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Monday June 26th: Ruminant Nutrition - Protein and Amino Acids 1

Energy source and amino acids independently alter mammary extraction of nutrients

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The objective of this study was to determine if metabolizable AA level (AAL) altered mammary extraction of nutrients based on energy source (ES, glucogenic (GE) vs ketogenic (KE)). Twenty dairy cows (75 DIM) were enrolled in a replicated 4x4 Latin square with four 28-d periods and 4 treatments arranged as a 2x2 factorial. Factors were AAL: 10% metabolizable AA deficient (DAA) or sufficient, balanced for Met, Lys, and Leu (BAA); and ES: GE (29.5% starch, 3.5% fat) or KE (21% starch, 6% fat, soy hulls replacing corn). Blood samples were collected from a coccygeal vessel and the subcutaneous abdominal vein, 6 times across d25-d26 of each period, staggered to represent every 2 h sampling between am and pm milkings. Plasma was analyzed for insulin, glucose, beta-hydroxybutyrate (BHB), non-esterified fatty acids (NEFA), triacylglycerol (TG), and AA. Data were analyzed with a mixed model containing ES, AAL, ESxAAL, period, and square as fixed effects and cow within square as random. Mammary plasma flow, based on the Fick principle, was not affected by ES (P=0.25) but tended to decrease in response to BAA (-54 L/h, P=0.13). Plasma insulin was higher for GE than KE (0.60, 0.54 ug/L P=0.02) and increased more in response to BAA under GE than under KE (0.16, 0.06 ug/L P=0.03). Plasma concentration and mammary extraction and uptake of glucose were not affected by ES or AAL (P>0.15). Plasma concentration of BHB, NEFA, and TG increased by KE (P<0.01) but were not affected by BAA (P>0.15). Mammary extraction and uptake of TG were increased (P<0.001) by KE, while BAA increased mammary extraction of BHB (+5%, P<0.001) and uptake of NEFA (+9.2%, P=0.01). Plasma concentration of essential AA (EAA), except Phe and Thr, increased for KE vs GE (P≤0.01), but mammary uptake on KE increased only for Arg (P=0.01) and decreased for Leu (P=0.02). Plasma concentration of His, Leu, Lys, Phe, and Val increased (P<0.001) and Thr and Trp decreased (P<0.001) for BAA. Mammary uptake of EAA increased (P<0.01) for BAA, except for Arg (P =0.3) and Trp that

tended to increase (P=0.13). In conclusion, there was no interaction between ES and AAL on mammary uptake of individual nutrients.

Keywords: Mammary gland, energy, amino acids

Adisseo Message:

Amino acid balancing of dairy cow rations has been observed to enhance both milk protein and fat synthesis. Additionally, insulin and glucogenic energy have been observed to stimulate milk protein yields in dairy cows. Both insulin and amino acids (AA), particularly methionine and leucine, stimulate the mechanistic target of rapamycin complex 1 (mTORC1), a cellular nutrient sensing complex that regulates metabolic processes like protein and fat synthesis. Therefore, the objective of this trial was to determine if mammary extraction of nutrients for the synthesis of milk components is affected by energy source (glucogenic or ketogenic) and a balanced AA supplementation.

Overall, energy source did not affect mammary extraction of nutrients, except fatty acids (FA) that were supplied at a higher level by the ketogenic diet. On the other hand, balanced AA supplementation increased mammary extraction of AA and FA, in line with the observed response in milk protein and fat production by that treatment. The observed results underscore the benefits of AA balancing on mammary uptake of essential AA, which can support the activation of mTORC1 and, thereby, milk components synthesis.