T.S.6 - Milk recording: a tool to improve dairy production.

Phenotyping new traits by mid infrared spectrometry: a way to improve milk quality and dairy cows’ management

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MIR spectra: a useful material

1. Milk sampling
2. MIR Spectrum extraction
3. Reference measurement
4. Mathematic model
5. Validation of the model
6. Use in routine

MIR: mid infrared
The French Livestock Institute is involved in several R&D projects using MIR spectra.
An efficient method to estimate milk composition

![Diagram showing milk composition estimation method]

**Possible use**

- Routine, any application
- Analytic use, quantitative information
- Screening, high or low levels
- Not recommended

**Relative $S_{y,x}$ (%)**

- $\alpha_{s1}$-cn
- $\alpha_{s2}$-cn
- $\kappa$-cn
- $\beta$-cn
- Calcium
- MUFA
- SFA
- C14:0
- C16:0
- C18:1c9
- Total cn
- PUFA
- C18:0
- C18:1/C16
- $\Sigma$C13-C17
- $\Sigma$C4+C6+C8+C10+C12/C5+C7+C9+C13
- $\omega_6$
- $\omega_3$
- FAVACAL
- AcID
- idele.fr

**R²**

0.5 0.6 0.7 0.8 0.9 1
From milk components to milk quality

**Nutritional quality**
- **Fatty acids:** neurological system, adiposity...
- **Proteins:** lysine, tryptophan and sulfur amino acid-rich proteins
- **Calcium:** constitution of the bones and teeth

**Technological quality**
- **C18:1/C16:0:** butter spreadability
- **Caseins:** curdling and cheese yield
- **Calcium:** linkage of the casein micelle

Dairy products composition reflects the composition of the initial milk.
Milk components as biomarkers of nutrition and physiology related traits

Health  Welfare  Expression of the potential
without metabolic troubles

SUBACUTE RUMINAL ACIDOSIS

15 – 30 % of the cows
Maybe more?

Milk Yield
Milk quality
Health

$\text{AcID project}$

ruminal $\frac{C_2}{C_3}$
milk $C_4+C_6+C_8+C_{10}+C_{12}$
$C_5+C_7+C_9+C_{13}$

➢ An interesting indicator to combine with Fat:Protein ratio for acidosis surveillance
Milk components as biomarkers of nutrition and physiology related traits

Health  Welfare  Expression of the potential
without metabolic troubles, with few impact on the environment

Better estimation

Feeding costs  Environmental impact

-  -

Prediction of nitrogen emissions?

MIR: mid infrared

Nutrition of the herd

MIR-estimated UREA

UREA project

N

Feeding costs

Environmental impact

Better estimation
Phenotyping qualitative traits

R²
Sy,x
MILK COMPONENT
MILK COMPONENT
MILK COMPONENT
QUALITATIVE TRAIT
Cumulative error
Limited information
Phenotyping qualitative traits by using the whole spectrum

The spectrum reflects the whole milk composition.
- More information is taken into account
- Less cumulative error

Adapted mathematic methods

QUALITATIVE TRAIT

Sensitivity  
Specificity

PPV / NPV

Accuracy

PPV: positive predictive value ~ NPV: negative predictive value
A good way to predict ketosis risk?

**KETOSIS**

- Loss of milk yield
- Change in milk composition

- Metabolic disorders
- Udder problems
- Culling rate

**Early Lactation**

**Type I**
- Blood BHB

**Type II**
- Blood NEFA

**Milk ketone bodies**
- LCFA
  - C18:1c9

- Fat:Protein ratio
- Citrate

*BHB: beta hydroxybutyrate ~ NEFA: non esterified fatty acids ~ SCFA: short chain fatty acids*
A good way to predict ketosis risk

Milk sampling → MIR Spectrum extraction → Logistic PLS regression → BHB and NEFA in blood

Cross-validation (n=566)

Sensitivity = 84.5 %
Specificity = 84.2 %

<table>
<thead>
<tr>
<th>Prediction</th>
<th>Low risk</th>
<th>High risk</th>
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<tr>
<td>Observation</td>
<td>Low risk</td>
<td>234</td>
</tr>
<tr>
<td></td>
<td>High risk</td>
<td>43</td>
</tr>
</tbody>
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BHB: beta hydroxybutyrate ~ NEFA: non esterified fatty acids
MIR spectrum: a tool to predict cheese making properties of milk?

- Is protein content a good predictor of cheese making ability of milk? 
  Not always

- Caseins? Calcium? 
  Not only

Coagulation → Acidification → Cheese yields...

Milk records & payment: FC, PC, lactose...

Reference analysis: proteins, minerals, cheesemaking abilities

Cheesemaking ability profile

PC: protein content ~ FC: fat content ~ MIR: mid infrared
Take home messages

- easy-to-get and low-cost material
- very promising to phenotype novel traits
- with many applications

- to meet farmers, dairy processors and consumers demand
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