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Relationships Between Blood Urea Nitrogen and Energy Balance or Measures of Tissue Mobilization in Holstein Cows During the Periparturient Period

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Abstract

Our objective was to determine if blood urea nitrogen (BUN) is related to calculated energy balance (EB) or a measure of tissue mobilization during the periparturient period. Blood samples were collected from 41 cows with varying postpartum EB and analyzed for BUN and nonesterified fatty acids (NEFA). The cows were fed the same diets throughout the experimental period. Although there was no relationship between BUN and EB or plasma NEFA at 2 wk prepartum and 1 wk postpartum, there was a relationship between BUN and plasma NEFA at wk 2 postpartum, and there was a tendency for BUN to be related with feed efficiency, BW, and postpartum BW loss at wk 2 postpartum. Although NEFA alone predicted only 14% of the BUN variation, feed efficiency, BW, and BUN, collectively, were reliable predictors of tissue mobilization in dairy cows in early lactation (R^2 = 0.65).

Key words: dairy cow, energy balance, blood urea nitrogen, nonesterified fatty acid, body weight change

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Introduction

Recent findings suggest milk urea nitrogen (**MUN**) may be indicative of metabolic status in early lactation dairy cows. Wattiaux and Karg (2004) concluded MUN concentration was negatively correlated with DMI and was greater in cows with a greater milk yield relative to DMI (i.e., greater feed efficiency) at 3 wk of lactation. This observation suggests MUN may be more reflective of energy and protein balance of the cows than the adequacy of dietary inputs in the first weeks of lactation. In a recent statistical analysis of test-day MUN from Dairy Herd Improvement Association records, MUN increased rapidly in the days after calving, peaked at 9 to 14 d, and then leveled off at approximately 21 d in milk (Wattiaux et al., 2005). Level of MUN may be affected by changes in DMI and diet composition. However, the results of Wattiaux and Karg (2004) suggest MUN might also be influenced by energy balance (**EB**). A commonly used diagnostic measure to determine the health status of dairy cows in early lactation is plasma nonesterified fatty acid (**NEFA**) concentrations. A blood sample is taken and analyzed for NEFA concentration, which gives an assessment of the amount of fat a cow is mobilizing at the time of sampling. If there is a relationship between MUN and plasma NEFA, it would allow producers to use a milk sample to determine if cows are in negative EB. This method is noninvasive, and the analysis is less expensive than NEFA analysis.

Assuming that blood urea nitrogen (**BUN**) and MUN are highly correlated in early lactation, as is the case after peak lactation (Broderick and Clayton, 1997), hepatic output of urea would increase after calving. Thus, the objective of this experiment was to determine if BUN is related to EB or a measure of tissue mobilization during the periparturient period. We hypothesized that BUN was related to EB and measures of tissue mobilization because MUN is elevated in the first few weeks of lactation when cows are mobilizing energy reserves and are in a state of negative EB.

Materials and Methods

Forty-one Holstein cows that were utilized by Rastani et al. (2005) were used for this experiment. Cows from 2 treatments: (1) 28-d dry period and (2) no planned dry period, were used because they were fed the same diets throughout the experiment (prepartum diet: NE_L = 1.75 Mcal/kg, CP = 16.8% on a DM basis; postpartum diet: NE_L = 1.71 Mcal/kg, CP = 16.9% on a DM basis). These cows had varying EB due to differences in dry period length (Rastani et al., 2005). Dry matter intake, milk yield, postpartum BW loss, postpartum BCS loss, and calculated EB were determined as described by Rastani et al. (2005). Blood samples were taken at 2 wk prepartum, and 1 wk and 2 wk postpartum in Vacutainer tubes (Becton Dickson, Franklin Lakes, NJ). Samples for NEFA were centrifuged at 915 × *g*, 4°C, for 15 min immediately after sample collection. Samples for BUN were centrifuged at 1,500 × *g*, 20°C, for 30 min, approximately 30 min after sample collection. Plasma and serum samples were decanted and stored at –20°C until later analysis. Plasma was analyzed for NEFA (NEFA-C kit; Wako Chemical USA, Richmond, VA; Johnson and Peters, 1993). Serum was analyzed for BUN using the procedure from Chaney and Marback (1962), with phenol nitroprusside (Sigma-Aldrich #/A1727, St. Louis, MO) and alkaline hypochlorite solution (Sigma-Aldrich #6403) as the color reagents.

Relationships between BUN and measurements, which included EB, DMI, nitrogen intake, milk yield, 4% fat-corrected milk (**FCM**) yield, milk nitrogen, milk yield/DMI, FCM yield/DMI, BW, postpartum BW loss, and plasma NEFA concentration, were determined using the REG procedure of SAS (SAS Institute Inc., Cary, NC). Because NEFA has an on-farm application as a measurement of energy status in the periparturient period, equations for the prediction of NEFA were evaluated with single factors, which included EB, DMI, milk yield, 4% FCM yield, milk yield/DMI, BW, postpartum BW loss, and BUN. Prediction of NEFA with multiple factors was conducted using a stepwise backward elimination procedure (Freund and Littell, 1991) to remove nonsignificant terms from each model. The threshold value to keep a term in the model was $P \leq 0.20$. Initial factors in the model to predict NEFA were BUN, BW, postpartum BW loss, and either milk yield/DMI or milk yield and DMI. A model was also used with only BUN and milk yield as initial factors because these factors are easily obtained in a field situation. We tested for multicollinearity (Freund and Littell, 1991), and variables were not collinear in the final models. Significance was declared at $P \leq 0.05$; trends were discussed at $P < 0.15$.

Results and Discussion

Descriptive statistics for the variables in the data set are presented by week in Table 1. Linear regression equations between BUN and other measurements with significance or tendencies are reported in Table 2. There was a tendency for a weak relationship ($0 < R^2 < 0.2$) between BUN and feed efficiency (milk yield/DMI), BW, postpartum BW loss, and plasma

Table 1. Descriptive statistics for variables in the data set.

	–2 wk[a]				+1 wk				+2 wk			
Item	Mean	SD	Min	Max	Mean	SD	Min	Max	Mean	SD	Min	Max
BUN[b] (mg/dL)	14.1	2.5	10.2	20.0	12.5	2.4	8.0	17.7	12.2	2.8	6.8	22.3
Energy balance (Mcal/d)	13.4	4.5	2.7	29.4	–1.8	7.3	–18.1	14.3	–5.3	7.2	–20.1	6.2
DMI (kg/d)	15.4	2.5	10.5	23.8	14.8	3.4	6.2	20.5	18.0	3.5	9.5	23.7
N[c] Intake (g/d)	162	26	111	251	155	36	65	216	189	37	100	249
Milk yield (kg/d)	NA[d]	NA	NA	NA	19.7	6.1	10.9	33.6	32.0	8.1	15.5	47.6
4% FCM[e] yield (kg/d)	NA	NA	NA	NA	22.3	7.6	10.5	44.0	35.4	9.8	15.1	60.2
Milk N (kg/d)	NA	NA	NA	NA	10.9	3.2	5.4	18.4	17.2	4.1	6.9	24.9
Milk yield/DMI	NA	NA	NA	NA	1.49	0.58	0.63	3.26	1.86	0.45	1.19	3.07
FCM yield/DMI	NA	NA	NA	NA	1.63	0.65	0.57	3.07	2.07	0.59	1.24	3.42
BW (kg)	756	76	600	920	682	78	545	830	675	77	489	818
Postpartum BW loss[f] (kg)	NA	NA	NA	NA	34	33	–14	107	33	32	–14	107
Plasma NEFA[g] (μEq/L)	125	34	72	213	382	268	123	1,504	275	214	70	936

[a]Time expressed as week relative to calving.

[b]BUN = Blood urea nitrogen.

[c]N = Nitrogen.

[d]NA = Not applicable.

[e]FCM = Fat-corrected milk.

[f]Postpartum BW loss = BW at calving - BW postpartum at a given time point.

[g]NEFA = Nonesterified fatty acid.