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Effects of encapsulated niacin on metabolism and production of periparturient holstein cows

Abstract

Niacin (nicotinic acid) can suppress lipolysis, but responses to dietary niacin have been inconsistent in cattle. A widely used commercial feed additive, niacin is thought to reduce heat stress and decrease postpartum plasma nonesterified fatty acid (NEFA) concentration. Raw niacin has poor stability in the rumen, however, and it is estimated that only 5% is bioavailable. Recently, an encapsulated niacin (EN) product with an estimated 40% bioavailability became commercially available, but its effects on health and metabolism in transition cows have not been tested previously. Twenty-two Holstein cows were used in a study beginning 21 days before expected calving; cows were assigned to the EN treatment (24 g/day) or control group until 21 days postpartum. Results showed that EN decreased peak plasma NEFA and ketone concentrations after calving but also caused a 9 lb/day decrease in dry matter intake during the final 4 days before calving in multiparous cows. These results indicate that a high dose of EN can decrease postpartum plasma NEFA and ketones but also may decrease prepartum dry matter intake.; Dairy Day, 2009, Kansas State University, Manhattan, KS, 2009; Dairy Research, 2009 is known as Dairy Day, 2009

Keywords

Kansas Agricultural Experiment Station contribution; no. 10-103-S; Report of progress (Kansas State University. Agricultural Experiment Station and Cooperative Extension Service); 1021; Dairy Day, 2009; Dairy; Lipolysis; Feed intake; Milk yield; NEFA; Niacin

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Effects of Encapsulated Niacin on Metabolism and Production of Periparturient Holstein Cows

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Summary

Niacin (nicotinic acid) can suppress lipolysis, but responses to dietary niacin have been inconsistent in cattle. A widely used commercial feed additive, niacin is thought to reduce heat stress and decrease postpartum plasma nonesterified fatty acid (NEFA) concentration. Raw niacin has poor stability in the rumen, however, and it is estimated that only 5% is bioavailable. Recently, an encapsulated niacin (EN) product with an estimated 40% bioavailability became commercially available, but its effects on health and metabolism in transition cows have not been tested previously. Twenty-two Holstein cows were used in a study beginning 21 days before expected calving; cows were assigned to the EN treatment (24 g/day) or control group until 21 days postpartum. Results showed that EN decreased peak plasma NEFA and ketone concentrations after calving but also caused a 9 lb/day decrease in dry matter intake during the final 4 days before calving in multiparous cows. These results indicate that a high dose of EN can decrease postpartum plasma NEFA and ketones but also may decrease prepartum dry matter intake.

Introduction

Use of niacin in dairy cattle is widely studied; however, most results are inconclusive or contradictory. Niacin is a B vitamin that is required in very small amounts to maintain cellular metabolism. At much higher inclusion rates, niacin also has the ability to suppress the release of fat stores. Degradation within the rumen likely destroys almost 95% of niacin fed to ruminants, making additional supplementation inefficient. A rumen-protected form of niacin (encapsulated niacin; EN) became commercially available several years ago, providing a more effective option for dietary supplementation of niacin.

Fatty liver affects up to 50% of postpartum dairy cattle; this can be costly to producers because of milk production losses and secondary diseases, such as ketosis. Fatty liver occurs when cattle enter a negative energy balance, usually during the first 2 weeks of lactation. Lipolysis occurs as a response to the negative energy balance and results in the liver being overwhelmed by high blood concentrations of nonesterified fatty acids (NEFA). In experiments, niacin has been shown to have antilipolytic effects when given to cattle with induced fatty liver. Until this experiment, no known studies have been done to explore the metabolic and production responses to EN in peripartum dairy cows. The purpose of this study was to determine if 24 g/day of dietary EN could reduce lipolysis enough to control plasma NEFA in postpartum dairy cattle. Other metabolic and production responses measured were body condition score, milk production, liver composition, and dry matter intake.

Experimental Procedures

Primiparous ($n = 9$) and multiparous ($n = 13$) Holstein cows were assigned randomly within parity to receive either 24 g/day EN or none (control) beginning 21 days before expected calving date and continuing until 21 days postpartum. Dry matter intake and milk production were measured daily until day 21 postpartum. Throughout the study, liver biopsies were collected for

triglyceride (TG) analysis and blood samples were collected for NEFA and β -hydroxybutyrate (BHBA) analyses. Cattle were housed in a tie-stall facility, milked thrice daily (0400, 1100, and 2100 hours), and fed twice daily (0700 and 1500 hours). Data were analyzed using mixed models with repeated measures over time.

Results and Discussion

Dry Matter Intake

There was a treatment by time by parity effect ($P < 0.07$, Figure 1) on prepartum dry matter intake caused by a 9 lb/day decrease in dry matter intake of EN-treated cows compared with control cows during the final 4 days before calving. There were no treatment effects on postpartum feed intake.

Plasma Traits

No prepartum treatment effects were detected for any of the plasma traits measured. In contrast, treatment by time by parity effects were detected for NEFA ($P = 0.09$, Figure 2) and BHBA concentrations ($P = 0.03$, Figure 3) during the postpartum period. Plasma NEFA peaked at 1700 and 1300 μM for control primiparous and multiparous cows, respectively, compared with 700 and 800 μM for treated primiparous and multiparous cows, respectively. Niacin treatment also suppressed peak BHBA concentrations in both parity groups.

Other Measures

No treatment effects were observed for liver TG concentration, body condition score, body weight, or milk and milk component production.

In this study, 24 g/day of EN inhibited lipolysis in postpartum cows as demonstrated by a decrease in postpartum NEFA and BHBA concentrations. Depression of prepartum dry matter intake in multiparous cows is a novel finding and is difficult to explain. However, the results of this study also indicate that when EN reduced dry matter intake in multiparous cows, it still suppressed plasma NEFA and BHBA after calving. Although significant alterations in plasma lipid metabolism were detected after EN treatment, this did not result in decreased liver TG content. Lack of changes in liver TG content likely reflects the fact that no cows suffered from severe fatty liver disease in this study regardless of treatment. In summary, a high dose of EN can decrease postpartum plasma NEFA and BHBA. Further work is needed to understand the effects of niacin on prepartum dry matter intake and mechanisms involving postpartum metabolism.

NUTRITION AND FEEDING

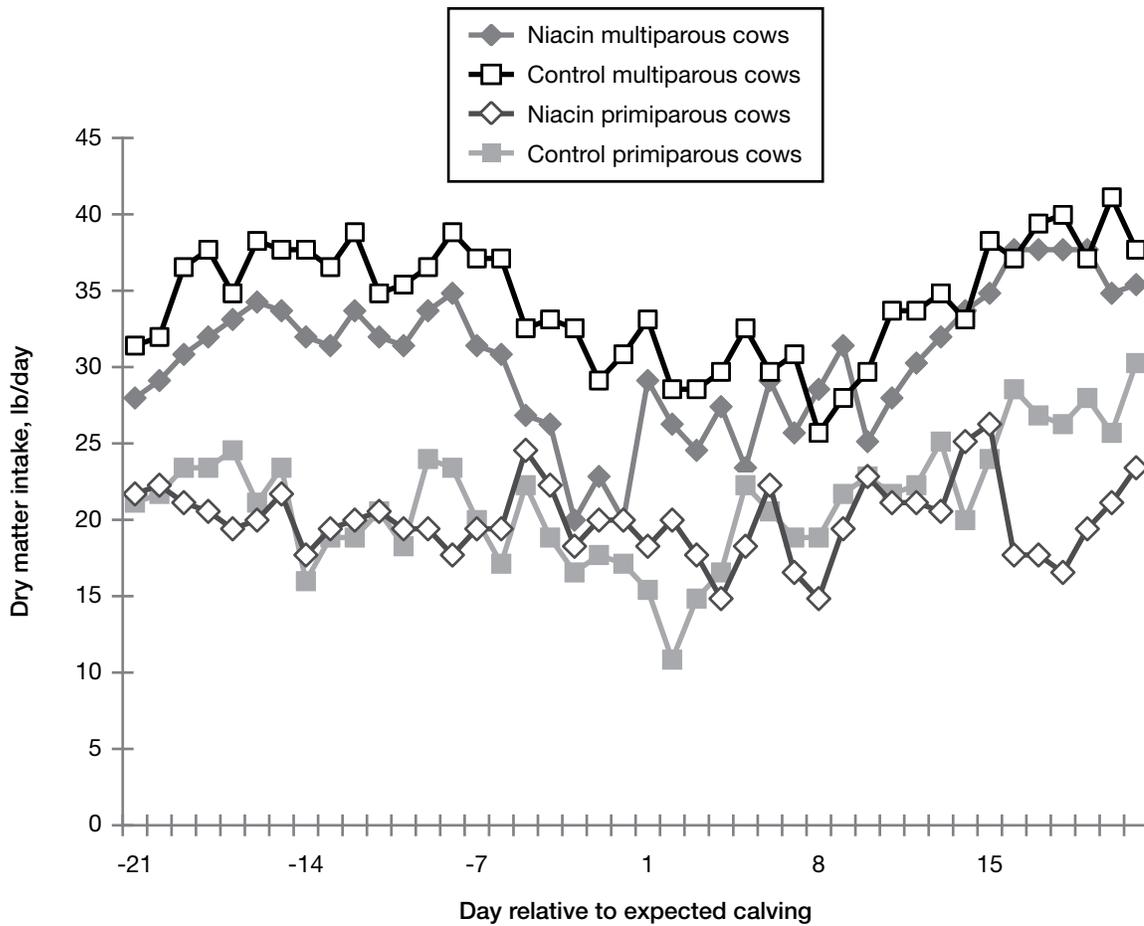


Figure 1. Dry matter intake of periparturient Holstein cows with or without 24 g/day of encapsulated niacin (EN) in the diet.

Dry matter intake in EN-treated multiparous cows decreased ($P < 0.01$) by 9 lb/day during the final 4 days before calving.

NUTRITION AND FEEDING

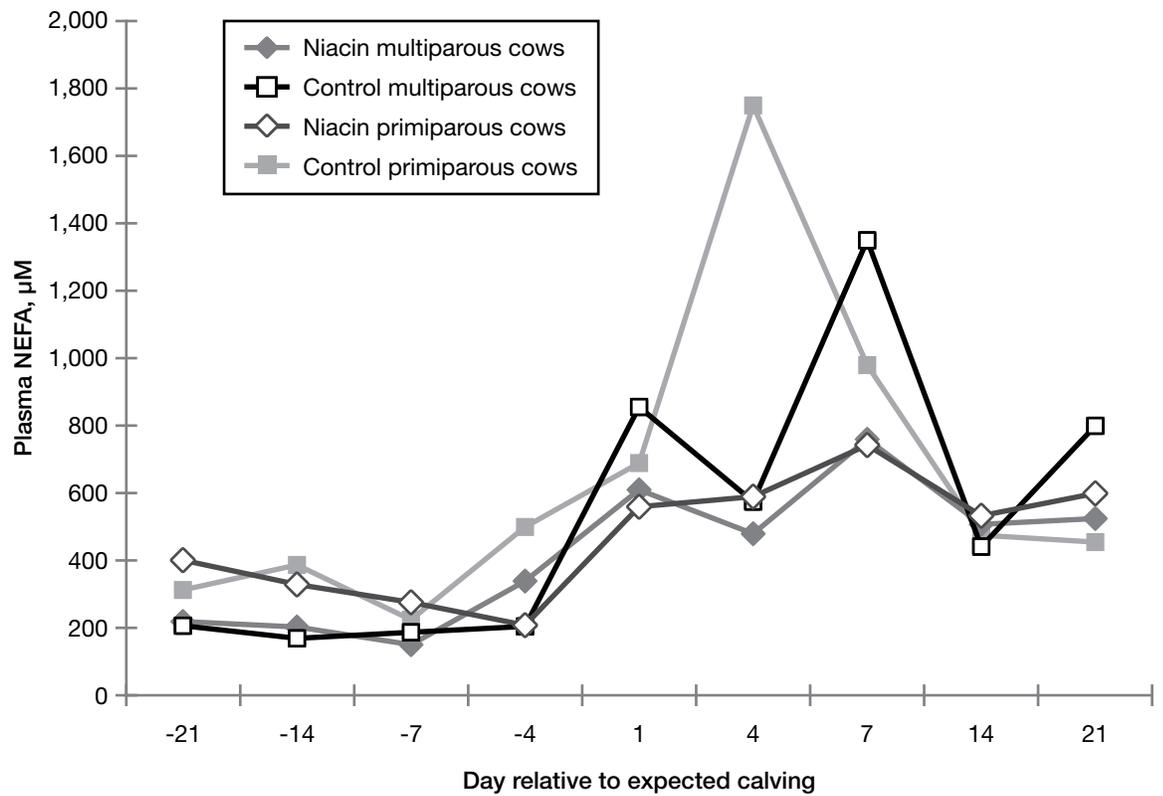


Figure 2. Plasma concentrations of nonesterified fatty acids (NEFA) in periparturient Holstein cows with or without 24 g/day of encapsulated niacin (EN) in the diet.

A treatment by time by parity interaction was detected ($P = 0.09$) after calving. Plasma NEFA peaked at 1700 and 1300 μM for primiparous and multiparous control cows, respectively, compared with 700 and 800 μM for EN-treated primiparous and multiparous cows, respectively.

NUTRITION AND FEEDING

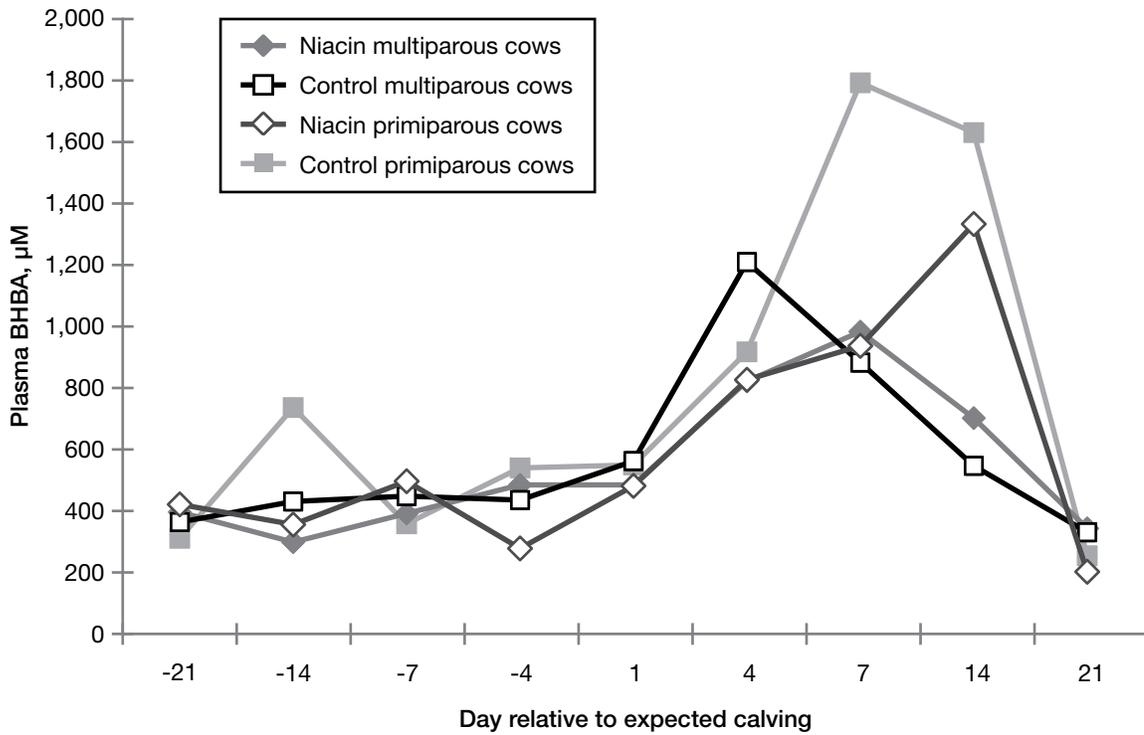


Figure 3. Plasma concentrations of β -hydroxybutyrate (BHBA) in periparturient Holstein cows with or without 24 g/day of encapsulated niacin (EN) in the diet.

A treatment by time by parity interaction was detected ($P = 0.02$) after calving. Plasma NEFA peaked at 1800 and 1200 μM for primiparous and multiparous control cows, respectively, compared with 1200 and 900 μM for EN-treated primiparous and multiparous cows, respectively.