2015

Digestibility of De-Oiled Modified Distillers Grains Plus Solubles in Forage-Based Diets

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Summary

Over half of Nebraska's ethanol plants are removing oil from distillers grains via centrifugation of the thin stillage constituent. Removing oil by this method does not impact intake or total tract digestibility in beef cattle growing diets. However, increasing the concentration of de-oiled distillers grains in the diet significantly improved intake and digestibility. Thus, concentration of distillers grain in the diet has a greater impact on total tract digestibility than the fat content in forage-based diets.

Introduction

Forage-based diets are frequently fed to growing cattle in Nebraska. Adding distillers grains plus solubles to the diet is an excellent source of protein and energy for growing cattle. Historically, distillers grains have contained approximately 12-13% fat. Corrigan et al., (*2007 Nebraska Beef Cattle Report,* pp. 17-18) found that feeding high levels of fat, a concern when distillers grains are added at high concentrations in the diet, hinders rumen fiber digestion. Optimal fat concentration to maximize ADG and feed efficiency in high quality forage-based diet was between 3.6-4.5% for this study.

Over half of Nebraska's ethanol plants remove oil from the thin stillage stream (condensed distillers solubles) via centrifugation and add it back to distillers grains to produce de-oiled distillers grains plus solubles. The impact of de-oiled distillers grains plus solubles on forage digestion in growing cattle is poorly understood. To address this concern, Jolly-Breithaupt et al., (*2013 Nebraska Beef Cattle Report,* pp. 25-26) fed de-oiled (6.3% fat) and normal (20.1% fat) condensed distillers solubles (CDS) at 20 or 40% concentrations replacing a 80:20 blend of brome hay and sorghum silage (DM basis) to growing cattle. Diets containing de-oiled CDS fed at 20 or 40% were 2.39% and 5.15% fat, respectively. Diets containing normal CDS at 20 or 40% concentrations were 3.23% and 8.83% fat, respectively. Both diets containing 40% CDS were above the fat threshold value that Corrigan et al., (*2007 Nebraska Beef Cattle Report,* pp. 17-18) deemed optimal for growing cattle performance. As a result, there tended to be an interaction between CDS concentration and CDS type for F:G. Cattle fed normal CDS were 13.4% more efficient than cattle consuming de-oiled CDS diets at 20% but not at 40%. At 40% concentrations of CDS in the diet, fat appeared to be a hindrance to fiber digestion in the rumen. Thus, the objective of this study was to determine if feeding de-oiled modified distillers grains plus solubles (MDGS) impacts nutrient (i.e., fiber) digestion in a forage-based diet similar to feeding de-oiled CDS.

Procedure

An 84-day digestion study utilized 12 (six yearling and six calf-fed) ruminally cannulated steers in a Latin square experimental design. Steers were assigned to one of six treatment diets, four of which pertain to this trial. Treatments were organized in a 2 × 2 factorial arrangement (Table 1). Concentration of MDGS (20 vs. 40%) and type of MDGS (de-oiled vs. normal fat content) were the factors examined. Both de-oiled and normal fat MDGS were purchased prior to the start of the study from *Green Plains Renewable Energy* (Central City, Neb.) and stored at the Agricultural Research and Development Center (ARDC) near Mead, Neb., until needed in silo bags. The remainder of all diets consisted of 1" grind corn residue and 4% of a formulated supplement. The 20% distillers grains diets contained urea to meet the ruminally degradable protein (RDP) requirements. In addition, metabolizable protein requirements of the animals were met with distillers grains and predicted bacterial protein. Steers were housed in individual slatted floor pens and fed once daily at *ad libitium* intake.

This study was comprised of four, 21-day periods. Cattle were acclimated to treatment diets through days 1-15 and dosed with titanium dioxide (TiO_2) on days 8-20. Fecal and diet samples as well as orts were collected on days 15-21. Titanium dioxide was used as a marker for digestibility measurements, and was administered via rumen bolus twice daily (at 0800 and 1200 hours) at 7.5 g per dosage. Fecal grab samples were collected from the yearling steers at 0800, 1200, and 1600 hours each day of the collection period. Total fecal collection via fecal collection bags was conducted on the steer calves in addition to TiO_2 as a marker. Fecal samples were composited on a wet-basis by day, freeze-dried, and then composited dry by period for each steer. The TiO_2 method of digestibility quantification

Table 1. Dietary treatments for ruminally fistulated steers.

Item	20[2]		40[2]	
	DO[3]	NO[3]	DO[3]	NO[3]
De-oiled MDGS[1]	20.0	—	40.0	—
Normal MDGS[1]	—	20.0	—	40.0
Corn residue	75.0	75.0	55.0	55.0
Supplement	5.0	5.0	5.0	5.0
Nutrient Composition				
Fat, %	2.19	3.15	3.43	5.35
NDF, %	68.1	68.3	59.4	59.8
CP, %	12.1	11.6	17.9	16.7

[1]MDGS = modified distillers grains plus solubles.
[2]20 and 40 = % concentration of MDGS in the diet.
[3]DO = de-oiled MDGS, NO = normal MDG.

Table 2. Nutrient composition of feed ingredients.

Ingredient	DO[1] MDGS[2]	NO[3] MDGS[2]	Corn Residue
Fat, %	7.2	12.0	1.0
CP, %	35.5	32.6	6.7
OM, %	95.2	94.5	94.8
Sulfur, %	0.63	0.57	0.10
NDF, %	37.5	37.5	80.8

[1]DO = de-oiled.
[2]MDGS = modified distillers grains plus solubles.
[3]NO = normal.

Table 3. Effects of dietary treatments on intake, fecal output, and total tract digestibility of DM, organic matter, and NDF.

Distillers Level	20[1]		40[1]			*P*-values		
Distillers Type	DO[2]	NO[2]	DO[2]	NO[2]	SEM	NO vs. DO[3]	20 vs. 40[4]	DO x Level[5]
DM								
Intake, lb	12.9	14.5	16.8	18.3	1.2	0.15	<0.01	0.90
Fecal output, lb	6.5	6.8	6.7	6.7	0.6	0.80	0.92	0.73
Digestibility, %	50.0	53.2	60.3	61.2	2.55	0.45	0.01	0.68
OM								
Intake, lb	11.7	13.2	15.3	16.6	1.1	0.15	0.01	0.91
Fecal output, lb	5.2	5.4	5.5	5.5	0.5	0.86	0.69	0.72
Digestibility, %	55.6	58.4	63.9	64.7	2.33	0.46	0.02	0.70
NDF								
Intake, lb	8.83	9.96	9.97	11.30	1.09	0.08	0.10	0.93
Fecal output, lb	3.88	4.26	4.22	4.50	0.58	0.72	0.61	0.98
Digestibility, %	55.02	58.10	57.78	58.67	3.18	0.52	0.59	0.72

[1]20 and 40 = % concentration of MDGS in the diet.
[2]DO = de-oiled, NO = normal.
[3]*P*-value for comparison of normal vs. de-oiled modified distillers grains plus solubles (MDGS).
[4]*P*-value for comparison of 20 vs. 40% MDGS.
[5]*P*-value for interaction of MDGS type with MDGS concentration.

Table 4. Main effects of dietary treatments on average, minimum, and maximum ruminal pH value of steers.

	Concentration			Type			
	20[1]	40[1]	*P*-value	De-oiled[2]	Normal[2]	*P*-value	SEM
Average pH	6.83	6.78	0.85	6.91	6.70	0.51	0.24
Minimum pH	6.57	6.35	0.22	6.44	6.47	0.88	0.14
Maximum pH	7.14	7.29	0.78	7.32	7.12	0.71	0.73

[1]20 and 40 = % concentration of MDGS in the diet.
[2]De-oiled and normal modified distillers grains plus solubles.

was compared to values obtained from total fecal collection digestibility measurements in order to compare methods. Both methods produced comparable values, and thus TiO_2 digestibility values are presented in this report. Fecal and ingredient samples were analyzed for DM, OM, NDF, and fat contents. Orts were dried for accurate calculation of DMI. Wireless pH probes (Dascor, Inc., Escondido, Calif.) collected pH measurements continuously the last 7 days of the period.

Ruminal pH data were analyzed as a crossover design using the GLIMMIX procedure of SAS (SAS Institute, Inc., Cary, N.C.) and the compound symmetry covariance structure was used with day as a repeated measure. The MIXED procedure was used to analyze intake, fecal output, and digestibility.

Results

MDGS Type

Nutrient composition of feed ingredients is presented in Table 2. No interactions between concentration of MDGS and MDGS type were detected for this study, thus main effects are presented (Table 3). Steers consuming normal fat MDGS diets tended to consume more DM, OM, and NDF per day than did steers consuming de-oiled MDGS diets ($P = 0.15$, $P = 0.15$, and $P = 0.08$, respectively). When comparing digestibility (Table 3) and rumen pH values (Table 4) between calves consuming de-oiled versus those consuming normal fat MDGS, no significance between MDGS types existed ($P > 0.45$ and $P = 0.51$, respectively). Therefore, these data suggest that oil removal from distillers grains plus solubles does not improve digestibility in forage-based diets similar to those fed in this study, which is contrary to previous work with solubles alone.

Concentration of MDGS

As previous research supports, increasing the concentration of distillers grains from 20 to 40% in the diet significantly increased DM intake, OM intake, and tended to increase NDF intake ($P < 0.01$, $P = 0.01$, and $P = 0.10$, respectively, Table 3). DM digestibility and OM digestibility were greater in steers consuming 40% MDGS ($P = 0.01$ and $P = 0.02$, respectively) compared to 20% MDGS, which is logical given that MDGS replaced corn residue. Average ruminal pH was not different between cattle consuming either 20 or 40% MDGS ($P = 0.85$, Table 4).

This study suggests that growing cattle tend to consume more when fed normal MDGS diets compared to when fed de-oiled MDGS diets. This is contrary to what would be expected as typically cattle consuming forage-based diets of a lower fat content have greater DMI than those being fed a forage-based diet of a higher fat content. Fat hinders fiber digestion in the rumen, thus typically decreasing intake. The digestibility of normal MDGS diets was not statistically different from the digestibility exhibited by cattle consuming de-oiled MDGS diets. The fat concentration of 5.35% in the normal MDGS diet did not depress fiber digestion in this study. When MDGS concentration was increased in the diet, cattle performed similarly to what has been seen previously because as concentration of MDGS increasingly replaced corn residue in the diet, digestibility of the diet improved.

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