Slow-Release-Urea and Energy Levels for Cattle Fed Low Quality Roughage

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Story in Brief

A new slow-release-urea compound (SRU) was compared to natural protein and prilled urea in winter supplements for grazing dry, pregnant Hereford cows and in drylot with crossbred heifers fed mature fescue hay. Slow release urea produced lower ($P<.05$) rumen ammonia levels in the grazing cows than urea and was more acceptable ($P<.05$). However, SRU did not improve cow performance and only slightly improved heifer performance over that seen with urea. Urea was poorly utilized by both cows grazing winter range grass and the heifers in drylot. Increasing the level of energy in supplements for the grazing cows improved performance of urea and SRU supplements but not with all natural protein supplements.

Introduction

The rapid breakdown of urea to ammonia in the rumen is the reason that toxicity sometimes occurs when urea is fed. If the ration is mostly roughage, the rapid breakdown of urea may be a further disadvantage since fermentable energy needed by the bacteria for protein synthesis will likely not be adequate during the short time period in which urea remains in the rumen. Slowing the rate at which urea is broken down in the rumen would reduce problems with toxicity and could enhance the utilization of urea for bacterial protein synthesis.

Development of a coated, slow-release-urea (SRU) by Nipak Corporation has made possible the evaluation of sustained ammonia release with beef cattle grazing low quality roughage. Previous work at this station (Lusby *et al.*, 1977; Owens *et al.*, 1978) has shown SRU to be more palatable and less toxic than prilled urea. However metabolism studies (Mizwicki *et al.*, 1978) and range cow trials (Forero *et al.*, 1978) have failed to show a consistent benefit of slow ammonia release over typical daily feeding of prilled urea.

The objectives of this research were to further evaluate SRU with dry, pregnant Hereford cows wintered on native tallgrass range and with growing crossbred heifers maintained in drylot.

Materials and Methods

Cow trial

Eighty-eight dry, pregnant, mature cows were used in a wintering trial to compare soybean meal, SRU and urea as protein sources for range cows. The trial was conducted at the Lake Carl Blackwell Range near Stillwater with little bluestem (*Andropo-*

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Table 1. Supplement compositions, trial 3[a].

Protein source		Soybean meal			Urea		Slow release urea		
% crude protein									
Ingredient (%)	IRN	15	20	40	20	40	20	40	70
Corn, ground	4-02-915	61	49		76.8	53.3	77	52.6	33.0
Cottonseed hulls	0-01-599	4	6		5.2		5.2		
Soybean meal	5-04-604	20	33	87.5		21		19.9	33.0
Alfalfa hay, ground	1-99-118	6	6	8	6	6	5	6	
Molasses, cane	4-04-696	5	5	2.5	5	6	5	6	5
Sodium sulfate	6-04-292	2	1	2	1.1	2.3	1.2	2.3	3.5
Trace mineral mix		.05	.05	.05	.05	.05	.05	.05	.1
KCl		2	0		1.6	2.4	1.5	2.4	4.1
Urea					4.3	8.9			
Slow release urea							5.2	10.7	22.0

[a]Phosphorus offered free choice in 6 mineral feeders containing a 1:1 mixture of salt:dicalcium phosphate.

gon scoparious), big bluestem (*Andropogon gerardi*), Indian grass (*Sorghastrum nutans*) and switch grass (*Panicum virgatum*) as the principal grasses present.

Each protein source (Table 1) was fed at two levels of energy (2 lb of 40 percent crude protein/day or 4 lb of 20 percent crude protein/day). Urea or SRU supplied 62.5 percent of the crude protein in urea-containing supplements. In addition a negative control consisting of 2 lb/hd/day of 15 percent natural protein and a very high protein supplement with 70 percent crude protein, 75 percent of the crude protein from SRU (1.3 lb/day), were fed. All supplements were fed in meal form.

All cows grazed a common pasture and were gathered once daily 6 days/week at 8 a.m. for individual feeding of their supplements. Supplements were offered for 1 hr in covered stalls with refusals recorded daily. Cow weights were taken after overnight withdrawal from feed and water. Rumen fluid for ammonia analysis was taken from each cow at 1 hr and 4 hr post supplement feeding once during January.

The trial period was from December 5, 1977 to March 15, 1978. Snow partially or completely covered the ground for 47 days in January and February. As a result, 15 lb/hd/day prairie hay was fed to all cows in 16 days.

Heifer trial

This study was conducted at the Kerr Foundation, Inc. at Poteau in eastern Oklahoma. Fifty-six 8-9-month-old crossbred heifers were allotted by breed and weight to four supplemental protein treatments: 2/lb/hd/day of 20 percent natural protein (negative control), 2 lb/hd/day of 40 percent natural protein (positive control), 2 lb/hd/day of 40 percent crude protein equivalent (62 percent of crude protein from coated urea), or 2 lb/hd/day of 40 percent crude protein equivalent (62 percent of crude protein from urea). Supplement compositions are shown in Table 2.

Each treatment was replicated three times with replications being heavy, medium and light weight heifers. Medium and light replications (five heifers each) and the heavy replication (four heifers each) were randomly assigned to pens of about 16 feet x 60 feet in size with about a third of each pen covered by a roof. Supplements were offered once daily in feed bunks. Mature fescue hay 8.6 percent crude protein was fed as the roughage source *ad libitum* in portable hay managers in each pen. Hay refusals were weighed back once each week.

Heifers were weighed initially, finally and at 28-day intervals after overnight shrink away from feed and water. All supplements were initially fed as 3/8 inch pellets. However, pelleting resulted in heavy damage to the coating of the coated urea and the coated urea supplement was fed in meal form for the last 56 days of the experiments.

Table 2. Supplement compositions, trial 4.

Protein source % crude protein Ingredient %	20%	40%	40%	40%
Soybean meal	33.0	87.5	21.0	19.9
Alfalfa hay	6.0	8.0	6.0	6.0
Cane molasses	5.0	2.5	6.0	6.0
Sodium sulfate	1.0	2.0	2.3	2.3
Ground corn	49.0		53.3	52.6
Cottonseed hulls	6.0			
Urea			8.9	
Coated urea				10.7
Potassium chloride			2.5	2.4
Trace mineral mix	.05	.05	.05	.05

Table 3. Slow release urea trial, individually fed pregnant cows, 1977-78, OSU.

Protein source	Soybean meal			Urea		Slow release urea			Prob.
lb supp/day	2	4	2	4	2	4	2	1.3	
% C.P.*	15	20	40	20	40	20	40	60	
NH_3, 1 hr (Mg%)	1.8^{b}	5.0^{b}	6.2^{b}	25.9^{a}	26.1^{a}	4.8^{b}	4.9^{b}	5.6^{b}	.001
NH_3, 4 hr (Mg%)	0.5^{e}	3.0^{d}	4.4^{d}	8.8^{b}	14.0^{a}	3.3^{d}	5.6^{cd}	7.3^{bc}	.001
NH_3 decrease (1-4 hr)	-1.3^{c}	-2.0^{c}	-1.7^{c}	-17.1^{a}	-12.1^{b}	-1.5^{c}	$+0.7^{c}$	$+1.7^{c}$	.001
Cow wt change, lb (Dec-Mar)	-68.8^{ab}	-45.0^{a}	-42.7^{a}	-65.9^{ab}	-93.4^{bc}	-75.2^{abc}	-93.1^{bc}	-102.2^{bc}	.001
% supp consumed	99.9^{a}	99.5^{ab}	99.4^{ab}	94.2^{c}	97.2^{b}	99.8^{ab}	99.7^{ab}	97.3^{ab}	.001
Cows/trt, NH_3 data	11	11	10	11	11	10	11	11	
Cows/trt/wt change and supp intake	10	10	9	11	11	10	10	10	

*62.5% of crude protein equivalent from urea in all NPN supplements except SRU with 70% crude protein in which case SRU provided 75% of the crude protein equivalent.
^{abcde}Means on a line with the same superscript letter do not differ ($P<.05$). (Duncans Test).

Results and Discussion

Cow trial

Weight losses for all groups (Table 3) were greater than anticipated due to the unusually severe winter encountered. Cows fed the negative control lost more weight than those fed an isocaloric amount of 40 percent natural protein supplement. This difference approached significance and undoubtedly would have been greater in a "normal" winter. Level of energy did not affect weight losses of cows fed natural protein. Previous work at OSU (Forero, *et al.*, unpublished; Lusby *et al.*, 1976) has shown that cows will reduce forage consumption when supplemental energy is increased. Cow weight losses suggest that urea was poorly utilized in either prilled or SRU form. Increasing the energy level of urea and SRU supplements improved performance in contrast to a lack of energy response seen with natural protein. It should be noted, however, that at best, performance of cows fed urea or SRU was about the same as the negative control. Cows fed 2 lb of 40 percent supplement with urea or SRU lost more ($P<.05$) weight than cows fed 2 lb of 40 percent natural protein supplement.

The 70 percent protein supplement with 75 percent of the crude protein from SRU was fed to evaluate the effect of feeding a slow-release ammonia source as the primary nitrogen supply to the rumen. Apparently nitrogen in the form of ammonia alone was insufficient to meet ruminal protein needs, since this group lost more weight than any other groups.

The SRU was effective in providing a lower level of ammonia in the rumen than was prilled urea (Table 3). Ruminal ammonia levels with SRU were lower ($P<.05$) at both 1 and 4 hr post-feeding than with urea, in agreement with Forero *et al.* (1978). Ammonia levels with all SRU supplements were similar to those produced by natural protein.

Feeding the higher energy level with urea resulted in a significantly faster fall in rumen ammonia between 1 and 4 hr post-feeding, suggesting that higher available energy may have increased the incorporation of ammonia into microbial protein. Increased energy also tended to be associated with faster declines in ruminal ammonia between 1 and 4 hr with SRU, although to a lesser degree than with urea.

Supplements with SRU were more palatable than urea supplements ($P<.05$). More refusals of urea supplements were noted toward the end of the trial suggesting that cows can "sense" urea levels and alter intake accordingly. Similar declines in urea intake were also noted by Forero *et al.* (1978).

Heifer trial

The pelleting process resulted in heavy damage to the coated urea fed the first 28 days of the trial. Therefore, only the last 56 days of the trial evaluated the effects of slow release of rumen ammonia on heifer performance. Although no supplement refusals were noted, heifers required much of the day to consume coated urea when pelleted and the urea supplement, especially toward the end of the trial.

Average daily gains (ADG) for the last 56 days of the study (Table 4) showed that heifers fed the positive control tended to gain the fastest while urea-fed heifers had the poorest gains. Gains for SRU-fed heifers were intermediate between the negative and positive controls.

Hay intakes were similar throughout the trial although heifers fed the 40 percent natural protein and SRU supplements tended to eat more hay than heifers fed the negative control or urea. Although differences in feed efficiency between treatments were large, the differences were not statistically significant ($P<.3$). Pens were the experimental unit for hay intake and feed efficiency allowing only 3 degrees of freedom for each treatment.

Table 4. Heifer gain, hay intake and efficiency for 84 and 56 days, trial 4.

Item	Natural 20% CP	Natural 40% CP	Coated Urea 40% CPE	Urea 40% CPE	Prob.
No. heifers	14	14	14	14	
84 days					
ADG, lb	.65	.82	.67	.61	.12
Hay intake, lb	13.0	13.2	13.7	13.0	.34
Lb hay/lb gain	20.4	16.2	20.6	21.7	.27
56 days					
ADG, lb	.45	.63	.55	.36	.08
Hay intake, lb	14.0	14.2	14.7	14.0	.54
Lb hay/lb gain	32.3	25.8	27.9	45.1	.31

Conversion of hay to gain (last 56 days) was similar between the positive control and coated urea (25.8 vs 27.9 lb hay/lb gain). Heifers fed coated urea showed a 38 percent improvement in conversion of hay to gain over heifers fed urea. These differences in feed efficiency suggest that the digestibility of the hay was improved by the positive control and coated urea.

These data again show that urea was poorly utilized as a nitrogen source for cattle fed roughage. Although SRU tended to be intermediate between soybean meal and urea, differences were too small to make any conclusive statement.

The two studies reported along with the previous work with SRU at this station show that slowing ammonia release alone may not be sufficient to achieve satisfactory utilization of urea. It is probable that the rumen microbes require amino acids, certain volatile fatty acids and other protein precursors as well as a constant ammonia supply. The coating process used to prepare SRU did, however, greatly reduce the possibility of toxicity and did improve the acceptability of urea-containing supplements.

Literature Cited

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