



NUWI
Institut für
Nutztier-
wissenschaften



Potential of cow-side blood tests, MIR-data or wearable sensor devices for breeding for metabolic health in dairy cows?

K.Schodl, B.Fuerst-Waltl, D4Dairy-Consortium, C.Egger-Danner
EAAP 2024



What is it about?

Ketosis in early lactation

- Breeding for metabolically stable cows
- Data is scarce, low frequencies and heritabilities of veterinary diagnoses

Tests for measuring ketone bodies in the blood

- Handheld devices allow on-farm use
- Early lactation is the most critical phase
- Additional work-load for farmers

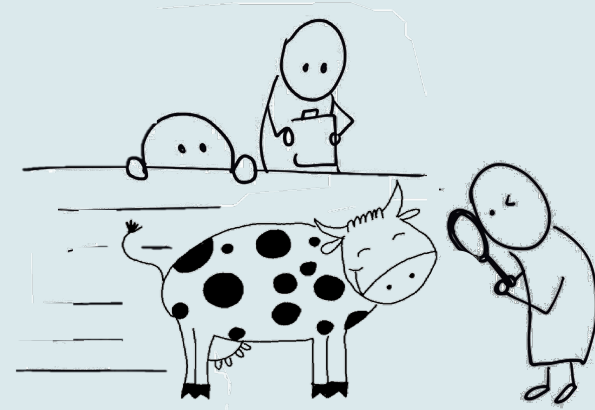


What do we need?

Trade-off between validity and feasibility of phenotyping

Auxiliary traits with potential for large scale phenotyping

- Milk recording including MIR-derived ketosis risk
- Sensor devices recording activity, rumination, eating behavior, etc.



Aim: analyse potential of MIR-derived ketosis risk from milk recordings and data from wearable sensor devices for breeding for metabolic health in dairy cows.

Farms, animals and data

- **25 Fleckvieh farms** equipped with **LELY** sensor system were motivated to participate in the **D4Dairy** project



Collar mounted sensor with output variables

- **Activity:** non-dimensional number
 - **Rumination:** min in 24 hours
 - **Eating:** min in 24 hours
- } 2 hour intervals



- Milk recordings from **Rinderdatenverbund** (RDV) for KetoMIR
- **Blood ketosis tests** measuring β -hydroxybutyrate (BHB) levels

Trait definition

Blood ketotest
n=3,034 cows from 63 farms

BHB value mmol/L
BHB value squared
BHB value log10

Score 1 BHB ≤ 1.2 mmol/L, **healthy**
Score 2 BHB 1.3 – 2.9 mmol/L, **subclinical ketosis**
Score 3 BHB ≥ 3 mmol/L, **clinical**

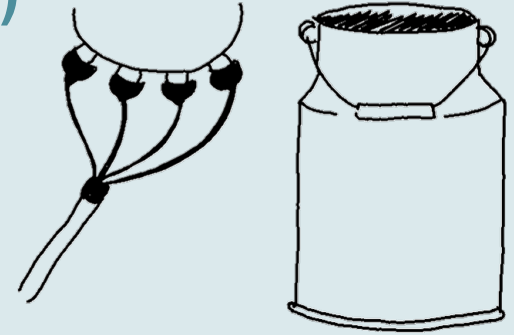
0 BHB ≤ 1.2 mmol/L, **healthy**
1 BHB ≥ 1.3 – 2.9 mmol/L, **diseased**



Trait definition

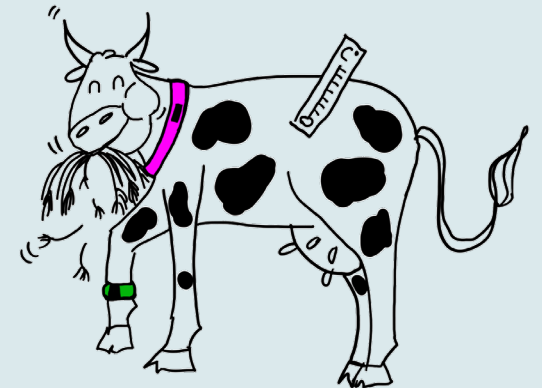
KetoMIR (n=4,237 milk recordings, 3,158 cows, 64 farms)

- MIR-predicted ketosis risk
- KM1, KM2, KM3
- Data used up to 30 days in milk



Sensor data ($n_{\text{act}}=2,096$ / $n_{\text{rum}}=3,695$ / $n_{\text{eat}}=1,599$, 1,630 animals)

- **Sum** (activity) or **mean** (rumination, eating)
- **Standard deviation (SD)**
- **At testday**



Bivariate linear animal models

- **Fixed effects**
 - **Lactation** (1,2,3,4, ≥ 5)
 - **Sensor generation** (activity & rumination or eating & rumination)
 - **Days in milk** (linear continuous effect)
- **Random effects**
 - Genetic effect of the animal
 - Permanent environment
 - Residual



Results ketosis traits

Ketotest traits	h^2 (S.E.)
BHB value	0.16 (0.04)
BHB ²	0.17 (0.04)
Log10(BHB)	0.18 (0.04)
Ketosis 1,2,3	
Ketosis 0/1	
KetoMIR	



Results ketosis traits

Ketotest traits	h^2 (S.E.)
BHB value	0.16 (0.04)
BHB ²	0.17 (0.04)
Log10(BHB)	0.18 (0.04)
Ketosis 1,2,3	0.19 (0.03)
Ketosis 0/1	0.09 (0.03)
KetoMIR	0.08 (0.04)



Results ketosis traits

Ketotest traits	h^2 (S.E.)	r_a KetoMIR (S.E.)
BHB value	0.16 (0.04)	0.47 (0.03)
BHB ²	0.17 (0.04)	0.54 (0.30)
Log10(BHB)	0.18 (0.04)	0.41 (0.26)
Ketosis 1,2,3	0.19 (0.03)	0.40 (0.26)
Ketosis 0/1	0.09 (0.03)	0.28 (0.28)
KetoMIR	0.08 (0.04)	



Results sensor traits



Sensor traits	h^2 (S.E.)
Activity sum	0.23 (0.09)
Activity SD	0.35 (0.15)
Rumination mean	0.28 (0.02)
Rumination SD	0.08 (0.03)
Eating mean	0.39 (0.09)
Eating SD	0.12 (0.07)



Results sensor traits

Sensor traits	h^2 (S.E.)	r_a BHB (S.E.)
Activity sum	0.23 (0.09)	-0.94 (0.17)
Activity SD	0.35 (0.15)	-0.62 (0.24)
Rumination mean	0.28 (0.02)	0.00 (0.02)
Rumination SD	0.08 (0.03)	-0.06 (0.19)
Eating mean	0.39 (0.09)	0.38 (0.09)
Eating SD	0.12 (0.07)	0.14 (0.16)



Results sensor traits

Sensor traits	h^2 (S.E.)	r_a BHB (S.E.)
Activity sum	0.23 (0.09)	-0.94 (0.17)
Activity SD	0.35 (0.15)	-0.62 (0.24)
Eating mean	0.39 (0.09)	0.38 (0.09)

- **Genetic correlations** were high for activity traits and moderate for mean eating time
- Moderate to high **heritabilities** for sensor traits → use in breeding?!

Discussion & conclusions

- Moderate heritability for **blood BHB-level** from on-farm blood ketotests, but routine implementation challenging
- **KetoMIR** genetically correlated to **BHB-level**, but has lower heritability
- **Sensor traits** are heritable and partly highly correlated to BHB-level
 - **Activity** derived traits show promising heritabilities and correlations
- **Metabolic index** could include KetoMIR and sensor derived traits
 - Inclusion of **farms without sensors** through milk recording
 - Correlations with other traits in the **TMI**?
- (Side-)Effect of selection based on sensor data on **animal welfare**?
 - Genetically: correlation to health and fitness traits
 - Welfare or more or less „active“ animals?



RINDERZUCHT
AUSTRIA
Innovation



NUWI
Institut für
Nutztier-
wissenschaften

**ZUCHT
DATA**



Thank you for your attention!



D4Dairy

BitKuh

