Principal Components Approach for Estimating Heritability of Mid-Infrared (MIR) Spectrum in Bovine Milk

H. Soyeurt [1,2], S. Tsuruta [3], I. Misztal [3] and N. Gengler [1,4]

[1] *Gembloux Agricultural University, Animal Science Unit, Passage des Déportés 2, 5030 Gembloux, Belgium*

soyeurt.h@fsagx.ac.be

[2] *F.R.I.A., Rue d'Egmont 5, 1000 Brussels, Belgium*

[3] *University of Georgia, Animal & Dairy Science Department, 425 River Road, 30605 Athens, USA*

[4] *F.N.R.S., Rue d'Egmont 5, 1000 Brussels, Belgium*

1. Aim and Objectives

MIR spectrometry is used routinely to measure the contents of fat, protein, urea or lactose in bovine milk.

→ The MIR **spectrum reflects the entire composition of milk**.

➔ **IDEA :** Used directly the **MIR spectral data to improve the nutritional quality of milk.**

➔ Difficulties **: 1,060 data points** composed the spectrum + **enough genetic variability** ?

➔ **OBJECTIVES : Reduce the number of traits** and **estimate the genetic parameters of these traits.**

2. Material and methods

Animal Population

- Due to the limited number of data, only the cows in the first lactation were studied.
- Milk samples were collected between April 2005 and May 2006 during the Walloon milk recording.
- 2,850 test day spectral records from 750 cows were used.

Reduction of traits

- Principal Components Approach (PCA) was applied to the spectral data.
- New traits were estimated from the eigenvectors which represented the highest relative eigenvalues.

Quantitative Model

- Multi-trait mixed model :

  Fixed effects : herd*date of test; class of 15 days in milk.

  Random effects : residual effect, animal additive, permanent environment.

- Variance components were estimated using REML by canonical transformation.
- Back transformation was applied to express (co)variances at the original 1,600 data points.

3. Results and discussion

Only **48 principal components** described 99.02% of spectral variability.

➔ **Heritabilities** of these **new traits** ranged between **0.80 to 49.66 %.**

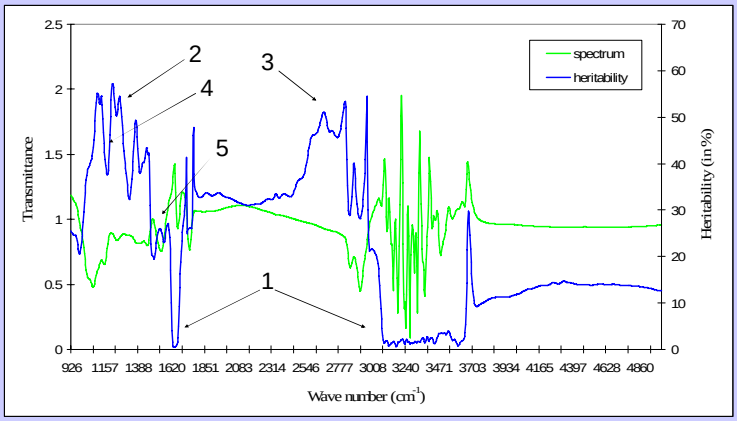

Figure 1. Heritability (in blue) estimated for the 1,060 spectral traits which composed the MIR milk spectrum (in green).

Heritability of 1,060 spectral traits ranged between **0.48 and 47.20 %.**

2 MIR regions with heritability close to 0 → **no potential genetic interest (1)**.

High heritability observed between 926 and 1,616 cm^{-1} was expected → fingerprint regions correlated to the C-O and C-C stretching bonds, common bonds in milk **(2).**

Spectrum could be useful to **study known traits**. Heritabilities for **lipids** (2,800 and 3,000 cm^{-1}) and **lactose** (around 1,100 cm^{-1}) were 36.09 % (literrature : 43%) **(3)** and 53.13% (litterature: 47.80%) **(4),** respectively.

Spectrum could be also used to **study new traits,** e.g., **lactate** (1,515 and 1,593 cm^{-1}) had a heritability of 24.86% **(5).**

4. Conclusion

PCA pre-treatment is useful to reduce the dimensionality of traits. **Genetic variability of spectral traits exists.** A **selection program based on spectral data** is **possible.** More studies are needed to link specific milk components to MIR spectrum. Subsequent studies need to be validated with a larger spectral data set.

Gembloux Agricultural University