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H.H. Köster

R.C. Cochran

E.S. Vanzant

See next page for additional authors

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Influence of increasing proportion of supplemental nitrogen from urea on intake and fermentation characteristics in beef steers consuming low-quality, tallgrass-prairie forage

Abstract

Five ruminally and duodenally fistulated Angus x Hereford steers were used to determine intake and fermentation responses associated with increasing the proportion of supplemental degradable intake protein (DIP) provided by urea. Steers had free access to a dormant, tallgrass-prairie forage. The supplemental DIP was provided by sodium caseinate and (or) urea , at a level that was determined previously to optimize use of a similar forage. Supplemental DIP was balanced with corn starch to provide a final supplement of 40% crude protein. Percentages of DIP from urea were: 0, 25, 50, 75, and 100%. Supplements were given intraruminally. Increasing the percentage of urea as supplemental DIP from urea did not significantly affect forage DM intake; however, fermentation characteristics changed.

Keywords

Cattlemen's Day, 1995; Kansas Agricultural Experiment Station contribution; no. 95-357-S; Report of progress (Kansas State University. Agricultural Experiment Station and Cooperative Extension Service); 727; Beef; Beef cows; Intake; Rumen fermentation; Forage

Authors

H.H. Köster, R.C. Cochran, E.S. Vanzant, K.K. Kreikemeier, G. St Jean, Evan C. Titgemeyer, and Tiruvoor G. Nagaraja

INFLUENCE OF INCREASING PROPORTION OF SUPPLEMENTAL NITROGEN FROM UREA ON INTAKE AND FERMENTATION CHARACTERISTICS IN BEEF STEERS CONSUMING LOW-QUALITY, TALLGRASS-PRAIRIE FORAGE [1]

H. H. Köster, R. C. Cochran, E. C. Titgemeyer, E. S. Vanzant [2], T. G. Nagaraja, K. K. Kreikemeier [3], and G. St Jean [4]

Summary

Five ruminally and duodenally fistulated Angus × Hereford steers were used to determine intake and fermentation responses associated with increasing the proportion of supplemental degradable intake protein (DIP) provided by urea. Steers had free access to a dormant, tallgrass-prairie forage. The supplemental DIP was provided by sodium caseinate and (or) urea, at a level that was determined previously to optimize use of a similar forage. Supplemental DIP was balanced with corn starch to provide a final supplement of 40% crude protein. Percentages of DIP from urea were: 0, 25, 50, 75, and 100%. Supplements were given intraruminally. Increasing the percentage of urea as supplemental DIP from urea did not significantly affect forage DM intake; however, fermentation characteristics changed.

(Key Words: Beef Cows, Intake, Rumen Fermentation, Forage.)

Introduction

Previous research has demonstrated limited utilization of low-quality forages when concentrations of ruminal ammonia and other microbial nutrients are low. Providing protein sources with a high concentration of degradable intake protein (DIP) like soybean meal addressed such limitations, but these natural protein sources are expensive. To minimize supplement costs, previous research has evaluated the efficacy of non-protein nitrogen (NPN, for example urea) for replacing natural proteins as a supplemental DIP source. Generally, response to NPN as a source of supplemental DIP has been poorer than response to natural protein when fed in supplements for livestock on low-quality forages. However, the NPN level in many previous studies was arbitrarily chosen and often represented a high percentage of the total crude protein. It may be possible to include low levels of urea in range supplements without significant loss of animal performance. This experiment represents the first in a series designed to identify optimal level of urea inclusion in "protein" supplements fed to beef cattle eating low-quality, tallgrass-prairie forage.

Experimental Procedures

Five ruminally and duodenally fistulated Angus × Hereford steers (904 lb) were penned in individual tie stalls with unlimited access to low-quality, tallgrass-prairie forage. Steers were supplemented with an amount of DIP previously determined to maximize utilization of a similar forage (.92 g/kg BW). The DIP (380 g/day) was comprised of sodium caseinate (casein; 90% CP) and (or) urea (287% CP) and was balanced with corn starch (0% CP) to provide a final supplement of 40% CP. Percentages of DIP from urea were: 0, 25, 50, 75, and 100%. The N:S ratio was maintained at 10:1. The total daily supplement was divided into two equal portions, and administered intraruminally at 6:30 AM and 6:30 PM, immediately

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[2]KSU Agricultural Research Center - Hays.
[3]KSU Southwest Research-Extension Center, Garden City.
[4]Department of Clinical Sciences.

before feeding forage. Supplements were given intraruminally because they were powdery and infeasible to pellet. Steers were adapted to diets for 14 days, followed by 4 days of voluntary intake measurement and digesta sampling. Ruminal fluid and DM contents were determined by manually evacuating the rumen just before (0 hour) and 4 hours after feeding and infusing supplements. Fluid dilution rate, pH, ammonia N (NH_3 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

Forage DM intake did not change ($P \geq .40$) with increasing urea levels, indicating that the replacement of natural protein with urea, per se, will not restrict nutrient intake from forages. However, because supplements were given intraruminally, effects on supplement palatability were not evaluated. Other research where high (> 40-50% of the CP equivalent) concentrations of urea have been used in grain-based supplements has reported occasional supplement refusal. If supplement consumption was compromised, forage intake likely would be reduced. The lack of change in forage intake in our study agrees with the lack of treatment effect on ruminal DM and fluid contents ($P \geq .20$) as well as the lack of response for fluid dilution rate ($P \geq .38$). Increasing urea proportions did not affect ($P \geq .12$) pH or total VFA concentration. However, linear increases ($P \leq .02$) in ruminal NH_3 N and molar percent acetate were observed with increasing percentage of urea in supplement. In contrast, all other VFA's decreased ($P \leq .05$) as urea increased, except for propionate, which did not change ($P \geq .18$). In conclusion, although increasing percentage of supplemental DIP from urea did not affect forage DM intake, changes occurred in fermentation characteristics. More information regarding effects of level of urea inclusion on digestion, supplement palatability, and livestock performance is needed.

Table 1. Effect of Increasing Amount of Degradable Intake Protein (DIP) on Intake, Ruminal Contents, Dilution Rate, and Fermentation Characteristics in Beef Steers Fed Dormant Tallgrass-Prairie Forage

	Casein CP:Urea CP (%)						Contrasts[a]		
Item	100:0	75:25	50:50	25:75	0:100	SEM	L	Q	C
Forage DM intake, g/kg $BW^{.75}$	64.2	64.4	61.8	61.9	61.2	2.98	.40	.94	.84
Ruminal DM contents, g/kg BW	20.6	21.0	20.8	21.0	21.9	.62	.20	.56	.56
Ruminal fluid contents, g/kg BW	132.0	126.0	132.0	129.0	135.0	4.64	.51	.38	.68
Fluid dilution rate %/hour	5.34	5.31	5.38	4.73	5.62	.61	.99	.64	.50
pH	6.50	6.43	6.42	6.52	6.52	.06	.48	.32	.41
Ammonia N, mM	3.32	3.24	3.28	4.29	5.48	.70	.02	.24	.19
Total VFA, mM	80.4	88.5	80.3	79.1	83.8	4.17	.85	.99	.12
	mol/100mol								
Acetate	73.4	75.0	76.2	75.6	76.5	.62	<.01	.19	.37
Propionate	15.0	15.1	14.8	15.5	15.7	.43	.18	.47	.98
Butyrate	7.03	6.54	6.19	6.54	6.20	.20	.01	.19	.23
Isobutyrate	1.50	1.16	.99	.84	.61	.07	<.01	.36	.26
Valerate	1.40	1.04	.89	.78	.58	.05	<.01	.05	.08
Isovalerate	1.66	1.16	.95	.77	.42	.09	<.01	.31	.12
Acetate:propionate	4.91	4.96	5.19	4.89	4.93	.18	.97	.42	.80

[a]Probability of a greater F value. L = linear change with increasing DIP, Q = quadratic change with increasing DIP, C = cubic change with increasing DIP.