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Development of models to estimate milk urea nitrogen concentrations*

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ABSTRACT

This study aimed to estimate milk urea nitrogen (MUN) as a function of days in milk (DIM), lactation number (LN) and calving season. In the study, 7.006 observations were used. Milk production (kg), DIM and LN were collected on the milk sampling days. Calving seasons (CS) were divided into summer and winter. A model to describe the lactation curve was used to estimate MUN, adding LN and CS to it and verifying the coincidence among curves. Concentrations of MUN showed similar pattern to the lactation curve and differed among 1st, 2nd, 3rd and 4th-5th lactation, being influenced by CS.

KEY WORDS: bovine, dairy cow, lactation curve, MUN

INTRODUCTION

Urea is the main form of nitrogen excretion in mammals. For a long time, blood urea nitrogen has been known to reflect the inefficient use of dietary crude protein by ruminants (Lewis, 1957) and has shown a good correlation with plasma and milk (MUN) urea nitrogen. Thus, MUN has been used as an indicator to monitor protein nutrition (Jonker et al., 1999), representing a simple, fast and cheap indicator to evaluate the nutritional status of cows during lactation (Roseler et al., 1993). Other factors have been shown to influence MUN: milk production, cow age, lactation stage, body weight, grazing system, milk composition and season of the year. In face of the conflicting results, the objective of this study was to develop models to estimate MUN concentrations.

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MATERIAL AND METHODS

In this study was used 7,006 observations from 855 Holstein cows belonging to a commercial herd, Sao Paulo State (Brazil). Data were collected from September 2000 to January 2002 and included cows with 5 lactations or less, until 305 days in milk (DIM) and MUN concentrations less than 25 mg/dL. Milk production (kg/day), DIM and lactation number (LN) were recorded on the milk sampling days. Calving seasons were divided into summer (from November to April) and winter (from May to October).

Animals were confined, fed 7 times/day and milked in milking parlour where each animal was identified and had its production registered. They received TMR (48% roughage on dry matter basis) composed of maize silage, grass haylage, soyabean meal, maize germ, high moisture grain silage, maize gluten feed, citrus pulp and mineral mixture.

To estimate MUN concentration as a function of DIM, a model to describe the lactation curve, proposed by Wood (1967), was used. Later, LN and CS were added, verifying the existence of coincidence among curves. Likelihood ratio test was used to verify the significance of model adjustments as well as other effects. A test for lack of fit was also calculated as suggested by Neter et al. (1996). Models were adjusted by square means (significance level of 5%), using the NLIN procedure of SAS (1999).

RESULTS AND DISCUSSION

On average, milk production of cows was 35.8 kg/d and MUN was 13.3 mg/dL. The MUN curve, estimated using Wood's model, showed a significant adjustment for MUN concentrations ($P<0.001$) by the likelihood ratio test and in addition, the test for lack of fit was not significant ($P=0.0576$). Peak of MUN was 14.1 mg/dL, occurring on the 83rd day in milk. In agreement with Carlsson et al. (1995), MUN concentration was lower in the beginning of lactation, considering all LN.

To verify the effect of lactation number, a model was built where the parameters of Wood's curve were estimated for each of the five LN at the same time, proceeding then, the likelihood ratio test to compare the model containing just one curve for all LN with that one with a curve for each LN. There was an effect of LN ($P<0.0001$) on the considered curve; in other words, at least two lactation curves differed amongst themselves. However, it was observed that two curves (4th and 5th lactations) were coincident ($P=0.6216$). Coincidence among curves in LN from 3 to 5 was also tested, and this test showed significant differences ($P=0.0108$) among at least two of the three LN studied in the model. Curves for the 2nd and 3rd lactation were different ($P=0.0002$), and so were curves for 1st and 2nd lactation ($P<0.0001$). Therefore, it is possible to affirm that there is no difference between curves in 4th and 5th lactation, i.e. it is only necessary to estimate four curves from the five LN studied. These results agree with Canfield et al. (1990) who suggested that LN should be considered, because primiparous had lower MUN concentration than the multiparous.

Table 1. Estimates of Wood's curve parameters with lactation number and calving season effects, standard error of mean and confidence interval, 95%

LN	CS	Parameters	Estimates	SEM	CI 95%	
					LB	UB
1st	Summer	A	5.6804	0.6892	4.3293	7.0314
		b	0.1957	0.0327	0.1316	0.2598
		c	0.000967	0.000264	0.000449	0.00149
2nd	Summer	A	8.7931	1.1475	6.5436	11.0426
		b	0.1210	0.0357	0.0511	0.1909
		c	0.00114	0.000300	0.000557	0.00173
3rd	Summer	A	12.5262	1.5453	9.4968	15.5555
		b	0.0239	0.0350	-0.0448	0.0926
		c	0.000104	0.000326	-0.00053	0.000743
4th - 5th	Summer	A	11.9115	1.2323	9.4957	14.3273
		b	0.0378	0.0295	-0.0200	0.0955
		c	0.000310	0.000287	-0.00025	0.000872
1st	Winter	A	5.6722	0.5381	4.6173	6.7271
		b	0.2591	0.0267	0.2067	0.3115
		c	0.00318	0.000258	0.00267	0.00368
2nd	Winter	A	9.4467	0.8226	7.8342	11.0593
		b	0.1736	0.0250	0.1246	0.2225
		c	0.00308	0.000254	0.00258	0.00357
3rd	Winter	A	8.3093	0.8906	6.5634	10.0552
		b	0.2014	0.0307	0.1412	0.2616
		c	0.00298	0.000314	0.00236	0.00359
4th - 5th	Winter	A	6.7479	0.8403	5.1006	8.3952
		b	0.2400	0.0350	0.1713	0.3086
		c	0.00313	0.000338	0.00246	0.00379

CI 95% - confidence interval (95%); LN - lactation number; CS - calving season; SEM - standard error of mean; LB - lower bound; UB - upper bound; A, b, c - curve parameters

The effect of calving season was verified on the MUN curves. The likelihood ratio test showed a significant difference ($P<0.0001$) among CS for at least one of LN. However, coincidence was observed between curves for the 4th and 5th lactation ($P=0.1390$). Coincidence was also tested among CS for curves describing LN from 3 to 5 and this test showed significant differences (P<0.0057) among at least two of the three LN in the studied model. So, it was necessary to estimate only eight curves (Table 1) out of the possible ten. For cows calved in wintertime, MUN concentrations followed the lactation curve pattern, increasing until the peak, and then declining until the end of lactation, independent on LN. Cows that calved in summertime began the lactation with higher or similar MUN concentration, increasing little and gradually during lactation, reaching peak much later compared with those that calved in the wintertime and remaining like that, with no decrease.

When parturitions occurred in summertime, MUN peak was 13.20, 13.70, 13.92 and 13.75 mg/dL at 202, 106, 230 and 122 days in milk, for 1, 2, 3 and 4-5 lactations, respectively. When parturitions occurred in wintertime, MUN peak was 13.69, 15.99, 15.87 and 15.04 mg/dL at 81, 56, 68 and 77 days in milk for 1, 2, 3 and 4-5 lactations, respectively.

CONCLUSIONS

Milk urea nitrogen concentrations showed a similar pattern to the lactation curve as a function of days in milk, differing among 1st, 2nd, 3rd and 4th-5th lactations, being influenced by calving season.

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