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ANHYDROUS AMMONIA OR LIQUID SUPPLEMENT TREATMENT OF WHEAT STRAW: DEMONSTRATION RESULTS

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Summary

The effect of anhydrous ammonia or liquid supplement treatment of wheat straw was evaluated by field demonstration in response to the drought of 1989. Ammoniation of wheat straw increased estimated TDN content by 7.8 percentage points and crude protein by 7 percentage points in comparison with untreated straw. Adding a liquid protein supplement to wheat straw increased estimated TDN content by 1.5 percentage points and crude protein by .6 percentage points. Ammoniation increased the quality of wheat straw to a level comparable to prairie hay. Based on nutrient analysis, the ammoniation procedure was more effective in improving the quality of wheat straw than addition of liquid supplement.

(Key Words: Wheat Straw, Anhydrous Ammonia, Liquid Supplement.)

Introduction

The droughts common to South Dakota can seriously reduce the winter feed supply. When the hay supply is limited, cow-calf producers oftentimes use wheat straw as part of the cow diet even though wheat straw is low in energy and crude protein.

Numerous research trials conducted nationwide have evaluated methods of chemically treating wheat straw and other crop residues to improve feeding value. Results indicate treatment with anhydrous ammonia consistently improved the feeding value of crop residues. Anhydrous ammonia was also the most cost effective and readily available material evaluated. Although treatment of wheat straw with anhydrous ammonia is not a difficult procedure, it does require labor and materials. Pouring a liquid supplement over wheat straw in an attempt to improve quality has received some attention as a simpler method for increasing forage crude protein.

The drought of 1989 provided an opportunity to demonstrate handling procedures and compare the effect of anhydrous ammonia or liquid supplement treatment on crude protein and TDN content of wheat straw.

Materials and Methods

An ammoniation demonstration was conducted in cooperation with Bill Bielmaier, Wall, SD, in August of 1989. After wheat harvest, the straw was baled into 800- to 850-lb round bales and hauled to a stack yard. Straw bales were stacked into a three-bale pyramid, 13 bales long. A total of four stacks was constructed. Each stack was covered with a 40 x 100 foot, 8-mm plastic cover and the edges were sealed with 8 to 12 inches of dirt. A 1 1/2 inch plastic pipe was run under the dirt edge from the outside of the stack into the center. Anhydrous ammonia was released into the stack via the plastic pipe. Anhydrous ammonia was applied at the rate of 3% or 60 lb per ton of straw.

On the day ammonia was applied to the covered stacks, 19 additional bales of wheat straw were individually sprayed with approximately 4 gallons of a liquid protein supplement[5] (LPS). Guaranteed analysis of the supplement indicated not less than 15% crude protein, with .0% equivalent protein from nonprotein nitrogen. Each bale was tipped on end for application of the LPS and placed back on its side 20 to 30 minutes later.

All LPS-treated bales were core sampled before and 2 to 3 hours after application. Core samples from ammoniated straw bales were obtained before and 82 days after treatment. Samples were analyzed for dry matter, crude protein, acid detergent fiber (ADF), neutral

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detergent fiber (NDF), in vitro dry matter disappearance (IVDMD) and gas production. The IVDMD was calculated after a 48-hour digestion in an artificial rumen. Gas production was calculated by measuring the volume of water displaced after 20 hours of fermentation.

The TDN content of feeds can be estimated by various means. In this demonstration, TDN was estimated from both ADF (% TDN = 96.35 - [1.15 * % ADF]) and IVDMD (% TDN = 16.7 + [.74 * % IVDMD]) values.

Results and Discussion

Crude protein and fiber values are shown in Table 1. Crude protein content prior to treatment was extremely low. LPS treatment increased the crude protein content of wheat straw by .6 percentage point to an average of 3.5%. Ammoniation increased the crude protein content to 9.9%.

Anhydrous ammonia reacts with the water molecules present in the straw to form ammonium hydroxide. This compound in turn aids in breaking lignin-cellulose bonds, thus reducing the amount of indigestible fiber. As shown in Table 1, addition of anhydrous ammonia reduced NDF and ADF content to a greater extent than addition of LPS.

LPS treatment caused a small increase in IVDMD, while anhydrous ammonia treatment increased IVDMD by 34% (Table 2). Ammonia treatment also caused higher 20-hour gas production which may indicate a higher rate of fermentation. Higher rates and extent of dry matter disappearance could be expected to allow greater daily digestible dry matter intake by beef cows. This is a critical aspect of meeting cow energy requirements.

The estimated TDN content varied with method of calculation (Table 2). The ADF method, used by many analytical laboratories, does not work well with wheat straw. The ADF-based calculation overestimated the TDN content of untreated and LPS-treated straws. Based on IVDMD-generated TDN values, LPS increased TDN content of wheat straw by 3.5%, while ammoniation increased TDN content by 19.7%.

Both treatments changed the nutrient analysis of wheat straw but by two different mechanisms. The increase in quality due to LPS addition represents a dilution of the supplement over the straw. Composition of the wheat straw itself was not changed. Conversely, the increase in quality through ammoniation represents a change in physical characteristics of the fiber component of the wheat straw. This change increases fiber fermentability. The modification of fiber fermentability is not accounted for in estimates of forage TDN content when the ADF equation is used.

Producers should be conservative when evaluating the protein content of ammoniated wheat straw. The increase in crude protein is through the addition of a nonprotein nitrogen source and should be considered only 50% utilizable.

Estimated cost of the different treatments, excluding labor and transportation charges for product, and cost benefit of additional TDN are presented in Table 3.

TABLE 1. COMPOSITION OF WHEAT STRAW SAMPLES[a]

Treatment	Dry matter	Crude protein	NDF[b]	ADF[c]
Ammoniation				
Pretreatment	94.7	2.8	77.6	46.7
Posttreatment	89.8	9.9	70.8	41.6
Liquid protein supplement				
Pretreatment	95.4	2.9	77.8	46.0
Posttreatment	95.2	3.5	75.7	42.2

[a] Percentage crude protein, NDF, ADF on a dry matter basis.
[b] Neutral detergent fiber.
[c] Acid detergent fiber.

TABLE 2. IN VITRO DRY MATTER DISAPPEARANCE, GAS PRODUCTION AND ESTIMATED TDN CONTENT OF WHEAT STRAW

Treatment	IVDMD[a], %	Gas production, ml/hour	TDN estimate ADF[b]	TDN estimate IVDMD[c]
Ammoniation				
Pretreatment	30.9[d]	9.2[d]	42.6	39.6[d]
Posttreatment	41.4[f]	12.7[e]	48.5	47.4[g]
Liquid protein supplement				
Pretreatment	33.3[e]	9.1[d]	43.5	41.3[e]
Posttreatment	35.2[g]	10.0[d]	47.8	42.8[f]
SEM	.55	.41		.41

[a] In vitro dry matter disappearance.
[b] TDN estimated from acid detergent fiber; not subjected to statistical analysis.
[c] TDN estimated from IVDMD.
[d,e,f,g] Means with unlike superscripts differ ($P<.05$).

TABLE 3. COST ANALYSIS FOR CHEMICALLY TREATED WHEAT STRAW[a]

Item	Treatment: Ammoniation	Treatment: Liquid protein supplement
Treatment costs, $/T	11.85	9.00
Cost/ton of TDN, $	91.62	94.81
Cost/% increase in TDN, $[b]	1.52	6.00

[a] Based on wheat straw costs of $30/T.
[b] For 1 ton wheat straw.