Prediction of dairy cows' heat stress response from milk mid-infrared spectra for detection and genetic selection

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The heat stress (HS) response of dairy cows remains difficult to record reliably at large-scale because physiological data are scarce and production traits lack specificity. An alternative is to develop a prediction equation based on mid-infrared (MIR) spectra, which are routinely collected and may contain a more specific signature of the HS response than production traits. The objectives were thus to develop this prediction (MIR-HS) and validate it using external data.

Surface body temperatures were recorded during official milk recording visits on 399 Holstein cows from 5 farms in summer 2024. MIR-HS was developed by combining two equations: (1) a partial least square (PLS) regression on surface body temperature and (2) a random forest classification of the HS response based on surface body temperature and milk trait residuals. MIR-HS was then applied to historical milk recording data for validation. This included assessing its response to temperature and humidity index (THI) and identifying the characteristics of the most affected cows. A genetic analysis was also performed to estimate MIR-HS heritability and genetic correlations with routine traits, as well as to identify genomic regions of interest through a genome wide association study (GWAS).

Equation (1) reached a validation R2 of 0.67 with an RMSE of 0.64°C, and equation (2) classified with an accuracy of 61%. Once applied to external data, the resulting MIR-HS reacted as expected to THI. The most affected cows were multiparous, in early lactation, and with high milk yield which is consistent with the literature. Similarly, an expected heritability (0.10) was obtained and the global profile of genetic correlations was favorable. Concerning the GWAS, most of the regions highlighted overlapped with traits related to energy balance, which is consistent as HS is considered a form of negative energy balance. In conclusion, MIR-HS, a routinely available new indicator of HS response in dairy cows shows strong potential for detecting heat-stressed cows and supporting genetic selection for heat tolerance.