

New traits predicted from milk mid-infrared spectra to reduce incidence of subclinical ketosis

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Ketosis is the most frequent metabolic disease in dairy cows. Recently, several new mid-infrared (MIR) traits have been derived that can be predicted from routine milk samples and provide a more accurate indication of subclinical ketosis than the commonly used fat-to-protein ratio, such as KetoMIR and other MIR-predicted traits (e.g. blood beta-hydroxybutyrate, acetone, citrate). KetoMIR was developed by LKV Baden-Württemberg based on ketosis diagnoses. KetoMIR is a three-class ketosis index: 1 = low ketosis risk, 2 = moderate ketosis risk, and 3 = high ketosis risk. The increased ketosis risk based on the KetoMIR index was associated with lower average herd milk yield (-1,975 kg milk). The interval from calving to first service was prolonged by +36 days, as was the calving interval with +58 days. Mean herd somatic cell count in first and higher lactations was increased by 60,000 and 134,000 cells/ml, respectively. So far, KetoMIR results have only been used for herd management. Feeding advisors use this new MIR trait to assess and, if necessary, adjust the feeding situation on the farm in the dry cow period and early lactation. Furthermore, a MIR equation for beta-hydroxybutyrate in blood was derived, which has already been validated on 49 Austrian farms and 670 dairy cows. For this purpose, capillary blood was analyzed for beta-hydroxybutyrate concentration in all cows during milk recording in early lactation (1st and 2nd test day after calving) using a handheld device (WellionVet BELUA, MED TRUST Handels GmbH, Marz, Austria). The result from the handheld device was considered as the gold standard for detecting subclinical ketosis (betahydroxybutyrate concentration > 1.2 mmol/l). Blood beta-hydroxybutyrate predicted from MIR had a sensitivity of 56% and a specificity of 81% for detecting cows with subclinical ketosis. Currently, data from Austria are being integrated into the MIR equation for beta-hydroxybutyrate to improve the equation. First genetic analyses showed high heritabilities between 0.16 and 0.30 for MIR-predicted traits. The moderate

Abstract

to high genetic correlations between MIR-predicted traits and subclinical ketosis suggest that consideration of these traits in selection would help to reduce subclinical ketosis.

Keywords: mid-infrared, subclinical ketosis, herd management, genetic selection

Introduction

Metabolic disorders occur more frequently after calving. In this phase, the energy demand due to milk production is higher than the feed intake, resulting in a more or less pronounced negative energy balance. Although the majority of metabolic disorders are not visible, but are present subclinically, these metabolic disturbances lower the cow's resistance and increase, for example, the risk of mastitis or hoof diseases (Pieper and Mahlkow-Nerge, 2017).

Ketosis is the most common metabolic disease of the dairy cow. Since affected cows usually show no signs of disease at all, detection is very difficult. Recently, several new mid-infrared (MIR) traits have been derived that can be predicted from routine milk samples and provide a more accurate indication of subclinical ketosis than the commonly used fat-to-protein ratio, such as KetoMIR and other MIR-predicted traits (e.g. beta-hydroxybutyrate (BHB) and acetone).

KetoMIR

KetoMIR was developed by the LKV Baden-Württemberg (Dale *et al.*, 2018). Using veterinary ketosis diagnoses and the MIR spectra of milk samples from the first 120 days of lactation from milk recording, KetoMIR, a three-level ketosis index, was developed (Dale *et al.*, 2018). Class 1 indicates low ketosis risk, class 2 indicates medium ketosis risk, and class 3 indicates high ketosis risk.

The KetoMIR index has a sensitivity of 68% and a specificity of 81% to detect clinical ketosis (Dale *et al.*, 2018). KetoMIR is an alert system to help in herd management during the first 120 days of lactation, but it is not diagnostic.

In Austria, the average frequency of cows with a positive KetoMIR result is 14% at the farm level. Highly elevated frequencies of >30% are found in 8.6% of farms. The increased ketosis risk based on the KetoMIR index was associated with lower average herd milk yield (-1,975 kg milk). Mean herd somatic cell count in first and higher lactations was increased by 60,500 and 134,400 cells/ml, respectively. The interval from calving to first service was prolonged by +36.5 days, as was the calving interval with +58.2 days.

Blood beta-hydroxybutyrate

A MIR equation for beta-hydroxybutyrate (BHB) in blood was available from European Milk Recording (EMR), which has already been validated on 49 Austrian farms and 670 dairy cows. For this purpose, capillary blood was analyzed for BHB concentration in all cows during milk recording in early lactation (1st and 2nd test day after calving) using a handheld device (WellionVet BELUA, MED TRUST Handels GmbH, Marz, Austria). The result from the handheld device was considered as the gold standard for detecting subclinical ketosis (BHB > 1.2 mmol/l). Blood BHB predicted from MIR had

a sensitivity of 55.9% and a specificity of 81.4% for detecting cows with subclinical ketosis, which was higher than for the commonly used fat-protein ratio > 1.5 (Table 1).

Heritabilities and genetic correlations for BHB measured with the handheld device and MIR predicted ketosis risk traits are shown in Table 2. Heritabilities for all traits were high, 0.26 for BHB results gained by the handheld device and between 0.16 and 0.30 for MIR predicted traits. The heritability estimates found in our study were consistent with previous literature results (Belay *et al.*, 2017; Hamann *et al.*, 2017; Benedet *et al.*, 2020). The genetic correlations between BHB concentration from the handheld device and the traits predicted by MIR ranged from 0.60 to 0.73. Genetic correlations between BHB results gained by a handheld device and MIR predicted traits recorded at the same time could not be found in the literature. However genetic correlations with clinical ketosis from veterinary diagnoses were available. A moderate genetic correlation of 0.47 between predicted blood BHB at first test day and clinical ketosis was reported by Belay *et al.* (2017). Because the standard errors of the estimates in our study were high, the results should be taken with caution. However, the moderate to high genetic correlations between MIR-predicted traits and subclinical ketosis suggest that consideration of these traits would reduce subclinical ketosis.

Genetic parameters

Recently, several new MIR traits have been derived that can be predicted from routine milk samples and provide a more accurate indication of subclinical ketosis than the commonly used fat-to-protein ratio, such as KetoMIR, beta-hydroxybutyrate and acetone. Preliminary results suggest that these new traits could be used in both herd management and breeding programs to reduce the incidence of subclinical ketosis.

Conclusion

Table 1. Sensitivity and specificity given that cows with subclinical ketosis have a beta-hydroxybutyrate-concentration > 1.2 mmol/l using the handheld device.

	Sensitivity	Specificity
Blood beta-hydroxybutyrate > 200µmol/L	55.9	81.4
Fat-protein ratio > 1.5	39.2	83.1

Table 2. Heritabilities (on diagonal) and genetic correlations (above diagonal) with standard errors in brackets.

	BHB – handheld device	KetoMIR	BHB-MIR	Aceton-MIR	Fat-protein-ratio
BHB – handheld device	0.26	0.61 (0.35)	0.60 (0.32)	0.73 (0.33)	0.60 (0.37)
KetoMIR		0.30	0.48 (0.37)	0.35 (0.39)	0.20 (0.45)
BHB-MIR			0.19	n.c. ¹	0.72 (0.32)
Aceton-MIR				0.16	0.61 (0.38)
Fat-protein-ratio					0.20

¹ n.c. = no convergence

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