GLOBAL EXPERIENCE ON KETOSIS SCREENING BY FTIR TECHNOLOGY

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Ketosis is a frequently occurring metabolic disease

- Mainly occurring in the early lactation – severe negative energy balance (NEB)
- Mobilisation of body fat to compensate NEB → ketone bodies (i.e. acetone (Ac), β-hydroxybutyrate (BHB)) originate and accumulate
- Major impact on future production, reproduction and overall health of the cow (e.g., Opsina et al., 2010; Duffield et al., 2009)
- Cost per case of ketosis: 265€ (Mc Art et al., 2015)

Diagnosis of subclinical ketosis:

- No visible symptoms – need for measurement of ketone bodies in blood, milk, or urine (Andersson, 1988)
- On-farm solutions: electronic hand-held blood BHB meters; high accuracy but labour-intensive (Iwersen et al., 2009)
Dedicated Analytical Solutions

SCREENING FOR SUBCLINICAL KETOSIS ON DHI SAMPLES

1999
- Fourier Transformed InfraRed (FTIR): Fast and inexpensive method for ketosis screening by predicting milk Ac (Hansen, 1999)

2006
- Joint project of CRV, FOSS and Qlip; development of milk Ac and BHB predictions; appropriate for herd level screening (de Roos et al., 2007)

Ketosis screening service on DHI samples:

2011
- Qlip, CRV and MCC Flanders, the Netherlands and Belgium;
- Valacta, Canada

2012
- CLASEL, France

2013
- Polish Breeders Association, Poland;
- Eurofins and Danish Cattle Federation, Denmark;
- Tokachi DHI, Japan

2014
- CanWest DHI, Canada

2015
- AgSource, US

Under evaluation
- DairyOne, US;
- ARAL, Italy;
- CIS, England;
- LIGAL, Spain

Milk Ac and BHB values:
- sensitivity (69 and 87%)
- specificity of 95%

(de Roos et al., 2007; Denis-Robichaud et al., 2014)
Instrument: Milkoscan FT+ (FTIR) with FOSS calibration for Ac and BHB

Establishment of method:
• 2,000 milk samples, analysis by a segmented flow analyser and FTIR to build Ac and BHB calibration
• Further validation based on a set of 1,500 samples
• Data processing by FOSS

Maintenance of method:
• Monthly analysis of 100 random samples (pilot milk) by reference method (Skalar)
• Valacta and CLASEL: Validation of FTIR predictions
• Qlip: no slope adjustment, no bias setting (original basic calibration established in 2006)
DHI LABORATORY: CLASSIFICATION AND APPLICATION OF RESULTS

Combination of Ac and BHB values with:
- fat:protein ratio
- parity
- month of milk recording

→ binary (yes/no) score for ketosis for cows with DIM <60 only
Overview on the proportion of samples, farms and cows under ketosis screening from January 1, 2012 to December 31, 2014.

<table>
<thead>
<tr>
<th>Laboratory</th>
<th>Total number of DHI samples analysed</th>
<th>Proportion of samples with milk BHB analysis (%)</th>
<th>Proportion of farms using ketosis screening (%)</th>
<th>Proportion of cows under ketosis screening (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Valacta</td>
<td>7,600,000</td>
<td>54</td>
<td>71&lt;sup&gt;1&lt;/sup&gt;</td>
<td>54</td>
</tr>
<tr>
<td>CLASEL</td>
<td>9,600,000</td>
<td>100&lt;sup&gt;2&lt;/sup&gt;</td>
<td>48</td>
<td>51</td>
</tr>
<tr>
<td>Qlip</td>
<td>35,000,000</td>
<td>100&lt;sup&gt;3&lt;/sup&gt;</td>
<td>85</td>
<td>90</td>
</tr>
</tbody>
</table>

<sup>1</sup> Proportion of farms that used the service for at least one test-day

<sup>2</sup> Ac and BHB values were predicted for all samples, but reported back to farms enrolled for CetoDetect® only

<sup>3</sup> All milk recording samples; however, just reported back for cows with days in milk<60
Prevalence of ketosis (low, medium, high risk) in Canada (Valacta), France (CLASEL) and Belgium (region Flanders) and the Netherlands (Qlip) in 2012 and 2014, respectively. Data for Belgium and the Netherlands are expressed as ketosis yes (high risk) or no (low risk).
REAL LIFE EXAMPLE – KETOSIS MANAGEMENT

Overview 1:
BHB values in cows with less than 90 days in milk

*Type I* (Fresh cow; Production > Dry matter intake, NEB)

**Type II** (Starts before calving; “fat cow syndrome”; insulin resistance)

Advisor’s suggestion: “Focus first on dry cow (far-off) rations as they obviously bring too much energy.”

Herd Results April 2013
REAL LIFE EXAMPLE – KETOSIS MANAGEMENT

Herd Results December 2013 (8 month later)

Overview 2:
BHB values at first test day over time

Proportion of cows with high BHB decreased from 40% to less than 10%
KETOSIS IMPACTS PROFITABILITY

Simulation for a herd with 50 cows

1) Economical losses

a) Milk loss
   300 l/lactation; ketosis prevalence: 15%; 2.250 l/lactation and herd; 0.33 €/l
   € 750

b) Losses due to associated diseases
   2 mastitis cases (150 € per case)
   3 metritis cases (50 € per case)
   Lameness, displaced abomasum, other
   € 300
   Total losses € 1,500

2) Costs for ketosis screening

a) 3 € per cow and year
   € 150

b) Interventions (e.g., treatment, optimised feeding ration)
   € ?
   Total costs € 150

3) Assumption: Improved animal health management due to ketosis screening

a) Reduction of milk loss by 50%
   € 375

b) Prevention of 50% of the associated diseases
   € 375
   Total gain € 600

Return on investment: 4
Experience from 3 years of ketosis screening in Canada, France, Belgium and the Netherlands using FTIR technology on regular DHI milk samples:

- Simple, practical and at low cost for milk producer
- Elevates awareness of an otherwise undetected problem
- With monthly testing, not all cows are tested in the period most at risk

Ketosis screening offers high value to milk recording clients → can help reduce the incidence of the problem

Development of recommendations for generation, application and interpretation of results

For further information, please do not hesitate to contact: das@foss.dk
REFERENCES


APPENDIX: KETOSIS IMPACTS PRODUCTION

Impacts on Test Day Milk Yield and Components

<table>
<thead>
<tr>
<th>Ketosis risk group</th>
<th>low</th>
<th>med</th>
<th>high</th>
<th>SE</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milk yield (kg/d)</td>
<td>32.5&lt;sup&gt;b&lt;/sup&gt;</td>
<td>32.3&lt;sup&gt;b&lt;/sup&gt;</td>
<td>30.1&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.2</td>
<td>0.001</td>
</tr>
<tr>
<td>Fat (%)</td>
<td>4.10&lt;sup&gt;a&lt;/sup&gt;</td>
<td>4.62&lt;sup&gt;b&lt;/sup&gt;</td>
<td>5.07&lt;sup&gt;c&lt;/sup&gt;</td>
<td>0.02</td>
<td>0.001</td>
</tr>
<tr>
<td>Protein(%)</td>
<td>3.25&lt;sup&gt;c&lt;/sup&gt;</td>
<td>3.17&lt;sup&gt;a&lt;/sup&gt;</td>
<td>3.19&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.01</td>
<td>0.001</td>
</tr>
<tr>
<td>Fat:protein ratio</td>
<td>0.82&lt;sup&gt;c&lt;/sup&gt;</td>
<td>0.71&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.65&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.01</td>
<td>0.001</td>
</tr>
</tbody>
</table>
**APPENDIX: ASSOCIATION WITH OTHER DISEASES**

**SCC (mastitis) depending on risk of ketosis**

- Low: 0-100 k cells/ml
- Medium: 100-200 k cells/ml
- High: >200 k cells/ml

**Frequency of clinical ketosis and displaced abomasum depending on the risk of ketosis**

- Negative
- Suspect
- Positive

Koeck *et al.*, 2014
APPENDIX: KETOSIS IMPACTS REPRODUCTION

Days Open

Ketosis risk group

- low
- medium
- high

Days

<table>
<thead>
<tr>
<th>a</th>
<th>130.7</th>
</tr>
</thead>
<tbody>
<tr>
<td>b</td>
<td>146.6</td>
</tr>
<tr>
<td>b</td>
<td>154</td>
</tr>
</tbody>
</table>

a, b: bars with different letters differ significantly at a level of P < 0.001
Overview 1: BHB values in cows with less than 90 days in milk

- High risk
- Medium risk
- Low risk

Days in milk

→ Information about type of ketosis present (i.e. type I vs. II)

Overview 2: BHB values at first test day over time

→ Tendency of ketosis within herd
Experience from 3 years of ketosis screening in Canada, France, Belgium and the Netherlands using FTIR technology on regular DHI milk samples:

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