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IFAS Extension

Comparing the Urine Ketone Strip Test and the Handheld Ketone Meter to Diagnose Ketosis in Early Lactation Dairy Cows[1]

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Introduction

Ketosis is a common metabolic disease in fresh dairy cows. Clinical and subclinical ketosis (SCK) can cause reduced milk yield, decreased milk protein, reduced reproductive capacity, and increased risk of displaced abomasum. Subclinical ketosis may be present in 30%–50% of early lactation cows in some herds (Divers and Peek 2008). Subclinical ketosis in dairy cattle is defined as an excess level of circulating ketone bodies in the absence of the clinical signs of ketosis (Andersson 1988).

Ketosis occurs in early lactation because of the drop in blood glucose levels, which leads to a high degree of fatty acids mobilization in the form of nonesterified fatty acids (NEFA). The NEFA are then oxidized by the liver, leading to ketone body production, namely acetone, acetoacetate and ß-Hydroxybutyrate (BHBA). Treatment for clinical ketosis or SCK is aimed at restoring glucose levels by administration of glucose i.v., glucocorticoids i.v., and propylene glycol orally or combinations.

Usually, diagnosing ketosis is performed by measuring acetoacetate or BHBA levels in the blood, urine, or milk samples. The threshold for BHBA levels in the blood or urine samples to classify cows as having SCK ranges from $\geq$ 1.0 mmol/L (Ospina et al. 2010) to $\geq$ 1.4 mmol/L (Duffield et al. 2009), with most using $\geq$ 1.2 mmol/L (McArt et al. 2011; Oetzel 2004). Cows are classified as having clinical ketosis if BHBA concentration is $\geq$ 3.0 mmol/L (McArt et al. 2011; Oetzel 2004). Converting the BHBA measurement from mmol/L to mg/dL is done by multiplying the measurement in mmol/L by 10 (10.4 to be precise; American Medical Association 2004).

Measuring BHBA in serum or plasma is considered the gold standard diagnostic test for subclinical ketosis, because this method has stability (Duffield 2000; Herdt 2000). However, Iwersen et al. (2009) demonstrated that diagnosis performed by an electronic BHBA measuring system (Precision Xtra®, Abbott Diabetes Care, Abingdon, UK) using blood samples showed higher sensibility and specificity; on the other hand, the results with milk and urine samples were considerably lower. Other studies (Burke, Leslie, and Neuder 2008; Oetzel and McGuirk 2008) showed similar results about the accuracy of Precision Xtra®. The price for Ketostix® is approximately $0.08/strip while the price for the Precision Xtra® is approximately $1.00.

Materials and Methods

To compare the urine ketone strip test and the handheld ketone meter to diagnose ketosis, we used a total of 72 Holstein cows between 14–40 days in milk from three dairy farms in north-central Florida with 450–800 lactating dairy cows. Cows were housed in free stall barns, and were milked and fed two to three times per day. Rations were formulated to meet or exceed the National Research Council (2001) nutrient requirements for lactating Holstein cows weighing 680 kg and producing 45 kg of 3.5% fat-corrected milk.

Diagnostic Test

The ketone strips (Ketostix®, Bayern Corporation, Elkhart, IN) are a dipstick containing the salt nitroprusside, which becomes pink in the presence of acetoacetate (AcAc), thus estimating the amount of AcAc in mg/dL. The color intensity varies with the amount of AcAc in urine. Tests were performed as described by the manufacturer on spontaneous urination or urination induced by manual stimulation of escutcheon (area below the vulva). The Ketostix® diagnostic test can be read in five categories: 1) negative (0 mg/dL), 2) trace (5 mg/dL), 3) small (15 mg/dL), 4) moderate (40 mg/dL), and 5) large (greater than 80 mg/dL of AcAc) presence of ketone bodies.

Precision Xtra® (Abbott Diabetes Care, Abingdon, UK), an electronic BHBA measuring system validated for use in cattle (Iwersen et al. 2009), was used according to the manufacturer's label directions using the disposable strip. After 10 sec, the concentration of BHBA is displayed on the meter in mmol/L. Blood was drawn from the coccygeal vein and/or artery with needles and a drop was placed on the strip.

Results

Of the cows tested, the following percentages had at least SCK for the negative (9%), trace (90%), small (100%), moderate (100%), and large (100%) categories for the Ketostix® (Table 1). Interestingly, there was no difference in mean BHBA concentration between trace and small categories of Ketostix®. The small category was actually slightly lower than trace. The linear regression analysis (Figure 1) showed good correlation between Ketostix® and Precision Xtra®, although there is considerable BHBA variation within each Ketostix® category.

Applying These Results in the Field

The key finding for this experiment is that no difference exists in BHBA concentration between cows that had a trace or small in the Ketostix® reading. Several dairies only treat cows that have a small reading; therefore, there is a missed opportunity for catching and treating cows with a trace reading sooner. Our findings indicate to treat any cow with a trace reading.

Fitted Line Plot
Precision Xtra, mmol/L = 0.8310 + 0.02919 Ketostix, mg/dL

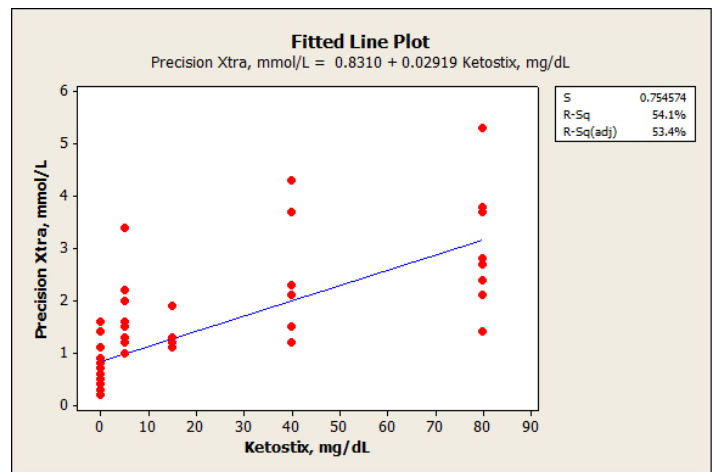| S | 0.754574 |
| R-Sq | 54.1% |
| R-Sq(adj) | 53.4% |

Figure 1. Linear regression analysis of BHBA concentration measured using the Precision Xtra® device by category of AcAc measured using Ketostix®.

Table 1. Prevalence of subclinical (SCK) and clinical ketosis (CK) as measured using the Precision Xtra® device according to Ketostix® category.

KetoStix®	N[a]	SCK[b], N (%)	CK[c], N (%)	Overall, N (%)	Precision Xtra® Results (mmol/L)	
					Mean (SE)	Range
Negative	43	4 (9%)	0 (0%)	4 (9%)	0.6 (0.05)	0.2-1.6
Trace	10	8 (80%)	1 (10%)	9 (90%)	1.8 (0.22)	1.0-3.4
Small	5	5 (100%)	0 (0%)	5 (100%)	1.5 (0.17)	1.1-1.9
Moderate	6	4 (67%)	2 (33%)	6 (100%)	2.5 (0.50)	1.2-4.3
Large	10	6 (60%)	4 (40%)	10 (100%)	2.9 (0.39)	1.4-5.3

[a]N = number of cows.
[b]The threshold for SCK was blood BHBA ≥1.2 to ≤ 2.9 mmol/L.
[c]The threshold for CK was blood BHBA >2.9 mmol/L.

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