows fed RU25. Cows that received RU25 returned to estrus sooner ($P < .02$), in the late-calving study, than cows fed RU50 (47 vs 56 d, respectively). The percentage of cows serviced in the first 21 d of breeding (96 and 100% for late- and early-calving studies, respectively) and pregnancy rates (88 and 86% for late- and early-calving studies, respectively) did not differ regardless of postpartum protein supplement. When adequate CP was provided in the diet for optimum function of the rumen, addition of ruminally undegraded CP decreased weight loss of mature, postpartum beef cows grazing native range. Overall, supplements that supplied 490 g of CP·animal^{-1}·d^{-1} (either RU25 or RU50) maintained an 87% pregnancy rate in mature range cows during a 46-d breeding season.

Key Words: Protein, Beef Cows, Reproduction

J. Anim. Sci. 1993. 71:2586–2593

Introduction

Reproduction has been cited as the major limiting factor governing efficiency of beef cattle production (Dziuk and Bellows, 1983) and, therefore, is of economic concern to beef cow-calf producers in the United States. In a review of literature, Randel (1990) concluded that inadequate precalving and(or) postcalving energy or protein nutrition lowers pregnancy rates and first-service conception rates and extends the postpartum interval in suckled beef cows.

Protein quantity (Sasser et al., 1988) and quality (Hunter and Magner, 1988; Wiley et al., 1991) have been shown to influence reproduction. Wiley et al. (1991) found that lactating beef cows supplemented with ruminally undegradable protein, added to an approximately 70% ruminally degradable supplement, responded with a shorter postpartum interval, regardless of prepartum nutrition.

To minimize labor inputs, maximize winter and spring native range utilization, and evaluate isonitrogenous supplements, the objectives of this study were to determine effect of site of protein digestion on 1) reproductive performance of lactating beef cows grazing native range and 2) milk production, nutrient status, weight and body condition score changes, and calf performance of lactating beef cows grazing native range.

[1]The authors gratefully acknowledge the Montana Beef Council for partial support of this research project.

[2]The authors gratefully acknowledge C. K. Clark, N. Roth, K. Bryan, Z. Brady, P. Olind, M. Guthrie, and D. M. Hallford for their technical assistance.

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Received December 10, 1992.
Accepted May 14, 1993.

Materials and Methods

One hundred twenty-eight crossbred, multiparous cows, ranging from 4 to 10 yr of age and primarily of Hereford and Angus breeding, were used in a randomized complete block design with prepartum protein treatments as the blocking criterion. Mature beef cows located at the Montana State University Red Bluff Research Ranch, Norris, MT (56 km west of Bozeman, MT) were assigned to one of two studies depending on date of parturition. Cows that calved in the second half of the calving season were included in Study 1 (late-calving cows). Cows that calved in the first half of the calving season were included in Study 2 (early-calving cows).

Prepartum supplementation was part of a companion study (Nisley and Brownson, 1992), which began for all cows on December 5, 1990, and continued until calving (average = 90 d of supplementation). Cows were group-fed cubed alfalfa (17% CP) or canola meal (21.3% CP) supplements at 1.82 kg/animal on an alternate-day basis. Cows that received the canola meal supplement gained 23 kg more ($P < .01$) BW and lost less ($P < .01$) body condition (.3 of a condition score) than cows fed alfalfa cubes before calving. Prepartum treatment effects were accounted for within the current study and will be discussed only when significant or when an interaction with postpartum supplementation exists.

Rationale. Two treatments were used in the present experiment. A negative control treatment was not included based on research by Sasser et al. (1988), who demonstrated a reduction in reproductive efficiency when protein was restricted in rations of lactating beef cows. In contrast to the previous research of Wiley et al. (1991) and Sasser et al. (1988), who used various quantities of total crude protein, our intent was to formulate supplements that were isonitrogenous in total crude protein but differed in quantity of ruminally undegradable protein. This would eliminate possible confounding results between total protein quantity provided by supplements and site of protein digestion. However, a second confounding factor was introduced. Because protein quantity in the diet was controlled and degradability differed between the two supplements, differences in ruminal function could occur (i.e., microbial protein synthesis and forage digestibility).

Intensive measurements were collected from late-calving cows because it was expected that these cows would have more difficulty returning to estrus and conceiving in a defined breeding season. A less intensive design was used with early-calving cows. These cows were group-fed protein supplements (Pitts et al., 1992). Our purpose was to reflect management practices more similar to those of range beef cow-calf producers in the local area.

Study 1 (Late-Calving Cows). Sixty-six mature beef cows weighing 601 ± 9 kg were assigned on an alternating basis as they calved (March 20 to April 23, 1991) to a postpartum supplement within prepartum treatment block. Cows were fed experimental supplements on alternate days that contained 50% (245/490 g of CP) ruminally undegradable protein calculated on a daily basis (**RU50**) or 25% (119/490 g of CP) ruminally undegradable protein per day (**RU25**). Supplements were formulated to be isonitrogenous (54% CP on DM basis) and nearly isoenergetic, in order to assess differences due to ruminal protein degradability without the factor of confounding protein quantity (Table 1). Supplements were evaluated for ruminal protein degradability using an in situ technique (Miner and Petersen, 1989). Protein remaining after 24 h of in situ incubation was 30.5% for RU50 and 1.5% for RU25, showing that the supplements met our experimental criterion. Cows had free access to water and a trace mineral salt supplement throughout the study.

The supplementation period before breeding was conducted in a 257-ha pasture that had not been grazed during the preceding 15 mo. Annual precipitation averaged from 350 to 406 mm (USDA-SCS, 1976) at the ranch. Carrying capacity was estimated to be 1.21 ha/animal unit month (**AUM**; Payne, 1973). Actual stocking rate was calculated at 1.94 ha/AUM, which indicated that there should have been no limitations in forage availability. Major grass species (Turner, 1985) include blue bunch wheat-grass (*Agropyron spicatum*), Idaho fescue (*Festuca idahoensis*), prairie junegrass (*Koeleria pyramidata*), and needle and thread (*Stipa comata*).

Cow weights and condition scores were recorded on December 5, 1990; before calving on March 5, 1991; at branding on May 22, 1991; and at the end of the study on August 16, 1991. Visual and palpable condition scores (1 = emaciated to 9 = extremely obese) were estimated by two technicians.

Ruminal extrusa samples were collected from two cannulated cows that were managed with experimental cows. Collections were made on April 30 and May 29, 1991, to evaluate chemical composition of grazed forage during the postpartum period before breeding. Ruminal contents were evacuated, and cows were allowed to graze for 1 h. Extrusa were then collected, air-dried, ground through a 2-mm screen, and prepared for laboratory analyses (Table 2).

Ten milliliters of blood was collected from cows via venous/arterial puncture of a tail vessel and centrifuged at 1,500 × g for 15 min within 1 h after collection; serum was frozen for later progesterone analysis by solid-phase RIA. Progesterone concentrations were determined by commercially available kits (Diagnostic Products, Los Angeles, CA). Intra- and interassay CV for progesterone analysis were 10.3 and 3.2%, respectively. Serum collections began at approximately 26 d postpartum and were continued at 4-d intervals until the beginning of the breeding season. First postpartum estrus was determined by

Table 1. Formulation of 25% (RU25) and 50% (RU50) ruminally undegradable protein supplements fed to mature beef cows grazing native range

Item	RU25%	RU50%
	%	
Ingredient[a]		
Soybean meal	66.0	35.0
Wheat mill run	22.0	29.5
Feathermeal	—	13.0
Blood meal	—	13.0
Urea	2.0	—
Ammonium phosphate	2.5	2.0
Molasses	6.5	6.5
Potassium chloride	1.0	1.0
Analysis (DM basis)		
DM	85.9	88.4
CP	54.2	54.1
Undegradable protein	11.3	23.9
TDN	86.4	81.7
ADIN	.4	2.7
ADF	3.5	6.4

[a]Vitamin A (22,500 IU/454 g) was added to each supplement.

progesterone levels > 1 ng/mL followed by observed standing heat during the first 21 d of the breeding season.

Serum and plasma samples for analysis (Technicon Instruments Corp., Tarrytown, NY) of blood metabolites (blood urea nitrogen [**BUN**], serum albumin, serum cholesterol, and plasma glucose) were collected on May 3 and 17 by the procedure described above, nearly 46 h after supplementation. Insulin concentrations also were determined from the same serum samples (Sanson and Hallford, 1984; appreciation is expressed to Dennis Hallford, New Mexico State Univ., for analysis of insulin concentrations). Intra-assay CV for insulin analysis was 14%. Milk production was estimated on the same days as blood collections by using a 6-h weigh-suckle-weigh technique (Ansotegui et al., 1991).

Fecal output was measured by administering Cap-Tec (Newmarket, Auckland, New Zealand) chromic oxide, slow-release boluses to 50 cows on d 27 of postpartum supplementation and collecting fecal grab samples on d 35, 37, and 39. Samples were immediately frozen until later laboratory analysis. After samples were thawed, DM and OM were determined by AOAC (1984) procedures. The remainder of the sample was ground through a 2-mm screen. Chromic oxide concentration was determined to estimate fecal output by analyzing duplicate subsamples using atomic absorption spectrophotometry (Williams et al., 1962).

Supplementation was terminated on June 2, 1991, and cows were moved to a 130-ha pasture for breeding. The breeding season began on June 3, 1991; AI was used during the first 21 d. Semen from two Angus and two Hereford sires was collected and assigned to cows based on their genetic make-up.

Table 2. Chemical analysis of ruminal extrusa samples (%, air dry basis) collected from two cows grazing spring range

Date	DM	CP	NDF	ADIN
April 30	91.7	5.8	66.8	.55
May 29	89.4	12.5	56.3	.73

Cows were observed for behavioral estrus twice daily and were bred approximately 12 h after detection of standing estrus. After insemination, cows were moved to an adjacent 257-ha pasture and were exposed to four Hereford bulls (1:41 bull:cow ratio) for the remainder of the breeding season. Cows not exhibiting estrus during the first 21 d of the breeding season were placed with bulls after the AI period. Bulls were removed from the pasture, and the 46-d breeding season was terminated on July 19, 1991.

Final data collections were made on August 16, 1991, for calf weights, cow condition scores and weights, and pregnancy detection via rectal palpation.

Study 2 (Early-Calving Cows). The second study used cows calving early and was conducted in a manner similar to the late-calving study with these modifications. Sixty-two of the early-calving, crossbred beef cows, weighing 599 ± 10 kg, were randomly assigned to one of two paddocks adjacent to the pasture for Study 1 (approximately 159 ha/paddock). Twenty-three 3-yr-old cows grazed in each paddock during the postpartum period but were not included in the study because they were managed differently before calving (actual stocking rate = 1.48 ha/AUM). The calving period ranged from March 4 to March 20, 1991. On March 25, 1991, supplementation was initiated with group feeding of RU50 supplement to cows in one pasture and RU25 supplement to cows in the other pasture at a rate of 1.82 kg/animal on alternate days. Supplementation continued for 66 d, or until the initiation of the breeding season. In addition, cows were fed approximately 5.4 kg of medium-quality grass hay (10.5% CP on a DM basis)·animal^{-1}·d^{-1} from calving to May 18, 1991 (55 d). Hay feeding was used to minimize potential pasture effects. Cows were rotated between the two pastures every 8 d as another method to reduce potential bias of pasture effects.

Estrual cyclicity before the breeding season was estimated by detection of an ovarian corpus luteum via rectal palpation on May 22 and then again on May 30, 1991. Weights and condition scores of cows postpartum were measured at the same times as in the late-calving study.

Supplementation was terminated on May 30, 1991. Early-calving cows were combined with cows in the late-calving study, and all were moved to the same pasture for breeding. The protocol for late- and early-calving cows was similar for the remainder of the study. A diagram illustrating supplementation regimens and arrangement of the two studies is provided (Figure 1).

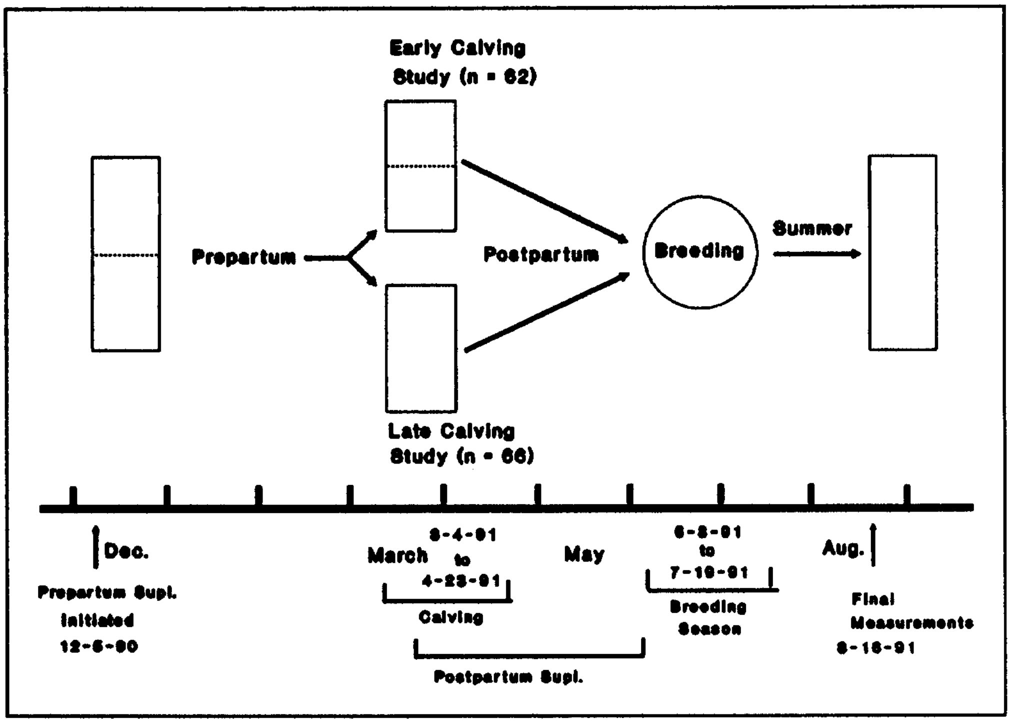

Figure 1. Illustration of early- and late-calving studies with mature beef cows supplemented pre- and postpartum. Dashed lines within boxes depict group-fed supplement.

Statistics. Cows weights, condition scores, and their respective changes were analyzed with the GLM procedure of SAS (1988). Class variables in the main model included prepartum and postpartum supplementation and prepartum × postpartum supplement interaction. Initial measurements were included as covariates in the model only when they accounted for significant ($P < .10$) variation. Because late-calving cows were fed supplement for an unequal number of days, cows were assigned to three calving groups (middle, March 20 to 26, 1991; late, March 27 to April 7, 1991; and very late, April 8 to 23, 1991) based on date of parturition. These calving date groups were tested for significance and included in the model along with the calving date group × postpartum supplement interaction. Main models were expanded to include calf age or birth weight as covariates for analyzing preweaning calf gain when significant. Cow age and cow age × postpartum supplement interactions were added as class variables and March condition score as a covariate to the model testing days to first estrus for late-calving cows. The GLM multivariate repeated measures analysis of variance was used for analysis of milk production, insulin concentrations, and blood metabolites with main model class variables. Multiple means were separated using a t-test for F-values ($P < .10$) (SAS, 1988). Pregnancy rate, percentage serviced during the first 21 d of the breeding season for both studies, and percentage that achieved estrual cyclicity before the breeding season in early-calving cows were analyzed using the chi-square procedure of SAS.

In the early-calving study, cows were group-fed, resulting in greater variation among animals within treatments due to uncontrolled feed consumption. Any significant differences would, therefore, be valid because use of animals as experimental units provides a conservative analysis (Pitts et al., 1992).

Results and Discussion

Cow Weight and Condition Score Changes

Cow weight responses due to protein supplementation during the postpartum period were different between late- and early-calving studies. In the late-calving study, postpartum weight change was influenced by prepartum supplementation ($P < .02$) and was unaffected by postpartum protein supplementation. Cows that were fed canola protein supplement prepartum lost 10 ± 3.2 kg more weight from March to initiation of breeding than those fed alfalfa supplement. Conversely, in the early-calving study prepartum supplement had no effect ($P = .49$) on weight change during the postpartum period, but cows fed RU50 lost 39 kg less ($P < .01$) weight than did cows fed RU25 (Table 3). Findings from early-calving cows agree with those of Hibberd et al. (1988), who also fed

Table 3. Effects of postpartum protein supplementation on beef cow BW after parturition in late- and early-calving cows[a,b]

Item	Late-calving RU25	Late-calving RU50	SE[c]	Early-calving RU25	Early-calving RU50	SE[c]
BW, kg						
March	595.7	606.1	8.6	600.5	597.0	9.5
May[d]	550.4	545.4	3.3	524.6	563.3	3.3
Change[de]	−48.7	−54.4	3.3	−73.0	−33.9	3.3

[a]Late-calving cows (n = 65); early-calving cows (n = 55).
[b]RU25 = 25% ruminally undegradable supplement, RU50 = 50% ruminally undegradable supplement.
[c]SE = pooled SE of least squares means.
[d]Early-calving, RU25 vs RU50 ($P < .01$).
[e]Weight change from March to May.

supplements with lower ruminal protein degradability that were isonitrogenous, as well as with those of Wiley et al. (1991), who fed supplements of unequal protein content. In the early-calving study it is appropriate to assume that rumen function would be optimized with the additional protein provided by the hay and that the undegradable protein provided by RU50 was better utilized to prevent BW loss than was protein provided by RU25.

Similarity in weight response for late-calving cows may be a result of reduced ruminal function postpartum, which provided the conditions for prepartum supplement effects after calving. Murphy et al. (1991) found that cow performance was compromised when undegradable protein supplements were fed to beef cows grazing range; however, a positive response was found when a higher undegradable protein supplement was offered to cows receiving ad libitum access to prairie hay. Schloesser et al. (1993) demonstrated that, although feed protein escaping digestion in the rumen from undegradable protein supplements was higher in range ewes, a subsequent decrease in ruminal fermentation resulted in nearly identical total protein flow to the small intestine for supplements containing higher proportions of ruminally undegradable or degradable protein. Another factor that may have contributed to similar weight responses observed for both protein supplements is the fact that late-calving cows were fed supplement for less time (55 ± 9 d) than were the early-calving cows (66 d).

Postpartum supplementation did not influence body condition scores in either study. Cows had average body condition scores of 3.9 ± .6 at calving and 4.1 ± .5 at breeding.

Late-Calving Study Measurements

On May 3, BUN concentrations were higher for cows receiving RU50 than for those receiving RU25 (10.9 vs 9.8 mg/dL, respectively; $P < .10$) and also were higher on May 17 (14.8 vs 13.1 mg/dL, respectively, $P < .01$). This is indicative of deamination for the excess metabolizable protein that was fed. Because of the low quality of native range early in lactation (Table 2) without the addition of hay that was provided to the early-calving cows, it is appropriate to assume that ruminal function was not optimized for late-calving cows and that ruminally degradable protein was first-limiting (Petersen et al., 1985). It is suggested for cows receiving RU50 that ruminal NDF and DM digestibility may have been reduced and that less ME was available. If diet digestibility was reduced, then the ratio of metabolizable protein:ME would be less desirable, hence the increase in BUN concentrations. This could explain the similarity in weight responses between late-calving cows supplemented with RU25 and those supplemented with RU50.

Insulin has been investigated as a metabolic mediator of reproduction (Harrison and Randel, 1986) and is positively correlated with CP absorbed in the small intestine (Bassett et al., 1971). In the current study a prepartum × postpartum protein supplement interaction ($P < .03$) for insulin concentration was found. Because of the length of time from protein supplementation to collection of blood for insulin analysis (46 h), the effects of protein absorption on insulin response were not measurable, as suggested by Lalman et al. (1993). The interaction observed would be biologically difficult to explain.

Serum albumin and cholesterol and plasma glucose were unaffected by postpartum protein supplementation (Table 4) and were within the normal range for beef cows (Kaneko, 1989). Similar milk production (Table 4) regardless of postpartum protein supplementation agrees with the findings of Wiley et al. (1991) and up to d 60 postpartum as reported by Hunter and Magner (1988). Fecal output (Table 4), which can be used to estimate intake, was also unaffected by postpartum supplement.

Preweaning Calf Gains

Age of calf affected ($P < .01$) preweaning calf gains in both studies. In addition, pre- and postpartum supplementation interacted to influence preweaning gain for early-calving cows ($P < .08$; Table 5). Cows that were fed alfalfa prepartum had calves with

Table 4. Measurements unaffected by postpartum protein supplementation for late-calving, mature beef cows[a,b]

Item	RU25	RU50	SE	n
Albumin, mg/dL				
May 3	4.09	4.11	.05	65
May 17	3.85	3.88	.04	65
Glucose, mg/dL				
May 3	63.22	64.00	.82	65
May 17	59.75	58.80	.93	65
Cholesterol, mg/dL				
May 3	115.41	115.23	2.93	65
May 17	118.40	115.10	2.96	65
Milk production, kg/d				
May 3	9.7	10.3	.94	52
May 17	10.6	10.9	.89	52
Fecal OM, g/d	2,519.6	2,510.5	74.5	39
Calf gain, kg	146.0	142.0	2.7	63

[a]RU25 = 25% ruminally undegradable supplement, RU50 = 50% ruminally undegradable supplement.
[b]All differences were nonsignificant ($P > .10$).

Table 5. Prepartum × postpartum protein supplementation interaction for preweaning calf gain of early-calving, mature beef cows grazing native range (n = 58)[a]

	Alfalfa		Canola		
Item	RU25	RU50	RU25	RU50	SE[b]
Calf gain, kg[c]	175.2[d]	164.8[e]	167.3[de]	172.4[de]	4.2

[a]RU25 = 25% ruminally undegradable supplement, RU50 = 50% ruminally undegradable supplement; alfalfa and canola supplements were fed prepartum.
[b]SE = pooled SE of least squares means.
[c]Preweaning calf gain from birth to August 16, 1991.
[d,e]Values with different superscripts differ ($P < .08$).

higher preweaning gains when cows were fed RU25 after calving than those that were fed RU50 supplement. Calf preweaning gains were unaffected by postpartum supplement when cows were fed canola before calving. A trend for a prepartum × postpartum supplement interaction also was observed in the late-calving study ($P = .12$); however, the relationship was the reverse of that detected in the early-calving study. Calf gains were reported by Rakestraw et al. (1986) to be unaffected for cows fed different amounts of protein and forage postpartum. Wiley et al. (1991) fed supplements that differed in ruminal protein degradability postpartum while varying nutrient intake prepartum and also failed to find an effect of cow nutrition on calf gain.

Reproductive Measurements

The interval from calving to first estrus in the late-calving study was affected by postpartum supplement ($P < .02$), cow age ($P < .01$), and calving date ($P < .01$). Cows that calved midway and late in the calving period had a longer postpartum interval than cows that calved very late (middle, 57 d ± 2.5; late, 56 d ± 2.9; very late, 41.0 d ± 4.0). Cows that received RU25 returned to estrus 9 d sooner ($P < .01$) than cows fed RU50 (47 vs 56 d, respectively). This finding conflicts with weight change data because all cows fed either supplement lost similar ($P = .22$) amounts of weight before breeding (Table 3). Because weight loss was not influenced by type of supplement fed, it would also be expected that reproduction would be similar for all late-calving cows. Because days to first estrus was affected by supplement whereas other measurements of nutrient status such as weight change and milk production were not, this study did not show a strong relationship between days to first estrus and nutrient status measures.

The percentage of early-calving cows that achieved estrual cyclicity before the breeding season was not affected (100 and 97% for RU50 and RU25, respectively) by postpartum supplements. In this study, early-calving cows fed RU50 had improved weight change after calving but similar reproductive responses compared with cows that received RU25. Because days to first estrus were not measured in the early-calving cows, similarities in reproductive performance may have been due to the fact that the time period from calving to breeding was longer for the early-calving cows than for the late-calving cows. This extension of time could have masked differences that may have occurred earlier in the postpartum period and were not measured (days to first estrus). Protein supplements could also have provided required amino acids or similar metabolizable protein that allowed for comparable reproductive performance without regard to ruminal protein degradability.

All early-calving cows were serviced during the first 21 d of the breeding season. Whereas 100% of late-calving cows that received RU50 were serviced during the first 21 d of the breeding season, which tended to be different ($P = .11$) when compared with 91% of RU25 supplemented cows, fall pregnancy rates did not differ between treatments in either study (Table 6). Overall, spring range supplements that contained 54% CP (either 25 or 50% ruminal degradability) fed at a rate of .91 kg/d to lactating, mature beef cows with body condition scores ≤ 4.5 resulted in an 87% pregnancy rate during a 46-d breeding season.

Supplemental Input

Quantities of supplemental inputs fed to cows in both studies are given in Table 7. Although early-calving cows received an additional quantity of grass hay, their reproductive performance was similar to that of late-calving cows, which only received protein supplement during the postpartum period. Within each study, we did not test hay feeding vs absence of

Table 6. Chi-square analysis of postpartum protein supplementation effects on percentage serviced during the first 21 days of the breeding season (21 d) and percentage pregnant (preg)[a]

Item[b]	Late-calving study		Early-calving study	
	21 d[c]	Preg[d]	21 d[d]	Preg[d]
No. of cows	63	63	58	58
RU25, %	91	86	100	83
RU50, %	100	89	100	89

[a]Six cows (three/study) aborted during the summer from undetermined causes and were considered nonpregnant.
[b]RU25 = 25% ruminally undegradable protein supplement; RU50 = 50% ruminally undegradable protein supplement.
[c]RU25 vs RU50 ($P = .11$).
[d]RU25 vs RU50 ($P > .51$).

Table 7. Pre- and postpartum supplemental inputs (kg) of mature beef cows grazing native range[a]

Item	Late-calving	Early-calving
Supplement		
Prepartum[b]	82	82
Postpartum[c]	50	60
Hay		
Postpartum[d]	—	367
Total	132	509

[a]Supplements offered to cows in late- and early-calving studies.
[b]Prepartum supplement fed for 90 d during last trimester.
[c]Postpartum supplement fed for an average of 55 d and 66 d before breeding for late- and early-calving studies, respectively.
[d]Postpartum grass hay fed for 55 d from calving before breeding, only to early-calving cows.

hay; however, evaluation of management practices in both studies indicated that there was no improvement in reproductive performance from the traditional practice of feeding hay. Further research may be necessary to support this statement.

Postpartum protein supplements fed in this study were unique in that they were highly concentrated and supplied 490 g of CP·animal^{-1}·d^{-1}. Labor and equipment resource requirements for feeding these protein supplements on alternate days would be lower than feeding supplemental energy or hay, which are fed on a daily basis and in larger quantities.

Implications

The effectiveness of supplements containing 54% CP in influencing weight change in cows grazing native range seems to be dependent on quality of ruminally available crude protein. Our interpretation of results from this experiment is that when adequate protein is provided for optimal ruminal function in the diet of lactating, mature beef cows, the addition of ruminally undegraded protein will decrease weight loss. However, important economic traits of mature beef cows grazing native range, such as percentage of cows serviced early in the breeding season and overall pregnancy rates, were affected similarly by supplements that provided 490 g of crude protein/d, with either 119 or 245 g of ruminally undegradable protein.

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