The Professional Animal Scientist 23 (2007):260–266

Effects of Proportions of Wet Corn Gluten Feed and Distiller's Dried Grains with Solubles in Steam-Flaked, Corn-Based Diets on Performance and Carcass Characteristics of Feedlot Cattle[1]

J. T. Vasconcelos[2] and M. L. Galyean, PAS
Department of Animal and Food Sciences, Texas Tech University, Lubbock 79409

ABSTRACT

Two hundred crossbred steers (initial BW = 388; SE = 7.9 kg) were fed 5 diets to evaluate the effect of the proportion of wet corn gluten feed (WCG), distiller's dried grains with solubles (DDGS), or both in diets based on steam-flaked corn on performance and carcass characteristics. Dietary treatments reflected ingredients available for use in feedlot diets in the Southern Great Plains region and consisted of the following (DM basis): 1) a steam-flaked, corn-based, high-concentrate diet with no WCG or DDGS (CON); 2) a diet with 7% DDGS; 3) a diet with 20% WCG; 4) a diet with 13% WCG and 7% DDGS; and 5) a diet with 20% WCG and 7% DDGS. Steers were weighed individually and sorted to 1 of 25 pens (8 steers/pen in 5 blocks with 5 pens/block). Final BW and carcass-adjusted (to a constant dressing percent) final BW tended to be greater (P = 0.07) for the average of all 4 WCG and DDGS treatments than for CON, but no differences were noted among the 4 WCG and DDGS treatments (P > 0.10). Average daily gain was greater by steers in the 4 WCG and DDGS treatments than by steers fed the CON treatment from d 0 to 84 (P = 0.01) and overall (P = 0.04), and there was a tendency (P = 0.08) for greater ADG by steers in the 4 WCG and DDGS treatments from d 0 to 42. Carcass-adjusted ADG also was greater (P = 0.04) for the average of the 4 WCG and DDGS treatments than for CON but not different among the 4 WCG and DDGS treatments. Dry matter intake was less by cattle fed the CON diet than by the cattle in the other treatments from d 0 to 42 (P = 0.03), d 0 to 84 (P = 0.02), and for the overall study period (P = 0.02). The G:F ratio did not differ among CON and the WCG and DDGS treatments (P > 0.10). Hot carcass weight tended to be less (P = 0.07) for cattle fed the CON diet than for cattle fed the other diets, but no differences were observed between the CON and the WCDG and DDGS treatments for other carcass characteristics. Percentage of cattle grading USDA Choice or greater was not affected by dietary treatment. Data suggest that up to 20% WCG and 7% DDGS can be effectively used in feedlot cattle steam-flaked, corn-based diets alone or in combination.

Key words: beef cattle, distiller's dried grains with solubles, feedlot, wet corn gluten feed

INTRODUCTION

Increased demand for fuel ethanol has increased the milling of corn for ethanol production. Distiller's dried grains with solubles (**DDGS**), produced as a coproduct of ethanol production by dry corn milling, is commonly used as protein and energy source for ruminants. Similarly, wet corn gluten feed (**WCG**) is a popular feedstuff resulting from wet-milling of corn. The NE concentration of WCG was reported to be 93 to 101%

[1]This experiment was supported by a grant from Cargill Corn Milling, Blair, NE, and by funds from the Jessie W. Thornton Chair in Animal Science Endowment at Texas Tech University.
[2]Corresponding author: judson.vasconcelos@ttu.edu

or 113 to 115% of dry-rolled corn, depending on the source (Stock et al., 2000). Inclusion of WCG in finishing diets decreases the incidence and severity of acidosis because of the addition of highly digestible fiber to high-starch diets (Krehbiel et al., 1995).

Cost and availability are important factors that enhance the role of WCG as an ingredient in beef cattle feedlot diets (Richeson et al., 2006). Therefore, many feedlots in the Southern Great Plains use WCG as an energy and protein source, replacing part of the steam-flaked corn (**SFC**) and supplemental protein in growing and finishing diets (Cole et al., 2006). Feedlots also may use WCG and DDGS in combination. These 2 coproducts contain complimentary nutritional profiles; therefore, synergistic results may be observed because of differences in fat, effective fiber, and protein components (Erickson and Klopfenstein, 2006).

The replacement of highly digestible SFC with corn milling coproducts could affect cattle performance (Cole et al., 2006). Most research on coproducts has been conducted in the Northern Great Plains, where corn is generally dry-rolled rather than steam-flaked (Cole et al., 2006). In addition, most research on the synergistic effects of coproducts has been with WCG combined with wet distiller's grains plus solubles (**WDGS**) rather than DDGS. The objective of the current study was to investigate the effects of feeding WCG and DDGS alone or in combination on performance and carcass characteristics of feedlot cattle fed SFC-based finishing diets.

MATERIALS AND METHODS

A total of 365 British and British × Continental steers were shipped approximately 580 km from El Reno, OK, to the Texas Tech University Burnett Center at New Deal, TX, on January 5, 2006. All cattle were immediately processed after arrival, which included placement of a uniquely numbered tag in the ear, vaccination with a modified live virus vaccine for various respiratory diseases (Vista-5 SQ; Intervet, Millsboro, DE) and a clostridial bacterin-toxid (Vision-7 with SPUR; Intervet), and treatment down the back line for internal and external parasites with moxidectin (Cydectin; Fort Dodge Animal Health, Overland Park, KS). After processing, the cattle were fed a 65% concentrate starter diet. The 365 steers were divided into 2 groups based on BW, with 200 steers of heavier BW selected for use in the experiment and the remainder designated for use in another experiment. The 200 selected steers were blocked by BW (5 blocks) and implanted with Revalor S (120 mg of trenbolone acetate + 24 mg of estradiol; Intervet) 9 d before the study began. On January 19, the 200 steers were weighed individually, sorted to their assigned pens (8 steers/pen in 5 blocks with 5 pens/block), and treatment diets were switched to 75% concentrate to begin the experiment. Of the 25 pens used in the experiment, 16 were 4.9 m wide × 30.5 m deep with 4.9 m of bunk space, and the 9 remaining pens were 5.2 m wide × 30.8 m deep with 5.2 m of bunk space.

Dietary treatment diets (DM basis; Table 1) consisted of a standard SFC-based, high-concentrate diet with no WCG or DDGS (**CON**); a diet with 7% DDGS (**7DDGS**); a diet with 20% WCG (**20WCG**); a diet with 13% WCG and 7% DDGS (**13WCG:7DDGS**); and a diet with 20% WCG and 7% DDGS (**20WCG:7DDGS**). Concentrations of WCG and DDGS were chosen because they reflect values commonly used in feedlot diets in the Southern Great Plains region. Wet corn gluten feed (Sweet Bran) and DDGS (loose-meal form) were provided by Cargill Corn Milling, Blair, NE. Composition of the WCG and DDGS is shown in Table 2. 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 diets (Table 1). The diets were formulated to contain 13.75% CP and equal concentrations of ether extract. Chopped alfalfa hay was included as 9% of the dietary DM (Table 1) in all diets; thus, the ADF concentration was expected to be greater in diets containing WCG and DDGS. The premix for diets containing WCG and DDGS (Table 1) was modified to remove ammonium sulfate (replaced by urea and ground corn to equalize the N concentration).

Cattle were fed once daily (approximately 0800 h) in quantities sufficient to ensure ad libitum consumption. Diet samples were taken weekly to determine the DM content (dried in a forced-air oven at 100°C for approximately 20 h). Feed bunks were cleaned and orts were weighed on d 42, 84, and before shipment to slaughter. 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 for chemical components (ADF, CP, DM, ash, Ca, P, and ether extract) by a commercial laboratory (SDK Laboratories, Hutchinson, KS).

Individual initial and final BW (unshrunk) before shipment to slaughter were obtained using a hydraulic squeeze chute (C&S Handling Equipment, Garden City, KS) equipped with electronic load cells (readability of 0.45 kg; Rice Lake Weighing Systems, Rice Lake, WI). Interim unshrunk BW data were recorded using a pen scale (2.27 kg readability) on d 42 and 84 of the study. Scales were calibrated with 453.5 kg of certified (Texas Department of Agriculture) weights before each use. Average daily gain was calculated as the difference in pen BW for various measurement periods divided by the number of days in the period. To determine DMI, daily DM deliveries to each pen (corrected for dry orts) were summed for the various periods and divided by number of animal days (number of animals multiplied by the number of days in the period) for each pen. Cattle in blocks 3 through 5 (120

Table 1. Composition and nutrient content (DM basis) of diets containing different proportions of wet corn gluten feed or distiller's dried grains with solubles

	Treatment diets[1]				
Item	Control	7DDGS	20WCG	13WCG: 7DDGS	20WCG: 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
WCG	—	—	19.65	12.77	19.67
Corn DDGS	—	6.92	—	6.92	6.94
Dicalcium phosphate	0.16	0.20	—	—	—
Limestone	—	—	0.14	0.15	0.10
Supplement[2]	2.49	2.50	2.51	2.51	2.51
Analyzed composition,[3] %					
DM	82.05	82.30	77.05	79.01	77.62
CP	13.06	13.69	13.15	13.48	12.86
DIP	8.82	8.17	8.91	7.89	7.82
ADF	7.03	7.74	8.58	8.49	8.92
EE	5.51	5.62	5.85	5.30	5.24
Ca	0.66	0.66	0.63	0.63	0.62
P	0.35	0.36	0.44	0.42	0.47
K	0.73	0.73	0.76	0.73	0.81
S	0.17	0.22	0.21	0.25	0.27

[1]Treatments were as follows: control = steam-flaked corn-based diet with neither wet corn gluten feed (WCG) nor corn distiller's dried grains with solubles (DDGS); 7DDGS = DDGS as 7% of the dietary DM; 20WCG = WCG only as 20% of the dietary DM; 13WCG:7DDGS = WCG and DDGS as 13 and 7% of the dietary DM, respectively; and 20WCG:7DDGS = WCG and DDGS as 20 and 7% of the dietary DM, respectively.

[2]Supplement for the control diet contained (DM basis) 23.37% cottonseed meal; 0.500% Endox (antioxidant; Kemin Industries, Des Moines, IA); 42.11% limestone; 1.036% dicalcium phosphate; 8.000% potassium chloride; 3.559% magnesium oxide; 6.667% ammonium sulfate; 12.000% salt; 0.0017% cobalt carbonate; 0.157% copper sulfate; 0.133% iron sulfate; 0.0025% ethylenediamine dihydroiodide; 0.267% manganese oxide; 0.100% selenium premix (0.2% Se); 0.845% zinc sulfate; 0.0079% vitamin A (1,000,000 IU/g); 0.126% vitamin E (500 IU/g); 0.675% Rumensin (176.4 mg/kg; Elanco Animal Health, Indianapolis, IN); and 0.45% Tylan (88.2 mg/kg; Elanco Animal Health). Concentrations in parenthesis are expressed on a 90% DM basis. Supplement for the WCG and DDGS diets did not contain ammonium sulfate and contained (DM basis) 29.962% cottonseed meal and 3.072% urea. Other ingredients were the same as for the control supplement.

[4]The DIP (degraded intake protein) and S concentrations were calculated from NRC (1996) tabular values. EE = ether extract.

steers) were weighed individually and shipped on May 15, 2006 (d 116), to the Cargill Meat Solutions facility in Plainview, TX, whereas those in blocks 1 and 2 (80 steers) were weighed and shipped on May 30, 2006 (d 131). Carcass measurements included hot carcass weight (**HCW**), longissimus muscle area, marbling score, USDA quality grade, fat thickness measured between the 12th and 13th ribs, percentage of kidney, heart, and pelvic fat, and calculated USDA yield grade. A carcass-adjusted final BW was calculated by dividing the HCW of each steer by the average dressing percent for all cattle (61.36%), and this value was used along with initial BW and days on feed to calculate carcass-adjusted ADG.

Statistical Analyses

Performance and carcass data were analyzed as a randomized complete block design using the MIXED procedure of SAS (SAS Inst. Inc., Cary, NC). Pen was the experimental unit for all analyses. The effects of treatment (fixed) and block (random) were included in the model. Nonorthogonal treatment contrasts were chosen to evaluate differences among treatments that reflected the study objectives: 1 = CON vs the average of the other 4 diets; 2 = 7DDGS vs 20WCG:7DDGS; 3 = 20WCG vs 20WCG:7DDGS; and 4 = 20WCG vs 13WCG:7DDGS. Carcass quality grade data (percentage of cattle grading USDA Choice or greater) were ana-

Table 2. Analyzed nutrient content (DM basis) of the wet corn gluten feed (WCG) and corn distiller's dried grains with solubles (DDGS)

	Ingredient[1]	
Item, %	WCG	DDGS
DM[2]	59.96	91.01
CP	24.24	26.20
ADF	11.57	15.20
NDF[3]	30.84	30.56
EE[4]	3.21	8.33
Ca	0.05	0.12
P	1.18	0.77
K	1.46	0.93

[1]All values except DM are expressed on a DM basis. Samples were collected weekly throughout the experiment and composited across the experiment.

[2]The DM for WCG was determined by a vacuum drying method by Cargill Corn Milling and represented the average value determined on loads of WCG.

[3]The NDF analyses were conducted by SDK Laboratories, Hutchinson, KS, on samples taken from loads of WCG and DDGS.

[4]EE = ether extract.

lyzed 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. For all statistical analyses, *P* values less than 0.05 were considered significant, whereas *P* values between 0.05 and 0.10 are discussed as trends.

RESULTS AND DISCUSSION

Chemical composition of the experimental diets is presented in Table 1. Crude protein content was similar to values expected from formulation. Ether extract concentration was similar among the diets, 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 anticipated fat content of the corn used during the study. As expected from the composition of DDGS and WCG (Table 2), ADF concentration increased with the addition of DDGS and WCG to the diet.

Performance data are presented in Table 3. Final live BW (unshrunk) and carcass-adjusted final BW tended to be greater ($P = 0.07$) for the average of the 4 WCG and DDGS treatments than for CON, but no differences were noted in the contrasts among the 4 WCG and DDGS treatments. As expected from the changes in final BW, ADG was consistently greater by steers in the 4 WCG and DDGS treatments than by steers in the CON treatment, with differences from d 0 to 84 ($P = 0.01$) and overall ($P = 0.04$), and there was a tendency ($P = 0.08$) for greater ADG by steers in the 4 WCG and DDGS treatments from d 0 to 42. Carcass-adjusted ADG also was greater ($P = 0.04$) for the average of the 4 WCG and DDGS treatments than for CON but not different among the 4 WCG and DDGS treatments.

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 CON diet than by the average of the cattle in the other 4 treatment groups (Table 3). Increased DMI was particularly evident for the cattle fed diets containing WCG, such that the contrast of 7DDGS vs 20WCG:7DDGS 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 4 contrasts were significant or tended to be so ($P = 0.01$ to 0.08). The increase observed in DMI with the WCG diets presumably reflects an increase in the dietary NDF resulting from the addition of WCG. Galyean and Defoor (2003) indicated that DMI by feedlot cattle was strongly correlated with NDF supplied by dietary roughage sources, and Galyean and Abney (2006) extended that observation to total dietary NDF. Although NDF was not measured directly in the diets fed in the current study, those containing WCG or combinations of WCG and DDGS would be expected to have a greater NDF concentration than CON and 7DDGS diets, based on the NDF concentrations of WCG and DDGS (Table 2).

Contrasts for G:F did not differ from d 0 to 42; however, from d 0 to 84, the cattle fed the 7DDGS diet had a greater G:F ($P = 0.05$) than those fed 20WCG:7DDGS (Table 3). This same difference was noted for the overall feeding period ($P = 0.04$) for G:F based on live weight gain; however, none of the contrasts was significant for G:F based on carcass-adjusted ADG, suggesting that differences in G:F for the 7DDGS vs 20WCG:7DDGS treatments might have resulted from differences in gastrointestinal fill.

As with final live BW and carcass-adjusted final BW, HCW was less ($P = 0.07$) for cattle fed CON than for the average of cattle fed the other 4 diets (Table 4), but no other differences were noted between the CON and the WCG and DDGS diets for carcass characteristics. Cattle in the 20WCG treatment had a lower dressing percent ($P = 0.04$) than those in the 13WCG:7DDGS treatment, and fat thickness tended to be greater ($P = 0.09$) for cattle fed the 20WCG:7DDGS diet than for those fed the 20WCG diet. The percentage of cattle grading USDA Choice or greater was not affected by treatment.

Performance responses to the use of WCG in the current study are consistent with recent research data using WCG as the only coproduct in the diet. For example, Scott et al. (2003) noted that including WCG in SFC-based feedlot diets increased DMI and ADG with no effect on G:F. Likewise, Block et al. (2005) found that including WCG in SFC-based finishing diets increased DMI and improved ADG with little effect on G:F. Block et al. (2002) reported a quadratic effect for ADG and G:F for 0, 20, 30, and 40% WCG (DM basis), with the

Table 3. Performance by steers fed diets containing different proportions of wet corn gluten feed and distiller's dried grains with solubles

Item	Treatment diets[1]					SE	Contrast *P*-value[2]			
	Control	7DDGS	20WCG	13WCG: 7DDGS	20WCG: 7DDGS		1	2	3	4
Initial BW, kg	387.7	388.7	387.3	386.1	389.9	7.90	0.93	0.74	0.50	0.75
Final BW, kg	632.1	645.3	648.9	639.2	646.7	9.10	0.07	0.88	0.80	0.27
Adjusted final BW,[3] kg	629.4	644.7	644.8	644.6	649.3	10.40	0.07	0.67	0.68	0.99
ADG, kg										
d 0 to 42	2.40	2.53	2.51	2.55	2.53	0.07	0.08	0.94	0.87	0.67
d 0 to 84	2.16	2.30	2.35	2.28	2.30	0.05	0.01	0.99	0.43	0.26
d 0 to end	2.00	2.10	2.15	2.08	2.11	0.05	0.04	0.88	0.55	0.27
Adjusted d 0 to end[3]	1.98	2.10	2.11	2.12	2.13	0.06	0.04	0.64	0.82	0.88
DMI, kg/d										
d 0 to 42	8.99	9.08	9.11	9.37	9.45	0.11	0.03	0.01	0.02	0.08
d 0 to 84	9.48	9.68	10.19	10.02	10.26	0.21	0.02	0.05	0.78	0.56
d 0 to end[3]	9.64	9.89	10.44	10.20	10.50	0.23	0.02	0.05	0.84	0.41
G:F										
d 0 to 42	0.267	0.279	0.276	0.272	0.267	0.007	0.39	0.22	0.39	0.74
d 0 to 84	0.229	0.238	0.231	0.227	0.224	0.005	0.76	0.05	0.30	0.57
d 0 to end	0.208	0.213	0.206	0.204	0.201	0.004	0.65	0.04	0.36	0.72
Adjusted d 0 to end[3]	0.205	0.212	0.202	0.208	0.203	0.004	0.84	0.16	0.90	0.32

[1]Treatments were as follows: control = steam-flaked corn-based diet with neither wet corn gluten feed (WCG) nor corn distiller's dried grains with solubles (DDGS); 7DDGS = DDGS as 7% of the dietary DM; 20WCG = WCG only as 20% of the dietary DM; 13WCG:7DDGS = WCG and DDGS as 13 and 7% of the dietary DM, respectively; and 20WCG:7DDGS = WCG and DDGS as 20 and 7% of the dietary DM, respectively.

[2]Observed significance level for nonorthogonal contrasts: 1 = control vs others; 2 = 7DDGS vs 20WCG:7DDGS; 3 = 20WCG vs 20WCG:7DDGS; 4 = 20WCG vs. 13WCG:7DDGS.

[3]Adjusted BW was calculated from hot carcass weight divided by the average dressing percent (61.36%) of all the cattle, after which ADG and G:F values were recalculated using the adjusted BW. Cattle were fed an average of 122 d.

Table 4. Carcass characteristics of steers fed diets containing different proportions of wet corn gluten feed and/or distiller's dried grains with solubles

Item	Treatment diets[1]					SE	Contrast *P*-value[2]			
	Control	7DDGS	20WCG	13WCG: 7DDGS	20WCG: 7DDGS		1	2	3	4
Hot carcass weight, kg	386.2	395.6	395.6	395.5	398.4	6.37	0.07	0.67	0.68	0.99
Dressing, %	61.07	61.29	60.93	61.89	61.60	0.33	0.29	0.46	0.13	0.04
Longissimus muscle area, cm^2	90.3	93.2	90.3	94.7	92.9	2.5	0.32	0.94	0.39	0.16
Fat thickness, cm	1.09	1.16	1.14	1.25	1.31	0.07	0.13	0.13	0.09	0.28
Yield grade	3.04	3.08	3.20	3.08	3.19	0.14	0.52	0.59	0.95	0.53
Marbling score[3]	404.5	410.8	438.3	422.0	411.3	15.66	0.37	0.98	0.24	0.47
USDA Choice, %	47.5	55.0	57.5	60.0	60.0	—	0.24	0.66	0.82	0.82

[1]Treatments were as follows: control = steam-flaked corn-based diet with neither wet corn gluten feed (WCG) nor corn distiller's dried grains with solubles (DDGS); 7DDGS = DDGS as 7% of the dietary DM; 20WCG = WCG only as 20% of the dietary DM; 13WCG:7DDGS = WCG and DDGS as 13 and 7% of the dietary DM, respectively; and 20WCG:7DDGS = WCG and DDGS as 20 and 7% of the dietary DM, respectively.

[2]Observed significance level for nonorthogonal contrasts: 1 = control vs others; 2 = 7DDGS vs 20WCG:7DDGS; 3 = 20WCG vs 20WCG:7DDGS; 4 = 20WCG vs 13WCG:7DDGS.

[3]300 = Slight 00; 400 = Small 00; 500 = Modest 00.

optimal range from 20 to 30%; thus, the optimal concentrations for WCG observed by Block et al. (2002) are similar to the concentrations fed in the current study. Loe et al. (2006) fed different combinations of WCG and barley in finishing diets and reported that DMI and ADG peaked at 35 and 52% WCG, respectively, but as in the current study, G:F was not affected by dietary treatment. Conversely, Sindt et al. (2003) observed decreased G:F when feeding WCG in SFC-based diets containing different combinations of WCG and alfalfa hay. Dry matter intake tended to increase with increasing levels of WCG, but ADG did not differ for crossbred heifers fed all combinations of WCG and alfalfa hay (Sindt et al., 2003); thus, feeding increasing amounts of WCG resulted in a linear decrease in efficiency of gain. Macken et al. (2004) also observed a linear increase in DMI with increasing concentrations of WCG; however, G:F and ADG did not differ among treatments.

Distiller's dried grains with solubles are often fed at relatively low levels in the diet as a protein source. Wet distiller's grains with solubles, however, are often fed at greater levels of the diet as an energy replacement (Erickson and Klopfenstein, 2006). Considerable research has been conducted with combinations of WDGS and WCG. Loza et al. (2004) conducted an experiment to verify possible synergies between WDGS and WCG. A blend of WDGS and WCG (50:50) was fed at inclusion levels varying from to 0 to 75% of DM combined with different levels of alfalfa hay. Performance by steers fed the maximal coproduct level (75% of DM), regardless of forage level, did not differ from the control, which was a typical corn-based diet with no coproducts. Diets containing 25 and 50% blends of WDGS and WCG, however, resulted in superior animal performance compared with the control diet. Quadratic responses to levels of coproducts (0, 25, 50, and 75%) were observed for DMI (11.1, 12.0, 11.7, and 10.6 kg/d, respectively), ADG (1.81, 2.10, 2.07, and 1.77 kg/d, respectively), and G:F (0.162, 0.177, 0.176, and 0.167, respectively). No differences were noted between performance of animals fed 25 and 50% blend of WDGS and WCG. Buckner et al. (2006) also fed WCG and WDGS as a blend (1:1 combination) at 2 inclusion levels (30 and 60% DM basis) or alone (30% DM basis) in dry-rolled and high-moisture corn (1:1 ratio on a DM basis) finishing diets and compared performance responses to a control diet. Addition of coproducts to the diet increased ADG and DMI. The authors observed that the blend could be used as up to 60% of DM with significant improvements in ADG and G:F compared with the control treatment. Buckner et al. (2006) further observed that the 30% WCG diet alone increased DMI and ADG with no changes in G:F. These responses are consistent with data from Block et al. (2002), Loe et al. (2006), and our data. Loza et al. (2006) fed increasing levels of WDGS with a fixed amount of WCG to evaluate performance by yearling steers. Treatments consisted of 0, 10, 15, 20, 25, and 30% inclusion of WDGS in combination with 30% WCG. A quadratic response was observed for ADG with increasing levels of WDGS and 30% WCG. No differences, however, were observed on G:F across WDGS levels compared with 30% WCG. Feeding 30% WCG and 0% WDGS resulted in increased ADG, DMI, and G:F compared with cattle fed the control diet. In addition, feeding 30% WCG and as much as 30% WDGS resulted in greater ADG and G:F than with the control diet. The inclusion of WDGS at levels of 15 to 20% in diets containing WCG increased ADG but not G:F (Loza et al., 2006).

IMPLICATIONS

Results from the present experiment suggest that corn DDGS and WCG can be used effectively in beef cattle finishing diets when fed alone or in combination. Data available from recent research and from the current study, although not completely consistent, also suggest that coproducts fed alone or in combination can be effectively used in feedlot cattle diets without major changes in G:F. Nonetheless, available data do not clarify the specific roles of dried or wet distiller's grains or WCG in terms of potential synergistic responses. Further research will be required to assess the extent to which fiber, fat, protein fractions (e.g., undegraded and degraded intake protein), and minerals (e.g., sulfur) from various grain milling coproducts affect performance responses by feedlot cattle and to define combinations of coproducts that optimize feedlot performance.

ACKNOWLEDGMENTS

The authors appreciate the insightful comments and cooperation of R. Stock and C. Parsons of Cargill Corn Milling, Blair, NE. We also thank Cargill Cattle Feeders (Wichita, KS) for providing the cattle used in the experiment, and DSM Nutritional Products (Parsippany, NJ), Elanco Animal Health (Indianapolis, IN), Fort Dodge Animal Health (Overland Park, KS), Intervet (Millsboro, DE), and Kemin Industries (Des Moines, IA) for supplying various products used during the experiment. Outstanding technical support in animal care and feeding was provided by K. Robinson, R. Rocha, and L. Shaw.

LITERATURE CITED

Block, H., C. Macken, T. Klopfenstein, R. Cooper, and R. Stock. 2002. Crude protein and wet corn gluten feed levels for steam flaked corn finishing diets. p. 68 in Nebraska Beef Cattle Rep. MP 79-A. Univ. Nebraska, Lincoln.

Block, H. C., C. N. Macken, T. J. Klopfenstein, G. E. Erickson, and R. A. Stock. 2005. Optimal wet corn gluten and protein levels in steam-flaked corn-based finishing diets for steer calves. J. Anim. Sci. 83:2798.

Buckner, C. D., G. E. Erickson, T. J. Klopfenstein, R. A. Stock, and K. J. Vander Pol. 2006. Effect of feeding a byproduct combination at 2 levels or byproduct alone in feedlot diets. J. Anim. Sci. 84(Suppl. 2):48. (Abstr.)

Cole, N. A., M. L. Galyean, J. Drouillard, L. W. Greene, F. T. McCollum, P. J. Defoor, and C. R. Richardson. 2006. Recent research with distiller's grains and corn milling byproducts - Southern Plains. p. 24 in Proc. Plains Nutr. Council Conf., Texas A&M AREC, Amarillo, TX.

Erickson, G. E., and T. J. Klopfenstein. 2006. Ethanol coproducts in Northern high plains feedlot cattle. p. 40 in Proc. Plains Nutr. Council Conf., Texas A&M AREC, Amarillo, TX.

Galyean, M. L., and C. S. Abney. 2006. Assessing roughage value in diets of high-producing cattle. p. 127 in Proc. Southwest Nutr. Manage. Conf., Univ. Arizona, Tucson.

Galyean, M. L., and P. J. Defoor. 2003. Effects of roughage source and level on intake by feedlot cattle. J. Anim. Sci. 81(E. Suppl. 2):E8.

Krehbiel, C. R., R. A. Stock, D. W. Herold, D. H. Shain, G. A. Ham, and J. A. Carulla. 1995. Feeding wet corn gluten feed to reduce subacute acidosis in cattle. J. Anim. Sci. 73:2931.

Loe, E. R., M. L. Bauer, and G. P. Lardy. 2006. Grain source and processing in diets containing varying concentrations of wet corn gluten feed for finishing cattle. J. Anim. Sci. 84:986.

Loza, P. L., G. E. Erickson, K. J. Vander Pol, M. A. Greenquist, R. A. Stock, and T. J. Klopfenstein. 2006. Addition of wet distiller's grains plus solubles in cattle finishing diets containing wet corn gluten feed. J. Anim. Sci. 82(Suppl. 2):81. (Abstr.)

Loza, P. L., K. J. Vander Pol, G. E. Erickson, R. A. Stock, and T. J. Klopfenstein. 2004. Corn milling byproducts and alfalfa levels in cattle finishing diets. J. Anim. Sci. 82(Suppl. 1):158. (Abstr.)

Macken, C. N., G. E. Erickson, T. J. Klopfenstein, and R. A. Stock. 2004. Effects of concentration and composition of wet corn gluten feed in steam-flaked corn-based finishing diets. J. Anim. Sci. 82:2718.

NRC. 1996. Nutrient Requirements of Beef Cattle. 7th ed. Natl. Acad. Press, Washington, DC.

Richeson, J. T., J. D. Rivera, J. J. Cranston, M. D. Abney, and M. L. Galyean. 2006. Effects of proportion of supplemental dietary crude protein supplied by urea on performance and carcass characteristics of beef cattle fed steam-flaked corn-based diets with wet corn gluten feed. Prof. Anim. Sci. 22:33.

Scott, T. L., C. T. Milton, G. E. Erickson, T. J. Klopfenstein, and R. A. Stock. 2003. Corn processing methods in finishing diets containing wet corn gluten feed. J. Anim. Sci. 81:3182.

Sindt, J. J., J. S. Drouillard, E. C. Titgemeyer, S. P. Montgomery, C. M. Coetzer, T. B. Farran, J. N. Pike, J. J. Higgins, and R. T. Ethington. 2003. Wet corn gluten feed and alfalfa hay combinations in steam-flaked corn finishing cattle diets. J. Anim. Sci. 81:3121.

Stock, R. A., J. M. Lewis, T. J. Klopfenstein, and C. T. Milton. 2000. Review of new information on the use of wet and dry milling feed by-products in feedlot diets. Proc. Am. Soc. Anim. Sci., 1999. http://www.asas.org/jas/symposia/proceedings/0924.pdf Accessed November 27, 2006.