Replacing Traditional Sources of Protein and Energy with Corn Dried Distillers Grains Plus Solubles in Dry Rolled Corn-Based Growing and Finishing Diets

B.P. Holland, C.R. Krehbiel, and D.L. VanOverbeke

Two experiments were conducted at the Willard Sparks Beef Research Center to evaluate replacing traditional protein and energy sources with corn dried distillers grains plus solubles (DDGS) in diets for growing and finishing cattle. In Experiment 1, 41 yearling steers were finished on a 95% concentrate diet that contained either 0 or 15% DDGS (dry matter basis). The 0% diet was formulated to contain equivalent concentrations of crude protein and crude fat. Across the 84 days during which the experimental diets were fed, steers fed DDGS consumed more feed. However, final body weight and average daily gain did not differ between treatments. Therefore, steers fed diets containing no DDGS were more efficient converters of feed to gain. When net energy of the diets were calculated based on steer performance, the 15% DDGS diet contained less net energy than expected. No differences in USDA quality or yield grade were detected. In Experiment 2, 0 vs 15% DDGS diets (dry matter basis) were fed to 120 steers during a 48-day growing period. No advantage in gain, dry matter intake, or feed efficiency was detected for either diet. Corn dried distillers grains plus solubles can be used to replace traditional sources of protein and energy in dry-rolled corn-based growing and finishing diets without suppressing gain or carcass merit. However, energy values of the product may be different than expected potentially due to the inherent variability of co-products.

Key Words: Beef Cattle, Co-Products, Fat, Net Energy, Protein

Introduction

The production of fuel ethanol from corn has dramatically increased in recent years, and this trend will likely increase in the near future (Westcott, 2007). This occurrence has shifted a portion of the corn in the United States away from livestock production. However, co-products of ethanol production, including corn dried distillers grains plus solubles (DDGS) have also become more available. Corn DDGS contains 89.2 ± 2.3% dry matter; 30.6 ± 1.5% crude protein; 10.3 ± 1.7% crude fiber, 10.3 ± 1.0% crude fat and 81.0 ± 2.2% TDN (means ± standard deviation of 13 loads of DDGS received at the Willard Sparks Beef Research Center from April 21, 2006 to June 25, 2007 as analyzed by Servi-Tech Laboratories, Dodge City, KS). These values indicate that DDGS could be a valuable feedstuff to provide both energy and protein in diets for growing and finishing cattle. The objective of these experiments were to evaluate replacing traditional sources of protein (urea and oilseed meals) and energy (corn and supplemental fat) with a modest amount of DDGS in dry-rolled corn-based growing and finishing diets.

Materials and Methods

Experiment 1. Forty-one yearling Brangus steers (average initial BW = 782 ± 64.9 lb) were received from the Dale Bumpers Small Farms Research Center, Booneville, AR on April 25, 2006. Initial processing occurred approximately 1 h after arrival and included vaccination against viral respiratory pathogens (Vista 5 SQ, Intervet Inc., Millsboro, DE), deworming

(Ivomec Pour-On, Merial, Duluth, GA), and implanting with trenbalone acetate and estradiol (Revalor S, Intervet Inc, Millsboro, DE). Steers were immediately allocated by weight into 8 pens (5-6 steers/pen) in a completely randomized design. Three step-up diets of increasing concentrate levels were fed during the first 23 d on feed. Each step-up diet contained 15% DDGS with cottonseed hulls and ground alfalfa hay as roughage sources. On d 21, steers were weighed as a pen group and pens were randomly allotted to one of two finishing diet treatments containing 0 or 15% DDGS (dry matter basis, 4 pens/treatment). The treatment diets were fed beginning on d 23. The experimental diets were formulated to meet or exceed NRC (2000) requirements and are shown are shown in Table 1. Both dry-rolled corn-based diets contained 5% cottonseed hulls as roughage and 5% Synergy 19-14 liquid supplement (Westway Feed Products, New Orleans, LA). The 0% DDGS diet was formulated with added cottonseed meal and urea in the pelleted supplement and added fat to equalize crude protein and crude fat between treatments. Both diets were mixed weekly as needed (Rotomix 184-8 Mixer, Dodge City, KS) and delivered to bunks twice daily at 0700 and 1300 h using plastic barrels. Bunks were managed such that less than 1 pound/steer remained each morning, but ad litibum intake could occur. Cattle were again weighed on a pen basis on d 48 and 76 and individually before shipment on d 104. Cattle were slaughtered commercially by Tyson Fresh Meats (Emporia, KS). Skilled personnel from the Oklahoma State University meats laboratory collected carcass data including hot carcass weight, percentage of kidney, pelvic, and heart fat, rib eye area, fat thickness over the 13th rib, yield grade, and quality grade.

Table 1. Composition of finishing diets in Experiment 1.

	Percent of Dry Matter	
Item	0% DDGS	15% DDGS
Dry Rolled Corn	80	69
DDGS	0	15
Synergy 19-14[a]	5	5
Dry Supplement	9[b]	6[c]
Yellow Grease	1	0
Cottonseed Hulls	5	5
Nutrient Composition		
Dry Matter, %	91.4	91.4
Crude Protein, %	13.6	12.5
Crude Fat, %	5.2	4.8
ADF, %	8.1	9.1
NDF, %	15.6	18.3
NEm[d], Mcal/lb	1.00	0.98
NEg[d], Mcal/lb	0.67	0.65

[a]Contained (% of DM): crude protein, 31.6 (26.5% of total crude protein from non-protein nitrogen); and crude fat 23.3.

[b]Contained (% of DM): crude protein, 46.7; urea, 5.56; monensin 317 g/ton; and tylosin, 85 g/ton.

[c]Contained (% of DM): crude protein, 7.2; and monensin 465 g/ton; and tylosin, 126 g/ton.

[d]Calculated based on diet ingredient formulation (NRC, 2000).

Experiment 2. One hundred twenty steers (604 ± 59.3 lb) which had previously been used in an experiment at the Willard Sparks Beef Research Center evaluating different antimicrobial mass-medication regimens (Step et al., 2007) were weighed on two consecutive days beginning August 7, 2006, blocked by weight and allocated to 8 pens (4 pens/treatment, 15 steers/pen). Steers were implanted with estradiol benzoate (Component ES, Vetlife, Overland Park, KS) at the beginning of the experiment. A 65% concentrate diet containing 15% DDGS had been limitfed for 77 d prior to initiating the experiment. Treatments were ad libitum feeding of 70% concentrate growing diets containing either 0 or 15% DDGS (Table 2). Diets were mixed and fed once daily (Rotomix 184-8, Dodge City, KS) at 0700. Cattle were weighed individually on d 48.

Calculation of Dietary Net Energy. Dietary net energy was calculated for both experiments for each pen using the quadratic equation (Zinn and Shen, 1998). Rather than using the mean body weight to estimate retained energy, the standard reference weight for animals finishing at small marbling (1,054 lb; NRC, 2000) was used to calculate the equivalent shrunk body weight and adjust the medium-frame steer calf equation for the current situation. The target final shrunk body weight in Exp. 1 was the actual final shrunk body weight for each pen and in Exp. 2 was set as 1,248 lb for all pens. The net energy values calculated from performance are also expressed as a fraction of net energy calculated based on diet formulation and NRC (2000) tabulated values.

Statistical Analysis. In both experiments, pen was considered the experimental unit. Interim and final body weights, average daily gain, dry matter intake, feed efficiency, energy values and carcass measures were analyzed using the MIXED procedure of SAS (SAS Institute, Cary, NC). Exp. 1 was a completely randomized design. Therefore, the model only included the effect of treatment. The categorical data of the distribution of cattle grading USDA Choice was analyzed as a binomial proportion using the GLIMMIX procedure of SAS. In Exp. 2, the PROC MIXED model included the main effect of treatment, and the weight block was included as a random effect. Differences were considered significant if $P<.05$.

Table 2. Composition of growing diets in Experiment 2.

	Percent of Dry Matter	
Item	0% DDGS	15% DDGS
Dry rolled corn	58.85	50.00
DDGS	.0	15.0
Yellow Grease	1.15	.00
Pelleted Supplement	10.0[a]	5.0[b]
Sorghum Silage	30.0	30.0
Nutrient Composition		
Dry Matter, %	48.3	48.3
Crude Protein, %	14.3	13.3
Crude Fat, %	5.0	3.8
Crude Fiber	14.2	16.3
NEm[c], Mcal/lb	.88	.87
NEg[c], Mcal/lb	.56	.56

[a]Contained (% of DM): crude protein, 63.7; urea, 8.0; and monensin 253 g/ton.

[b]Contained (% of DM): crude protein, 47.5; urea, 4.0%; and 506 g/ton.

[c]Calculated from diet formulation (NRC, 2000).

Results and Discussion

Experiment 1. Body weights and performance of steers in Exp. 1 are presented in Table 3. After 28 d on the final finishing diets, steers fed 15% DDGS weighed more (P=.006) than steers not fed DDGS. However, while the means maintained the same trend, no significant differences were observed on d 76 or 104. For the entire finishing period (d 20 – 104), ADG did not differ (P>.10) between treatments. Daily dry matter intake was greater (P=.01) for steers fed DDGS than control steers. Because ADG was not different, control steers were more efficient (P=.02), gaining 0.016 lb/d more per pound of dry matter consumed than DDGS steers. With the exception of crude protein, which was 1% unit greater in the 0% DDGS diet, our goal in formulation to provide equal nutrients was reached. However, the 15% diet had significantly decreased net energy for maintenance (P=.02) and gain (P=.02) and net energy for gain tended

(P=.10) to be 4 percentage units lower than expected compared with the control diet. Depenbusch et al. (2007) did not find a difference in ADG or DMI when replacing steam-flaked corn with DDGS. However, both total tract and organic matter digestibility decreased 3% with the addition of distillers grains which may explain some of the reduced energy values observed here. No differences were detected in dressing percentage, hot carcass weight, loin-muscle area, marbling score, external fat thickness, percentage of kidney, pelvic, and heart fat, or USDA yield or quality grade (P>.27; Table 4).

Table 3. Body weight, average daily gain, dry matter intake, and feed efficiency of steers fed 0 or 15% DDGS during finishing (Experiment 1[a]).

Item	0% DDGS	15% DDGS	S.E.M[b].	Probability[c]
BW, lb				
d 0	777	786	8.19	.46
d 20	850	870	11.99	.30
d 48	991	1031	6.76	.006
d 76	1130	1148	15.25	.42
d 104	1222	1238	14.53	.45
ADG, lb/d				
d 20 - 48	5.02	5.76	.28	.11
d 48 - 76	4.96	4.19	.19	.37
d 76 - 104	3.29	3.24	.23	.87
d 20 - 104	4.42	4.40	.11	.86
DMI, lb/d				
d 20 - 48	24.62	27.46	.51	.007
d 48 - 76	27.16	28.70	1.14	.38
d 76 - 104	25.89	27.90	.70	.09
d 20 - 104	24.38	26.40	.41	.01
G:F				
d 20 - 48	.203	.209	.007	.57
d 48 - 76	.183	.145	.010	.03
d 76 - 104	.127	.116	.007	.33

d 20 - 104	.173	.157	.004	.02
Net Energy				
Maint.	.95	.88	.015	.02
Gain	.64	.58	.014	.02
Observed/expected dietary NE, Mcal/lb				
Maint.	.96	.93	.016	.21
Gain	1.01	.97	.021	.10

[a]Experimental finishing diets were fed beginning on d 20.

[b]Standard error of the means (n=4 pens/treatment).

[c]Probability of the overall F test.

Table 4. Carcass characteristics of cattle fed either 0 or 15% DDGS during the finishing(Experiment 1).

Item	0% DDGS	15% DDGS	S.E.M[a].	Probability[b]
Hot carcass wt, lb	758	761	13.84	.85
Dress %	62.25	61.56	.93	.85
LM area, in.[2c]	12.61	12.44	.23	.63
Grade fat[c]	.49	.56	.04	.31
KPH[d]	1.93	1.91	.06	.85
Yield Grade	2.96	3.21	.15	.27
Marbling Score[e]	413	412	13.36	.94
Choice, %	63.33	57.50	-	.60
Select, %	36.67	42.50	-	.85

[a]Standard error of the means (n=4 pens/treatment).

Experiment 2. Steers grown on 15% DDGS gained similarly to steers not fed DDGS (3.32 vs 3.19 lb/d; P=.29). However, similar to Exp. 1, steers receiving no DDGS consumed less feed (16.29 vs 16.94; P=.05). Growth efficiency was not different, possibly due to the numeric advantage in ADG for steers consuming DDGS. Contrary to Exp. 1, net energy values did not differ between diets and were very similar to those expected based calculated values from NRC (2000).

The analysis of DDGS received in our facility is similar to that reported in NRC (2000) and Preston (2007). However, the coefficient of variation was 4.8% for crude protein, 9.4% for crude fat, and 16.4% for crude fiber. Spiehs et al. (2002) formed a nutrient database (n=118 samples from 1997 to 1999) from their area in Minnesota and South Dakota and observed variation within and between plants and compared to published values from previous years and other locales. Maintaining a current database of the product received at each facility is an important step in formulating rations and predicting performance of cattle fed DDGS.

Table 5. Body weight, average daily gain, dry matter intake, and feed efficiency of steers grown on diets containing 0 or 15% DDGS (Experiment 2)

Item	0% DDGS	15% DDSG	S.E.M.	Probability
Initial BW, lb	576	576	40.32	.44
Final BW, lb	728	736	49.88	.26
ADG, lb/d	3.19	3.32	.21	.29
DMI, lb/d	16.29	16.94	.65	.05
G:F	.204	.204	.003	.99
Net Energy				
Maint.	.85	.84	.044	.88
Gain	.56	.56	.036	.88
Observed/expected dietary NE, Mcal/lb				
Maint.	.96	.97	.047	.84
Gain	.99	.99	.064	.99

[a]Standard error of the means (n=4 pens/treatment).

[b]Probability of the overall F test.

Conclusion

Traditional sources of crude protein and energy may be replaced in dry-rolled corn-based growing and finishing diets with corn dried distillers grains for both growing and finishing steers. Steers consuming corn dried distillers grains plus solubles could be expected to consume more feed. Contrary to other reports, corn dried distillers grains plus solubles resulted in decreased efficiency in finishing steers. Care should be taken to monitor the nutrient content of ethanol co-products due to the inherent variability that results from their production.

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Acknowledgements

The authors would like to thank Dr. Mike Looper, USDA Dale Bumpers Small Farms Research Center, Booneville, AR and Windell Shockey, Chickasha, OK for providing the cattle used in these experiments.

Authors

Holland, B.P. – Graduate Student.

Krehbiel, C.R. – Associate Professor.

VanOverbeke, D.L. – Assistant Professor