

The influence of dry-rolled corn particle size and dried corn distillers grains plus solubles inclusion levels on total tract digestibility

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The objectives of this study were to determine the influence of dry-rolled corn particle size and dried distillers grains with solubles (DDGS) inclusion level on total tract digestibility. The results indicate no effects on feed intake or fecal excretion among treatments. Neutral detergent fiber (NDF) and acid detergent fiber (ADF) concentration increased in dietary treatments containing greater proportions of DDGS and lower amounts of corn grain, whereas differences among treatments with alternative particle size were less. These results suggest that the DDGS-to-corn ratio has a greater impact on the nutrient profile of rations than the particle size of corn, and that total tract digestibility was not greatly affected by DDGS inclusion or corn particle size.

Summary

Eight cannulated Holstein steers (1,159 ± 8 pounds) were used in a 4 × 4 Latin square experiment to examine the impact of fine- vs. coarse-rolled corn and 20 vs. 40 percent DDGS inclusion on digestibility. The animals were housed in separate stalls in a temperature-controlled environment at the North Dakota State University Animal Nutrition and Physiology Center. Dietary treatments (Table 1) were offered for ad libitum intake and consisted of 1) coarse-rolled corn with 20 percent DDGS, 2) coarse-rolled corn with 40 percent DDGS, 3) fine-rolled corn with 20 percent DDGS and 4) fine-rolled corn with 40 percent DDGS. Steers were provided experimental diets for a period of 14 days, and daily feed intake and fecal excretion was measured during the final seven days. Intake, excretion and digestibility of dry matter (DM), organic matter (OM), crude protein

(CP), NDF and ADF were measured. Dry-matter and OM intake and DM and OM excretion were not different among treatment groups. Neutral detergent fiber intake and excretion, along with ADF intake and apparent digestibility, were greater ($P \leq 0.03$) in the diets containing 40 percent DDGS.

Introduction

Dried corn distillers grains plus solubles (DDGS) provide a valuable feed source for ruminants. In addition to being an economical supplement, DDGS provides approximately 10 percent more energy than corn (Klopfenstein et al., 2008). In addition, DDGS supplies approximately 30 percent protein, 5 to 10 percent fat and 1 percent phosphorus (Jacob et al., 2010). Feeding DDGS often results in improved feed efficiency in finishing cattle (Swanson et al., 2014).

While DDGS offers a desirable nutrient profile, careful consideration must be taken when formulat-

ing rations because other feedstuffs will contain these nutrients as well. Excess nitrogen and phosphorus from such rations results in wasted nutrients and increased excretion, leading to environmental concerns. With this in mind, developing feeding strategies is important to determine the optimum DDGS inclusion rates and corn processing method to obtain the greatest benefit from each ration.

Corn distillers grains commonly are mixed with cattle rations in ranges from 10 to 50 percent (DM basis), depending on the goal of supplementation. When used as a protein source, 10 to 15 percent inclusion usually is the most desirable, while an addition of 20 to 30 percent is more common when used for energy, with approximately 40 to 50 percent generally the upper limit (Klopfenstein et al., 2008). The available information on particle size reduction of rolled corn is limited, but Loe et al. (2006) reported an increase in intake when offering finely vs. coarsely rolled corn.

Again, attention must be given to diet formulation when implementing various processed corn to avoid issues with ruminal acidosis and reduced intake while maintaining or improving feed efficiency. Still, combining these feedstuffs has the potential to optimize performance for livestock producers.

Experimental Procedures

All procedures involving animals were approved by the NDSU Animal Care and Use Committee. Eight cannulated Holstein steers (1,159 ± 8 pounds) were used in a 4 ×

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4 Latin square-designed experiment to examine the impact of dry-rolled corn processing and DDGS inclusion rate on total tract digestibility. Steers were housed in individual stalls in a temperature-controlled environment at the North Dakota State University Animal Nutrition and Physiology Center.

Dietary treatments (Table 1) were offered to ensure ad libitum intake and approximately 6 percent feed refusal daily. Treatments consisted of 1) coarse-rolled (2.5 millimeters) and 20 percent DDGS, 2) coarse-rolled corn and 40 percent DDGS, 3) fine-rolled corn (1.7 millimeters) and 20 percent DDGS and 4) fine-rolled corn and 40 percent DDGS.

Diets were formulated to meet or exceed recommendations for degradable intake protein (DIP), metabolizable protein (MP), vitamins and minerals (National Research Council, 1996). Before the initiation of the experiment, steers were adapted to a high-grain diet during a period of 21 days. A preliminary period of seven days on the animal's respective treatment preceded seven days of sample collection for each period. This then was followed by a three-day rest period in which steers were offered an intermediate diet to allow all animals to return to a basal level.

Daily feed consumption was recorded. Animals were fitted with fecal bags to accurately collect total fecal excretion. Daily samples were composited for each collection period. At the end of the treatment periods, feed and fecal samples were dried in a forced-air oven and ground through a 0.079-inch screen using a Wiley mill for laboratory testing. Proximate analysis was determined by AOAC (1990) procedures.

Results and Discussion

Corn and distillers grains commonly are used in finishing rations because of cost and success in improving feed conversions. Because of this, researchers often are testing new approaches to optimize corn-processing methods and DDGS inclusion rates to generate the most effective ration.

The amount of DMI consumed in this study was not different among treatment groups. The amount of feces excreted also was not different. Crude protein concentration, in feed or feces, was not different among dietary treatment groups. Neutral detergent fiber intake and excretion was greater

($P \leq 0.03$) when diets contained 40 percent DDGS. Acid detergent fiber intake and apparent digestibility (expressed as pounds/day and as a percentage) also was greater ($P \leq 0.03$) when diets with greater amounts of distillers grains were fed.

The starch from corn grain is removed during ethanol production and these diets contained less rolled corn than that included in the 20 percent DDGS treatments. Diets containing less starch typically have higher levels of NDF and ADF because 50 to 75 percent of the DM in cereal grains is composed of structural carbohydrates such as cellulose and hemicellulose (Fir-

Table 1. Dietary composition and analyzed nutrient concentration of diets (DM basis).

Dietary component, % of DM	Coarse-rolled corn		Fine-rolled corn	
	20% DDGS	40% DDGS	20% DDGS	40% DDGS
Coarse-rolled corn	65.0	45.0	-	-
Fine-rolled corn	-	-	65.0	45.0
Dried corn distillers grains with solubles	20.0	40.0	20.0	40.0
Grass-legume hay	5.0	5.0	5.0	5.0
Corn silage	5.0	5.0	5.0	5.0
Limestone	1.56	1.90	1.56	1.90
Urea	0.85	-	0.85	-
Salt	0.20	0.20	0.20	0.20
Vitamin premix	0.01	0.01	0.01	0.01
Trace mineral premix	0.05	0.05	0.05	0.05
Rumensin/Tylan premix	0.03	0.03	0.03	0.03
Fine-ground corn	2.05	2.56	2.05	2.56
Chromium oxide	0.25	0.25	0.25	0.25
Feed Analysis				
Dry matter, % of as fed	82.2	82.9	82.4	83.6
Organic matter, % of DM	94.9	93.7	95.1	93.8
Crude protein, % of DM	16.3	17.9	15.9	17.4
Neutral detergent fiber, % of DM	27.1	30.2	24.5	30.5
Acid detergent fiber, % of DM	9.02	11.1	8.47	11.0
Fat, % of DM	4.45	4.92	3.77	4.86
Calcium, % of DM	0.794	0.929	0.757	1.00
Phosphorus, % of DM	0.408	0.537	0.409	0.538

kins et al., 2001). These components typically are digested to a lesser extent than other components (Table 2), although that was not observed in the current experiment with the NDF and ADF source coming from DDGS.

Overall, the impact of using fine- vs. coarse-rolled corn and 20 vs. 40 percent inclusion of distillers grains did not result in any large differences in nutrient digestibility. Site of digestion and the dietary influences on ruminal pH and fermentation, which also could impact growth performance, may vary. This data is being analyzed.

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Table 2. Influence of dry-rolled corn processing and distillers grains on dry matter, organic matter, nitrogen, neutral detergent fiber and apparent digestibility in steers fed high-concentrate diets.

	Coarse-rolled corn		Fine-rolled corn		SEM	P-Values		
	20% DDGS	40% DDGS	20% DDGS	40% DDGS		Corn	Distillers	Corn* Distillers
Feed intake, lb/d								
DM	26.8	27.1	27.6	27.9	1.13	0.48	0.78	0.99
OM	25.5	25.5	26.3	26.2	1.04	0.47	0.97	0.97
CP	4.33	4.76	4.39	4.84	0.043	0.79	0.11	0.99
NDF	7.21	8.04	6.73	8.44	0.568	0.94	0.03	0.45
ADF	2.42	3.02	2.30	3.08	0.246	0.90	0.009	0.74
Fecal excretion, lb/d								
DM	5.77	6.39	6.05	6.40	0.404	0.72	0.24	0.75
OM	5.21	5.71	5.43	5.66	0.360	0.81	0.32	0.72
CP	1.01	1.13	1.03	1.13	0.014	0.89	0.21	0.97
NDF	2.55	2.99	2.71	3.09	0.170	0.45	0.02	0.85
ADF	1.07	1.20	1.14	1.23	0.069	0.49	0.12	0.80
Apparent digestibility, lb/d								
DM	21.0	20.7	21.5	21.5	0.90	0.47	0.87	0.88
OM	20.3	19.8	20.9	20.6	0.84	0.43	0.63	0.92
CP	3.31	3.64	3.36	3.71	0.036	0.79	0.15	0.97
NDF	4.65	5.05	4.01	5.35	0.462	0.71	0.07	0.32
ADF	1.35	1.83	1.17	1.85	0.203	0.70	0.008	0.63
Apparent digestibility, %								
DM	78.4	76.4	78.1	77.3	1.08	0.80	0.22	0.60
OM	79.5	77.6	79.4	78.6	1.04	0.68	0.21	0.60
CP	76.5	76.2	76.6	76.7	1.40	0.83	0.96	0.90
NDF	64.4	61.9	59.0	62.4	2.097	0.25	0.83	0.17
ADF	54.4	58.9	49.9	58.8	2.90	0.42	0.03	0.44