New tools for a more sustainable dairy sector

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Predicting the risk of ketosis using mid infrared spectrometry

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Ketosis: a metabolic disease of high productive dairy cows

Ketosis = trouble of energy metabolism of dairy cows in high negative energy balance in early lactation

- 2 ketosis types signalled by different biomarkers:
  - Hypoglycemic ketosis → high beta-hydroxybutyrate content in blood
  - Hyperglycemic ketosis → high non esterified fatty acids content in blood

- High prevalence but few clinical symptoms

- Consequences on animal welfare and farms competitiveness but difficult to diagnose
Ketosis modifies milk composition
• Increase in Fat:Protein ratio
• Expression of biomarkers in milk

Mid infrared spectrum reflects milk composition
• Each molecular bond absorbs the light at specific wavelengths

Is MIR spectroscopy a reliable method to predict ketosis risk situations?
Material & Methods

Milk samples (large variability)

DATA COLLECTION

DATA PREPARATION

DATA PROCESSING

MI R spectra

Standardization

Cf. Grelet et al

Milk samples (large variability)

Reference analysis for the trait

Classification

Mathematic models

Sensitivity / Specificity / Accuracy

Session 1
Wednesday 10th June
Data collection in 4 French and German experimental farms

Les Trinottières

Marcenat

Poisy

Hofgut Neumühle

Session 1
Wednesday 10th June
1,124 collected phenotypes on 214 cows

Data collected during each test-day:

LDHVet. Nantes (FRA):
Blood BHB & NEFA

Milk Recording Organizations:
Milk fat and protein contents + Spectra

Experimental farm:
- Weight
- BCS
- Diet

BHB: beta hydroxybutyrate - NEFA: non esterified fatty acids
Classifying the reference ketosis status of the cows

No correlation between biomarkers

Combination of biomarkers into a classification

Classification | Distribution
--- | ---
Low Risk of Ketosis | 71 %
High risk of Ketosis | 29 %
Risk of type I Ketosis | 18.7 %
Risk of type II Ketosis | 5.1 %
Suspected ketosis | 5.2 %

Correlation = 0.1

BHB: beta hydroxybutyrate - NEFA: non-esterified fatty acids

Session 1
Wednesday 10th June

Session 1
Wednesday 10th June
Prediction of the level of ketosis risk

Reference ketosis status
High risk / Low risk

Logistic PLS regression

Results on external validation dataset
Sensitivity = 81 %
Specificity = 69 %
PPV = 48% / NPV = 91%

<table>
<thead>
<tr>
<th>Observation</th>
<th>Prediction</th>
<th>Negative</th>
<th>Positive</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low risk</td>
<td></td>
<td>188</td>
<td>83</td>
</tr>
<tr>
<td>High risk</td>
<td></td>
<td>18</td>
<td>78</td>
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</tbody>
</table>

VPP: Positive Predictive Value - NPV: Negative Predictive Value
Prediction of the type of ketosis high risk

Reference ketosis status

Risk due to BHB / Risk due to NEFA / Ketosis

canonical powered PLS regression & DA

Results on external validation dataset:
Accuracy = 85%

<table>
<thead>
<tr>
<th>Observation</th>
<th>Prediction</th>
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</thead>
<tbody>
<tr>
<td>Risk due to BHB</td>
<td>65</td>
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<tr>
<td>Risk due to NEFA</td>
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<tr>
<td>Ketosis</td>
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BHB: beta hydroxybutyrate - NEFA: non esterified fatty acids
Conclusion

MIR spectrum gives the possibility of giving an alarm on the level of risk and the type of risk

- Information on animals
  - To treat (« ketosis »)
  - To monitor (« high risk »)

- Information on practices to change (energy density in early lactation and/or managing the dry period...)

Prospects for improvement:
- Increase in the volume of records
- Better balance of the calibration dataset
Thank you for your attention!