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# Short- and longer-term effects of feeding increased metwabolizable protein with or without an altered amino acid profile to dairy cows immediately postpartum

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## ABSTRACT

The first few weeks after parturition is marked by low, but increasing feed intake and sharply increasing milk production by dairy cows. Because of low intake, the nutrient density of the diet may need to be higher during this period to support increasing milk yields. We hypothesized that feeding higher levels of metabolizable protein (MP) or a protein supplement with rumen-protected lysine and methionine during the immediate postpartum period would increase yields of milk and milk components. Fifty-six Holstein cows (21 primiparous and 35 multiparous) starting at 3 d in milk were used in a randomized block design. In phase 1 (3 through 23 d in milk), cows were fed 1 of 3 diets that differed in supply of MP and AA profile. At 23 d in milk, all cows were moved to a common freestall pen and fed the control diet used in phase 1 for an additional 63 d (phase 2). Diets were formulated using the National Research Council model and were control [16.5% crude protein (CP), 10.9% rumen-degradable protein (RDP), and 5.6% rumen-undegradable protein (RUP)], high MP (HMP; 18.5% CP, 11.6% RDP, 6.9% RUP), and AA (MPAA; 17.5% CP, 10.5% RDP, 7.0% RUP 29.7). The MPAA diet included a proprietary spray-dried blood meal product (Perdue Agribusiness, Salisbury, MD) and contained a model-estimated 7.2 and 2.6% of digestible lysine and methionine (% of MP). The HMP and control diets contained 6.3 and 6.7% digestible lysine and both had 1.8% digestible methionine. In phase 1, diet did not affect milk yield (33.6, 34.7, and 33.2 kg for control, HMP, and MPAA, respectively), dry matter intake (17.8, 18.0, and 18.5 kg/d for control, HMP, and MPAA), or milk protein yield (1.07 kg/d). Feeding additional protein (HMP or MPAA) increased both the concentration and yield of milk fat, and milk protein concentration was greater (3.30 vs. 3.17%) for MPAA compared with the HMP diet. Energy-corrected milk was greater (38.4 and 38.6 vs. 35.3 kg/d, respectively) for MPAA and HP than for the control. Cows fed MPAA had the greatest plasma concentrations of Met and the lowest concentrations of isoleucine, but lysine was not affected by treatment. Feeding additional MP (HMP or MPAA) reduced the concentrations of 3-methylhistidine in plasma, indicating reduced muscle breakdown. Diet effects on milk composition continued after cows were changed to a common diet in that cows fed MPAA the first 3 wk of lactation had greater concentration of milk protein for the entire experiment than cows fed HMP, and cows fed additional MP (HMP and MPAA) during phase 1 had greater concentrations of milk fat for the entire experiment. Increasing dietary protein and AA supply in early lactation had short-term effects on yield of energy-corrected milk and long-term effects on milk composition.
**Key words:** amino acid, metabolizable protein, carryover effects

## INTRODUCTION

In the early postpartum period cows are unable to consume enough feed to meet demands of lactation and must rely on mobilization of body reserves to support lactation. Feeding these cows high-protein diets may limit protein mobilization, but will increase feed costs and can result in increased manure N excretion and environmental problems. When postpartum cows were fed a diet with 19% CP they produced more milk but did not consume more DM than cows fed a 16% CP diet (Komaragiri and Erdman, 1997), which led to similar degrees of body protein mobilization; however, in that study all the additional CP was provided by RUP. Increasing concentrations of RDP can increase digestibility of DM (Agle et al., 2010) and fiber (Lee et al., 2012b), resulting in greater DMI. Increasing both MP and RDP may lead to greater milk production and DMI, sparing body protein reserves in early lactation. Reduced mobilization of muscle tissue in early lacta-

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tion may allow the cow to have additional reserves to mobilize after treatment ceases, thus increasing total milk production throughout peak lactation. Previous experiments showed that cows fed a diet with higher concentrations of energy and protein during the first 4 wk postpartum had greater milk yields after treatment ceased (Jørgensen et al., 2016).

An alternative to feeding high-protein diets in early lactation is to formulate diets for improved AA supply to the tissues. In traditional North American diets, corn silage and soybean meal are often major components, and those types of diets are limiting in lysine and methionine (NRC, 2001). Amino acid supplementation started in late gestation and continued during the early postpartum period has increased milk yields (Xu et al., 1998), FCM yields (Overton et al., 1996; Xu et al., 1998; Socha et al., 2005), and milk protein concentration and yield (Xu et al., 1998; Socha et al., 2005); however, because of experimental design, effects of prepartum supplementation could not be separated from postpartum supplementation effects. Increased milk protein production when AA supply was increased in early lactation could be (1) a direct effect of providing AA needed for milk protein synthesis; (2) an indirect effect caused by AA influences on cell signaling and regulation of protein synthesis within the mammary gland (Appuhamy et al., 2012); or (3) caused by increased mammary gland protein synthetic capacity.

We hypothesized that increasing the concentration of MP and RDP in early lactation would support greater milk and milk component production and stimulate DMI so that the effects would continue after treatments ceased. In addition, we hypothesized that similar effects would be observed when cows were fed a diet that provided less total protein but a better AA profile.

**Table 1**. Experimental diets fed to cows in phase 1

| | Diet[1] | | |
|---|---|---|---|
| Ingredient, % | Control | HMP | MPAA |
| Corn silage | 40.0 | 40.0 | 40.0 |
| Alfalfa silage | 12.0 | 12.0 | 12.0 |
| Alfalfa hay | 5.00 | 5.00 | 5.00 |
| Whole cottonseed | 9.00 | 9.00 | 9.00 |
| AminoPlus[2] | 2.00 | 7.03 | — |
| Corn gluten meal | — | 1.62 | — |
| LysAAMet[3] | — | — | 2.28 |
| Corn, ground | 15.7 | 14.0 | 15.7 |
| Soybean hulls | 4.43 | 1.85 | 4.39 |
| Soybean meal (48% CP) | 8.95 | 7.05 | 8.72 |
| Hydrolyzed tallow | 0.49 | 0.49 | 0.49 |
| Trace mineral salt | 0.49 | 0.49 | 0.49 |
| Limestone | 0.81 | 1.01 | 0.76 |
| Dicalcium phosphate | 0.35 | 0.11 | 0.35 |
| Magnesium oxide | 0.16 | 0.07 | 0.07 |
| Selenium, 200 mg/kg | 0.16 | 0.16 | 0.16 |
| Biotin, 220 mg/kg | 0.34 | 0.34 | 0.34 |
| Zinpro 120[4] | 0.02 | 0.02 | 0.02 |
| Copper sulfate | 0.001 | 0.001 | 0.001 |
| Vitamin A (30,000 IU/g) | 0.02 | 0.02 | 0.02 |
| Vitamin D (3000 IU/g) | 0.05 | 0.05 | 0.05 |
| Vitamin E (44 IU/g) | 0.08 | 0.08 | 0.08 |

[1]Diets were control (16.5% CP), high metabolizable protein (HMP; 18.5% CP), and additional MP with a better AA profile (MPAA; 17.5% CP). The control diet was fed to all cows in phase 2.

[2]AminoPlus, Ag Processing Inc., Omaha, NE.

[3]LysAAMet, Perdue Agribusiness, Salisbury, MD.

[4]Zinpro zinc methionine (Eden Prairie, MN).

## MATERIALS AND METHODS

### *Cows and Diets*

All procedures involving the use of animals were approved by The Ohio State University Animal Care and Use Committee. Fifty-six Holstein cows were blocked by parity (6 blocks primiparous and 15 blocks multiparous) and calving date. Between 5 to 7 d before expected calving, cows were moved into individual box stalls and fed a common diet formulated to meet the nutrient requirements (NRC, 2001) of a late-gestation cow. Upon calving, cows were kept in box stalls for 2 d (fed the control diet plus ad libitum alfalfa hay; Table 1) and then moved to the tiestall barn and fed 1 of 3 diets (Tables 1 and 2). Cows were fed treatment diets for 21 d (23 DIM; phase 1) and then moved to a common freestall pen (phase 2), where they were fed the control diet for 63 d (86 DIM). In both phases, adequate TMR was fed to achieve approximately 5% orts. While in tiestalls, feed delivered and refused for each individual cow was measured daily to determine DMI. Cow density in the freestall pen (contained 30 freestalls) was maintained at 30 cows by adding nonexperimental cows when necessary.

The 3 treatments were control, high metabolizable protein (**HMP**), and amino acid supplementation (**MPAA**). All diets were similar in composition except for CP, RDP, RUP, and AA (Table 1 and 2). Diets were formulated (NRC, 2001) assuming an average DMI of 17 kg during the first 23 DIM. The control diet was formulated to support 25 kg/d of MP-allowable milk; the HMP diet was formulated to support 30 kg/d of MP-allowable milk and have a greater concentration of RDP because it can stimulate NDF digestibility (Lee et al., 2012b). The MPAA diet was formulated to support the same MP-allowable milk as HMP, but with similar RDP as the control and a Lys:Met closer to 3:1, as recommended by NRC (2001). The source of additional AA was a spray-dried blood meal product (LysAAMet, Perdue Agribusiness, Salisbury, MD). Formulation values used for the AA product were 78% of the DM as