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Metabolism and Digestibility of Corn Bran and Corn Steep Liquor/ Distillers Solubles

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Corn steep liquor/distillers solubles lowered pH while feeding corn bran tended to increase pH. Corn steep liquor/distillers solubles fed alone changed the ruminal fermentation pattern of steers.

Summary

Six ruminally cannulated steers and six intact steers were used in a 6x6 Latin square design to determine the effect of corn bran and/or corn steep liquor/distillers solubles on ruminal metabolism and digestibility. Steers fed corn steep liquor/distiller's solubles had lower average daily pH. Corn bran helped maintain a higher average pH. Corn steep liquor/distillers solubles fed alone altered the fermentation pattern of steers. There was a tendency for corn bran to reduce digestibility and for corn steep liquor/distillers solubles to improve digestibility.

Introduction

The corn wet milling industry continues to offer Nebraska cattle feeders opportunities to include byproduct ingredients in their finishing diets. Including byproducts in cattle rations requires a fundamental working knowledge of their effect on nutrient metabolism and their overall effect on animal performance. Corn bran is the fibrous fraction left after corn is wet milled. Corn steep liquor contains the soluble fraction (amino acids, peptides, vitamins, minerals, etc.) of the corn, as well as lactate and other fermentation endproducts. Processing plants producing ethanol have distillers solubles that also may be added back to the corn steep liquor. Previous research at the University of Nebraska has shown a significant interaction between corn bran and corn steep liquor/distillers solubles for gain efficiency . This experiment was designed to determine the effect of corn bran, corn steep liquor/distillers solubles and combinations of the two feed ingredients on metabolism and digestibility.

Procedure

Six ruminally cannulated (873 lb) and six intact (872 lb) steers were used in a 6 x 6 Latin square design (2). The experimental treatment structure was a 2 x 3 factorial with treatments based upon adding corn bran (B), corn steep liquor/distillers solubles (ST) and com-

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binations of B and ST to a dry-rolled corn (DRC) control diet. Treatments were DRC, 15%B, 15%ST, 30%ST, 15%B-15%ST and 15%B-30%ST (DM basis). Diets (Table 1) were formulated to contain (DM basis) a minimum of 13% CP, .70 % Ca, .30% P and included 25 g/ton Rumensin and 10 g/ton Tylan. Steers were fed once daily and allowed ad libitum access to diets. Steers were adapted to a 92.5% concentrate diet by using adaptation diets containing (DM basis) 35 (9 d), 25 (9 d) and 15% (7 d) forage.

Ruminally cannulated steers were used to continuously monitor pH and intake using the system described by Cooper et al. (Nebraska Beef Cattle Report, 1997 pp. 49). In addition, rumen fluid samples were taken for VFA analysis. Each period was 14 days: diet adaptation days 1-7, pH and intake measurements days 8-13, and rumen fluid sampling day 14. Samples of rumen fluid were taken every hour for 24 hours beginning at 0900 on day 14. Analyses of VFA were performed on 12 and 24 hour samples and a composite sample of each of the hourly samples.

Intact steers were used to determine the effect of B, ST or combinations of B and ST on total tract digestibility. Each period lasted 14 days: diet adaptation day 1-10 and total fecal collection days 11-14. Feed ingredient samples were taken weekly and feed refusals were weighed daily. Samples of feed refusals were taken for days 9-12 (48 hours before initiation/termination of total fecal collection). Fecal collection bags were weighed, sampled and cleaned twice daily. Samples of feed ingredients, feed refusals and feces were dried in a 60°C oven and composited for analysis. Analyses included DM, CP, NDF and starch.

Results

There were no differences in DMI among steers due to addition of B and/or ST to the DRC basal diet. Steers consumed an average of 2.4 lb of feed in each of 9.5 meals per day with each meal averaging 37.9 min. There were no differences in the number, size or length of meals (data not presented) due

Table 1. Diet Composition.

	Diet[a]					
Ingredient	DRC	15ST	30ST	15B	15B-15ST	15B-30ST
DRC	87.5	73.5	58.5	72.5	58.5	43.5
Bran				15.0	15.0	15.0
Steep		15.0	30.0		15.0	30.0
Alfalfa	7.5	7.5	7.5	7.5	7.5	7.5
Supplement[b]	5.0	4.0	4.0	5.0	4.0	4.0

[a]DRC = dry-rolled corn; B = corn bran; ST = steep liquor/distillers solubles.
[b]Includes vitamins, minerals, and feed additives

Table 2. Intake and pH data from cannulated steers.

	Diet[a]						P=[bc]		
Item	DRC	15ST	30ST	15B	15B-15ST	15B-30ST	B	ST	BxST
DMI, lb	18.7	20.7	17.9	20.2	20.2	21.3	.15	ns	ns
Max pH[d]	6.59	6.59	6.40	6.76	6.61	6.45	ns	.06	ns
Avg pH[e]	6.01	5.92	5.75	6.12	5.95	5.92	.14	.03	ns
Min pH[f]	5.42	5.42	5.25	5.43	5.35	5.50	—	—	.06
pH<5.6 x min[g]	26.8	28.6	138.9	26.2	48.6	5.1	—	—	.01

[a]DRC = dry-rolled corn; B = corn bran; ST = steep liquor/distillers solubles.
[b]Equals P value for effect of corn bran, effect of steep liquor/distiller's solubles and corn bran x steep liquor/distiller's solubles interaction.
[c]ns = not significant (P > .20).
[d]Max pH = maximum pH.
[e]Avg pH = average pH.
[f]Min pH = minimum pH.
[g]pH<5.6 x min =pH x minutes below pH 5.6.

Table 3. Composite VFA analysis.

	Diet[a]						P=[bc]		
Item	DRC	15ST	30ST	15B	15B-15ST	15B-30ST	B	ST	BxST
Acetate[d]	58.6	53.9	49.7	55.1	57.6	55.8	—	—	.09
Propionate[e]	33.6	38.3	41.6	38.6	33.6	33.3	—	—	.05
A:P[f]	1.74	1.41	1.19	1.43	1.71	1.68	—	—	.09
Butyrate[g]	2.39	2.85	2.95	1.96	3.68	4.07	.11	.01	.12
Total VFA, mM	97.6	96.2	96.0	96.7	94.9	91.6	ns	ns	ns

[a]DRC = dry-rolled corn; B = corn bran; ST = steep liquor/distillers solubles.
[b]Equals P value for effect of corn bran, effect of steep liquor/distiller's solubles and corn bran x steep liquor/distiller's solubles interaction.
[c]ns = not significant (P > .20).
[de]Molar proportion.
[f]Acetate to propionate ratio.
[g]Molar proportion.

Table 4. Total tract digestibility.

	Diet[a]						P=[bc]		
Item	DRC	15ST	30ST	15B	15B-15ST	15B-30ST	B	ST	BxST
DMI, lb	17.3	19.4	16.1	18.1	17.9	19.0	ns	ns	ns
DM, %	84.5	87.8	84.5	80.3	83.0	82.4	.05	ns	ns
CP, %	79.4	83.3	79.0	77.1	78.0	81.5	ns	ns	ns
NDF, %	76.0	78.4	71.8	73.8	75.6	82.2	—	—	.05
Starch, %	99.8	99.8	99.8	99.6	99.7	99.7	ns	ns	ns

[a]DRC = dry-rolled corn; B = corn bran; ST = steep liquor/distillers solubles.
[b]Equals P value for effect of corn bran, effect of steep liquor/distiller's solubles, corn bran x steep liquor/distiller's solubles interaction.
[c]ns = not significant (P > .20).

to addition of B and/or ST to the diet.

Laboratory analyses for CP, NDF and starch were determined for DRC, B and ST. The CP contents were 8.2, 12.0 and 26.5% for DRC, B and ST, respectively. Fiber (NDF) contents were 19.8, 78.2 and 0.0% for DRC, B and ST, respectively. Starch contents were 80.7, 23.1 and 15.0% for DRC, B and ST, respectively.

Adding ST to the diet lowered average ruminal pH (Avg pH, Table 2). Corn steep liquor/distillers solubles has an inherently low pH (4.0-4.5), as well as an appreciable amount of lactic acid and unfermented carbohydrates. There was a tendency (P = .14) for B to increase average pH. There was a B x ST interaction for both minimum pH and pH<5.6 x min (Min pH and pH<5.6, Table 2). When ST was fed alone, minimum pH decreased and pH<5.6 x min increased as additional ST was added. However, when B and ST were fed in combination, minimum pH decreased at the 15% level of ST, but did not further decrease with additional ST. Similarly, pH<5.6 x min increased at the 15% level of ST but did not further increase at the 30% level of ST.

Analyses of VFA composite samples (Table 3) resulted in a B x ST interaction for molar proportion of acetate and propionate, as well as acetate to propionate ratio (A:P). When ST was fed alone, acetate decreased, propionate increased and the acetate to propionate ratio decreased as level of ST increased. However, when B and ST were fed in combination, acetate, propionate and acetate to propionate ratio were similar to the DRC control, regardless of the level of ST in the diet. Inclusion of ST in the diet increased the molar proportion of butyrate. Total VFA concentration was not changed by feeding of B and/or ST. The fermentation pattern change that accompanied the feeding of ST alone may help to explain a previous finding: that when ST replaced DRC in the diet it appeared to have a higher energy value (Nebraska Beef Cattle Report, 1997 pp. 72). The high lactic acid content of ST may contribute to the change, due to metabolism of lactic acid to propionate.

Results using intact steers showed no differences in DMI due to inclusion of B and/or ST in the diet (Table 4). Inclusion of B in the diet reduced DM digestibility. Though highly digestible, corn bran is likely slightly less digestible than the DRC it replaced. There was a B x ST interaction for NDF digestibility. The digestibility of CP and starch were not changed by feeding B and/or ST.

Results of this research indicate feeding corn steep liquor/distillers solubles lowers the average ruminal pH of steers. Feeding corn bran may help to maintain a higher average pH. The acetate to propionate ratio of steers is lowered when corn steep liquor/distillers solubles is fed alone. Feeding corn bran reduced dry matter digestibility.

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