INFLUENCE OF ABOMASAL INFUSION OF L-CARNITINE ON PRODUCTION AND LIPID METABOLISM IN FEED-RESTRICTED LACTATING COWS

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TAKE HOME MESSAGES

- L-Carnitine is the naturally-occurring compound required for oxidation of long-chain nonesterified fatty acids (NEFA).
- Postruminal infusion of L-carnitine enhanced NEFA oxidation in the liver of feed-restricted lactating cows leading to lower liver triglyceride and blood NEFA.
- The potential for L-carnitine to prevent and treat fatty liver in transition dairy cows is currently being investigated.

INTRODUCTION

Fatty liver is a metabolic disorder that can negatively impact production and health of dairy cows in the transition period and subsequent lactation. It has been reported that over 50% of dairy cows experience fatty liver to some degree, although the severity of the disease is dependent upon many factors. Plasma nonesterified fatty acids (NEFA) increase around calving in order to support heavy milk production during a time of depressed dry matter intake (DMI). In the liver, NEFA storage can exceed oxidation and export capacity, leading to fatty liver and other related disorders such as ketosis.

L-Carnitine is required for transport and subsequent oxidation of NEFA in the liver. Experiments have been conducted to study the role of L-carnitine in lactating dairy cows fed supplemental fat. However, the effect of L-carnitine on liver metabolism of lactating dairy cows in negative energy balance is unclear. The objective of this study was to determine the influence of supplemental L-carnitine on specific aspects of hepatic fatty acid metabolism in lactating cows subjected to feed restriction.

MATERIALS AND METHODS

Eight lactating Holstein cows (in 2nd lactation or greater) fitted with ruminal cannulas were used in this study. To properly meet the objective of the experiment, L-carnitine was infused into the abomasum by way of the ruminal cannula in order to prevent ruminal degradation of L-carnitine. The experimental design was a replicated 4 x 4 Latin Square design with a 2 x 2 arrangement of treatments. Treatments were: 1) water infusion, ad libitum DMI (WA), 2) water infusion, restricted DMI (WR), 3) carnitine infusion, ad libitum DMI (CA), and 4) carnitine infusion, restricted DMI (CR). Each cow was subjected to each treatment in random sequence and each treatment was imposed for 14 days. During each 14-day period, water was infused into all cows from day 1-4, while either water (1.2 L/day) or L-carnitine (20 g L-carnitine + 1.2 L of water) was infused on day 5-14. Feed was restricted to 50% of the cow’s previous 5-day average on
day 9-14. The purpose of feed restriction was to cause body fat mobilization in order to mimic the effects of DMI depression at and around calving.

Liver tissue was obtained on day 14 of each period, and blood samples were taken on days 4, 8, and 12 of each period. Liver samples were analyzed for triglyceride and carnitine concentration. Additionally, an in vitro assay was performed to determine the capacity of liver tissue to oxidize fatty acids.

RESULTS AND DISCUSSION

Feed restriction significantly decreased milk production regardless of type of infusion. However, feed-restricted cows that received L-carnitine had higher 3.5% fat-corrected milk compared with feed-restricted, water-infused cows. Therefore, it seems that L-carnitine maintained higher fat-corrected milk production during negative energy balance. Serum insulin was lower and plasma NEFA was higher in feed-restricted cows. L-Carnitine infusion reduced plasma NEFA in feed-restricted cows.

Infusion of L-carnitine significantly increased carnitine concentration of both plasma and liver tissue. L-Carnitine reduced total lipid and triglyceride concentrations in the liver of feed-restricted cows. Infusion of L-carnitine increased fatty acid oxidation to carbon dioxide and ketone bodies as determined by the in vitro fatty acid metabolism assay. Likewise, L-carnitine reduced esterification of fatty acids to triglyceride in vitro. The in vitro fatty acid metabolism data clearly supports the mechanism by which liver triglyceride concentration was reduced.

This study provides evidence that L-carnitine can reduce triglyceride concentration in liver by increasing hepatic oxidation of NEFA. L-Carnitine also reduces plasma NEFA concentration in cows experiencing DMI depression and negative energy balance, presumably by increasing NEFA oxidation. Therefore, supplementation of L-carnitine may be an effective tool for the prevention of fatty liver disease in transition dairy cows, which is currently being investigated in our laboratory.