1972

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A.S. Series 72-25

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Efficiency of urea utilization may be affected by several factors. Among these are level and source of energy, level and source of protein and amount of urea in the total diet and in the supplement. Other essential nutrients in the diet should be properly balanced. There has been a tendency in recent years to use higher levels of urea than was earlier recommended. Under some conditions, urea has been satisfactory as the only supplemental protein to diets for cattle. However, consideration should be given to likely problems of palatability and potential toxicity as well as to efficiency of urea utilization.

Research on feeding urea has been extensive and varied. Much interest has been shown in amino acid supplementation since protein needed by animals is a need for amino acids. Some experiments have shown that the sulfur-containing amino acids are the first limiting ones when ruminants are fed diets with urea furnishing the major source of nitrogen. It has also been shown that rumen microorganisms are able to synthesize the sulfur-containing amino acids when adequate sulfur is present. Sulfur content of feeds appears to be closely related to the protein content. Substituting urea for preformed protein lowers the sulfur content of diets and a supplemental source may become necessary.

The objectives of this experiment were to study the effects of sulfur and methionine hydroxy analog additions to diets when urea was used as the supplemental protein. A diet of ground ear corn was selected. The grain portion furnished a relatively high concentrate diet and the cob portion furnished a low protein roughage. Neither are considered of high quality protein as measured in terms of amino acid content in relation to requirements for nonruminants. A low protein feed was desired in order to use a substantial quantity of urea.

Procedures

Ninety-six Hereford steers were used in the experiment. They received a full feed of alfalfa-bromegrass haylage for about 3 weeks prior to starting on the trial. The cattle were allotted into 12 pens of 8 each for 6 replicated treatments as follows:

1. Soybean meal control
2. Urea
3. Urea + sodium sulfate
4. Urea + calcium sulfate
5. Urea + methionine hydroxy analog
6. Urea + sodium sulfate + methionine hydroxy analog

Prepared for the Sixteenth Annual Cattle Feeders Day, October 27, 1972.

Diets consisted of ground ear corn and 2 lb. per head daily of protein supplement. The dietary treatments were provided by the protein supplements. Urea supplements were formulated using corn grain, feed grade urea (45% N), limestone and dicalcium phosphate to be approximately equal to the soybean meal supplement in protein, calcium and phosphorus contents. Inorganic sulfur, when included in the urea supplements, was added to provide 1 part sulfur to 10 parts nitrogen from urea. Methionine hydroxy analog was included in the supplements to provide 3 grams per head daily for this treatment. Calcium sulfate and sodium sulfate were the sources of sulfur. When calcium sulfate was used, the calcium level was adjusted to that of the other supplements by reducing the amount of limestone added. Chemical and ingredient compositions of the supplements are shown in tables 1 and 2.

Ground ear corn fed for the first 3 months of the experiment was field harvested at approximately 30% moisture. It was ground with a hammer mill and stored in an upright concrete stave silo. The silo was refilled after this time with ear corn with water added to give a final moisture content of about 20 percent.

The cattle were fed 5 lb. per head daily of the ear corn at the beginning of the experiment. Amount of ear corn offered was increased by 1 lb. per head daily until a full feed was reached. Thereafter, it was fed in amounts to be nearly consumed by the next feeding. Feeding was once daily in outside, paved pens without access to shade or shelter.

The experiment was terminated after 224 days. The cattle were not marketed until 4 weeks later. Results are presented only for weight and feed data during the 224-day experiment.

Results

Results of the feedlot performance are shown in table 3. Performance of the steers fed a ground ear corn diet was good for all treatments with an average daily gain of 2.72 pounds.

All supplements were calculated to be isonitrogenous, and approximately 80% of the nitrogen was furnished by urea in the supplements containing this ingredient. This amount of urea provided about 25% of the total dietary nitrogen. It presented no apparent palatability problems, and weight gain for the urea control supplement was about equal to that from soybean meal. The slightly higher feed intake for steers fed the urea supplement with about the same rate of gain as for those fed soybean meal resulted in a slight increase in feed requirements which was statistically significant ($P<.05$). This would indicate that urea as the primary supplemental protein to the ground ear corn diet did not affect weight gain but that it was utilized slightly less efficiently than soybean meal.

Highest rates of gain were obtained when the urea-containing supplements were supplemented with calcium sulfate or sodium sulfate. The differences amounted to an average of only about 3% compared to the urea control and were not statistically significant. Results on weight gain were essentially the same for the two sulfur compounds.

Feed intake was slightly lower when sulfur was added to the urea supplement. This lower feed intake with slightly higher rate of gain resulted in lower feed requirements for the sulfur-supplemented steers in comparison to the urea control ($P<.05$).

The calculated ratio of sulfur to nitrogen in the urea control diet was 1 to 19.1. The sulfur additions reduced the ratio to about 1 to 15.7. While this resulted in a more favorable ratio of sulfur, the diets might still be considered borderline in sulfur in relation to a ratio considered to furnish adequate sulfur (about 1:10 to 1:12 by some researchers).

When methionine hydroxy analog was added to provide 3 grams per head daily with the urea supplement or with urea plus sodium sulfate, rate of gain was about the same as for steers fed the urea control supplement. Feed consumption was slightly lower than for the urea control and feed requirements were reduced slightly, being statistically significant ($P<.05$) for the methionine plus sodium sulfate treatment.

Summary

Urea-containing supplements with urea providing most of the supplemental protein and about 25% of the total dietary nitrogen to a ground ear corn diet for finishing steers resulted in about the same rate of gain as was obtained from soybean meal. Feed intake was slightly greater for the urea supplement resulting in slightly higher feed requirements. Results indicate that the urea had no effect on weight gain in comparison to soybean meal but that it was used less efficiently.

Additions of sulfur as calcium sulfate or sodium sulfate to furnish 1 part sulfur to 10 parts of nitrogen from the urea resulted in slightly higher (not statistically significant) weight gains. The improvement amounted to only about 3 percent. Feed intake was slightly lower when sulfur was added and there was an improvement in feed efficiency in comparison to the urea control. The two sources of sulfur appeared to be about equal.

No improvement in rate of gain resulted from adding methionine hydroxy analog to the urea diets, either with or without added sulfur. There was a slight reduction in feed requirements in comparison to the urea control, being lower ($P<.05$) for methionine plus sulfur.

While effects of sulfur supplementation to the urea diet were quite small in the experiment, the results were consistent. Diets apparently were not seriously deficient in sulfur before supplementation and large improvements probably should not be expected. Because of the apparent close relationship between sulfur and nitrogen contents of feeds and requirements of cattle, it would appear that sulfur supplementation is advisable when urea is substituted for preformed protein.

Table 1. Chemical Composition of Ear Corn and Protein Supplements (Moisture-Free Basis)

	Ground ear corn	Soybean control	Urea control	Urea + sodium sulfate	Urea + calcium sulfate	Urea + MHA[a]	Urea + sodium sulfate + MHA[a]
	%	%	%	%	%	%	%
Protein	9.25	40.84	42.96	40.19	43.21	43.19	42.44
Calcium	0.012	4.79	4.00	3.24	4.68	3.78	3.46
Phosphorus	0.28	0.54	0.67	0.24	0.67	0.69	0.58
Sulfur	0.092	0.318	0.143	0.789	0.602	0.189	0.866
Calculated nitrogen to sulfur ratio	16.29	20.53	48.04	8.15	11.48	36.56	7.84

[a]Methionine hydroxy analog.

Table 2. Ingredient Composition of Supplements for Experiment

Ingredient	Type of supplement					
	Soybean control	Urea control	Urea + sodium sulfate	Urea + calcium sulfate	Urea + MHA[a]	Urea + sodium sulfate + MHA[a]
	%	%	%	%	%	%
Soybean meal	85.53	--	--	--	--	--
Ground corn	--	72.93	70.73	71.53	72.60	70.40
Urea (281%)	--	11.10	11.10	11.10	11.10	11.10
Limestone	8.80	8.30	8.30	6.70	8.30	8.30
Trace mineral salt	5.00	5.00	5.00	5.00	5.00	5.00
Dicalcium phosphate	--	2.00	2.00	2.00	2.00	2.00
Antibiotic premix[b]	0.35	0.35	0.35	0.35	0.35	0.35
Diethylstilbestrol premix[c]	0.25	0.25	0.25	0.25	0.25	0.25
Vitamin A premix[d]	0.07	0.07	0.07	0.07	0.07	0.07
Sodium sulfate	--	--	2.20	--	--	2.20
Calcium sulfate	--	--	--	3.00	--	--
Methionine hydroxy analog	--	--	--	--	0.33	0.33

[a]Methionine hydroxy analog.
[b]Chlortetracycline at 35 mg. per pound of supplement.
[c]Diethylstilbestrol at 5 mg. per pound of supplement.
[d]10,000 I.U. vitamin A per pound of supplement.

Table 2. Ingredient Composition of Supplements for Experiment

Ingredient	Type of supplement					
	Soybean control	Urea control	Urea + sodium sulfate	Urea + calcium sulfate	Urea + MHA[a]	Urea + sodium sulfate + MHA[a]
	%	%	%	%	%	%
Soybean meal	85.53	--	--	--	--	--
Ground corn	--	72.93	70.73	71.53	72.60	70.40
Urea (281%)	--	11.10	11.10	11.10	11.10	11.10
Limestone	8.80	8.30	8.30	6.70	8.30	8.30
Trace mineral salt	5.00	5.00	5.00	5.00	5.00	5.00
Dicalcium phosphate	--	2.00	2.00	2.00	2.00	2.00
Antibiotic premix[b]	0.35	0.35	0.35	0.35	0.35	0.35
Diethylstilbestrol premix[c]	0.25	0.25	0.25	0.25	0.25	0.25
Vitamin A premix[d]	0.07	0.07	0.07	0.07	0.07	0.07
Sodium sulfate	--	--	2.20	--	--	2.20
Calcium sulfate	--	--	--	3.00	--	--
Methionine hydroxy analog	--	--	--	--	0.33	0.33

[a]Methionine hydroxy analog.
[b]Chlortetracycline at 35 mg. per pound of supplement.
[c]Diethylstilbestrol at 5 mg. per pound of supplement.
[d]10,000 I.U. vitamin A per pound of supplement.

Table 3. Sulfur and Methionine Supplementation With Urea for Feedlot Cattle (February 17 to September 29, 1971 - 224 Days)

Item	Type of supplement					
	Soybean control	Urea control	Urea + sodium sulfate	Urea + calcium sulfate	Urea + MHA[a]	Urea + sodium sulfate + MHA[a]
Number of steers	16	15	15	16	16	16
Initial shrunk wt., lb.	484	486	480	490	487	484
Final shrunk wt., lb.	1092	1091	1099	1112	1089	1084
Avg. daily gain, lb.	2.71	2.70	2.76	2.78	2.69	2.68
Avg. daily feed, lb.						
Ground ear corn	20.7	21.4	20.7	20.6	20.7	20.3
Protein supplement	2.0	2.0	2.0	2.0	2.0	2.0
Total	22.7	23.4	22.7	22.6	22.7	22.3
Feed per 100 lb. gain, lb.	835[b]	865	823[b]	814[c]	844	834[b]

[a]Methionine hydroxy analog.
[b]Significantly different (P<.05) from urea control.
[c]Significantly different (P<.01) from urea control.