Ketosis in dairy cows -
prevalence, significance and treatment options

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Introduction

Subclinical and subclinical ketosis are commonly believed to be the central factor for dairy cow health and production. Historically Ketosis was classified as being either “primary” or “secondary”, the latter being a consequence of preceding disease (Gordon et al. 2013). Today, ketosis is mainly understood as being a consequence from an excessive and ill-regulated Negative Energy Balance after calving. Ketosis is differentiated into a clinical and a subclinical form, the latter today attracting most research and generally believed to be the economic most relevant as being the “tip of the iceberg”.

For diagnostic purposes, today generally ß-hydroxybutyrate (BHB) is used as a marker, for the use of nonesterified fatty acids, which would in diagnostic terms be even more significant, is largely limited to laboratory testing. BHB can easily be tested by a variety of devices in blood, milk and urine.

Definition & Diagnosis

The diagnosis of clinical ketosis is based on the presence of risk factors (early lactation), changes in behaviour, mostly reduced milk production, an erratic feeding pattern and decreased activity. The picture is being described as “a gradual loss of appetite and milk production over several days” (Smith 2002). As the clinical signs are determining the diagnosis, there is little information on what blood parameters are to be expected. Generally, an animal in clinical ketosis may be expected to show blood values of more than 3 mmol/l (Oetzel 2007). In milk, animals with clinical ketosis may exhibit a BHB concentration of more than 0.8 mmol/l (Smith 2002).

While the clinical form is associated with various signs, the definition of subclinical ketosis is somewhat arbitrary. Most definitions use the level of ß-hydroxybutyrate in blood, the threshold set between 1,0 mmol/l and 1,4mmol/l. A range of between 1.2 and 2.9 mmol/l is occasionally used to explicitly mark subclinical ketosis (McArt et al. 2012). The study of Suthar et al. (2013) uses various cut-off points of 1.0 to 1.7 mmol/l, respectively. In milk, a quantity of 0.1 mmol/l BHB is believed to be indicative of SCK (Roos et al. 2007; Berge und Vertenten 2014). In a large study covering several hundred Canadian dairy herds, a cut-off value of 0.15 mmol/l BHB was used (Tatone et al. 2017).

Occurrence of Ketosis

It is appears questionable to differentiate the forms of ketosis, instead, ketosis should be assessed by measured parameters instead of relying on the recognition of clinical signs. (Oetzel 2007).

The prevalences reported in literature are deriving from field studies, using both milk and serum values.

- Using 1.2 mmol/l in blood: Prevalences in different European countries ranging from 11.2% to 36.6%, in average 21.8% (Suthar et al. 2013)
- Using 0.15 mmol/l in milk: Prevalence in Ontario of 21% with herd prevalence of 11%
- 31%. Seasonality with lowest prevalences July – November. Higher prevalences in farms with AMS (Tatone et al. 2017)
- Using 0.1 mmol/l in milk: Prevalence in day 7 – 21 pp being 43% in Germany, 53% in France, 31% in Italy, 46% in the Netherlands, and 31% in the United Kingdom. 85% of farms assessed having more than 25% of fresh cows with subclinical ketosis. Clinical ketosis seldom reported, highest incidence of clinical

ketosis was 23%. larger herd size negatively correlated with ketosis, positive correlation with part-TMR (AMS?). Lower incidence from April to June. (Berge und Vertenten 2014).

- Using 1.2 mmol/l to 2.9 mmol/l in blood: 43% of 1717 cows with at least one measurement above the threshold within 16 DIM (McArt et al. 2012).

Significance

A whole body of literature describes the role of ketosis as initial for further disease. An example will be given (Raboisson et al. 2014):

The relative risk or OR (95% confidence interval) for cases of subclinical ketosis based on a cut off value of 1.4 mmol/l were:

- abomasal displacement 3.33 (2.60-4.25),
- clinical ketosis 5.38 (3.27-8.83),
- early culling and death 1.92 (1.60-2.30),
- metritis 1.75 (1.54-2.01),
- placental retention 1.52 (1.20-1.93),
- clinical mastitis 1.61 (1.24-2.09),
- lameness 2.01(1.64-2.44)
- doubling of the SCC 1.42 (1.26-1.60)

The direct mean ± standard deviation of the 305-d milk losses associated with SCK were 251 ± 73 kg after adjusting for abomasal displacement, clinical ketosis, metritis, and placental retention.

In a model trying to calculate the cost of subclinical ketosis (defined at values above 1.2 mmol/l) it was estimated that one case including its consequences would be at $134 for animals in first lactation, $111 for multiparous animals, mainly due to losses in reproduction, culling in milk (McArt et al. 2015).

Treatment

Using a cut-off value of 1.2 mmol/l, a study estimated whether a standard treatment with 300 ml of propylene glycol was economically advantageous (Ospina et al. 2013). The model used a group of 100 fresh cows as standard and used different prevalences. See picture for detailed results. Even for a low prevalence of 15%, identified by means of a cow-side BHB-test, a standard treatment of all animals with propylene glycol would be advantageous in 90% of scenarios. Once the tested prevalence reaches 25%, the standard treatment would be advantageous in almost every cases, the returns per 100 animals being around $1000.

Table 8
Stochastic simulation results for testing all cows 3 to 9 DIM 2 times per week and treating those cows with BHS ≥ 1.2 mmol/L with 300 mL of propylene glycol orally for 5 days

Sample Prevalence	Estimated Incidence[a]	Percentage of Time that Outcome is Positive (%)	Percentage of Time that Outcome is > $500 per 100 Cows (%)	Mean of Distribution ($)
15	20	90	18	289
20	30	98	59	618
25	35	99	73	780
30	45	99	88	1108
35	50	99.9	92	1271
40	60	99.9	96.2	1598
45	65	99.9	97.4	1765
50	75	100	98.8	2092
60	90	100	99.5	2582

The expected monetary return is per 100 fresh cows at various incidence levels of BHB **≥** 1.2 mmol/L.
[a] Conservative approximation of incidence (1.5 times prevalence): for ease of interpreatationm the number was rounded down to the nearest 5th or 10th.

Summary

- **It is questionable to differentiate between clinical and subclinical ketosis**
- **The cut-off values for ketosis are varying, mostly values of BHB in blood of 1.2 mmol/l and 1.4 mmol/ L are used**
- **Cut-off values for BHB in milk are 0.1 or 0.15 mmol/L**
- **The prevalence is generally to be reported around 20%**
- **There is an influence of season with early month having the highest prevalence, AMS systems having a higher prevalence. Milk production is not necessarily a risk factor**
- **Due to its significance for animal health and strong association with other diseases, a treatment for ketosis is most ikely to be economically beneficial.**

Literature used

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