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Prediction of evaluated energy balance (NeI and Me) in dairy cows by milk mid-infrared (MIR) spectra

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With the help of milk mid-infrared spectra (MIR) a wealth of information can be obtained by establishing relationships with so-called reference methods. Well-known and established is the determination of the milk ingredients fat, protein, lactose and urea. Additional to being used in herd management, fat and protein content are also used to determine the „milk price“. The current research focus is the detection of indirect quantities, such as: pregnancy, mastitis, ruminal acidosis, lameness, energy balance, ketosis or methane emissions. The objective of this study was to build global spectrometric equations for energy balance calculated by the two evaluation systems net energy lactation (NEL) and metabolisable energy (ME), in order to determine the cow energy status. The application may be used in the field of herd management and also as a possible factor in breeding selection. The present work is part of the collaborative project optiKuh, funded by the German Federal Ministry of Food and Agriculture. 12 research farms from different German states such as Baden Württemberg, Nordrhein- Westfalen, Bayern, Schleswig-Holstein, Rheinland-Pfalz, Niedersachsen and Mecklenburg-Vorpommern provided NEL and ME in between 2014 and 2017. The German Association for Quality and Performance Testing e.V. (DLQ), in which the regional MROs are united, provided approx. 40,000 milk samples available with energy balance information for the calibration equation establishment for the two energy balances. The energy balance models are built on standardised and unstandardized spectral data. To detect the outliers a difference between fat determined by the FOSS or Bentley spectrometers and the RobustMilk equation was calculated and no more than 2% difference was accepted. Out of the complete data set, 30% were considered outliers. To identify animal variables that were positively or negatively associated with cow energy status, the spectral data set was first pre-processed by Savitzky-Golay first derivative to remove the offset differences between samples for baseline correction, before Legendre polynomial modelling. Then the data was submitted to ridge regression using the “glmnet” package in R. For “glmnet” model, the sampling moment, lactation stage and important breeds such as Holstein (HOL), Red Holstein (HOL), Brown Swiss (BSW) and Simmental (SIM) and the Legendre polynomial data based on DIM for the 212 OptiMIR wavenumbers of spectral data were considered as fixed effects. There were three models performed. The 1st model was based on spectral data random selection, the 2nd on random selection of animals and the 3rd, a global model with a cross-validation trial. The global energy balances, NEL and ME calibration models showed high coefficients of determination (R^2 = 0.74, respectively R^2 = 0.84) and very poor RPD 1.95, respectively a poor RPD 2.5. The RPD is the ratio of standard deviation to standard error of cross validation. We have to underline that a very poor model means that it allows to compare groups of cows, or to distinguish high or low values while the poor model allows rough screening. Standardised

spectra showed a better robustness compared to unstandardized spectra (RPD: NEL 2.2 vs. 1.95, ME 3.0 vs. 2.7).
Keywords: energy balance, NEL, ME, MIR milk spectral data, dairy cow, cow health