2001

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Published in Optimizing Nitrogen Management in Food and Energy Production and Environmental Protection: Proceedings of the 2nd International Nitrogen Conference on Science and Policy, *The Scientific World* 1 (2001); doi 10.1100/tsw.2001.364

Published with the approval of the director as paper no.13431, journal series, Nebraska Agricultural Research Division.

Submitted October 9, 2001; revised November 6, 2001; accepted November 7, 2001.

Nutritional methods to decrease N losses from open-dirt feedlots in Nebraska

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Abstract

Nitrogen losses from cattle feedlots are a concern due to loss of valuable N and enrichment of the atmospheric N pool. Nutritional methods to decrease losses would have economic and environmental benefit. One method to decrease N losses is by increasing carbon on the pen surface. From a management perspective, feeding a diet that will increase carbon may be the most cost effective. Therefore, three experiments evaluated feeding corn bran (less digestible than corn) at either 0, 15, or 30% of the diet. The 15 and 30% bran diets increase organic matter (carbon) excretion by approximately 0.5 and 1.0 kg/steer/d, respectively. Compared with no bran, feeding 15 and 30% decreased feed efficiency by 7.8 and 10.4%, respectively. Nutrient balance was assessed for two trials from October through May and one trial from June to September. During the trials from October to May, N losses were decreased by 14.5 and 20.7% for the 15 and 30% bran diets compared with no bran. Feeding 15 or 30% bran did not influence N losses in the experiment from June to September. Increasing the carbon:nitrogen ratio of manure prior to cleaning open-dirt feedlots has variable results depending on time of year.

Keywords: Nitrogen, Volatilization, Cattle feedlots, C:N ratio, Carbon

Abbreviations: ADG average daily gain; **BW** body weight; **C:N** carbon:nitrogen; **DIP** degradable intake protein; **DM** dry matter; **DMI** dry matter intake; **DRC** dry rolled corn; **MP** metabolizable protein; **N** nitrogen; **NDF** neutral detergent fiber; **OM** organic matter; **0-bran** no bran treatment; **15-bran** 15% bran treatment; **30-bran** 30% bran treatment

Synopsis

Decreasing digestibility to increase carbon may decrease N losses but is dependent on time of year. However, decreasing digestibility does have negative impacts on animal performance. Therefore, until suitable carbon sources are available and N losses are better understood for the warm summer months, changing diet to increase C:N ratio has limited value.

Introduction

Nitrogen emissions from livestock production are a concern for producers. When large losses occur, it is detrimental to water resources and also decreases fertilizer value of livestock manure. Nitrogen volatilization (primarily as NH_3) estimates from open-dirt feedlots range from 30 to 70% of N that is excreted.[7,9]

One method to decrease NH_3 emissions is to increase the carbon to nitrogen (C:N) ratio of manure. Dewes (1996) added straw to cattle manure and decreased N losses from 23.2 to 5.1% of the initial N over 14 d. Others have decreased N losses from pig slurry by adding carbon.[2,29] Immobilization of N during composting has been enhanced by adding carbon to feedlot manure.[14] Adding carbon to manure decreases N losses by lowering pH when stored anaerobically[17] or by microbial immobilization when stored aerobically.[14]

One method to increase C:N ratio of manure is by feeding diets lower in digestible OM but this conflicts with the principles of diet formulation in use today. Corn bran is a fibrous byproduct of the corn wet milling industry that contains high concentrations of NDF[4] that is readily digested,[5] but has lower digestibility than corn.[24] However, corn bran may maintain animal performance when fed at 15 to 30% of diet DM.[23] Therefore, the objectives of these experiments were to determine if increasing dietary corn bran in beef finishing diets would: increase carbon excretion, decrease N losses by increasing carbon excretion, and maintain animal performance.

Experimental Methods

Feedlot performance

Three experiments were conducted consecutively to assess the impact of increasing dietary corn bran on animal performance and mass balance of N. Experiment 1 utilized 96 yearling steers (initial BW = 385 ± 15.6 kg) fed for 128 days from October 5, 1999 until February 9, 2000. Ninety-six steers (initial BW = 408 ± 19.7 kg) were fed from February 10 until May 24, 2000 or 105 days in Exp. 2. In Exp. 3, 96 steer calves (initial BW = 420 ± 20.5 kg) were fed from June 2 until September 19, 2000 or 110 days. As indicated, all three experiments were conducted consecutively spanning 343 days with large, yearling steers.

In each experiment, steers were randomly assigned (8 steers/pen) to one of 3 treatments (4 pens/treatment). Treatments consisted of three different diets (Table 1) in each experiment that contained either 0 (0-bran), 15 (15-bran), or 30% (30-bran) corn bran as a percentage of diet DM. Diets were evaluated using the NRC (1996) model to ensure adequate degradable intake protein (DIP) and metabolizable protein (MP) for 420 kg steers. The goal was to utilize the NRC model so dietary supply would meet protein requirements during the feeding period while minimizing excess protein. If protein was supplied in excess of requirements, the excess supply was equivalent in grams per day across all treatments.

Animal performance was monitored due to the importance in animal production systems. Methods used for collection of performance data were typical of Nebraska production systems. Initial weight was based on two consecutive day weights recorded prior to feeding following a 5-d limit fed period. Steers were implanted on d 27 with Revalor-S® (Intervet Inc., Somerville, NJ) in Exp. 1. In Exp. 2, steers were implanted with Revalor-S® on d 19. In Exp. 3, steers were implanted initially with Revalor-S® on d 1.

Cattle were adapted to finishing diets by replacing alfalfa hay with DRC. Roughage was provided from both corn silage and alfalfa. Roughage levels during adaptation were 45, 35, 25, and 15% fed for 3, 4, 7, and 7 d, respectively. Steers on the 15-bran and 30-bran were adapted similarly except corn bran was included at target levels (either 15 or 30%) during the entire 21 d adaptation period. Corn silage was the only roughage source in finishing diets and was included at 15% of diet DM. Corn silage was assumed to contain 50% grain and 50% roughage on a DM-basis.

When animals were visually appraised as finished, they were marketed to a commercial abbatoir (IBP Inc., West Point, NE). At slaughter, hot carcass weights were recorded and used to determine final weights assuming a common dressing percentage (62). Following a 24-hour chill, fat depth and marbling scores were collected at the 12th rib.

Nutrient Balance

Nitrogen mass balance was conducted in 12 open-dirt feedlot pens used previously to assess nutritional impacts on nutrient balance in feedlots.[3,9] Steers in each experiment had 29.6 m^2 of pen space and 61 cm of linear bunk space with ad libitum access to water. Animals were fed once daily in the morning.

Mass balance procedures were conducted similar to procedures outlined by Bierman et al., (1999). Nitrogen balance was divided into two separate components with one conducted from October to May (Exp. 1 and Exp. 2) and then Exp. 3 handled separately with steers fed from June through September. The main reason for combining Exp. 1

Table 1. Diet composition (% of diet DM) for Exp. 1, Exp. 2, and Exp. 3 finishing diets. Diets for digestibility experiment were similar except 1.5% urea was used to ensure abundant degradable nitrogen and 0.25% Cr_2O_3 was added as a marker.

	Corn bran level		
Ingredient	0-bran	15-bran	30-bran
Corn bran	0	15	30
Dry-rolled corn	75	60	45
Corn silage	15	15	15
Molasses	5	5	5
Supplement	5	5	5
Composition			
Crude protein	11.9	11.9	12.0
DIP*	6.7	7.6	8.7
Calcium	0.65	0.65	0.65
Phosphorus	0.23	0.21	0.18

*DIP was increased as corn bran increased because microbial efficiency was predicted to increase with higher levels of bran. DIP increased because less feather meal/blood meal was included as bran level increased.

and Exp. 2 was difficulty in hauling manure and soil sampling pens in February. Time of year can impact N losses due to ambient temperature.[6,9] Mass balance accounting was conducted to assess the impact of dietary treatment on N flow in open-dirt feedlot pens. Briefly, nitrogen intake was quantified by accounting for DMI and N concentration of dietary ingredients. Feed refusals were quantified, composited, and analyzed to correct N intakes. Nitrogen excretion was calculated by difference between N intake and N retained in cattle. Nitrogen retention in the animal was based on animal performance and weights using retained energy and retained protein equations.[20] These equations are currently the best estimates of N retention. However, due to the small amount of N retained and the subsequent small impact on N excreted, the errors associated with use of these equations are small. At the time of slaughter, cattle were removed and the pens scraped. Collected manure was piled on the cement apron and sampled at the time of removal. Wet manure was weighed at time of removal and samples (20-25 subsamples corresponding to 1 subsample per loader bucket) used to account for nutrients (DM, OM, N) removed in manure. Pens were cleaned in a manner to minimize soil contamination. Because of inherent differences in cleaning from pen to pen and the difficulty in minimizing soil contamination, soil in clean pens were sampled before each experiment and again following cleaning. The soil cores from before and after the nutrient balance experiment were used to correct for either manure left in the pen or soil removed at cleaning. This method allows for accounting of either N addition or loss from pen soil. Soil cores (15 cm depth) were grid sampled (16 locations) within each pen to account for sampling variation. It was assumed that no N movement has occurred below 15 cm based on compaction and water movement in feedlot pens.[19,8] Each core accounted for a 14.8 m^2 grid area. Nitrogen in precipitative runoff was also quantified by sampling each runoff event and measuring total volume. Pens are designed to drain into retention ponds with two pens on the same treatment draining into one pond due to pen design and slope. Runoff volumes were quantified with a flow meter during draining (ISCO 4230 bubbler flow meter, ISCO Inc., Lincoln, NE) and subsamples collected. For each experiment, weighted composite samples were analyzed for total Kjeldahl N[1] and used to calculate total N weight per animal. Nitrogen in sediment that may have settled out of runoff was accounted for in retention ponds and assumed to be a fraction of "runoff." Nitrogen losses were calculated by difference between N excreted and N in manure, soil core balance, and runoff.

Total nitrogen was assayed on feed and feed refusals by combustion method using a nitrogen analyzer (LECO FP428, LECO Corporation, St. Joseph, MI). Feed ingredients were composited by month and ground prior to analysis. Feed refusals were composited by pen for each experiment using a weighted average for total DM refused within experiment. Runoff samples were analyzed wet by Kjeldahl N procedure[1]. Dry matter analysis was conducted by drying in forced-air ovens at 60°C for 48 hours for all feeds, manure, and soil cores. Manure samples were ground and composited by pen for N analysis. Based on numerous experiments conducted here, ammonium concentration in open-dirt feedlot manure is less than 5% of total N and was not accounted for due to potential loss from oven-drying of manure. Soil core samples were ground following drying and composited by pen prior to analysis. Manure and soil core analysis for N was conducted at commercial laboratory using combustion techniques[1] (Ward Laboratories, Kearney, NE). All grinding was conducted using a Wiley mill (1-mm screen).

Digestibility trial

Six ruminally and duodenally cannulated steers (BW = 611 kg) were used in a replicated, 3 × 3 Latin square digestibility trial. Surgical and post-surgical care procedures were similar to those outlined by Stock et al.[27]. Diets were similar to diets used in the feedlot except 1.5% urea and .25% chromic oxide (Cr_2O_3, DM-basis) were provided in the supplement. Steers were fed by automatic feeders with feed provided every two hours. Steers were housed in 1.5 × 2.4-m individual pens with slotted floors. Pens were cleaned twice daily and room temperatures were controlled and maintained at 25°C. Digestibility was determined using Cr_2O_3 as a marker and differences between Cr intake and excretion via feces.[18] Periods were 14 d in duration with feces collected during the last 5 d. Fecal samples were dried in a 60°C forced air oven (1 replicate) or freeze-dried (1 replicate) for DM determination, ground, and composited by steer within period. Oven-dried fecal samples were analyzed for OM and Cr. Nitrogen analysis was conducted by combustion method[1] (LECO FP428, LECO Corporation, St. Joseph, MI) on freeze-dried feces. Organic matter analysis was conducted by ashing in a muffle furnace at 600°C for 4 h.[1] Chromium analysis was conducted by atomic absorption[31] following ashing and digestion to ensure Cr in solution. Because the digestibility trial was used only to estimate OM excretion in the nutrient balance experiments, N in urine was not quantified.

Statistical analysis and animal care

Animal care and procedures for the feedlot and metabolism experiments were approved by the University of Nebraska Institute for Animal Care and Use Committee (IACUC approval #98-04-021). Experiments were analyzed as a completely randomized design using GLM procedures of SAS.[21] Animal performance data were tested for experiment by treatment interactions. If no interaction was detected, main treatment effects were evaluated for performance. Nitrogen mass balance data were analyzed as two separate components with Exp. 1 and Exp. 2 analyzed together and Exp. 3 separately. Orthogonal contrasts (linear and quadratic) were used to test effects of dietary bran level on performance, digestibility, and N mass balance.

Results and Discussion

Feedlot performance

No significant interactions between experiment and treatment were detected for performance variables across

Exp. 1, Exp. 2, and Exp. 3 which reflects the similar type of cattle used across experiments as well as the same dietary treatments. The only change between experiments was time of year. Therefore, performance data were pooled and are presented in Table 2. Final weight tended (P = 0.07) to decrease linearly as bran level increased in the diet, which reflects linear depressions (P = 0.05) in ADG. Intakes increased by feeding higher levels of corn bran in place of DRC. Comparing 0-bran to 15-bran, DMI increased 5.1%. Dry matter intake increased 6.8% comparing 0-bran to 30-bran. Because ADG decreased while DMI increased, feed efficiency expressed as ADG:DMI decreased linearly (P = 0.01) as bran level increased. Based on feed efficiency, corn bran provided less energy than replaced DRC. Cattle consumed more feed to maintain ADG by offsetting lower energy concentrations in the 15-bran and 30-bran treatments.

Feed efficiency decreased 7.8% comparing 0-bran to 15-bran, but only decreased another 2.8% when bran increased from 15 to 30% of diet DM (comparing 15-bran to 30-bran). Surprisingly, these performance data suggest that the second 15% increment was used more efficiently than the first 15% increment of corn bran. Scott et al., (1997) evaluated 15 or 30% bran inclusion with DRC based diets individually fed to yearling steers and observed higher feed efficiency with 15% bran compared to no bran. However, feeding 30% bran slightly (2%) decreased feed efficiency compared to cattle fed the DRC-control diet with no bran.[23] When replacing corn with corn bran which is less digestible, performance results can "mask" depressed digestibility because control cattle are experiencing acidosis.[28] Therefore, results from Exp. 1, Exp. 2, and Exp. 3 suggest that cattle fed 0-bran treatments were not experiencing acidosis related problems and that corn bran negatively impacted performance.

Nutrient balance

Because nutrient balance in Exp. 1 and Exp. 2 had to be conducted together, data for N mass balance are presented as one balance period in Table 3. Because DMI increased as bran inclusion increased while N concentration of diets was similar, N intake increased linearly (P = 0.01) as bran increased. Nitrogen excretion responded similar to N intake because N retained by the animal was not impacted by dietary treatment. As the data suggest, most (>90%) of the N fed was excreted based on NRC (1996) prediction equations. The steers used in these experiments were large (>380 kg BW) suggesting that fat deposition was large while protein deposition (N retention) was small. The large steers were also fed protein in excess of requirements during the entire experiment. The relatively low retention of N (as % of N fed) agrees with other research.[3,9] Feeding less protein can improve the percentage of N fed that is retained from 10 to 20%[10].

Nitrogen removed in manure corrected for soil core balance was increased linearly (P = 0.01) by increasing dietary corn bran in Exp.1 and Exp. 2. Manure N increased 68% comparing 0-bran to 15-bran and almost doubled (98% increase) when comparing 0-bran to 30-bran. When expressed as a percentage of total N excreted, 25.6, 40.1, and 46.0% of the N was in manure for 0-bran, 15-bran, and 30-bran treatments, respectively. Nitrogen lost via volatilization was also linearly reduced (P = 0.01) by increasing dietary bran. Expressed as a percentage of N excreted, 74.1, 59.8, and 53.8% of the N was lost from pens on the 0-bran, 15-bran, and 30-bran treatments, respectively. Comparing 0-bran to 15-bran, N losses was reduced by 14.2%. Comparing 0-bran to 30-bran, N losses were reduced by 20.4%. More OM was removed from pens on the higher bran treatments compared to 0-bran. However, despite increased manure N and decreased N losses, neither percent N in manure DM nor C:N ratios of manure were different across dietary treatments. These data suggest that more N was contained in manure for the 15-bran and 30-bran treatments because more manure was removed. Manure N as a percentage of manure OM was 5.7, 6.3, and 5.5% for 0-bran, 15-bran, and 30-bran, respectively. Amount of N lost via precipitative runoff was small (< 0.4% of excreted N) relative to N in manure and volatilized N.

In Exp. 3 with yearlings fed from June until October, N intakes and N excretion tended to increase linearly (P = 0.08) as dietary bran increased (Table 4). As was observed in Exp. 1 and Exp. 2, the small increase in N intake and excretion with the 15-bran and 30-bran treatments are related to increased DMI because N concentration in diets were similar. No differences were observed for N in manure, N in runoff, or N volatilized from the pen surface. Nitro-

Table 2. Effects of dietary corn bran on finishing performance of yearlings fed either 0 (0-bran), 15 (15-bran), or 30% (30-bran) of diet DM as corn bran in place of dry-rolled corn. Data were pooled for Exp. 1, Exp. 2, and Exp. 3, with 96 steers in each experiment and fed for an average of 114 days.

	Corn bran level						
Item	0-bran	15-bran	30-bran	SEM	Trial*trt[a]	Linear[b]	Quadratic[b]
Initial wt., kg	404	404	404	1	0.99	0.86	0.93
Final wt., kg	612	605	604	3	0.47	0.07	0.48
DMI, kg/d	11.8	12.4	12.6	0.1	0.62	0.01	0.10
ADG, kg/d	1.82	1.76	1.74	0.03	0.31	0.05	0.58
ADG/DMI, kg gain/kg feed	.154	.142	.138	0.002	0.10	0.01	0.09

[a] Experiment by bran level interaction.

[b] Linear and Quadratic orthogonal contrasts to corn bran level of 0, 15, and 30%.

gen losses were not decreased by feeding bran despite linear increases (P = 0.02) in C:N ratio and OM percentage of manure (P = 0.08). Volatile nitrogen losses were large and averaged 66.8% of total N excreted. Approximately 30.7% of excreted N was removed in manure at cleaning across dietary treatments. Runoff N was greater in Exp. 3 than Exp. 1 and Exp. 2 and averaged 4.5% of total N excreted. The runoff amounts observed in this Exp. 3 agree with previously published averages of 3 to 6% of nutrient excreted[3,9,12,13]; however, little runoff occurred during Exp. 1 and Exp. 2 because of low precipitation.

Increasing the C:N ratio by increasing dietary bran had variable impacts on N losses in these experiments. During the colder winter spring months (Exp. 1 and Exp. 2), N losses were markedly decreased by adding corn bran to feedlot diets. However, small differences in N losses were observed between treatments in Exp. 3. Dewes (1996) evaluated N losses from cattle manure in chambers by studying two different factors separately, temperature and carbon additions. Increasing ambient temperature resulted in rapid (within 4 days) losses at high temperatures (40°C) whereas losses at temperatures of 20°C were still large but

Table 3. Effect of dietary corn bran on nitrogen balance in the feedlot and manure characteristics for steers fed from October to June (Exp. 1 and Exp. 2). Data were combined for both experiments and handled as one nutrient balance period. Nutrient balance data for N are expressed as total kg/steer for the both experiments (233 d).

	Corn bran level					
Item	0-bran	15-bran	30-bran	SEM	Linear[a]	Quadratic[a]
N intake, kg/steer	54.4	57.9	59.5	0.5	0.01	0.20
N excretion, kg/steer	49.2	52.6	54.3	0.5	0.01	0.24
N manure, kg/steer[b]	12.6	21.1	25.0	1.6	0.01	0.28
N runoff, kg/steer	0.20	0.09	0.06	0.01	0.01	0.01
N volatilization, kg/steer[c]	36.7	31.5	29.2	1.8	0.03	0.52
% volatilization[d]	74.1	59.8	53.8	3.2	0.01	0.33
% N manure[e]	1.80	1.69	1.76	0.11	0.83	0.55
C:N manure[f]	13.5	14.3	14.4	0.7	0.41	0.67
OM manure, kg/steer	222	335	455	17	0.01	0.86

[a] Linear and Quadratic orthogonal contrasts to corn bran level of 0, 15, and 30%.
[b] Manure N is corrected for change in pen soil N concentration and N amount from before and after experiments.
[c] Volatilization calculated as N excretion – N manure – N from soil balance – N in runoff
[d] Percent volatilization expressed as a percent of N excretion.
[e] Nitrogen concentration of manure removed at cleaning expressed as % of manure DM.
[f] Carbon to nitrogen ratio of manure removed at cleaning.

Table 4. Effect of dietary corn bran on nitrogen balance in the feedlot and manure characteristics for steers fed from June to October. Nutrient balance data for N are expressed as total kg/steer for the entire experiment.

	Corn bran level					
Item	0-bran	15-bran	30-bran	SEM	Linear[a]	Quadratic[a]
N intake, kg/steer	24.7	25.7	26.0	0.4	0.08	0.53
N excretion, kg/steer	22.5	23.5	23.7	0.4	0.07	0.50
N manure, kg/steer[b]	6.6	7.6	7.2	1.3	0.76	0.70
N runoff, kg/steer	1.04	1.02	1.09	0.14	0.82	0.79
N volatilization, kg/steer[c]	14.9	16.3	15.5	1.5	0.79	0.57
% volatilization[d]	66.3	69.2	65.0	5.9	0.88	0.63
% N manure[e]	1.33	1.13	1.34	0.13	0.94	0.22
C:N manure[f]	12.6	13.5	14.0	0.4	0.02	0.61
OM manure, kg/steer	146	168	182	13	0.08	0.81

[a] Linear and Quadratic orthogonal contrasts to corn bran level of 0, 15, and 30%.
[b] Manure N is corrected for change in pen soil N concentration and N amount from before and after experiments.
[c] Volatilization calculated as N excretion – N manure – N from soil balance – N in runoff
[d] Percent volatilization expressed as a percent of N excretion.
[e] Nitrogen concentration of manure removed at cleaning expressed as % of manure DM.
[f] Carbon to nitrogen ratio of manure removed at cleaning.

much slower.[6] In Exp. 3, increasing the C:N ratio of manure by dietary manipulation in the summer may not influence N losses because of the rapid losses with higher temperature. Based on average high and low temperatures for these experiments, the average temperature for Exp. 1 and Exp. 2 was 6.0°C whereas average temperature for Exp. 3 was 23.1°C.

Another observation from these experiments is that N lost from pens on the 0-bran treatment were higher (74.1% of N excreted) for Exp. 1 and Exp. 2 compared to Exp. 3 (66.3% of N excreted). Despite colder average ambient temperatures during Exp. 1 and Exp. 2, just as much N was lost from pens on the same diet as that in Exp. 3. This observation suggests an interaction between diet type (C:N ratio of manure) and temperature. It appears that if adequate carbon is present when temperatures rise in May, then N losses may be minimized. However, if inadequate carbon is present (0-bran), then N losses will be just as large as continuous warm temperatures.

Other research has given variable results when carbon is added to manure. Andersson (1996) added rapidly degraded (glucose) and slowly degraded (straw and peat) to liquid hog manure to determine the impact on N losses. Glucose decreased N losses during the initial 8 days. However, adding straw and peat decreased N losses more (15×) and longer (7 weeks) compared to untreated and glucose-amended hog manure. Subair et al., (1999) added either 2.5 or 5.0% paper products to hog manure and monitored volatilization. In their study, adding paper decreased N losses from 53 to 28%. In both of these studies,[2,29] manure was stored under aerobic conditions. When carbon added to manure was evaluated under anaerobic conditions, variable results were observed with some decreasing N losses[30,16] and some had no effect.[25]

None of these studies were conducted either to evaluate dietary modifications to increase C:N ratio or with open-dirt feedlot pens. Bierman et al., (1999) evaluated diets containing no roughage, 7.5% roughage, or 7.5% roughage with 40% wet corn gluten feed (WCGF) fed to steers in open-dirt feedlot pens. Wet corn gluten feed fed at 40% would be similar to diets containing approximately 27% corn bran based on the source of WCGF in their study. However, dietary N concentration was not equivalent across treatments in their study. Despite different N intakes, N removed in manure was improved by feeding roughage and roughage with wet corn gluten feed. In a similar experiment with open-dirt feedlot pens, corn silage increased in the diet from 15 to 45% had no impact on N losses.[9] Presumably, corn silage fiber is less available to microbes on the pen surface because of ensiling and feeding as compared to corn bran used in these experiments. Corn bran may pass through the rumen more quickly due to smaller particle size than corn silage and stimulate carbon excretion in the feces as compared to corn silage. Based on previous literature and these results, carbon additions to manure either through the diet or by direct addition may have variable results on N losses due to how rapidly degradation occurs.

Rainfall was different across these two time periods as well (Exp. 1 and Exp. 2 versus Exp. 3). During Exp. 3, there were 27.4 cm of precipitation during the 110 d. In Exp. 1 and Exp. 2, precipitation totaled 19.0 cm over 233 d. The increased moisture from 8.4 cm of precipitation in less than half as many days for Exp. 3 compared to Exp. 1 and Exp. 2 may have obscured differences in N loss between treatments in Exp. 3. Numerous researchers have concluded that N volatilization is positively correlated with moisture content and is most rapid during drying cycles.[15,26]

Digestibility trial

Cannulated steers used in the digestibility trial consumed 9.8 kg of DM per d but DMI was not affected by dietary treatment (Table 5). In the feedlot experiments, DMI increased linearly and tended to increase quadratically as dietary bran increased. Based on marker concentrations in feces, DM digestibility decreased linearly (P = 0.07) as corn bran increased from 0 to 30% of diet DM. Similarly, OM digestibility decreased linearly (P = 0.07) from 77.3 to 73.1% of OM intake. Scott et al., (1998) evaluated DRC-based diets with or without 15% corn bran in a total fecal collection digestion trial and observed a decrease in DM digestibility from 84.5 to 80.3% when bran was added.

Table 5. Dry matter, OM, and N digestibility results from replicated Latin square digestibility trial using ruminally and duodenally cannulated steers.

Item	Corn bran level			SEM	Linear*	Quadratic*
	0-bran	15-bran	30-bran			
DM intake, kg/day	9.7	10.1	9.7	0.2	0.81	0.23
DM digestibility, %	75.8	74.3	71.7	1.4	0.07	0.75
OM intake, KG/day	9.2	9.6	9.2	0.2	0.87	0.23
OM digestibility, %	77.3	75.9	73.1	1.5	0.07	0.70
N intake, grams/day	194	209	208	5	0.08	0.24
N excreted, grams/day in feces	61	66	70	3	0.05	0.80
N digestibility, %	68.7	68.3	66.4	1.4	0.11	0.51

* Linear and Quadratic orthogonal contrasts to corn bran level of 0, 15, and 30%.

More N was excreted in the feces (70 versus 61 g/d) for steers fed 30-bran compared to 0-bran suggesting that route of excretion for N may have been affected by dietary treatment. Increasing fiber inclusion in corn-based diets may change route of N excretion from urine to feces by stimulating hindgut fermentation.[3,11] Presumably, corn bran would increase hindgut fermentation compared to 0-bran diets comprised of corn and 15% corn silage. Corn bran contains between 70 and 86% NDF[5,22]. Bran used in these experiments averaged 81.3 ± 1.3% NDF. Bierman et al., (1999) changed route of excretion from urine to feces when a 40% wet corn gluten feed (WCGF) diet was compared to a 7.5% roughage diet similar to the 0-bran diet fed in this experiment. Because WCGF is comprised of corn bran and corn steep from the wet milling industry, corn bran alone may have similar effects on route of excretion. Bran is probably the sole stimulant of hindgut fermentation in WCGF based diets because steep is more digestible than corn.[22]

Conclusions

Increasing the C:N ratio of feedlot manure by dietary manipulation may have value in decreasing N losses but is dependent on time of year. However, nutritional methods that increase C:N ratio of manure will lead to decreases in feed efficiency which may limit their adoption and usefulness for producers. Corn bran may offer value in minimizing N losses; however, decreasing digestible OM will depress performance. Nitrogen losses during the summer months are a concern and are not easily controlled by changing the C:N ratio of manure.

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