6. Milk Analysis Workshop 1 Securing Value from Milk Analysis

Title presentation

Application of a predictive model for beta-hydroxybutyrate and non-esterified fatty acids using milk Fourier-transform infrared spectroscopy

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Abstract

Negative energy balance following parturition predisposes dairy cattle to numerous metabolic disorders. Fourier-Transformed Infrared spectroscopy (FTIR) of milk has the potential to improve the characterization of metabolic disorders, including those not diagnosed via hyperketonemia alone. To develop a predictive model for blood beta-hydroxybutyrate (BHBA) and non-esterified fatty acids (NEFA) we evaluated 15,736 milk samples (data set 1) and recorded production data from 1,334 dairy cows on nine farms in Germany. A subset of these observations, data set 2 (n=622), had blood BHBA and blood NEFA values measured concurrently with milk sampling. Data set 2 samples for FTIR data and production information was fit to predictive models using ElasticNet regression and k-fold cross-validation for both, log-transformed blood BHBA and log-transformed blood NEFA. The R2 of the best fitting model was 0.56 and 0.51 for log-transformed BHBA and log-transformed NEFA, respectively. A 90% sensitivity and 83% specificity were obtained, using a cut-off value of 1.2 mmol/L for elevated BHBA and a model sensitivity of 73% and specificity of 74% were calculated for an elevated NEFA cut-off value of 0.7 mmol/L. We applied our prediction model to an external data set (n= 9660) (data set 3) using bootstrap resampling to validate prediction accuracy of log-transformed BHBA and log-transformed NEFA. Log-transformed BHBA root mean square error (RMSE) was 0.4018 and log-transformed NEFA RMSE was 0.4043.

Differential responses to negative energy balance in dairy cattle are becoming a more widely recognized issue. Cows suffering from these disorders without concurrent elevated BHBA are often undiagnosed. Proper identification of these animals is challenging because simultaneous measurement of negative energy balance indicators (BHBA, NEFA, and fat protein quotient (FPQ)) are required. We used our numeric prediction models for BHBA and NEFA, and FPQ to classify animals into five cowtypes based on previous research regarding differential response to negative energy balance. In conjunction we evaluated animals as either metabolically healthy or imbalanced. Using known blood values of BHBA and NEFA, we assessed cowtype prediction accuracy. Cowtype prediction accuracy was 67% , but positive predictive values were lower for individual cowtypes. Our prediction for metabolic imbalance identified using predicted BHBA, NEFA, and FPQ had an overall accuracy of 93%, positive and negative predictive values of 91% and 95% respectively. The continued study of FTIR as a method for differentiating specific clusters of metabolic disorders is promising, and improved prediction models will generate more accurate cowtype predictions in the near future.