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Effect of arginine supplementation on the production of milk fat in dairy cows

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ABSTRACT

Arginine, one of the conditionally essential AA, has been reported to affect fat synthesis and metabolism in nonruminant animals by influencing adenosine monophosphate activated protein kinase (AMPK) in some organs. In dairy cows, the effect of Arg on milk fat production is not clear, and any potential mechanism that underlies the effect is unknown. We tested the hypothesis that Arg infusion would improve the production of milk fat, and explored possible mechanism that might underlie any effect. We used 6 healthy lactating cows at 20 ± 2 d in milk, in fourth parity, with a body weight of 508 ± 14 kg, body condition score of 3.0 ± 0, and a milk yield of 30.6 ± 1.8 kg/d (mean ± standard deviation). The cows were blocked by days in milk and milk yield and each cow received 3 treatments in a replicated 3 × 3 Latin square design, with each of the experimental periods lasting 7 d with a 14-d washout between each period. The treatments, delivered in random order, were (1) infusion of saline (control); (2) infusion of 0.216 mol/d of L-Arg in saline (Arg); (3) infusion of 0.868 mol/d of L-Ala in saline (the Arg and Ala treatments were iso-nitrogenous) through a jugular vein. On the last day of each experimental period, blood was sampled to measure insulin, nitric oxide, glucose, and nonesterified fatty acid, and the liver and mammary gland were biopsied to measure the expression of genes. Milk yield was recorded, and milk fat percentage was measured daily during each of the experimental periods. The yield and composition of fatty acid (FA) in milk was measured daily on the last 3 d during each of the experimental periods. The data were analyzed using a mixed model with treatment as a fixed factor, and cow, period, and block as random factors. The daily milk yield and milk fat yield when the cows were infused with Arg were 2.2 kg and 76 g, respectively, higher than that in control, and 1.8 kg and 111 g, respectively, higher than that in Ala. When the cows were infused with Arg they had higher concentration and yield of de novo synthesized FA, than when they received the control or Ala infusions, although milk fat percentage, daily feed intake, and the digestibility of nutrients were not affected by treatment. The serum concentration of nitric oxide and insulin were higher during Arg than during control or Ala, with no difference between control and Ala. In the liver, the expression of the genes coding for AMPK (*PRKAA1*, *PRKAB1*, and *PRKAG1*) and genes related to the oxidation of FA were higher during Arg than during control or Ala, whereas in the mammary gland the expression *PRKAB1* was lowest, and the expression of genes involved in the synthesis of milk fat were highest, during Arg infusion. The results suggest the intravenous infusion of Arg enhanced the production of milk fat by promoting the de novo synthesis of FA and increasing milk yield.

Key words: AMP-activated protein kinase, energy balance, fatty acid oxidation, milk fat production

INTRODUCTION

Arginine, one of the conditionally essential AA, has been reported to stimulate body fat metabolism and milk fat production in nonruminant mammals, (Wu et al., 2009; McKnight et al., 2010). For example, a recent study in sows found that dietary supplementation with Arg increased the milk fat percentage and daily milk fat yield without affecting daily DMI (Moreira et al., 2018). In ruminants, Arg within ruminal digestible protein is mostly degraded in the rumen, meaning that it does not pass to the small intestine and is not absorbed into the blood (Wu, 2017). If ruminants are supplemented

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