Potential Estimation of Fatty Acid Content in Cow Milk by Mid-Infrared Spectrometry

H. Soyeurt, P. Dardenne, G. Lognay, C. Bertozzi, P. Mayeres and N. Gengler

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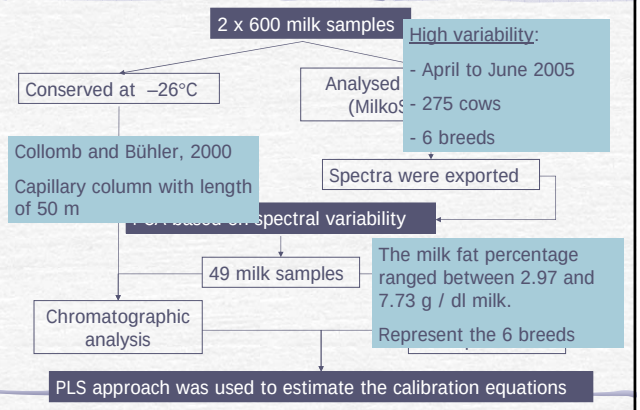
Context

- Chromatographic analysis:
  - Major advantage : reliability
  - Major inconvenient :
    - Expensive reagents
    - Time consuming
- Mid-Infrared analysis :
  - Fast analysis (up to 500 samples / hour)
  - Used in routine milk recording

Objective

- Calibration of Mid-Infrared Spectrometry to estimate the fatty acid content in bovine milk

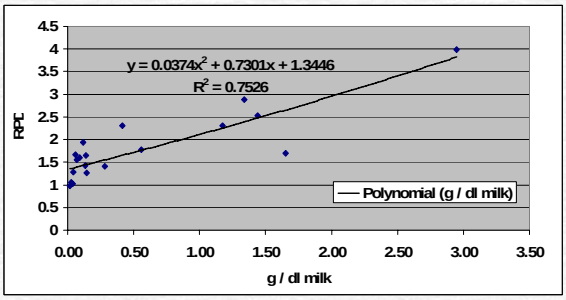
Methodology



Results and Discussion

- Globally, CV of chromatographic data for each fatty acid were inferior to 5 %
- 41 calibration equations were estimated:
  - Fatty acid in milk (g / dl MILK)
  - Fatty acid in milk fat (g / 100 g FAT)

Results and Discussion



RPD = Ratio of standard error of cross validation to standard deviation

- Cross-validation R^2 was higher if the FA concentration in milk was higher.

Results and Discussion

Fatty acids	g / 100 g fat CV	g / 100 g fat R²cv	g / dl milk CV	g / dl milk R²cv
C4:0	32.35	0.39	39.51	0.51
C6:0	43.41	0.41	48.54	0.52
C8:0	43.85	0.46	49.12	0.59
C10:0	42.76	0.53	45.78	0.64
C10:1 *9-cis*	58.47	0.45	48.15	0.01

R²cv were smaller for the prediction of FA in milk fat

CV for FA content in milk fat were generally higher than the CV for FA concentration in milk

Fatty acids	g / 100 g fat CV	g / 100 g fat R²cv	g / dl milk CV	g / dl milk R²cv
C14:0	21.03	0.67	28.63	0.82
C14:1 *9-cis*	44.28	0.23	39.68	0.07
C15:0	29.82	0.53	30.07	0.40
C16:0	19.06	0.50	33.01	0.82
C16:1 *9-cis*	34.81	0.37	52.48	0.65

CV = Coefficient of variation ; **R²cv** = cross-validation coefficient of determination.

Results and Discussion

Fatty acids	g / 100 g fat CV	g / 100 g fat R²cv	g / dl milk CV	g / dl milk R²cv
C18:1	19.67	0.53	37.92	0.88
C18:2 *9-cis,12-cis*	23.55	0.11	34.39	0.62
C18:3 *9-cis,12-cis,15-cis*	38.68	0.20	42.69	0.14
C18:2 *9-cis,11-trans*	54.99	0.34	48.74	0.07

R^2_{cv} were smaller for the prediction of FA in milk fat

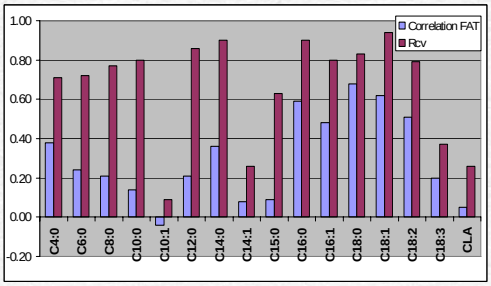
CV for FA content in milk fat were generally higher than the CV for FA concentration in milk

Fatty acids	g / 100 g fat CV	g / 100 g fat R²cv	g / 100 dl milk CV	g / 100 dl milk R²cv
saturated	9.44	0.63	26.50	0.94
unsaturated	17.44	0.63	34.66	0.66
monounsaturated	18.49	0.52	38.13	0.85
polyunsaturated	22.70	0.10	31.26	0.39

CV = Coefficient of variation ; **R²cv** = cross-validation coefficient of determination.

Results and Discussion

- Predicted concentrations of FA were due to a real absorbance of these FA or due only to the correlations between total fat content and FA ?



If the R_{CV} were not due to real absorbance specific to FA, these correlations would not be higher than the correlations FA.

Results and Discussion

- Validation with external milk samples is beginning
  - Calibration : June 2005
  - Validation : May 2006
- 31 samples were analysed by gas chromatography and by MIR Spectrometry. The contents were compared

Fatty acids	N	Validation correlations
C4:0	31	0.22
C6:0	31	0.74
C8:0	31	0.91
C10:0	31	0.91

Fatty acids	N	validation correlations
C12:0	31	0.86
C14:0	31	0.84
C14:1 *9-cis*	31	0.21
C16:0	31	0.82
C16:1 *9-cis*	31	-0.52

Results and Discussion

Fatty acids	N	validation correlations
C18:0	31	-0.26
C18:1 *9-cis*	31	0.91
C18:2 *9-cis, 12-cis*	31	0.32
C18:3 *9-cis, 12-cis, 15-cis*	31	0.006
C18:2 *9-cis, 11-trans*	31	0.05

Fatty acids	N	validation correlations
saturated	31	0.92
unsaturated	31	0.83
monounsaturated	31	0.82
polyunsaturated	31	0.19

Preliminary results are promising

Conclusions

- Estimation of FA concentrations in milk by MIR Spectrometry seems feasible
- For potential use, high R^2_{CV} and high RPD parameters would be required

Conclusions

g / dl milk	Mean	SD	SEC	R^2c	SECV	R^2cv
MG	4.55	1.18	0.05	1.00	0.06	1.00
saturated	2.95	0.78	0.12	0.98	0.20	0.94
unsaturated	1.65	0.57	0.29	0.74	0.34	0.66
monounsaturated	1.44	0.55	0.18	0.89	0.22	0.85
polyunsaturated	0.14	0.05	0.03	0.43	0.04	0.39
C4:0	0.28	0.11	0.07	0.59	0.08	0.51
C6:0	0.13	0.06	0.04	0.69	0.04	0.52
C8:0	0.07	0.03	0.02	0.75	0.02	0.59
C10:0	0.14	0.06	0.03	0.77	0.04	0.64
C10:1 *9-cis*	0.01	0.01	0.01	0.05	0.01	0.01
C12:0	0.12	0.04	0.02	0.82	0.02	0.74
C14:0	0.41	0.12	0.04	0.90	0.05	0.82
C14:1 *9-cis*	0.03	0.01	0.01	0.12	0.01	0.07
C15:0	0.04	0.01	0.01	0.58	0.01	0.40
C16:0	1.17	0.39	0.11	0.91	0.17	0.82
C16:1 *9-cis*	0.06	0.03	0.02	0.75	0.02	0.65
C18:0	0.56	0.24	0.12	0.73	0.13	0.69
C18:1	1.34	0.51	0.12	0.95	0.18	0.88
C18:2 *9-cis,12-cis*	0.09	0.03	0.02	0.76	0.02	0.62
C18:3 *9-cis,12-cis,15-cis*	0.03	0.01	0.01	0.20	0.01	0.14
C18:2 *9-cis,11-trans*	0.04	0.02	0.02	0.12	0.02	0.07

C18:1 = sum of pics for this type of fatty acid; **SD** = standard error; **SEC** = standard error of calibration; **R^2c** = calibration coefficient of determination; **SECV** = standard error of cross-validation; **R^2cv** = cross-validation coefficient of determination.

Conclusions

- Potential uses :

  Give some indications of FA profiles for:
  - Farmers in the routine milk recording
  - Dairy Industry to check their production
  - Future selection program to select animals which produce fat with differentiated fatty acid profile

Thank you for your attention