Applying Corn Condensed Distillers Solubles to Hay Windrows Prior to Baling: II. Effects on Growing Cattle Performance

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Summary

Two experiments evaluated the feeding value of grass hay bales previously treated with CCDS in growing cattle diets. In Experiment 1, heifers fed bales treated with 20% CCDS (DM) gained less than those fed an equal level of dried distillers grains plus solubles and non-treated hay. In Experiment 2, ADG and F:G linearly improved with increasing CCDS levels. Furthermore, supplementing cattle to meet metabolizable protein requirements when fed diets of CCDS and hay did not improve ADG at levels greater than 15% CCDS. Data indicate hay bales previously treated with CCDS are adequate for use in growing diets, confirming that within-bale storage is a viable method for CCDS.

Introduction

Corn condensed distillers solubles (CCDS) is an energy and protein dense co-product that can often be economically utilized in diets for cow-calf and backgrounding operations. Because this product is a liquid, incorporation with low-quality forages is an ideal strategy for both feeding and storage. Trials conducted in recent years (*2009 Nebraska Beef Cattle Report*, pp. 11-12 and 30-32) demonstrated mixtures of CCDS ensiled with either cornstalks or wheat straw result in high quality diets for growing cattle. Current experiments have investigated applying CCDS to hay windrows before baling as an alternative form of within-bale storage. Performance of cattle fed CCDS-treated bales can indicate the extent that storage was successful.

Because CCDS is an excellent source of degradable intake protein (DIP), it is attractive for use in forage-based diets. However, growing cattle have greater metabolizable protein requirements and may be deficient unless supplemented with by-pass protein (UIP). Thus, cattle fed CCDS in high-forage diets may respond to additional UIP supplementation. Therefore, our objectives were to: 1) evaluate the feeding value of hay bales previously treated with CCDS and thus determine the extent of within-bale storage; and 2) measure the effect of supplemental UIP on the performance of cattle fed CCDS.

Procedure

All procedures and facilities described in the following experiments were approved by the University of Nebraska–Lincoln Institutional Animal Care and Use Committee.

Experiment 1

Weaned, crossbred (Simmental x Angus), spring-born heifers (n = 66, initial age = 332 days) were utilized in a 62-day development trial conducted at the University of Nebraska–Lincoln Dalbey-Halleck Research Unit located near Virginia in southeast Nebraska. Heifers were weaned in October of the previous year and fed a common diet to target an approximate ADG of 1.22 lb prior to the experiment beginning in mid-winter. In February, heifers were stratified by BW and randomly assigned within strata to one of four pens (two pens per treatment, 16-17 heifers per pen). Pens were assigned randomly to one of two dietary treatments: 1) ad libitum intake of large round native grass hay bales treated with CCDS at 20% of bale weight (DM basis) (CCDS) or 2) ad libitum intake of native large round hay bales and fed dried distillers grains plus solubles (DDGS) at 20% of the diet (DM basis) (DDGS). The CCDS-treated bales used in the current study were produced the previous summer in a concurrent experiment at the same research location.

Treatment diets (Table 1) were formulated using the 1996 NRC model to contain a 20% dietary inclusion (DM basis) of ethanol co-products, thereby remaining similar in CP and TDN, to allow heifers to achieve approximately 60% of mature BW at the onset of breeding. This inclusion level was chosen based on previous data (*2007 Nebraska Beef Cattle Report*, p. 5) indicating DDGS fed at 0.57% of BW (DM basis) is sufficient to produce an ADG of 1.50 lb for developing heifers prior to breeding.

Large-round hay bales were offered to both treatment groups in metal bale-ring feeders, and hay DMI was not quantified. Limestone was added to DDGS prior to feeding to achieve a minimum Ca:P ratio of 1.5:1. Both

Table 1. Composition of dietary treatments fed to growing replacement heifers in Experiment 1.

	Treatment	
Ingredient[1]	CCDS[2,4]	DDGS[3,4]
Grass hay	80.00	80.00
Corn condensed distillers solubles	20.00	—
Dried distillers grains plus solubles	—	20.00
Total	100.00	100.00

[1]% of diet DM.
[2]CCDS = heifers fed ad libitum grass hay bales treated with solubles at 20% DM.
[3]DDGS = heifers fed ad libitum grass hay bales and DDGS at 20% DM.
[4]Salt, trace mineral, and vitamin supplement provided free choice.

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treatments were offered ad libitum access to a mineral and vitamin supplement (18.7% Ca, 18.0% salt, 6% Mg, 5,500 ppm Zn, 2,500 ppm Cu, 26.4 ppm Se, 400,000.0 IU/lb vitamin A, and 400.0 IU/lb vitamin E). DDGS heifers were group-fed daily in metal feed bunks with at least 18 inches of bunk space per heifer.

Three-day consecutive initial and final BW measurements were recorded to determine performance. Weights (without restriction from feed and water) were collected after heifers had been fed a common diet of grass hay and DDGS for one week. Body condition score was assessed visually at the beginning and end of the experiment by the same experienced technician. Data were analyzed as a completely randomized design with pen as the experimental unit. The model for all analyses included the fixed diet treatment effect.

Experiment 2

A total of 60 crossbred steer calves (initial BW = 635 ± 26 lb) were utilized in an 84-day growing experiment conducted at the University of Nebraska–Lincoln Agricultural Research and Development Center (ARDC) feedlot located near Mead, Neb. The trial was a completely randomized design with a 3 x 2 factorial arrangement of treatments resulting in six dietary treatments (10 steers per treatment; Table 2). Treatment factors included: 1) inclusion of corn condensed distillers solubles (0, 15, and 30% of diet; DM basis) mixed with ground grass hay and 2) with (MP) or without (No MP) supplemental UIP to meet metabolizable protein requirements. The mixture of ground grass hay and previously-applied CCDS served as the basal diet ingredient with a supplement top-dressed at the time of feeding. Supplemental UIP was provided using a 1:1 ratio of Soypass® and corn gluten meal to meet predicted metabolizable protein requirements for all MP diets using the 1996 NRC model. Urea was added to diets containing 0% CCDS to meet DIP requirements. All supplements were formulated to provide 200 mg/steer daily of monensin sodium.

Table 2. Diet and supplement composition of treatments fed to growing steer calves in Experiment 2.

	No MP			MP		
Ingredient[1]	0	15	30	0	15	30
Grass hay	93.83	78.82	63.80	93.83	78.82	63.80
CCDS	0.00	15.01	30.03	0.00	15.01	30.03
Supplement	6.17	6.17	6.17	6.17	6.17	6.17
Total	100.00	100.00	100.00	100.00	100.00	100.00
Supplement[1]						
Corn gluten meal	0.000	0.000	0.000	2.240	1.680	1.680
Soypass	0.000	0.000	0.000	2.240	1.680	1.680
Soybean hulls	4.632	4.700	4.700	0.000	1.271	1.271
Limestone	0.413	0.963	0.963	0.502	1.032	1.032
Urea	0.320	0.000	0.000	0.480	0.000	0.000
Salt	0.300	0.300	0.300	0.300	0.300	0.300
Dicalcium phos.	0.298	0.000	0.000	0.201	0.000	0.000
Tallow	0.125	0.125	0.125	0.125	0.125	0.125
Trace mineral	0.050	0.050	0.050	0.050	0.050	0.050
Vitamin premix	0.015	0.015	0.015	0.015	0.015	0.015
Rumensin-90[2]	0.013	0.013	0.013	0.013	0.013	0.013
Total	6.17	6.17	6.17	6.17	6.17	6.17

[1]% of diet DM.
[2]Formulated to provide 200.00 mg/steer daily monensin sodium.

Table 3. Effect of diet on replacement heifer performance in Experiment 1.

	Treatment			
Item	CCDS[1]	DDGS[2]	SEM	*P*-value
Pens (n)	2	2		
Initial BW, lb	640.9	640.8	0.59	0.87
Initial BCS	5.1	5.1	0.04	0.42
Final BW, lb	682.1[a]	716.0[b]	2.45	0.01
Final BCS	5.1	5.5	0.14	0.18
ADG, lb	0.67[a]	1.22[b]	0.04	0.01

[1]CCDS = heifers fed ad libitum grass hay bales treated with solubles at 20% DM.
[2]CON = heifers fed ad libitum grass hay bales and DDGS at 20% DM.
[a,b]Within a row, least squares means without common superscripts differ at $P \leq 0.05$.

Table 4. Nutrient composition (DM basis) and daily protein balance of dietary treatments in Experiment 2.

	No MP			MP		
Item	0	15	30	0	15	30
CP, %[1]	6.2	9.2	13.2	9.0	10.9	14.9
TDN, %[1]	54.6	61.0	66.7	55.0	61.0	67.0
MP balance, g/day[2]	-151	-68	-37	-96	+3	+52
DIP balance g/day[2]	-15	+4	+195	+44	+25	+221

[1]Calculated using 1996 NRC model level 1.
[2]Predicted MP and DIP balances calculated using 1996 NRC model level 1 based on average BW, DMI, and ADG.

The CCDS-treated bales fed in the current study were produced the previous summer in a concurrent experiment at the Dalbey-Halleck Research Unit. In December, bales treated with 0, 16, or 32% (DM basis) CCDS were transported to the ARDC feedlot and ground through a 3-inch screen using a tub grinder. The mixture of ground grass hay and CCDS was stored prior to feeding in a partially enclosed commodity bay with concrete flooring.

Cattle were limit fed (2% of BW; DM basis) a diet of 50% alfalfa hay and 50% wet corn gluten feed for 5 days prior to initiation and upon completion of the trial to minimize variation in rumen fill. Initial and final BW measurements were the

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Table 5. Effect of level of CCDS and metabolizable protein on growing steer calf performance in Experiment 2.

	No MP			MP				*P*-value		
Item	0	15	30	0	15	30	SEM	Level[1]	Protein[2]	L x P[3]
Initial BW, lb	635	634	635	636	636	636	8.45	0.99	0.89	0.99
Final BW, lb[5]	700[c]	753[b]	839[a]	746[b]	767[b]	838[a]	10.46	<0.01	0.03	0.09
ADG, lb[6]	0.78[d]	1.41[b,c]	2.42[a]	1.31[c]	1.56[b]	2.41[a]	0.08	<0.01	<0.01	<0.01
DMI, lb/day[7]	12.4[c]	15.2[b]	17.9[a]	13.8[b,c]	14.5[b]	17.9[a]	0.54	<0.01	0.60	0.13
F:G[4,5]	17.00[d]	10.90[c]	7.39[a]	10.92[b,c]	9.35[b]	7.55[a]	—	<0.01	<0.01	<0.01

[1]Fixed effect of CCDS level.
[2]Fixed effect of metabolizable protein.
[3]CCDS level x metabolizable protein interaction.
[4]Analyzed as G:F, reported as F:G.
[5]Linear effect of CCDS level within No MP and MP diets ($P \leq 0.01$).
[6]Linear effect of CCDS level within No MP diets, and linear and quadratic effect within MP diets ($P \leq 0.01$).
[7]Linear main effect of CCDS level ($P \leq 0.01$).
[a-d]Within a row, least squares means without common superscripts differ at $P \leq 0.05$.

mean of 3 day consecutive weights. Steers were individually fed daily with Calan electronic gates. Bunks were evaluated daily, feed refusals collected weekly, and DM determination was conducted using a 60° C forced air oven for 48 hours. Dry matter intake was calculated by subtracting DM refused from DM offered.

Data were analyzed as a completely randomized design with individual animal as the experimental unit. Model fixed effects included CCDS inclusion level, supplemental metabolizable protein, and the level x protein interaction. Orthogonal contrasts were constructed to test the linear and quadratic effects of inclusion level within No MP and MP diets when an interaction occurred, or for the main effect of level no interaction was observed.

Results

Experiment 1

Heifer BW and BCS data are presented in Table 3. By design, initial BW and BCS were similar between treatments. Average daily gain was greater for DDGS than CCDS heifers (1.22 and 0.67 lb, respectively). As a result, DDGS heifers had increased final BW relative to CCDS females upon completion of the trial. Although not statistically different, BCS responded in similar fashion and was 0.40 units greater for DDGS than CCDS heifers.

Reasons for the difference in gain between treatments are not clear. DDGS heifers were bunk-fed and consumed essentially all their supplement daily, whereas CCDS heifers had ad libitum access to treated hay. Even though metal bale feeders were used, CCDS heifers appeared to waste a considerable amount of forage which may have produced differences in co-product intake. Differences in metabolizable protein also may have contributed to the gain response observed because DDGS contains more UIP than CCDS (65% vs. 20% of CP, respectively). Therefore, Experiment 2 was designed based on these results to further investigate contributing factors.

Experiment 2

The dietary nutrient composition and daily protein balance of treatments are shown in Table 4. Protein balances were calculated using the 1996 NRC model based on average BW, DMI, and ADG during the feeding period. Supplements for all MP diets were formulated to meet, but not greatly exceed, requirements for metabolizable protein.

Steer performance data are presented in Table 5. There was a significant level by protein interaction for ADG. Within No MP diets, daily gain increased linearly as CCDS inclusion level increased. However, the response to increased dietary CCDS was both linear and quadratic for MP diets. Supplemental metabolizable protein improved ADG and final BW, but only for cattle fed diets with no added CCDS. Final BW increased linearly with greater levels of CCDS regardless of supplemental protein.

Dry matter intake was not affected by supplemental metabolizable protein, but did increase linearly with elevated levels of CCDS. The level by protein interaction was significant for F:G; however, F:G improved linearly as CCDS inclusion level increased regardless of supplemental metabolizable protein. Cattle fed MP diets had improved F:G compared to those fed No MP diets but only up to 15% CCDS (DM basis).

The greatest response to supplemental metabolizable protein occurred for cattle fed diets with 0% CCDS. This is expected given those animals are the most deficient as predicted by the NRC model (Table 4). Supplementing to meet requirements had minimal impact for cattle fed 15% or 30% CCDS (DM basis). Apparently, the metabolizable protein deficiency at these inclusion levels was too small to elicit differences in gain. This suggests the results observed in Experiment 1 were likely due to other factors, not a metabolizable protein deficiency. In Experiment 2, cattle responded to greater levels of CCDS-treated hay implying successful within-bale storage occurred. Collectively, data indicate grass hay bales treated with CCDS have acceptable feeding value for use in growing diets which could minimize the need for additional protein or energy supplementation and storage facilities for CCDS.

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