ADDITION OF BUFFER AND/OR AMMONIA TO CORN-SUPPLEMENTED NATIVE GRASS HAY DIETS

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Story in Brief

Combinations of bicarbonate buffer and ammonia compounds were intraruminally dosed to four mature beef heifers fed low-quality native grass hay supplemented with corn. Four mature beef heifers in individual pens were offered free access to coarsely chopped native grass hay (4.8 percent crude protein) and fed a corn supplement (3.6 lb corn/hd/d) at 0800h. Isomolar solutions of either NaCl, $NaHCO_3$, NH_4Cl or NH_4HCO_3 were infused through the ruminal cannulae four times daily. The combination of ammonia and buffer (NH_4HCO_3) increased hay intake compared to the NaCl and $NaHCO_3$ (21.0 vs 16.3 and 15.0 lb). Hay consumption with NH_4Cl dosing (11.2 lb) was lower than with other compounds, probably due to ruminal acidosis. Ammonia compounds, especially NH_4Cl, increased fiber (NDF) digestibility. Low ruminal ammonia-N levels (< 1 mg/dl) with NaCl and $NaHCO_3$ may have limited bacterial action. Increased hay intake and fiber digestibility with NH_4HCO_3 increased digestible dry matter intake. Buffer alone ($NaHCO_3$) had little effect on ruminal pH when compared to NaCl. Ammonia alone (NH_4Cl) decreased ruminal pH while the combination (NH_4HCO_3) maintained ruminal pH similar to NaCl. Consequently, the depression in hay intake and utilization commonly encountered as a result of supplementation with large amounts of corn (>2 lb/d) may be partially alleviated by the addition of a source of ammonia. Ammonia addition, however, may stimulate fermentation to the extent that buffer addition may be helpful.

(Key Words: Buffer, Ammonia, Intake, Digestibility, Native Grass)

Introduction

Beef cows wintered on native range require energy supplementation when forage supply is inadequate or when energy requirements are increased by inclement weather, stress or lactation. Energy-dense cereal grains and other high starch supplements are commonly fed to provide additional energy for wintering cattle. When starch-based supplements are fed at levels greater than 2 lb/d, digestibility and intake of low-quality grass decrease. This depression has been attributed to low ruminal pH which would inhibit the action of fiber-digesting bacteria or to competition for ammonia which could be overcome with protein supplementation. The objective of this experiment was to determine the response in digestibility and intake of corn-supplemented low-quality native grass hay diets with beef heifers intraruminally dosed with buffer and/or ammonia compounds.

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Materials and Methods

Four ruminally cannulated Hereford x Angus heifers (935 lb) were utilized in a 4 x 4 latin square design. Isomolar solutions of NaCl (.24 lb/d), $NaHCO_3$ (.35 lb/d), NH_4Cl (.22 lb/d) or NH_4HCO_3 (.33 lb/d) were intraruminally dosed four times daily (Table 1). Heifers were fed 3.8 lb of a corn supplement each day (Table 2) and offered free access to coarsely chopped (2 in. screen) native grass hay (4.8 percent crude protein, 49.1 percent acid detergent fiber, 71.1 percent neutral detergent fiber). Supplemental nitrogen infusions (NH_4Cl and NH_4HCO_3) supplied an additional .41 lb of crude protein equivalent per day.

Following a 9 d adaptation period, fecal samples were collected at 0700 and 1900 h for four consecutive days. Quantities of supplement and native grass hay offered and refused were weighed and sampled on days 9 through 12. All samples were composited by animal within period, dried and ground (1 mm screen) prior to analysis. Dry matter and neutral detergent fiber digestibilities were estimated using acid-insoluble ash as an indigestible marker.

Table 1. Chemical composition of intraruminally-dosed compounds.

Component	Treatment			
	NaCl	$NaHCO_3$	NH_4Cl	NH_4HCO_3
	lb/d			
Na	.10	.10	-	-
Cl	.15	-	.15	-
HCO_3	-	.25	-	.25
NH_4	-	-	.08	.08
Total	.25	.35	.23	.33

Table 2. Supplement intake and nutrient supply (DM basis).

Supplement intake	lb/d
Corn, ground	3.58
Mineral premix[a]	.26
Total	3.84
Supplemental nutrient supply	lb/d
Crude protein	.31
Starch[b]	2.57
TDN[b]	3.22

[a]Mineral premix contained 63.4% dicalcium phosphate, 15.1% potassium chloride, 20.0% trace mineralized salt and .6% Vitamin A (20,000 IU/d).
[b]Estimated.

On d 13 of each period, rumen samples were obtained at 0900 (1 h postfeeding) and pH immediately measured. Ruminal fluid was strained through four layers of cheesecloth, acidified, frozen and later analyzed for ammonia-N concentration. The data were subjected to least squares analysis and differences between treatment means detected with Tukey's HSD test.

Results and Discussion

Compared to NaCl, dosing of the buffer alone ($NaHCO_3$) tended to decrease NDF digestibility and hay intake (Table 3). The combination of buffer and ammonia (NH_4HCO_3), however, increased ($P < .05$) hay intake by 4.8 lb compared to NaCl dosing. The addition of nitrogen as NH_4Cl decreased ($P < .05$) hay intake compared with the other compounds even though both sources of N, NH_4Cl or NH_4HCO_3, tended to increase fiber digestibility. Part of the increase in digestibility with NH_4Cl can be attributed to decreased forage intake which would slow rate of passage and increase digestibility. Because the two ammonia compounds (NH_4Cl and NH_4HCO_3) increased fiber digestibility, cattle maintained on low-quality forage and fed corn supplements are probably deficient in ruminal ammonia. The very low ruminal ammonia-N concentrations, below 1 mg/dl, with the NaCl and $NaHCO_3$ treatments, suggests that ammonia supply was inadequate for bacterial growth in the rumen.

Despite the increase in digestibility with infused NH_4Cl, hay intake decreased by 32% compared to NaCl. Intraruminal dosing of NH_4Cl decreased ($P < .05$) ruminal pH by .6 units to 6.02. If ruminal pH drops below about 6.2, cellulose-digesting organisms are inhibited. Perhaps ruminal acidosis decreased rate of fiber digestion and hay intake (Table 4).

The combination of ammonia and buffer (NH_4HCO_3) increased ($P < .10$) intake of digestible dry matter by 2.6 lb over the NaCl control. Although digestible dry matter intake (DDMI) is an inexact estimation of energy status, increased DDMI should increase energy balance.

Table 3. Daily intake and digestibility of hay and supplements.

Item	Treatment				SE
	NaCl	$NaHCO_3$	NH_4Cl	NH_4HCO_3	
Hay intake, lb	16.3^{b}	15.0^{b}	11.2^{c}	21.1^{a}	.74
Hay intake, % BW	1.7^{b}	1.6^{b}	1.2^{c}	2.3^{a}	.07
Neutral detergent fiber digestibility, %	43.4^{ab}	40.7^{b}	53.2^{a}	47.1^{ab}	2.34
Dry matter intake, lb	20.1^{b}	18.8^{b}	15.0^{c}	24.9^{a}	.74
Apparent dry matter digestibility, %	49.3^{b}	50.0^{b}	57.8^{a}	50.4^{b}	1.41
Digestible dry matter intake, lb	9.9^{y}	9.4^{y}	8.7^{y}	12.5^{x}	.62

^{a,b,c}Means in rows with different superscripts differ ($P < .05$).
^{x,y}Means in rows with different superscripts differ ($P < .10$).

Table 4. Ruminal fluid parameters (1 hour post-dosing).

Item	Treatment			
	NaCl	$NaCO_3$	NH_4Cl	NH_4HCO_3
Rumen pH,	6.63	6.75	6.02	6.61
Rumen NH_3-N, mg/dl	.51	.44	11.35	8.36

Bicarbonates ($NaHCO_3$ or NH_4HCO_3) did not increase ruminal pH compared to NaCl. Although the primary response in fiber utilization in this study is due to ammonia, the value of the buffer in the NH_4HCO_3 treatment cannot be ignored. With increased fiber digestion due to ammonia, the NH_4HCO_3 provided additional buffering to maintain ruminal pH.

This study suggests that the decrease in hay intake and utilization commonly observed when large amounts of corn (>2 lb/d) are supplemented to cattle consuming low-quality native grass hay is due to an inadequate supply of ruminal nitrogen. By providing a soluble source of nitrogen to meet the microbial demands for ammonia, many of the deleterious effects associated with corn supplementation may be overcome. Consequently, when range supplements are formulated to contain large quantities of cereal grains (starch), the protein content should be high and extremely degradable in the rumen to provide ample ammonia for microbial growth.