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

A. Köck, K. Schodl, B. Fuerst-Waltl, H. Schwarzenbacher, L.M. Dale, A. Werner, M. Mayerhofer, F.J. Auer, C. Grelet, J. Sölkner, L. Rienesl, N. Gengler, J. Leblois & **C. Egger-Danner**[1]

[1]ZuchtData EDV-Dienstleistungen GmbH, Dresdner Str. 89, 1200 Vienna, Austria

Background

- Subclinical ketosis is the most frequent metabolic disease of dairy cows

- 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 such as KetoMIR and other MIR-predicted traits (e.g. ß-hydroxybutyrate (BHB) and acetone)

- The objective of this study was to provide an overview of these new MIR traits and their implications for herd management and genetic selection to reduce the incidence of subclinical ketosis

Background KetoMIR

- Model development by Laura Dale, Andreas Werner et al. - LKV Baden-Württemberg

- Calculation of ketosis risk in the first 120 days of lactation from MIR spectra from MLP milk analysis based on clinical ketosis diagnoses from health monitoring:
  - KM1: Low ketosis risk
  - KM2: Medium ketosis risk
  - KM3: High ketosis risk
- Used routinely by LKV Austria since 2017

- Results are used primarily for herd management to optimize feeding in the dry period and early lactation

Herd health report 2017 – 12,909 herds (at least 10 cows per herds)
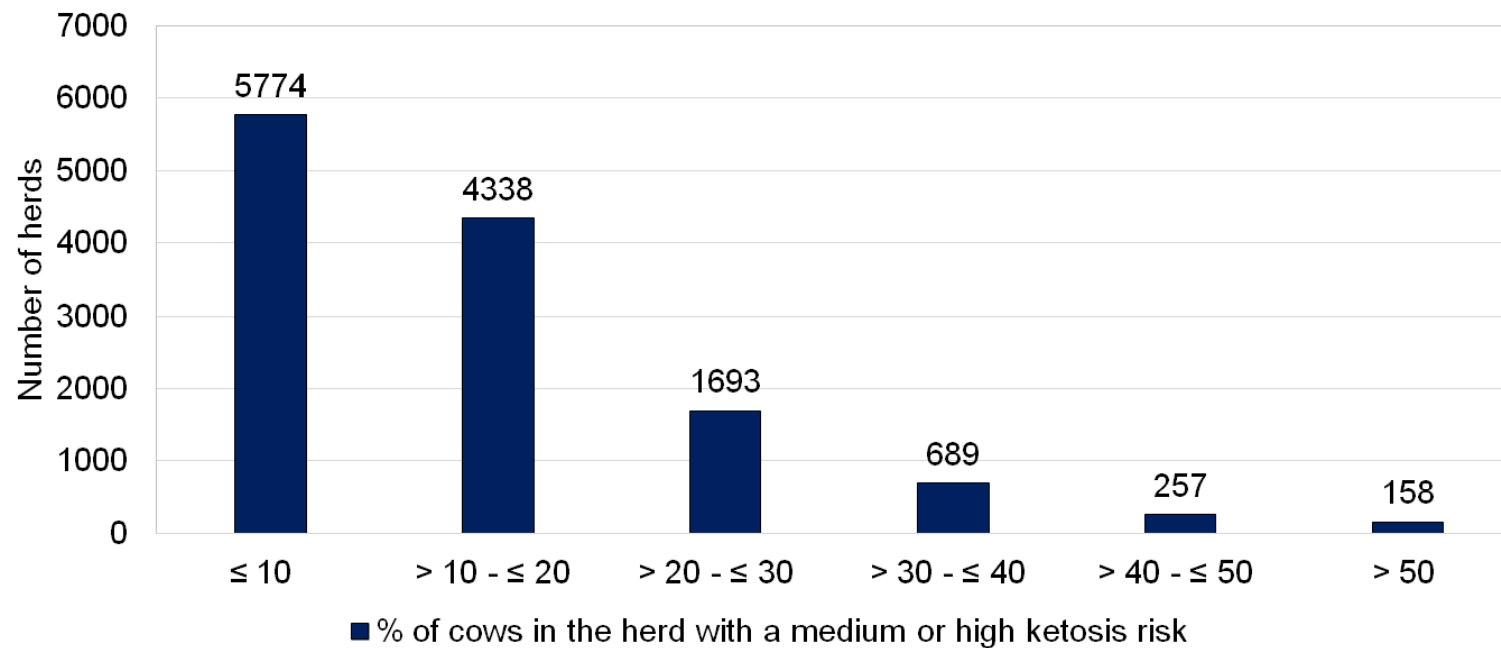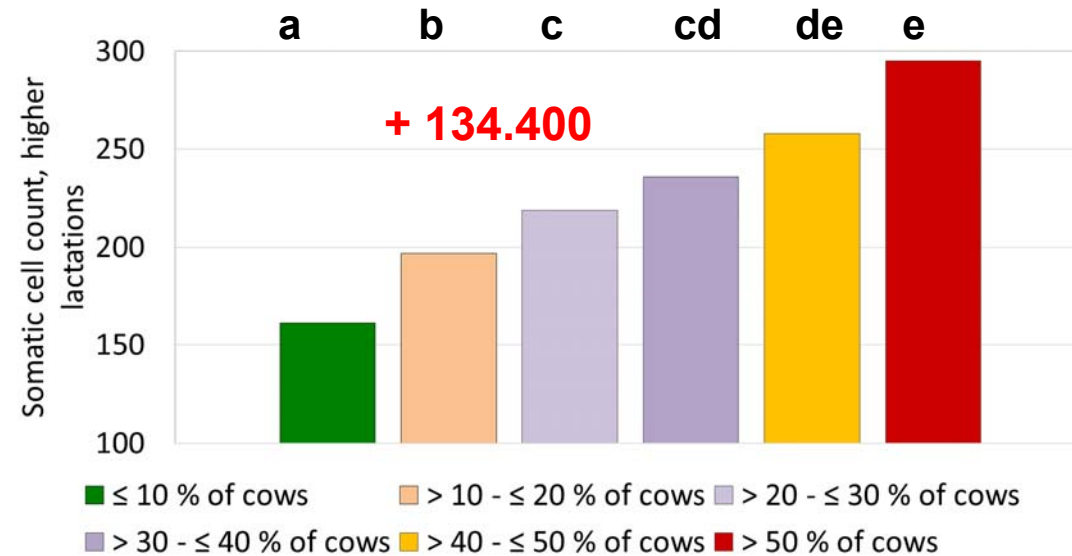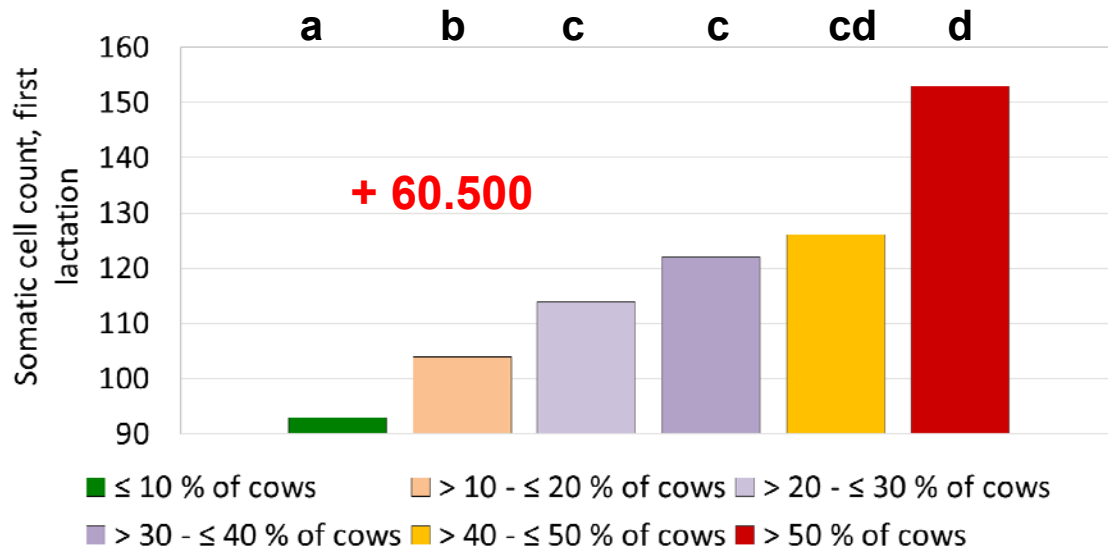

In Austria, the average frequency of cows with a positive KetoMIR result is 14% at the farm level. Highly elevated frequencies of >30% are found in 8.6% of farms
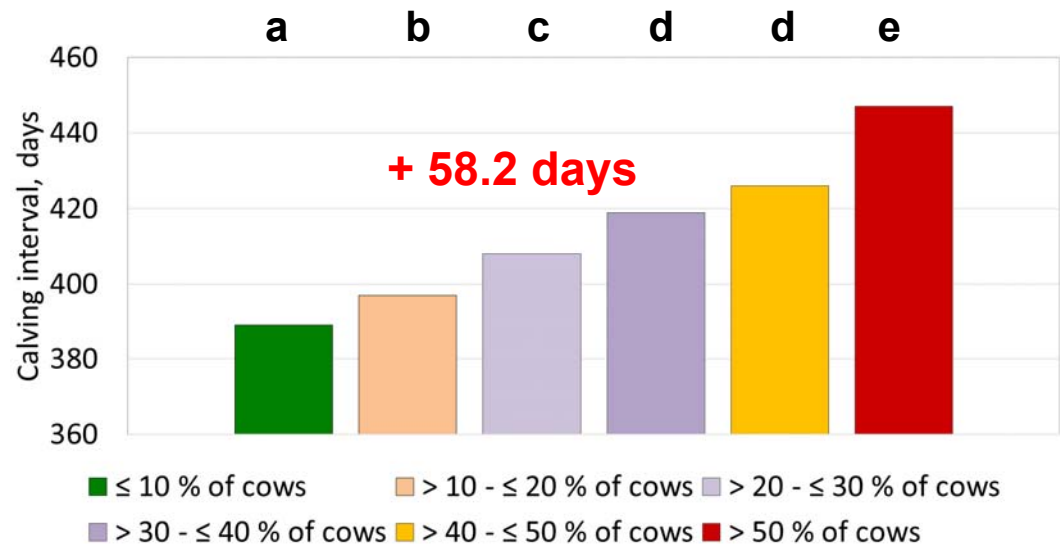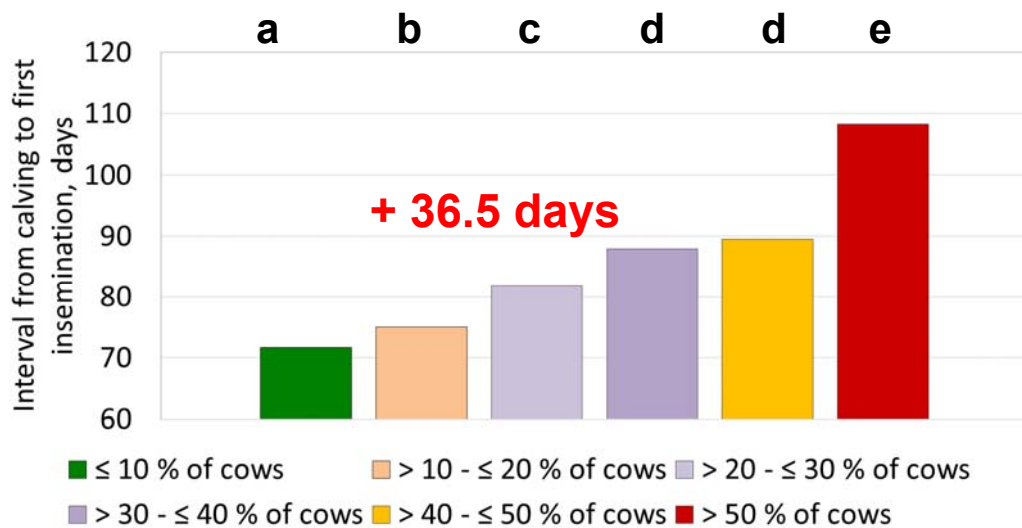
KetoMIR and Milk kg
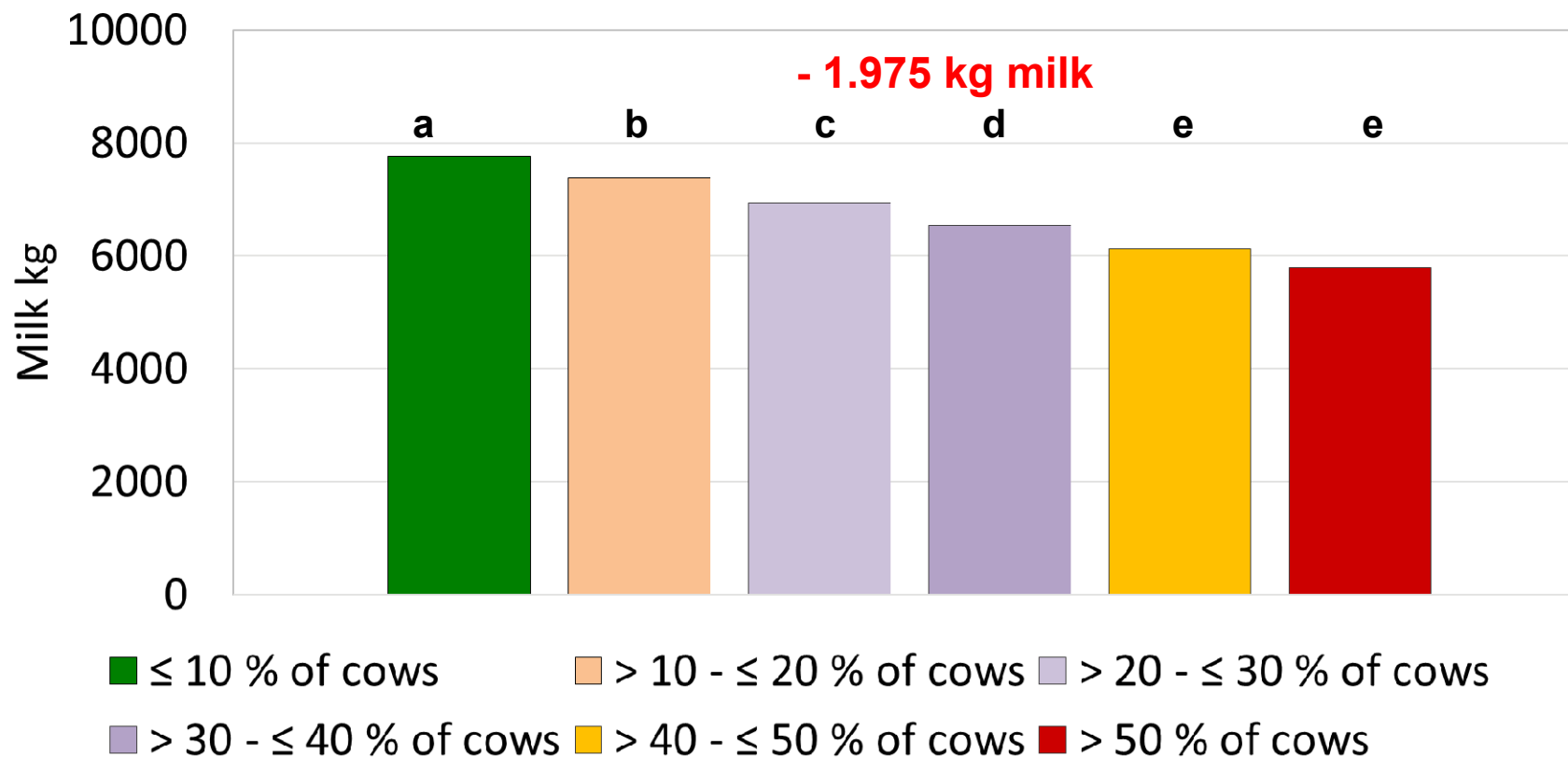
KetoMIR and Somatic cell count

KetoMIR and Fertility

Validation Blood BHB – MIR Data

- MIR equation for ß-hydroxybutyrate (BHB) in blood from EMR (European Milk Recording)

- Validation of equation on 49 Austrian farms (farms with metabolic problems) and 670 dairy cows

- Data were collected from September 2020 to March 2021

- Data collection was carried out by the regional milk recording organizations

- 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)

  - Khol et al., 2019: 98% of all the samples were correctly classified as SCK or non-SCK by the handheld device in capillary blood (sensitivity 0.96, specificity 0.98) and 97.4% in venous whole blood (sensitivity 0.889, specificity 0.991), respectively
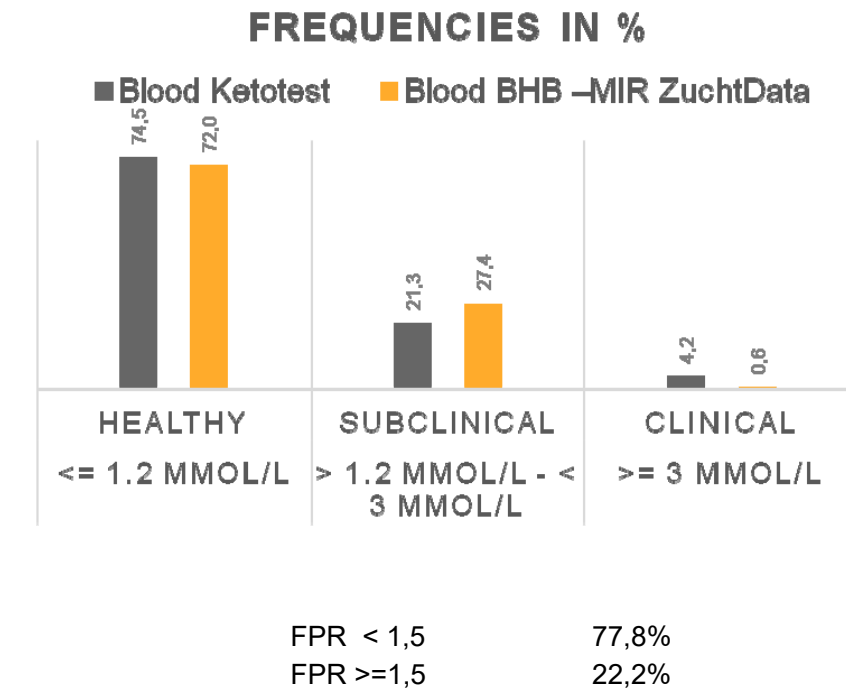
Validation Blood BHB – MIR Data

- Recording of feeding behavior (1=does not eat, 2 = eats reduced, 3 = eats normal)

- Recording of metabolism (ketosis prevention, ketosis treatment, milk fever prevention, milk fever treatment)

- Blood BHB predicted from MIR and fat-to-protein ratio were available at each milk recording.

In total

- 1,020 blood ketotests with associated data from milk performance testing (5-97 days in milk), only 8 records with a clinical ketosis treatment

FREQUENCIES IN %

■ Blood Ketotest   ■ Blood BHB –MIR ZuchtData

HEALTHY	SUBCLINICAL	CLINICAL
<= 1.2 MMOL/L	> 1.2 MMOL/L - < 3 MMOL/L	>= 3 MMOL/L

(values: Healthy 74,5 / 72,0; Subclinical 21,3 / 27,4; Clinical 4,2 / 0,6)

FPR < 1,5   77,8%
FPR >=1,5   22,2%

Validation Blood BHB – MIR – All data

- BHB concentration from handheld device (WellionVet Belua) was used as gold standard to detect subclinical ketosis (BHB-concentration > 1.2 mmol/l)

	Sensitivity	Specificity
Blood BHB – MIR		
FPR > 1.5		

Sensitivity: the ability of a test to correctly identify animals with a disease.
Specificity: the ability of a test to correctly identify animals without the disease.

Validation Blood BHB – MIR – Fleckvieh

	Sensitivity	Specificity
Blood BHB – MIR	47.2	83.0
FPR > 1.5	39.4	82.8

Validation Blood BHB – MIR – Brown Swiss

	Sensitivity	Specificity
Blood BHB – MIR	63.6	87.3
FPR > 1.5	32.7	87.8

Validation Blood BHB – MIR – Holstein

	Sensitivity	Specificity
Blood BHB – MIR	64.2	69.3
FPR > 1.5	43.2	77.3

Genetic parameters between subclincal ketosis and MIR predicted traits

- 504 records from 323 Fleckvieh cows

	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**

Genetic parameters between subclincal ketosis (milk keto test), BCS, fat-protein-ratio and KetoMIR

3,364 cows (1,806 milk keto tests, 2,493 BCS scores, 7,202 fat-protein-ratios, 2,227 KetoMIR results)

	BHB – milk ketotest	BCS	Fat-protein-ratio	KetoMIR
BHB – milk ketotest	**0.07 (0.02)**	-0.49 (0.11)	0.22 (0.10)	0.41 (0.11)
BCS		**0.16 (0.03)**	-0.25 (0.05)	-0.43 (0.10)
Fat-protein-ratio			**0.11 (0.01)**	0.60 (0.06)
KetoMIR				**0.19 (0.02)**

Data from a previous project, Efficient Cow
Milk keto test recorded as 0, 1 or 2 positive tests on lactation day 7 and 14
BCS recorded on first test day (mean 3.31, FPR and KetoMIR recorded on lactation days <= 120, means 1.28 and 0.31)

Conclusions

- Increased incidence of animals with a medium or high ketosis risk (KetoMIR) has significant negative effects on milk yield, somatic cell count and fertility in the herd

- Blood BHB predicted from MIR had a sensitivity of 56% and a specificity of 81% → not accurate enough for individual cow detection, only available at milk recording

- Heritabilities for MIR predicted traits were high, ranging from 0.16 for acetone to 0.30 for KetoMIR

- The moderate to high genetic correlations between MIR-predicted traits and subclinical ketosis suggest that consideration of these traits would reduce subclinical ketosis

Acknowledgement

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D4Dairy – Progress through networking

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Company partners:

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