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Potential use of milk based biomarkers to assess and to select for heat tolerance in dairy cattle

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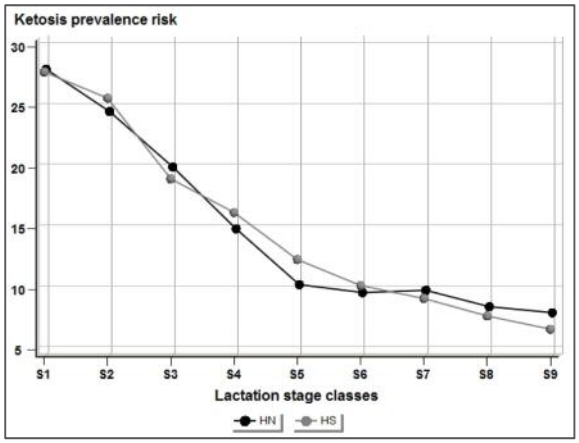
Heat stress (HS) has major impact on milk production, fertility, health, and welfare of dairy cows. Comfortable cows exhibiting minimal stress will consume, produce, and reproduce better. Therefore, controlling HS is important for animal welfare. Genetic selection has been proven as an effective tool to improve traits of interest and therefore potentially also heat tolerance, by inducing in a cost effective manner permanent and cumulative effects. Yet, direct measures of HS in routine remain complex and difficult. High-throughput analytic methods are increasingly available from milk recording schemes allowing routine quantification of several potential biomarkers in milk. Therefore, the main goals of this study were i) to estimate HS impacts on milk production, udder health, and milk fatty acids (FA) and ii) to assess the potential of milk FA as biomarkers of HS for dairy cattle. A total of 202,733 test-day records for milk, fat, and protein yields, fat and protein contents, somatic cell score, but also 7 groups of FA and 10 individual milk FA contents predicted by mid-infrared spectroscopy were collected from 34,468 Holstein cows in first lactation between 2007 and 2010 in 862 herds in the Walloon Region of Belgium. Test-day records were merged with a daily temperature humidity index (THI) measured at the nearest meteorological station to each herd. Reaction norm models without fixing priors for thresholds were used to estimate HS effects. Results show that when THI values increased, most milk and FA traits showed negative phenotypic and genetic trends. Moreover, genetic correlations between low and high THI values for these traits were relatively high (>0.80) indicating moderated influence of HS on genetic expression of traits. Conversely, somatic cell score, fat yield, unsaturated FA and specifically C18:1 cis-9 content in milk increased with THI. These traits showed lower genetic correlations (<0.68) between extreme THI values. Content of C18:1 cis-9 in milk was the most sensitive trait to hot conditions. Since this trait is known to reflect body reserve mobilisation, using its changes under hot conditions could be a very affordable milk biomarker of HS for dairy cattle expressing the equilibrium between intake and mobilization under HS.



Heat stress status	Lactation stage classes								
	S1	S2	S3	S4	S5	S6	S7	S8	S9
HN	22.17	22.35	22.66	22.81	21.73	22.30	21.85	22.22	22.08
HS	22.09	22.51	22.49	23.24	21.96	22.60	21.66	21.74	21.87

Figure 1: Effect of heat stress on ketosis prevalence risk and milk production according to lactation stage classes