

Using MIR spectra to estimate the ration composition of lactating dairy cows

Presentation by Michael Klaffenböck



Contents

- MIR spectrometry
- Research question
- Animals, data and methods
- Results
- Discussion
- Conclusion

Mid-infrared spectrometry

- Uses in milk analysis and assessing phenotypes
 - Milk solids (*standard practice!*)
 - Fatty acid and protein composition (*Ferrand-Calmels et al., 2014*)
 - Body energy status (*McParland et al., 2011*)
 - *Discriminating feeding systems* (*Valenti et al., 2013*).
 - ...

Research question

Can the percentages and absolute quantities of certain feedstuffs and groups of feedstuffs in the rations of lactating dairy cows be estimated using MIR spectra of milk samples?

INDIVIDUAL FEEDSTUFFS	Concentrates	$C_{kg}, C_{\%}$
	Hay	$H_{kg}, H_{\%}$
	Maize silage	$MS_{kg}, MS_{\%}$
	Grass silage	$GS_{kg}, GS_{\%}$
	Pasture	$P_{kg}, P_{\%}$
GROUPS OF FEEDSTUFFS	Forages A (<i>Hay+Grass silage</i>)	$FA_{kg}, FA_{\%}$
	Forages B (<i>Hay+Grass silage+Pasture</i>)	$FB_{kg}, FB_{\%}$
	Energy-dense feedstuffs (<i>Concentrates+Maize silage</i>)	$EDF_{kg}, EDF_{\%}$

ANIMALS, DATA & METHODS

Animals, data and methods (1)

■ Milk data

- 10200 samples collected in Raumberg-Gumpenstein
- Analysed using MIR spectrometry
- Fat, protein, lactose, cell score and urea
- MIR spectra (>1000 absorbance rates)

■ Cow data

- Days in milk, number of lactation, daily milk yield
- Weight, BCS, daily gains (est.), back fat
- Feed intake
 - Five different feedstuffs *measured or estimated* (pasture)

Animals, data and methods (2)

- **Partial least square (PLS) regression**
 - Data set is randomly split into a **calibration** data set and a **validation** data set
 - Equation from calibration data set applied to validation data set → estimates
 - Number of LVs (explanatory factors) determined by trial&error
- **Determining accuracy:**
 - Coefficient of correlation (**R**)
correlation between observed value and estimated value

RESULTS&DISCUSSION

Results

	CALIBRATION			VALIDATION				
	LV	RMSE	R	RMSE	Bias	Slope	R	RPD
C_{kg}	90	1.84	0.79	1.98	0.00	0.95	0.75	1.51
H_{kg}	90	2.31	0.66	2.47	0.00	0.91	0.60	1.24
GS_{kg}	80	2.26	0.71	2.39	-0.01	0.94	0.67	1.35
MS_{kg}	100	1.06	0.79	1.17	0.00	0.93	0.74	1.47
P_{kg}	90	2.25	0.87	2.42	0.01	0.97	0.85	1.91
FA_{kg}	80	2.21	0.86	2.34	0.01	0.98	0.84	1.86
FB_{kg}	110	2.17	0.77	2.39	-0.01	0.92	0.72	1.43
EDF_{kg}	90	2.12	0.84	2.28	0.00	0.97	0.82	1.74
C_%	90	9.67	0.77	10.45	-0.04	0.94	0.73	1.46
H_%	80	11.86	0.66	12.70	0.00	0.92	0.60	1.25
GS_%	90	11.79	0.78	12.74	-0.03	0.94	0.74	1.48
MS_%	120	6.73	0.80	7.44	-0.02	0.93	0.75	1.50
P_%	90	16.02	0.89	17.22	0.05	0.97	0.87	2.02
FA_%	110	11.98	0.88	13.11	0.00	0.96	0.85	1.89
FB_%	100	10.02	0.86	10.90	0.01	0.96	0.83	1.79
EDF_%	90	10.12	0.86	10.87	0.00	0.97	0.83	1.80

Discussion (1)

- *Coppa et al. (2015)* used fatty-acid profiles of bulk milk samples to predict feed ration composition.

Feedstuff (% of DM)	R <i>(Coppa et al., 2015)</i>	R <i>(this study)</i>
Fresh herbage	0.90	0.87
Total herbage	0.85	0.83
Corn silage	0.81	0.75
Grass silage	0.79	0.74
Concentrates	0.71	0.73

Discussion (2)

- Most MIR studies investigated direct milk components, while this study looks for a ‘finger print’ of the feed ration in the MIR spectra
→ **Determining thresholds for R difficult**

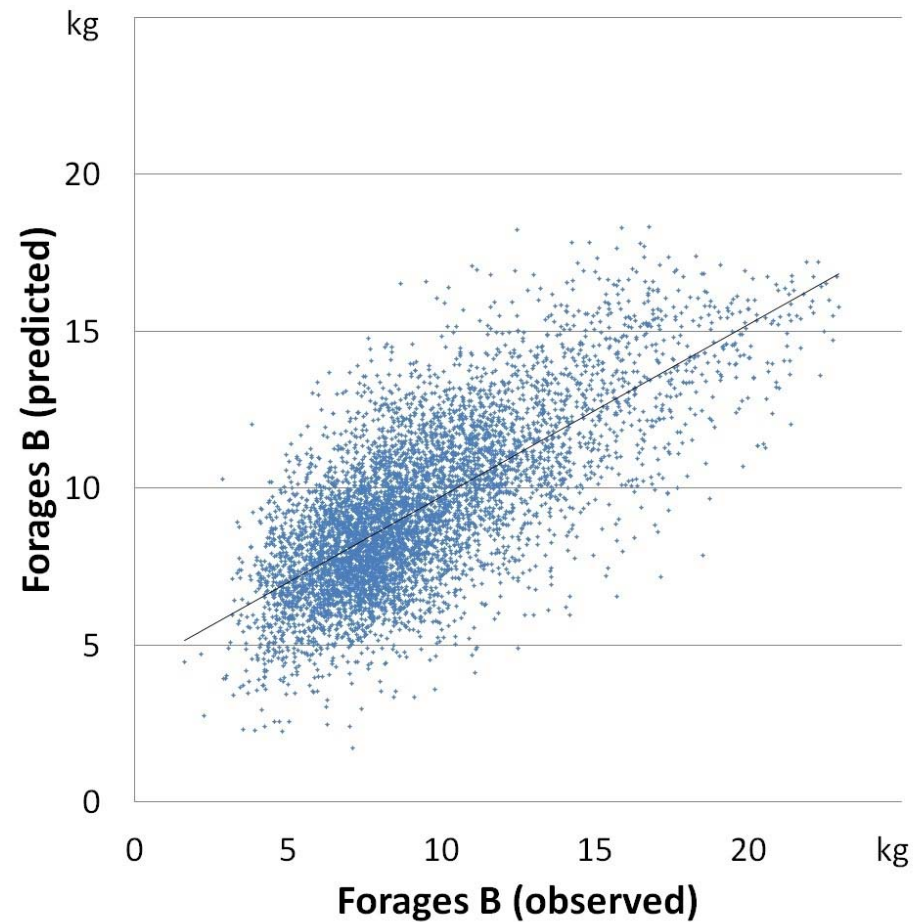
	VALUE	ACCURACY	
R	>0.87	<i>Adequate for animal breeding purposes</i>	SOYEURT et al., 2011
	>0.98	<i>Adequate for milk payment systems</i>	
	0.81-0.90	<i>Approximate quantitative predictions</i>	KAROUI et al., 2006
	0.91-0.95	<i>Good predictions</i>	
	>0.95	<i>Excellent predictions</i>	
	0.5-0.8	<i>Reasonably accurate</i>	MCPARLAND et al., 2011&2012
	~0.85	<i>Adequate for widespread herd-screening</i>	VANLIERDE et al., 2016

Discussion (3)

- Estimates for **groups of feedstuffs** were generally **better** than for individual feedstuffs (R: 0.82 vs. 0.73)
- **Pasture > FA composition > MIR spectrum > high accuracy of estimation**

Discussion:

Observed-predicted clouds



Conclusions

- Basis for developing a method to **cheaply and accurately** estimate the feed ration of dairy cows using MIR spectra
- Estimates for all **groups of feedstuffs** and certain single feedstuffs like **pasture, maize silage and concentrates** were promising.
- While estimates are **good on average** - individual estimates can deviate strongly.

**THANK YOU FOR YOUR
ATTENTION!**