Journal of Animal and Feed Sciences, 13, Suppl. 1, 2004, 651–654

Carbohydrate and lipid metabolism in the transition dairy cow fed linseed*

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ABSTRACT

Thirty-three Holstein cows were stratified by groups of three within parity for similar expected calving dates; cows within group were assigned to one of three isonitrogenous and isoenergetic total mixed diets: control with no added fat (CO) and supplement with either 85% saturated fatty acids (EB) or linseed (LI). The experiment was conducted from wk 6 before to wk 4 after calving. Feeding EB increased plasma concentrations of non-esterified fatty acids (NEFA) and β-OH butyrate (BHBA) and it decreased concentration of glucose compared to feeding CO and LI. Cows fed EB would be more susceptible to develop fatty liver.

KEY WORDS: dairy cow, fatty liver, linseed

INTRODUCTION

Grum et al. (1996) have shown that high fat diets fed to dry cows decrease liver triglycerides (TG) accumulation and increase liver peroxisomal β-oxidation, suggesting that high fat diets could decrease hepatic TG accumulation after parturition. Douglas et al. (1998) have demonstrated that cows fed at restricted intake during the transition period had lower hepatic TG concentrations 1 day after parturition. Recent studies have shown that a group of nuclear hormone receptors, termed peroxisome proliferator-activated receptors (PPARs) binds potentially ω-3 polyunsaturated fatty acids (FA; Power and Nesholme, 1997). Activation of PPARα would then change hepatic lipid metabolism, which in turn could increase hepatic FA oxidation and lower the incidence of fatty liver in the early postpartum period of dairy cows.

* Supported by Dairy Farmers of Canada and the Matching Investment Initiative of Agriculture and Agri-Food Canada

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MATERIAL AND METHODS

Thirty-three dry Holstein cows were stratified by groups of three within parity (primiparous or multiparous) for similar expected calving dates; cows within group were randomly assigned to one of three diets: control with no added fat (CO) and supplement with either 85% saturated FA, energy booster (EB) or ω-3 FA as linseed (LI). Diets were fed from wk 6 before parturition to wk 4 of lactation to meet requirements of dry and lactating cows. Blood was withdrawn on wk -6, -4, -2, -1, 0, 1, 2, and 4 relative to calving for determination of NEFA, BHBA, and glucose. Data were analysed as repeated measures using the PROC MIXED procedure of SAS (1999). The model included the fixed effects of treatment, parity (primiparous or multiparous), week, treatment by week interaction, the random effect of cows nested within treatment, and the residual error. Probability values greater than 0.10 were considered nonsignificant.

RESULTS

Yield of 4% fat corrected milk was similar among treatments and averaged 31.8, 31,1, and 30.1 kg/d for CO, LI, and EB, respectively. There was no interaction between parity and treatment for blood glucose concentration. However, there was a significant interaction between treatment and time due to a greater decrease in blood glucose concentration between wk 1 and 2 postpartum (PP) for cows fed EB compared to those fed CO and LI (Figure 1). There was a significant interaction between parity and time for glucose concentration as a result of greater concentrations of glucose for primiparous than for multiparous cows on wk 1, 2, and 4 PP. Feeding EB compared to CO and LI decreased blood glucose concentrations from wk 1 PP. There was an interaction between time and treatment for blood NEFA concentration (Figure 2); cows fed CO and LI had similar blood NEFA concentrations overtime while concentrations increased after calving for cows fed EB. There was an interaction between parity and treatment for blood NEFA concentration; multiparous cows fed EB had greater NEFA concentration than primiparous cows while there was no difference between parity for diets CO and LI. There was an interaction between time and parity for blood NEFA concentration; multiparous cows showed a greater increase in NEFA concentration after calving than primiparous cows. There was a triple interaction for BHBA concentration (Figure 3). When analysing concentrations of BHBA within parity, there was a significant interaction between treatment and time for both parities. Multiparous cows fed EB had greater BHBA concentrations on wk 2 and 4 PP while primiparous cows fed EB had greater BHBA concentrations only on wk 2 PP compared to cows fed either CO or LI. Concentrations of BHBA were similar among treatments for the other weeks.

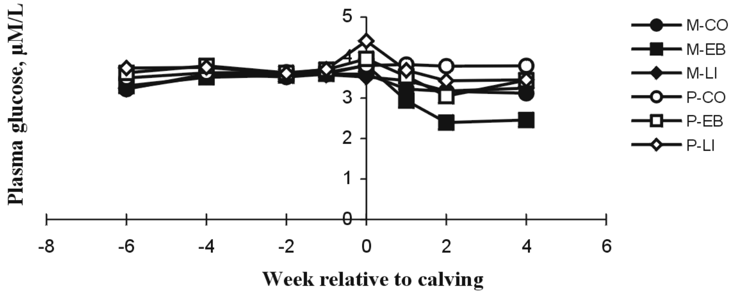

Figure 1. Plasma glucose concentration of multiparous (M) or primiparous (P) Holstein cows fed no fat (CO), saturated fat (EB) or whole linseed (LI)

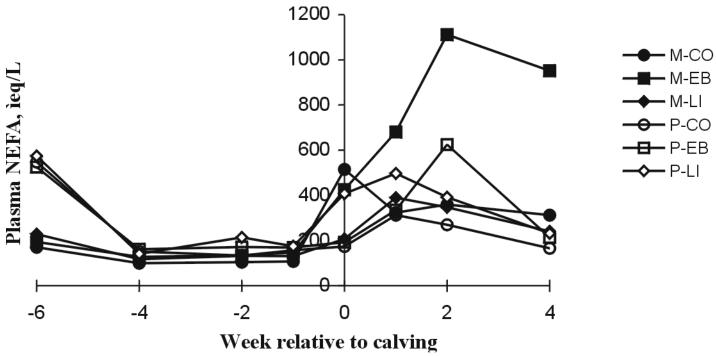

Figure 2. Plasma NEFA concentration of multiparous (M) or primiparous (P) Holstein cows fed no fat (CO), saturated fat (EB) or whole linseed (LI)

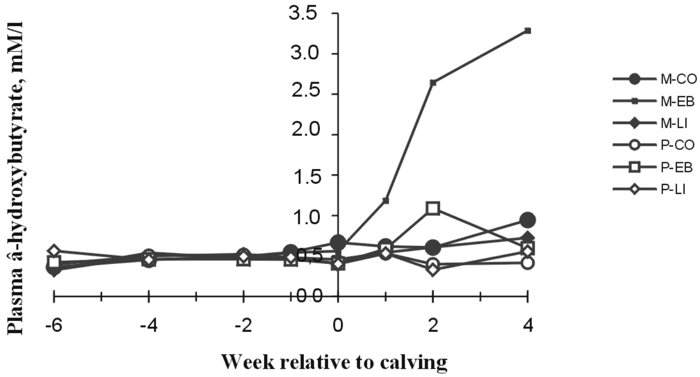

Figure 3. Plasma BHBA concentration of multiparous (M) or primiparous (P) Holstein cows fed no fat (CO), saturated fat (EB) or whole linseed (LI)

DISCUSSION

Greater NEFA concentrations are associated with more severe hepatic lipidosis (Rukkwamsuk et al., 1999), suggesting that cows fed EB were more susceptible to fatty liver infiltration than those fed CO or LI. Multiparous cows would be more subjected to fatty liver as the increase in NEFA plasma concentrations after calving was greater than that observed for primiparous cows. Increasing the severity of lipid accumulation in the liver would decrease hepatic gluconeogenesis and contribute to decrease blood glucose concentrations as observed for cows fed EB and more specifically for multiparous cows. The data would suggest that lipolysis of body reserve occurs at a rate that exceeded the liver's capacity to completely oxidize or esterify NEFA, thus increasing plasma BHBA concentrations as observed for multiparous cows fed EB.

CONCLUSIONS

Feeding saturated fatty acids increases plasma concentrations of NEFA and BHBA and decreases concentration of glucose compared to feeding no fat supplement or 10% whole linseed. These data suggest that cows fed saturated fatty acids would be more susceptible to develop fatty liver than those fed no fat supplement or a source of omega 3 fatty acids.

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