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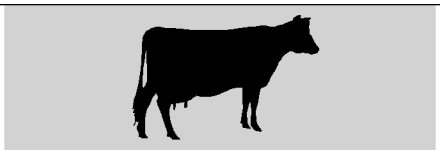

Case Study: Using Urine pH as a Predictor for Ketosis in Transition Dairy Cows[1]

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Abstract

*An experiment was conducted to determine whether urine pH could be used to predict the incidence of ketosis in transition dairy cows. Urine was collected three times weekly from 41 Holstein cows from approximately 21 d prepartum until 21 d postpartum. Concentrations of acetoacetate and the pH of the urine were measured immediately; then, the urine was stored frozen until later analysis for concentrations of β-hydroxybutyrate (**BHBA**). Correlations between urine pH and concentrations of acetoacetate and BHBA were –0.50 and –0.65, respectively. Stepwise regression was used to determine variables that were related to concentrations of ketones in the urine. Urine pH was a significant (P<0.05) predictor for both acetoacetate and BHBA concentrations in urine. Additional predictor variables for acetoacetate concentrations were somatic cell count score (**SCCS**), DMI, milk protein yield, day relative to calving, and calving date. Additional predictor variables for BHBA concentrations were SCCS, DMI, milk protein percentage, milk fat yield, day relative to calving, calving date, and animal identification. Inclusion of the cow-specific variables calving date, day relative to calving, and animal identification as significant predictors is an indication that urine pH is not a good predictor of ketosis status across an entire herd but may be useful for specific cows with a known history.*

(Key Words: Ketosis, Urine, Transition, Dairy Cow.)

Introduction

Ketosis is a metabolic disorder characterized by elevated levels of ketone bodies in the blood. It is caused when the mobilization of fat exceeds the ability of the liver and other cells to metabolize the fat for energy. Ketosis has a great potential to negatively impact productivity of dairy farms. A single incidence has an estimated financial impact from lost milk production and treatment costs of over $150 (Schultz, 1971; Kelton et al., 1998). Early identification and treatment can lower these costs and result in great savings to the dairy producer (Kelton et al., 1998). Numerous tests have been developed to assess the level of ketone bodies in both blood and milk (Duffield et al., 1997; Geishauser et al., 1998; Kelton et al., 1998; Enjalbert et al., 2001). However, if a test could be developed that utilized data already being collected on farms, it would decrease the cost associated with administering and record keeping. Many dairy producers in the US measure the pH of transition cows as a monitoring tool when adjusting the dietary cation-anion balance to decrease the incidence of parturient paresis (NRC, 2001). Ketone bodies are also referred to as keto-acids. One route that is used to remove them from circulation is filtering in urine. Urine has a low buffering capacity; therefore, if keto-acids are being concentrated by the kidney, the pH should drop. A feeding trial was conducted to determine whether this decrease in urine pH could be used as a screening tool for ketosis in transition dairy cows.

Materials and Methods

Forty-one Holstein cows (mean prepartum BW = 669 kg) were used in a feeding trial to determine whether urine pH could be used as a screening tool for ketosis in transition dairy cows. Data for this trial were collected in conjunction with a larger feeding trial designed to evaluate the impact of prepartum dietary energy level and calcium propionate (**CAP**) on transition period milk production and glucose metabolism during the transition

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TABLE 1. Ingredient composition and chemical analysis of the normal prepartum energy, high prepartum energy, and postpartum (lactation) diets. All values are expressed as percentages of DM unless otherwise noted.

Item	Normal energy	High energy	Lactation
Alfalfa hay	—	—	17.07
Bermudagrass hay	49.98	8.16	—
Corn silage	10.00	40.82	29.01
Ground corn	15.02	20.41	10.24
Protein concentrate[a]	25.00	30.61	29.01
Whole cottonseed	—	—	13.65
Sodium bicarbonate	—	—	1.02
DM, %	65.18	43.43	48.35
OM	93.55	92.37	92.73
N	2.21	2.48	2.28
NDF	51.65	40.99	42.10
ADF	25.42	17.97	23.51

[a]Contained 22.16% corn, 56.16% soybean meal, 10.85% dolomitic limestone, 5.42% monocalcium phosphate, and 5.42% trace-mineralized salt.

period (Beem et al., 2003; Stanley et al., 2003). All animal care and handling was completed under protocols approved by the Louisiana State University Agricultural Center Institutional Animal Care and Use Committee.

Cows were trained to use electronic feeding gates (American Calan, Inc., Northwood, NH) starting approximately 28 d prior to anticipated calving date. As-fed intake was measured daily beginning 21 d prior to anticipated calving date. Samples of diets were collected weekly and stored frozen (–20°C) until analyzed for DM, OM, N, NDF, and ADF. Cows received one of two basal diets (Table 1) starting 21 d prepartum. The first diet was formulated to meet the requirements of a mature 748-kg dry Holstein cow consuming 14.51 kg of DM/d (NRC, 2001). The second diet was formulated to provide 145% of the energy requirements for the same cow. One-half of the cows on each prepartum diet were also supplemented with 113.5 g of CAP daily (Nutro CAL™, Kemin Americas, Inc., Des Moines, IA). At parturition, the cows were abruptly switched to a transition diet that was formulated to meet the requirements of a mature 658-kg lactating Holstein cow that was 15 d in milk, was producing 23 kg of 3.5% fat and 3.3% true protein milk, and was consuming 13.52 kg of DM/d (NRC, 2001). Supplemental CAP continued postpartum for cows that received it prepartum.

Milk was sampled beginning on d 3 relative to parturition to avoid sampling colostrums, and production was recorded at each milking. Milk samples were analyzed for content of fat, protein, and somatic cells by the Louisiana Dairy Herd Improvement Laboratory (Baton Rouge).

Samples of urine from each cow were collected 3×/wk during wk –3, –2, –1, 1, 2, and 3 relative to parturition by gentle massage of the perineum. All urine samples were collected between 1400 and 1600 h, and urine pH was recorded. Acetoacetate concentrations were measured using Ketostix® test strips (Bayer Corporation Diagnostics Division, Elkhart, IN) (Magers and Tabb, 1979). Urine samples were then frozen (–20°C) for later laboratory analysis of β-hydroxybutyrate (BHBA; procedure No. 310-UV, Sigma Diagnostics; St. Louis, MO).

All statistical calculations were conducted using SAS (SAS Inst., Inc., Cary, NC). Dummy variables were constructed to correspond to treatment diets as follows: 1 = high energy, no CAP; 2 = high energy, CAP; 3 = normal energy, no CAP; and 4 = normal energy, CAP. Dummy variables were included in all statistical calculations. Correlation analysis was performed to determine which, if any, measured variables were related to urine ketone concentrations. When measured data were in discrete increments, Spearman's rank correlations were calculated. Correlations were declared significant at $P \leq 0.05$. Data were also used in regression analysis to estimate the relationship between urine measures and production variables. Stepwise selection was used to parameterize three linear models. Urine pH, urine acetoacetate concentrations, and urine BHBA concentrations were used as the dependant variables in each of the three models. The default probability of $P<0.15$ was used to determine when variables entered or left the regression models. Chi-square goodness-of-fit analysis was performed to determine whether prepartum treatment affected the incidence of disease or metabolic disorders. Expected values for the incidence of disease or metabolic disorder were assumed to be those of the normal energy, no CAP treatment.

Results and Discussion

There was a high incidence of metabolic disorders observed in this trial (Table 2). However, there was no indication that the incidence of diseases or disorders was affected by the differences in diets fed prepartum. Greater than 50% of the cows exhibited signs of at least one metabolic disorder or disease during the trial. All cases of ke-