Investigating the use of Mid Infrared spectral data to predict dairy cow cellular immune traits

SJ Denholm, SL Smith, TM McNeilly, V Hicks and E Wall

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Introduction
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Health\textsuperscript{1, 2} Fertility\textsuperscript{1, 2} Production\textsuperscript{1, 2} measurable in blood!

\textsuperscript{1} Banos et al. (2013)
\textsuperscript{2} Denholm et al. (subm)
Mid infrared (MIR) spectroscopy of milk samples

- Uses infrared light for detection of different substances
- Different molecules absorb different frequencies
- Variety of phenotypes successfully predicted
- Internationally used method
- Routinely (and quickly) measure the composition of milk

Figure 2. Published papers (retrieved from ISI Web of Science; http://thomsonreuters.com/web-of-science/) on mid-infrared spectroscopy (MIRS) and milk. For 2013, papers published up to October are reported.
Cellular IA trait sampling

- 357 Holstein-Friesian dairy cows

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<tbody>
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<td>Byproducts</td>
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Flow cytometry

2013 - 2015
12 bi-monthly Sampling periods
Routine milk sampling

2013 - 2015

Spectral data pre-treated

immune – MIR data aligned
Predict traits using spectrum of 1,060 wavelengths via PLS:

\[ y = Xb + e \]
Calibration & validation

Spectral data

Validation dataset

25%

Calibration dataset

75%

REMOVE phenotype

4-way cross validation

Predicted phenotypes

Milk yield + DIM data

Actual phenotype

Milk yield + DIM data

Actual phenotype

Milk yield + DIM data

Actual phenotype

Milk yield + DIM data

Actual phenotype

* image source: www.transferready.co.uk
Prediction and accuracy

Prediction accuracy determined via square root of the coefficient of determination, $\sqrt{R^2}$
Prediction accuracy

- Eosinophils
- Neutrophils
- PBMC
- Monocytes
- NKp46+
- Lymphocytes
- CD4+
- CD8+
Methods for increasing accuracy

- For example:
  - Data thinning (e.g., Grelet et al., 2016)
  - Reference data transformation
  - Definition of outliers based on residuals
Conclusions

• Predicting cellular IA traits from MIRS promising

• Further research required to:
  - improve prediction accuracy
  - extend to serological IA traits
  - highlight practicality of MIR-predicted IA traits to dairy industry
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