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Information for the Dairy Industry

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Mepron® supports milk performances of transition cows by stimulating the activity of amino acid and glucose transporters in the mammary gland

Introduction

According to recent studies with ruminant and non-ruminant mammary cells, methionine (MET) is assumed to modify several mammary gland functions. First, by increasing overall insulin sensitivity, MET may enhance glucose uptake by the mammary gland, which may consequently increase milk yield. Second, MET might upregulate pathways involved in protein synthesis (mTOR), having a direct impact on milk protein secretion. In addition, production of nutrient transporters may help the mammary gland to uptake amino acids (AA) and glucose. Third, upregulation of protein kinase B (AKT; via mTOR) may enhance expression of genes involved in intracellular fatty acid synthesis.

Whether these mechanisms exist in bovine mammary tissue during early lactation when the cow experiences systemic insulin resistance is unknown. Therefore, this study aimed at assessing the effect of Mepron® supply to transition cows on protein and expression of genes associated with milk protein and fat synthesis in the mammary gland.

Materials and Methods

This study was conducted by the research group of Dr. Juan Loor at the University of Illinois (USA; Batistel et al., 2017; Ma et al., 2019). Starting 4 weeks before expected parturition until 60 DIM, 2 balanced groups of 30 Holstein cows were fed the same corn silage based-diet without (LYS:MET = 3.8:1) or with Mepron® (LYS:MET = 2.8:1) fed at a rate of 0.09% and 0.10% of DMI during the prepartum and postpartum periods, respectively (Figure 1).

Daily DM intake and milk production were recorded, and milk composition was analyzed weekly. Three weeks after calving, mammary gland tissue was harvested from 5 cows per group to assess activity of genes and abundance of proteins involved in glucose and AA transport, protein synthesis, insulin signaling, AA sensors and milk fat synthesis. Blood samples were also collected before and after calving to analyze variations in AA profile (Vailati-Riboni et al., 2019).

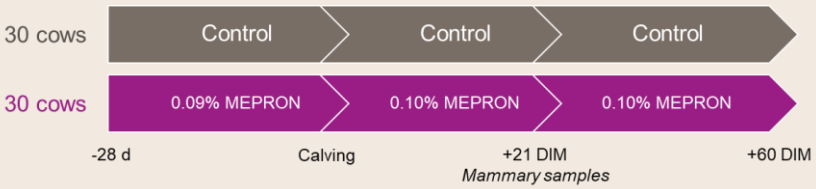

Figure 1: Experimental design

Mepron® stimulates AA utilization and improves protein efficiency

Plasma MET concentration increased with Mepron®. Uptake and utilization of AA by tissues was enhanced in Mepron®-fed cows, which explains the lower concentrations of several AA (GLY, HIS, ASP, GLU, PRO, TYR and taurine) in plasma after about a week post calving. As a consequence, the need for muscle mobilization was reduced as indicated by the tendency for decreased 1,3-methylhistidine (biomarker of muscle protein breakdown). Overall, given the variation in plasma AA profile, we can conclude that transition cows fed Mepron® have an overall better dietary AA efficiency.

Mepron® stimulates activity of genes coding for glucose and AA transporters

Mepron® upregulated activity of several genes involved in insulin signaling, leading to higher insulin sensitivity in the mammary gland and greater glucose uptake by this tissue. This was supported by enhanced activity of two genes encoding for the most abundant glucose transporters in the bovine mammary gland. These combined effects of Mepron® participated in supporting milk production of early-lactating cows.

Mepron® supplementation to transition cows also increased the activity of genes coding for AA transporters. This result can be related with the lower AA concentrations reported in plasma of cows fed additional MET: the enhanced uptake of circulating AA by the mammary gland increased AA availability in this tissue, contributing to milk protein production.

Therefore, the effect of Mepron® in the mammary gland is mostly related to the increased activity of nutrient transporters, rather than a direct impact on genes involved in protein and fat synthesis. However, we also observed some changes in activity of genes related to the endoplasmic reticulum, an organelle involved in protein synthesis, transport, and processing, which indicates an increased protein secretion from the mammary gland.

Mepron® increases milk yield and milk protein content of transition cows

The modifications in mammary gland metabolism induced by Mepron® supplementation during transition supported performances of cows throughout the first 8 weeks after parturition (Figure 2). Compared with control cows, Mepron® cows had higher milk yield during the fresh (+4.1 kg/d; P = 0.03) and high-producing (+4.4 kg; P = 0.04) periods. Milk protein content was also greater for Mepron® cows (+0.16 percentage units; P = 0.04). However, Mepron® did not impact milk fat content despite upregulation of AKT.

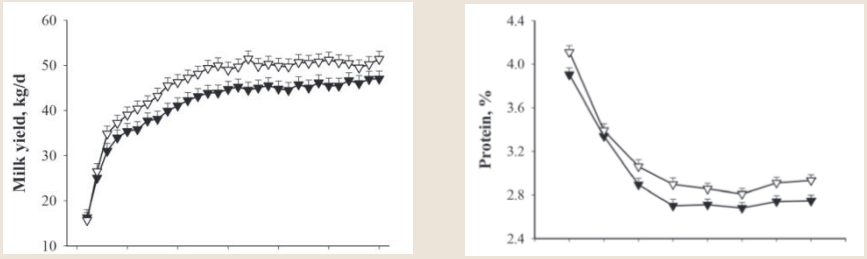

Figure 2: Milk yield (left) and milk protein content (right) of cows fed a control diet without (black triangle) or with Mepron® (white triangle) during transition (0 to 8 weeks after calving)

Reference

- Batistel F et al (2017): Ethyl-cellulose rumen-protected methionine enhances performance during the periparturient period and early lactation in Holstein dairy cows. J Dairy Sci 100(9): 7455-7467
- Ma YF et al (2019): Phosphorylation of AKT serine/threonine kinase and abundance of milk protein synthesis gene networks in mammary tissue in response to supply of methionine in periparturient Holstein cows. J Dairy Sci 102(5): 4264-4274
- Vailati-Riboni M et al (2019): Hepatic cystathionine β-Synthase activity is increased by greater postruminal supply of Met during the periparturient period in dairy cows. Curr Dev Nutr 3(12): nzz128

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