Effect of grain type and dried distillers grain with solubles oil concentration on site of digestion

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The objective of this experiment was to determine the effects of grain type (corn vs. barley) and oil concentration of dried distillers grains plus solubles (DDGS; moderate = 7.9 percent vs. low = 4.5 percent ether extract) on site of digestion. Our data indicate that including a lower-fat DDGS, as compared with a moderate-fat DDGS, in a finishing diet may not have an influence on site of digestion of nonlipid nutrients in finishing cattle.

Summary

Eight Holstein steers (1,579 ± 137 pounds) were used in a 4 x 4 Latin Square design consisting of four periods and four dietary treatments, with two steers assigned per treatment per period to determine the impact of grain type (corn vs. barley) and DDGS oil concentration (DDGS; moderate = 7.9 percent vs. low = 4.5 percent) on intake and total-tract digestibility. Apparent ruminal dry-matter and intestinal digestibility as a percentage of intake decreased ($P \leq 0.03$) in steers fed corn-based diets. We found no difference in total-tract dry-matter digestibility between grain types. No effects on dry-matter intake or digestibility were observed between steers fed low- and moderate-oil concentrations of DDGS. Starch intake was greater ($P = 0.01$) in steers fed corn-based diets, and total-tract starch digestibility was greater ($P = 0.01$) in steers fed barley-based diets. We found no effects on intake or digestibility of starch between low- and moderate-oil concentrations of DDGS. Intake of total lipids increased ($P < 0.001$) in steers fed corn diets as well as in steers fed diets with moderate oil of DDGS. Apparent ruminal lipid digestibility increased ($P = 0.02$) in steers fed moderate-oil DDGS, while intestinal lipid digestibility as a percent of intake was increased ($P = 0.04$) in steers fed low-oil DDGS. No differences were found in lipid apparent ruminal digestibility or lipid intestinal digestibility between grain types. Total-tract lipid digestibility was increased ($P < 0.001$) in steers fed moderate-oil DDGS. In summary, utilizing barley, as compared with corn, in finishing diets increases total-tract starch digestion, and decreasing the oil concentration of DDGS had no effect on site of digestion or total-tract digestibility of dry matter, crude protein and starch of the diets, although lipid digestibility was greater in steers fed moderate-fat DDGS. Therefore, utilizing low-oil DDGS in finishing diets may not affect digestibility of nonlipid nutrients in finishing cattle.

Introduction

Feed costs represent the largest expense in beef production. Grain type, specifically feeding barley vs. corn, can result in differences in digestibility and performance (Gozho and Mutsvangwa, 2008). Corn dried distiller grains plus solubles (DDGS) is a valuable feed product utilized in finishing diets (Klopfenstein et al., 2008) and may influence growth performance differently, depending on grain source and processing.

The beef cattle National Research Council (NRC, 1996) reports DDGS having 11 percent ether extract on a dry-matter basis. This concentration has changed, however, as the ethanol industry has evolved and extracts more oil from the corn, resulting in DDGS with a lower oil content of approximately 4 to 5 percent. This raises the question of what happens to the digestibility of this low-oil DDGS product.

We hypothesized that grain type and DDGS oil concentration would have an effect on site of digestion. Our objectives were to determine the effect of grain type and DDGS oil concentration on ruminal, intestinal and total-tract digestibility.

Experimental Procedures

All animal care and handling procedures were approved by the NDSU Animal Care and Use Committee. Eight Holstein steers (1,579 ± 137 pounds) were used in a 4 x 4 Latin Square design consisting of four periods and four dietary treatments, with two steers assigned per treatment per period to determine the impact of grain type (corn vs. barley) and DDGS oil concentration (DDGS; moderate = 7.9 percent vs. low = 4.5 percent; Tables 1 and 2) on intake and total tract digestibility.

Steers were housed in individual tie stalls in a temperature-controlled environment at the North Dakota State University Animal

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Nutrition and Physiology Center. Dietary treatments were offered to ensure ad libitum intake and 6 percent feed refusal daily. Treatments were 1) corn with moderate-fat DDGS, 2) corn with low-fat DDGS, 3) barley with moderate-fat DDGS and 4) barley with low-fat DDGS.

Steers were adapted from a high-forage diet to a high-concentrate diet during a 21-day period. Then steers were adapted to their respective treatments during a seven-day period followed by a seven-day sample (feed, feed refusals, feces, and duodenal and ileal digesta) collection period. Finally, a 10-day transition period occurred in which steers were transitioned to their next treatment diet.

Data were analyzed as a replicated 4 x 4 Latin Square, with a 2 x 2 factorial arrangement of treatments using generalized least square means mixed procedure in SAS. A *P*-value of less than or equal to 0.05 was considered a significant difference, while a *P*-value of greater than 0.05 but less than 0.10 was considered a tendency.

Table 1. Dietary composition.

	Corn		Barley	
Dietary Component, % of dry matter	**Low-fat DDGS**	**Moderate-fat DDGS**	**Low-fat DDGS**	**Moderate-fat DDGS**
Rolled corn	50	50	–	–
Rolled barley	–	–	50	50
DDGS	25	25	25	25
Corn silage	20	20	20	20
Limestone	2	2	2	2
Urea	0.15	0.15	–	–
Salt	0.05	0.05	0.05	0.05
Vitamin premix[1]	0.01	0.01	0.01	0.01
Mineral premix[2]	0.05	0.05	0.05	0.05
Rumensin[3]	0.02	0.02	0.02	0.02
Tylan[4]	0.01	0.01	0.01	0.01
Fine-ground corn	2.46	2.46	2.61	2.61
Chromium oxide	0.25	0.25	0.25	0.25

[1]Contained 48,510 kilo International Units per kilogram (kIIU/kg) vitamin A and 4,630.5 kIU/kg vitamin D.
[2]Contained 3.62 percent calcium, 2.56 percent copper,16 percent zinc, 6.5 percent iron, 4 percent manganese, 1.050 milligrams per kilogram (mg/kg) iodine and 250 mg/kg cobalt.
[3]Contained 176.4 grams (g) monensin/kg premix.
[4]Contained 88.2 g tylosin/kg premix.

Table 2. Analyzed nutrient concentration of diets.

	Rolled Corn		Rolled Barley	
Dietary Component, % of dry matter	**Low-fat DDGS**	**Moderate-fat DDGS**	**Low-fat DDGS**	**Moderate-fat DDGS**
Crude protein	13.7	14.0	14.8	14.8
Neutral detergent fiber	29.8	31.8	32.6	34.7
Acid detergent fiber	11.9	12.5	13.3	14.1
Ether extract	3.49	4.18	2.40	3.11
Calcium	1.09	1.16	1.15	1.07
Phosphorus	0.46	0.46	0.50	0.48
Starch	43.6	42.1	37.1	37.5

Results and Discussion

We found no differences in dry-matter intake between grain types (Table 3). Apparent ruminal dry-matter digestibility decreased ($P = 0.02$) in steers fed corn-based diets. Intestinal dry-matter digestibility as a percent of intake decreased ($P < 0.03$) in steers fed barley-based diets.

We observed no difference in total-tract dry-matter digestibility between grain types. No effects on dry-matter intake or digestibility were observed between steers fed low- or moderate-oil concentrations of DDGS. We also found no differences in crude protein intake between grain types.

We observed a tendency for apparent ruminal crude protein digestibility (percent of intake) to decrease ($P = 0.06$) in steers fed corn-based diets. We found a tendency ($P = 0.09$) for intestinal crude protein digestibility as a percent of intake to decrease in steers fed barley-based diets.

No differences were found in total-tract crude protein digestibility between grain types. No effects were found on crude protein intake or digestibility between steers fed low- or moderate-oil concentrations of DDGS.

Starch intake was greater ($P = 0.01$) in steers fed corn-based diets than in steers fed barley-based diets. Apparent ruminal starch digestibility and intestinal digestibility as a percent of intake did not differ between grain types. Total-tract starch digestibility decreased ($P = 0.01$) in corn-based diets.

We found no effects on intake or digestibility of starch between low- and moderate-oil concentrations of DDGS. Intake of total lipids increased ($P < 0.001$) in steers fed

Table 3. Effects of grain source and oil level of dried distillers grains plus solubles on nutrient intake and site of digestion.

	Treatment							
	Rolled Corn		Rolled Barley					
Items	Low-fat DDGS	Mod-fat DDGS	Low-fat DDGS	Mod-Fat DDGS	*P*-value SEM	Grain	DDGS	Grain*DDGS
Intake, lb.								
Dry matter	33.3	31.5	32.4	32.6	1.34	0.99	0.46	0.37
Crude protein	4.94	4.83	4.87	4.85	0.218	0.89	0.64	0.76
Starch	17.9	16.1	14.9	15.0	0.767	0.01	0.28	0.21
Lipid	1.35	1.69	0.96	1.47	0.050	<0.001	<0.001	0.03
Digestiblity, % of intake								
Apparent ruminal								
Dry matter	46.2	43.1	51.7	53.7	3.22	0.02	0.85	0.37
Crude protein	-18.6	-19.4	-1.15	-7.2	9.32	0.06	0.60	0.67
Starch	88.3	93.3	90.9	91.8	1.8	0.78	0.11	0.26
Lipid	-58.8	-45.3	-75.1	-22.5	14.24	0.82	0.02	0.13
Intestinal								
Dry matter	33.2	35.6	26.7	25.8	3.16	0.01	0.78	0.53
Crude protein	96.6	96.8	80	87.4	9.32	0.09	0.55	0.55
Starch	7.99	3.21	7.58	7.01	1.803	0.36	0.14	0.24
Lipid	140	130	152	107	13.7	0.68	0.04	0.15
Total Tract								
Dry matter	79.5	78.7	78.6	79.1	0.94	0.78	0.86	0.45
Crude protein	78.7	77.6	78.8	79.8	1.08	0.3	0.94	0.33
Starch	96.6	96.9	98.3	98.8	0.7	0.01	0.49	0.93
Lipid	81.1	85.5	77.5	84.4	1.32	0.07	<0.001	0.25

[a]Standard error of the mean (n = 8).

corn diets as well as in steers fed diets with moderate oil of DDGS. Apparent ruminal lipid digestibility increased ($P = 0.02$) in steers fed moderate oil DDGS, while intestinal lipid digestibility as a percent of intake was increased ($P = 0.04$) in steers fed low-oil DDGS.

No differences were found in lipid apparent ruminal digestibility or lipid intestinal digestibility between grain types. Total-tract lipid digestibility was increased ($P < 0.001$) in steers fed moderate-oil DDGS and tended ($P = 0.07$) to increase in steers fed corn-based diets.

Little is known about how the oil concentrations of DDGS affect the site of digestion in finishing cattle. Jolly-Breithaupt et al. (2015) reported a decrease in total-tract digestibility of fat in de-oiled condensed distillers solubles vs. normal condensed distillers solubles, similar to what we observed in our study.

This might indicate that the animal utilizes more of the lipid from the moderate-oil DDGS than the low-oil DDGS, which supports the theory that the lipids in the lower-oil-concentration products may not be as digestible. This theory needs to be studied further to know the full effects and implications that can be associated with feeding ethanol coproducts with lower-oil concentrations.

In conclusion, utilizing barley, as compared with corn, in finishing diets increases total tract starch digestion, which may increase the amount of volatile fatty acids and glucose available to the animal and potentially provide more energy to the animal, resulting in improved growth performance.

Also, decreasing the oil concentration of DDGS had no effect on the site of digestion or total-tract digestibility of dry matter, crude protein or starch of the diets. Therefore, utilizing low-oil DDGS in finishing diets may not affect digestibility of nonlipid nutrients in finishing cattle.

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