Use of MIR to predict milk fat composition

An across breed and country validation

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The farmers
Milk quality

- Milk quality related to human health
  - Fat
  - Protein
  - Minerals

- Fat → milk contains a wide range of different saturated and unsaturated fatty acids (FA)
  - Favorable FA (like Conjugated Linoleic acid (CLA) and Omega 3)
  - Unfavorable FA (like Myristic acid and Palmitic acid)
Methods to measure

- Gas Chromatography (GC)
  - Expensive 😞
  - Time consuming 😞
  - Accurate 😊

- Mid-Infrared spectrometry (MIR)
  - Cheap 😊
  - Fast 😊
  - Less accurate ..
MIR

- Measure absorption of different infrared frequencies
- Infrared range 900 cm\(^{-1}\) to 5,000 cm\(^{-1}\); 1,060 data points
- Calibration equations to predict FA composition
  - GC as golden standard
Aim

- Validation of calibration equations to predict detailed fatty acid composition using MIR-spectra

→ Across breed and country
Calibration equations

- Developed in the EU FP 7 project RobustMilk

- Calibration data set contained 1236 milk samples
  - from herds in Ireland, Scotland, and the Walloon Region of Belgium
  - with purebred and crossbred cows from different breeds like Holstein Friesian, Jersey, Red and White, and dual purpose Belgium Blue.

- Calibration data samples were selected based on maximizing variability of MIR spectra
Validation data set

- 190 milk samples from 12 herds in the Netherlands

- Cows from different breeds:
  - 47 samples from Dutch Friesians (DF)
  - 52 samples from Meuse-Rhine-Yssel (MRY)
  - 45 samples from Groningen White Headed (G)
  - 46 samples from Jersey (JER)

- Each milk sample was analyzed using both MIR and GC
Results: $R^2$ of prediction – individual FA

<table>
<thead>
<tr>
<th>Trait</th>
<th>G</th>
<th>MRY</th>
<th>DF</th>
<th>JER</th>
</tr>
</thead>
<tbody>
<tr>
<td>C14:0</td>
<td>0.93</td>
<td>0.97</td>
<td>0.93</td>
<td>0.92</td>
</tr>
<tr>
<td>C16:0</td>
<td>0.86</td>
<td>0.90</td>
<td>0.93</td>
<td>0.86</td>
</tr>
<tr>
<td>C18:0</td>
<td>0.80</td>
<td>0.64</td>
<td>0.65</td>
<td>0.58</td>
</tr>
<tr>
<td>C18:2 cis 9,12 (omega 6)</td>
<td>0.17</td>
<td>0.63</td>
<td>0.26</td>
<td>0.32</td>
</tr>
<tr>
<td>C18:3 cis 9,12,15 (omega 3)</td>
<td>0.29</td>
<td>0.10</td>
<td>0.02</td>
<td>0.10</td>
</tr>
<tr>
<td>C18:2 cis9 trans11</td>
<td>0.36</td>
<td>0.30</td>
<td>0.49</td>
<td>0.00</td>
</tr>
</tbody>
</table>

1G = Groningen White Headed, DF = Dutch Friesian, MRY = Meuse-Rhine-Yssel, JER = Jersey, and HF = Holstein Friesian.

2Breeds total is $R^2$ across all predictions for G, DF, MRY, and JER.
## Results: R² of prediction – groups of FA

<table>
<thead>
<tr>
<th>Trait</th>
<th>Breed¹</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>G</td>
</tr>
<tr>
<td>Saturated FA</td>
<td>0.99</td>
</tr>
<tr>
<td>Mono unsaturated FA</td>
<td>0.94</td>
</tr>
<tr>
<td>Unsaturated FA</td>
<td>0.97</td>
</tr>
<tr>
<td>Short chain FA</td>
<td>0.91</td>
</tr>
<tr>
<td>Medium chain FA</td>
<td>0.91</td>
</tr>
<tr>
<td>Long chain FA</td>
<td>0.94</td>
</tr>
<tr>
<td>C18:1 cis (total)</td>
<td>0.97</td>
</tr>
</tbody>
</table>

¹G = Groningen White Headed, DF = Dutch Friesian, MRY = Meuse-Rhine-Yssel, JER = Jersey, and HF = Holstein Friesian.

²Breeds total is R² across all predictions for G, DF, MRY, and JER.
Results: $R^2$ vs. concentration g/dL milk
Conclusions

- RobustMilk calibration equations accurately predict FA content for G, DF, MRY, and JER cows in the Netherlands
  - Groups of FA and FA with higher content in milk are generally predicted with high accuracy
  - Predictions were highly accurate ($R^2 > 0.80$) over all breeds for:
    - C4:0, C6:0, C8:0, C10:0, C12:0, C14:0, C16:0, C18:1cis9
    - groups of FA
Thank you for your attention!

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