# Prediction of Serum Metabolic Profile Biomarkers in Early Lactation Dairy Cows Using Mid-Infrared Spectroscopy of Milk

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## Summary

Metabolic diseases in early lactation have significant negative effects on dairy cow health and welfare, and farm profitability. The most commonly described metabolic diseases are ketosis, hypocalcaemia, and hypomagnesaemia. Subclinical metabolic diseases, which are not associated with obvious clinical signs, are of particular interest due to their relatively high prevalence and significant effects on animal welfare and performance. Currently one of the most common methods for monitoring the metabolic health of cows is serum metabolic profiling, which utilises well-established associations between the concentrations of several metabolites in serum, and the presence of both subclinical and clinical metabolic disease.

An emerging technology to evaluate subclinical metabolic disease is mid-infrared spectroscopic analysis (MIR) of milk samples. In this cross-sectional study we investigated the use of MIR spectroscopy of milk for estimating the concentrations a number of serum metabolites commonly employed in metabolic profiling. A single plain/clotted blood sample was taken from a 1027 cows from 5 farms in the Gippsland region of south-eastern Victoria, Australia, on the same day as milk recording. All cows had calved within 8 weeks of sampling. Serum samples were analysed for beta hydroxybutyrate (BHB), non-esterified fatty acids (NEFA), calcium, magnesium, blood urea nitrogen, total protein, albumin and globulins.

Milk samples were analysed by MIR spectroscopy using a Bentley Instruments FTS Combi. Calibration models were constructed using partial least square (PLS) regression, and external validation was performed using both a farm exclusion (a calibration equation derived using data from 4 farms was used to predict the outcome on the 5th farm) and a random sampling method (a random sample of 20% of cows was excluded from the calibration dataset and used for validation). The $R^2$ and root mean square error (RMSE) values for MIR predictions using random external validation were 0.49 (0.19) for BHB, 0.51 (0.24) for NEFA, 0.88 (0.79) for Urea, 0.18 (0.14) for calcium, 0.23 (0.10) for magnesium, 0.28 (2.01) for albumin, and 0.31 (4.76) for globulins.

Our results demonstrate that MIR spectroscopic analysis of milk shows promise for evaluating short-term protein status of animals through accurate estimation of BUN concentration, and reasonable prediction of energy balance by estimation of serum BHB and NEFA concentrations.

Keywords: mid-infra-red spectral prediction, metabolic profiles, ketosis