Effects of Individual Sweet Bran Components in Beef Finishing Diets on Nutrient Digestion

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Summary with Implications

Sweet Bran is a branded wet corn gluten feed recognized for improving rumen health, energy intake, and gains in finishing cattle. Eight ruminally cannulated steers were utilized in a replicated 4 × 4 Latin Square design to evaluate the effect of individual Sweet Bran components on total tract digestibility and rumen fermentation parameters. Three Sweet Bran components (solvent extracted germ meal, corn bran, and mixed steep) were included at 40% of diet dry matter in their respective treatment, with a steam-flaked corn control diet. Total tract dry matter and organic matter digestibility were least for bran, intermediate for solvent extracted germ meal, and greatest for steep and control diets. Neutral detergent fiber digestibility was least for control and intermediate for bran and steep with a tendency for solvent extracted germ meal to have the greatest fiber digestibility. Overall, steep and solvent extracted germ meal have similar energy densities as the steam-flaked corn control, and bran and solvent extracted germ meal are highly digestible fiber sources. The nutrient and physical characteristics of steep, solvent extracted germ meal, and bran are complementary and may contribute to the greater energy value of Sweet Bran compared to dry-rolled corn.

Introduction

Wet corn gluten feed is a common by-product from the wet corn milling process but can vary in nutrient composition and feeding value based on the level of corn bran, mixed steep, and solvent extracted germ meal (SEM) in the mixture. Corn bran is the highly digestible, fibrous portion of the corn kernel. During the manufacturing of corn gluten feed, wet bran is pressed and may be dried before the addition of steep. Mixed steep is a mixture of heavy steep water and distiller's solubles and contains amino acids, minerals, and vitamins as well as fermentation end products such as lactate. Solvent-extracted germ meal is the fraction remaining after oil is extracted from the germ.

Sweet Bran is a branded corn gluten feed consisting of corn bran, mixed steep, and SEM and recognized for a consistent supply and nutrient composition. Incorporation of bran, steep, and SEM in Sweet Bran may vary, within feed label requirements, resulting in slight changes to ingredient proportions. Therefore, the objective of this digestion study was to evaluate the effect of individual Sweet Bran components, corn bran, SEM, and steep, on total tract nutrient digestion and rumen fermentation parameters.

Table 1. Diet composition (DM basis) fed to steers to evaluate nutrient digestion of individual Sweet Bran components

	Treatment[1]			
Ingredient	CON	SEM	BRAN	STEEP
Steam-flaked corn	79	40	40	40
Solvent extracted germ meal	-	40	-	-
Dry corn bran	-	-	40	-
Steep liquor	-	-	-	40
Corn silage	15	15	15	15
Supplement[2]				
Fine ground corn	0.305	2.83	1.33	1.86
Soybean meal	2.0	-	-	-
Limestone	1.66	1.66	1.66	2.63
Tallow	0.15	0.125	0.125	0.125
Urea	1.5	-	1.5	-
Salt	0.3	0.3	0.3	0.3
Vitamin A-D-E premix	0.015	0.015	0.015	0.015
Beef trace premix	0.05	0.05	0.05	0.05
Rumensin premix[3]	0.017	0.017	0.017	0.017
Tylan premix[4]	0.0035	0.0035	0.0035	0.0035
Analyzed nutrient composition, %				
Organic matter	96.82	96.33	96.78	91.75
Neutral detergent fiber	10.59	23.49	32.16	8.00
Crude protein	12.02	14.58	14.04	29.28
Starch	62.59	43.12	39.68	35.39

[1]Treatments included CON- control, SEM-solvent extracted germ meal, BRAN- corn bran, STEEP-mixed steep

[2]Supplement fed at 6% for CON treatment and 5% for SEM, BRAN, and STEEP.

[3]Formulated to supply Rumensin-90 (Elanco Animal Health) at 30 g/ton DM.

[4]Formulated to supply Tylan-100 (Elanco Animal Health) at 90 mg per steer daily.

[5]Individual feed ingredients analyzed for nutrient composition

Procedure

Eight ruminally cannulated crossbred steers were used in a replicated 4 x 4 Latin

square design with 21-d periods consisting of a 16-d adaptation period followed by a 5-d sample collection period. The study was conducted over 84 d. There were four dietary treatments in an unstructured treatment design: 1) control (CON) consisting of 80% steam-flaked corn (SFC), 2) solvent extracted germ meal (SEM), 3) dried corn bran (BRAN), and mixed steep (STEEP), included at 40% of diet dry matter with 40% SFC (Table 1). All the dietary treatments contained 15% corn silage and 5% supplement, except for the control. The control treatment contained 6% supplement with soybean meal to meet protein requirements and equalize protein content among dietary treatments. All supplements were formulated to include 30 g/ton of monensin (Rumensin, Elanco Animal Health) and 8.8 g/ton of tylosin (Tylan, Elanco Animal Health).

Steers were fed twice daily at 0700 h and 1300 h and had ad libitum access to feed and water. Cattle were housed in individual, rubber slatted pens in a temperature-controlled room. Ingredient samples were taken during the collection period at the time of mixing, composited by period, freeze-dried and ground through a Wiley Mill using a 1-mm screen. Feed refusals were collected on d 18 and 19 before feeding, dried in a forced air oven, ground through a Wiley Mill using a 1-mm screen, and composited by steer within collection period. Beginning on d 7 of each period, titanium dioxide was dosed intraruminally at 0700 and 1700 h to provide a total of 20 g/d. Fecal samples were collected at 4 times/d at 0700, 1100, 1500, 1900, 2300, and 0300 h on d 19 and 20. Fecal samples were composited by day, freeze-dried, ground as previously described, and composited by animal within period. Fecal samples were analyzed for titanium dioxide to determine fecal output and nutrient digestibility. Feed ingredients, feed refusals, and fecal samples were analyzed for dry matter (DM), organic matter (OM), neutral detergent fiber (NDF), total starch, and crude protein (CP).

Ruminal pH was measured continuously throughout the trial with SmaXtec wireless pH probes. Measurements for pH included average ruminal pH, minimum and maximum pH, magnitude of change, and variance. The number of minutes spent ruminating was also continuously measured using CowManager Sensor ear-tags.

Table 2. Nutrient intake and digestibility of steers fed individual Sweet Bran components

	Treatment[1]					
Item	CON	SEM	BRAN	STEEP	SEM	*P*-value
DM						
Intake, lb	24.8	23.8	25.5	25.6	0.95	0.15
Digestibility, %	82.24^{c}	77.45^{b}	68.97^{a}	84.24^{c}	2.02	<0.01
OM						
Intake, lb	22.3	22.0	23.6	21.9	1.31	0.51
Digestibility, %	83.00^{c}	78.56^{b}	69.56^{a}	86.30^{c}	1.75	<0.01
NDF						
Intake, lb	2.41^{a}	5.13^{b}	7.73^{c}	1.82^{a}	0.34	<0.01
Digestibility, %	20.96^{a}	52.69^{b}	37.03^{b}	37.62^{b}	6.14	0.02
Starch						
Intake, lb	15.23^{a}	9.96^{b}	9.50^{b}	8.83^{b}	0.66	<0.01
Digestibility, %	99.49	99.10	99.04	99.36	0.19	0.16
DE						
Apparent energy digestibility, %	81.58^{bc}	76.57^{b}	67.96^{a}	85.55^{c}	2.13	<0.01
DE, Mcal/d	38.45^{b}	35.82^{ab}	33.42^{a}	41.59^{c}	1.52	<0.01
DE, Mcal/lb	7.54^{b}	7.32^{b}	6.44^{a}	7.89^{b}	2.01	<0.01

^{abc}Means in a row with different superscripts are different ($P < 0.05$)

[1]Treatments included CON- control, SEM-solvent extracted germ meal, BRAN- corn bran, STEEP-mixed steep

Data were analyzed using the MIXED procedure of SAS (SAS Institute, Inc.) with period, treatment, and steer within square as fixed effects. Ruminal pH was analyzed using the MIXED procedure of SAS with treatment, hour, treatment by hour interaction included in the model and hour being considered a repeated measure. The Toeplitz covariate structure provided the best fit for ruminal pH. Probabilities less than or equal to alpha ($P \leq 0.05$) were considered significant, with tendencies acknowledged at *P*-values between 0.05 and 0.10.

Results and Discussion

No dietary treatment effects were observed for DM or OM intake ($P \geq 0.15$; Table 2). However, in a prior feedlot trial, an increase in DMI was observed as bran inclusion increased in the diet up to 30% and a reduction in DMI as the steep inclusion increased in the diet up to 30% when replacing DRC (*1997 Nebraska Beef Cattle Report*, pp 72–74). The effects on DMI were attributed to higher fiber in bran and differences in energy intake between the two ingredients.

Dry matter and OM digestibility for BRAN was least, intermediate for the SEM, and greatest for the CON and STEEP ($P < 0.01$). Neutral detergent fiber intake was greatest for BRAN, intermediate for SEM, and least for CON and STEEP ($P < 0.01$). The difference in NDF intake is related to differences in NDF content of the diets. Neutral detergent fiber digestibility was least for CON and intermediate for BRAN and STEEP ($P = 0.02$) with a tendency for SEM to be greater in NDF digestibility ($P = 0.07$). Starch intake was greatest for the CON because of 40% greater SFC inclusion in the diet. It is important to note that SEM and bran are not devoid of starch and contain 12.41 and 21.07% starch, respectively. No differences in starch digestibility were observed among treatments ($P \geq 0.16$). Apparent energy digestibility was greatest for STEEP and CON (85.6 and 81.6%; $P < 0.01$), although there was no difference between CON and SEM (76.6%). The BRAN treatment had the least apparent energy digestibility (68.0%; $P < 0.01$). Furthermore, cattle fed STEEP consumed the greatest amount of energy per day, with CON being intermediate, and SEM and BRAN being the lowest ($P < 0.01$). Digestible energy (Mcal/lb) was greatest for STEEP, CON, and SEM, which were all greater than the BRAN treatment ($P < 0.01$).

Table 3. Ruminal pH characteristics of steers fed individual Sweet Bran components

	Treatment[1]					
Item	CON	SEM	BRAN	STEEP	SEM	*P*—Value
Minimum	5.56	5.41	5.43	5.51	0.11	0.78
Maximum	7.07	6.90	6.83	6.95	0.10	0.45
Average	6.29	6.22	6.25	6.27	0.06	0.91
Magnitude	1.51	1.49	1.39	1.44	0.15	0.91
Variation[2]	0.33	0.31	0.28	0.30	0.04	0.90

[1]Treatments included CON- control, SEM-solvent extracted germ meal, BRAN- corn bran, STEEP-mixed steep

[2]Standard deviation of daily ruminal pH

Table 4. Rumination characteristics for steers fed individual Sweet Bran components

	Treatment[1]					
Item	CON	SEM	BRAN	STEEP	SEM	*P*—Value
Ruminating, min/day	264.5[b]	229.5[b]	361.5[c]	124.6[a]	25.59	<0.01

[abc]Means in a row with different superscripts are different ($P < 0.05$)

[1]Treatments included CON- control, SEM-solvent extracted germ meal, BRAN- corn bran, STEEP-mixed steep

Physical and digestion characteristics

The physical characteristics of bran, steep, and SEM are also important to consider in addition to the digestion characteristics, although they were not assessed in the current experiment. Steep is a liquid feed, making it difficult to transport, store, and mix in large quantities. Additionally, high inclusions of steep without corn bran and SEM may cause mineral imbalances due to high levels of phosphorus, magnesium, sulfur, sodium, and potassium. As a result, steep is often formulated at low inclusions when fed as an individual ingredient. Steep has a high energy content and is high in protein, especially rumen degradable protein, but low in fiber content. In contrast, corn bran is relatively low in protein, but a highly digestible NDF source. Corn bran is bulky as a single ingredient but is a useful carrier for liquid ingredients such as steep. Corn bran as a carrier allows for higher proportions of steep to be incorporated into the diet due to a reduction in handling, storage, and mixing concerns, in addition to contributing a highly fermentable fiber source. Solvent-extracted germ meal is a medium protein, highly digestible fiber source and is comprised of dry, finely ground particles. This results in SEM settling in the bunk and sorting by cattle. Mixing SEM with corn bran and steep diminishes the separation potential. Overall, the combination of bran, steep, and SEM in Sweet Bran alleviates the handling and sorting concerns when the components are fed individually, resulting in a high protein, highly digestible energy product.

Ruminal pH

No differences were observed for minimum, maximum, average, magnitude of change, or variation of ruminal pH among treatments ($P \geq 0.45$; Table 3). This is inconsistent with previous research that observed lower average pH when steep was included at 30% of diet DM and higher average pH when bran was included at 15% of diet DM when compared to the average pH of a DRC control (*1998 Nebraska Beef Cattle Report*, pp. 69–71). It is unclear why there were no differences observed for ruminal pH considering the inclusion of the bran and steep were higher than in previous experiments.

Rumination

Steers fed the BRAN diet (7.74 lb/d NDF) spent the greatest amount of time ruminating (expressed as minutes per day) with SEM and CON (2.40 and 5.17 lb/d NDF) being intermediate, and STEEP (1.81 kg/d NDF) ruminating the least ($P < 0.01$; Table 4).

Conclusion

Steep and SEM have similar energy densities as the SFC control, while bran is high in NDF and may help control ruminal pH, although this was not observed in the current experiment. These data suggest the physical and nutrient digestibility characteristics of bran, steep, and SEM are complementary when fed in combination and may contribute to the higher energy value of Sweet Bran compared to DRC.

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