January 2002

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Urinary Allantoin as an Estimate of Microbial Protein Synthesis

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Urinary allantoin is a measure of bacterial protein production and has potential to be used in production settings.

Summary

Allantoin excretion in the urine was evaluated as a marker for bacterial protein production in lactating and dry cows grazing Sandhills range and meadows. Allantoin excretion declined with season as diet digestibility declined. Bacterial protein predicted from allantoin was significantly related (R^2 = .62) to bacterial protein predicted by NRC. Urinary allantoin has potential as a tool to predict bacterial protein production in grazing cattle.

Introduction

Supplementing forages with a protein source is a common practice used among cow/calf producers to improve the digestibility and intake of the forage. To be profitable, the supplement must provide the right type and adequate amount of protein. Metabolizable protein (MP) is the protein absorbed by the intestine and used by the host animal and is the sum of the digestible true bacterial protein produced in the rumen (BCP) and the digestible rumen undegradable intake protein (UIP) from the feedstuffs. There is little UIP in forages and therefore, BCP production is the primary source of MP; furthermore, most beef cows are fed forage diets of varying quality so it is important to have accurate estimates of BCP production.

Allantoin, an end product of purine metabolism excreted in urine, has been shown to be an effective indicator of BCP synthesis (*2001 Nebraska Beef Cattle Report,* pp. 115-116; *2002 Nebraska Beef Cattle Report,* pp. 66-68). The determination of allantoin in

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Table 1. Allantoin excretion, diets and BCP estimates for cows grazing Sandhills range or subirrigated meadows.

	May		June		July		August		September		December
Item	M[a]	R[a]	M	R	M	R	M	R	M	R	R
BW, lb	889	905	971	1005	1046	1064	1054	1080	1080	1093	1097
IVDMD	70.2	67.7	67.3	63.6	59.0	61.8	57.2	55.8	50.4	52.5	52.4
DMI, lb[b]	23.3	23.0	24.9	24.8	24.2	25.0	23.6	23.9	23.7	23.4	22.4
A:C[c]	3.87	3.23	4.00	3.20	4.03	3.56	1.80	1.67	1.88	1.63	1.07
Allantoin, g/d	41.5	34.9	47.1	38.8	49.4	46.0	19.4	21.7	23.9	20.5	14.5
BCP[de], g/d	889	745	1014	834	1085	989	496	467	524	459	308
BCP[f], g/d	964	922	994	895	713	820	644	597	434	490	463

[a]M = meadow, R = range.
[b]Predicted dry matter intake from NRC
[c]Allantoin:Creatinine ratio.
[d]Bacterial CP production estimated from allantoin.
[e]Standard error = 21.6; Meadow vs Range (P < 0.01); period effect (P <0.01).
[f]Bacterial CP production estimated from NRC, 1996.

urine has the advantage of being a noninvasive method which can be applied to a larger number of animals and under practical feeding conditions, in contrast to the use of cannulated animals. Therefore, the objectives of this study were to 1) determine the BCP production in forage fed beef cows by using allantoin excretion as a marker, and 2) to compare our results with NRC estimates.

Procedure

Sixteen March-calving cows (primiparous) were randomly assigned to either upland native range or subirrigated meadow at the Gudmunsen Sandhills Laboratory near Whitman, Neb. Cows were allowed to graze their respective pastures for two weeks, the first week for adaptation and the second week for collection, from May to September. Collections were made in May, June, July, August, September, and December. In December, cows were assigned only to the rangeland treatment. Approximately 50 ml of urine were taken as a spot sample from each cow for five days during the second week of each period. Samples were frozen and aliquots were analyzed for allantoin and creatinine. Urinary creatinine excretion is used as a marker of total urine excretion, and it has been suggested that the ratio of allantoin to creatinine in spot urine samples can be used to determine the amount of microbial protein supply. Creatinine is excreted in the urine at the rate of .14 mmole/kg BW. Individual body weights were taken in each collection period.

Esophageally-fistulated cows were

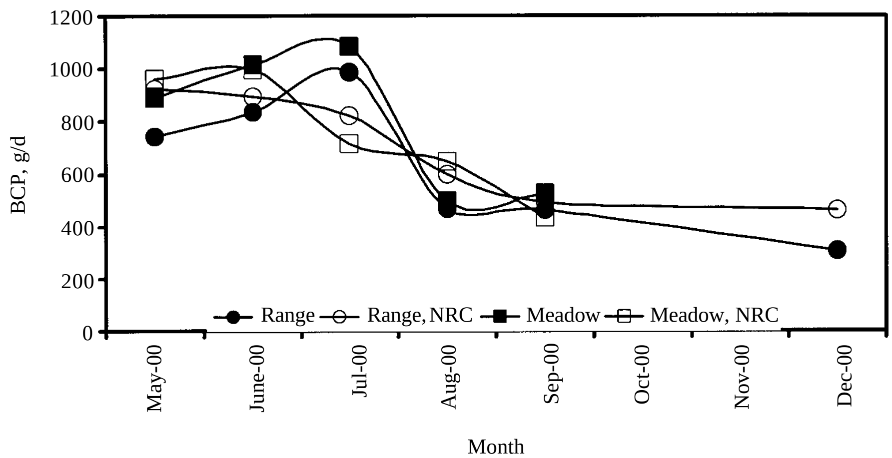

Figure 1. BCP predicted from allantoin or NRC.

used to obtain diet samples from range and meadow during each sampling period. Diet samples were freeze dried and analyzed for IVDMD.

The NRC (1996) model was used to predict BCP production and dry matter intakes (DMI). Actual measured body weights and measured IVDMD values were used as inputs.

Results

Cow weights increased from 900 lb in May to 1100 lb in September and December (Table 1). Range IVDMD decreased from 70% in May to 52% in September and December, Meadow IVDMD values tended to be higher than range values, especially early in the season. The allantoin to creatinine ratio, and therefore, the amount of allantoin decreased from May, June, and July to August, September, and December.

Bacterial CP was predicted by two methods — from allantoin excretion and by using the NRC model. The BCP values (Table 1) decreased with advancing season (Figure 1) and were related to the diet digestibility. Diet digestibility, DMI, and microbial efficiency are the primary factors that determine BCP production. The NRC model estimates the requirements for DIP by multiplying total digestible nutrients (TDN) intake by microbial efficiency. Microbial efficiency, the amount of microbial protein produced from TDN, is in general assumed to be 13%. However, at low TDN levels, which occurs in the case of low-quality forages, a decrease in microbial efficiency is likely to occur due to a slower rate of passage. Slower rates of passage lead to more energy used for microbial maintenance. Therefore, we estimated, in the NRC model, that microbial efficiency declined from 13% in May to 8% in December. The BCP predicted by allantoin excretion was well related to the BCP predicted by the NRC model (Figure 2; R^2 = .62).

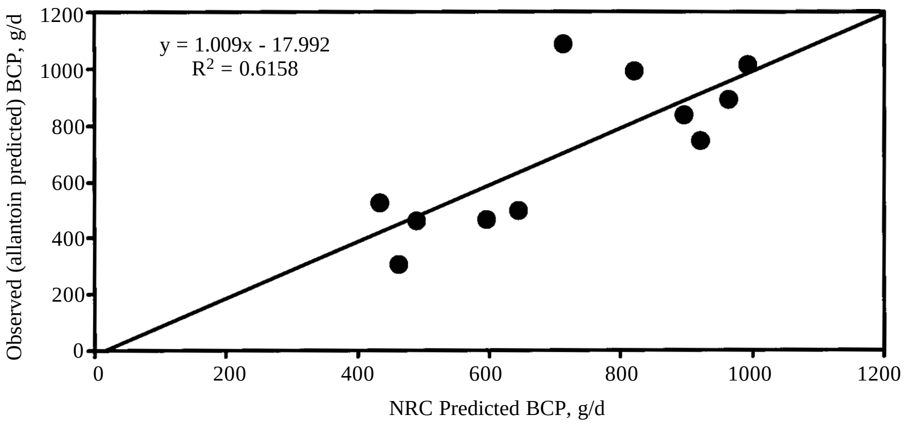

Figure 2. BCP predicted by NRC versus BCP predicted from allantoin excretion in urine.

It is very important to predict BCP production in grazing cows because the BCP supplies most of the MP to the cow. The NRC model may predict BCP production quite well, but that has not been well validated. The use of allantoin as a predictor of BCP production is interesting because it is noninvasive and the cows graze and produce normally. Urine is readily collected once daily. In general, there was good agreement between BCP predicted from allantoin and NRC (R^2 = .62). Where there was not good agreement, for example July meadow, either of the predictions could be incorrect. The NRC prediction is generalized over the days of the month and metabolic functions of the cow during that period; on the other hand, allantoin represents five specific days and the specific intake and functions of the cows on those days.

Specific examples where differences could have occurred follow. In May, the digestibility of range was high but forage availability may have limited intake and therefore the NRC intake would be over predicted. July is a transition period when digestibility of the diet is decreasing. Accurate estimates of the diet are critical. We used 11% microbial efficiency in the NRC model and that may be too low. The DIP content of the grasses in August, September, and December may have limited BCP production as estimated by allantoin but the NRC model does not account for DIP deficiency.

It was concluded that urinary allantoin has potential to be a useful tool to estimate BCP production in grazing cattle. We believe this will allow us the opportunity to further refine the MP system and allow more accurate supplementation schemes.

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