Stage of lactation alters metabolic profiles in blood and liver of cows subjected to feed restriction.

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Introduction

Hormonal changes, as well as changes in the nervous system and immune system, play a pivotal role with regards to the cow's ability to adapt to changes in physiological state and the partitioning of nutrients in support of lactation.

As lactation progresses, feed energy intake becomes adequate to meet or exceed the energy required for lactation. A key question is: how do cows in early lactation adapt to sudden changes in energy supply when compared to cows in mid-lactation?

Objective

Our objective was to determine the effect of feed restriction (FR) on metabolic responses (i.e. blood and liver) of cows at different stages of lactation. Milk yield and component responses were presented at the annual meeting of the American Dairy Science Association in Denver, CO, USA (July 11-15, 2010).

Materials and Methods

Data Collection

- **Twenty-nine Holstein dairy cows in early (n = 14; 22-90 days in milk) and mid (n = 15; 91-220 days in milk) lactation were used.**
- **At the beginning of the study, all cows were fed a standard total mixed ration (TMR) for ad libitum intake. After 8-d, all cows were FR to provide ~40% of net energy for lactation requirements by supplementing the TMR with 60% wheat straw. After 4-d of FR, cows returned to full feed.**
- **Blood was collected every morning and plasma was analysed for concentration of non-esterified fatty acids (NEFA, mEq/L), beta-hydroxybutyric acid (BHBA, m*M*), glucose (m*M*), and plasma urea nitrogen (PUN, m*M*). Liver biopsies were collected once before, during and after FR and analyzed for triacylglycerols (TAG, m*M*), glycogen (m*M*), phospholipids (m*M*), and total lipid content (mg).**

Data Analysis

- **The percent change relative to pre-restriction averages (i.e. 0%) were calculated for each variable at each time point throughout the study period.**
- **The mixed model used included parity, stage of lactation, hour, and the interaction of stage of lactation*hour.**
- **Hour was the repeated measure; the random effect of cow was used as the error term in the REPEATED statement with unstructured (UN) as the covariance structure.**

Acknowledgements

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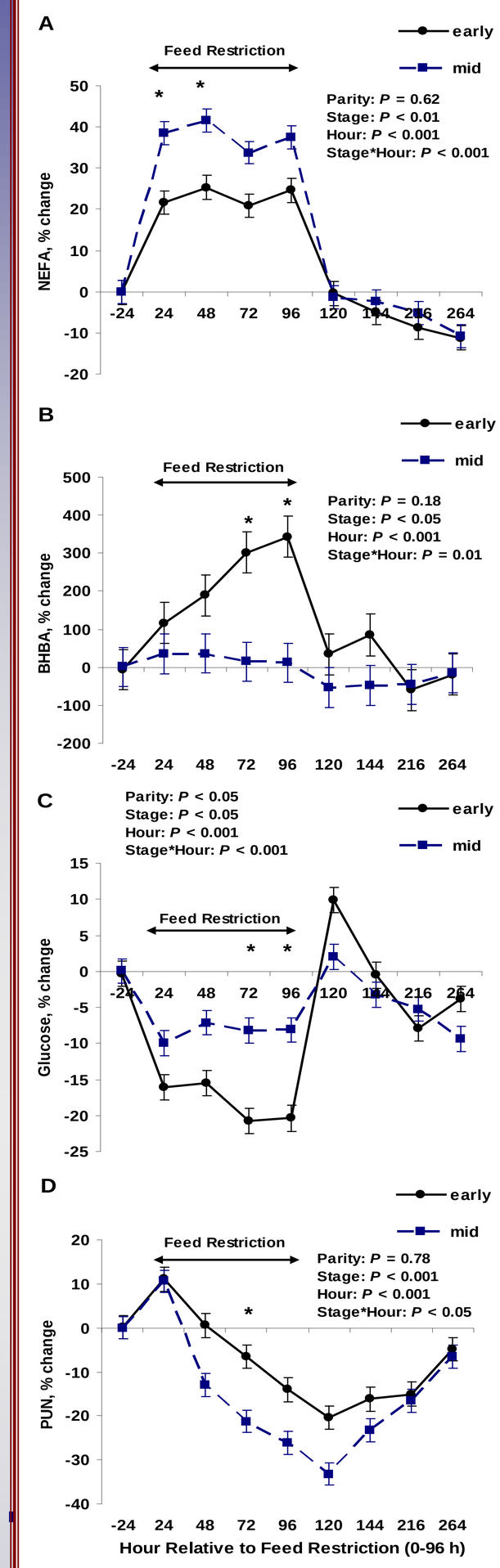

Figure 1. **Percent change in plasma non-esterified fatty acid (NEFA; A), beta-hydroxybutyric acid (BHBA; B), glucose (C), and urea nitrogen (PUN; D) at time points relative to feed restriction (h = 0-96) in 29 Holstein cows in early (●) and mid-( ) lactation. *Differences (*P* < 0.05) between groups at any given time point.**

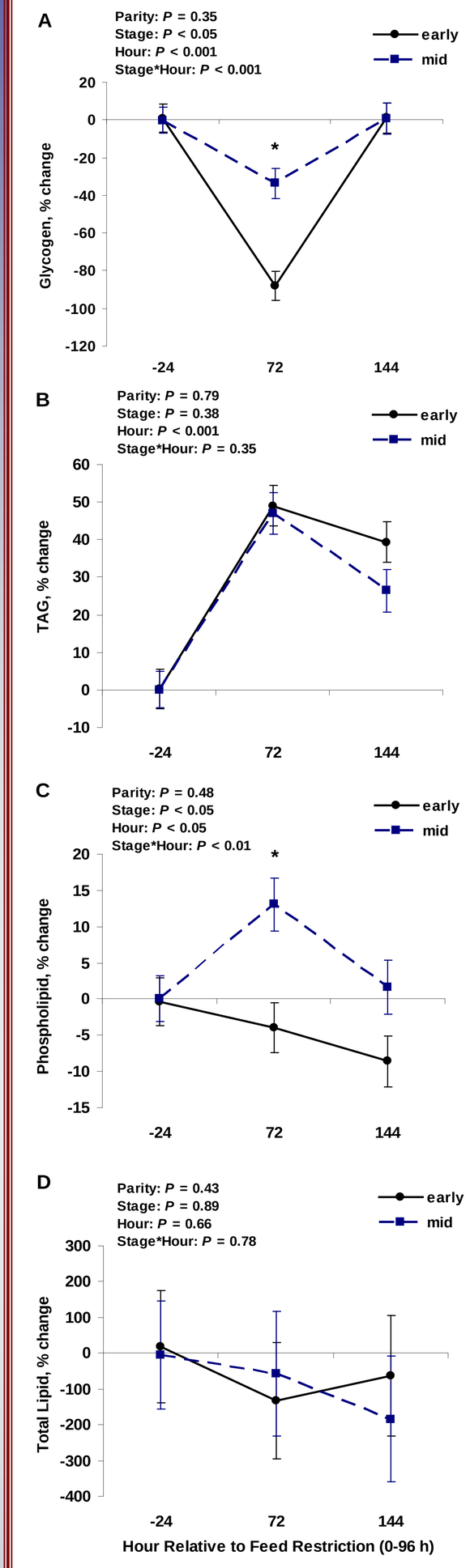

Figure 2. **Percent change in liver concentration of glycogen (A), triacylglycerols (TAG, B), phospholipids (C), and total lipid (D) at time points relative to feed restriction (h = 0-96) in 29 Holstein cows in early (●), mid-( ) lactation. *Differences (*P* < 0.05) between groups at any given time point.**

Summary and Conclusions

•For cows in early lactation, NEFA were greater prior to FR (data not shown) and resulted in less pronounced changes in NEFA (Figure 1A) during FR. This, coupled with greater changes in glucose (Figure 1C), resulted in marked increases in BHBA (Figure 1B) implying increased incomplete beta-oxidation of fatty acids when compared to cows in mid-lactation.

•The greater decrease in PUN (Figure 1D) for cows in mid-lactation indicates less protein was utilized for energy than cows in early lactation.

•Increased liver phospholipids (Figure 2C) for cows in mid-lactation suggests that the majority of fatty acids mobilized for energy were derived from cell membranes rather than adipose tissue.

•These results indicate that cows in early lactation adapt to changes in energy supply primarily via increased utilization of liver glycogen and fatty acids from adipose tissue (Figure 2A).

•This study provides insight into the homeorhetic mechanisms controlling the partitioning of nutrients of dairy cows during early and mid-lactation and should be beneficial for our understanding of how to maintain animal health and productivity throughout the lactation cycle.