Application of a standardisation procedure on an international network of MIR instruments for milk analysis

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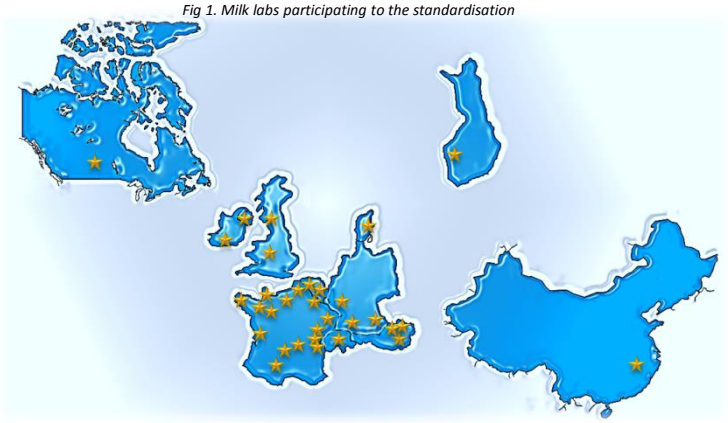
Context and objectives

- MIR equations are increasingly used in the dairy sector to obtain quick and cheap indications on milk quality or cow status (fatty acids and minerals profiles, technological properties, methane emitted by day, health of the cow…).
- Due to the **existing differences between each MIR instrument,** there is a need of spectral standardisation to merge spectra into common database in order to create robust equations, and to be able transferring these equations on several instruments.

Procedure

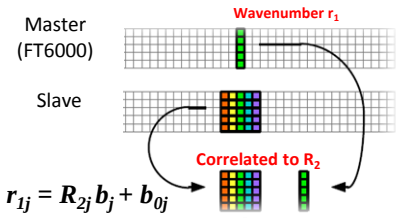
- Monthly an identical set of 5 milks is sent to the 83 instruments of the network, into 31 labs equipped with Delta, Bentley and Foss MIR machines.

Fig 1. Milk labs participating to the standardisation



- Using the spectra of the common milks analyzed, the instruments (the slaves) are mathematically matched on a reference instrument (the master) using Piecewise Direct Standardisation method (Grelet et al., 2015). PDS is based on the fact that response of the master at the wavenumber r_1 is highly correlated to the response in windows R_2 on the slave instrument.

Fig 2. Principle of PDS method



- Use of an equation predicting methane emitted by dairy cows built in the master format (Vanlierde et al., 2015) to validate the method.

Results and discussion

- As shown in figures 3 and 4, standardisation allows to reduce the spectral variability between all instruments by matching them into the reference instrument spectral format.
  → Spectra can be merged into a common database.
- When using an equation predicting methane emitted by dairy cows, there is a strong bias between slave instrument predictions and the results obtained on the master (RMSE= 200.5 g/methane/day/ cow, figure 5).
  → Equations built on one instrument (the master) cannot be used directly on another instrument.
- After standardisation the error between slave and master predictions is reduced by 10 (RMSE= 21.2 g/methane/day/cow, figure 6).
  → Possible use of a model developed on one instrument by another machine of the network.

*Fig 3. PCA on informative wavenumbers, for 5 common samples analysed on 45 instruments from the same brand, **before standardisation***

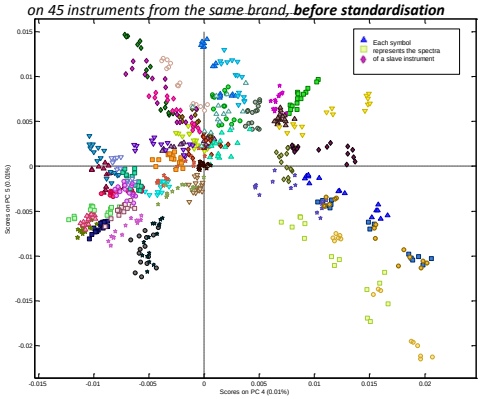


*Fig 4. PCA on informative wavenumbers, for 5 common samples analysed on 45 instruments from the same brand, **after standardisation***

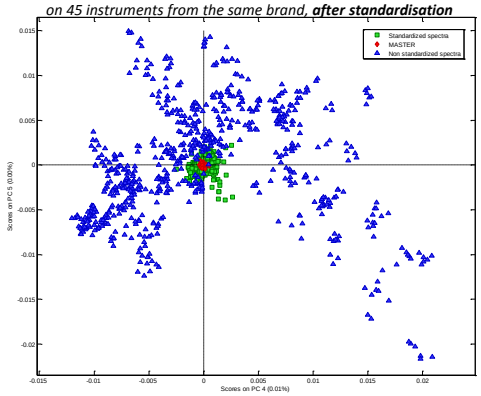


Fig 5. Equation predicting methane emitted by dairy cows used on the master and on a slave instrument before standardisation

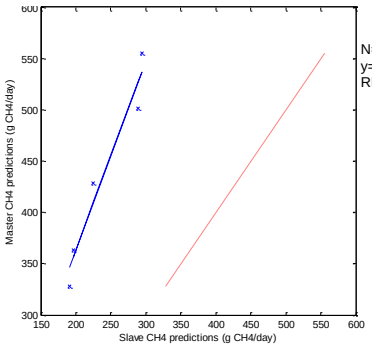
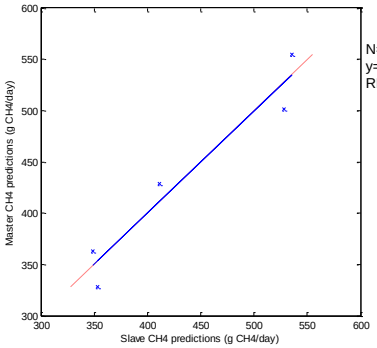


Fig 6. Equation predicting methane emitted by dairy cows used on the master and on the slave instrument after standardisation



Conclusion

- Standardisation allows to reduce the spectral variations between instruments of the network
- **Possibility to build common equations and use them on all MIR instruments**

Grelet et al., 2015. Standardization of milk mid-infrared spectra from a European dairy network. J. Dairy Sci. 98:2150–60.

Vanlierde et al., 2015. Innovative lactation-stage-dependent prediction of methane emissions from milk mid-infrared spectra. J. Dairy Sci. 98:5740–5747.

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