Predicting calcium status in early lactation multiparous Holsteins using milk constituent analysis

J. Seminara,[1] BS; K. Callero,[1] BS; C. Seely,[1] BS, MS; M. Van Althuis[3]; S. An[3]; C. Salpekar[3]; D. Barbano,[2] BS, MS, PhD; J. McArt,[1] BS, DVM, PhD, DABVP

[1]Department of Population Medicine and Diagnostic Sciences, College of Veterinary Medicine, Cornell University, Ithaca, NY 14853
[2]Department of Food Science, College of Agriculture and Life Sciences, Cornell University, Ithaca, NY 14853
[3]College of Agriculture and Life Sciences, Cornell University, Ithaca, NY 14853

Introduction

Due to the unique challenges of supporting milk production, subclinical hypocalcemia (SCH) is common among early lactation dairy cows. Though SCH immediately following parturition may constitute normal adaptation to the transition period, there is growing evidence that cows with SCH beyond 4 days postpartum (DIM) have developed dyscalcemia, a pattern of calcium dysregulation that has been associated with negative health and production outcomes. Despite prevalence of dyscalcemia ranging from 25% to 45%, identifying cows with dyscalcemia remains a major challenge on commercial dairies. Our objective was to develop an algorithm for predicting dyscalcemia status using Fourier-transform mid-infrared spectroscopic (FT MIR) analysis of milk samples at 3 and 4 DIM.

Materials and methods

Through a prospective cohort study design, we collected blood from multiparous Holsteins (n = 453) on 4 herds in New York at 4 DIM for total calcium concentration (tCa) analysis. We classified cows as eucalcemic (tCa ≥ 2.2 mmol/L; n = 353) or dyscalcemic (tCa < 2.2 mmol/L; n = 100), based on a tCa thresholds supported in the literature for use at 4 days postpartum. Proportional milk samples were collected at 3 and/or 4 DIM and analyzed via FT MIR for the following constituents: lactose, protein, fat, de novo fatty acids (FA), mixed origin FA and preformed FA; relative percentages of each FA group; individual FA including C16:0, C18:0, and C18:1 cis:9; milk urea nitrogen, milk acetone, milk β-hydroxybutyrate, and milk predicted blood non-esterified FA. Milk weights were also collected at each milking. Partial least squares regression models were fit for each DIM separately and were used to predict calcium status at 4 DIM using individual daily estimated milk constituents, daily milk yield and parity group (2, 3 and ≥ 4). Receiver operating characteristic curves were generated using predictions from each model.

Results

Area under the curve was 0.76 and 0.81 for 3 and 4 DIM respectively. Sensitivity, specificity, positive and negative predictive values for the models were 0.57, 0.84, 0.51 and 0.88, respectively, at 3 DIM, and 0.62, 0.86, 0.55 and 0.89, respectively, at 4 DIM. The diagnostic accuracies of these tests at 3 and 4 DIM were 0.78 and 0.81, respectively.

Significance

Our results demonstrate that FT MIR milk constituent analysis at 3 and 4 DIM can accurately identify cows that will be eucalcemic by 4 days postpartum, indicating clinical utility as a diagnostic tool for discriminating between healthy cows and those at risk for dyscalcemia. Though further work is needed to enhance the diagnostic value of these methods, FT MIR milk constituent analysis could be useful to develop targeted treatment protocols and optimized management strategies for early lactation dairy cows to improve health and production outcomes.

