

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

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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 %**.

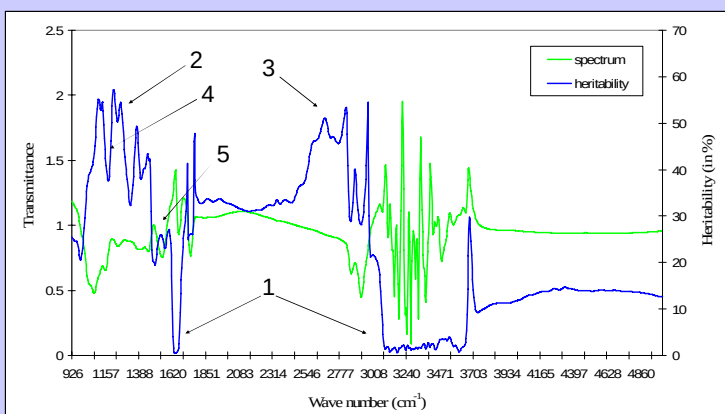


Figure 1. Heritability (in blue) estimated for the 1,060 spectral traits which composed the MIR milk spectrum (in green).

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 % (litterature : 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.