Cow-Side Milktests for Subclinical Ketosis

T. Geishauser, K. Leslie, T. Duffield, D. Kelton
Department of Population Medicine, Ontario Veterinary College, University of Guelph, Guelph, N1G 2W1, Canada

Abstract

The objective of this article is to report on the evaluation of cow-side ketosis-tests used with milk to detect subclinical ketosis. Our findings indicate that Pink Milk® and Ketolac® BHB are highly sensitive and specific tests for subclinical ketosis when used with milk. Other tests such as Ketocheck™, Utrecht, Bioketone, Ketostix®, Rapignost®, Uriscan™, Ketur®, Medi, and Azetonreagenz were poorly sensitive but highly specific for subclinical ketosis. Hence, Pink Milk® and Ketolac® BHB may be useful to monitor cows for subclinical ketosis on a regular basis.

Cows with subclinical ketosis produced one to four liters milk less daily (Dohoo and Martin 1984, Duffield 1997). The interval from calving to first service was longer, they needed more services to conceive (Wenninger and Distl 1994), and they were at increased risk of developing cystic ovaries (Gustafsson and Emanuelson 1996), clinical ketosis and displaced abomasum (Duffield 1997, Geishauser et al. 1998b). About 90% of the subclinical ketosis cases were diagnosed within the first two months after calving, and the prevalence of ketosis peaked in the second or third week after calving. Between 10% and 30% of fresh cows already had subclinical ketosis in the first week after calving (Dohoo and Martin 1984, Duffield 1997, Francos et al. 1997). However, losses due to subclinical ketosis can be minimized by early detection and treatment of cows affected (Girschewski et al. 1977).

Threshold of Subclinical Ketosis

Various thresholds of ß-hydroxybutyrate (BHB), acetoacetate (AcAc) and acetone (Ac) in blood, milk or urine have been used to define subclinical ketosis (Girschewski et al. 1977, Andersson 1984, Gravert et al. 1986, Dirksen et al. 1997, Duffield 1997, and others). We assume that cows with more than 1400 µmol BHB/l blood suffer from subclinical ketosis. In a previous study cows with more than 1400 µmol BHB/l blood were at significantly higher risk of developing clinical ketosis than cows with less than 1400 µmol. Cows with more than 1600 µmol BHB/l blood produced 1.8 kg less milk daily, those with more than 1800 produced 3 kg less milk, and those with more than 2000 µmol BHB/l produced 4 kg milk less daily (Duffield 1997). To prevent losses from subclinical ketosis it might be useful to detect and treat cows with more than 1400 µmol BHB/l blood. It would be very practical to identify those cows by using milk parameters. In two studies we have evaluated cow-side ketosis-tests in order to find out how useful they are in detecting subclinical ketosis when used with milk. For each test we determined its sensitivity (percentage of positive tests in cows with subclinical ketosis) and its specificity (percentage of negative tests in cows without subclinical ketosis) for subclinical ketosis (>1400 µmol BHB/l blood).

Evaluation of Tests With Milk to Detect Subclinical Ketosis

An ongoing study uses fresh cows in the first week after calving. The prevalence of subclinical ketosis is 10%. Eight tests are being evaluated (Table 1). A very sensitive and specific test for subclinical ketosis is Pink Milk®.[a] Pink Milk is a liquid test that turns milk pink if more than 100 µmol AcAc/l milk are present (Figure 1). Taking all Pink Milk findings that indicate more than 100 µmol AcAc/l milk as a positive test result, the sensitivity of Pink Milk for subclinical ketosis is 75%. That means that 75% of the cows that have subclinical ketosis are detected. Its specificity is 85%. That means that this test seldom (15%) indicated subclinical ketosis where there was no subclincal ketosis. Taking all Pink Milk results that indicate more than 300 µmol AcAc/l as a positive test result, its sensitivity is 63% and its specificity is 98%. Pink Milk findings are not affected by somatic cell count (SCC).

Ketolac® BHB[b] is also a highly sensitive test for subclinical ketosis. Ketolac is a strip that indicates certain ranges of BHB in milk. Taking all Ketolac-findings that indicate more than 50 µmol BHB/l milk as a positive test result, the sensitivity of this test for subclincal ketosis is 88%. The specificity was 57%, when used in this manner. That means that this test often (43%) indicated subclinical ketosis where there was no subclinical ketosis. Taking all Ketolac-findings that indicated more than 100 µmol BHB/l milk as a positive test result, the sensitivity of Ketolac was 79% and its specific-

Table 1. Sensitivity and specificity of eight cow-side tests used with milk for detection of subclinical ketosis (>1400 µmol BHB/l blood). 276 blood and milk samples of 276 cows from 21 herds were used. Cows were in first week of lactation.

Test	Sensitivity (%)	Specificity (%)
Pink Milk		
>=100	75	85
>=300	63	98
Ketolac		
>=50	88	57
>=100	79	75
>=200	50	88
Rapignost	4	100
Uriscan	4	100
Ketostix	0	100
Ketur	0	100
Medi	0	100
Azetonreagenz	0	100

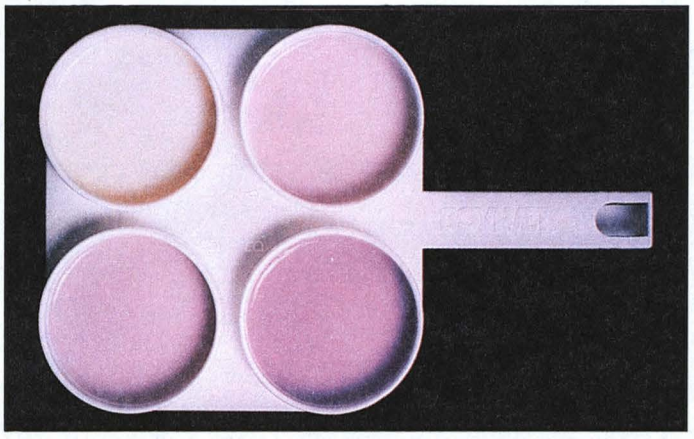

Figure 1. Using the Pink Milk® test in a milk paddle. Top left: normal milk. Top right: weak pink milk (100 µmol AcAc/l milk). Bottom left: pink milk (300 µmol AcAc/l milk. Bottom right: purple milk (500 µmol AcAc/l milk).

ity was 75%. Ketolac findings are affected by SCC. When SCC increased by one million cells per ml milk Ketolac findings increased by 20 µmol BHB/l.

Other tests such as the Rapignost®,[c] Uriscan®,[d] Ketostix®,[e] Ketur®[f] and Medi[g] strips as well as the Azetonreagenz[h] tablet are poorly sensitive for subclinical ketosis. However, they are very specific. That means if they test positive then there is in fact subclinical ketosis. All the latter tests test for AcAc.

Another study was performed on cows within nine weeks after calving (Geishauser et al. 1998a). In the first week after calving 12% of the cows had subclinical ketosis. The prevalence of subclinical ketosis peaked in the second week after calving and declined until the ninth week p.p. (Figure 2). Five tests were evaluted (Table 2). Again Ketolac® BHB was a very sensitive test for subclinical ketosis. Other tests such as the Ketocheck™,[i] Utrecht[j] and Bioketone[k] powders as well as the Ketostix®[l] strip were poorly sensitive. However, they were highly specific. All the latter tests test for AcAc.

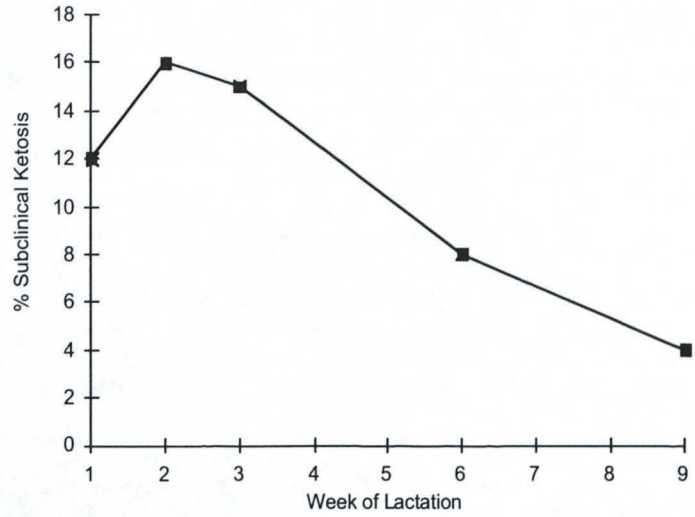

Figure 2. Percent of cows with subclinical ketosis (>1400 µmol BHB/l blood) during the first nine weeks after calving. 1446 blood samples of 609 cows from 25 herds were used (Geishauser et al. 1998a).

Table 2. Sensitivity and specificity of five cow-side tests used with milk for detection of subclinical ketosis (>1400 µmol BHB/l blood). 529 blood and milk samples of 266 cows from 25 herds were used. Cows were in first, second, third, sixth or ninth week of lactation (Geishauser et al. 1998a).

Test	Sensitivity (%)	Specificity (%)
Ketolac		
>=50	97	52
>=100	89	87
>=200	61	96
Ketocheck	39	100
Utrecht	36	94
Bioketone	29	100
Ketostix	7	100

Monitoring Fresh Cows for Subclinical Ketosis

We conclude from our studies that Pink Milk® and Ketolac® may be useful tests to detect cows with sub-

clinical ketosis. Hence, these tests may be used to monitor cows for subclinical ketosis on a regular basis. Most subclinical ketosis cases were diagnosed in the first two months after calving. An episode lasted at least one week (Dohoo and Martin 1984), and on average three weeks (Müller and Schäfer 1979). Thus, to detect subclinical ketosis fresh cows should be examined on a regular basis during the first two months after calving. Examining fresh cows on a weekly basis provides better insight into the ketosis status than examining fresh cows on a monthly basis (Andersson 1988). However, even with testing for subclinical ketosis once in the first week after calving or twice in the second and sixth week after calving disorders of health and production were detected, and treated with economical success (Girschewski et al. 1977, Francos et al. 1997).

References

1. Andersson, L. 1984. Detection, occurrence, causes and effects of hyperketonaemia in Swedish dairy cows. Skara 1984, ISBN 91-576-2082-2.
2. Andersson, L. 1988. Subclinical ketosis in dairy cows. Vet. Clin. N. Amer. Food Anim. Pract. 4:2, 233-251.
3. Dirksen, G., C. Hagert-Theen, M. Alexander-Katz and A. Berger. 1997.Stoffwechselüberwachung bei Kühen in der Hochlaktation anhand von Milchparametern. 2. Azeton-, Azetazetat- und Beta-Hydroxybutyratkonzentration. Tierärztl. Umsch. 52:476-484.
4. Dohoo, J.R., and S.W. Martin. 1984. Subclinical ketosis: prevalence and association with production and disease. Can. J. Comp. Med. 48:1-5 .
5. Duffield, T.F. 1997. Effects of a monensin controlled release capsule on energy metabolism, health, and production in lactating dairy cattle. Guelph/Canada, University, Thesis.
6. Francos, G., G. Insler and G. Dirksen. 1997. Routine testing for milk beta-hydroxybutyrate for the detection of subclinical ketosis in dairy cows. Bov. Practitioner 31.2:61-64.
7. Geishauser, T., K. Leslie, D. Kelton, and T. Duffield. 1998a. Evaluation of five cowside tests for use with milk to detect subclinical ketosis in dairy cows. J. Dairy Sci. 81:438-443.
8. Geishauser, T., K. Lelsie, T. Duffield, D. Sandals and V. Edge. 1998b. The association between selected metabolic parameters and left displaced abomasum in dairy cows. Zbl. Vet. Med. A 45: 499-511.
9. Girschewski, H., J. Voigt and B. Piatkowski. 1977. Untersuchungen über Vorkommen, Erfassung und Behandlung der subklinischen Ketose bei Hochleistungskühen. Mh. Vet.-Med. 32:201-203.
10. Gravert, H.O., R. Langner, L. Diekmann, K. Pabst and H. Schulte-Coerne. 1986. Ketonkörper in Milch als Indikator für die Energiebilanz der Milchkühe. Züchtungskunde 58:309-318.
11. Gustafsson, H., and H. Emanuelson. 1996. Milk acetone concentration as an indicator of hyperketonemia in dairy cows - The critical value revised. Anim. Sci. 63:183-188.
12. Müller, K.H., and M. Schäfer. 1979. Untersuchungen zur Häufigkeit und Dauer der Ketonurie bei Milchkühen. Mh. Vet.-Med. 34:481-484.
13. Wenninger, A., and O. Distl. 1994. Harnstoff- und Azetongehalt in der Milch als Indikatoren für ernährungsbedingte Fruchtbarkeitsstörungen der Milchkuh. Dtsch. Tierärztl. Wschr. 101:152-157.

[a] Thomas, Wittibreut, Germany
[b] Hoechst, Unterschleißheim, Germany
[c] Behringwerke, Marburg, Germany
[d] Yeodong, Seoul, Korea
[e] Bayer, Leverkusen, Germany
[f] Boehringer, Mannheim, Germany
[g] Macherey and Nagel, Düren, Germany
[h] WDT, Garbsen, Germany
[i] Butler, Saint Joseph, Missouri
[j] University of Utrecht, Utrecht, Netherlands
[k] Biopharm, Laval, Quebec
[l] Bayer, Etobicoke, Ontario