the straw was only 9.7 percent, and digestibility was apparently 100 percent because the acid detergent fiber content of the feces was greater than the neutral detergent fiber content. Lignin was 13.3 percent of the straw DM and had a digestibility of 34.0 percent.

The results of this study would indicate that lambs will not eat enough ammoniated wheat straw silage to maintain body weight. Supplementing the ammoniated straw silage with either soybean meal or corn gluten meal resulted in similar increased silage DM consumption and gain. Doubling the supplement level but maintaining protein intake resulted in a doubling of lamb gain with no effect on silage intake. The ammoniated straw silage DM was 59 percent digestible and contained only 10 percent hemicellulose and 3.70 percent Kjeldahl nitrogen.

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Effect of Protein Level and Supplement Level on Voluntary Intake and Performance of Lambs Fed Ammoniated Wheat Straw Silage

C. L. Streeter, G. W. Horn and D. G. Batchelder

Story in Brief

Lambs were fed a basal ration of wheat straw that had been chopped, moistened to approximately 35 percent dry matter (DM), ammoniated with anhydrous ammonia and ensiled in an Ag-Bagger. Lambs were fed one of three levels of supplement, each with .128 or .256 lb of crude protein per day. Protein level did not affect ($P>.05$) silage DM consumption, but there was significant ($P<.15$) supplement level- by-protein level interaction. Silage dry matter intake decreased as level of supplement increased from .44 to 1.32 lb, regardless of the amount of protein fed. Silage dry matter consumption was only 68 percent of that observed during a previous study. The reduced intake was attributed to the large ammonia intake or less desirable ensiling conditions. Average daily gain was not affected ($P>.05$) by protein level but increased ($P<.01$) with supplement level.

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Introduction

A previous study (Streeter *et al.*, 1981) showed that lambs ate more dry matter (DM) from ammoniated straw silage when supplemented with .44 lb/day of a 36-percent crude protein, soybean meal-based supplement than when supplemented with only molasses and minerals. Feeding twice as much of an 18-percent crude protein, soybean meal-based supplement did not affect DM consumption of the straw.

It was the objective of this study to evaluate the effect of protein level and level of supplementation on lamb performance and DM consumption of ammoniated straw silage.

Materials and Methods

Wheat straw was chopped through a 1-inch screen in a tub grinder. Water was added with the straw to provide a dry matter (DM) content of approximately 35 percent. The straw and water were delivered into the hopper of an Ag-Bagger[1] for storage. Anhydrous ammonia was added to the straw with a manifold attached to the floor of the Ag-Bagger hopper. The ammonia was delivered under water to minimize vaporous ammonia loss.

Weight loss of the anhydrous ammonia tank indicated that 3.4 percent ammonia w/w was actually applied. Initially, it was felt that this quantity of ammonia would be adequate based on reported values for dry ammoniation (Sundstol *et al.*, 1978). Samples of the ensiled material were analyzed for Kjeldahl nitrogen 10 days after ammoniation. The straw was found to contain only 1.36 percent nitrogen and had no ammonia odor. The contents of the Ag-Bag were thus re-ammoniated 2 weeks after the first ammoniation. Anhydrous ammonia was added to the contents of the bag with a ¾ inch perforated steel pipe. The pipe was passed through the bag and ammonia applied at six locations approximately 1.5 ft above ground level and 6 ft apart. The ammonia tank was weighed before and after the application, and 1170 lb of ammonia were applied to approximately 13,000 lb of straw or 9 percent ammonia w/w. The ammoniated straw was left in the Ag-Bag for 30 days prior to feeding. Silage was removed from the bag every 3 to 4 days, mixed in a mixer wagon and stored in sealed plastic drums prior to feeding. Heating during this storage period did not occur as had been experienced in the previous trial when the ambient temperature was higher (60 vs. 100°F).

The form of the nitrogen present in the ammoniated straw silage was evaluated as described in the previous experiment.

The silage was individually fed *ad lib* to 60 ewe and wether lambs randomly assigned by sex to six supplement treatments. The silage and supplements were mixed prior to feeding. The supplements were fed at three levels of intake (.44, .88 and 1.32 lb/day) at a low protein level (.128 lb/day) and at three levels of intake (.66, .88 and 1.32 lb/day) at a high protein level (.256 lb/day). The low level of supplement had to be increased from .44 lb to .66 lb when used with the high protein level to prevent changing ingredients. The ingredient composition of each supplement is shown in Table 1.

Voluntary silage DM intake was measured for 20 days following a 12-day adaptation. Average daily gain (ADG) was calculated from weights taken 30 hours off feed and 12 hours off water at the beginning and end of a 40-day feeding period.

Results and Discussion

Lambs fed .44 lb of the low-protein supplement consumed 1.17 lb per day (1.70 percent of their body weight) of ammoniated straw silage DM (Table 2). Protein level did not affect ($P>.05$) silage DM consumption. Supplement level, however, had a

[1]Ag-Bag Corporation, Astoria, Oregon.

Table 1. Ingredient composition and crude protein content (DM basis) of supplements fed with ammoniated straw silage

	Crude protein level, lb/day					
	0.128			0.256		
Supplement level, lb/day	0.44	0.88	1.32	0.66	0.88	1.32
Soybean meal, %	61.34	18.01	3.56	87.86	59.57	31.28
Ground shelled corn, %	23.90	73.3	89.77	2.53	32.56	62.59
Molasses, %	3.00	3.00	3.00	3.00	3.00	3.00
Dicalcium carbonate, %	7.87	3.42	1.95	3.52	2.39	1.27
Calcium carbonate, %	2.88	1.77	1.39	2.42	1.98	1.53
TM-salt, %	1.00	0.50	0.33	0.67	0.50	0.33
Crude protein, %	32.5	16.2	10.8	43.3	32.5	21.7

Table 2. Effect of level of supplement and crude protein level on ammoniated straw silage DM intake and average daily gain

	Crude protein level, lb/day					
	0.128			0.256		
Supplement level, lb/day	0.44	0.88	1.32	0.66	0.88	1.32
Mean lamb wt, lb	69.1	71.3	73.0	69.7	70.4	74.6
Straw silage DM intake,						
lb/day[ab]	1.17	1.01	0.94	1.08	0.95	1.01
% body wt[ab]	1.70	1.42	1.29	1.55	1.35	1.35
Average daily gain, lb/day[ab]	0.059	0.146	0.234	0.069	0.100	0.263

[a]Main effect of protein level was not significant (P> .05) but main effect for supplement level was significant (P<.01).
[b]Interaction between protein level and supplement level was significant (P<.15).

Table 3. Form of nitrogen present in ammoniated straw silage

Form	% of DM	% of total N
Total Kjeldahl	4.25	100
ADF-bound	0.49	11.5
Free ammonia	3.34	78.6
Undetermined	0.42	9.9

significant (P<.01) effect on silage DM intake. The supplement level-by-protein level interaction was significant (P<.15) for silage DM intake. Silage DM intake decreased as level of supplement increased. The linear relationship between lb of silage DM intake (I) and lb of supplement fed (S) was: $I_1 = 1.27 - (.273)\ (S_1)$ with the low-protein supplement and $I_2 = 1.09 - (.0833)\ (S_2)$ with the high-protein supplement. There was no difference (P>.10) between the regression coefficients.

ADG of lambs fed .44 lb of the low-protein supplement was .059 lb/day (Table 2). Protein level did not affect (P>.05) ADG. The lack of gain response with additional protein can be interpreted to mean that the low level of supplemental protein was sufficient for the limited amount of available energy in the straw. Supplement level had a significant (P<.01) effect on ADG at the two higher levels of supplement with both protein levels. The increased gain with added supplement can be attributed to a greater supply of readily available energy. The protein level-by-supplement level interaction was significant (P<.15) for ADG.

The silage DM intake for lambs consuming .44 lb of a 32.5-percent crude protein, soybean meal-based supplement was only 68 percent of that found previously when .44 lb of a 36-percent crude protein, soybean meal-based supplement was fed (Streeter *et*

al., 1981). The silage in the present trial contained more Kjeldahl nitrogen (4.25 vs. 3.70 percent of DM), and more of this nitrogen was present as free ammonia (78.6 vs. 56.8 percent—Table 3). The present study was also conducted during cooler weather, which may have resulted in less vaporization of ammonia and a greater intake of ammonia by lambs. The lower silage intake in the present study could also be attributed to chemical differences in the silage resulting from fermentation following the first ammoniation treatment.

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Alkaline Treatment of Wheat Straw Before Ensiling

W. A. Phillips and F. P. Horn

Story in Brief

Wheat straw was ground and reconstituted to 35 percent dry matter, then treated with sodium hydroxide, potassium hydroxide or a 50:50 mixture of both at five concentrations (0, 2.5, 5.0, 7.5 and 10.0 percent of the straw dry matter). Addition of alkali significantly increased the initial pH of the ensiling material and maintained a pH above 7 throughout the 45-day fermentation period (Table 1). Although alkali treatment increased the amount of available fermentable material, insufficient organic acids were produced to neutralize the added base. As a result of the poor fermentation, mold was found in silos with more than 2.5 percent added alkali. Thus, even though alkali treatment did dramatically increase *in vitro* dry matter digestibility, the benefit of increased digestion was offset by potentially poor stability of the product and undesirable effects of handling large amounts of hydroxide.

Introduction

Alkali treatment of low quality forage improves the use of otherwise low productivity feedstuffs. Such forages would be well suited as emergency feeds for stocker cattle grazing winter wheat pasture, as a roughage source in receiving diets for transported calves or as extenders of wheat and summer pastures. Because addition of alkali to wheat straw requires handling of the straw, ensiling the material would appear logical. This experiment was conducted to determine the effects of two hydroxide sources at various concentrations on wheat straw digestibility and fermentation characteristics.

Experimental Procedure

Baled wheat straw harvested and stored for one year was ground (1 inch) and reconstituted to 35 percent dry matter by addition of water, then treated with one of five

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