

# Influence of dry period plane of energy on peripartal concentration of $\beta$ -hydroxybutyrate, non-esterified fatty acids, glucose and insulin

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## Introduction

Exacerbated postpartum negative energy balance (NEB) in dairy cows leads to downstream negative health events, poor reproductive performance, and production loss. Different feeding strategies during the dry period have the potential to affect peripartal energy metabolism. The objective of this study was to describe the concentration of markers of negative energy balance (non-esterified fatty acids (NEFA) and  $\beta$ -hydroxybutyrate (BHB)), as well as glucose and insulin in cows being fed different dry period planes of energy.

## Materials and Methods

Holstein dairy cows ( $n = 84$ ) entering their second or greater lactation were enrolled into 3 dietary treatment groups in a randomized block design. Following dry-off at 57 days before expected calving, cows in the controlled-energy group (C) received a high-straw diet containing 46.2% NDF and 13% starch, whereas cows in the intermediate group (I) were fed a diet containing 42.4% NDF and 18.1% starch, and cows in the high group (H) were fed a diet containing 38.7% NDF and 23.2% starch. All diets were formulated with the Cornell Net Carbohydrate and Protein System (CNCPS, v.6.1) and fed for ad libitum intake as total mixed rations (TMR). On days  $28 \pm 1$  and  $10 \pm 1$  before expected parturition as well as on days  $4 \pm 1$  and  $21 \pm 1$  after parturition, blood samples were obtained from the jugular vein 4 hours after feed removal, analyzed cow-side for BHB using a Precision Xtra meter (Abbott Laboratories, IL), and plasma and serum harvested and frozen for subsequent analysis (glucose: PGO enzyme, Sigma Aldrich; NEFA: NEFA HR (2), Wako; insulin: Millipore). Milk production was measured daily throughout the first 42 DIM. Dry matter intake (DMI) was recorded daily and weekly averages were computed. Multiple comparisons of concentrations across groups were adjusted using Tukey's posthoc LSD for 1-way ANOVA or with the Wilcoxon method in case of non-parametric analysis.

## Results

The average overall predicted energy balance (% of predicted requirement) during the dry period was 112, 126, and 153% in the C, I, and H group, respectively (CNCPS). Plasma glucose concentrations decreased post-calving in all treatment groups; however, on day 10 prepartum cows in group H had higher plasma glucose (75.9 mg/dL) than both groups C (69.6 mg/dL,  $p = 0.002$ ) and I (70.6 mg/dL,  $p = 0.002$ ), as well as lower glucose levels on day 4 postpartum (55.9 mg/dL) compared to group C (59.9 mg/dL,  $p = 0.08$ ) and I (58.4 mg/dL,  $P = 0.40$ ). Concentration of BHB was highest in cows in group H on day 4 postpartum (1.0 mmol/L) compared to cows in group C (0.75 mmol/L,  $P = 0.01$ ). NEFA concentration was higher in group H on day 4 postpartum (1.60 mEq/L) compared to groups C (1.36 mEq/L,  $P = 0.004$ ) and group I (1.38 mEq/L,  $P = 0.008$ ). Insulin concentrations were higher on day -28 prepartum (C: 18.6, I: 18.7, H: 20.0 uIU/ml,  $P = 0.70$ ) compared to day -10 (C: 11.1, I: 13.2, H: 12.4 uIU/ml,  $P = 0.25$ ) in all groups. Cows in group H had the lowest concentration of insulin on day 4 after calving (0.95 uIU/ml) compared to group C (1.65 uIU/ml,  $P = 0.10$ ) and I (2.33 uIU/ml,  $P = 0.08$ ). Average milk production during the first week in lactation was 30.6, 31.2 and 32.1 kg for the C, I and H group, respectively ( $P = 0.60$ ). DMI postpartum was 17.5, 18.6 and 18.0 kg for the C, I and H group, respectively ( $P = 0.33$ ).

## Significance

The concentration of markers of NEB were highest in cows in group H postpartum, indicating that the energy deficit was more pronounced in cows being fed a higher energy ration during the dry period. Results of this study also show that the blood glucose concentration in cows differs in the peripartal period depending on the dry period plane of energy. Lower concentrations of glucose and insulin after calving may contribute to increased rates of lipolysis and higher NEFA as well as BHB concentrations in the immediate postpartum period. An increase in the severity of negative energy balance predisposes cows to a higher risk of disease, poor reproductive performance, and reduced milk production.