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Metabolizable Protein Requirements of Lactating Two-Year-Old Cows

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Lactating two-year-old cows consuming meadow hay were deficient in metabolizable protein. Supplementation with undegradable intake protein alleviated the deficiency and improved postpartum weight gain.

Summary

Eighteen lactating two-year-old cows maintained on meadow hay were used to determine the effects of supplementation to meet metabolizable protein or degradable intake protein requirements on production traits during the first two months after calving. Cows supplemented to meet metabolizable protein requirements had a higher ADG than degradable protein supplemented cows. Milk production declined from 15.9 to 10.8 lb/day at 26 to 69 days after calving, respectively. Hay intake averaged 2.4% of body weight. Supplementation to meet metabolizable protein requirements increased postpartum weight change, but did not affect intake or milk production.

Introduction

Lactating two-year-old cows have a high requirement for metabolizable protein (MP), protein absorbed into the body, relative to nonlactating cows. The protein in meadow hay harvested in the Nebraska Sandhills is predominately rumen degradable intake protein (DIP). Conventional supplementation strategies typically supply DIP as the predominant source of protein. Meeting the DIP requirements of young cows is important, but supplemental undegradable intake protein (UIP), protein that escapes rumen degradation, may be necessary to meet MP requirements of two-year-old lactating cows consuming meadow hay in the Sandhills. In Montana, supplementing UIP to young, lactating cows improved weight gain and percentage of cows bred early in the breeding season. We hypothesized that meeting NRC (1996) requirements for MP would positively affect production traits in lactating two-year-old cows in the Sandhills.

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The objectives of this study were to determine the effects of supplementing UIP (to meet MP requirements) to two-year-old lactating cows consuming meadow hay on performance, intake, and milk production.

Procedure

The experiment was conducted at the University of Nebraska's Gudmundsen Sandhills Laboratory near Whitman, Neb. in spring of 1999. Eighteen two-year-old cows (average calving date March 23) were maintained in a large dry lot and allowed ad-libitum access to late-June harvested meadow hay (8.6% CP, 1.8% UIP, 80% NDF (OM basis), and 54% in vitro organic matter digestibility). On April 5, 1999, cows that were at least seven days postpartum (n = 13) were blocked by previous winter treatment (*2001 Nebraska Beef Report*, p. 19), stratified by weight and body condition score (BCS), and randomly assigned to one of two supplemental treatments. Treatments were: 1) supplementation to meet metabolizable protein requirements (MP**),** and 2) supplementation to meet DIP requirements (DIP). Cows and their calves were weighed both on April 5 and 6 without deprivation from food or water, and a BCS was assigned to each cow by two technicians on each day. At seven-day intervals, cows that were not allotted to treatments on April 5, but were at least seven days postpartum were assigned alternately to one of the two supplemental treatments. Cows and their calves were weighed and cows were assigned a BCS on two consecutive days when allotted to treatments. The five cows that were not allotted to treatments on April 5 eventually calved, with one additional cow allotted on April 12 and the final four cows allotted on April 19. Cows and calves were weighed off-test (without deprivation from feed or water) and cows assigned a BCS on May 27 and 28, 1999.

Both supplements were formulated to meet DIP requirements, and the MP had additional UIP to balance metabolizable requirements (Table 1). Requirements were generated using the NRC (1996) Model assuming a peak milk production of 12 lb, forage DM intake of 2.5% of BW, and diet microbial yield of 10.5% of total digestible nutrient intake. The NRC (1996) reports that microbial yield decreases with low-quality forages because of slow passage rates. In the *1998 Beef Cattle Report* (p. 7) it was proposed that values of 9% to 10% be used for low-quality forages plus one percentage unit after calving. We therefore used 10.5%. The MP supplement was 61% CP and 31% UIP (DM basis) and the DIP supplement was 32% CP and 2% UIP. The MP was fed at the rate of 1.2 lb/day (169 g of UIP/day) and the DIP supplement was fed at 1.3 lb/day (12 g of UIP/day). Supplements were pelleted and fed individually three times weekly from April 7 to April 24, 1999. Any refused supplement was weighed and the amount recorded.

Table 1. Composition of supplements fed to lactating 2-year-old cows consuming meadow hay (DM basis)[a].

Ingredient	MP[b]	DIP[c]
Soybean meal	55.0	—
Feather meal	38.4	—
Soybean hulls	6.6	91.9
Urea	—	6.9

[a]Supplements fed thee times weekly from 15 to 64 day post-parturition, on average. Meadow hay was 9.5% CP, 80% NDF (OM basis).
[b]Formulated to meet metabolizable protein requirement.
[c]Formulated to meet the degradable intake protein requirement

Twelve-hour milk production was determined by the weigh-suckle weigh method on April 21 and May 18. Twenty-four-hour milk production was estimated by multiplying 12-hour milk production by two. Intake measurements were taken in a six-day period beginning May 3. Time release chromium boluses were used to determine fecal output in each animal, and predictions were validated with four steers using total fecal collection.

Beginning April 12, cows were bled once weekly via jugular venipuncture. Plasma was harvested by centrifugation and stored in plastic screw-cap vials for subsequent determination of progesterone concentration. Animals were considered to be exhibiting normal estrous activity when plasma progesterone was greater than 1 ng/ml.

Data were analyzed in an unbalanced block design using the GLM procedure of SAS. Calving date was tested as a covariate for all variables. Calving date was only significant as a covariate for cow ADG, calf on weight, and calf off weight. All other variables were analyzed by analysis of variance.

Results

The average calving date was similar for the MP and DIP treatments (Table 2; March 23 and March 22, respectively). Cows on the MP treatment had a higher ADG (P =0.02) than cows on the DIP treatment (0.90 versus 0.31 lb/day for MP and DIP, respectively). There were no differences in cow BCS change ($P = 0.21$), but cows on the MP had positive BCS change compared to the negative change of cows in the DIP treatment. Calf gain was not affected by treatment.

Cow weights at the start of the intake period (May 3), which were estimated from initial weight and ADG for each animal, were the same (Table 3; 853$\pm$ 18 lb). There were no effects ($P = 0.53$) of treatment on hay intake. Hay OM intake averaged 20.3 lb and 2.4% of body weight.

Twenty-four-hour milk production did not differ ($P = 0.97$) between treatments in April or May (Table 4). Milk production declined ($P = 0.0005$) from an average 15.9 lb/day in April to 10.8 lb/day in May. Peak milk production occurred sooner than the predicted 8.5 wk postpartum time period (NRC, 1996). Milk production is important in young cows because it affects nutrient status and the ability of a young cow to return to estrous after calving. Previous research has demonstrated supplemental UIP to both increase and decrease milk production. The UIP levels supplemented in this study did not affect milk production.

The nutrient balance of both treatments in April and May are shown in Table 4. Cows on the DIP treatment did not consume all of the supplement offered. On average, the DIP cows consumed 1.0 of the offered 1.3 lb of supplement per day, with a range of 0.8 to 1.1 lb/day across all cows in that

Table 2. Performance of 2-year-old lactating cows (Exp. 3) consuming meadow hay and supplemented to meet metabolizable protein requirements (MP) or degradable intake protein requirements (DIP)[a].

Item	MP	DIP	SEM[b]
Calving date	March 23	March 22	—
Cow start BW, lb	831	842	20
Cow end BW, lb	875	860	15
Cow ADG, lb[c]	0.90	0.31	0.15
Cow start BCS	4.6	4.8	0.1
Cow end BCS	4.8	4.7	0.1
Average daily BCS change	0.004	-0.001	0.003
Calf start BW, lb	103	101	4
Calf end BW, lb	170	165	4
Calf ADG, lb	1.37	1.30	0.07

[a]Supplements fed thee times weekly from 15 to 64 day post-parturition, on average. Meadow hay was 9.5% CP, 80% NDF (OM basis).
[b]n = 18.
[c]Treatments differ, $P = 0.02$.

Table 3. Organic matter intake of 2-year-old lactating cows (Exp. 3) consuming meadow hay and supplemented to meet metabolizable protein requirements (MP) or degradable intake protein requirements (DIP)[a].

Item	MP[b]	DIP[c]
BW, lb[d]	853 ± 18	853 ± 18
Hay intake, lb	19.4 ± 1.8	20.9 ± 1.5
Hay intake, % of BW	2.3 ± 0.2	2.5 ± 0.2

[a]Supplements fed three times weekly from 15 to 64 day post-parturition, on average. Meadow hay was 9.5% CP, 80% NDF (OM basis).
[b]n = 6.
[c]n = 8.
[d]Body weight at start of intake (May 3, 1999) estimated by on trial BW and ADG.

Table 4. Milk production and estimated nutrient balance of lactating 2-yr-old cows (Exp. 3) consuming meadow hay and supplemented to meet metabolizable protein (MP) or degradable intake protein (DIP) requirements[ab].

	April 21, 1999		May 18, 1999	
Item	MP	DIP	MP	DIP
Milk production, lb/day[c]	15.9	16.1	10.8	10.6
DM intake, lb[d]	23.2	23.8	23.2	23.8
NE_m balance, Mcal	-2.4	-2.2	-0.6	-0.4
MP supplied, g[e]	643	531	643	531
MP required, g[e]	710	712	585	587
MP balance, g[e]	-66	-181	58	-57
DIP supplied, g[f]	858	863	858	869
DIP required, g[f]	592	608	592	608
DIP balance, g[f]	266	255	266	255
Days to lose one BCS	54	60	197	292

[a]Calculated using 1996 NRC Model, nine cows/treatment.
[b]Supplements fed three times weekly from 15 to 64 day post-parturition. Average calving day March 23, 1999. Meadow hay was 9.5% CP, 80% NDF (OM basis).
[c]Twenty-four-hour milk production determined by weigh suckle weigh procedure; SEM = 0.6; Intake declined ($P = 0.0005$) across measurement dates.
[d]Total intake; Hay intake determined using a marker on May 3-8, 1999.
[e]MP = metabolizable protein.
[f]DIP = degradable intake protein.

treatment. Few refusals were recorded for the MP treatment. Despite the low supplement consumption on the DIP treatment, DIP was in excess for both treatments in April and May based on the NRC model using 10.5% microbial efficiency. Energy was markedly deficient for both treatments in April and slightly deficient in May based on the model (days to lose 1 BCS). Metabolizable protein was deficient for both groups in April (-68 and -181 g/d for MP and DIP, respectively). The reason that the MP did not meet MP requirements in April is that milk production was under-predicted for the cows when supplements were formulated. In May, when milk production declined, the MP cows were 58 g/day positive in MP compared to -57 g/day for the DIP cows. Reducing the MP deficiency in April and alleviating the deficiency in May resulted in the higher ADG recorded for the MP cows. Plasma progesterone was not above 1 ng/ml for any cow at any sampling point, indicating no cows exhibited luteal activity by May 17 (second to last bleeding).

Research in Montana showed UIP supplementation increased percentage of cows bred in the first 21 days of the breeding season. Breeding performance was not measured in the current study, but no differences were noted in luteal activity within 60 days after calving. Young cows often have longer postpartum intervals (interval from calving to luteal activity) than mature cows. Postpartum intervals greater than 100 days in two-year-old cows have been reported by other researchers. Both precalving energy level and BCS at calving can affect postpartum interval. The cows in the current study were in a negative energy balance prior to calving (2001 Nebraska Beef Report, p 19). The BCS of the cows at the initiation of the experiment was 4.7, which is a marginal level of condition for young, lactating cows.

The results of the current study indicate supplementation of UIP to meet metabolizable protein requirements will increase postpartum weight change of spring calving, two-year-old cows consuming meadow hay of this quality.

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