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IN VITRO DIGESTIBILITY OF UNTREATED AND AMMONIA TREATED OAT MILL BY-PRODUCT

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Summary

Oat mill by-product (OMB, approximately 80% oat hulls) was treated with 0, 1%, 3% or 5% NH_3 and 10%, 20%, 30%, 40% or 50% H_2O (4 x 5 factorial design) and allowed to react for 28 days. Samples were analyzed for in vitro dry matter digestibility (IVDMD), crude protein (CP) and fiber content (NDF, ADF, ADL). Treatment with 3% NH_3 and 20% H_2O resulted in maximum improvement of IVDMD. CP was increased and NDF decreased due to treatment. Nutritional value of OMB can be improved by NH_3 treatment.

(Key Words: Oats, By-product, Ammonia, Digestibility.)

Introduction

Oats have been an important crop in South Dakota for many years. Recently, production has ranged from 46 to 87 million bushels. A portion of this crop is milled in or near the border of South Dakota, resulting in localized supplies of oat mill by-product (OMB). As with other by-products, composition is variable, but it typically contains greater than 80% oat hulls. Oat mill by-product use is limited in cattle diets because of poor digestibility.

Techniques for chemical treatment of poor quality crop residues have been available for many years and have been demonstrated to increase digestibility and dry matter intake of residues such as wheat straw and corn stalks. Ammonia (NH_3) has become the most popular chemical for treatment, mainly due to the readily available supply, ease of application and contribution of N to the residue. Residues high in hemicellulose tend to respond best to treatment, and moisture (H_2O) additions usually enhance the response. OMB is high in hemicellulose and should respond well to treatment.

The objective of this study was to determine if NH_3 treatment of OMB would increase in vitro digestibility and what levels of NH_3 and H_2O would maximize the response.

Materials and Methods

Unground OMB samples (100 g) were treated with 0, 1, 3 and 5% NH_3 (dry matter basis) at 10, 20, 30, 40 and 50% H_2O, sealed in glass jars and allowed to react for 28 days. The samples were then opened to allow volatile NH_3 to evaporate, dried at 60 C and ground. In vitro dry matter digestibilities (IVDMD) were determined in the conventional manner by incubating triplicate .6 g samples in a rumen fluid-buffer solution for 48 hours and then pepsin for an additional 48 hours to simulate the ruminant digestive process. A sample of alfalfa hay was included for comparison. The in vitro procedure was replicated twice and the data were analyzed as a 4 x 5 factorial within run. The alfalfa hay, untreated OMB and OMB treated with the lowest NH_3 and H_2O levels resulting in maximum IVDMD were analyzed for crude protein (CP), neutral detergent fiber (NDF), acid detergent fiber (ADF) and acid detergent lignin (ADL) to evaluate the chemical changes occurring as a result of treatment that might be responsible for IVDMD differences.

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Results and Discussion

IVDMD response to increasing NH_3 and H_2O additions are shown in Figure 1. Increasing NH_3 and H_2O treatment levels increased IVDMD ($P<.001$). The interaction between NH_3 and H_2O was also significant ($P<.001$), indicating the response to NH_3 was greater with higher H_2O content. Maximum effect was achieved with 3% NH_3 and 20% H_2O with no significant improvement above these levels ($P>.10$).

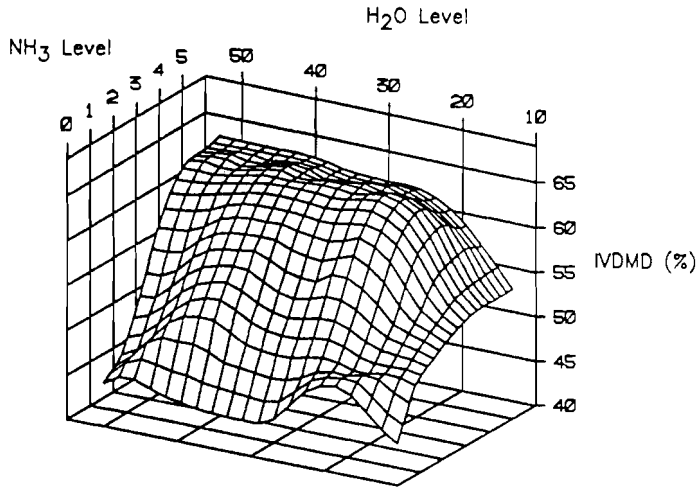

Figure 1. Effect of NH_3 and H_2O level on IVDMD of oat mill by-product.

Chemical analyses and IVDMD for the alfalfa hay, untreated OMB and 3% NH_3-20% H_2O OMB are shown in Table 1. The 3% NH_3-20% H_2O sample was included because these conditions involved the lowest levels of NH_3 and H_2O necessary to achieve the maximum response. The untreated OMB contained higher crude protein and lower NDF, ADF and ADL than would be expected of oat hulls and reflected a grain content that was probably near 20%. Untreated OMB was obviously of poorer quality than the alfalfa hay, however (i.e., lower CP and higher fiber). NH_3 and H_2O treatment increased CP content by 5.23 percentage points, bringing it up to a level comparable to fair quality grass hay. This is a typical response to NH_3 treatment and previous research has shown this additional CP to be of at least some nutritional value to cattle. NDF was decreased ($P<.05$), while ADF remained unchanged by treatment ($P>.10$), indicating a solubilization of hemicellulose. A small but significant decrease in ADL was also found ($P<.05$). This decrease in fiber content was likely a major contributor to the 19.20 percentage point increase in IVDMD compared to untreated OMB ($P<.05$). In fact, treatment resulted in an IVDMD substantially greater than the

TABLE 1. CHEMICAL ANALYSES AND IN VITRO DIGESTIBILITY OF THE ALFALFA HAY CONTROL, UNTREATED AND 3% AMMONIA-20% MOISTURE OAT MILL BY-PRODUCT (OMB)

	Composition, % (dry matter basis)				
Feed	CP[a]	NDF[b]	ADF[c]	ADL[d]	IVDMD[e]
Alfalfa hay	21.18[f]	53.10[fg]	43.47[f]	7.72[f]	50.00[g]
Untreated OMB	8.49[h]	58.97[f]	30.45[g]	5.48[g]	44.78[h]
3% NH_3-20% H_2O OMB	13.72[g]	51.34[g]	28.49[g]	5.26[h]	63.98[f]

[a] Crude protein (N x 6.25).
[b] Neutral detergent fiber.
[c] Acid detergent fiber.
[d] Acid detergent lignin.
[e] In vitro dry matter digestibility.
[f,g,h] Feeds differ ($P<.05$).

alfalfa hay ($P<.05$). Because of factors such as particle size and rate of passage through the digestive tract, it is unlikely that differences of this magnitude would occur when fed to cattle. However, it appears obvious that substantial improvements can be made and that feeding studies are warranted.

The results from this study indicate that NH_3 treatment of OMB can substantially improve its potential nutritional value by increasing CP content and digestibility. Optimum levels of NH_3 and H_2O appear to be 3% and 20%, respectively.