Soluble Non-Protein Nitrogen and High Moisture Corn Utilization

E. C. Prigge, R. R. Johnson[1]
N. A. Cole and D. E. Williams[2,3]

Story in Brief

Two trials were conducted to determine the influence of high levels of soluble non-protein nitrogen in ground high moisture corn on nitrogen utilization. Four fistulated Holstein steers were fed rations containing approximately 80 percent corn in the dry or high moisture form with either soybean meal (SBM) or urea supplements. The levels of soluble non-protein nitrogen for the dry corn + SBM, dry corn + urea, high moisture + SBM and high moisture corn + urea rations were 35, 52, 73 and 92 percent of the total nitrogen, respectively. Peak rumen ammonia levels were higher ($P<.05$) with dry corn + urea ration.

Plasma urea levels were higher for steers when fed the dry corn ration than when fed the high moisture rations. Urea appeared to be utilized more efficiently with ground high moisture corn rations. A second trial was conducted in which twelve ram lambs were fed a nitrogen depletion ration for 3 weeks after which they were assigned to the rations used in trial 1. Lambs fed high moisture corn produced ($P<.05$) less urinary nitrogen and retained a greater percent of absorbed nitrogen than those fed dry corn rations. This further suggests that nitrogen in high moisture corn rations can be utilized efficiently even though it is high in soluble non-protein nitrogen.

Introduction

High moisture corn is becoming increasingly important in the feedlot industry. This method of corn storage has proven to be economical and energetically efficient when fed to ruminants. Protein of high moisture grain during storage changes from insoluble to high soluble forms and much of the protein is degraded to non-protein nitrogen (NPN). Instances of reduced feeding value of high moisture corn have been attributed to this solubilization of nitrogen.

Depressed appetites and poor gains have been observed in feedlot cattle when levels of soluble nitrogen became excessive. Cattle feeders

[1] Present address: Head Dept. of Animal Science, University of Tennessee, Knoxville, Tennessee 37900.
[2] Grain Utilization Research, Garden City, Kansas 67846.
[3] The authors greatfully acknowledge the technical assistance of T. Watson, W. Zearfoss and S. Schuermann.

are therefore reluctant to add additional NPN sources, such as urea, to high moisture corn rations, since urea would further increase soluble NPN levels and accentuate the feeding problems. In addition research suggests that use of NPN is limited in rations in which a high percentage of nitrogen is in the soluble form and proteins of low solubility are utilized less efficiently than proteins of high solubility. These observations suggest that the nitrogen of high moisture corn grain would be utilized poorly.

The objective of this study was to determine: 1) if urea can be well utilized when fed with high moisture corn and 2) if the high percentages of soluble NPN reduce efficiency of protein utilization.

Materials and Methods

The rations used in both trials of this study consisted mainly of ground high moisture corn or dry corn (Table 1). Soybean meal or urea were supplemental crude protein sources. The chemical composition of the rations are listed in Table 2. The soluble NPN content was determined in an aqueous buffer solution using sodium tungstate to precipitate the soluble protein. The solution NPN levels (Table 2) ranged from 35 percent of the total N for the dry corn (DC) + SBM ration to 92 percent for the high moisture corn (HMC) + urea ration.

Trial 1 was conducted to determine if increasing levels of soluble NPN in fermented grains would contribute to high rumen ammonia (NH_3-N) levels which might in turn limit both consumption and the ability of urea to be utilied with these rations. Rumen and blood samples were taken from four mature rumen fistulated Holstein steers fed either

Table 1. Ration Composition[1]

Ingredient	Ration			
	DC, SBM	DC, Urea	HMC, SBM	HMC, Urea
Corn	76.81	80.24	76.81	80.24
Corn Silage	15.00	15.00	15.00	15.00
Alfalfa Dehy., 17%	0.70	0.70	0.70	0.70
Soybean meal	5.75	1.72	5.75	1.72
Urea	---	0.60	---	0.60
Dicalcium Phosphate	0.20	0.20	0.20	0.20
$CaCO_3$	1.00	1.00	1.00	1.00
KCl	0.24	0.24	0.24	0.24
T. M. Salt	0.30	0.30	0.30	0.30
Aurofac-50	240 mg/kg	240 mg/kg	240 mg/kg	240 mg/kg
Vitamin A	220 mg/kg	220 mg/kg	220 mg/kg	220 mg/kg

[1] On dry matter basis.

Table 2. Chemical Composition of the Rations

Constituent	Ration			
	DC, SBM	DC, Urea	HMC, SBM	HMC, Urea
Dry Matter	73.4	73.1	61.0	61.9
ADF %[1]	8.2	7.1	8.5	7.3
Crude Protein %[1]	12.1	12.2	12.3	12.2
Soluble NPN %[2]	34.9	52.3	72.9	92.0

[1] DM basis.
[2] Percent of total nitrogen.

the DC + SBM, DC + urea, HMC + SBM or HMC + Urea rations for one sampling period. Samples were taken prior to feeding (0 hours) and at .5, 1, 2, 4, 6 and 8 hours after offering feed. Levels of ammonia, pH were determined on the rumen samples and urea in blood samples.

After the initial 10 day preliminary and 5 day sampling period the steers were switched to another ration for 15 days and again sampled twice during the last five days of this period. This was continued until all steers were sampled on all rations. On sampling days the steers were fed the assigned ration in amounts equivalent to that consumed on the dry corn+SBM ration as determined in a preliminary period. If the total ration was not consumed within 30 minutes after feeding, the remaining portion was fed through a rumen fistula. This procedure was used to assure comparable consumption and zero times for sampling.

Utilization of nitrogen for the rations used in trial 1 were determined in trial 2 using 12 western type ram lambs averaging 72 lbs. A nitrogen depletion-repletion balance trial was used. The rams were fed a depletion ration which was fairly high in energy, but contained only 2.3 percent digestible protein, for three weeks. Such depletion increases the sensitivity of the lambs to the differences in proteins. After the depletion phase, the lambs were randomly assigned to one of the four rations used in trial 1 and allowed 10 days to adapt to the ration changes. The repletion phase lasted four weeks during which samples of the ration, feces and urine were taken and nitrogen balance was determined.

Results and Discussion

The rumen pH values of the steers on the various rations (Figure 1) agree with previous observations in this laboratory with a characteristically high pH depression for high moisture corn. The levels of rumen NH_3-N (Figure 2) were not as expected. Rumen NH_3-N levels have been generally related to the solubility of the protein content of rations, but

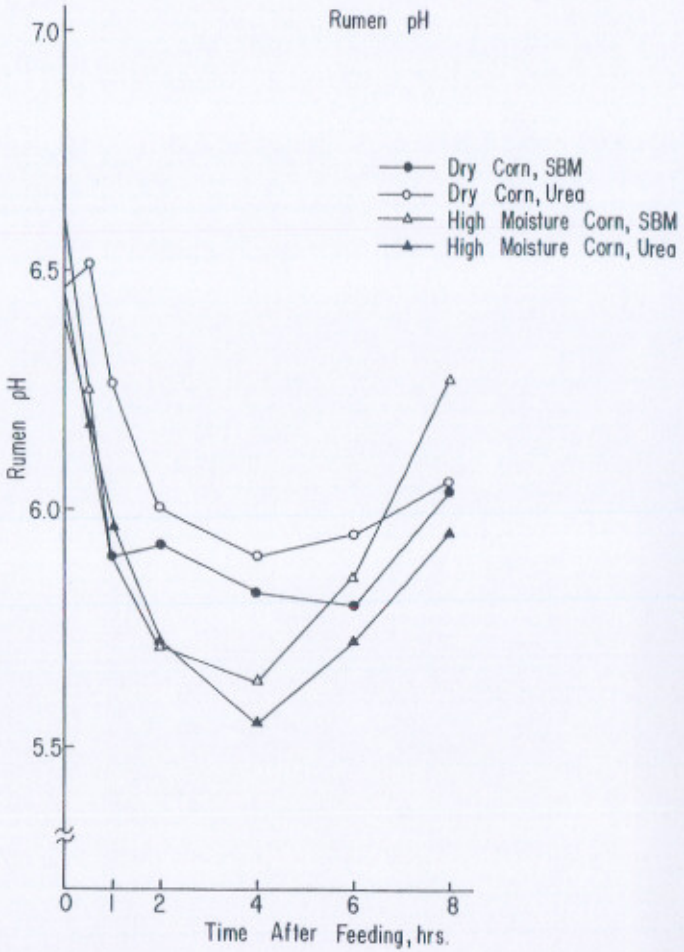

Figure 1. Rumen pH of steers fed ground dry corn supplemented with SBM or urea and ground high moisture corn supplemented with SBM or urea.

this study indicated that the dry corn + urea ration, with less soluble NPN then either of the high moisture corn rations, had greater ($P<.05$) rumen NH_3-N levels than other rations. This finding suggests that urea can be utilized efficiently in high moisture corn rations despite higher dietary levels of soluble NPN.

The plasma urea levels (Figure 3) were greater ($P<.01$) 2 hours post-feeding with the dry corn rations, suggesting greater absorption of NH_3-N

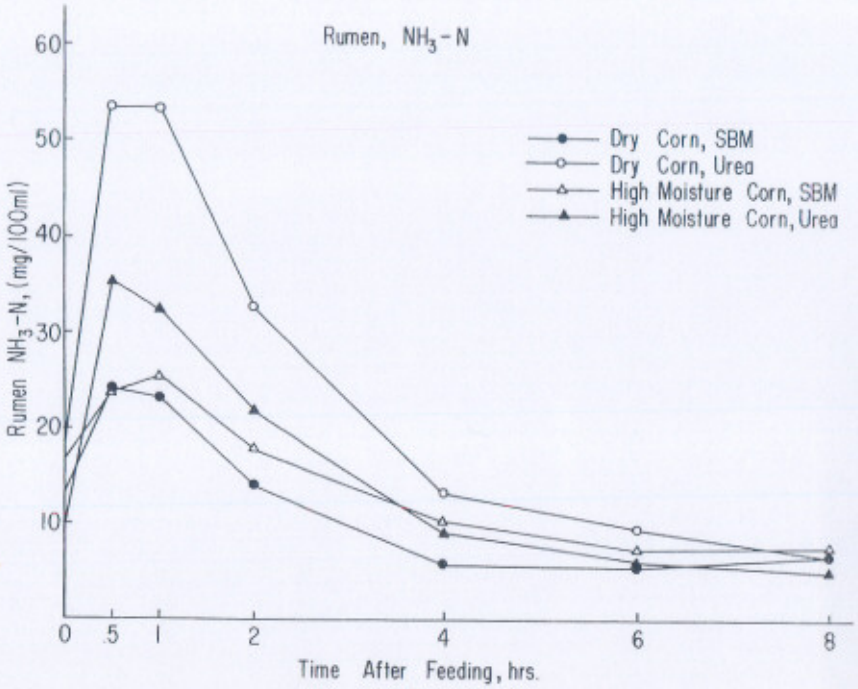

Figure 2. Rumen ammonia levels of steers fed ground dry corn supplemented with SBM or urea and ground high moisture corn supplemented with SBM or urea.

from the rumen into the blood occurred with the dry corn rations. Plasma urea level is also related to rumen pH, so higher plasma urea levels might be expected on the dry corn rations. The plasma urea levels observed for the dry corn + urea rations reflect the high rumen NH_3-N levels while the lower levels with HMC + urea rations in conjunction with the equal or lowered rumen NH_3-N levels suggest that either 1) less ammonia is formed in the rumen or 2) more ammonia is incorporated into microbial protein.

The results of the lamb repletion study are summaried in Table 3. No differences were observed in digestibility of dry matter, however protein digestibility was slightly lower for the high moisture corn rations. The urinary nitrogen was greater ($P<.05$) for the dry corn rations. Nitrogen retained as a percent of intake slightly favored ($P<.10$) the high moisture corn and the percent of the nitrogen absorbed retained was greater ($P<.05$) for the high moisture corn rations. The decrease in urinary nitrogen and increase in percent of nitrogen absorbed retained

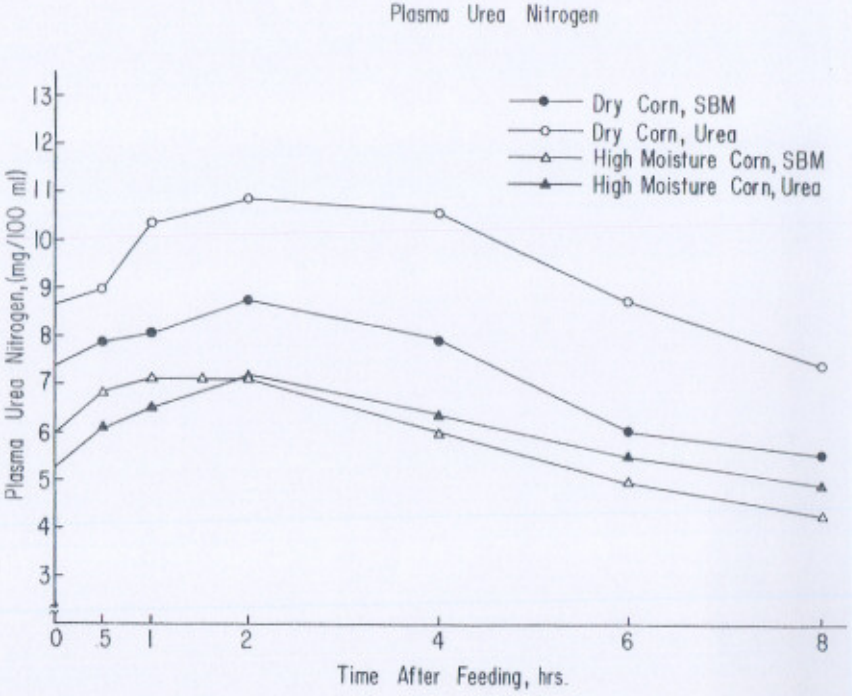

Figure 3. Plasma urea nitrogen levels of steers fed ground dry corn supplemented with SBM or urea and ground high moisture corn supplemented with SBM or urea.

Table 3. Nitrogen Depletion-Repletion Trial

Item	Ration			
	DC, SBM	DC, Urea	HMC, SBM	HMC, Urea
Digestable Dry Matter	74.2	77.3	74.4	73.5
Digestable Protein	66.5	68.7	62.5	62.4
N Intake g/day	16.6	16.4	15.4	14.1
N Retained, g/day	5.0	5.4	5.4	5.2
Fecal N, g/day	5.6	5.1	5.8	5.5
Urinary N, g/day	6.1^{A}	6.8^{A}	4.6^{B}	4.0^{B}
% N Intake Retained	30.2^{a}	32.5^{a}	35.0^{b}	36.0^{b}
% N Absorbed Retained	46.4^{A}	44.0^{A}	56.0^{B}	59.1^{B}

^{A,B} Values with different superscripts differ significantly ($P<.05$).

^{a,b} Values with different superscripts differ significantly ($P<.10$).

indicates that the overall protein quality of the ration was higher for high moisture corn.

In vitro gas production data in this laboratory has previously indicated that the energy from ground high moisture corn might be more readily available than that of dry corn. Thus microbial protein synthesis could occur at a great rate using more rumen NH_3-N in the process. Studies with corn silage have indicated that the soluble NPN derived from plants is degraded by rumen microbes at a slower rate than urea; therefore the soluble NPN in high moisture corn could contribute ammonia at a more efficient rate for microbial protein synthesis. Since deamination of the soluble NPN fraction would continue over a longer time, ammonia losses by absorption into the blood would be limited.

Conclusion

This study indicates that nitrogen is utilied in high moisture corn rations efficiently and that urea can as effectively supplement high moisture corn rations as dry corn rations. In addition, the results suggest that supplemental protein levels necessary for optimum performance might be lower with high moisture corn rations if bacterial protein production is increased. Further studies will determine the extent to which urea can be utilized and levels of protein required with high moisture corn rations.

Influence of Processing on the Digestion of Corn Based Rations by Steers

Mike Galyean, R.R. Johnson, and Donald G. Wagner

Story in Brief

Four mature Heredford steers were used to compare the digestion of dry rolled (DR), steam flaked (SF), propionic acid treated whole shelled high moisture (AHMC), and coarsely ground ensiled high moisture (GHMC) corn based rations.

In general, all four rations were similar in digestibility of dry matter, organic matter, crude protein, and acid detergent fiber. However, starch digestibility of SF and GHMC rations (99.14%) were higher than AHMC (95.81%) and DR (96.34%) rations. This might indicate an increased availability of energy from starch in SF and GHMC as compared with AHMC and DR rations.