Interaction of Sweet Bran Inclusion and Corn Processing Method in Beef Finishing Diets on Digestibility

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Summary with Implications

Six ruminally and duodenally fistulated steers were utilized in a 6 × 6 Latin square design to evaluate the interaction of corn processing method and Sweet Bran inclusion in finishing diets on total tract digestibility and rumen fermentation characteristics. Treatments were designed as a 2 × 3 factorial, with one factor as corn processing method (steam-flaked corn or a blend of high-moisture and dry-rolled corn) and the second factor as Sweet Bran inclusion at 0, 20, or 40% of diet dry matter. Cattle fed steam-flaked corn diets had greater starch digestibility while cattle fed high-moisture/dry-rolled corn diets had greater neutral detergent fiber digestibility. As Sweet Bran concentration increased in the diet, cattle fed both steam-flaked corn and high-moisture/dry-rolled corn diets had greater dry matter intakes and as a result, greater intakes of digestible energy. Increased energy intake may contribute to improvements in gain and efficiency when feeding Sweet Bran observed in a corresponding finishing trial.

Introduction

A recent finishing study (*2022 Nebraska Beef Cattle Report*, pp. 42–45) evaluated 0, 20, and 40% of Sweet Bran (SB) in steam-flaked corn (SFC) and high-moisture corn (HMC)/ dry-rolled corn (DRC) based finishing diets. When cattle were fed 0% SB, feeding SFC resulted in a 11.7% improvement in F:G compared to feeding HMC/DRC. As SB increased in the diet, there was a linear improvement in F:G for HMC/DRC fed steers and no change in F:G for SFC fed cattle. Accordingly, in diets with 40% SB, the improvement in F:G due to feeding SFC narrowed to 3.7%. Therefore, feeding up to 40% SB in SFC based finishing diets did not affect animal performance. Additionally, the optimal inclusion for high-moisture/dry-rolled corn-based finishing diets was 40%. The hypothesis of this experiment was that the improvement in animal performance results from a reduction in the occurrence and severity of acidosis or increased energy intake due to greater DMI. Therefore, the objective of this digestion study was to evaluate the interaction of corn processing method and SB inclusion on total tract digestibility and rumen fermentation characteristics to understand the performance response observed in the finishing study.

Procedure

Six ruminally and duodenally fistulated crossbred steers were used in a 6 × 6 Latin square design with 21-d periods consisting of an 18-d adaptation followed by a 3-d collection period. The study was conducted over 126 days. Dietary treatments were designed in a 2 × 3 factorial arrangement with factors consisting of 1) corn processing method ((2/3 HMC 1/3 DRC blend, or 100% SFC) and 2) Sweet Bran inclusion (0, 20, or 40% of diet DM). Steam-flaked corn was processed to a flake density of 28.6 lb/bushel at a commercial feedlot (Raikes Feedyard, Ashland, NE) and delivered to the research feedlot on a weekly basis. High-moisture corn was harvested at approximately 73% moisture , processed through a roller mill, and stored in a concrete bunker for approximately 250 d. All supplements were formulated to include 30 g/ton of monensin (Rumensin, Elanco Animal Health, Greenfield, IN) and 8.8 g/ton of tylosin (Tylan, Elanco Animal Health). Diet and supplement composition are shown in Table 1.

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 prior to 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 16 g/d. Fecal samples were collected at 6 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 and eating per day was also continuously measured using CowManager Sensor ear-tags.

Data were analyzed using the MIXED procedure of SAS as a 6 × 6 latin square experimental design with period and steer as a fixed effect. The treatment design was a 2 × 3 factorial with two corn processing methods (steam-flaked corn or high-moisture/dry rolled corn) and three inclusions of Sweet Bran (0, 20, or 40%). Data were tested for linear and quadratic interactions between treatment factors using covariate regression. If no interaction was observed, then main effects of corn processing and Sweet Bran inclusion were

Table 1. Dietary treatment composition (DM basis) for finishing steers fed high-moisture and dry-rolled corn or steam-flaked corn with 0, 20, or 40% Sweet Bran

	Treatment[1]					
	SFC	SFC	SFC	HMC/DRC	HMC/DRC	HMC/DRC
Ingredient	0	20	40	0	20	40
Steam-flaked corn	80	60	40	-	-	-
High-moisture corn	-	-	-	53.33	40	26.67
Dry-rolled corn	-	-	-	26.67	20	13.33
Sweet Bran	0	20	40	0	20	40
Corn Silage	15	15	15	15	15	15
Supplement[2]						
Fine Ground Corn	1.32	2.39	2.96	1.32	2.39	2.96
Limestone	1.66	1.59	1.52	1.66	1.59	1.52
Tallow	0.125	0.125	0.125	0.125	0.125	0.125
Urea	1.5	0.5	0	1.5	0.5	0
Salt	0.3	0.3	0.3	0.3	0.3	0.3
Vitamin A-D-E Premix	0.015	0.015	0.015	0.015	0.015	0.015
Beef Trace Premix	0.05	0.05	0.05	0.05	0.05	0.05
Rumensin Premix[3]	0.17	0.17	0.17	0.17	0.17	0.17
Tylan Premix[4]	0.009	0.009	0.009	0.009	0.009	0.009
Analyzed Nutrient Composition, % of DM						
Organic Matter	96.13	94.98	93.73	95.57	94.49	93.45
Neutral Detergent Fiber	13.04	20.10	26.97	11.90	19.18	26.40
Crude Protein	13.22	14.10	16.39	13.66	14.50	16.61
Starch	61.58	49.25	37.40	56.14	45.46	34.68
Gross Energy, cal/g	4248	4256	4324	4274	4309	4338

[1]Treatments included SFC 0: steam-flaked corn with 0% Sweet Bran, SFC 20: steam-flaked corn with 20% Sweet Bran, SFC 40: steam-flaked corn with 40% Sweet Bran, HMC/DRC 0: high-moisture corn/dry-rolled corn with 0% Sweet Bran, HMC/DRC 20: high-moisture corn/dry-rolled corn with 20% Sweet Bran, and HMC/DRC 40: high-moisture corn/dry-rolled corn with 40% Sweet Bran.

[2]Supplement fed at 5% of dietary DM for all treatments.

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

[4]Formulated to supply Tylan-40 (Elanco Animal Health) at 90 mg per steer daily.

evaluated. If an interaction was observed, simple effects of Sweet Bran inclusion were evaluated within each corn processing method.

Results

Intake

There were no significant linear or quadratic interactions for corn processing method and SB inclusion ($P \geq 0.19$, Table 2). Increasing the concentration of SB in the diet resulted in a linear increase in DM and OM intake, regardless of corn processing method ($P < 0.01$). There was a tendency for a quadratic interaction for corn processing and SB inclusion for starch intake ($P = 0.09$; not shown). At 0% SB, starch intake was similar (11.16 and 11.17 lb/d) for cattle fed SFC and HMC/DRC. Even though starch content of the diet was lesser at 20% SB, cattle fed SFC had greater intakes resulting in a greater starch intake for SFC-fed steers (12.13 vs 9.28 lbs/d). In comparison, cattle fed HMC/DRC had lower DMI resulting in lower starch intakes at 20% SB. As SB increased to 40%, starch intake continued to decrease for cattle fed HMC/DRC (8.56 lbs/d) and significantly decreased for cattle fed SFC (9.66 lbs/d). Steers fed SFC had greater starch intakes compared to steers fed HMC/DRC ($P <$

Table 2. Nutrient intake and digestibility of cattle fed a combination of high-moisture and dry-rolled corn or steam-flaked corn with 0, 20, or 40% Sweet Bran[1]

	Treatment							*P*-value[2]		
Item	SFC 0	SFC 20	SFC 40	HMC/DRC 0	HMC/DRC 20	HMC/DRC 40	SEM	Corn × SB Linear	Corn	SB Linear
DM										
Intake, lb/d	18.6	24.6	26.2	20.0	22.0	24.7	1.01	0.19	0.29	< 0.01
Digestibility, %	74.96	76.30	74.75	77.37	77.62	74.60	1.32	0.30	0.26	0.24
OM										
Intake, lb/d	18.2	23.3	24.1	19.5	19.7	23.3	1.23	0.42	0.31	< 0.01
Digestibility, %	78.25	78.61	76.41	79.62	78.11	77.15	1.35	0.76	0.60	0.10
NDF										
Intake, lb/d	2.5	4.9	7.1	2.4	4.1	6.7	0.33	0.64	0.11	< 0.01
Digestibility, %	36.26	49.03	51.72	39.99	51.12	59.83	4.78	0.66	0.08	< 0.01
Starch										
Intake, lb/d	11.61	12.13	9.66	11.17	9.28	8.56	0.61	0.57	< 0.01	< 0.01
Digestibility, %	99.03	99.39	99.18	95.07	96.11	96.58	0.75	0.31	< 0.01	0.24
DE										
Apparent Energy Digestibility, %	73.76	74.36	73.87	74.88	75.72	73.66	1.19	0.62	0.41	0.70
DE, Mcal/d	26.52	35.34	37.90	28.94	32.39	36.08	1.74	0.25	0.58	< 0.01
DE, Mcal/lb	6.91	6.97	7.05	7.05	7.20	7.05	0.12	0.59	0.25	0.59

[1]Arithmetic means are reported

[2]CornxSB= *P*-value for linear interaction between corn processing method (a combination of high-moisture corn and dry rolled corn or steam-flaked corn) and Sweet Bran inclusion (0, 20, or 40%); corn=*P*-value for main effect of corn processing method; SB= *P*-value for linear main effect of SB inclusion

0.01). There was a linear increase in NDF, and digestible energy intake as SB concentration increased in the diet, regardless of corn processing method ($P < 0.01$).

Digestion

Steers fed HMC/DRC tended to have greater NDF digestibility than cattle fed SFC ($P = 0.08$). Steers fed SFC had greater starch digestibility compared to steers fed HMC/DRC ($P > 0.01$). There were no differences for the main effect of corn processing method for DM, OM, or apparent energy digestibility ($P \geq 0.58$). As SB concentration increased in the diet, OM digestibility tended to decrease ($P = 0.10$). In addition, NDF digestibility increased as Sweet Bran increased in the diet because the NDF in Sweet Bran being is more digestible than NDF from silage ($P < 0.01$). Digestible energy intake per day also increased as SB concentration increased ($P < 0.01$).

Ruminal pH

There were no interactions ($P \geq 0.16$, Table 3), no effect of corn processing method ($P \geq 0.64$) and no effect of Sweet Bran ($P \geq 0.29$) observed for minimum, maximum, average, magnitude of change or variation.

Rumination

There were no interactions ($P \geq 0.73$, Table 4), effect of corn processing method ($P \geq 0.20$), or effect of Sweet Bran ($P \geq 0.35$) observed for number of minutes spent ruminating or eating per day.

These data suggest cattle fed increasing concentrations of Sweet Bran have greater DM, OM, NDF, and starch intake. OM digestibility tended to decrease as Sweet Bran increased in the diet while ADG and feed conversion in the finishing trial improved from 0 to 40% Sweet Bran. The decrease in OM digestibility is consistent with increasing NDF intake. While gross energy was similar among diets, DMI increased from 0 to 40% Sweet Bran resulting in greater digestible energy intakes per day. As a result, cattle have a greater intake of energy for gain over maintenance energy requirements, which may have contributed to the greater gains and conversions as observed in the finishing trial.

Table 3. Ruminal pH characteristics of cattle fed a combination of high-moisture and dry-rolled corn or steam-flaked corn with 0, 20, or 40% Sweet Bran[1]

	Treatment							*P*-value[2]		
Item	SFC 0	SFC 20	SFC 40	HMC/DRC 0	HMC/DRC 20	HMC/DRC 40	SEM	Corn × SB Linear	Corn	SB Linear
Minimum pH	5.88	5.77	5.76	5.78	5.83	5.72	0.078	0.67	0.80	0.29
Maximum pH	6.58	6.68	6.63	6.71	6.66	6.58	0.067	0.23	0.75	0.71
Average pH	6.24	6.20	6.15	6.19	6.21	6.15	0.087	0.66	0.81	0.33
pH magnitude	0.69	0.91	0.87	0.92	0.79	0.86	0.087	0.20	0.64	0.48
pH variance[3]	0.17	0.21	0.23	0.34	0.18	0.22	0.027	0.16	0.68	0.46

[1]Arithmetic means are reported

[2]CornxSB= P-value for linear interaction between corn processing method (a combination of high-moisture corn and dry rolled corn or steam-flaked corn) and Sweet Bran inclusion (0, 20, or 40%); corn=*P*-value for main effect of corn processing method; SB= *P*-value for linear main effect of SB inclusion

[3]Standard deviation of daily ruminal pH

Table 4. Rumination characteristics of cattle fed a combination of high-moisture and dry-rolled corn or steam-flaked corn with 0, 20, or 40% Sweet Bran[1]

	Treatment							*P*-value[2]		
Item	SFC 0	SFC 20	SFC 40	HMC/DRC 0	HMC/DRC 20	HMC/DRC 40	SEM	Corn × SB Linear	Corn	SB Linear
Rumination, min/d	212	282	325	228	207	249	59	0.81	0.20	0.35
Eating, min/d	59	46	89	72	75	57	20	0.73	0.80	0.67

[1]Arithmetic means are reported

[2]CornxSB= P-value for linear interaction between corn processing method (a combination of high-moisture corn and dry rolled corn or steam-flaked corn) and Sweet Bran inclusion (0, 20, or 40%); corn=*P*-value for main effect of corn processing method; SB= *P*-value for linear main effect of SB inclusion

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