

Characterizing Digestion Traits of Novel Corn Bran Products

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Summary with Implications

A digestion study was conducted to evaluate novel corn bran products from Cargill Corn Milling on nutrient digestibility in beef steers. Three bran products (Bran A/B/C) were included at 70% of diet dry matter of TRT A, B and C, with an internal control (SFC control) diet which consisted of 70% SFC. The SFC control exhibited the greatest dry matter (DM), organic matter (OM) and starch digestibility, and the least neutral detergent fiber (NDF) digestibility. Among TRT A, B and C when bran products were included at 70%, there was no difference in DM or OM intake and digestibility. NDF digestibility was greatest for TRT A fed steers, least for TRT C with TRT B intermediate. Starch intake was greatest for TRT C fed steers, least for TRT A with TRT B intermediate; while starch digestibility was greatest for TRT A fed steers, least for TRT C with TRT B intermediate. Bran products had minimal effect on energy digestibility, ruminal pH, rumination activity and blood parameters. Digestion trait differences existed among different corn bran products, of which Bran A was better digested, and corn bran products could replace SFC up to 70% dietary inclusion without compromising digestible energy of diet.

Introduction

Sweet Bran® is a well-known feed from Cargill wet milling of corn. As the wet milling process continues evolving over time,

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Table 1. Diet composition (DM basis) fed to fistulated steers to evaluate nutrient digestion of steers fed different corn bran products

Ingredient, % DM	Treatments ¹			
	TRT A	TRT B	TRT C	SFC Control
Bran A	70	-	-	-
Bran B	-	70	-	-
Bran C	-	-	70	-
Sweet Bran™	-	-	-	25
Steam Flaked Corn (SFC)	25	25	25	70
Wheat Straw	5	5	5	5
Nutrient composition², %DM				
Organic Matter (OM)	93.9	95.4	95.8	95.4
Crude Protein	17.9	14.2	13.7	14.3
Starch	28.8	42.8	48.6	58.5
Neutral Detergent Fiber (NDF)	33.5	26.6	24.3	20.1

¹ Treatment include: TRT A, 70% Bran A, 25% SFC, 5% wheat straw on dry matter basis; TRT B, 70% Bran B, 25% SFC, 5% wheat straw on dry matter basis; TRT C, 70% Bran C, 25% SFC, 5% wheat straw on dry matter basis; SFC Control, 25% Sweet Bran™, 70% SFC, 5% wheat straw on dry matter basis

² Based on analyzed nutrients for each ingredient

novel bran products emerge, which may be used as cattle feed. The evaluation of new bran products is necessary for continued improve of use by the cattle industry. The objective of this study was to evaluate three novel corn bran products from Cargill Wet Milling on rumen fermentation, digestion and blood profiles in cattle.

Procedure

All corn bran products (Bran A/B/C) and Sweet Bran® were provided by Cargill Wet Milling (Blair, NE). Eight ruminally cannulated beef steers were utilized in a 4×4 replicated Latin Square design with four treatment periods. Steers were housed individually in concrete slatted pens with *ad libitum* access to feed and water. Within Square, four steers were assigned randomly to four treatment diets over four periods.

Composition of treatment diets (Table 1, dry matter basis) were 70% Bran A, Bran B or Bran C in TRT A, B and C, respectively, in addition to 25% steam flaked corn (SFC) and 5% wheat straw. The SFC Control diet served as an internal control which consisted of 25% Sweet Bran®, 70% SFC and 5% wheat straw. Minerals and vitamins were blended in the bran products and Sweet Bran® to meet or exceed the animals' requirements. Each period was 21 d in length with 14 d of adaptation followed by 7 d of collection. Diets were mixed twice weekly and stored in a cooler to ensure freshness. Steers were fed twice daily at 0700 h and 1300 h, and feed refusals were removed and weighed daily before morning feeding. Refusals were collected for day 16 to 19, and dried in 140 °F forced-air oven for 48 hours to correct DMI. Refusals were ground through a 1-mm screen using a

Table 2. Total tract digestibility for steers fed different corn bran products

Item ²	Treatments ¹				SEM	P-Value
	TRT A	TRT B	TRT C	SFC Control		
DM						
Intake, lb	26.6	26.4	27.1	27.2	1.36	0.97
Fecal output, lb	7.8	7.5	7.9	7.2	0.43	0.68
Digestibility, %	71.37 ^b	71.92 ^b	71.05 ^b	73.63 ^a	0.65	0.05
OM						
Intake, lb	25.0	25.2	26.0	26.0	1.28	0.93
Fecal output, lb	6.6	6.5	7.0	6.3	0.38	0.63
Digestibility, %	74.26 ^b	74.58 ^{ab}	73.20 ^b	75.82 ^a	0.63	0.06
NDF						
Intake, lb	9.0 ^a	7.1 ^b	6.6 ^b	5.5 ^c	0.38	<.01
Fecal output, lb	3.8	3.7	4.0	3.6	0.23	0.67
Digestibility, %	59.04 ^a	48.31 ^b	39.97 ^c	34.95 ^d	2.00	<.01
Starch						
Intake, lb	7.8 ^d	11.6 ^c	13.4 ^b	16.2 ^a	0.60	<.01
Fecal output, lb	0.1 ^c	0.3 ^b	0.5 ^a	0.1 ^c	0.04	<.01
Digestibility, %	99.20 ^a	97.60 ^b	96.58 ^c	99.29 ^a	0.23	<.01
Energy						
Apparent Energy Digestibility, %	70.69	70.83	68.68	71.25	0.93	0.24
DE, Mcal/day	36.80	36.31	36.19	36.62	1.84	0.99
DE Mcal/lb	1.40	1.39	1.34	1.35	0.02	0.21

^{a-d} Means in a row with different superscripts are different ($P < 0.10$)

¹ Treatment include: TRT A, 70% Bran A, 25% SFC, 5% wheat straw on dry matter basis; TRT B, 70% Bran B, 25% SFC, 5% wheat straw on dry matter basis; TRT C, 70% Bran C, 25% SFC, 5% wheat straw on dry matter basis; SFC Control, 25% Sweet Bran[™], 70% SFC, 5% wheat straw on dry matter basis

² DM: Dry matter; OM: Organic matter; NDF: Neutral detergent fiber; DE: Digestible energy

Wiley mill, composited by steer within each period and analyzed to correct nutrient intake. Samples of individual ingredients were taken before diet mixing during collection week, composited by period, lyophilized, and ground through a 1-mm screen. Steers were dosed twice daily through the rumen cannula with titanium dioxide (5g/dose or 10 g/day) at 0700 and 1700 h from day 7 to day 20 of each period. Fecal grab samples were taken at 0700, 1100, 1500, 1900, 2300 and 0300 h and composited on wet basis (30 g each) daily on day 19 and 20. The

lyophilized and ground (1 mm) daily fecal composites were then composited on a dry weight basis by steer within each collection period. Fecal samples (ground through 0.5 mm screen) were analyzed for titanium dioxide concentration and used to determine total fecal output.

Feed, refusals and fecal samples (ground through 1 mm screen) were analyzed for gross energy content (calories/g) using a bomb calorimeter. Digestible energy (DE) was calculated by subtracting the fecal energy from the total gross energy intake.

Nutrients such as dry matter (DM), organic matter (OM), neutral detergent fiber (NDF), and starch content of feed, refusals and fecal samples were also analyzed and used for calculation of total tract nutrient digestibility. Behavior measuring tags (CowManager) and pH probes (Smaxtec) were used during the entire period to measure rumination activity and ruminal pH, respectively. Catheters were put in jugular vein to collect blood at 0700, 1100, 1500, 1900, 2300 and 0300 h on day 19 and 20 for blood gas (ABL90 FLEX blood gas analyzer) measurements.

Nutrient digestibility, rumination and ruminal pH (by day average, minimum, maximum, etc) data were analyzed using the PROC MIXED procedure of SAS 9.4 (SAS Institute, Inc., Cary, NC, USA), with period, treatment and steer within square as fixed effect. The ruminal pH and blood gas measurements were analyzed using the PROC MIXED procedure with treatment, period, hour, treatment by hour interaction included in the model and hour being considered a repeated measure. P -values ≤ 0.10 were considered significant.

Results

There was no dietary treatment effect on DM and OM intake or fecal output (Table 2; $P \geq 0.63$). Dry matter and OM digestibility was greatest ($P \leq 0.06$) for SFC control, with no difference among TRT A, B and C in which each of the bran products were included at 70%. Neutral detergent fiber intake was greatest ($P < 0.01$) for TRT A, least for SFC control, with TRT B and C being intermediate. The NDF intake difference was due to different dietary NDF content (Table 1) of each diet, in which the TRT A diet had the greatest NDF content, SFC control had the least NDF content provided mainly by wheat straw. There was no difference for NDF fecal output ($P = 0.67$) among treatments. The digestibility of NDF ($P < 0.01$) was least for SFC control when compared to other treatments. Among TRT A, B and C where each bran product included at 70%, the NDF digestibility was greatest for TRT A, least for TRT C, with TRT B being intermediate. Starch intake was greatest ($P < 0.01$) for steers fed SFC control diet as it contained the greatest starch content (58.5% of diet DM; Table 1). Starch intake

Table 3. Ruminal pH characteristics for steers fed different corn bran products

Item ²	Treatments ¹				SEM	P-Value
	TRT A	TRT B	TRT C	SFC Control		
Minimum	5.96	5.97	5.86	5.90	0.05	0.38
Maximum	6.56	6.61	6.67	6.70	0.05	0.24
Average	6.25	6.29	6.29	6.32	0.04	0.69
Magnitude	0.59 ^b	0.64 ^b	0.81 ^a	0.80 ^a	0.06	0.05
Variation	0.138 ^b	0.145 ^b	0.181 ^a	0.190 ^a	0.013	0.02

^{a,b} Means in a row with different superscripts are different ($P < 0.10$)

¹ Treatment include: TRT A, 70% Bran A, 25% SFC, 5% wheat straw on dry matter basis; TRT B, 70% Bran B, 25% SFC, 5% wheat straw on dry matter basis; TRT C, 70% Bran C, 25% SFC, 5% wheat straw on dry matter basis; SFC Control, 25% Sweet Bran[™], 70% SFC, 5% wheat straw on dry matter basis

² Averages of pH over 4 days during the collection week

Table 4. Rumination characteristics for steers fed different corn bran products

Item	Treatments ¹				SEM	P-Value
	TRT A	TRT B	TRT C	SFC Control		
Ruminating, min/day	298	319	339	356	19.1	0.20
Ruminating, min/ lb DMI	10.8	11.5	12.5	12.9	0.66	0.13
Eating, min/day	33.9	48.7	44.6	47.5	6.58	0.39

^{a,b} Means in a row with different superscripts are different ($P < 0.10$)

¹ Treatment include: TRT A, 70% Bran A, 25% SFC, 5% wheat straw on dry matter basis; TRT B, 70% Bran B, 25% SFC, 5% wheat straw on dry matter basis; TRT C, 70% Bran C, 25% SFC, 5% wheat straw on dry matter basis; SFC Control, 25% Sweet Bran[™], 70% SFC, 5% wheat straw on dry matter basis

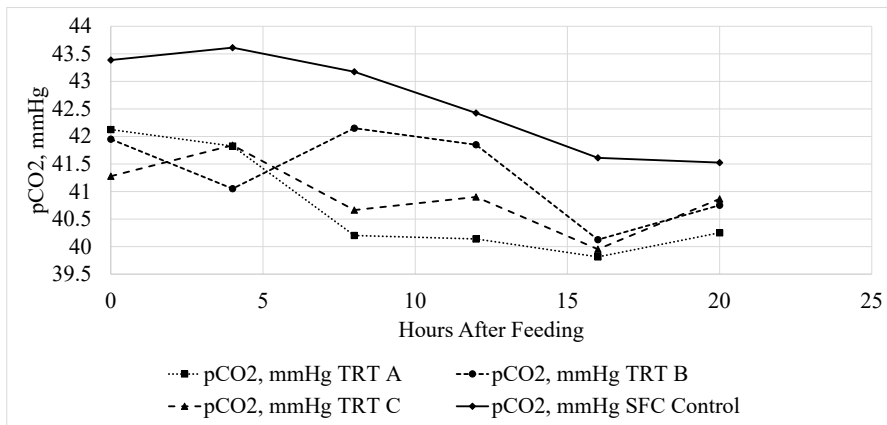


Figure 1. Jugular Vein Blood pCO₂ for Steers fed Different Corn Bran Products

was least for TRT A, with TRT B having less starch intake than TRT C. Fecal starch output ($P < 0.01$) was greatest for TRT C, least for TRT A and SFC control, with TRT B being intermediate. There was no difference ($P = 0.78$) for starch digestibility between TRT A and SFC control; with TRT C having the least starch digestibility and TRT B being intermediate. Even though apparent energy digestibility of the SFC control treatment was numerically higher,

there was no dietary treatment effect ($P \geq 0.20$) on energy digestibility, digestible energy intake per day or digestible energy per lb of the DMI among treatments.

There was no dietary treatment effect ($P \geq 0.24$; Table 3) on average, minimum, and maximum rumen pH parameters. Ruminal pH values below 5.6 were not observed in this study, mainly due to the higher inclusion of corn bran products in the diets; even the SFC control diet had a NDF level

greater than 20%. There were significant differences ($P \leq 0.05$) in the magnitude and variation of ruminal pH. Steers fed SFC control and TRT C diet exhibited greater ruminal pH change magnitude ($P \leq 0.05$) and variation ($P \leq 0.02$) when compared to steers fed TRT A or B. There was no treatment effect ($P \geq 0.13$) on ruminating (expressed as minutes per day or per lb DMI) and eating (expressed as minutes per day) activity of steers fed different corn bran products (Table 4). Among the jugular vein blood parameters measured in this study, no treatment effect ($P \geq 0.20$) was observed for blood Glucose, Lactate, pH and partial pressure of O₂ (data not shown). A Treatment \times Hour effect ($P = 0.04$) on blood partial pressure of CO₂ (pCO₂) was observed where the SFC control-fed steers exhibited greater pCO₂ (Figure 1). The increased pCO₂ may indicate an increased production and absorption of VFA from the rumen to the blood.

Conclusion

There was no difference in DM/OM digestibility among the three corn bran products when included at 70% of the diet DM; while the NDF and starch digestibility were greatest for TRT A, least for TRT C with TRT B being intermediate. Results indicated that digestion trait differences existed among different corn bran products from corn wet milling processing and Bran A resulted in better digestion in terms of NDF and starch. The SFC Control exhibited the highest DM, OM and starch digestibility, and the least NDF digestibility, while the digestible energy was not different among treatments, which suggested that either corn bran products could replace SFC in the diet up to 70% inclusion without impacting digestible energy intake.

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