EFFECT OF INCREASING UREA LEVEL IN PROTEIN SUPPLEMENTS ON INTAKE AND DIGESTION OF LOW-QUALITY TALLGRASS-PRAIRIE FORAGE BY BEEF STEERS [1]

H. H. Kster, R. C. Cochran, E. C. Titgemeyer, E. S. Vanzant[2], and G. St Jean[3]

Summary

Twelve ruminally fistulated steers were used to evaluate the effect of changing the proportion of supplemental degradable intake protein (DIP) derived from urea on forage intake and digestion. Steers had ad libitum access to a low-quality tallgrass-prairie hay. Supplemental treatment groups were: 1) 0% of the supplemental DIP from urea, 2) 20% of the supplemental DIP from urea, and 3) 40% of the supplemental DIP from urea. Supplements were formulated to contain 30% CP and were fed with prairie hay once daily. Results from this study indicated that urea can replace up to 40% of the supplemental DIP without affecting forage intake and digestion.

(Key Words: Steers, Forage, Nonprotein Nitrogen, Intake, Digestibility.)

Introduction

Because true protein (e.g., soybean meal) is one of the most costly components in winter range supplements, there has been a long-standing interest in the potential of nonprotein nitrogen (NPN) to substitute for true protein in supplements. Recent work at Kansas State University suggests that, conservatively, up to 50% of the supplemental DIP can be provided by urea without compromising forage intake and digestion. However, in that study, the supplements were infused into the rumen, so it is unclear how different levels of urea inclusion might affect supplement palatability or livestock performance. Therefore, this digestion study was conducted in conjunction with a performance study to evaluate forage intake and digestion responses when urea accounted for up to 40% of the supplemental DIP in supplements fed to beef cattle consuming low-quality, tallgrass-prairie forage.

Experimental Procedures

Twelve ruminally fistulated steers (average BW = 835 lb) were used in a randomized complete block design to evaluate the effect of changing the proportion of supplemental degradable intake protein (DIP) derived from urea on forage intake, digestion, and ruminal fermentation characteristics. Animals were housed in a partially enclosed barn (one side open) in 6 ft 18 ft individual pens and had ad libitum access to water and low-quality, tallgrass-prairie hay (2.4% CP, 73.5% NDF). Steers were assigned randomly to one of three supplemental treatment groups: 1) 0% of the supplemental DIP from urea (0% supplemental CP from urea), 2) 20% of the supplemental DIP from urea (15% supplemental CP from urea), and 3) 40% of the supplemental DIP from urea (30% supplemental CP from urea). Supplements were formulated with soybean meal, urea, sorghum grain, and molasses to contain approximately 30% CP and a N:S ratio of 10:1. Steers received 3.63 lb of supplement DM daily. Based on previous research, the amount of DIP provided by the supplements and forage should have been sufficient to maximize digestible OM intake (DOMI) of the low-quality forage fed.

[1]The authors express their appreciation to Gary Ritter and Wayne Adolph for their assistance in conducting this experiment.

[2]KSU Agricultural Research Center - Hays.

[3]Department of Clinical Sciences.

Supplements and forage were fed once daily in the morning (8 AM) with the supplement offered just before feeding the hay. Generally, all supplements were consumed within 45 minutes. The experimental period consisted of a 14-day adaptation followed by 7-day intake and 7-day total fecal collection periods. Feed and orts samples from days 21 to 27 and fecal samples obtained during the 7-day fecal collection period (days 22 to 28) were used to estimate OM, NDF, and N digestibility. Ruminal DM and fluid content were determined by manually evacuating the rumen just before (0 hour) and 4 hours after feeding. Fluid dilution rate, pH, ammonia N, and volatile fatty acid (VFA) concentrations were determined on ruminal fluid samples collected at feeding (0 hour) and 3, 6, 9, 12, and 24 hours after feeding.

Results and Discussion

Increased proportions of supplemental DIP from urea did not change ($P \geq .38$) forage OM intake, total OM intake, or DOMI in this study (Table 1). Similarly, total tract OM and NDF digestibilities did not respond ($P \geq .37$) to increasing urea level.

These responses agree with previous work from our laboratory and others reporting that forage intake and digestion were similar for cattle fed supplements containing different proportions of the supplemental DIP as urea. This suggests that negative performance responses generally observed when true protein is replaced by NPN would not be due to differences in intake and digestion. Ruminal DM contents were relatively constant ($P=.39$) across urea levels. In contrast, the apparent quadratic response ($P \leq .06$) for ruminal fluid contents and fluid dilution rate, although small in magnitude, was unexpected. Increasing urea levels did not affect ($P \geq .25$) ruminal pH or total VFA concentration. However, ammonia N concentrations increased linearly ($P \leq .01$) as percentage of supplemental DIP from urea increased. This probably reflects the more rapid rate of hydrolysis for urea then for the true protein. None of the individual VFA proportions were altered substantively ($P \geq .10$) with increasing urea level, indicating that the level of urea substitution was limited enough to minimize the chance of observing VFA shifts. In conclusion, urea can replace up to 40% of the supplemental DIP (30% of CP) in a supplement with 30% total CP without affecting forage intake and digestion.

Table 1. Effect of Different Proportions of DIP from Urea on OM Intake, OM, NDF, and N Digestibility, Ruminal DM and Fluid Content, and Fermentation Characteristics in Steers Fed Dormant, Tallgrass-Prairie Forage

	% Supplemental DIP from Urea[a]				Contrasts[b]	
Item	0	20	40	SE	L	Q
Forage OM intake, g/kg BW $^{.75}$	74.1	69.3	70.6	4.83	.63	.63
Supplement OM intake, g/kg BW $^{.75}$	16.4	17.0	16.6	.12	.41	.02
Total OM intake, g/kg BW $^{.75}$	90.5	86.3	87.2	4.86	.65	.68
Digestible OM intake, g/kg BW $^{.75}$	43.9	41.3	42.9	1.51	.72	.38
Total tract OM digestibility, % of intake	48.5	47.8	49.5	1.75	.70	.58
Total tract NDF digestibility, % of intake	50.0	48.8	52.5	1.92	.43	.37
Total tract N digestibility, % of intake	36.8	46.0	42.8	4.40	.18	.12
Ruminal DM content, g/kg BW	29.6	27.9	27.7	1.47	.39	.69
Ruminal fluid content, g/kg BW	163	148	181	8.36	.19	.06
Fluid dilution rate, %/h	7.13	8.70	7.32	.46	.77	.04
pH	6.65	6.64	6.71	.03	.25	.37
Ammonia N, m*M*[c]	.18	.94	1.77	.20	<.01	.89
Total VFA, m*M*[c]	74.3	78.2	73.6	2.79	.87	.26
Acetate, mol/100 mol	76.8	76.8	77.6	.52	.31	.57
Propionate, mol/100 mol	13.9	13.9	13.6	.22	.38	.48
Butyrate, mol/100 mol	7.76	8.01	7.45	.07	.50	.32
Isobutyrate, mol/100 mol	.48	.40	.42	.02	.10	.11
Valerate[c], mol/100 mol	.50	.49	.52	.02	.49	.37
Isovalerate, mol/100 mol	.46	.36	.46	.05	.92	.13
Acetate:propionate	5.55	5.52	5.73	.13	.35	.47

[a]Percent of the total supplemental N from urea is 0, 15, and 30, respectively.
[b]Probability of a greater F value. L = lin ear change with increasing urea, Q = quadratic change with increasing urea.
[c]Trt time (P ≤.02).