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Summary

Eighty-one steer calves were fed growing diets that contained 50% of either 1) ground brome hay (BROME), 2) unground oat hulls (OH), or 3) unground oat hulls treated with 3% ammonia and enough water to raise the moisture content to 20% (NH_3-OH). Treated oat hulls were allowed to react for 63 days prior to feeding. Daily gains of NH_3-OH fed steers were 18 and 13% greater than those of OH and BROME fed steers, respectively, during the 88-day study (P<.01). Dry matter intakes were not affected by diet (P>.10). However, feed efficiency was 13% better for NH_3-OH fed steers than steers fed OH and 9% better than those fed the BROME diet (P<.05). Calculated NE_m and NE_g estimates for the brome hay, untreated and treated oat hulls used in this study were 53.9 and 31.9, 51.0 and 29.2, and 64.7 and 40.8 Mcal/cwt DM, respectively. Oat hulls respond well to ammonia treatment and may contain as much as 23% more net energy than brome hay in calf growing diets.

Key Words: Oat Hulls, Ammoniation, Growing Diets

Introduction

Oats have been an important crop in South Dakota for many years. In recent years, 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 hulls. Oat hull use in cattle diets is limited because of its 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 NH_3 treatment, and moisture additions usually enhance the response. Oat hulls are high in hemicellulose and recent South Dakota work demonstrated substantial improvement in digestibility in vitro due to NH_3 treatment.

The objective of this study was to determine the effect of ammoniated oat hull based growing diets on weaned calf performance.

Materials and Methods

Treatment of oat hulls. Approximately 18 ton of cleaned, unground oat hulls were mixed in a mixer wagon with sufficient water to bring their moisture content up to 20% and then piled on bare ground. A length of plastic tubing had previously been laid on the ground such that the end was positioned in the middle of the pile and extended upward about 1½ feet into the oat hulls. The pile was then covered with a 6-mil black plastic sheet and sealed by burying the edges in an 8-inch deep trench. Two rows of tires were

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also placed around the edges of the plastic to help keep it in place. Anhydrous NH_3 was injected into the pile at a level equal to 3% of the oat hull dry weight. Based on previous work, the moisture and NH_3 addition levels were considered the minimum necessary for maximum response. The oat hulls were allowed to react with the NH_3 and water for 63 days before feeding.

Feeding trial. A group of 95 Charolais steer calves with an average weight of 590 lb were vaccinated (IBR, BVD, BRSV, Lepto and 7-way clostridium), dewormed (Ivermectin[3]), implanted (Synovex-S[4]), and ear tagged upon arrival at the feedlot. From these, 81 steers were randomly allotted to one of nine pens and fed growing diets containing 50% of either 1) ground brome hay (BROME), 2) untreated oat hulls (OH), or 3) NH_3-treated oat hulls (NH_3-OH). The balance of the diets consisted of rolled corn and supplement. Diet composition is presented in Table 1.

Initial and final weights were taken after overnight removal of feed and water. The steers were fed for 88 days.

Table 1. Test diet compositions (dry matter basis)

	Diet		
Item	BROME	OH	NH_3OH
Ingredient		Percent	
Rolled corn	41.27	32.23	32.65
Brome hay	50.00		
Oat hulls		50.00	
NH_3-oat hulls			50.00
Molasses	4.00	4.00	4.00
Soybean meal	2.73	11.35	11.35
Limestone	1.00	1.00	1.00
Dicalcium phosphate		.35	.35
Urea	.42	.42	
Trace mineral salt	.50	.50	.50
Premix[a]	.08	.15	.15
Analysis			
Dry matter	80.2	79.3	75.7
Crude protein	10.5	11.0	13.1
Natural	9.3	9.8	9.4
NPN	1.2	1.2	3.7

[a]Provided 180 mg Rumensin and 45,000 IU vitamin A per day.

[3]IVOMEC, MSD AGVET, Rahway, NJ, 90965.
[4]Syntex Animal Health, Des Moines, IA, 50303.

Daily weight gains (ADG) were analyzed appropriately for a completely random design to test for diet effects using the individual animal as the experimental unit with initial weight included in the model as a covariate. Feed dry matter intake (DMI) and feed efficiency (F:G) were analyzed using the pen as the experimental unit.

Results and Discussion

It was apparent during the study that the extent of ammoniation varied throughout the pile of oat hulls. Although the entire pile was obviously treated, the most intense NH_3 concentrations were present in the middle one third. There was only one point of NH_3 injection and this was in the middle of a pile that measured approximately 40 ft x 15 ft x 8 ft (LxWxH). The addition of water and the fact that NH_3 is water soluble may have reduced the migration of NH_3 throughout the pile and additional injection points would probably be necessary to treat larger quantities.

Overall, treatment of the oat hulls resulted in a decrease in NDF and an increase in crude protein content (75.65 vs 84.66% of DM and 9.87 vs 2.51% of DM, respectively). ADF content was not affected. These changes are typical of ammonia treatment. Dry matter content of the treated oat hulls fed during the study was 4.4 percentage points lower than calculated from original oat hull analysis and added water. This may have been due to the relatively slow rate at which oat hulls absorbed the water, allowing it to migrate downward in the pile where the majority of the oat hulls were removed for feeding. The remainder of the treated oat hulls not fed may have been drier than expected. Formulations were maintained on a dry matter basis.

Although formulated to contain at least 12% total crude protein, diets were lower due to the light test weight, low protein corn which was prevalent in this region at that time (Table 1). However, crude protein intakes for all treatments were above expected requirements, with 7% or less of the requirement covered by nonprotein N. Additionally, DMI for diets was slightly greater than expected based on energy content. Treatment differences likely reflect differences primarily in energy availability.

Performance data are presented in Table 2. Ammoniation of oat hulls resulted in an increase of 18% in ADG compared to steers fed untreated oat hulls ($P<.01$). ADG of NH_3-OH steers was also 13% greater than those of BROME fed steers ($P<.01$). ADG was greater in spite of the fact that DMI did not differ among treatments ($P<.10$). Intake is usually increased as a result of ammoniation due to increased rate of particle size reduction and digestion. Lack of intake response in this case may be due to the small initial particle size of the oat hulls. As a result of increased ADG but similar DMI, F:G of NH_3-OH fed steers was 13 and 9% better ($P<.05$) than that of OH and BROME fed steers, respectively.

The oat hulls used in this study were cleaned and not ground. Much of the oat hulls currently available are ground to increase bulk density and decrease transportation costs. It seems likely that similar responses would be seen with ground oat hulls since oat hulls are of small particle size already and further reduction would probably have limited effect. However, levels lower than those used in the test diets may be necessary to keep diets from becoming too dense which may reduce intake.

Additionally, it should be noted that, on occasion, ammoniation of feeds has apparently resulted in the occurrence of "crazy cow" syndrome. The fact that its occurrence is mainly associated with ammoniation of good quality forages (i.e., grass hay) instead of crop residues (i.e., wheat straw) is apparently due to the lack of soluble sugars in the latter. Oat hulls are similar to crop residues in this respect and not likely to be a problem. However, oat processing by-products often contain not only oat hulls but also considerable amounts of broken groats and it is not known if their presence could contribute to the formation of the compound thought to be responsible for the syndrome. In this case, caution may be advisable until more information is available.

Table 2. Performance data for steers fed growing diets containing brome hay (BROME), untreated oat hulls (OH), or oat hulls treated with ammonia (NH_3OH)

	Diet			
Item	BROME	OH	NH_3OH	SE
No. of steers	27	27	27	
Initial wt, lb	591	588	592	7.2
Final wt, lb	801[a]	794[a]	830[b]	6.7
Weight gain, lb/day	2.40[a]	2.31[a]	2.72[b]	.076
Dry matter intake, lb/day	17.6	17.8	18.1	.40
Feed:gain	7.35[c]	7.68[c]	6.67[d]	.206

[a,b]Means with different superscripts differ ($P<.01$).
[c,d]Means with different superscripts differ ($P<.05$).

Based on cattle performance and published values, NE_m and NE_g estimates for the brome hay, untreated oat hulls, and ammoniated oat hulls used in this study were 53.9 and 31.9, 51.0 and 29.2, and 64.7 and 40.8 Mcal/cwt DM, respectively.

In conclusion, these data suggest that oat hulls respond well to ammoniation and that, after treatment, they may contain as much as 23% more net energy than brome hay in calf growing diets. Ammoniated oat hulls are an effective substitute for conventional roughages in feedlot growing diets.