depends upon keeping it in a growing state as long as possible to prevent it from becoming mature. This may be accomplished by proper fertilization, using a stocking rate appropriate to maintain the desired amount of forage and mowing as necessary.

Comparison of NPN Supplements For Dry Native Grass

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Story in Brief

Pregnant and lactating beef cows wintered on dry range grass were individually fed winter protein supplements to evaluate the supplemental value of non-protein-nitrogen (NPN) from feed grade biuret, "pure" biuret, urea and extruded urea-grain and to study the effects of adding relatively high levels of dehydrated alfalfa to biuret and urea supplements. The supplemental value of urea and extruded urea-grain for heifers consuming harvested forages was also evaluated. Steers with rumen cannulas were grazed and fed with the cows and rumen samples were collected to measure the rate and extent of cattle adaptation to biuret.

The NPN source in each supplement provided one-half of the nitrogen in a 30 percent crude protein (CP) supplement and was compared to a negative (15 percent natural protein) and a positive (30 percent natural protein) control supplement. The value of a mixture of urea and biuret (one-half of each) was also evaluated.

Winter weight loss and condition loss were significantly different for the cows receiving the positive and negative control suggesting that the level of protein supplementation was too low for the negative control supplement and additional protein was beneficial.

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It appeared that very little benefit was obtained from NPN in any of the supplements containing 5 percent dehydrated alfalfa, suggesting NPN utilization was poor. There appeared to be a trend for less winter weight and condition loss for cows receiving biuret than for cows receiving urea containing supplements.

Urea supplements were less palatable than those containing biuret. The addition of high levels of alfalfa (40 percent) appeared to improve utilization of urea and biuret.

Steers grazed and fed biuret containing supplements with the cows were able to degrade a considerable amount of biuret 6 days after biuret feeding began and reached near maximum level within 21 days; a high level of biuretolytic activity was maintained throughout the trial even though biuret feeding was frequently interrupted for several days in succession.

Introduction

The use of urea in range supplements has increased in past years due to the increased cost of natural protein. This trend will probably continue in the future as a larger amount of natural protein will be used for human consumption. Urea presently replaces a large portion of natural protein in feedlot rations; however urea is usually utilized very poorly when used to supplement cattle consuming low quality roughage. When urea enters the rumen it is broken down very rapidly and if adequate energy is not available the ammonia produced from urea passes across the rumen wall and a large portion is lost. Also, when relatively large quantities of urea are fed toxicity may develop. Because of the rapid breakdown of urea, methods to slow down the ammonia release from urea and other NPN compounds that have a slower ammonia release, such as biuret, have been investigated.

Processing urea by heating and extruding it with grain appears to slow down ammonia release. When feeding urea with high roughage diets the slow ammonia release would be advantageous to improve urea utilization by increasing microbial protein synthesis and reducing the danger of urea toxicity.

Considerable research has been conducted with various other NPN compounds that alleviate some of the disadvantages of urea. Of those investigated biuret appears to be most promising. Biuret is synthesized by joining two molecules of urea and is broken down more slowly than urea in the rumen and toxicity does not appear to be a problem. Biuret has the disadvantage that the rumen microorganisms must develop the ability to break it down and limited research conducted in the laboratory indicates that the length of adaptation may be 3 to 6 weeks. Research

concerning adaptation of the rumen microorganisms to biuret by cattle grazing low quality forage is lacking.

Urea is currently less expensive than feed grade biuret, therefore methods to improve its utilization under range conditions should continue to be investigated. Alfalfa has consistently improved urea utilization when included in supplements at a low level. Limited research suggests that high levels of dehydrated alfalfa may provide additional benefit for NPN utilization.

Commercial feed grade biuret contains approximately 15 percent urea and it appears that a combination of urea and biuret may be beneficial. Hydrolysis of biuret occurs at approximately the same rate as the availability of energy from low quality roughages.

The purpose of this trial was to compare the supplemental value of NPN from feed grade biuret, "pure" biuret, urea and extruded urea-grain in supplements for cattle consuming low quality roughages and to determine the effects of adding high levels of alfalfa to biuret and urea supplements. The rate and extent of biuret adaptation by steers grazing winter range grass was also investigated.

Procedure

Trial 1.

Trial 1 was conducted at the Lake Carl Blackwell Range located 10 miles west of Stillwater. The predominant forage was of the tallgrass prairie type with climax species consisting of little bluestem, tall bluestem, Indian and switch grass. Since these grasses were dormant during the wintering period the major portion of the cows' diet consisted of dry weathered grass. When severe weather prevented the feeding of protein supplements, prairie hay was fed; this occurred on 22 days of the 112 day wintering period.

The experimental cattle were 81 Hereford, 44 Angus and 39 Angus x Holstein crossbred cows that calved from October 6, 1972 to February 23, 1973 with an average calving date of December 14, 1972. The calves were weaned August 14, 1973 and the cows were weighed and pregnancy tested at that time. Hereford cows were artificially inseminated for 72 days and pasture exposed for 77 days; Angus cows were exposed by natural service for 127 days.

The composition of the protein supplements is shown in Table 1. Two supplements (1 and 2) contained 15 and 30 percent natural protein and served as negative and positive control supplements, respectively. The other protein supplements contained 30 percent CP with one-half (15 percent) being natural protein and the other one-half coming from a non-protein-nitrogen source. In supplement 7 urea was present in a

Table 1. Ingredient Makeup of Protein Supplements[1] (Percent)

Ingredient	Supplement, % CP									
	1 Neg. control 15	2 Pos. control 30	3 Feed grade biuret[2] 30	4 Biuret[3] 30	5 Urea 30	6 Biuret + urea 30	7 Extruded urea 30	8 Biuret + alf. 30	9 Urea + alf. 30	10 Extruded urea 30
Milo	64.3	23.8	50.6	53.2	55.1	54.5	34.7	27.5	29.4	37.2
Soybean meal, sol (44%)	16.9	57.5	21.3	19.3	18.8	18.9	18.9	10.5	10.1	17.8
Alfalfa, dehydrated	5.0	5.0	5.0	5.0	5.0	5.0	5.0	40.0	40.0	5.0
Molasses, blackstrap	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Wheat middlings	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Biuret	-----	-----	7.47	6.73	-----	2.92	-----	6.73	-----	-----
Urea	-----	-----	-----	-----	5.31	2.92	-----	-----	5.31	-----
Extruded grain-urea[4]	-----	-----	-----	-----	-----	-----	25.5	-----	-----	24.12
Dicalcium phosphate	1.13	0.73	1.10	1.12	1.12	1.12	1.13	-----	-----	1.14
Monosodium phosphate	2.58	2.36	2.66	2.67	2.66	2.66	2.70	3.67	3.66	2.66
Sodium sulfate[5]	-----	0.63	1.92	1.97	1.97	1.98	1.98	1.59	1.59	2.02
Trace minerals	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05

[1] Formulated on 90% dry matter basis, vitamin A added to all supplements to supply 10,000 IU per kilogram.
[2] Approximate chemical composition (dry weight basis): biuret 60%, urea 15%, cyanuric acid 21% and total nitrogen 37%.
[3] Approximate chemical composition (dry weight basis): biuret 91.3%, urea 7.9%, cyanuric acid 0.8%, and total nitrogen 37.1%.
[4] Formulated to contribute 5.31% urea in supplement. The remaining portion of the product was gelatinized grain.
[5] Formulated to supply 14:1 nitrogen:sulphur ratio.

urea-grain extruded mixture; however, the mixture contributed 5.31 percent urea which was the same level as present in the other urea containing supplements. All supplements were formulated to contain 1.25 percent phosophorus, 0.5 percent calcium and a nitrogen:sulfur ratio of 14:1. The supplements were initially processed into ¼ in. pellets; however, due to problems encountered in processing the supplements containing the extruded urea-grain mixtures they were fed in the meal form during the last part of the trial. The amount of supplement offered per cow at each feeding was 2.33 and 4.66 lb. for the Hereford and Angus cows and 3.5 and 5.8 lb. for the crossbred cows, before and after calving respectively. Some of the supplements were not palatable and the cows did not consume the entire amount offered during the 20 minutes allowed. The amount of feed refused was weighed each day and discounted from feed intake. The calves were creep-fed dehydrated alfalfa pellets during the wintering period. The cows were gathered daily (except Sunday) and fed the supplements individually in 3 x 8 ft. stalls.

Since the number of cows which calved previous to the trial was not equal for all treatments, the initial weight of the cows that had calved before the trial started were adjusted to a pregnant weight basis with the following formula:

Adjusted initial weight = Actual initial weight + (calf birth weight × 1.9697 — 19.0)

At the initiation and conclusion of the trial the cows were scored for condition on a scale of 1 to 9 with 1 being the thinnest and 9 the fattest.

Trial 2.

A trial was conducted during the summer for 93 days wherein the supplemental value of urea and urea-milo was compared to an all-natural protein supplement. Twenty-seven Hereford (9 head) and Hereford x Angus-Holstein (18 head) yearling heifers were used in the trial.

The trial was divided into two phases with early cut tallgrass prairie hay (5 percent CP) fed during the first phase (44 days) and low quality late cut winter range grass (3.9 percent CP) that was cut in early April fed during the second phase (44 days). The late cut range grass was used to simulate the poor quality dry range grass consumed by cattle grazing native range during the winter. Nine heifers (three from each treatment) were maintained in each of three lots and the hay was group fed free choice in each pen.

The three protein supplements (No. 2, 5 and 10) shown in Table 1, were fed individual twice daily at the rate of 1 lb. per head per feeding. At the end of each feeding phase the heifers on each treatment were maintained in separate lots and the intake of hay was measured for 5 days.

The change in condition of the heifers was measured in the same manner as in trial 1.

Biuret Adaptation Trial

Nine mature steers were used to measure the rate and extent of adaptation of rumen microorganisms to biuret when grazed under winter range conditions. The steers were allowed to graze with the cows in trial 1 and were fed supplements 2, 4 and 8 (Table 1) individually and managed in the same manner as the cows in trial 1. The steers were fed supplements the first 74 days of trial 1 at the rate of 3.5 lbs. per feeding.

Rumen samples were collected from the steers on days 0, 4, 6, 17, 20, 28, 34, 49 and 74 of the experiment. The extent of biuretolytic activity or the "adaptation" of the rumen microorganisms was determined by measuring the disappearance of biuret from each rumen sample after 8 and 24 hours of incubation in a water bath (103°F).

Results and Discussion

Trial 1.

The results of trial 1 are shown in Table 2 and Figure 1. Cows consuming the positive control supplement lost significantly less weight and condition than cows receiving the negative control. This indicates that protein was deficient on the negative control supplement and additional protein supplementation was beneficial.

Weight and condition loss of the cows consuming the NPN supplements with 5 percent alfalfa was excessive for all treatments and comparable to the weight and condition loss encountered with the cows consuming the negative control supplement. This suggests that the utilization of the NPN in the supplements was at a low level. A combination of urea and biuret did not appear to be beneficial. The winter weight loss of the cows receiving the biuret containing supplements tended to be less than that of cows fed comparable supplements containing urea.

The urea containing supplements were lower in palatability and this may account for larger weight and condition loss of cows fed the urea containing supplements. Because the intake of the urea containing supplements was at a lower level, analysis of covariance, a statistical procedure, was used to adjust the weight and condition loss treatment means of the cows to an equal supplement intake basis. After correcting for the lower supplement intake the weight loss for the cows receiving the urea containing supplements with 5 percent alfalfa was approximately the same as that of cows receiving the negative control.

Processing urea by extruding it with a grain did not appear to be of any benefit. The extruded urea supplement was less palatable than

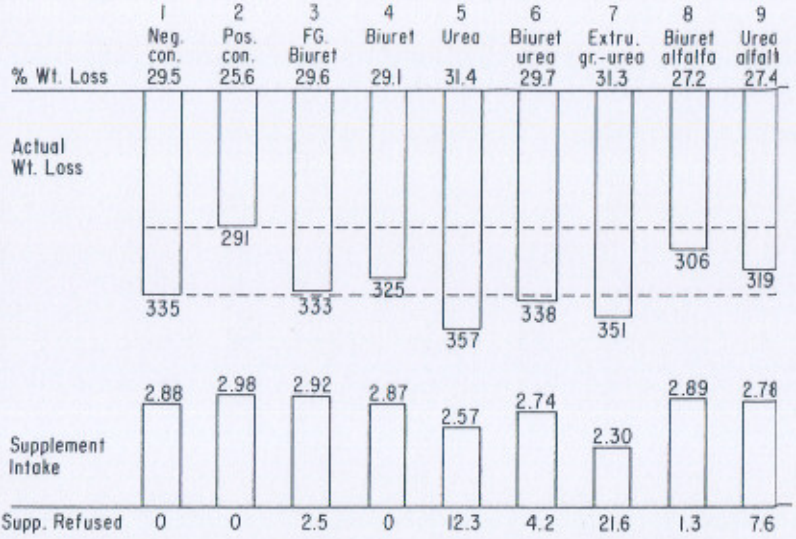

Figure 1. Weight loss and supplement intake for cows in trial 1.

the supplement containing an equivalent amount of unprocessed urea as indicated by greater supplement refusal (12.3 *vs.* 21.6 percent). The weight loss of cows fed urea and extruded urea-grain supplements was approximately equal; however, weight loss was excessive for both treatments suggesting that the utilization of urea in both supplements was poor.

It appears that high levels (40 percent of supplement) of dehydrated alfalfa meal was beneficial as the weight loss of cows fed the supplements with high levels of dehydrated alfalfa was lower than that of cows fed comparable supplements containing 5 percent dehydrated alfalfa and was intermediate between the cattle receiving the negative and postive control supplements.

The cows losing the most weight during the winter were able to compensate for the large winter weight loss and gained the most weight during the spring and summer, consequently the fall weights of the cows were similar. The supplemental treatments did not appear to affect the average daily gain or the weaning weight of the calves.

Table 2. Supplement Intake and Cow and Calf Performance

Item	Supplements 1 Negative control	2 Positive control	3 Feed grade biuret	4 Biuret	5 Urea	6 Biuret + urea	7 Extruded grain-urea	8 Biuret + alfalfa	9 Urea + alfalfa
No. cows	19	20	19	16	19	18	18	19	16
Daily supplement consumer, lb.	2.88	2.98	2.92	2.87	2.57	2.74	2.30	2.89	2.78
Supplement refused, %	0	0	2.5	0	12.3	4.2	21.6	1.3	7.6
Cow weight									
Adjusted initial, lb.[1]	1118	1121	1113	1101	1130	1116	1152	1147	1193
Winter loss, lb.	335[7 9]	291[9 10]	333[7 8]	325[7 8]	357[7]	338[7 8]	351[7 4]	306[8 9 10]	319[8 9 10 11]
Winter loss, %[2]	29.5[7 8]	25.6[9]	29.6[7 8]	29.1[7 8 10]	31.4[7]	29.7[7 8]	31.3[7]	27.2[9 10]	27.4[8 9 10]
Summer gain, lb.[3]	162[7 8]	119[9]	160[7 8]	146[7 9]	166[7 8]	157[7 8]	171[7]	135[8 9]	140[8 9]
Condition score[4]									
Initial	5.53[8 6 9]	5.35	5.26[7 9 11]	5.25[7 10 12]	5.58	5.83	5.94	5.74	6.13
Winter loss	2.91[7 8 9]	2.27[10]	2.77[7 9 10]	2.81[7 10 12]	3.43[8 9 12 13]	3.50[8 13 14]	3.55[13]	2.87[9 10 14]	6.13[7 8 9 11 13]
Calf Performance									
Daily gain, lb.[5]	1.20	1.35	1.22	1.33	1.19	1.18	1.09	1.28	1.12
Adjusted weaning wt., lb.[6]	447	444	436	438	443	448	437	461	441

[1] Initial weights of mature cows that calved before the treatment started were adjusted to a pregnant basis by the following formula: Adjusted initial weight = actual weight + ((calf birth weight × 1.9697) − 19.0).
[2] Percent of the adjusted initial weight lost on winter treatment.
[3] Gain from end of treatment to the weaning date of calf.
[4] Based on a scale of 1 to 9 with 1 being the thinnest and 9 the fattest.
[5] Gain from birth to end of treatment.
[6] Adjusted to 205-day, steer equivalent basis.
[7, 8, 9, 10, 11, 12, 13, 14] Means with different superscripts are significantly different ($P<.05$).

Trial 2.

The weight gain of the heifers shown in Table 3 did not appear to be markedly affected by the different protein supplements during the first phase of the trial; however, the heifers fed all-natural supplement gained slightly more than heifers on the urea containing supplements. When the late cut range grass was fed, during the second phase of the trial, the heifers that received the all-natural protein supplement lost significantly less than heifers fed the urea-containing supplements. When both phases of the experiment were combined the heifers fed all-natural protein gained significantly more; however, the heifers fed the two urea supplements were not significantly different. As was found in Trial 1 the processing of urea by extruding it with grain did not appear to be of any benefit.

Forage intake was not affected by type of supplement in either phase. Heifers receiving all-natural protein maintained approximately the same level of condition during the trial while heifers fed the other two supplements lost a small amount.

Biuret Adaptation Trial

The amount of biuretolytic activity in the rumen of the heifers, which was estimated by measuring the disappearance of biuret in the

Table 3. Performance and Hay Intake of Heifers In Trial 2

Item	Supplements 2 Positive control	5 Urea	10 Extruded urea-grain
	Phase 1 - Prairie hay (5.0% CP)		
No. heifers	9	9	9
Initial wt., lb.	514	519	516
Wt. gain (44 days), lb.	68	62	58
Hay intake (5 days), lb.	18.7	19.4	19.6
	Phase 2 - Late cut range grass (3.9% CP)		
Wt. loss (44 days), lb.	1[a]	18[b]	20[b]
Hay intake (5 days), lb.	14.7	14.1	23.8
	Both Phases combined		
Wt. gain (93 days), lb.	64[a]	43[b]	36[b]
Condition score[1]			
Initial	3.33	3.11	3.22
Loss	0	0.44	0.66
Hay intake (10 days), lb.	16.7	16.7	16.7

[1] On a scale of 1 to 9 with 1 being the thinnest and 9 the fattest.
[a, b] Means with different superscripts are significantly different ($P<.05$)

rumen fluid of steers during a 24 hr. *in vitro* fermentation period, is shown in Figure 2. Very little biuret was degraded by the rumen fluid collected on days 0 and 4 of the trial. By day 6 the steers supplemented with the biuret containing supplements were able to degrade a large amount of biuret. Due to severe weather during the winter of 1972-73 protein supplements were not fed from day 7 to day 16 (9 days) and some of the biuretolytic activity was lost by day 17. The supplemental feeding pattern continued to be intermittent; however, the steers maintained a relatively high level of biuretolytic activity from day 20 to the end of the trial. The steers fed supplements without biuret did not develop an appreciable amount of biuretolytic activity during the entire trial.

This trial suggests that cattle grazing low quality forage were able to degrade a large portion of biuret 6 to 20 days after it was first fed. Also the steers were able to maintain a relatively high level of biuretolytic activity although the supplement feeding pattern was intermittent. Biuret is degraded more slowly than urea and this may explain why the winter weight and condition loss of the biuret supplemented cows was less than that of the cows supplemented with urea.

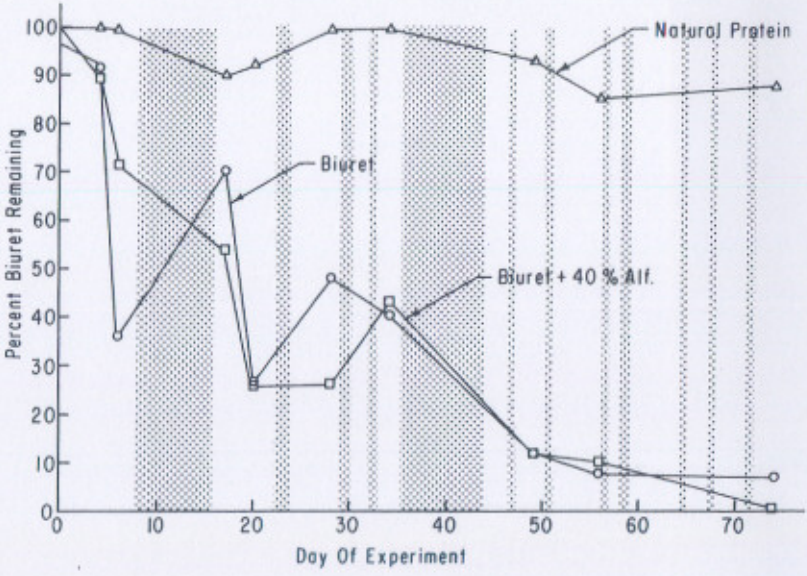

Figure 2. The amount of biuetolytic activity in the rumen of steers.