Blood and Milk Urea Nitrogen as a Tool to Monitor the Protein Nutrition of Cattle under Tropical Conditions

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Abstract

Three experiments were carried out in the tropical lowlands of Colombia to evaluate the effect of different factors on rumen ammonia nitrogen and blood (BUN) and milk urea nitrogen (MUN) and to establish relationships between these variables and the protein nutrition of cattle. BUN was linearly correlated with rumen ammonia nitrogen (r^2= 0.74-0.88) and MUN was linearly correlated with BUN (r^2= 0.93). From the factors analyzed, the protein to energy ratio in the diet was related closest to variations in BUN and MUN. This study confirms that BUN and MUN may be useful tools to monitor protein supply of cattle grazing tropical pastures.

Introduction

Tropical grasslands constitute a large natural feed resource. Much of these lands is mainly suited for grazing by ruminants, which are able to convert the long-chain structural carbohydrates to products suitable for man. This is particularly important for production of milk and meat from ruminants by small holders. In these systems quality and quantity of forage often are limiting factors for animal performance, especially during the dry season. This results in a low consumption of digestible nutrients, limited microbial activity in the rumen, deficient absorption of nutrients in the lower gut and, consequently, in low animal production and productivity. Nevertheless, productivity could be increased by supplementation of limiting nutrients such as protein and minerals. Any type of supplementation should consider quantity and quality of the basal diet and of the supplement, and the expected level of animal production. Under practical conditions, determination of feed quality and intake is difficult and of low accuracy. Therefore, in the last two decades extensive work has been done to find reliable indicators of the nutritional status of

cattle. The levels of blood urea nitrogen (BUN) and milk urea nitrogen (MUN) have proven to be useful tools to monitor protein and energy nutrition of beef and dairy cattle under temperate conditions (Hammond *et al*., 1994; Butler *et al*., 1996; Hof *et al*., 1997). At present, the level of MUN is therefore determined along with routine milk-control in several European countries. However, up to date relatively little information is available on the relationship between these variables and the nutritional status of cattle fed on tropical forages.

The objectives of the present work were (1) to evaluate the effect of different nutritional and animal factors on rumen ammonia nitrogen, blood urea nitrogen and milk urea nitrogen and (2) to establish relationships between these variables and the protein nutrition of cattle under tropical conditions. The knowledge of these relationships would allow the use of BUN and MUN as metabolic indicators of the protein and energy status of cattle and could be helpful in making nutritional management decisions (e.g. timing and level of protein supplementation).

Materials and methods

In two experiments carried out in the Eastern Plains of Colombia, the levels of rumen ammonia nitrogen and of blood urea nitrogen of steers receiving diets with different crude protein contents were measured. In the first experiment the level of dietary crude protein, rumen ammonia and BUN was followed in eight esophagus and rumen fistulated steers grazing two pure grass pastures (*Brachiaria humidicola* and *Brachiaria dictyoneura*) and two grass-legume pastures (*B. humidicola*/*Desmodium ovalifolium* and *B. dictyoneura*/*Arachis pintoi*) in a 4x4 crossover design. The pastures had been selected to present contrasting levels of dietary crude protein contents (5.7 to 11.8% in dry matter (DM)). One grass-legume pasture contained *D*. *ovalifolium*, a legume with a high tannin content. Rumen fluid samples were taken during four days at 8:00, 11:00, 14:00, and 16:00 h in each experimental period. Blood samples as well as samples of the diet selected (esophageal extrusa) were taken once at the end of each period.

In the second experiment four rumen fistulated steers were assigned to four levels of protein supplementation, using a 4x4 Latin square design. The basal diet consisted of *Cynodon nlemfuensis* (star grass) hay supplemented with four levels of urea. Dietary crude protein in this trial varied between 7.3 and 15.8% in DM. Blood samples were taken on days 5 and 10 of each 10-day experimental period (at 8:00 h before feeding). Rumen fluid was sampled on days 7 and 9, at 4:00, 8:00, 12:00, 16:00, 20:00 and 24:00 h.

The third experiment consisted of a field study on nine commercial dual purpose cattle farms located in the Northern Cost region of Colombia. Samples and information were collected during two seasons of the year (dry and rainy season). Farms of different technological levels were selected to obtain representative results for a wide range of production systems. On each farm, 12 healthy cows were selected, covering different phases of lactation. To determine MUN content, approximately 250 ml of milk were taken. A blood sample was taken from each selected cow. Results were used to quantify the effect of different nutritional and animal factors on urea levels in blood and milk.

Results and discussion

In general, rumen ammonia nitrogen concentration was linearly correlated with the level of dietary crude protein ($P<0.001$, $r^2= 0.77$-0.92) in experiment 1 and 2 (Figure 1). However, in diets containing elevated proportions of tannins, rumen ammonia level did not reflect variations in content of dietary crude protein. Although crude protein content in the diet selected in the pasture with *Desmodium ovalifolium* (high tannin forage) was higher than in the pasture with *Arachis pintoi* (11.8% vs. 10.4% CP in DM; $P<0.05$), steers grazing *D. ovalifolium* presented much lower rumen ammonia nitrogen levels (64.0 vs. 134.3 mg NH_3-N/l; $P<0.05$) (Hess *et al*., 1992). Independent of the type of forage, a high correlation between BUN and rumen ammonia nitrogen was observed ($P<0.001$, $r^2= 0.74$-0.88) (Figure 2). Experiment 3 showed that MUN level was highly correlated with BUN ($P<0.001$, $r^2= 0.93$) in dual purpose cows (Figure 3). From the nutritional and animal factors analyzed, the protein to energy ratio was related closest to variations in BUN and MUN (Figure 4).

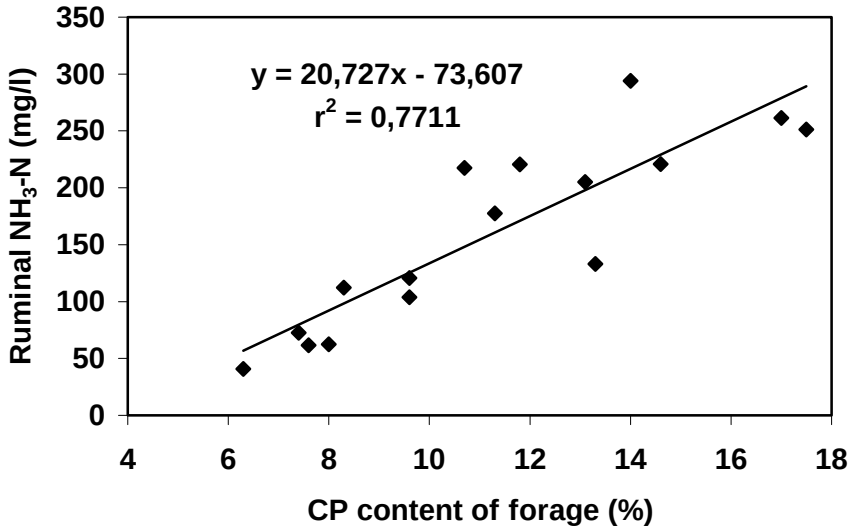

Figure 1. Relationship between the level of ammonia nitrogen (NH_3-N) in the rumen and crude protein content (CP) in the feed of steers receiving a basal diet of star grass hay supplemented with different proportions of urea (experiment 2; adapted from Hess *et al*., 1999b).

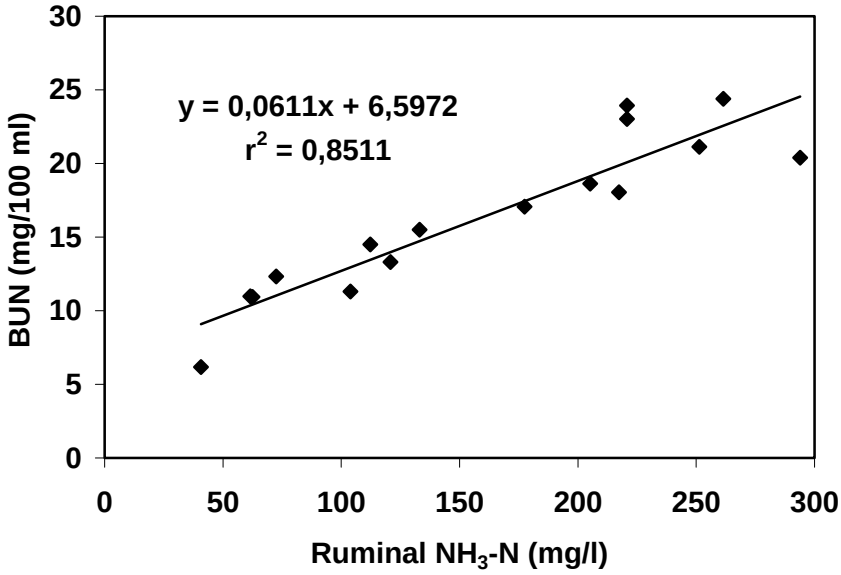

Figure 2. Relationship between levels of blood urea nitrogen (BUN) and rumen ammonia nitrogen (NH_3-N) of steers receiving a basal diet of star grass hay supplemented with different proportions of urea (experiment 2; adapted from Hess *et al*., 1999b).

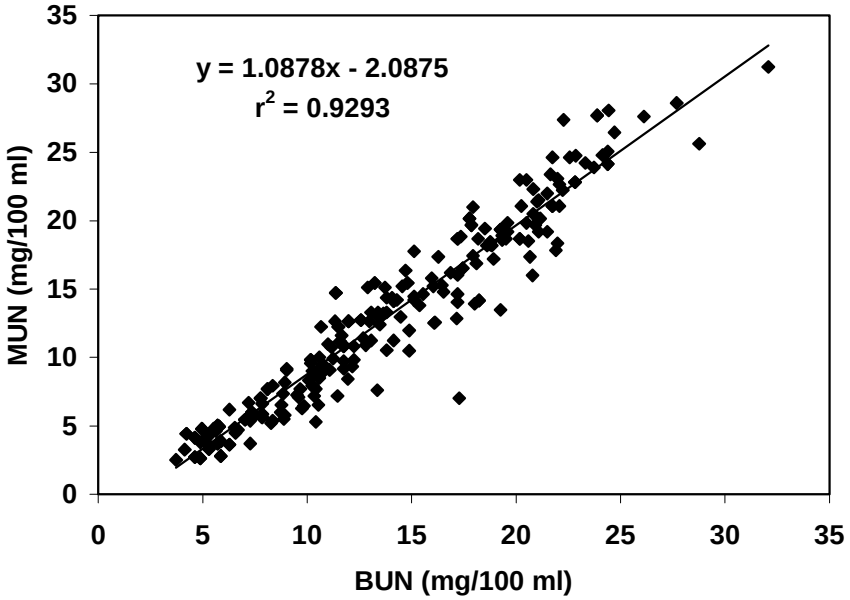

Figure 3. Relationship between levels of milk urea nitrogen (MUN) and blood urea nitrogen (BUN) of cows in dual purpose production systems in the tropical lowlands of Colombia (experiment 3; adapted from Hess *et al*., 1999a)

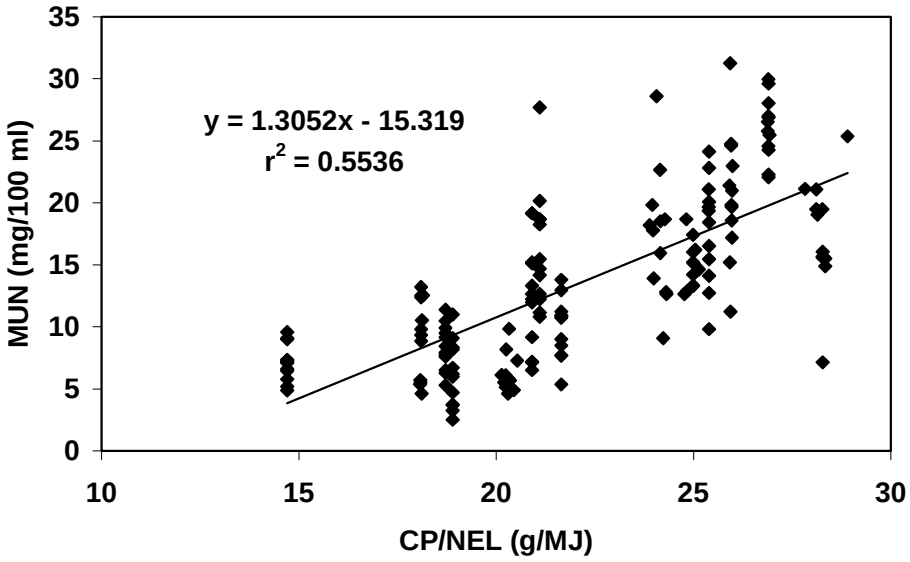

Figure 4. Relationship between the level of milk urea nitrogen (MUN) and the protein to energy ratio (CP/NEL) in the diet of cows in dual purpose production systems in the tropical lowlands of Colombia (experiment 3; adapted from Hess *et al*., 1999a).

This study confirms that BUN and MUN could be useful tools for monitoring rumen ammonia nitrogen level and protein intake of ruminants and may serve to adjust protein and energy supply of cattle grazing tropical pastures. In pastures containing legumes high in tannins,

BUN or MUN should be measured to estimate nitrogen availability in the rumen. The results further indicated that the minimum milk urea nitrogen level for cows in dual purpose systems is approximately 10 mg/100 ml. Values below this level are usually associated with dietary protein deficiency, and cows at these levels will probably respond to protein supplementation.

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