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Better postpartal performance in dairy cows supplemented with rumen-protected methionine compared with choline during the peripartal period

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ABSTRACT

The onset of lactation in dairy cows is characterized by high output of methylated compounds in milk when sources of methyl group are in short supply. Methionine and choline (CHOL) are key methyl donors and their availability during this time may be limiting for milk production, hepatic lipid metabolism, and immune function. Supplementing rumen-protected Met and CHOL may improve overall performance and health of transition cows. The objective of this study was to evaluate the effect of supplemental rumen-protected Met and CHOL on performance and health of transition cows. Eighty-one multiparous Holstein cows were used in a randomized, complete, unbalanced block design with 2 × 2 factorial arrangement of Met (Smartamine M, Adisseo NA) and CHOL (ReaShure, Balchem Inc., New Hampton, NY) inclusion (with or without). Treatments (20 to 21 cows each) were control (CON), CON+Met (SMA), CON+CHOL (REA), and CON+Met+CHOL (MIX). From −50 to −21 d before expected calving, all cows received the same diet (1.40 Mcal of NE_L/kg of DM) with no Met or CHOL. From −21 d to calving, cows received the same close-up diet (1.52 Mcal of NE_L/kg of DM) and were assigned randomly to treatments (CON, SMA, REA, or MIX) supplied as top dresses. From calving to 30 DIM, cows were fed the same postpartal diet (1.71 Mcal of NE_L/kg of DM) and continued to receive the same treatments through 30 DIM. The Met supplementation was adjusted daily at 0.08% DM of diet and REA was supplemented at 60 g/d. Incidence of clinical ketosis and retained placenta tended to be lower in Met-supplemented cows. Supplementation of Met (SMA, MIX) led to greater DMI compared with other treatments (CON, REA) in both close-up (14.3 vs. 13.2 kg/d, SEM 0.3) and first 30 d postpartum (19.2 vs. 17.2 kg/d, SEM 0.6). Cows supplemented with Met (SMA, MIX) had greater yields of milk (44.2 vs. 40.4 kg/d, SEM 1.2), ECM (44.6 vs. 40.5 kg/d, SEM 1.0), and FCM (44.6 vs. 40.8 kg/d, SEM 1.0) compared with other (CON, REA) treatments. Milk fat content did not differ in response to Met or CHOL. However, milk protein content was greater in Met-supplemented (3.32% vs. 3.14%, SEM 0.04%) but not CHOL-supplemented (3.27 vs. 3.19%, SEM 0.04%) cows. Supplemental CHOL led to greater blood glucose and insulin concentrations with lower glucose:insulin ratio. No Met or CHOL effects were detected for blood fatty acids or BHB, but a Met × time effect was observed for fatty acids due to higher concentrations on d 20. Results from the present study indicate that peripartal supplementation of rumen-protected Met but not CHOL has positive effects on cow performance.
Key words: methionine, choline, transition cow

INTRODUCTION

During the transition from pregnancy to lactation (transition period), dairy cattle enter a period of negative energy and MP balance as a result of increased metabolic demand by the mammary gland and the low DMI (Drackley, 1999). Because methyl donors are required for the synthesis of key compounds such as phosphatidylcholine (**PC**) and carnitine in tissues (Pinotti et al., 2002), a negative methyl donor balance also may be an important challenge for the transition dairy cow (i.e., milk is high in methylated compounds and their levels secreted into milk are maintained even at the cost of depleting reserves of these compounds in liver tissue; Pinotti et al., 2002).

Due to extensive microbial degradation in the rumen, dietary availability of key methyl donors [(e.g., Met and choline (**CHOL**)] is limited (Sharma and Erdman, 1989; Girard and Matte, 2005). Consequently, the increased mobilization of body protein in dairy cows during this period may serve, at least in part, to compensate for the shortfall in methyl groups required by mammary gland and liver (Komaragiri and Erdman,

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1997). Supplementing rumen-protected methyl donors may help fulfill the daily methyl group requirement, and possibly improve the overall production and health of dairy cows during the transition period (Zom et al., 2011; Osorio et al., 2013, 2014).

Both Met and CHOL are key methyl donors in mammals and their availability is important for various biological functions. For instance, Met together with Lys are the 2 most limiting AA for milk synthesis in lactating cows (NRC, 2001). Being the only essential sulfur-containing AA, Met acts as the precursor for other sulfur-containing AA such as Cys, homocysteine, and taurine (Brosnan and Brosnan, 2006). It has been estimated in lactating goats that as much as 28% of absorbed Met could be used for CHOL synthesis (Emmanuel and Kennelly, 1984). Hence, it is thought that rumen-protected CHOL supplementation could spare Met to help cows achieve better overall performance (Hartwell et al., 2000; Pinotti, 2012). Current recommendations for duodenal supply of Lys and Met to maximize milk protein content and yield in established lactation are 7.2 and 2.4% of MP, respectively (NRC, 2001). More recent work demonstrated a benefit of supplementing rumen-protected Met to achieve a Lys:Met ratio close to 2.8:1 during the peripartal period in terms of production performance (Osorio et al., 2013).

Oxidative stress status during the peripartal period also was influenced by increased Met availability due to the fact that it serves as a substrate for glutathione synthesis, the most abundant natural antioxidant produced within cells (Martinov et al., 2010; Osorio et al., 2014). Furthermore, as a lipotropic agent, Met is directly involved in very low-density lipoprotein (**VLDL**) synthesis via the generation of S-adenosylmethionine, the most important methyl donor (Martinov et al., 2010). In turn, S-adenosylmethionine can be used to methylate phosphatidylethanolamine to generate PC, which is essential for VLDL synthesis (Auboiron et al., 1995). In the context of VLDL synthesis and liver lipid metabolism, CHOL-containing nutrients (mainly in the form of PC) are indispensable for the synthesis and release of chylomicrons and VLDL (Pinotti et al., 2002). Thus, supplementation of rumen-protected Met, CHOL, or both (Zom et al., 2011) may increase hepatic triacylglycerol (**TAG**) export and consequently decrease lipidosis.

To date, the reported effects of rumen-protected Met or CHOL supplementation (or both) on dairy cow performance have been inconsistent. Although previous studies from our group and others have observed beneficial effects of Met (Chen et al., 2011; Osorio et al., 2013) or CHOL (Pinotti et al., 2003; Zom et al., 2011) supplementation, other studies did not detect significant improvements on peripartal production performance with Met (Socha et al., 2005; Ordway et al., 2009; Preynat et al., 2009) or CHOL (Guretzky et al., 2006; Leiva et al., 2015) supplementation. In particular, data demonstrating whether CHOL alone or in combination with Met provide equal or different benefits to cows are limited. Our general hypothesis was that supplementation of rumen-protected Met or CHOL improves overall health and lactation performance during the peripartal period. The objective of this study was to evaluate the effect of feeding a commercially available rumen-protected Met or CHOL products alone and in combination on transition cow performance and health.

MATERIALS AND METHODS

Experimental Design and Dietary Treatments

All procedures for this study (protocol 13023) were approved by the Institutional Animal Care and Use Committee of the University of Illinois. The experiment was conducted as a randomized, complete, unbalanced block design with 2 × 2 factorial arrangement of Met (Smartamine M, Adisseo NA) and CHOL (ReaShure, Balchem Inc., New Hampton, NY) inclusion (with or without). A total of 88 cows were blocked according to the expected calving date. Each block had 12 cows (except for the last block with 4 cows all of which completed the study). Cows within each block were balanced for parity, previous lactation milk yield, and BCS before the close-up. A complete data set was obtained from 81 cows receiving a basal control (**CON**) diet (n = 20) with no Met or CHOL supplementation; CON plus Met (**SMA**, n = 21) at a rate of 0.08% of DM; CON+CHOL (**REA**, n = 20) at 60 g/d; or CON+Met+CHOL (**MIX**, n = 20). Dosage of Met was based on Osorio et al. (2013), whereas CHOL was supplied following the manufacturer's recommendations. All cows received the same far-off diet (1.40 Mcal of NE_L/kg of DM, 10.2% RDP, and 4.1% RUP) from −50 to −23 d before expected calving, the same close-up diet (1.52 Mcal of NE_L/kg of DM, 9.1% RDP, and 5.4% RUP) from −21 d to expected calving, and the same lactation diet from calving (1.71 Mcal of NE_L/kg of DM, 9.7% RDP, and 7.5% RUP) through 30 DIM (Table 1).

The Met and CHOL supplements were both top-dressed from −21 ± 2 to 30 DIM once daily at the AM feeding using approximately 50 g of ground corn as carrier. The TMR DM for the close-up and lactation diets was measured weekly for estimation of daily TMR DM offered. Supplementation of SMA (0.08% DM of TMR offered) was calculated daily for each cow. Smartamine