

VALUE OF PROTEIN IN AMMONIATED STRAW FOR GROWING STEERS

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Story in Brief

The feeding value of crude protein in ammoniated wheat straw was tested in two trials with steers. In trial 1, ammoniation of straw by the stack method increased the crude protein content of straw from 3.66 to 9.13 percent of dry matter. Weight gains of steers limit-fed an ammoniated straw diet with no added soybean meal were similar (about 1 lb/day) to gains of steers fed an untreated straw diet with 1.3 lb/day of soybean meal. Therefore, the crude protein of ammoniated straw had a value equal to that of soybean meal for steers consuming moderate levels of corn (i.e., 0.8 percent of body weight) at a growth rate of 1 lb/day. In trial 2, steers were fed ammoniated straw with corn at 0, 3 or 6 lb/day with or without 1 lb of corn gluten meal. Steers fed untreated straw received 3 lb corn and 1 lb corn gluten meal/day. Ammoniation of straw increased gains of steers from .13 to .83 lb/day. Added corn decreased straw intake but added corn gluten meal did not. Supplementation of ammoniated straw diets with corn gluten meal increased gains of steers by about .8 lb/day. The marked improvement in daily gains of steers, due to supplementation with corn gluten meal, cannot be fully attributed to the slightly increased total feed intake, and may be due to an increased supply of amino acids to the small intestine. With either treated or untreated straw, protein levels below 9.6 percent of dry matter reduced feed intake and gains.

(Key Words: Growing Steers, Wheat Straw, Ammoniation.)

Introduction

Treatment of a low-quality roughage with ammonia frequently (1) increases digestibility of dry matter (DM) by 20 to 40 percent, (2) doubles its crude protein (CP) content and (3) increases voluntary consumption by ruminant livestock by 20 to 35 percent. Increased feed consumption accounts for a large proportion of the increased performance of ruminants fed ammoniated roughages.

Ruminants can potentially utilize the increased nitrogen (crude protein) of ammoniated roughages by transforming the nitrogen (N) into microbial protein if adequate energy is available to the rumen microorganisms for this process. The N/energy ratio of ammoniated roughages is usually excessive. This limits synthesis of microbial protein and, thereby, animal performance.

Adding moderate levels of supplemental energy permits the N of ammoniated roughages to be used which decreases the amounts of supplemental protein needed by animals. The value of ammoniated roughages to spare supplemental protein has not been quantitated.

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At high levels of animal performance, the amount of microbial protein synthesized in the rumen and flowing to the small intestine may be insufficient. The additional need is for protein that is not degraded in the rumen ("bypass" protein). This idea seems appropriate for ammoniated roughage diets because the ammonia contributes only to the ruminal ammonia pool, not to bypass protein.

The objectives of these feeding trials were:

1. To determine the value of the increased crude protein of ammoniated wheat straw to spare a ruminally degraded supplemental protein, soybean meal (SBM), for growing steers.
2. To determine the effect of addition of a higher "bypass" protein, corn gluten meal (CGM), to basal diets of ammoniated wheat straw with various amounts of corn on growth of steers.

Materials and Methods

Straw was ammoniated for both trials by the stack method (4.4 percent NH_3 of as-fed straw).

Trial 1

Thirty-two Beefmaster x Hereford-Angus crossbred steers (634 lb) from one cow herd were allotted by weight into eight blocks of four animals each. Steers within each block were individually penned and randomly assigned to four treatments. Three treatments were untreated wheat straw (US) supplemented with soybean meal (SBM) to supply 70, 80 or 100 percent of the crude protein requirements for steers gaining 1 lb/day. Treatment four was ammoniated wheat straw (AS) plus corn but no SBM. Dry matter intakes of steers on treatment four were limited to those of steers of treatment 3 (i.e., US plus 1.3 lb SBM/head/day). Ground corn was fed at a level of 5.3 to 6.7 lb/head/day to all steers to meet energy requirements for gain. A mineral-vitamin supplement was fed to supply needed Ca, P, S, Mg, K and vitamins A, D and E. Intake of straw was calculated by weighing refusals weekly. Initial and final body weights were recorded after withholding feed and water for 18 hours. At the end of the trial, all steers were fed a maintenance level of alfalfa hay for five days prior to the final shrink to minimize effects of ruminal fill on final body weights.

Trial 2

Fifty-six Charolais x Hereford-Angus crossbred steers (699 lb) from one cow herd were individually allocated by weight to eight blocks of seven animals each. Steers within each block were individually penned and randomly assigned to seven treatments. Six treatments included ammoniated wheat straw with either 0, 3 or 6 lb corn/head/day with or without 1 lb of corn gluten meal (CGM)/head/day. Treatment 7 was untreated wheat straw plus 3 lb corn and 1 lb CGM/head/day. All steers received 1.7 lb/day of a mineral-vitamin supplement that contained approximately 78.0 percent ground corn as the carrier, to provide additional Ca, P, S, Mg, K and vitamins A, D and E. Both types of straw were offered ad libitum. Straw intakes and body weights of steers were measured as in trial 1.

Results and Discussion

Trial 1

Ammoniation of wheat straw more than doubled the crude protein content of the untreated straw (US = 3.66 vs AS = 9.13 percent). Supplementation of untreated wheat straw with SBM up to 1.3 lb/head/day increased voluntary consumption of wheat straw and daily gains of steers (Table 1) suggesting that protein content limited intake and performance on untreated straw diets. Weight gains of steers limit-fed ammoniated wheat straw with no supplemental SBM were similar (i.e., about 1 lb/day) to gains of steers fed untreated wheat straw and the highest level of SBM (Figure 1). Therefore, for steers fed a moderate level of corn (0.8 percent of body weight) at a growth rate of 1 lb/day, the 0.44 lb of crude protein added by ammoniation of wheat straw spared 0.57 lb of protein from SBM.

Calculated net energy and crude protein contents of the diets are shown in Table 1. Diets of untreated straw with 1.3 lb SBM and of ammoniated straw with no supplemental SBM had CP contents of about 9.6 percent of DM. Had the initial CP content of the untreated straw been lower and/or had the ammoniation procedure increased the CP content of the straw less, complete replacement of supplemental SBM might not have been possible.

Trial 2

The effects of ammoniation on the nutritive content of wheat straw, and the chemical composition of the feedstuffs for this trial are shown in Table 2. The increase in both the crude protein content and in vitro dry matter digestibility (IVDMD) of straw from ammoniation was substantially less than expected. This was due to wind blowing part of the plastic sheeting from the stack of ammoniated straw. Commonly, the crude protein content is doubled and IVDMD of straw is increased by about 33 percent by ammoniation.

Feed intakes and performance of steers are shown in Table 3 and Figure 2. Ammoniation of wheat straw increased gains of steers fed 3 lb corn plus 1 lb CGM/day from .13 to .83 lb/day. Straw intake was increased by only 12 percent by ammoniation in this trial. Therefore, the .7 lb increase in daily gain of steers fed ammoniated straw is higher than what would be anticipated from the increased feed intake alone. The limited increase in intake of ammoniated straw in this trial can be partially attributed to incomplete ammoniation of the straw.

Increasing the amount of corn decreased ($P < .01$) intake of ammoniated straw by steers fed diets with and without CGM. For each pound of added corn, straw intake decreased an average of 0.9 lb. Total feed intake and digestible energy intake increased as level of corn increased which increased gains by steers. In contrast, added CGM did not decrease intake of ammoniated straw. Supplementation of the ammoniated straw diets with CGM increased the crude protein contents of the diets from about 6.6 percent to 10.1 percent of DM and increased gains of steers by about .8 lb/day. Since this marked improvement in daily gains from supplementation with CGM cannot be attributed to the slightly increased total feed intake, it must be due to other factors, such as a greater quantity or more balanced supply of amino acids for digestion in the small intestine.

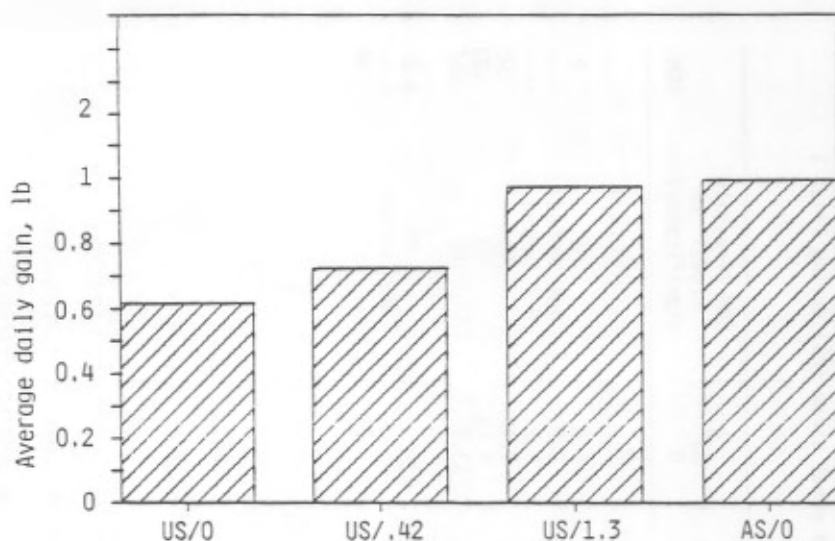
Table 1. Feed intakes, nutrient content of diets and performance of steers fed untreated wheat straw (US) and increasing amounts of soybean meal (SBM) or ammoniated wheat straw (AS) during Trial 1 (90 days).

Straw type: ^a SBM, lb as-fed/head/day:	US 0	US .42	US 1.30	AS ^b 0	SBM linearity (Level of significance)	SEM
No. of animals	8	8	8	8		
Total intake, lb/day						
Dry matter ^c	13.9	14.3	14.6	14.6	NS	.2
Straw DM	7.2	7.6	7.9	8.0	Not tested	----
Corn DM	5.1	4.9	4.1	5.1	Not tested	----
Crude protein	.967	1.12	1.41	1.43	.01	.02
DM intake, % BW	2.10	2.13	2.14	2.13	NS	.03
Straw DM/total, %	51.0	52.6	53.7	53.5	.01	.57
Body weight, lb						
Initial	634	633	638	631	NS	3.5
Final	691	710	729	741	Not tested	----
Average daily gain	.62	.72	.97	.99	.01	.04
Calculated nutrient content (DM basis) of diets						
NE _{Maint} , Mcal/cwt	70.6	69.9	68.6	69.3		
NE _{Gain} , Mcal/cwt	34.8	34.2	33.3	33.4		
Crude protein, %	6.76	7.62	9.64	9.57		

^aUS = untreated wheat straw; AS = ammoniated wheat straw.

^bIntakes of ammoniated wheat straw by steers were limited to those of treatment 3 (i.e., US plus 1.3 lb SBM/day).

^cIncludes 1.55 lb DM/head/day of a mineral vitamin supplement with 78.0% corn as a carrier.



US = untreated wheat straw AS = ammoniated wheat straw
 0, .42 and 1.3 = pounds of SBM fed/head/day

Figure 1. Average daily gains of steers, Trial 1.

TABLE 2. Chemical composition and nutritive content of feedstuffs, Trial 2.

Item	DM basis (%) ^a						
	DM	OM	CP	NDF	ADF	HEM	IVDMD
Untreated straw	87.1	95.7	3.5	81.6	49.0	32.6	44.4
Ammoniated straw	84.7	94.4	5.9	81.7	45.6	36.1	52.6
Corn gluten meal	91.0	97.2	63.9	----	----	----	----
Corn, dry rolled	89.8	98.6	8.8	----	----	----	----
Vitamin/Mineral supplement ^b	92.0	79.6	7.5	----	----	----	----

^aDM = dry matter; OM = organic matter; CP = crude protein; NDF = neutral detergent fiber; ADF = acid detergent fiber; HEM = hemicellulose; IVDMD = in vitro dry matter digestibility.

^bSource of Ca, P, S, Mg, K, Vit A, D and E, with 78% corn as the carrier feed.

Table 3. Feed intakes and gains of steers, Trial 2.

Corn, lb/h/day: CGM, lb/h/day:	Type of wheat straw						Untreated	Sources variation				
	Ammoniated			Untreated				AS vs US	CGM	Corn	SEM	
Number of animals	8	8	8	8	8	8	8	<u>Probability level</u>				
Daily feed (as _c fed ^a)												
Total intake												
lb	13.4	15.2	17.6	14.3	16.6	18.6	14.8	.01	.01	.01	.29	
% BW (DM basis)	1.70	1.90	2.16	1.75	1.96	2.20	1.87					
Straw, lb	11.7	10.5	9.9	11.6	10.9	9.9	9.2	.01	NS	.01	.34	
Straw/total, %	88	70	57	88	70	57	67					
Crude protein intake, lb	.70	.88	1.08	1.27	1.48	1.66	.21	.01	.01	.01	.02	
Body weight, lb												
Initial	697	693	699	697	703	700	703	NS	NS	NS	4.23	
Final	656	697	723	713	768	784	713	.01	.01	.01	7.33	
Avg daily gain, lb	-.52	.05	.27	.19	.83	1.07	.13	.01	.01	.01	.09	
Calculated nutrient content (DM basis) of diets												
NE _{maint} , Mcal/cwt	50.5	61.1	68.6	54.1	63.1	70.3	65.0					
NE _{gain} , Mcal/cwt	13.7	24.7	32.5	17.6	27.0	34.5	29.1					
Crude protein, %	6.1	6.6	7.0	10.2	10.1	10.1	9.1					

^a89% dry matter.^bIncludes 1.7 lb/head/day of a mineral-vitamin supplement with 78.0% corn as the carrier.

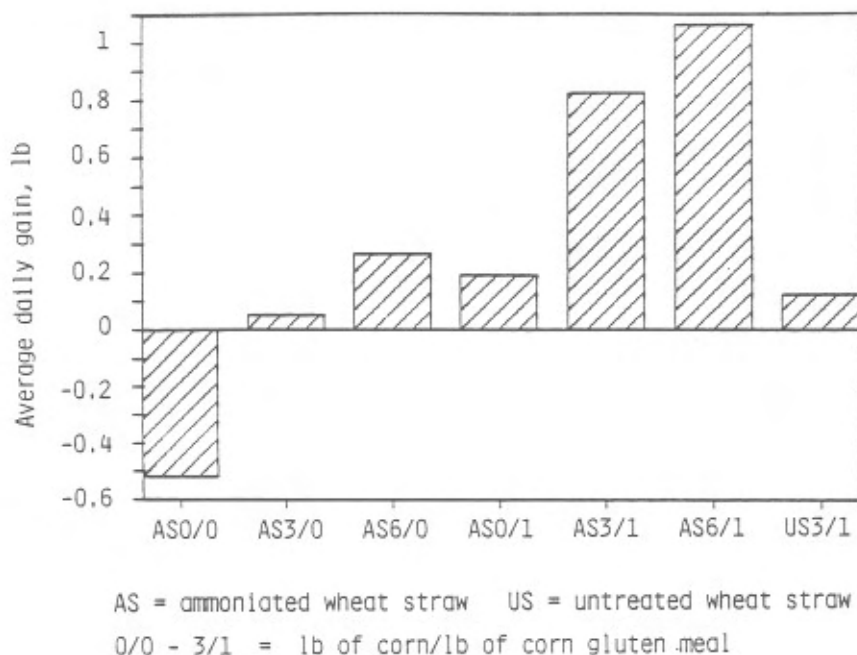


Figure 2. Average daily gains of steers, Trial 2.

Discussion

In both trials, diets based on ammoniated wheat straw supported weight gains of large frame steer calves of about 1 lb/day. Ammoniated wheat straw represented about 55 percent of total DM of the diets. Diets 3 and 4 of trial 1 and diet 6 of trial 2 contained additional energy as corn to reach NE_{Maint} and NE_{Gain} contents of about 69 and 33 Mcal/cwt DM, respectively, and crude protein contents of 9.6 to 10.1 percent of DM. Daily gains of 1 lb/day would be considered marginal in most stocker operations. However, this rate of gain would be acceptable in emergency feeding situations for stocker cattle. Also, feeding programs based on ammoniated wheat straw might be used (1) to add short-term stability to forage programs and (2) to add flexibility in timing the purchase or sale of cattle and thereby aid short-term profit to stocker and/or backgrounding operations.