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Effect of Corn Bran and Corn Steep Inclusion in Finishing Diets on Diet Digestibility and Fiber Disappearance

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Summary

Eight ruminally cannulated heifers were used in a replicated 4 x 4 Latin square to determine the effects of replacing dry rolled corn with corn bran or a combination of corn bran and corn steep, on diet digestibility and rumen environment. Heifers received diets including 0% bran, 30% bran, 30% bran/15% steep and 45% bran/15% steep. Byproduct diets were effective in reducing acidosis and had lower dry matter and organic matter digestibilities than the control diet, regardless of steep inclusion. Fiber digestion and microbial efficiency may have been promoted with the inclusion of corn bran and steep in the diet. Feeding a diet containing corn bran and steep may be valuable for improving nutrient utilization in the rumen.

Introduction

Providing options to decrease ammonia emissions is essential for future progress of the feedlot industry. Feeding corn bran, which is a source of highly digestible fiber, is an effective means of reducing N losses from the feedlot pen surface. When 30% bran replaced dry rolled corn (DRC), N losses were reduced by 38% in the winter months (*2003 Nebraska Beef Report*, pp 54-58). The reduction in N lost was achieved by reducing diet digestibility, increasing fecal N output, and increasing OM on the pen surface.

Fecal N is more stable than urinary N. Increasing the amount of fermentable carbohydrates to the hind gut, via feeding a lower digestible diet, is an effective means to increase fecal N (*1996 Nebraska Beef Cattle Report*, pp 74-77). The consequence of reducing diet digestibility is reduced feed efficiency in cattle (*2002 Nebraska Beef Cattle Report*, pp 54-57; *2003 Nebraska Beef Report*, pp 54-58).

Corn steep is a by-product of the wet corn milling industry that is a combination of both distillers solubles and steep liquor. It has a higher energy value than DRC (*1998 Nebraska Beef Cattle Report*, pp 69-71). The objective of the following metabolism study was to evaluate the effect of corn bran and steep inclusion in finishing diets on diet digestibility and rumen environment.

Procedure

Eight ruminally cannulated crossbred heifers were used in a replicated 4 x 4 Latin square design. All diets included 15% corn silage, 5% supplement and DRC. Treatments included a 0% corn bran control (CON), 30% bran (30/0), 30% bran/15% steep (30/15), and 45% bran/15% steep (45/15), with by-products replacing DRC and molasses (Table 1). These diets were similar in composition to those fed in two finishing trials used to evaluate cattle performance and N mass balance (*2005 Nebraska Beef Cattle Report*, pp 54-56). Periods included 16-day adaptation and 5-day collection. Chromic oxide was used as a marker to determine total tract digestibility, dosed 7.5 g, twice daily through the rumen cannula. The chromic oxide was dosed 72 hours before the first collection day, to ensure it was equally concentrated throughout the digesta. Fecal samples were taken three times during each collection day, dried in a 60ºC oven for 48 hours, and composited. Intake was continuously measured similar to the system described by Cooper et al., (*1997 Nebraska Beef Report*, pp 49). Ruminal fluid was collected prior to feeding and at 2, 4, 6, 8, 10 and 12 hours after feeding on each of the 5 days during a collection period.

An in-situ trial also was conducted during the final collection period. Corn bran and DRC were incubated as-is at time points of 0, 12, 24, 48, and 96 hours, with corn bran extent of 96 hours and DRC at a 48-hour extent. Each time point used two steers per diet and two replications per sample, with an empty dacron bag incubated for a control. Both bran and DRC were evaluated for DM disappearance

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rate; corn bran also was evaluated for NDF disappearance rate within each of the four diets. Potential digestible fractions were calculated by subtracting the extent hour value from the 0 hour value. A log transformation calculation was used to calculate DM and NDF disappearance rates (%/hour).

Results

Dry matter intake was similar among all treatments, averaging 25 lb/day ($P > 0.10$; Table 1). By-product diets had higher ruminal pH (5.96) than CON (5.75), averaged across all time points ($P < 0.01$; Table 2). The lower ruminal pH supports the concept that feeding by-products helps minimize the effects of acidosis. Acetate: propionate ratios were 2:09, 2:25, 2:30, and 2:52 for the CON, 30/0, 30/15, and 45/15 diets, respectively (P<0.05). When diets had a higher fiber content (i.e. bran included in the diet), acetate concentrations were higher and propionate concentrations were lower.

Total tract DM digestibility (Table 2) was higher in CON than by-product diets (79% vs 73.0%, $P < 0.01$), as was OM digestibility (80.2% vs. 74.6%, $P < 0.01$). Steep provided no improvement in DM or OM digestibility of the 30/15 diet. This is somewhat different from previous research that evaluated 15% corn bran and 15% corn bran plus 15% steep (15/15). Scott et al. (*1998 Nebraska Beef Report*, pp 69-71) reported the DM digestibility of a 15% bran diet to be 80%, while the 15/15 diet was 83% digestible. Although there was no statistical difference in the data from Scott et al., (1998) steep did tend to improve total tract digestibility.

In-Situ Results

DM disappearance (%/hour) of DRC was lower in CON diet than by-product diets ($P < 0.01$; Table 3), suggesting that because the rumen pH was higher in the byproduct

Table 1. Composition of dietary treatments for metabolism and in situ trials (% DM basis).

Ingredient	CON	30/0	30/15	45/15
Dry Rolled Corn	75	45	35	20
Corn Silage	15	15	15	15
Corn Bran	—	30	30	45
Steep	—	—	15	15
Molasses	5	5	—	—
Dry Supplement[a]	5	5	5	5
Nutrient Composition (%)				
CP[b]	13.7	13.4	14.0	14.2
Calcium[c]	0.70	0.70	0.70	0.70
Phosphorus[c]	0.32	0.26	0.47	0.44

[a]Supplement formulated to provide 28g/ton Rumensin® and 10 g/ton Tylan®.
[b]Calculated based on CP analysis of feedstuffs.
[c]Calculated using tabular values for ingredients.

Table 2. Effect of dietary treatment on DM intake, total tract digestibility, and ruminal pH.

	Treatment[a]					
Item	CON	30/0	30/15	45/15	SE[b]	F-Test[c]
Avg pH[d]	5.75[g]	5.95[h]	5.94[h]	5.98[h]	0.06	<0.01
DM Intake, lb/d	23.8	25.8	25.4	25.2	1.4	0.56
DM Digested, lb/d	18.8	19.0	18.5	18.3	1.0	0.90
DMD,%[e]	79.0[g]	73.7[h]	72.8[h]	72.6[h]	1.5	0.03
OM Intake, lb/d	22.1	24.0	23.6	23.4	1.3	0.56
OM Digested, lb/d	17.7	18.0	17.6	17.4	1.0	0.95
OMD,%[f]	80.2[g]	75.0[h]	74.4[h]	74.4[h]	1.5	0.03

[a]CON = dry rolled corn based diet with no by-product inclusion; 30/0 = dry rolled corn replaced with 30% bran and 0% steep; 30/15 = dry rolled corn and molasses replaced with 30% bran and 15% steep; 45/15 = dry rolled corn and molasses replaced with 45% bran and 15% steep.
[b]Standard error of the mean.
[c]Data were analyzed using a protected F-test where numbers represent P-value for variation due to treatment.
[d]Avg pH = average pH.
[e]DMD = DM digestibility.
[f]OMD = OM digestibility.
[gh]Means within row with unlike superscripts have differing values.

Table 3. Disappearance rates (%/hour) of corn bran and dry rolled corn incubated within each dietary treatment.

	Treatment[a]					
Item	CON	30/0	30/15	45/15	SE[b]	F-Test[c]
DMd (corn)[d]	2.36[f]	2.71[g]	2.99[g]	2.89[g]	0.22	<0.01
DMd (bran)[d]	0.76[f]	2.18[g]	1.70[g]	1.92[g]	0.22	<0.01
NDFd (bran)[e]	0.82[f]	1.71[g]	1.79[g]	2.08[h]	0.05	<0.01

[a]CON = dry rolled corn-based diet with no by-product inclusion; 30/0 = dry rolled corn replaced with 30% bran and 0% steep; 30/15 = dry rolled corn and molasses replaced with 30% bran and 15% steep; 45/15 = dry rolled corn and molasses replaced with 45% bran and 15% steep.
[b]Standard error of the means.
[c]Data were analyzed using a protected F-test where numbers represent P-value for variation due to treatment.
[d]DMd = Dry matter disappearance rate calculated as%/hour.
[e]NDFd = NDF disappearance rate calculated as%/hour for corn bran.
[fgh]Means with unlike superscripts within row have differing values.

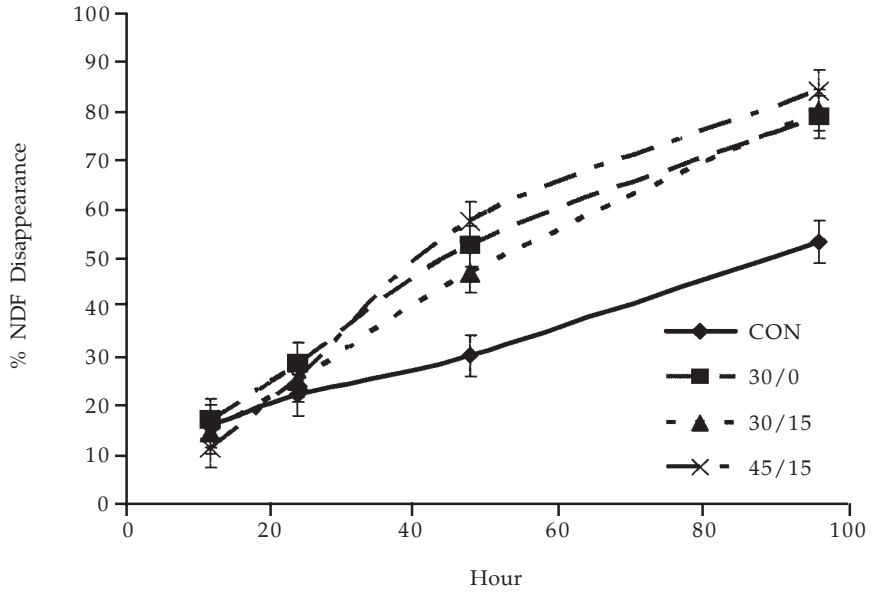

Figure 1. Corn bran NDF disappearance (%), reported at 12, 24, 48, and 96 hours, incubated within each dietary treatment.

diets, the microbial population was more efficient at digesting the DRC. The NDF content of corn bran was 72.9%. NDF disappearance rates (%/hour) were highest for the 45/15, similar for 30/0 and 30/15, and lowest for CON ($P < 0.01$; Table 3). This suggests that when corn bran is increased in the diet, the microbial population has more cellulolytic bacteria. A higher cellulolytic bacteria population would promote an increase in the acetate: propionate ratio, as well as an increase in ruminal fluid pH.

The percentage of NDF disappearance was not different among diets at 0, 12 and 24 hours; however, at 48 and 96 hours (Figure 1), the NDF disappearance for bran was lower for CON than by-product diets ($P < 0.01$). Digestion of corn bran occurred to a further extent when bran was incubated in 30/0, 30/15, and 45/15 diets, compared to incubation in the CON diet. These data support the theory that because of a higher ruminal pH and an altered microbial population, digestion of both dry rolled corn and bran occurs to a greater extent.

While adding steep to the diet did not improve total tract digestibility, it did improve cattle performance (*2005 Nebraska Beef Report*, pp 54-56). By-product diets are effective in reducing acidosis, and have lower dry matter and organic matter digestibilities than typical corn-based diets, regardless of steep inclusion. Rate of corn bran digestion and extent is greater in by-product-based diets. Feeding corn bran and steep in combination is an effective means of promoting fiber digestion, and maintaining a healthier rumen environment.

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