# METABOLIZABLE PROTEIN REQUIREMENTS OF EARLY LACTATING BEEF COWS GRAZING DORMANT NATIVE (OKLAHOMA) RANGE

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## ABSTRACT

Sixty-three Angus x Hereford cows, 3-7 years, were used to determine the metabolizable protein (MP) requirements of spring calving beef cows grazing dormant native range. The MP requirements of beef cows (499 kg) with a peak milk production of 6.4 kg/d is predicted at 734 g/d (NRC, 1996). When feeding a standard supplement (40% CP; 1.36 kg/d), MP balance is predicted at -152 g/d. Treatments were fed increases in undegradable intake protein (UIP) by varying amounts of blood meal and corn gluten meal. The MP balance for the treatments was calculated to be -152, -95, -39 and 18 g/d respectively. Forage DM intake was determined and forage masticate samples collected. Protein degradability of the forage and the supplements was determined. Cow weight and body condition score changes and calf weight changes were used to determine the response to treatment. Milk production was determined at 30 and 45 days postpartum. Blood samples were collected postpartum and analyzed for progesterone to determine the initiation of ovarian function.

The MP balance for treatments was calculated to be -129, -90, -94 and -58 g/d. The cows in this study (487±14 kg; 5.56±0.04 BCS) had higher MP requirements (807±8 g/d) due to greater milk production (7.9±0.2 kg/d). Treatment did not influence forage DM intake, cow weight and BCS change, milk production, calf weight change or number of days from calving until the first normal luteal function. For all cows, weight loss from calving to weaning was 27±6 kg and the interval from calving to ovarian function was 54.4±3.3 d. Lack of response to treatment could be due to the smaller MP balance range across treatments and/or the limited duration of treatment (37 d). The high production and reproduction responses indicate that the cows were probably not deficient in MP and MP requirements of the cows may have been over predicted.

## INTRODUCTION

In the past, protein requirements of beef cattle were expressed in terms of crude protein. This system predicts animal protein requirement by accounting for nitrogen losses in the form of metabolic fecal nitrogen, urinary nitrogen and scurf as well as nitrogen required for growth, fetal growth during gestation and milk production (NRC, 1984). The crude protein system assumes that all feedstuffs have equal protein degradation in the rumen. In 1985 the metabolizable protein system for predicting protein requirement was introduced which includes an estimate for bacterial protein supply to the animal (NRC, 1985). This system accounts for protein degradation in the rumen and therefore makes use of two protein fractions to predict the protein requirement of animals: protein that is degraded in the rumen and utilized by the ruminal microorganisms for the synthesis of microbial protein, primarily bacterial crude protein (BCP) and that fraction of crude protein which escapes digestion in the rumen (NRC, 1996). Metabolizable protein is defined as the true protein which is absorbed by the intestine and supplied by both microbial protein and protein which escapes degradation in the rumen; the protein which is available to the animal for maintenance, growth, fetal growth during gestation and milk production (NRC, 1996).

Bacterial crude protein contains about 80% amino acids or bacterial true protein (BTP) since approximately 20% of BCP is present in the form of nucleic acids (Owens and Zinn, 1988). The digestibility of BTP is estimated to be about 80%, giving the conversion of BCP to metabolizable protein (MP) a coefficient of 0.64. Undegradable intake protein (UIP) is also assumed to be about 80% digestible, giving a coefficient of 0.80 for the conversion of UIP to MP. Metabolizable protein requirements can be expressed as estimated crude protein (CP) requirements. These estimates are obtained by dividing the MP requirement by a value ranging between 0.64 and 0.80, depending on the extent to which the dietary protein is degraded within the rumen. The coefficient of 0.64 would be used when all of the dietary protein is DIP (NRC, 1996). Depending on the amount of UIP supplied in the diet, 50-100% of the MP required by beef cattle can be supplied by BCP (NRC, 1985). Owens and Zinn (1988) suggested a greater range in which microbial nitrogen can comprise about 40-100% of the non-ammonia nitrogen entering the small intestine. For ruminants fed most diets, it was suggested that microbial protein generally makes up about 50% of the protein digested in the small intestine (Owens and Bergen, 1983).

Postpartum beef cows have high protein and energy requirements due to lactation and postcalving tissue regeneration. A lactating cow producing 4 kg milk/d requires substantially more TDN (1.3 kg/d) than a steer gaining 1.5 kg/d (Owens *et al.*, 1991). In addition, cold stress may further increase protein requirements of beef cows (NRC, 1996). In Oklahoma, spring calving cows often graze dormant native range and are subject to harsh weather conditions in the first few months after calving, a time which coincides with peak milk production. The nutritive value of dormant winter range in Oklahoma is typically low and crude protein may fall below 3% of DM (Waller *et al.*, 1972). Low forage quality is directly related to low dry matter digestibility and indirectly to a decrease in dry matter intake, resulting in decreased animal performance. Dormant native range does not meet the lactating cows protein and energy requirements and thus supplementation is necessitated. It is well documented that supplementation with

Table 1. Values used to predict metabolizable protein balance for beef cows grazing dormant native range during early lactation

| | |
|---|---|
| Body weight, kg | 499 |
| Milk production, kg/d | 6.4 |
| Forage intake, % of BW | 2.2 |
| Forage CP, % | 4 |
| Forage DIP, % of CP | 77 |
| [a]Supplement CP, % | 41 |
| Supplement DIP, % of CP | 65 |
| Forage TDN, % | 49 |
| Microbial efficiency, % | 10 |

[a]Supplement was formulated to supply DIP and UIP according to industry standard supplementation practices.

ruminally available nitrogen may increase feed intake and performance due to an increased digestibility of the forage (Van Soest, 1982; Paterson *et al.*, 1994; Köster *et al.*, 1997).

Commercial range supplements are formulated on the basis of crude protein. In Oklahoma, a standard industry practice is to supplement lactating beef cows grazing dormant native range with approximately 1.36 kg of a 40% crude protein supplement daily. Since the nutrient requirements of the rumen micro-organisms and the animal are not accounted for separately, this practice generally exceeds degradable intake protein (DIP) requirement while under providing undegradable intake protein (UIP). Consequently, the metabolizable protein requirement of the animals is not met. In terms of meeting the protein requirements of beef cattle, it is economically important to optimize BCP synthesis. Because DIP requirements are directly related to BCP synthesis, it is important to accurately predict BCP synthesis. The objective of this study was to determine the early lactation metabolizable protein requirement of spring calving beef cows grazing native winter range in Oklahoma.

## MATERIALS AND METHODS

Sixty-three Angus x Hereford cows, 3-7 years of age, were used to determine the MP requirements of early lactating spring-calving beef cows grazing dormant native range. Prior to initiating the study, the Beef NRC (1996) was used to predict MP requirements and MP supply from range forage and a standard high protein supplement fed at the rate of 1.36 kg per cow daily. Animal, forage and supplement characteristics used in the initial evaluation are shown in Table 1. The model (NRC, 1996) predicted a MP deficiency of 152 g per day (Table 2).

Table 2. Predicted metabolizable protein balance for beef cows grazing dormant native range during early lactation and fed an industry standard supplement

| | |
|---|---|
| Body weight, kg | 499 |
| Forage intake, % of BW | 2.2 |
| Forage digestibility, % of DM | 49 |
| DIP required, g/d | 538 |
| Forage DIP supplied, g/d | 338 |
| [a]Supplement DIP supplied, g/d | 327 |
| DIP balance, g/d | 127 |
| [b]MP required, g/d | 734 |
| Microbial MP supplied, g/d | 345 |
| MP supplied from forage UIP, g/d | 81 |
| [a]Supplement MP supplied, g/d | 158 |
| MP balance, g/d | -152 |

[a]Supplement composition shown in Table 10.
[b]Calculated from NRC (1996).

Using this value, three experimental supplements were formulated to provide incremental levels of UIP, with the industry standard supplement serving as the control. The calculated MP balance provided by the supplements ranged from -152 to 18 g/d (Table 3). Supplemental UIP for the treatments was increased in titration fashion by adding 63 g/d (C+63), 126 g/d (C+126) and 189 g/d (C+189) additional UIP in the form of a fixed combination of blood meal (36%) and corn gluten meal (64%). The main supplement components were soybean meal (54% CP, 65% DIP), soybean hulls (12% CP, 75% DIP), blood meal (94% CP, 25% DIP) and corn gluten meal (66% CP, 41% DIP). The supplements were calculated to supply equal DIP

Table 3. Experimental supplement composition and predicted metabolizable protein balance (DM basis)

| | Treatment | | | |
|---|---|---|---|---|
| | Control | C+63 | C+126 | C+189 |
| Soybean meal, % | 81.93 | 72.76 | 62.77 | 52.77 |
| Soybean hulls, % | 9.40 | 5.65 | 2.62 | 1.27 |
| Blood meal, % | - | 4.55 | 9.15 | 13.18 |
| Corn gluten meal, % | - | 8.08 | 16.27 | 23.44 |
| Dicalcium phosphate, % | 2.02 | 1.99 | 1.97 | 1.91 |
| Potassium chloride, % | 3.69 | 3.99 | 4.26 | 4.45 |
| Molasses, % | 2.89 | 2.92 | 2.89 | 2.92 |
| Vitamin A (30 000 IU), % | 0.07 | 0.07 | 0.07 | 0.06 |
| Amount fed, g/d | 1360 | 1360 | 1360 | 1360 |
| DIP supplied, g/d | 396 | 396 | 396 | 396 |
| UIP supplied, g/d | 211 | 274 | 337 | 400 |
| NEm, Mcal/d | 2.59 | 2.59 | 2.59 | 2.61 |
| MP from supplement base, g/d | 190 | 247 | 303 | 360 |
| Additional MP supplied, g/d | 0 | 57 | 113 | 170 |
| Predicted MP balance, g/d | -152 | -95 | -39 | 18 |

(396 g/d) and energy (2.59 Mcal NEm/d) while supplying 211 g/d (Control), 274 g/d (C+63), 337 g/d (C+126) and 400 g/d (C+189) UIP.

Prior to calving the cows were individually supplemented daily with the control supplement to acquaint them with the supplementation barn. Body condition was individually determined by two trained technicians and the average value used. Cows were also weighed prior to calving and then at 14 d intervals until the end of supplementation. Cows were penned the evening prior to weighing and 16 hour shrunk weights were used consistently. Calves were individually identified and weighed within 48 hours of calving. Post calving (early February through late March) the cows were allotted to one of the four treatments based on calving date, body condition score (BCS) and age and individually supplemented an equal amount of 1.59 kg/d, six days per week. Supplementation continued until the forage started greening (mid April).

At the end of supplementation, cow weights and BCS and calf weights were recorded. At weaning (early October), cows and calves were once again weighed and BCS determined. Body condition score was based on a nine-point scale (Spitzer, 1986; Wagner *et al.*, 1988) and determined by the same two trained technicians.

Forage intake was determined at the end of March using eight cows from each of the four treatments. Slow release chromic oxide boluses were used and boluses were lubricated with mineral oil before administering. A five-day adaptation period was followed by a five day fecal collection period. Fecal grab samples were obtained daily during supplementation. For validation of marker release, total fecal collections were conducted using four steers equipped with fecal collection bags. Total fecal collections coincided with the time that fecal samples were collected from the cows to determine forage intake and the steers were bolused at the same time at which the cows were bolused. The bags were strapped on the steers the evening before the first grab samples were taken from the cows and then weighed and emptied at 12 hour intervals until after the last samples had been taken from the cows. Steers were housed in a pen and fed prairie hay. They were adapted to the diet and acquainted with the bags for one week prior to the fecal collection period. All fecal samples were dried at 60 °C in a forced air oven and then ground through a 2 mm Wiley mill screen. Chromium analysis was conducted using atomic absorption.

Within the time of supplementation, milk production at 30 d and 45 d postpartum (late March and mid April) was determined using the weigh-suckle-weigh technique (Totusek *et al.*, 1973) with ten cows and their calves from each of the four treatments. Twenty-four hour milk production was estimated by conducting three consecutive weigh-suckle-weighs at eight-hour intervals. The total of the three measurements was used to obtain daily milk production per cow.

A 10 ml blood sample was collected from each cow within one week after calving and thereafter at the same time weekly until the end of supplementation. Vacutainer tubes with EDTA were used to collect these samples. Following collection, the blood samples were cetrifuged at 2500 rpm for 15 minutes. The blood plasma was then discanted and stored at -25 °C until analyzed. Samples were analyzed for plasma progesterone concentration as an indication of the first normal luteal phase to determine the time from calving until the initiation of cyclicity. Two consecutive weeks of plasma progesterone concentrations >1 ng/ml were used to indicate that ovulation had occurred and that a functional corpus luteum was present on the ovary (Vizcarra *et al.*, 1997). Plasma samples were assayed for progesterone via RIA using coated tube methodology.

Four oesophageally cannulated heifers were used to collect masticate samples of the grazed forage. Samples were collected late February, mid March, mid April and early May using masticate collection bags. The heifers received no supplementation and were held in drylot for three hours prior to sample collection to ensure a sizeable sample. Samples were squeezed to remove excess saliva (Hart, 1983) and then immediately stored at -30 °C. At a later stage the samples were lyophilized (without defrosting) at -50 °C and then ground through a 2 mm Wiley mill screen.

Masticate samples and supplement samples (also ground through a 2 mm Wiley mill screen) were incubated *in situ* to determine protein degradability. The *in situ* neutral detergent fiber nitrogen (NDFN) procedure was used (Mass *et al.*, 1997; Mass *et al.*, 1998; Bodine *et al.*, 1998). This procedure estimates the amount of UIP of feeds by determining the amount and rate of disappearance of fiber-bound nitrogen (NDFN). The estimates of UIP are calculated based on initial NDFN, rates of disappearance and average retention time in the rumen.

The *in situ* study was conducted and replicated in two consecutive weeks using two ruminally cannulated steers each week. The steers were fed prairie hay (4.8% CP) and a soybean meal supplement (1.36 kg/d; 46.7% CP) to ensure that they were not DIP deficient and were adapted to the diet a week prior to incubating the samples. For each of the masticate and supplement samples duplicate 10 x 20 cm dacron bags (53±10 microns pore size) each containing 5±0.001 g of sample, were suspended in the rumen of each animal for 2, 12 and 96 hours. The bags were placed in an oven for 24 hours at 100 °C and then weighed before weighing out the sample. For each time, the dacron bags were placed together in a polyester mesh bag. Prior to incubation, the bags were all soaked in 39 °C water for 20 minutes. After removal from the rumen, the bags were rinsed in a top-load washing machine in cold water on the delicate cycle for 2 minutes and then spun for 1 minute on the same cycle. This was repeated ten times. The bags were then dried in a forced air oven for 48 hours at 50 °C and reweighed. The residue was then sub-sampled (0.5±0.001 g) and NDF determined for each sample. The bags used for NDF analyses were placed in an oven for 24 hours at 100 °C and then weighed before weighing out the sub-sample. After the NDF analyses the bags were again placed in an oven for 24 hours at 100 °C and reweighed. The post NDF residue was then analyzed for nitrogen using the combustion method.

Rate of digestion was calculated from the slope of the regression of the natural logarithm of mg NDFN/g sample over time. The 2 and 12 hour mg NDFN/g sample values were used for the

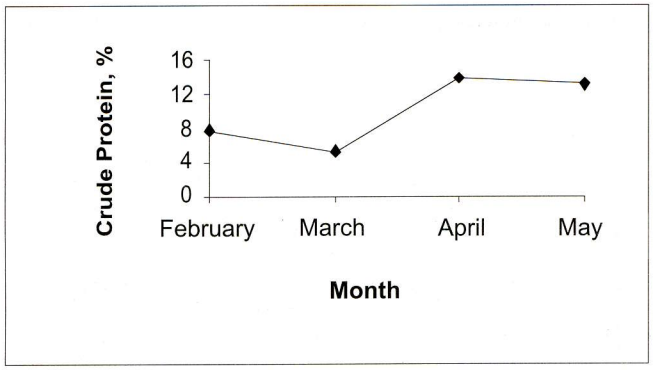


Figure 1. Crude protein content of Oklahoma native range in 1997 (% of DM).

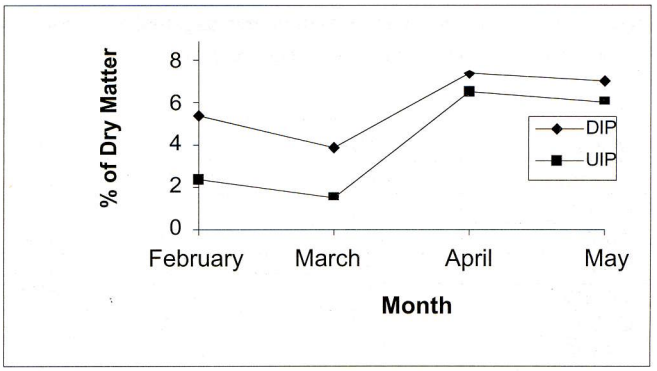


Figure 2. Degradable intake protein and undegradable intake protein content (% of DM) of native range in 1997.

regression after being corrected for the 96 hour mg NDFN/g sample value (the ruminally undegraded NDFN). The exponential value of the Y-intercept value depicts the original pool (0 hours) of mg NDFN/g sample corrected for 96 hours (the fiber-bound nitrogen in the original sample less that which is not degraded within the rumen). There was no need to correct for microbial contamination of the in situ residue as bacterial crude protein is solubilized in the neutral detergent solution. Estimated passage rates of 2%/h were used for the forage samples and 4%/h for the supplement samples. The masticate and supplement samples were also analyzed for dry matter (DM), ash, NDF and acid detergent fiber (ADF) and nitrogen. The ADF content of the samples was used to predict in vivo DM digestibility: %DMD = 88.9 - 0.779 (%ADF) (NRC, 1984).

*Statistical analyses*

The effect of the supplementation treatments on all the dependent variables were analyzed using the GLM procedure of SAS (1989) for a completely random design with individual animals as the experimental unit. The statistical model for intake and days to cyclicity included treatment. The model for milk production included treatment and stage in lactation curve. For analyzing the effect of treatment on cow weight change and BCS change, the model included treatment and time on treatment. The model for change in calf weight included treatment, calf age and calf sex. Linear, quadratic and cubic contrasts were also tested in each case.

## RESULTS AND DISCUSSION

### Metabolizable Protein Balance

Nitrogen analyses on the masticate samples collected with oesophageally cannulated heifers revealed that the CP content of the native range was higher than expected in 1997 and averaged 7.8%, 5.4%, 14.0% and 13.2% in February, March, April and May, respectively (Figure 1). From the in situ trials it was also found that the UIP fraction of the protein was higher than anticipated at 30%, 28%, 47% and 46% (% of CP). Expressed as a percentage of DM, UIP values of 2.3%, 1.5%, 6.6% and 6.1% were determined for the respective months (Figure 2).

Consequently, when predicting the MP balance of the cows during the trial period, primarily February and March, forage CP was underestimated (4% CP) while DIP was overestimated (77% DIP). Nitrogen analyses of the supplements fed to the four treatment groups showed that the actual CP percentage was less (36%, 40%, 44% and 48% CP) than the calculated CP values (41%, 45%, 49% and 53% CP). Protein degradability determined *in situ* further revealed the DIP fraction of the actual supplements was greater (72%, 66%, 63% and 59% DIP) than that of the calculated values (65%, 59%, 54% and 50% DIP) as shown in Table 4. Forage NDF declined in the treatment period from 69.9% in February to 61.9% in April while forage ADF declined from 43.0% in February to 40.0% in April. Calculated DMD increased from 55.4% to 57.7% in that same period (Table 5).

Table 4. A comparison of calculated and observed values of incremental UIP protein supplements fed at 1.36 kg daily to early lactating cows grazing dormant native range

| | Calculated | | Observed | |
|---|---|---|---|---|
| Supplement | CP (% of DM) | DIP (% of CP) | CP (% of DM) | DIP (% of CP) |
| Control | 41 | 65 | 36 | 72 |
| C+63 | 45 | 59 | 40 | 66 |
| C+126 | 49 | 54 | 44 | 63 |
| C+189 | 53 | 50 | 48 | 59 |

Table 5. Means of ash, crude protein, protein degradability, neutral detergent fibre, acid detergent fibre and *in vivo* dry matter digestibility of the supplements and Oklahoma native range (% of DM)

| Month | ASH | CP | DIP | UIP | NDF | ADF | [a]DMD |
|---|---|---|---|---|---|---|---|
| February | 16.2 | 7.8 | 5.5 | 2.3 | 69.9 | 43.0 | 55.4 |
| March | 13.9 | 5.4 | 3.9 | 1.5 | 68.4 | 44.7 | 54.0 |
| April | 12.7 | 14.0 | 7.4 | 6.6 | 61.9 | 40.0 | 57.7 |
| May | 13.9 | 13.2 | 7.1 | 6.1 | 49.5 | 29.4 | 65.9 |
| Control | 11.0 | 36.3 | 26.1 | 10.2 | 12.3 | 6.8 | 83.6 |
| C+63 | 13.5 | 40.4 | 26.7 | 13.7 | 11.1 | 5.1 | 84.9 |
| C+126 | 11.5 | 44.1 | 27.8 | 16.3 | 10.5 | 4.4 | 85.5 |
| C+189 | 11.3 | 48.4 | 28.6 | 19.8 | 8.9 | 3.6 | 86.1 |

[a]Acid detergent fiber content was used to predict *in vivo* DM digestibility: %DMD = 88.9 - 0.779 (%ADF) (NRC, 1984).

Table 6. Metabolizable protein balance of early lactating cows grazing dormant native range and fed increasing amounts of undegradable intake protein

| | Treatment | | | | |
|---|---|---|---|---|---|
| | Control | C+63 | C+126 | C+189 | SE |
| Body weight, kg | 500 | 476 | 473 | 481 | 18 |
| Body condition | 5.58 | 5.56 | 5.59 | 5.63 | 0.18 |
| Milk production, kg/d | 7.74 | 7.90 | 7.90 | 8.10 | 0.65 |
| Forage intake, % of BW | 2.38 | 2.47 | 2.33 | 2.35 | 0.13 |
| DIP required, g/d | 583 | 576 | 540 | 555 | |
| Forage DIP supplied, g/d | 591 | 584 | 548 | 563 | |
| Supplement DIP supplied, g/d | 318 | 324 | 340 | 347 | |
| DIP balance, g/d | 326 | 332 | 348 | 355 | |
| MP required, g/d | 807 | 800 | 799 | 814 | |
| Microbial MP supplied, g/d | 373 | 369 | 346 | 355 | |
| MP supplied from forage UIP, g/d | 193 | 191 | 179 | 184 | |
| Supplement MP supplied, g/d | 111 | 150 | 180 | 217 | |
| MP balance, g/d | -129 | -90 | -94 | -58 | |

Based on the actual weights of the cows (487±14 kg) and the measurements for milk production (7.9±0.2 kg/d) the MP requirements for the cows were greater than initially calculated (807±8 g MP/d versus 734 g MP/d). The estimated average BW of the cows prior to the start of the experiment was 499 kg and the estimated average milk production 6.4 kg/d. The initial body condition scores of the cows in the study were 5.56±0.04.

The actual DIP and MP balance of the cows within each treatment was calculated based on measured values for BW, milk production, forage intake, forage CP, forage DIP and UIP, supplement CP and supplement DIP and UIP. From these values it was determined that all the cows had a positive DIP balance (341±15 g DIP/d) during the supplementation period but even the C+189 supplement did not meet MP requirements. The actual calculated MP balance of the four treatments was -129, -90, -94 and -58 g MP/d as compared with predicted values of -152, -95, -39 and 18 g MP/d (Table 6).

**Forage Dry Matter Intake**

The actual chromic oxide release rate from the boluses used to determine intake was 1.47±0.56 g/d. The chromic oxide boluses had a predetermined release rate of 1.49 g/d.

No significant differences (P>0.22) were determined for amount of forage intake between treatments. The treatments, Control, C+63, C+126 and C+189, had respective average daily forage DM intakes of 11.90, 11.75, 11.03 and 11.32 kg. As a percentage of body weight, respective treatments had forage DM intakes of 2.38%, 2.47%, 2.33% and 2.35% (Table 7).

Table 7. Daily forage dry matter intakes of early lactating cows grazing dormant native range and fed increasing amounts of undegradable intake protein

| | Treatment | | | | |
|---|---|---|---|---|---|
| | Control | C+63 | C+126 | C+189 | SE |
| Forage intake, kg/d | 11.90 | 11.75 | 11.03 | 11.32 | 0.63 |
| Forage intake, % of BW | 2.38 | 2.47 | 2.33 | 2.35 | 0.13 |

Table 8. Weight changes of beef cows and their calves and body condition score changes of cows grazing native range and fed increasing amounts of undegradable intake protein

| | Treatment | | | | |
|---|---|---|---|---|---|
| | Control | C+63 | C+126 | C+189 | SE |
| Initial body weight, kg | 500 | 476 | 473 | 481 | 18 |
| Cow weight changes, kg | | | | | |
| Calving to end treatment, 37d | -33 | -35 | -31 | -32 | 5 |
| [a]End treatment to weaning, 173d | 12 | 5 | 9 | -1 | 7 |
| Calving to weaning, 211d | -21 | -30 | -23 | -33 | 7 |
| Initial body condition score | 5.58 | 5.56 | 5.59 | 5.63 | 0.18 |
| Cow BCS changes | | | | | |
| Calving to end treatment, 37d | -0.66 | -0.64 | -0.83 | -0.77 | 0.16 |
| End treatment to weaning, 173d | 0.04 | -0.14 | 0.03 | -0.08 | 0.18 |
| Calving to weaning, 211d | -0.62 | -0.78 | -0.80 | -0.85 | 0.19 |
| Calf birth weight, kg | 43 | 41 | 42 | 42 | 1 |
| Calf weight changes, kg | | | | | |
| [b]Calving to end treatment, 37d | 31 | 35 | 34 | 36 | 3 |
| End treatment to weaning, 173d | 144 | 137 | 138 | 138 | 6 |
| Calving to weaning, 211d | 176 | 172 | 172 | 174 | 8 |

[a]There was a linear effect ($P < 0.11$) post treatment to weaning with the cows fed the least amounts of undegradable intake protein gaining the most weight.

[b]There was a linear effect ($P < 0.11$) in the treatment period with calves gaining more weight when cows were fed undegradable intake protein.

An increase in forage DM intake increases animal DIP requirement. If DIP requirement is met, bacterial MP supplied will increase and MP requirement from supplementation UIP will consequently decrease. This is clearly illustrated in this study by the C+63 and C+126 treatments. Treatments had equal MP requirements (799.5±0.05 g/d), but forage DM intakes were higher for the C+63 treatment (2.47% of BW) than for the C+126 treatment (2.33% of BW). Degradable intake protein requirements for the treatments were 576 g/d and 540 g/d respectively. Metabolizable protein balance for the C+126 treatment was more negative (-94 g/d) than for the C+63 treatment (-90 g/d), despite having received 63 g additional UIP per day.

**Weight and Body Condition Score**

Weight losses were recorded for all cows from calving to the end of treatment (33±2 kg) and for the entire period from calving to weaning (27±6 kg). These weight losses for all the treatments could possibly be ascribed to the fact that the MP requirements were not met for any of the treatments. No treatment differences were found for the treatment period ($P>0.67$) and for the period from calving to weaning ($P>0.23$). From the end of supplementation until weaning there was a linear decrease in weight gain as supplementation UIP increased ($P<0.11$). Cow weight gains in the post supplementation period were 6±7 kg, with the C+189 treatment losing weight (Table 8).

Body condition losses were also recorded for all cows from calving to the end of treatment (0.7±0.1) and for the entire period from calving to weaning (0.7±0.1). No BCS changes were observed in the post supplementation period (Table 8). Treatment did not influence BCS during the supplementation period ($P>0.30$), the period after supplementation until weaning ($P>0.76$) or for the entire period from calving until weaning ($P>0.26$).

**Milk Production and Calf Weight**

Milk production at 30 days postpartum was 8.65±0.30 kg/d and at 45 days postpartum 7.16±0.03 kg/d (Table 9).

Treatment did not influence milk production at 30 ($P>0.55$) and 45 days postpartum ($P>0.60$). Calf weight gain in the treatment period was 33±3 kg and 140±4 kg in the post treatment period. Calves gained 174±2 kg from calving until weaning (Table 8). In the treatment period there was a linear increase in calf weight gain as supplementation UIP increased ($P<0.11$). No treatment differences were observed for calf weight gains for the period from supplementation until weaning ($P>0.35$) and for the entire period from calving until weaning ($P>0.84$).

Table 9. Milk production and number of days from calving until the first normal luteal phase of beef cows grazing dormant native range and fed increasing amounts of UIP

| | Treatment | | | | |
|---|---|---|---|---|---|
| Milk production | Control | C+63 | C+126 | C+189 | SE |
| 30 days postpartum, kg/d | 8.40 | 8.35 | 8.94 | 8.76 | 0.87 |
| 45 days postpartum, kg/d | 7.08 | 7.45 | 6.98 | 7.45 | 0.71 |
| Average, kg/d | 7.74 | 7.90 | 7.90 | 8.10 | 0.65 |
| Days to cyclicity, d | 57.7 | 55.4 | 51.1 | 53.4 | 4.3 |

### Reproductive Performance

Treatment did not influence the number of days from calving until the first normal luteal function (P>0.21). The average number of days was 54.4±3.3 (Table 9). This relatively short postpartum interval for all treatments indicates that although the MP balance for all the treatments was negative, the cows were not very MP deficient and it is possible that the MP requirements were over predicted.

## CONCLUSIONS

The cows used in this study had higher MP requirements than expected due to greater milk production. According to calculations for the MP intake of the actual treatments, the MP requirements were not met for any of the treatment groups and the range in MP balance among treatments was smaller than anticipated. Some trends were observed for incremental levels of supplementary UIP but no treatment differences were found for forage intake, cow weight and BCS change, milk production, calf weight change and number of days from calving until the first normal luteal function.

The high production and reproduction responses of all the treatments indicate that although according to the MP system the MP requirements were not met for any of the treatments, the cows were probably not MP deficient and MP requirements may have been over predicted. Lack of response to treatment could also be due to the fact that the actual MP range across treatments was smaller than originally calculated and/or that the duration of the treatment from calving until the first availability of high quality spring forage was very limited and possibly the cows did not have sufficient time to respond to treatment.

Due to the natural variation of the CP content and the DIP and UIP fractions in forages and in supplements, accurately feeding a specific amount of supplemental UIP and/or DIP is difficult. To compound matters, supplements are calculated and mixed based on previous data prior to the season in which they are fed and thus may or may not accurately compliment the DIP and UIP values of the forages and native range which is available and utilized in the time that the supplement is fed.

To date there is still limited data available for the evaluation of the MP system. Many production responses to feeding additional DIP and UIP are varying or contradictory and therefore reasons for production responses to supplemental DIP and UIP need further research. It was noted by Galyean (1996) that in the case of beef cattle finishing diets, improvements in performance noted in recent research seemed to be more consistent when supplemental CP was derived from DIP rather than UIP sources.

Despite its sensitivity, the MP system has merit in predicting and meeting the protein requirements of beef cattle. For cattle that are deficient in DIP and/or UIP the use of the MP system should allow producers to more accurately predict the type and amount of supplements necessary to achieve and maintain predetermined performance standards. By feeding the correct amount and type of supplement at specific times, overall cost of supplementation could be reduced.

## APPENDIX

Table 10. Estimated values of components of protein supplements fed to early lactating beef cows grazing dormant native range

| | DM | CP | DIP | UIP | NEm | Ca | P | K |
|---|---|---|---|---|---|---|---|---|
| Item | % | % | % | % | Mcal/kg | % | % | % |
| Soybean meal | 90 | 54 | 65 | 35 | 2.15 | 0.29 | 0.71 | 2.42 |
| Soybean hulls | 90 | 12 | 75 | 25 | 1.86 | 0.53 | 0.18 | 1.29 |
| Blood meal | 91 | 94 | 25 | 75 | 1.51 | 0.40 | 0.32 | 0.31 |
| Corn gluten meal | 88 | 66 | 41 | 59 | 2.20 | 0.07 | 0.61 | 0.48 |
| Molasses | 7 6 | 6 | 100 | 0 | 1.70 | 0.15 | 0.03 | 6.06 |
| Dicalcium phosphate | 97 | 0 | 0 | 0 | 0 | 22 | 19.3 | 0 |
| Potassium chloride | 100 | 0 | 0 | 0 | 0 | 0 | 0 | 50.54 |

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