

Mid-infrared prediction of β -hydroxybutyrate, acetone and citrate contents in milk



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Background

- ▶ Mid-infrared analysis of milk is a cost-effective and rapid tool to collect routinely new phenotypes for genetic and management purposes in dairy cattle.
- ▶ Ketone bodies in milk are indicators of (sub)clinical ketosis.
- ▶ Citrate in milk is identified as an indicator of physiological imbalance and mastitis.

Bjerre-Harpøth et al., 2012, *J. Dairy Sci.*, 95:2362-2380
De Marchi et al., 2014, *J. Dairy Sci.*, 97:1171-1186
De Roos et al., 2007, *J. Dairy Sci.*, 90:1761-1766

Material & Methods

566 milk samples were collected in research and commercial farms in Luxembourg, Germany, and France

Reference analyses were performed by flow injection (Skalar) at .

Spectral data were obtained from local milk labs and were standardized.

Descriptive statistics of the reference analyses for acetone, β -hydroxybutyrate and citrate (N=566)

	Mean	Range
Acetone ($\mu\text{mol/L}$)	103	20 to 3355
β -hydroxybutyrate ($\mu\text{mol/L}$)	215	21 to 1595
Citrate (mmol/L)	8.9	4.5 to 15.5

Calibration procedure:

- ✓ Log-transformation of β -hydroxybutyrate and acetone to approach a normal distribution
- ✓ Strict editing to select informative samples
- ✓ Modified partial least square regression after first derivative and selection of informative wavelengths (212)

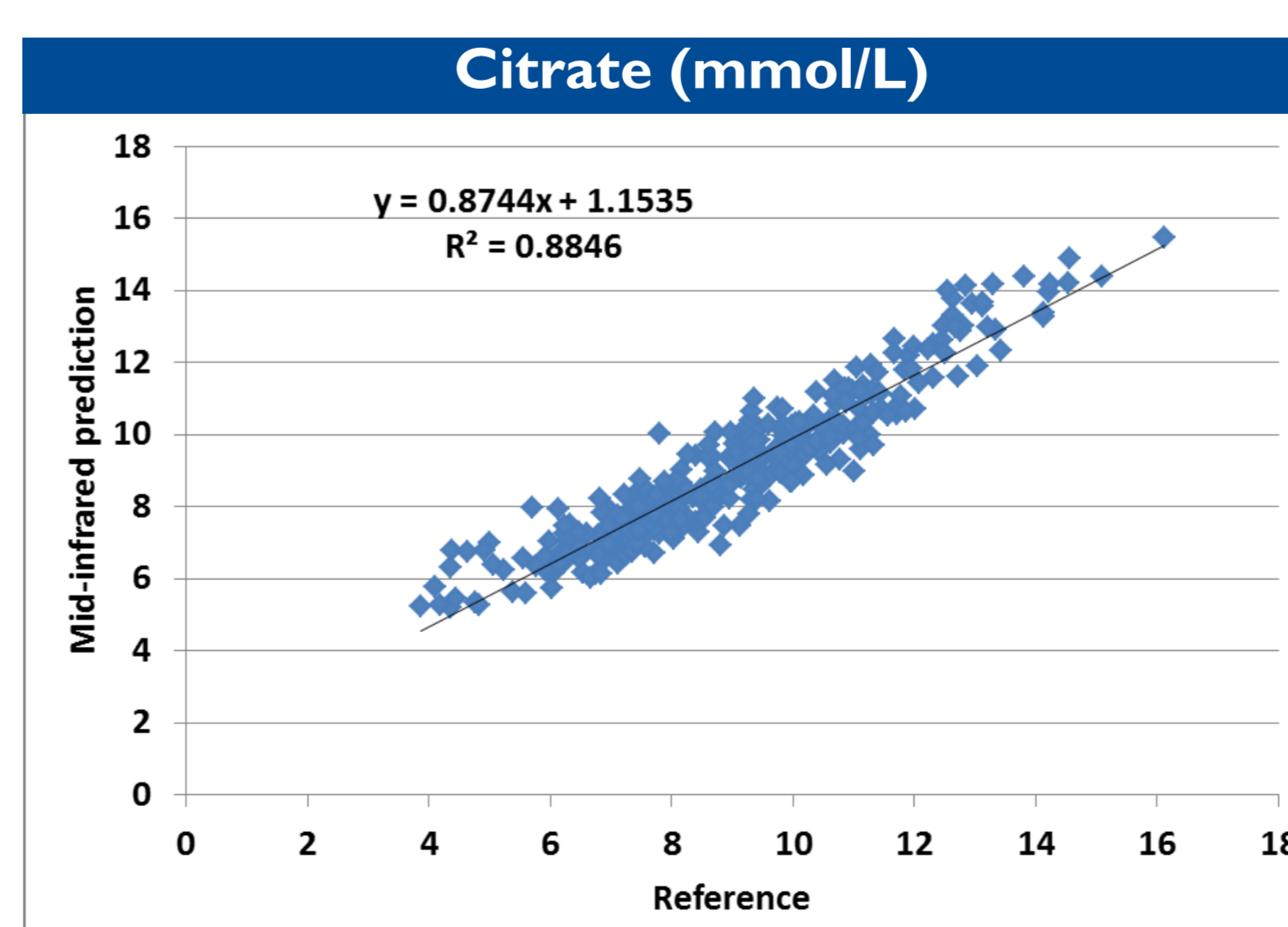
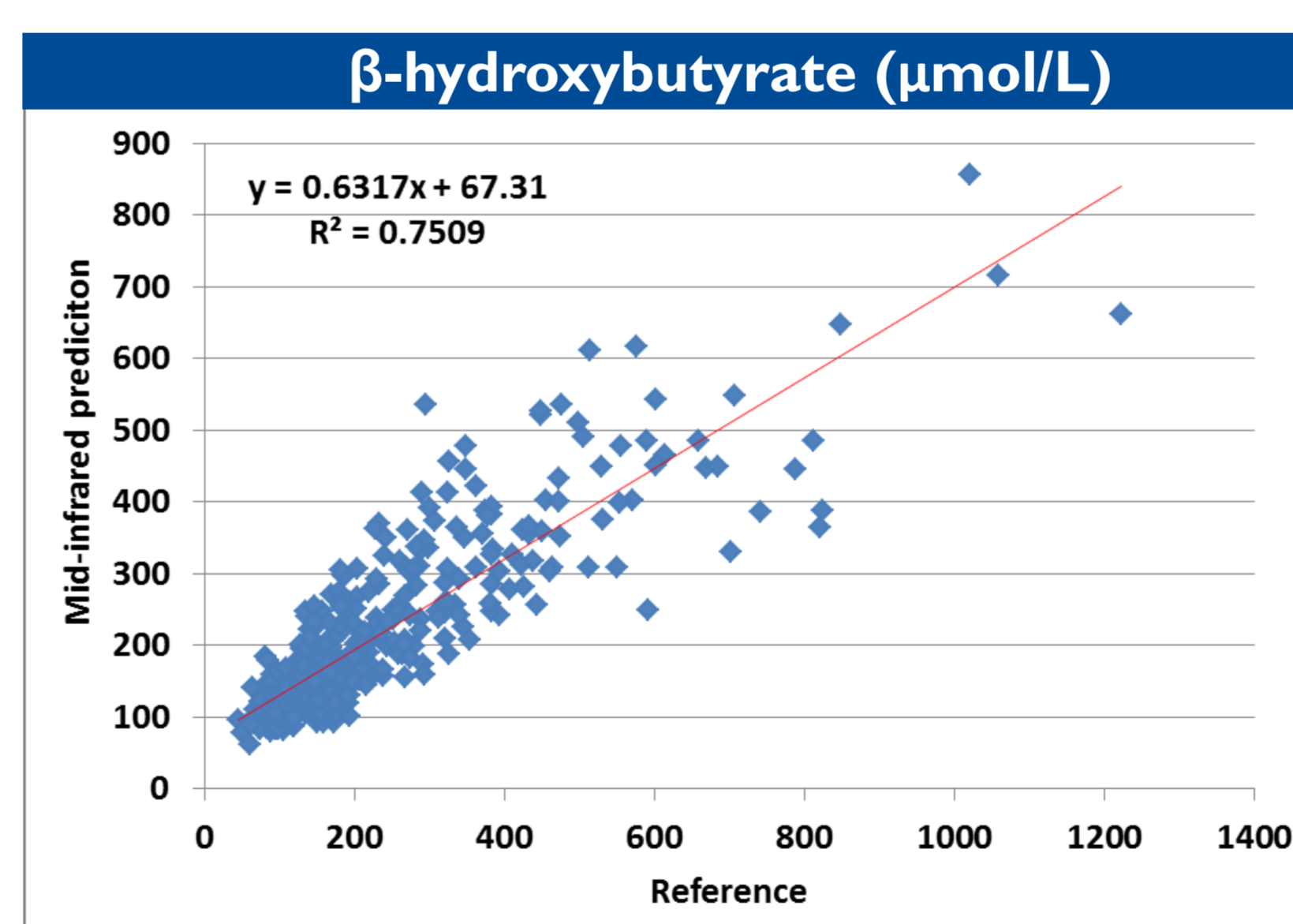
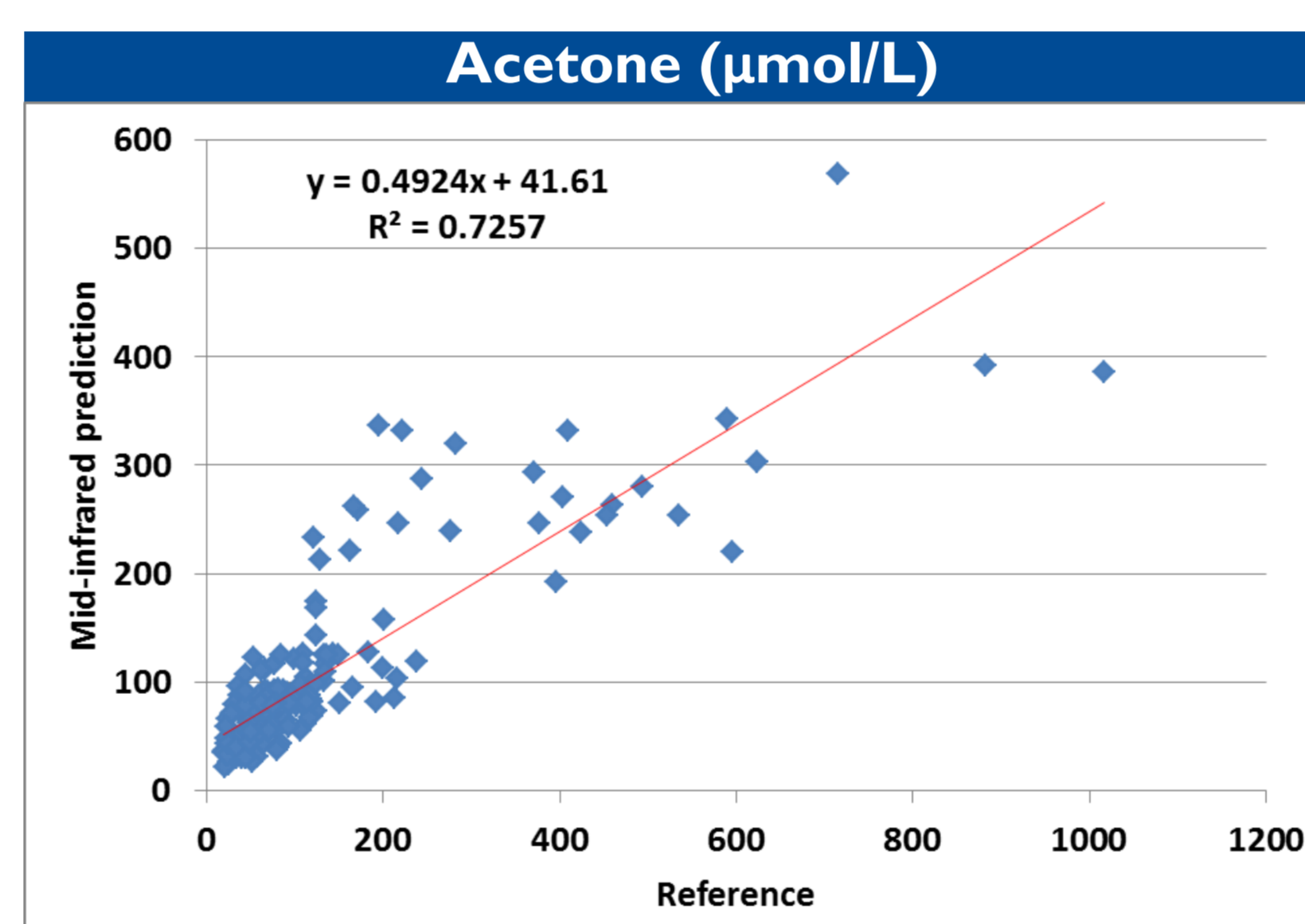
Objective

Predict the content in milk of β -hydroxybutyrate, acetone, and citrate by mid-infrared spectrometry

Conclusion

- ▶ Citrate content can be predicted by mid-infrared spectrometry with good accuracy (RPDc > 3).
- ▶ Mid-infrared prediction of β -hydroxybutyrate and acetone contents can be used for screening.

Results



Calibration statistics

	β -hydroxybutyrate ($\mu\text{mol/L}$)	Acetone ($\mu\text{mol/L}$)	Citrate (mmol/L)
N	419	201	338
No. of terms	9	8	9
Mean	225	117	9.05
SD	171	145	2.19
RMSEc	86	88	0.73
R ² c	0.75	0.73	0.88
RPDc	1.97	1.65	3.01

SD = standard deviation
RMSEc = root mean square error of calibration
R²c = coefficient of determination of calibration
RPDc = SD/SEC

External validation statistics

	β -hydroxybutyrate ($\mu\text{mol/L}$)	Acetone ($\mu\text{mol/L}$)	Citrate (mmol/L)
N	124	233	128
Mean	156	50	9.01
RMSEv	65	45	0.80

RMSEv = root mean square error of validation

Implications?

- ▶ Equations have been disseminated through the OptiMIR network.
- ▶ Advisory tools for monitoring (sub) clinical ketosis have been / are being developed based on mid-infrared predictions of β -hydroxybutyrate and acetone.