Digestibility of Diets with Corn Grain and Urea Replaced with Corn Distillers Grains or Solubles

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Summary

Ten steers were used in a digestion experiment to evaluate replacing dry rolled corn and urea with 4% and 8% condensed distiller solubles (CDS), or 10% and 20% wet corn distillers grain with solubles (DGS). The steers were placed in digestion crates for total collection of feces during a 5 d period following 14 d of diet adaptation. Intake (kg/d) of DM, starch, NDF, ADF, CP, and fat were: 7.99, 8.71, 8.62 & 8.41, 7.84; 4.92, 4.87, 4.93, & 4.81, 3.95; 1.19, 1.25, 1.19, & 1.42, 1.42; 0.43, 0.48, 0.45, & 0.56, 0.55; 0.96, 1.08, 1.03, & 1.03, 1.03; 0.27, 0.36, 0.43, & 0.43, 0.50; for 0%, 4%, 8% CDS and 10%, 20% DGS. Respective apparent digestibility of DM, starch, NDF, ADF, CP, and fat were 79, 78, 76 & 77, 76; 97, 94, 95, & 95, 94; 53, 53, 46 & 52, 56; 41, 45, 37, & 48, 50; 72, 72, 70, & 69, 69; 63, 66, 65, & 68, 75. Replacing corn and urea with distillers co-products did not affect DM intake or digestibility of NDF, ADF, or CP, but did increase fat intake. Feeding DGS decreased starch intake and increased NDF and ADF intake. The steers fed 20% DGS had lower starch intake than the control diet and along with 4% CDS diet had lower starch digestibility compared with the control diet. Steers fed 8% CDS had lower DM digestibility. Steers fed 20% DGS had a significantly higher fat digestibility. The results of this study suggest that 8% CDS tended to decrease digestibility, probably as a result in increased fat intake. Replacing a portion of corn and urea with wet DGS increased digestibility of NDF, ADF and fat indicating these components were more digestible in the DGS than the control diet.

Introduction

The rapid increase in number of dry-grind ethanol plants has resulted in a large supply of corn distillers co-products. Wet distillers grains (DGS) is usually dried, but can be fed to cattle in the wet form. Condensed corn distillers solubles (CDS) is produced by condensing thin stillage to 30 to 40% DM. A portion of CDS is added back to the wet grains to produce distillers grains with solubles (DGS). Being a liquid, CDS is not as widely accepted as DGS as a feed for cattle. Based on nutrient composition, both DGS and CDS are considered a source of energy and protein in cattle diets and both have been shown to be excellent feeds for cattle, replacing corn grain and protein supplement in cattle finishing diets (A.S. Leaflet R1451, 1997; A.S. Leaflet R1772, 2002). When fed at concentrations to supply adequate protein, replacing corn and protein supplement with distillers co-products has resulted in equal or superior performance of the cattle. With increasing supplies of these co-products, there is interest in feeding higher concentrations. The objective of this study was to measure digestibility of diets with and without the co-products to determine if feeding the co-products altered digestibility of corn-based finishing diets typically fed to cattle.

Material and Methods

Ten crossbred steers, Angus and Charolais, weighing 840 lbs were placed in digestion crates for total collection of feces and urine during a 5 d period following 14 d of diet adaptation. Two steers were assigned to each of five diets during each period in a 5 x 5 Latin rectangle design. The five diets were: 1) Control, 2) 4% CDS, 3) 8% CDS, 4) 10% WDGS or 5) 20% WDGS (Table 1). A grain mix containing all ingredients except chopped hay, corn silage or distillers co-product was made for each diet. The steers were fed twice daily (8 a.m. and 4 p.m.) at which time the silage, chopped hay, grain mix and distillers co-product were weighed and mixed before feeding. Samples of the grain mixes, silage, hay, distillers co-products and feed refusals were taken daily and then the daily collections were pooled together for each 5-d collection period. Feces were collected daily, weighed, a 5% representative sample saved and pooled for each animal at the end of each 5-d period. Samples were dried and analyzed for dry matter, crude protein, neutral detergent fiber (NDF), acid detergent fiber (ADF), nitrogen bound to ADF (ADIN), ether extract and starch. Apparent nutrient digestibility was calculated by nutrient consumed (kg/d) minus fecal nutrient (kg/d) divided by nutrient consumed (kg/d).

Data were analyzed as a 5 x 5 Latin rectangle using the GLM procedure of SAS. The Dunnett test was used to compare diets containing the co-products with the control diet. The experimental unit was the individual animal and the class was the diet. Data were considered statistically significant at $P < 0.05$.

Results and Discussion

Composition of diet ingredients and co-products are given in Tables 2 and 3. Most of the fiber in corn grain is concentrated in DGS rather than CDS. Both co-products contained minimal concentrations of starch. About 4% of the nitrogen was found bound to ADF (ADIN) which was greater than found in the grain mix. An increase in ADIN results in some loss in availability of nitrogen, probably as a result of heating during the processing and fermentation processes. The concentration of fat in CDS was higher and

Table 1. Composition of diets (Dry basis).

Ingredient	Distillers co-products, % dry matter				
		CDS		DGS	
	0	4	8	10	20
Dry rolled corn	86.26	82.67	79.10	77.08	67.65
Chopped grass hay	5.00	5.00	5.00	5.00	5.00
Corn silage	5.00	5.00	5.00	5.00	5.00
Distillers solubles		4.00	8.00		
Wet distillers grains				10.00	20.00
Cane molasses	0.75	0.75	0.75	0.75	0.75
Urea	1.29	0.99	0.68	0.52	
Limestone	1.00	1.00	1.00	1.00	1.00
Sodium chloride	0.30	0.30	0.30	0.30	0.30
Potassium chloride	0.21	0.11		0.19	0.21
Trace mineral premix[a]	0.024	0.024	0.024	0.024	0.024
Vitamin A premix[b]	0.04	0.04	0.04	0.04	0.04
Multi vitamin premix[c]	0.06	0.06	0.06	0.06	0.06
Rumensin premix[d]	0.02	0.02	0.02	0.02	0.02
Elemental sulfur	0.04	0.03	0.02	0.02	0.04

[a]Trace mineral premix contained: Ca 13.2%, Co 0.10%, Cu 1.5%, Fe (ferrous) 10.0%, Fe (ferric) 0.44%, I (as EDDI) 0.20%, Mn 8.0%, S 5.0% and Zn 12.0%.
[b]Vitamin A premix contained 5 million IU/kg.
[d]Multi Vitamin premix contained vitamin A 454,000 IU/kg, vitamin D3 90,900 IU/kg, vitamin E 454 IU/kg and vitamin K (menadione) 182 mg/kg.
[d]Monensin sodium premix contained 176 g/kg.

more variable than expected. This might have been the result of separation of oil and particulate matter with storage in the holding tanks at the ethanol plant and not getting representative samples of the stored material because of the small batches obtained for the experiments.

Dietary intake and apparent digestibilities are shown in Table 4. There were no significant differences in dry matter intake related to diet. There was a trend for cattle fed CDF and 10% wet DGS to consume more feed DM. Feeding wet DGS significantly increased NDF and ADF intake and decreased starch intake compared with the control diet. Feeding ether co-product significantly increased intake of fat.

Feeding 8% CDS tended to decrease digestibility of dry matter, NDF and ADF. This decrease in digestibility might have been the result of increased fat intake. Feeding distillers co-products did not significantly affect NDF, ADF, or crude protein digestibility. Steers fed 4% CDS and 20% WDGS diets had lower starch digestibility compared with the control diet. The trend for increased intake of the 4% CDS diet may have affected starch digestibility. There is a negative associative affect between starch and fiber digestibility which might explain the decreased starch digestion observed in the steers fed 20% DGS. Steers fed DGS tended to digest a greater percentage of fiber and ether extract.

The performance of cattle fed wet DGS in feeding trials at Iowa State and Nebraska suggests that wet DGS has a greater energy value than corn grain. The results of this digestion experiment indicated the fiber and fat in DGS was highly digested compared with the control diet and would suggest that DGS should have an energy value similar to corn grain even though nearly all the starch has been removed. The results of the digestion study however do not provide an obvious explanation for an energy content greater than corn grain.

Implications

Condensed corn distillers solubles and wet distillers grain were both found to be highly digestible when fed to cattle replacing a portion of the corn grain and urea in a finishing diet. The results of this study support the earlier finding that wet distillers co-products can effectively replace a portion of the corn and protein in finishing diets without affecting performance.

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Table 2. Chemical composition of grain mix, chopped hay and corn silage.

	Ingredient		
Item	Grain mix	Chopped hay	Corn silage
Dry matter, %	88.8	90.1	35.5
Organic matter, % DM	97.0	92.2	95.6
Starch, % DM	68.8	0	16.3
NDF, % DM	9.9	72.7	41.3
ADF, % DM	2.5	40.6	22.5
Crude protein, % DM	11.3	7.6	7.9
Ether extract[a], % DM	3.5	1.2	3.6
ADIN[b], % total N	0	6.0	3.6

[a]Fats and oils.
[b]Nitrogen bound to ADF, considered unavailable in the rumen and not digested.

Table 3. Chemical composition of distillers co-products.

	Distillers co-products, % dry matter			
	CDS		DGS	
	Avg.	Range	Avg.	Range
Dry matter, %	36.6	33.1 – 44.3	31.9	28.8 – 33.2
Organic matter, % DM	90.0	89.1 – 92.5	93.7	93.5 – 94.1
Starch, % DM	3.8	2.6 – 5.9	1.3	0.5 – 1.7
NDF, % DM	6.3	4.5 – 8.7	28.4	26.1 – 31.9
ADF, % DM	3.0	0 – 8.6	11.5	9.7 – 15.
Crude protein, % DM	16.6	14.0 – 20.9	32.1	31.0 – 33.4
Ether extract[a], % DM	37.2	20.2 – 46.3	17.9	16.0 – 19.4
ADIN[b], % total N	3.6	2.5 – 5.4	4.2	3.1 – 5.1

[ab]See Table 2.

Table 4. Consumption and digestibility of diets containing condensed distillers solubles or wet distillers grains.

	Distillers co-products, % dry matter					
		CDS		DGS		
Item	0	4	8	10	20	SEM[a]
Daily intake (dry basis)						
Dry matter, kg	7.99	8.71	8.62	8.41	7.84	0.20
Starch, kg	4.92	4.87	4.93	4.81	3.95**	0.14
NDF, kg	1.19	1.25	1.19	1.42**	1.42**	0.03
ADF, kg	0.43	0.48	0.45	0.56**	0.55**	0.01
Crude protein, kg	0.96	1.08	1.03	1.03	1.03	0.03
Ether extract, g	270	360**	430**	430**	500**	14
ADIN, g	0.46	0.86**	1.17**	2.42**	3.90**	0.08
Apparent digestibility, % of intake						
Dry matter	78.6	78.1	75.7*	77.1	75.9	0.78
Starch	96.6	94.1*	94.7	95.2	94.1*	0.60
NDF	52.9	52.9	46.0	52.0	56.1	2.19
ADF	41.2	45.1	36.6	48.0	49.6	2.49
Crude protein	71.9	72.2	69.6	69.1	69.3	0.89
Ether extract	63.2	66.0	65.3	68.0	75.0**	2.51

[a]Standard error of the means.
*Different from control ($P < 0.05$).
**Different from control ($P < 0.01$).