Effects of Isolated Nutrients in Distillers Grains on Total Tract Digestibility and Digestible Energy in Forage Diets

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Summary with Implications

A digestion study was conducted to evaluate the contribution of individual nutrient components of distillers grains on nutrient digestibility and digestible energy. All diets contained 56% brome hay with a control diet containing either 40% corn; or 40% modified distillers grains. Four additional diets compared the contribution of fat, protein, fiber, and solubles components of distillers grains. No differences were observed for digestibility of DM, OM, and NDF among treatments. Feeding the isolated protein resulted in similar digestible energy to modified distillers grains, suggesting the bypass protein component contributes heavily to energy in distillers.

Table 1. Composition of diets (DM basis) fed to growing steers.

	Treatments					
Ingredient, % of DM	CON	DG	FIB	PROT	SOL	TAL
Brome	56.0	56.0	56.0	56.0	56.0	56.0
DRC[1]	40.0	-	20.0	20.0	25.0	37.0
Corn bran	-	-	20.0	-	-	-
CGM[2]	-	-	-	20.0	-	-
Tallow	-	-	-	-	-	3.0
MDGS[3]	-	40.0	-	-	-	-
Distillers Solubles	-	-	-	-	15.0	-
Supplement[4]	4.0	4.0	4.0	4.0	4.0	4.0
Nutrient Composition						
NDF_{om}[5], %	49.8	57.1	61.2	48.0	48.3	49.4
CP, %	12.4	19.3	12.9	22.6	14.1	12.1
Fat, %	3.34	5.47	3.39	2.33	3.02	6.15

[1]DRC: Dry rolled corn

[2]CGM: Corn gluten meal

[3]MDGS: Modified distillers grains plus solubles

[4]Supplements contained 1.4% limestone, 0.1% tallow, 0.3% salt, 0.05% trace minerals, 0.02% vitamin ADE, and 0.01% Rumensin. Supplements contained varying amounts of urea and fine ground corn so all diets met 12.5% CP at minimum. Diets were formulated to meet 200 mg/steer of Rumensin daily at 20 lb DM consumption.

[5]NDF_{om}: neutral detergent fiber accounted for ash.

Introduction

The ethanol industry is adopting new techniques that will remove oil and potentially fiber leading to changes in the byproducts available for cattle producers. Determining the contributions of nutrient components to the feeding value of distillers grains is important. It was previously observed that the feeding values for corn gluten meal, which provides rumen undegradable protein (RUP) identical to distillers, was similar to modified distillers grains (MDGS; *2016 Nebraska Beef Cattle Report*, pp. 29–30) when fed to growing cattle. Isolation and feeding of the fiber and solubles components of MDGS did not result in similar performance as MDGS fed at 40% of diet DM in forage growing diets, suggesting the greater protein content of MDGS contributes to the increase in feeding value. However, the effects of nutrient components on diet digestibility, fiber digestibility, and digestible energy were not evaluated.

The objectives of this study were to evaluate the contribution of different components of distillers grains on nutrient digestibility and digestible energy (DE) when replacing corn in high forage diets and to determine the effects of byproduct inclusion and type of fiber on in situ NDF disappearance.

Procedure

An 84-d digestibility study was conducted utilizing 6 ruminally cannulated steers (initial BW = 796 lb, SD = 59 lb). The study consisted of 6 periods, 14 d in length, allowing 10 d of adaptation to diets before 4 d of fecal collections. Steers were fed once daily at 0800 h and dosed intraruminally with titanium dioxide (5 g / dose) daily at 0800 and 1600 h (10 g / d). Steers were fed ad libitum on d 1–8 and fed 95% ad libitum on d 9–14. Feed refusals were collected daily and recorded prior to feeding and saved for d 9–12. Fecal grab samples were taken from steers on d 11–14 at 0700, 1100, 1500, and 1900 h.

Diets contained 56.0% brome and 40% concentrate (DM basis; Table 1). The control diet (CON) contained 40% dry-rolled corn (DRC) while the distillers grains diet (DG) contained 40% MDGS (DM basis). The remaining four diets replaced a portion of DRC and included the following byproducts selected to isolate the various nutrient components found in MDGS: 1) corn bran included at 20% of the diet DM to represent the fiber found in MDGS (FIB), 2) corn gluten meal included at 20% of the diet DM to represent the protein in MDGS (PROT), 3) tallow included at 3% of diet DM to represent the fat in MDGS (TAL), and 4) solubles (SOL) included at 15% of diet DM to represent the solubles found in MDGS. Inclusion of byproducts were chosen to simulate nutrient content provided by feeding 40% MDGS (DM basis).

Table 2. Total tract digestibilities and digestible energy of diets fed to growing steers.

	CON	DG[1]	FIB[2]	PROT[3]	SOL[4]	TAL[5]	SEM	*P*-values
DM								
Intake, lb / d	22.0	23.2	22.1	21.4	21.9	21.1	1.06	0.75
Output, lb / d	9.42	9.58	9.30	8.41	8.94	9.29	0.46	0.41
Digestibility, %	56.8	58.2	57.8	60.2	59.2	55.6	1.84	0.49
OM								
Intake, lb / d	20.6	21.2	20.7	20.0	20.0	19.7	0.97	0.87
Output, lb / d	8.11	8.11	8.00	7.11	7.64	7.95	0.42	0.38
Digestibility, %	60.2	61.2	61.2	63.8	62.1	59.2	1.83	0.49
NDF_{om}[6]								
Intake, lb / d	10.6^{b}	13.2^{a}	136^{a}	10.3^{b}	10.4^{b}	10.2^{b}	0.55	<0.01
Output, lb / d	4.96^{bc}	6.10^{a}	5.53^{ab}	4.65^{c}	4.93^{bc}	4.93^{bc}	0.26	<0.01
Digestibility, %	52.6	53.4	59.2	54.3	52.7	51.4	2.21	0.16
Fat								
Intake, lb / d	0.79^{b}	1.30^{a}	0.77^{b}	0.53^{c}	0.68^{b}	1.34^{a}	0.04	<0.01
Output, lb / d	0.15	0.22	0.15	0.18	0.15	0.15	0.02	0.16
Digestibility, %	80.3a^{b}	83.1^{a}	80.8a^{b}	67.5^{c}	75.6^{b}	89.0^{a}	2.77	<0.01
DE[7], Mcal / lb DM	1.12^{c}	1.38^{a}	1.20^{bc}	1.34^{a}	1.28^{ab}	1.20^{bc}	0.05	<0.01
TDN, %	56.1^{c}	69.2^{a}	59.9^{bc}	67.2^{a}	64.2^{ab}	60.0^{bc}	2.29	<0.01

^{a,b}Means within a row with differing superscripts are different.

[1] DG: Modified distillers grains plus solubles replacing DRC at 40% diet DM.

[2] FIB: Replacing DRC with 20% diet DM corn bran.

[3]PROT: Replacing DRC with 20% diet DM CGM.

[4]SOL: Replacing DRC with 15% diet DM solubles.

[5]TAL: Replacing DRC with 3% diet DM tallow.

[6]NDF_{om}: neutral detergent fiber corrected for ash.

[7]DE: digestible energy.

Feed samples, feed refusals, and fecal samples were all composited by period and analyzed for DM, OM, NDF, and gross energy. Fecal samples were analyzed for titanium dioxide to determine daily fecal output. Digestibilities were then calculated by the following equation: (nutrient intake– nutrient output) / nutrient intake.

An *in situ* procedure was performed to determine disappearance of fiber from brome and bran within different diets. Dacron bags (Ankom Technology, Fairport, NY) with a 50-µm pore size (5 x 10-cm), were filled with 1.25 g of dried brome ground through a 2-mm screen or bran (not ground) and heat sealed. Two bags per sample were placed in mesh bags in the ventral rumen of each steer on d 14 and two bags per sample were set aside for time point 0 h to calculate wash out. Bags were incubated for 24 h and removed before feeding. All bags were washed and refluxed in NDF solution using the ANKOM Fiber Analyzer (Ankom Technology) to determine NDF disappearance.

All data were analyzed using MIXED procedures of SAS. Steer within period was the experimental unit. The model included period and treatment as independent fixed effects. *In situ* disappearance of NDF from bran or brome was analyzed with steer as the experimental unit. The model included diet, period and type of fiber (bran or brome) as fixed effects.

Results

No differences were observed in DM or OM intake ($P > 0.05$; Table 2). Fiber intake was affected by type of byproduct included in the diet ($P < 0.01$) with the FIB diet having the greatest NDF intake at 13.7 lb / d which did not differ in NDF intake from the DG diet (13.3 lb / d). All other diets had lower NDF intake ($P < 0.05$) but did not differ among one other. Fat intake differed among treatments with the TAL diet having the greatest fat intake at 1.34 lb / d which did not differ from DG diet (1.30 lb / d intake). The CON, FIB, and SOL diets were intermediate with the PROT diet having the lowest fat intake of all treatments ($P \leq 0.01$). Similar intake of NDF between FIB and DG and similar intake of fat between TAL and DG suggested that treatments were successful in matching nutrient intake.

No differences were observed in DM digestibility (DMD), OM digestibility (OMD), and NDF digestibility (NDFD) among treatments ($P > 0.05$; Table 2). Replacement of DRC with tallow resulted in greater fat digestibility (89.0%) compared to CON, FIB, PROT, and SOL ($P < 0.05$). Diets containing MDGS had similar fat digestibility to TAL ($P = 0.12$). Inclusion of MDGS also resulted in similar fat digestibility to CON and FIB ($P < 0.05$) and a tendency to be greater than SOL ($P = 0.06$).

Inclusion of MDGS and CGM resulted in increased DE (1.38 and 1.35 Mcal / lb; respectively) and the DG diet tended to be greater than SOL ($P = 0.10$). The SOL diet did not differ in DE from the FIB and TAL diets which had 1.21 and 1.20 Mcal / lb of DE, respectively. The CON diet had

Table 3. ***In situ*** **disappearance of fiber from different sources (bran vs. brome) in growing steers fed varying diets.**

	CON	DG[1]	FIB[2]	PROT[3]	SOL[4]	TAL[5]	SEM	*P*-value
Bran NDF disappearance[6], %	44.0	51.0	48.0	42.5	47.7	43.8	3.09	0.17
Brome NDF disappearance[6], %	33.6	39.9	34.9	34.2	39.2	33.4	2.20	0.12

[a,b,c]Means within a row with differing superscripts are different.

[1] DG: Modified distillers grains plus solubles replacing DRC at 40% diet DM.

[2] FIB: Replacing DRC with 20% diet DM corn bran.

[3]PROT: Replacing DRC with 20% diet DM CGM.

[4]SOL: Replacing DRC with 15% diet DM solubles.

[5]TAL: Replacing DRC with 3% diet DM tallow.

[6]NDF: Neutral detergent fiber disappearance after 24 h ruminal incubation.

the lowest DE (1.14 Mcal / lb) but did not differ from the FIB and TAL diets (*P* =0.20). Overall the increased DE for DG and PROT resulted in greatest calculated TDN values of 69.2% and 67.2%, respectively, when MDGS or CGM were included in the diet.

No interaction between diet and type of fiber (bran vs. brome) was observed (*P* = 0.83) for *in situ* NDF disappearance. No differences were observed for *in situ* NDF disappearance of bran or brome among diets (*P* ≥ 0.12; Table 3) averaging 46.2% for bran and 35.9% for brome.

Conclusion

The inclusion of byproducts increases TDN compared to DRC potentially due to the added energy density of fat, undegradable protein, and digestible fiber of byproducts. Relative to corn, MDGS has an increased fat content and fat digestibility. Greatest improvements in TDN were observed when feeding CGM and MDGS, suggesting the RUP contribution of MDGS explains the increased feeding value is underappreciated.

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