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Effects of the proportions of Sweet Bran® (wet corn gluten feed) and/or corn dried distiller's grains with solubles on performance and carcass characteristics of finishing beef cattle fed steam-flaked corn-based diets

J. T. Vasconcelos, C. S. Abney, T. L Covey, S. A. Keyser, J. P. McMeniman, R. J. Rathmann, R. R. Reuter, L. M. Shaw, and M. L. Galyean

Department of Animal and Food Sciences
Texas Tech University, Lubbock 79409-2141

Introduction

Increased demand for fuel ethanol has increased wet and dry milling of corn for ethanol production. Ethanol production produces large supplies of coproducts that can be used as feedstuffs in the cattle feeding industry. Distiller's dried grains with solubles (DDGS), for example, have been commonly used as protein and energy sources for ruminants. Similarly, wet corn gluten feed (WCGF) is a popular feedstuff resulting from the corn wet milling process. To date, most of the research conducted with DDGS and WCGF has been with dry-rolled corn-based diets (Macken et al., 2004). The present study was designed to investigate the optimal proportions and the possible interactions of WCGF and DDGS in steam-flaked corn-based finishing diets.

Experimental Procedures

Cattle. Three hundred sixty-five steers (primarily British x British breeding) were purchased in El Reno, OK on January 4, 2006, loaded on that day and delivered 362 miles to the Texas Tech University (TTU) Burnett Center at New Deal, TX on January 5. After arrival, cattle were housed in soil-surfaced pens, and allowed access to a 65% concentrate diet (approximately 10 lb/steer, as-fed basis), sudangrass hay (approximately 2 lb/steer, as-fed basis), and water. On January 6, 2006, beginning at 0900, all cattle were taken through the Burnett Center working facilities for initial processing, which included: 1) placement in the left ear of an individually numbered ear tag; 2) measurement of individual BW; 3) vaccination with Vista 5 SQ and Vision 7 with SPUR (Intervet, Millsboro, DE); and 4) treatment with Cydectin (Fort Dodge Anim. Health, Overland Park, KS) down the back line. After processing, cattle were returned to the same soil-surfaced pen they had been housed in on the previous day and fed the 65% concentrate diet.

Experimental Design and Treatment and Pen Assignment. The BW data measured on January 6 were entered in a spreadsheet and sorted in ascending order. Of the 365 steers available for use in the study, 28 were excluded for various reasons (e.g., presence of horns, eye problems, and undesirable temperament), and these steers, along with the 7 heaviest steers were designated as Extra cattle. Of the remaining 330 steers, the lightest 130 steers were sorted to be used in another experiment, leaving 200 steers for use in the experiment. The ear tag and corresponding BW data and coat color code for the 200 selected steers were then sorted in ascending order by BW. The first 40 steers of lightest BW were designated as Block 1, continuing through blocking groups of 40 steers to the 40 steers of heaviest BW, which were designated as Block 5. Within each block, a sequence of 5 randomly selected integers was assigned to steers, starting with the lightest 5 steers and proceeding through the heaviest 5 steers in a block. This process was continued until each of the 200 steers had been assigned a random number. Five treatments (described in a subsequent section) were assigned randomly to the integers, and blocks were assigned to 5 contiguous pens in the Burnett Center soil-surfaced pens. Within each group of 5 contiguous pens in a block, treatments were assigned randomly to pens by the use of 5 sets of 5 randomly selected integers, with the first pen in the block assigned to the corresponding treatment code of the first randomly selected integer, continuing through the last pen in the block, which was assigned to the corresponding treatment code of the last randomly selected integer of the 5. Pen and treatment designations were entered in the spreadsheet, which was then sorted by pen number and subsequently by ear tag number within pen.

On January 10 cattle were taken through the Burnett Center working facilities and presorted into 10 pens of 20 steers each. One week later, these 200 steers were taken through the working facilities and implanted in the right ear with Revalor S (Intervet). Finally, on January 19, the 200 steers assigned to the experiment were weighed individually and sorted to their assigned pens. Of the 25 pens used in the experiment, Pens 1 through 16 were 16 ft wide x 100 ft deep, with 16 ft of bunk space. Pens 17 through 25 were 17 ft wide x 101 ft deep, with 17 ft of bunk space. Treatment diets (switched to 75% concentrate) were fed to start the experiment.

Experimental Diets. Treatment diets had steam-flaked corn as the primary ingredient. The intermediate 75 and 85% concentrate diets (composition not shown; included cottonseed hulls to provide additional roughage) were each fed for 1 wk as the cattle were being stepped up to the final 91% concentrate diet (Table 1). Treatment diets (dry matter [DM] basis) consisted of:

- Control (no **Sweet Bran**® [SB] or corn distiller's dried grains with solubles [DDGS]);
- A diet with 7% DDGS (**7DDGS**);
- A diet with 20% SB (**20SB**);
- A diet with 13% SB and 7% DDGS (**13+7**); and
- A diet with 20% SB and 7% DDGS (**20+7**).

All final 91% concentrate diets were formulated to contain 13.75% CP, and chopped alfalfa hay was the roughage source (Table 1). Vitamins, minerals, Rumensin (30 g/ton DM basis), and Tylan (10 g/ton DM basis) were provided in a loose-meal premix (Table 2). The premix for diets containing SB and DDGS was modified to remove ammonium sulfate (replaced by urea and cottonseed meal to equalize the nitrogen concentration). **Sweet Bran**® brand wet corn gluten feed was provided by Cargill Corn Milling, Blair, NE), as was DDGS (loose-meal form). Laboratory analyses (SDK Laboratories, Hutchinson, KS) of composite sample of the 5 diets and of SB and DDGS are shown in Tables 3 and 4, respectively.

Management, Feeding, and Weighing Procedures. Estimates of the approximate quantity of unconsumed feed remaining in the feed bunk were made in each of the 5 pens per treatment from 0700 to 0730 daily. Adjustments to the feed delivery for each pen were made to ensure ad libitum access to feed. Diets were mixed in a 1.27-m^3-capacity paddle mixer (Marion Mixers, Inc., Marion, IA) and transferred by a drag chain conveyor to a tractor-pulled mixer/delivery unit (Rotomix 84-8, Dodge City, KS; scale readability of ± 1 lb), which was used to deliver feed to each pen. Diet samples were taken weekly to determine the DM content (dried in a forced-air oven at 100°C for approximately 24 h). Weights for DM determination were taken on an Ohaus (Pine Brook, NJ) electronic balance (readability of ± 0.1 g). Feed bunks were cleaned on d 42, 84, and before shipment to slaughter, and orts were weighed using an Ohaus electronic scale (readability of ± 0.1 lb). The DM content of feed weighed back from the bunks was determined as described for weekly diet samples. The DM intake (DMI) by each pen during various periods of the study was calculated by subtracting the quantity of dry feed refusal at the end of each period from the total dietary DM delivered to each pen during that period. The number of animals housed per pen was multiplied by number of days in the weigh period to determine animal days, which were then divided into the corrected total DM delivered to the pen to obtain average DMI per steer. Weekly DM content was determined for each of the 5 diets, as well as for SB and DDGS, by drying grab samples in a 100°C forced-air oven for approximately 24 h. Weekly samples of feed were collected, composited across the overall study period, and ground to pass a 2-mm screen in a Wiley mill. Ground samples were subsequently analyzed by SDK Laboratories as noted previously.

Individual initial BW and final BW before shipment to slaughter were obtained using a hydraulic squeeze chute (C & S, Garden City, KS) equipped with electronic load cells (Rice Lake Weighing Systems, Rice Lake, WI; readability of ± 1 lb). Interim weights were recorded using a pen scale (± 5 lb readability) on d 42 and 84 of the study. Scales were calibrated with 1,000 lb of certified (Texas Department of Agriculture) weights before each use. Cattle in Blocks 3 through 5 (120 steers) were weighed individually on May 15, 2006 (d 116) and shipped to the Cargill Meat Solutions facility in Plainview, TX. On May 30, 2006, cattle in Blocks 1 and 2 (80 steers) were weighed individually (d 131) and shipped to the Cargill Meat Solutions facility in Plainview, TX.

Carcass Evaluation. Personnel from Texas Tech University obtained all carcass data. Measurements included longissimus muscle area, marbling score, USDA quality grade, fat thickness measured between the 12^{th} and 13^{th} ribs, percentage of kidney, heart, and pelvic fat, and calculated USDA yield grade.

Statistical Analyses. Performance and carcass data were analyzed using the Mixed procedure of SAS (SAS Inst. Inc., Cary, NC) as a randomized complete block design. The effects of treatment and block were included in the model for pen-based data. Nonorthogonal treatment contrasts were used to evaluate differences among treatments, including: 1 = Control vs. others; 2 = 7DDGS vs. 20SB:7DDGS; 3 = 20SB vs. 20SB:7DDGS; and 4 = 20SB vs. 13SB:7DDGS. Carcass quality grade data (percentage of cattle grading USDA Choice or greater) were analyzed as a binomial proportion using the Glimmix procedure of SAS. The same model and contrasts used for performance data were used to evaluate treatment differences in quality grade data.

Results and Discussion

Laboratory Analyses

Crude protein content (Table 3) was similar to values expected from formulation. Ether extract concentration was similar among the diets (average 5.5%), but somewhat less than values expected from formulation using NRC (1996) estimates of fat content (approximately 7%). Lower dietary fat content than expected might reflect less than expected fat content of the corn used during the study or errors in sampling feeds. As expected, acid detergent fiber concentration increased with the addition of DDGS and SB to the diet.

Cattle Performance

Body Weight and Average Daily Gain. Initial BW did not differ among treatments, averaging 855.3 lb (Table 5). Final live BW (unshrunk) and carcass-adjusted final BW were greater (*P* = 0.07) for the average of the 4 SB/DDGS treatments than for the Control, but no differences were noted in the contrasts among the 4 SB/DDGS treatments. As would be expected from the changes in final BW, average daily gain (ADG) was consistently greater by steers in the 4 SB/DDGS treatments than by Control steers, with differences from d 0 to 42 (*P* = 0.08), d 0 to 84 (*P* = 0.01), and overall (*P* = 0.04). Carcass-adjusted ADG also was greater (*P* = 0.04) for the average of the 4 SB/DDGS treatments than for the Control but not different among the 4 SB/DDGS treatments.

Dry Matter Intake. Dry matter intake from d 0 to 42 (*P* = 0.03), d 0 to 84 (*P* = 0.02), and for the overall study period (*P* = 0.02) was less by cattle fed the Control diet than by the average of the cattle in the other 4 treatment groups (Table 6). This increase in DMI was particularly evident for the cattle fed diets containing SB, such that the contrast of 7DDGS vs. 20+7 was significant for d 0 to 42 (*P* = 0.01), as well as for d 0 to 84 and the overall feeding period (*P* = 0.05). For d 0 to 42, all four contrasts were significant or tended to be so (*P* = 0.01 to 0.08). The increased DMI with the SB diets presumably reflects an increase in the dietary neutral detergent fiber (NDF) resulting from the addition of SB. Galyean and Defoor (2003) indicated that DMI was strongly correlated with NDF supplied by dietary roughage sources, and Galyean and Abney (2006) recently extended that observation to total dietary NDF. Although NDF was not measured directly on the diets fed in the present study, based on the NDF concentrations of SB and DDGS (Table 4), diets containing SB or combinations of SB and DDGS would be expected to have a greater NDF concentration than the Control and 7DDGS diets

Feed Efficiency. Contrasts for feed:gain ratio (F:G) did not differ from d 0 to 42; however, from d 0 to 84, the cattle fed 7DDGS had an improved F:G (*P* = 0.07) compared with those fed 20+7 (Table 7). This same difference was noted for the overall feeding period (*P* = 0.04) for F:G based on live weight gain; however, none of the contrasts was significant for F:G based on carcass-adjusted ADG. This result might suggest that differences in F:G for the 7DDGS vs. 20+7 treatments were a result of differences in gastrointestinal fill that affected ADG measured on an unshrunk, live basis.

Carcass Characteristics. As with final live BW and carcass-adjusted final BW, hot carcass weight was less (*P* = 0.07) for cattle fed the Control diet than for the average of cattle fed the other 4 diets (Table 8). Few other differences were noted in carcass characteristics. Cattle on the 20SB treatment had a lower dressing percent (*P* =

0.04) than those on the 13+7 treatment (61.89 vs. 60.93%), and 12th rib fat tended to be greater (P = 0.09) for cattle fed the 20+7 diet than for those fed the 20SB diet. Percentage of cattle grading USDA Choice or greater was not affected by treatment.

Conclusions

Feeding dried corn distiller's grain with solubles (7% of the dietary DM), **Sweet Bran®** wet corn gluten feed (20% of the dietary DM), or combinations of dried corn distiller's grain with solubles and **Sweet Bran®** (7% distiller's grain with either 13 or 20% **Sweet Bran®**) increased average daily gain and dry matter intake by finishing beef steers compared with a steam-flaked corn-based control diet with ground alfalfa hay as the roughage source. Gain efficiency with coproduct diets did not differ from the control diet. Hot carcass weight was increased for coproduct diets compared with the control, but few other differences were noted in carcass characteristics. Among coproduct diets, no differences were noted in average daily gain, but adding **Sweet Bran®** to diets generally increased dry matter intake. Based on the results of this experiment, dried corn distiller's grain with solubles and **Sweet Bran®** can be used effectively in beef cattle finishing diets when fed alone or in combination.

Literature Cited

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Table 1. Ingredient composition (% DM basis) of the 91% concentrate finishing diets

	Treatment[1]				
Ingredient	Control	7DDGS	20SB	13SB:7DDGS	20SB:7DDGS
Steam-flaked corn	76.50	73.36	64.56	65.20	58.57
Alfalfa hay	8.96	8.97	8.99	9.00	9.00
Cottonseed meal	3.32	-	-	-	-
Urea	1.13	1.09	0.53	0.43	0.09
Molasses	3.94	3.95	-	-	-
Fat (yellow grease)	3.50	3.01	3.62	3.02	3.12
Sweet Bran®[2]	-	-	19.65	12.77	19.67
Corn distiller's grain[3]	-	6.92	-	6.92	6.94
Dicalcium phosphate	0.16	0.20	-	-	-
Limestone	-	-	0.14	0.15	0.10
Supplement premix[4]	2.49	2.50	2.51	2.51	2.51

[1]Control = standard diet with neither **Sweet Bran**® (SB) nor corn distiller's dried grains with solubles (DDGS); 7DDGS = DDGS as 7% of the dietary DM; 20SB = SB only as 20% of the dietary DM; 13SB:7DDGS = SB and DDGS as 13 and 7% of the dietary DM, respectively; and 20SB:7DDGS = SB and DDGS as 20 and 7% of the dietary DM, respectively.

[2]**Sweet Bran**® wet corn gluten feed; Cargill Corn Milling, Blair NE.

[3]Corn dried distiller's grain with solubles (loose meal form).

[4]Composition of the premix is shown in Table 2.

Table 2. Composition of the premixes used in experimental diets[1]

Ingredient	Control	**Sweet Bran**®
Cottonseed meal	23.367	26.962
Endox (antioxidant)[2]	0.500	0.500
Limestone	42.105	42.105
Dicalcium phosphate	1.036	1.036
Potassium chloride	8.000	8.000
Magnesium oxide	3.559	3.559
Ammonium sulfate	6.667	-
Urea	-	3.072
Salt	12.000	12.000
Cobalt carbonate	0.002	0.002
Copper sulfate	0.157	0.157
Iron sulfate	0.133	0.133
EDDI	0.003	0.003
Manganese oxide	0.267	0.267
Selenium premix, 0.2% Se	0.100	0.100
Zinc sulfate	0.845	0.845
Vitamin A, 1,000,000 IU/g[3]	0.008	0.008
Vitamin E, 500 IU/g[3]	0.126	0.126
Rumensin, 176.4 mg/kg[3]	0.675	0.675
Tylan, 88.2 mg/kg[3]	0.450	0.450

[1]The Control premix was fed in the Control diet, whereas the **Sweet Bran**® premix was fed in the 4 diets containing **Sweet Bran**® and/or corn distiller's dried grains with solubles.

[2]Kemin Industries, Des Moines, IA.

[3]Concentrations noted by ingredients are on a 90% DM basis.

Table 3. Chemical composition of the 91% concentrate finishing diets[1]

	Treatment[2]				
Item	Control	7DDGS	20SB	13SB:7DDGS	20SB:7DDGS
DM, %	82.05	82.30	77.05	79.01	77.62
CP, %	13.06	13.69	13.15	13.48	12.86
ADF, %	7.03	7.74	8.58	8.49	8.92
EE, %	5.51	5.62	5.85	5.30	5.24
Ca, %[3]	0.66	0.66	0.63	0.63	0.62
P, %[3]	0.35	0.36	0.44	0.42	0.47
K, %[3]	0.73	0.73	0.76	0.73	0.81

[1]All values except DM (dry matter) are expressed on a DM basis. CP = crude protein; ADF = acid detergent fiber; and EE = ether extract.

[2]Control = standard diet with neither **Sweet Bran**® (SB) nor corn distiller's dried grains with solubles (DDGS); 7DDGS = DDGS as 7% of the dietary DM; 20SB = SB only as 20% of the dietary DM; 13SB:7DDGS = SB and DDGS as 13 and 7% of the dietary DM, respectively; and 20SB:7DDGS = SB and DDGS as 20 and 7% of the dietary DM, respectively.

[4]Calculated from NRC (1996) feed composition values.

Table 4. Chemical composition of the **Sweet Bran**®and corn distiller's dried grains with solubles (DDGS) used in the experiment[1]

	Ingredient	
Item	**Sweet Bran**®	Corn DDGS
DM, %[2]	59.96	91.01
CP, %	24.24	26.20
ADF, %	11.57	15.20
NDF, %[3]	30.84	30.56
EE, %	3.21	8.33
Ca, %	0.05	0.12
P, %	1.18	0.77
K, %	1.46	0.93

[1]All values except DM (dry matter) are expressed on a DM basis. Samples were collected weekly throughout the experiment, dried in a 100^0C oven overnight, and composited across the experiment. CP = crude protein; ADF = acid detergent fiber; NDF = neutral detergent fiber; and EE = ether extract.

[2]The DM for **Sweet Bran**® was determined by a vacuum drying method by Cargill Corn Milling and represented the average value determined on loads of **Sweet Bran**® delivered to the Burnett Center during the experiment.

[3]The NDF analyses were conducted by SDK Laboratories, Hutchinson, KS on samples taken from loads of **Sweet Bran**® and corn dried distiller's grain with solubles delivered to the Burnett Center during the experiment.

Table 5. Effects of proportions of **Sweet Bran**® (SB) corn distiller's dried grains with solubles (DDGS) on body weight and average daily gain (ADG) by finishing beef steers

	Treatment[1]						Contrast *P*-value[2]			
Item	Control	7DDGS	20SB	13SB:7DDGS	20SB:7DDGS	SE[3]	1	2	3	4
Initial BW, lb	854.8	856.9	853.9	851.3	859.6	17.40	0.93	0.74	0.50	0.75
Final BW, lb	1,393.6	1,422.7	1,430.6	1,409.2	1,425.7	20.15	0.07	0.88	0.80	0.27
Carcass-adjusted final BW, lb[4]	1,387.5	1,421.4	1,421.5	1,421.1	1,431.5	22.88	0.07	0.67	0.68	0.99
ADG, lb										
d 0 to 42	5.29	5.58	5.54	5.62	5.57	0.154	0.08	0.94	0.87	0.67
d 0 to 84	4.77	5.07	5.19	5.02	5.07	0.104	0.01	0.99	0.43	0.26
d 0 to end[5]	4.42	4.63	4.73	4.58	4.65	0.109	0.04	0.88	0.55	0.27
Carcass-adjusted ADG, d 0 to end, lb[4]	4.37	4.62	4.66	4.68	4.70	0.127	0.04	0.64	0.82	0.88

[1]Control = standard diet with neither SB nor DDGS; 7DDGS = DDGS as 7% of the dietary DM; 20SB = SB only as 20% of the dietary DM; 13SB:7DDGS = SB and DDGS as 13 and 7% of the dietary DM, respectively; and 20SB:7DDGS = SB and DDGS as 20 and 7% of the dietary DM, respectively.

[2]Nonorthogonal treatment contrasts: 1 = Control vs. others; 2 = 7DDGS vs. 20SB:7DDGS; 3 = 20SB vs. 20SB:7DDGS; 4 = 20SB vs. 13SB:7DDGS.

[3]Standard error of treatment means, n = 5 pens/treatment.

[4]Adjusted final BW was calculated using the average dressing percent (61.36%) across all treatments, and carcass-adjusted ADG was calculated from adjusted final BW, initial BW, and days on feed.

[5]Cattle were fed an average of 122 d.

Table 6. Effects of proportions of **Sweet Bran**® (SB) corn distiller's dried grains with solubles (DDGS) on dry matter intake (DMI) by finishing beef steers

	Treatment[1]						Contrast *P*-value[2]			
Item	Control	7DDGS	20SB	13SB:7DDGS	20SB:7DDGS	SE[3]	1	2	3	4
DMI, lb/(steer•d)										
d 0 to 42	19.83	20.01	20.09	20.66	20.84	0.253	0.03	0.01	0.02	0.08
d 0 to 84	20.89	21.33	22.46	22.10	22.63	0.468	0.02	0.05	0.78	0.56
d 0 to end[4]	21.26	21.80	23.02	22.48	23.15	0.514	0.02	0.05	0.84	0.41

[1]Control = standard diet with neither SB nor DDGS; 7DDGS = DDGS as 7% of the dietary DM; 20SB = SB only as 20% of the dietary DM; 13SB:7DDGS = SB and DDGS as 13 and 7% of the dietary DM, respectively; and 20SB:7DDGS = SB and DDGS as 20 and 7% of the dietary DM, respectively.

[2]Nonorthogonal treatment contrasts: 1 = Control vs. others; 2 = 7DDGS vs. 20SB:7DDGS; 3 = 20SB vs. 20SB:7DDGS; 4 = 20SB vs. 13SB:7DDGS.

[3]Standard error of treatment means, n = 5 pens/treatment.

[4]Cattle were fed an average of 122 d.

Table 7. Effects of proportions of **Sweet Bran**® (SB) corn distiller's dried grains with solubles (DDGS) on feed:gain ratio (F:G) of finishing beef steers

	Treatment[1]						Contrast *P*-value[2]			
Item	Control	7DDGS	20SB	13SB:7DDGS	20SB:7DDGS	SE[3]	1	2	3	4
F:G										
d 0 to 42	3.76	3.61	3.63	3.68	3.75	0.105	0.40	0.31	0.40	0.72
d 0 to 84	4.39	4.21	4.33	4.41	4.46	0.099	0.70	0.07	0.31	0.56
d 0 to end[3]	4.82	4.71	4.86	4.91	4.99	0.101	0.67	0.04	0.34	0.71
Carcass-adjusted F:G, d 0 to end[4]	4.88	4.73	4.95	4.80	4.93	0.103	0.83	0.19	0.90	0.33

[1]Control = standard diet with neither SB nor DDGS; 7DDGS = DDGS as 7% of the dietary DM; 20SB = SB only as 20% of the dietary DM; 13SB:7DDGS = SB and DDGS as 13 and 7% of the dietary DM, respectively; and 20SB:7DDGS = SB and DDGS as 20 and 7% of the dietary DM, respectively.

[2]Nonorthogonal treatment contrasts: 1 = Control vs. others; 2 = 7DDGS vs. 20SB:7DDGS; 3 = 20SB vs. 20SB:7DDGS; 4 = 20SB vs. 13SB:7DDGS.

[3]Standard error of treatment means, n = 5 pens/treatment.

[4]Cattle were fed an average of 122 d.

[5]Carcass-adjusted F:G was calculated as the ratio of carcass-adjusted ADG to DMI (see Tables 5 and 6).

Table 8. Effects of proportions of **Sweet Bran**® (SB) corn distiller's dried grains with solubles (DDGS) on carcass characteristics of finishing beef steers

	Treatment[1]						Contrast *P*-value[2]			
Item[3]	Control	7DDGS	20SB	13SB:7DDGS	20SB:7DDGS	SE[4]	1	2	3	4
Hot carcass weight, lb	851.3	872.1	872.2	872.0	878.3	14.04	0.07	0.67	0.68	0.99
Dressing percent	61.07	61.29	60.93	61.89	61.60	0.325	0.29	0.46	0.13	0.04
12th rib fat, in	0.43	0.46	0.45	0.49	0.52	0.027	0.13	0.13	0.09	0.28
LM area, in^2	14.00	14.44	13.99	14.68	14.41	0.385	0.32	0.94	0.39	0.16
KPH, %	1.78	1.88	1.85	1.78	1.80	0.074	0.55	0.48	0.64	0.48
Yield grade	3.04	3.08	3.20	3.08	3.19	0.139	0.52	0.59	0.95	0.53
Marbling score	404.5	410.8	438.3	422.0	411.3	15.66	0.37	0.98	0.24	0.47
Choice, %[5]	47.5	55.0	57.5	60.0	60.0	-	0.24	0.66	0.82	0.82

[1]Control = standard diet with neither SB nor DDGS; 7DDGS = DDGS as 7% of the dietary DM; 20SB = SB only as 20% of the dietary DM; 13SB:7DDGS = SB and DDGS as 13 and 7% of the dietary DM, respectively; and 20SB:7DDGS = SB and DDGS as 20 and 7% of the dietary DM, respectively.

[2]Nonorthogonal treatment contrasts: 1 = Control vs. others; 2 = 7DDGS vs. 20SB:7DDGS; 3 = 20SB vs. 20SB:7DDGS; 4 = 20SB vs. 13SB:7DDGS.

[3]LM = longissimus muscle; KPH = kidney, pelvic, and heart fat. For marbling score: 300 = Slight^{00}; 400 = Small^{00}; 500 = Modest^{00}.

[4]Standard error of treatment means, n = 5 pens/treatment.

[5]Percentage of carcasses grading USDA Choice or greater within a treatment.