January 2004

Urea Inclusion in Forage Based Diets Containing Dried Distillers Grains

Leslie Aaron Stalker
University of Nebraska-Lincoln, stalkera@byui.edu

Terry J. Klopfenstein
University of Nebraska-Lincoln, tklopfenstein1@unl.edu

Don C. Adams
University of Nebraska-Lincoln, dadams1@unl.edu

Galen E. Erickson
University of Nebraska-Lincoln, gerickson4@unl.edu

Urea Inclusion in Forage Based Diets Containing Dried Distillers Grains

L. Aaron Stalker
Terry J. Klopfenstein
Don C. Adams
Galen E. Erickson[1]

Summary

Two experiments evaluated supplemental degradable intake protein requirements when dried distillers grains were fed as an energy source in forage-based diets. Diets were formulated to be greater than 100 g/day deficient in degradable intake protein but with excess metabolizable protein. In both experiments, no response in performance was observed when urea was added to the diet. Sufficient urea was probably recycled to correct the degradable intake protein deficiency. These studies indicate adding urea to meet the degradable intake protein requirement is not necessary when dried distillers grains are fed as an energy source in forage-based diets.

Introduction

As the corn milling industries continue to expand, an increased availability of distillers grains is expected. Dried distillers grains (DDG) are appropriate for forage-based production systems when forage quality is poor (winter) or quantity is limiting (drought). Dried distillers grains are considered a protein supplement when fed at less than 15% of the diet DM and as an energy source when fed at levels greater than 15% of the diet. Energy supplied by DDG is in the form of digestible fiber and fat (1996, Nebraska Beef Report, pp. 65-66) making its energy value superior to corn in forage-based diets (2003, Nebraska Beef Report, pp. 8-10). Dry distillers grains contain approximately 65% UIP (% of CP), consequently forage-based diets that include dried distillers grains fed as an energy source are commonly deficient in degradable intake protein (DIP) but contain excess metabolizable protein (MP). Cattle convert excess MP to urea which is potentially recycled to the rumen and can serve as a source of DIP. Many factors influence urea recycling and the amount of urea that is recycled when DDG is included in a forage-based diet is not known. The objective of these trials was to determine if added DIP (i.e. urea) is required in forage-based diets where DDG is included at levels in excess of the MP requirement.

Procedure

In experiment one, 60 Angus heifers (613 ± 36 lb) were stratified by weight then assigned randomly to one of five treatments. Treatments were designed to supply 0, 33, 67, 100 and 133% of the NRC (1996) predicted DIP deficiency of the base diet. Heifers were individually fed in Calan electronic gates for ad libitum consumption of a diet consisting of 58% ground corn cobs and 12% sorghum silage. The remaining 30% of the diet was one of the DDG based supplements described in Table 1. For five days before and at the end of the 84 day experiment heifers were limit fed. Heifer weights were recorded on three consecutive days following each limit-feeding period. Beginning on day 46 of the experiment, approximately 50 mL of urine was collected from each heifer for 5 consecutive days to estimate microbial crude protein (MCP) production. Urine samples were assayed for allantoin and creatinine. The ratio of allantoin to creatinine is indicative of the amount of MCP produced.

Feedstuffs used in the trial were analyzed for DM, organic matter (OM), CP, in-vitro dry matter disappearance (IVDMD) and for in-situ undegradable intake protein content (2003, Nebraska Beef Report, pp. 81-83, Table 2).

In experiment two, 48 crossbred heifers (451 ± 44 lb) were stratified by weight then assigned randomly to one of eight pens. Pens then were

Table 1. Ingredient composition of supplements (%DM) used in both experiments where 0, 33, 67, 100 or 133 % of the NRC predicted degradable intake protein deficiency was met with supplemental urea.

	Experiment 1[a]					Experiment 2[b]	
Ingredient	0	33	67	100	133	0	100
Dry distillers grain	95.59	94.25	92.92	91.58	90.24	94.20	91.85
Molasses	—	—	—	—	—	2.90	2.90
Urea	—	1.33	2.67	4.00	5.33	—	2.50
Limestone	3.16	3.16	3.16	3.16	3.17	1.60	1.60
Salt	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Trace mineral premix	0.17	0.17	0.17	0.17	0.17	0.16	0.16
Melangestrol Acetate	0.05	0.05	0.05	0.05	0.05	—	—
Vitamin premix	0.03	0.03	0.03	0.03	0.03	0.06	0.06

[a]Supplement comprised 30% of the diet.
[b]Supplement comprised 25% of the diet.

Table 2. Chemical composition (± SD) of feedstuffs used in Experiment 1.

Item	Sorghum silage	Corn cobs	DDG
DM, %	34.6 ± 0.008	88.8 ± 0.014	90.5 ± 0.007
OM, %	93.1 ± 0.001	98.1 ± 0.001	97.7 ± 0.003
IVDMD, %	68.1 ± 0.003	51.5 ± 0.017	—
CP, %DM	9.4 ± 0.17	4.6 ± 0.27	31.5 ± 0.15

Table 3. Performance and allantoin to creatinine ratios in urine of animals fed diets where 0, 33, 67, 100, or 133% of the NRC predicted degradable intake protein requirement was met with supplemental urea.

	Diet					F-Test	
Item	0	33	67	100	133	SEM	P-value
Experiment 1							
Initial BW, lb	611	611	615	617	614	11	0.99
Final BW, lb	694	697	680	702	702	15	0.85
ADG, lb	1.06	1.03	0.93	1.01	1.04	0.07	0.77
Total DMI, lb	11.3	11.4	11.4	11.5	11.4	0.2	0.95
F:G	11.1	11.8	13.2	11.8	11.7	0.9	0.54
Allantoin:creatinine	0.66	0.66	0.56	0.68	0.67	0.08	0.84
Experiment 2							
Initial wt., lb	452			449		1	0.10
Final wt., lb	579			585		4	0.38
ADG, lb	1.53			1.63		0.05	0.17
Total DMI, lb	11.9			11.6		0.5	0.76
F:G	9.8			9.1		0.5	0.33
Allantoin:creatinine	0.89			0.89		0.04	0.98

[ab]Means within a row with unlike superscripts differ (P<0.05)

Table 4. Diet evaluation using the NRC (1996) model where 0, 33, 67, 100, or 133% of the NRC predicted degradable intake protein requirement was met with supplemental urea.

	Experiment 1					Experiment 2	
Item	0	33	67	100	133	0	100
Inputs							
TDN, %	70	70	69	69	69	64	64
CP, %	12.6	13.6	14.6	15.6	16.6	11.8	13.6
NE adjuster, %	100	98	95	101	103	91	96
Outputs							
DIP balance, g/day	-124	-66	-7	54	112	-129	1
MP balance, g/day	120	127	138	108	97	219	188

assigned randomly to one of two supplement treatments. Heifers were fed for ad libitum consumption of grass hay (54% TDN, 7.4% CP) and supplemented with either 3 lb (DM) DDG/head/day or 3 lb (DM) DDG plus 0.1 lb urea/head/day. This was the amount of urea required to meet the NRC predicted DIP requirement. Supplement composition is listed in Table 1. Heifers were weighed on two consecutive days at the beginning and end of the 84-day trial. Beginning on day 55 of the experiment, approximately 50 mL of urine was collected from each heifer for 3 consecutive days. Urine samples were composited by animal and analyzed as described in experiment one.

Data were analyzed using animal as the experimental unit for experiment one and pen as the experimental unit for experiment two.

Results

In experiment one, heifer ADG did not differ among treatments. Similarly, total DMI and F/G did not differ (Table 3). We hypothesized that heifers consuming the 0, 33 and possibly the 67% diets would exhibit reduced ADG compared to the 100 and 133% diets because of their DIP deficiency (Table 4). This was not the case, however, as no differences in performance were observed. One explanation for this lack of difference is that sufficient urea was recycled to the rumen to meet the DIP requirement in all treatments. The NRC (1996) sets the DIP requirement equal to microbial crude protein (MCP) production. In this experiment we measured the allantoin to creatinine ratio in the urine to estimate MCP production based on the theory that these are directly related. Allantoin to creatinine ratio did not differ among treatments (Table 3). Our hypothesis was that allantoin to creatinine ratios would be similar for the 100, 133 and perhaps even the 67% treatments but would be reduced in the 0 and 33% treatments. The actual relationships among treatments for allantoin to creatinine ratios observed in this study fit nicely with the performance data and suggest that MCP production was not reduced in the DIP deficient diets relative to the diets where the DIP requirement was met with urea. Endogenous urea recycling explains the lack of difference among treatments for both ADG and allantoin to creatinine ratios.

Upon completion of the study animal performance, intake and nutrient analyses were used as inputs to evaluate the diets using the NRC (1996) model. Variables used as inputs as well as outputs generated from the model are reported in Table 4. These data are reported as an aid in formulating diets containing dried distillers grains.

In experiment 2, heifer ADG did not differ between treatments. Likewise, total DMI and F/G were not different (Table 3). Allantoin: creatinine ratio (Table 3) was also similar between treatments. These results are consistent with experiment 1 and also suggest that sufficient urea was recycled to the rumen to meet the DIP requirement of heifers not fed urea.

In conclusion, providing urea to meet the DIP deficiency did not improve ADG, intake, or F/G in either experiment. No differences in allantoin to creatinine ratio, which are indicative of microbial crude protein production, were noted in either experiment. We interpret these results to indicate that additional DIP is not necessary when DDG are fed as an energy source in forage-based diets.

[1]Aaron Stalker, graduate student; Terry Klopfenstein, professor, Animal Science, Galen Ericksen, assistant professor, Lincoln; Don Adams, professor, West Central Research and Extension Center, North Platte.