*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.

## Literature Cited

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# Alkaline Treatment of Wheat Straw Before Ensiling

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## 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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concentrations of alkali from each of three sources. Alkali concentrations were 0, 2.5, 5.0, 7.5, 10.0 percent of straw dry matter. The alkaline sources were potassium hydroxide, sodium hydroxide and a 50:50 mixture of both. The treated high moisture straw was then ensiled for 45 days in 1-gallon cardboard containers lined with two plastic bags. The ensiling material was packed with a hand operated press to expel as much air as possible, and each bag was separately sealed with a twist tie. Three silos were prepared for each treatment combination and allowed to ferment for 45 days. At the end of the fermentation period, each silo was opened and samples taken for determination of the dry matter content, *in vitro* dry matter digestibility and pH. Data were analyzed as a 3 by 5 factoral arrangement.

## Results and Discussion

Initial dry matter of treated wheat straw (Table 1) was not affected by source or amount of alkali used and averaged 34.4 percent. Wheat straw is not easily reconstituted because the physical structure of the straw does not allow for the rapid uptake of added water. The fact that the dry matter content of the ensiled material was less than initially observed reflects the fermentation of organic matter to acids, water and gases. The addition of increasing amounts of alkali decreased dry matter loss during ensiling.

As anticipated, the addition of increasing amounts of alkali increased ($P<.10$) the initial pH of the treated straw. After 45 days of fermentation, the pH of each treatment combination had decreased, but only the control and 2.5 percent alkali treatment had a final pH below 7. The alkali treated straw did ferment, but organic acids were not produced in sufficient amounts to neutralize the added base. The amount of pH reduction of treated straw was actually 2.8 times greater than that of the control or water-only treatments.

*In vitro* dry matter digestibility (IVDMD) is a relative measurement of digestibility. When IVDMD values for alkali treated straw were compared to the control treatment, each increment of alkali addition above 2.5 percent resulted in an increase ($P<.10$) in IVDMD, but the amount of increase was less with each addition of alkali. With equal amounts of each source of alkali, differences were noted in final pH and IVDMD. Sodium hydroxide had a higher final pH (7.9) than potassium hydroxide (7.1) as well as higher IVDMD (46.41 percent vs. 30.53 percent, respectively). The hydroxide part of the alkali breaks down the indigestible components in wheat straw, and since sodium hydroxide contains more hydroxide units (43 percent) than potassium hydroxide (30 percent) on a weight basis, sodium hydroxide should be more effective in increasing IVDMD than potassium hydroxide.

**Table 1. Dry matter, pH and digestibility (IVDMD) of alkali treated wheat straw**

| | Amount of alkali added (% of DM) | | | | |
|---|---|---|---|---|---|
| | 0 | 2.5 | 5.0 | 7.5 | 10.0 |
| Dry matter (%): | | | | | |
| Initial | 33.8 | 34.8 | 34.5 | 34.7 | 34.4 |
| Final | $33.0^{ab}$ | $33.1^{ab}$ | $32.6^{a}$ | $33.7^{bc}$ | $34.3^{c}$ |
| pH: | | | | | |
| Initial | $6.71^{a}$ | $9.79^{b}$ | $10.55^{c}$ | $11.35^{d}$ | $11.64^{d}$ |
| Final | $5.46^{a}$ | $6.39^{b}$ | $7.67^{c}$ | $8.36^{c}$ | $9.61^{d}$ |
| IVDMD$^{e}$(%) | $28.96^{a}$ | $31.43^{a}$ | $43.57^{b}$ | $53.48^{c}$ | $59.21^{d}$ |

$^{abcd}$Means in the same row with different superscripts are significantly different ($P<.10$).
$^{e}$*In vitro* dry matter disappearance.