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Summary

A finishing study was conducted to determine the value of the fiber, protein, fat, and solubles components from wet distillers grains plus solubles (WDGS) alone or in combination for feedlot cattle in comparison to WDGS diets. The fiber portion alone did not improve F:G. When protein was included in the composite with fiber, F:G improved. With fat and solubles both added separately, F:G continued to improve. None of the components alone could make up the feeding value of WDGS, however the composite diet of fiber, protein, fat, and solubles combined matched the performance observed when WDGS is fed.

Introduction

The ethanol industry is interested in ways to make use of portions of distillers grains to sell as separate commodities or to use in other processes. Ethanol plants are able to remove portions of fiber, protein, fat, and solubles from the distillers grains to be sold separately. Previous research suggests a feed composite can mimic wet distillers grains plus solubles (WDGS) to improve feed efficiency when compared to wet corn gluten feed (WCGF), however the question remained as to what interactions of the fiber, protein and fat contributed to the feeding value of WDGS (*1997 Nebraska Cattle Beef Report*, pp. 63–64). Recent research found the fiber portion to have the closest performance to that of a DGS diet out of the individual feeding components of fiber, fat, and protein of WDGS (*2016 Nebraska Beef Cattle Report*, pp. 122–23). Therefore, the objective of this study was to determine the nutritional energy value of the fiber, protein, fat, and solubles and their interactions in WDGS in terms of their contribution to finishing performance and carcass characteristics by using composites of feed ingredients similar to nutrient composition of WDGS.

Procedure

A finishing experiment was conducted using 600 crossbred steers (initial BW = 680 ± 40 lb) in a randomized block design to evaluate the feeding value of the fiber, protein, fat, and solubles in WDGS. Steers were limit-fed to 2% BW for five days before the start of the trial. Steers were weighed on two consecutive d (0 and 1) to determine initial BW. On day 1, steers were implanted with Revalor-XS (Merck Animal Health). Steers were blocked by BW into four blocks, stratified by BW within each block and assigned randomly to pen. Pens were assigned randomly to one of ten treatments with 6 pens per treatment and ten steers per pen.

Diets were formulated to contain the same amount of the fat, fiber and protein as in WDGS. Control diet (Table 1) had a 1:1 mix of dry rolled corn (DRC):high moisture corn (HMC) with a 5% inclusion of sorghum silage and 2.5% inclusion of grass hay. The WDGS20 and WDGS40 had 20% and 40% inclusion of WDGS, respectively. The Fiber20 contained corn bran at 7% and solvent extracted germ meal at 1.5% inclusion to mimic the fiber portion of the WDGS20. In the Fiber40 diet corn bran and solvent extracted germ meal inclusion were increased to 14% and 3%, respectively to mimic the WDGS40 fiber. Protein was then added to the diet in the form of corn gluten meal at 17.5% to mimic the crude protein in WDGS40. Whole fat germ was used to mimic the fat portion at 7.5% inclusion. Solubles was added to each Fiber diet at 8% to evaluate its contribution to energy. All diets were formulated to provide 30 g/ton DM daily of Rumensin® (Elanco Animal Health) and 90 mg/steer daily of Tylan® (Elanco Animal Health).

The first two blocks were harvested on d 182 and the second two blocks were harvested on d 188 at a commercial abattoir (Greater Omaha Packing, Omaha, Neb.) with HCW taken at slaughter. Carcass 12th rib fat, LM area, and USDA marbling score were recorded after a 48-hour chill. Yield Grade was calculated using the USDA Yield Grade equation [YG = 2.5 + (2.5 × 12th Rib Fat thickness, in) − (0.32 × LM area, in^2) + (0.2 × KPH fat, %) + (0.0038 × HCW, lb)]. Final BW, ADG, and F:G were calculated using the HCW adjusted to 63% common dress.

Data were analyzed using the Mixed procedure of SAS (SAS Institute, Inc., Cary, N.C.) as a randomized block design with pen as experimental unit. Linear and quadratic simple effects were evaluated for WDGS20 and WDGS40 and for Fiber20 and Fiber40 with the control diet as a common intercept. The fiber content was also evaluated comparing WDGS20 and WDGS40 vs. Fiber20 and Fiber40. Preplanned contrasts were also used to evaluate: 1) the protein effect (Fiber40, Fiber40 Sol vs. Fiber40 CGM, Fiber40 CGM Sol), 2) the fat effect (Fiber40 CGM, Fiber40 CGM Sol vs. Fiber40 CGM Germ, Fiber40 CGM Germ Sol), and 3) the solubles effect (Fiber40, Fiber40 CGM, Fiber40 CGM Germ vs. Fiber40 Sol, Fiber40 CGM Sol, Fiber40 CGM Germ Sol). The feeding value of each diet was calculated relative to the control corn diet using the calculation: Feeding Value = ((Treatment G:F − Control G:F) / Control G:F) / inclusion rate of compared treatment.

Results

Linear and Quadratic Simple Effects: WDGS and Fiber

Final BW, HCW, DMI, and ADG increased quadratically as WDGS replaced the corn blend in the diet ($P \leq 0.02$, Table 2). Gain increased at a greater magnitude compared with DMI causing a decrease in F:G ($P = 0.02$). Yield grade increased linearly ($P = 0.03$) and had a tendency to increase quadratically ($P = 0.06$) with the inclusion of WDGS in the diet.

Table 1. Composition of dietary treatments (% of dietary DM) fed to finishing steers to evaluate components within WDGS

Ingredient	Control	WDGS20	WDGS40	Fiber20	Fiber40	Fiber Sol[b]	Fiber Protein	Fiber Protein Sol[b]	Fiber Protein Fat	Fiber Protein Fat Sol[a]
DRC[a]	43.75	33.75	23.75	39.5	35.25	31.25	26.5	22.5	24.25	20.25
HMC[a]	43.75	33.75	23.75	39.5	35.25	31.25	26.5	22.5	24.25	20.25
Sorghum Silage	4	4	4	4	4	4	4	4	4	4
Grass Hay	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
WDGS[a]	—	20	40	—	—	—	—	—	—	—
Corn Bran	—	—	—	7	14	14	14	14	14	14
SEM[a]	—	—	—	1.5	3	3	3	3	—	—
CGM[a]	—	—	—	—	—	17.5	17.5	17.5	17.5	17.5
Whole Fat Germ	—	—	—	—	—	—	—	—	7.5	7.5
CDS[a]	—	—	—	—	—	8	—	8	—	8
Urea	1.45	—	—	1.45	1.45	0.91	—	—	—	—
Supplement[c]	3.55	5	5	3.55	3.55	4.09	5	5	5	5
Analyzed Composition, % of diet										
Crude Protein	11.1	15.4	19.7	11.3	11.5	13.4	21.8	23.7	21.7	23.6
NDF	14.2	18.7	23.2	19.9	25.5	25.3	24.6	24.4	25.7	25.5
Crude Fat	4.03	5.71	7.38	3.81	3.60	3.83	3.30	3.51	6.12	6.32
Sulfur	0.12	0.23	0.35	0.13	0.14	0.20	0.30	0.36	0.30	0.36

[a]DRC = Dry Rolled Corn, HMC = High Moisture Corn, WDGS = Wet distillers grains plus solubles, SEM = Solvent extracted germ meal, CGM = Corn gluten meal, CDS = Condensed Distillers Solubles
[b]Sol = Solubles
[c]Formulated for 30 g/ton for Rumensin®, 90 mg/steer daily of Tylan®, and 300 mg/steer daily of Optaflexx the last 28d for blocks 1 and 2 and the last 35 d for blocks 3 and 4

Table 2. Linear and quadratic simple effects for increasing levels of WDGS and Fiber diets on finishing performance

	Con	WDGS20	WDGS40	Fiber20	Fiber40	SEM	Fiber Content[a]	Lin[b] WDGS	Quad[b] WDGS	Lin[b] Fiber	Quad[b] Fiber
Initial BW, lb	693	691	692	692	692	1	0.70	0.26	0.35	0.37	0.47
Final BW, lb[c]	1374	1458	1442	1384	1361	12	< 0.01	< 0.01	< 0.01	0.45	0.25
DMI, lb/day	23.0	23.6	22.6	23.0	23.3	0.2	0.82	0.26	0.02	0.44	0.68
ADG, lb	3.69	4.15	4.06	3.75	3.62	0.06	< 0.01	< 0.01	< 0.01	0.47	0.23
F:G[d]	6.25	5.68	5.57	6.15	6.44	0.002	< 0.01	< 0.01	0.02	0.15	0.07
HCW, lb	866	919	909	872	858	7.4	< 0.01	< 0.01	< 0.01	0.45	0.25
LM area, in[b]	13.5	13.5	13.5	14.1	13.7	0.18	0.02	0.74	0.91	0.46	0.04
12th Rib Fat, in	0.57	0.65	0.63	0.49	0.50	0.03	< 0.01	0.12	0.1	0.06	0.16
Marbling score[e]	494	512	507	467	471	12	< 0.01	0.45	0.45	0.19	0.29
Calculated YG[f]	3.39	3.80	3.72	3.03	3.11	.10	< 0.01	0.03	0.06	0.07	0.09

[a]Fiber content analyzed by comparing the average of WDGS20 and 40 vs average of Fiber20 and 40.
[b]Linear and quadratic simple effects term
[c]Final BW calculated from hot carcass weight adjusted to a common dressing percentage of 63%
[d]Analyzed as G:F, reciprocal of F:G
[e]Marbling score:400 = Small00
[f]Calculated YG = 2.5 + (2.5 × 12th rib fat thickness) – (0.32 × LM area in^2) + (0.2 × KPH) + (0.0038 × HCW)

Table 3. Effects of soluble, protein and fat in the diet

	Con	WDGS 20	WDGS 40	Fiber 20	Fiber 40	Fiber Sol	Fiber Protein	Fiber Protein Sol	Fiber Protein Fat	Fiber Protein Fat Sol	SEM	Solubles Effect[a]	Protein Effect[b]	Fat Effect[c]
Initial BW	693	691	692	692	692	691	690	690	692	692	1	0.99	0.26	0.05
Final BW, lb[d]	1374	1458	1442	1384	1361	1396	1417	1429	1396	1443	12	< 0.01	< 0.01	0.78
DMI, lb/day	23.0	23.6	22.6	23.0	23.3	24.2	22.9	23.2	21.8	22.5	0.2	< 0.01	< 0.01	< 0.01
ADG, lb	3.69	4.15	4.06	3.75	3.62	3.81	3.93	3.99	3.81	4.06	0.06	< 0.01	< 0.01	0.68
F:G[e]	6.25	5.68	5.57	6.15	6.44	6.35	5.82	5.82	5.71	5.54	0.002	0.19	< 0.01	< 0.01
HCW, lb	866	919	909	872	858	880	892	900	879	909	7.4	< 0.01	< 0.01	0.78
LM area, in[b]	13.5	13.5	13.5	14.1	13.7	13.8	13.7	13.6	13.4	13.6	0.18	0.57	0.43	0.41
12th Rib Fat, in	0.57	0.65	0.70	0.49	0.50	0.56	0.59	0.63	0.55	0.62	0.03	0.03	< 0.01	0.38
Marbling score[f]	494	512	507	467	471	492	473	496	467	483	12	0.05	0.80	0.44
Calculated YG[g]	3.39	3.80	3.72	3.03	3.11	3.32	3.50	3.66	3.45	3.66	0.10	0.03	< 0.01	0.76

[a]Solubles effect analyzed by comparing average of Fiber 40, Fiber Protein, and Fiber Protein Fat vs Fiber Sol, Fiber Protein Sol, Fiber Protein Fat Sol
[b]Protein effect analyzed by taking the average of Fiber 40 and Fiber Sol vs the average of Fiber Protein and Fiber Protein Sol
[c]Fat effect analyzed by comparing average of Fiber Protein and Fiber Protein Sol vs the average of Fiber Protein Fat and Fiber Protein Fat Sol
[d]Final BW calculated from hot carcass weight adjusted to a common dressing percentage of 63%
[e]Analyzed as G:F, reciprocal of F:G
[f]Marbling Score: 400 = Small00
[g]Calculated YG = 2.5 + (2.5 × 12th rib fat thickness) – (0.32 × LM area in^2) + (0.2 × KPH) + (0.0038 × HCW)

The increased performance with higher inclusion of WDGS agrees with previous research where increased levels of WDGS improved performance (*2006 Nebraska Cattle Beef Report*, pp 51–53). The LM area increased quadratically with the increased inclusion of corn bran and SEM in the Fiber diets (P = 0.04, Table 2). In addition, the fiber diets had a tendency to increase F:G quadratically (P = 0.07, Table 2) as the fiber inclusion increased.

Fiber Content vs WDGS

Feeding WDGS at 20 and 40% resulted in greater final BW, HCW, ADG, 12th rib fat, marbling score, and yield grade when compared to the cattle fed Fiber20 and Fiber40 diets (P < 0.01, Table 2). Due to similar DMI and greater ADG, F:G was improved for WDGS compared to feeding fiber (P < 0.01, Table 2). However, LM area was significantly less for the WDGS diets than for the Fiber20 and Fiber40 diets (P = 0.02, Table 2). When compared to the control diet, the Fiber20 diet had an increased feeding value of 119%, while the Fiber40 diet decreased to 83%. Neither diet matched the feeding value of WDGS40 at 130%, indicating the fiber portion alone of the WDGS contributes only a portion of the positive performance that we see from WDGS.

Solubles Effect

When comparing diets with and without solubles inclusion, final BW, HCW, DMI, ADG, 12th rib fat, marbling score, and yield grade all increased significantly with the inclusion of solubles (P ≤ 0.05, Table 3), while having no effect on F:G (P = 0.18, Table 3) or LM area (P = 0.57). These data suggest the inclusion of solubles to the diet increases performance while increasing the feeding value 0% to 20%, but with no improvement in F:G, the solubles addition by itself cannot match the feeding value of WDGS at 130%.

Protein Effect

The addition of corn gluten meal to the Fiber40 and Fiber40 Sol diet significantly increased final BW, HCW, DMI, ADG, 12th rib fat, and yield grade while improving F:G (P < 0.01, Table 3). With the addition of corn gluten meal to the fiber diet, the feeding value increased 17% to 47%. With this increased performance and value, protein is a major part of the positive performance observed with WDGS, however, numerically WDGS still had a better feeding value at 130% compared to the protein diets that are 121% and 117%. The protein effect is when protein is fed in excess as rumen undegradable protein and used for energy.

Fat Effect

With the addition of fat to the diet, DMI decreased and F:G also decreased (improved) (P < 0.01, Table 3), along with increasing the feeding value an additional

2% to 8%.With the improved conversions, fat inclusion with protein and solubles in the diet shows that it is a major part of the WDGS that improves performance with a feeding value at 127% almost matching WDGS40 at 130%.

The fiber portion alone of WDGS is not responsible for its increased performance in a feedlot. Protein, fat, and solubles inclusion in the diet each further increased performance when added to the basal fiber diet. When comparing the WDGS diets to the mimicking diets, the inclusion of fiber, protein, fat, and solubles together gave the same performance as the WDGS diet at 40% inclusion. The WDGS40 diets had improved feed efficiencies compared to WDGS20. This research demonstrates that the interactions between fiber, protein, fat, and solubles in WDGS are all important, and have a similar feeding value to WDGS.

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