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### Urinary Allantoin as an Estimate of Microbial Protein Synthesis

Mariela Lamothe

*University of Nebraska-Lincoln*

Terry J. Klopfenstein

*University of Nebraska-Lincoln*, [tklopfenstein1@unl.edu](mailto:tklopfenstein1@unl.edu)

Don C. Adams

*University of Nebraska-Lincoln*, [dadams1@unl.edu](mailto:dadams1@unl.edu)

Jacqueline A. Musgrave

*University of Nebraska-Lincoln*, [jmusgrave1@unl.edu](mailto:jmusgrave1@unl.edu)

Galen E. Erickson

*University of Nebraska-Lincoln*, [gerickson4@unl.edu](mailto:gerickson4@unl.edu)

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703 lb while the September heifers weighed 727 lb ( $P < 0.05$ ). These weights were about 60% of mature weight. The percentage of heifers cycling before breeding was similar for both groups.

The 45-day yearling pregnancy rate was 5% higher ( $P > 0.20$ ) for the September heifers (93% vs 88%) over the August heifers. September heifers were 30 days older at breeding than the August heifers. At pregnancy check time, heifer weights were similar.

In Table 3, the 2-year-old cows in both groups had similar weights at calving and at weaning times. Calf birth weights were similar for the two groups, but calving difficulty percentage was higher for the cows calving in May (14%) than those calving in June (2%). The prebreeding pelvic area (Table 2) was slightly larger ( $6\text{cm}^2$ ) for the June calving cows, which may have had some influence on calving difficulty. However, when comparing calving difficulty between the various groups (March vs May vs June calving), cows calving late in the spring or summer had fewer problems. This difference was not due to smaller calf birth weights. The factors influencing less calving difficulty may

have included warmer temperatures, less heifer stresses, more pelvic relaxation, better nutrition on green grass and more heifer exercise.

Calf ADG to weaning was greater for the calves on the May calving cows. Actual calf weaning weights were 64 lb heavier ( $P < 0.05$ ) from the May calving cows, but the 205-day adjusted weights were 20 lb different ( $P < 0.05$ ) between groups.

Cow pregnancy rates for the second calf were low for both groups (May = 79%, June = 75%). This was probably due to the mature grass and lower nutrition during the September and October breeding season for these 2-year-old cows on range. However, cows were supplemented with 1.0 lb/day of 48% CP cake during the breeding season. Also, the summer cows were smaller (about 900 lb) at calving which may have influenced rebreeding rates.

Another year of data on calf production of the spring and summer 2-yr-old cows is being collected. However, the results at this writing indicate the following. Spring heifers developed during the winter at a low gain (1.1 ADG) to reach 53% of mature weight prebreed-

ing, had similar reproduction and calf production as higher gain heifers (1.4 ADG) that reached 57% of mature weight.

Summer heifers bred to calve 30 days before the mature cows had slightly lower yearling pregnancy rates, but slightly higher 2-year-old pregnancy rates than heifers bred to calve at the same time as the cows. May calving heifers had heavier 205-day calf weaning weights compared to June calving heifers. Summer-born calves had similar birth weights to spring-born calves, but less calving difficulty was experienced with June calving.

Pregnancy rates of summer heifers were satisfactory at yearling breeding, but unsatisfactory at 2-year-old rebreeding. Only 54% of the summer heifers were still in the herd at 4 years of age. Growth rates of summer-born calves appear to be lower than spring-born calves.

<sup>1</sup>Gene Deutscher, professor emeritus, Animal Science; Rex Davis, beef unit manager, Animal Science, West Central Research and Extension Center, North Platte; Brent Plugge, extension educator, Thedford; Andy Applegarth, GSL Unit Manager, Whitman, Neb.

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## Urinary Allantoin as an Estimate of Microbial Protein Synthesis

**Mariela Lamothe**  
**Terry Klopfenstein**  
**Don Adams**  
**Jacki Musgrave**  
**Galen Erickson<sup>1</sup>**

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

(Continued on next page)

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

Item	May		June		July		August		September		December
	M <sup>a</sup>	R <sup>a</sup>	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 <sup>b</sup>	23.3	23.0	24.9	24.8	24.2	25.0	23.6	23.9	23.7	23.4	22.4
A:C <sup>c</sup>	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 <sup>de</sup> , g/d	889	745	1014	834	1085	989	496	467	524	459	308
BCP <sup>f</sup> , g/d	964	922	994	895	713	820	644	597	434	490	463

<sup>a</sup>M = meadow, R = range.

<sup>b</sup>Predicted dry matter intake from NRC

<sup>c</sup>Allantoin:Creatinine ratio.

<sup>d</sup>Bacterial CP production estimated from allantoin.

<sup>e</sup>Standard error = 21.6; Meadow vs Range (P < 0.01); period effect (P < 0.01).

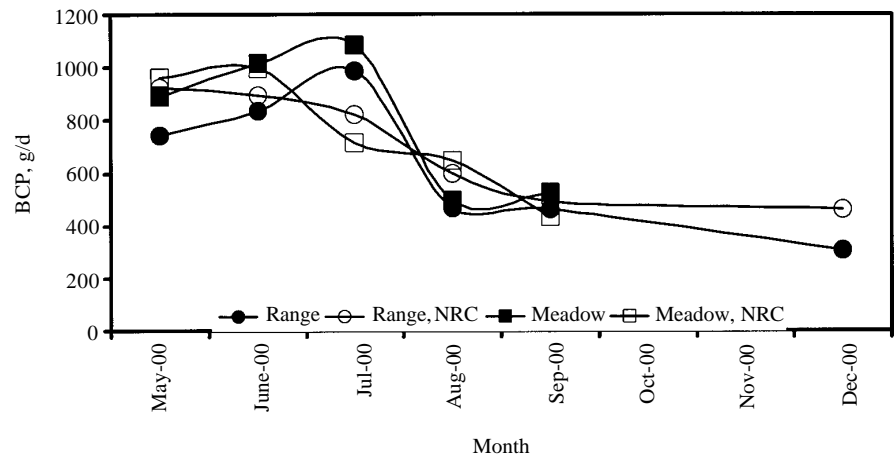
<sup>f</sup>Bacterial CP production estimated from NRC, 1996.

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 Gudmunson 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<sup>2</sup> = .62).

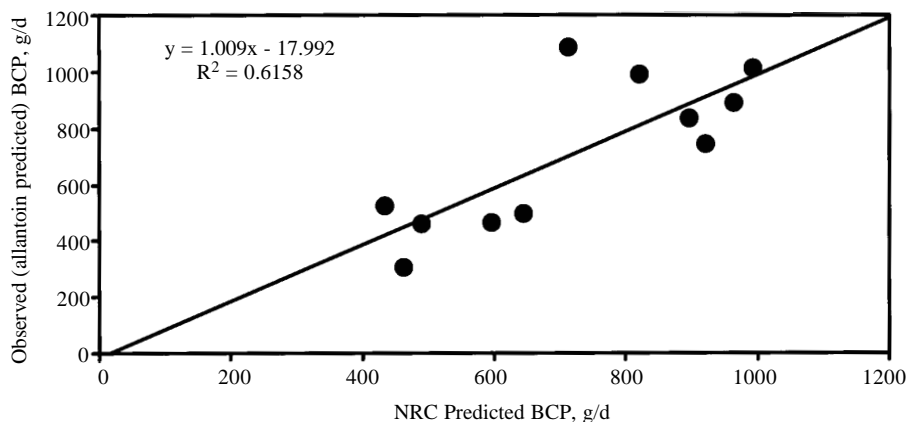


Figure 2. BCP predicted by NRC versus BCP predicted from allantoin excretion in urine.

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.

<sup>1</sup>Mariela Lamothe, graduate student; Terry Klopfenstein, professor; Galen Erickson, assistant professor, Animal Science, Lincoln; Don Adams, professor; J. Musgrave, research technician, West Central Research and Extension Center, North Platte.

## Metabolizable Protein Requirements of Lactating Two-Year-Old Cows

Trey Patterson  
Don Adams  
Terry Klopfenstein  
Amelia Hopkin<sup>1</sup>

Lactating two-year-old cows consuming meadow hay were deficient in metabolizable protein. Supplementation with undegradable intake protein alleviated the deficiency and improved postpartum weight gain.

### Summary

*Eighteen lactating two-year-old cows maintained on meadow hay were used to determine the effects of supplementation to meet metabolizable protein or degradable intake*

*protein requirements on production traits during the first two months after calving. Cows supplemented to meet metabolizable protein requirements had a higher ADG than degradable protein supplemented cows. Milk production declined from 15.9 to 10.8 lb/day at 26 to 69 days after calving, respectively. Hay intake averaged 2.4% of body weight. Supplementation to meet metabolizable protein requirements increased postpartum weight change, but did not affect intake or milk production.*

### Introduction

Lactating two-year-old cows have a high requirement for metabolizable protein (MP), protein absorbed into the body, relative to nonlactating cows.

The protein in meadow hay harvested in the Nebraska Sandhills is predominately rumen degradable intake protein (DIP). Conventional supplementation strategies typically supply DIP as the predominant source of protein. Meeting the DIP requirements of young cows is important, but supplemental undegradable intake protein (UIP), protein that escapes rumen degradation, may be necessary to meet MP requirements of two-year-old lactating cows consuming meadow hay in the Sandhills. In Montana, supplementing UIP to young, lactating cows improved weight gain and percentage of cows bred early in the breeding season. We hypothesized that meeting NRC (1996) requirements for MP would positively affect production traits in lactating two-year-old cows in the Sandhills.

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