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The use of fatty acid profiles from milk recording samples to predict body weight change of dairy cows in early lactation in commercial dairy farms

Franziska Dettmann[1,2], Daniel Warner[1], Albert Johannes Buitenhuis[3], Morten Kargo[3,4], Anne Mette Hostrup Kjeldsen[4], Niels Henning Nielsen[5], Daniel M. Lefebvre[1], Debora E. Santschi[1]

[1]Valacta, Sainte-Anne-de-Bellevue, Canada

[2]LKV Niedersachsen e.V., Leer, Germany

[3]Molecular Biology and Genetics, Aarhus University, Tjele, Denmark

[4]SEGES, Aarhus, Denmark

[5]RYK, Aarhus, Denmark

Most cows face energy deficits in early lactation during peak milk production, which is reflected in the milk fatty acid (FA) profile. These cows typically mobilize body reserves to maintain milk fat production, and synthetize less FA de novo in the mammary gland. Milk FA can be predicted routinely by Fourier-transform infrared spectroscopy (FT-IR). This rapid milk analysis offers therefore an opportunity to develop an early indicator for body weight (BW) change based on the milk FA profile. The objective of this study was to validate if the milk FA profile can be used to predict BW change in early lactating cows in commercial dairy farms. Data originated from 17,067 Danish Holstein cows at 7–35 days in milk across 166 herds in Denmark between March 2015 and March 2017 with BW records from floor scales in Lely automatic milking systems at each milking. Milk FA were predicted by FT-IR on FOSS instruments providing seven groups of FA and four individual FA. Data for BW change predictions included parity, stage of lactation, and test day data for milk production and components (fat, protein, somatic cell count, and FA concentrations). Daily BW change (median ± standard deviation) was −0.32 ± 2.66 g/kg of BW (first parity), −0.46 ± 2.82 g/kg of BW (second parity) and −0.60 ± 5.53 g/kg of BW (third parity and longer). Predictions of BW change were based on a random forest model that can account for nonlinear and high dimensional interactions. The model was validated with ten-fold repeated cross-validation for which 20% of the herds were randomly withhold for validation such that data of a specific herd are used exclusively either to train or to cross-validate the model. The overall root mean square error of prediction after cross-validation was 1.66 g/kg of BW with the model explaining 89.6% of the variance. The five most important variables to develop the model were the short-chain FA group (C4:0–C10:0), oleic acid (C18:1), the medium-chain FA group (C12:0–C16:1), the saturated FA group, and palmitic acid (C16:0). The short-chain and some medium-chain FA are synthesized de novo in the mammary gland, oleic acid originates from body reserves (e.g., during energy deficits), and palmitic and palmitoleic acid (C16:1) originate either from the de novo FA pool or from body reserves and from feed. These results suggest that the FT-IR milk FA profile may be used as an early indicator of BW change in early lactation cows. Nonetheless, before this model can be used in commercial farms, the model needs to be validated for different herd management and feeding strategies, breeds and country- or region-specific conditions. Further work is needed to assess the impact of the level of BW change on milk production, reproductive performance and health. Future models may gain from the inclusion of other milk components such as beta-hydroxybutyrate known to be linked to BW loss in early lactation. An early warning system may be implemented for cows with a large BW loss in early lactation based on the FT-IR milk FA profile.

Keywords: dairy herd improvement, fatty acid profile, FT-IR, body weight loss, machine learning