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Abstract

In previous experiments, we observed that the nutritional value of dried distiller's grains is less when added to finishing diets made of steam-flaked corn than when added to diets of dry-rolled corn. We hypothesized that effects of grain processing on value of distiller's grains are attributable to differences in the digestion characteristics of grains processed via flaking or dry rolling. In this study, our objective was to evaluate differences in ruminal metabolism and total tract digestion of diets made from dry-rolled or steam-flaked corn with and without dried distiller's grains.

Keywords

Cattlemen's Day, 2008; Kansas Agricultural Experiment Station contribution; no. 08-212-S; Report of progress (Kansas State University. Agricultural Experiment Station and Cooperative Extension Service); 995; Beef; Cattle; Dry-rolling; Steam-flaked

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DIGESTIBILITY OF DRIED DISTILLER'S GRAINS WITH SOLUBLES IN STEAM-FLAKED OR DRY-ROLLED CORN DIETS

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Introduction

In previous experiments, we observed that the nutritional value of dried distiller's grains is less when added to finishing diets made of steam-flaked corn than when added to diets of dry-rolled corn. We hypothesized that effects of grain processing on value of distiller's grains are attributable to differences in the digestion characteristics of grains processed via flaking or dry rolling. In this study, our objective was to evaluate differences in ruminal metabolism and total tract digestion of diets made from dry-rolled or steam-flaked corn with and without dried distiller's grains.

Procedures

Holstein steers (n = 16; 773 lbs) were used in a metabolism study. Two 15-day experimental periods were used, each consisting of a 12-day diet adaptation phase and a 3-day sample collection phase. Cattle were fed in individual pens with free access to diets. Treatments were: steam-flaked corn with 0% dried distiller's grains with solubles (DDGS), steam-flaked corn with 25% DDGS, dry-rolled corn with 0% DDGS, and dry-rolled corn with 25% DDGS (Table 1). Diets were formulated to contain similar fat content. Steers were dosed daily with 10 mg of chromic oxide via the ruminal cannula, which was used as an indigestible marker to estimate total fecal output. Collection times for feces and ruminal digesta were at hours 0, 6, 12, and 18 post feeding on day 1; hours 2, 8, 14, and 20 on day 2; and hours 4, 10, 16, and 22 on day 3. Ruminal pH was measured immediately after retrieving samples from the rumen. Concentrations of ruminal ammonia and volatile fatty acids also were determined from the digesta samples. Additionally, apparent total tract digestibilities were determined for dry matter, organic matter, neutral detergent fiber, starch, and fat (ether extract).

Results and Discussion

Steers fed dry-rolled corn consumed more dry matter, organic matter, and neutral detergent fiber than those fed steam-flaked corn. Steers fed dry-rolled corn also excreted more dry matter, organic matter, starch, neutral detergent fiber (NDF) and ether extract than those fed steam-flaked corn. Apparent total tract digestibilities of dry matter, organic matter, starch, NDF, and ether extract all were greater when cattle were fed flaked grain diets than when they were fed rolled grain diets.

Ruminal ammonia concentrations were higher for cattle fed dry-rolled corn than for cattle fed steam-flaked corn. This likely reflects the increased demand for ruminally available protein when grains are flaked and decreased protein availability due to the effects of hydrothermal processing of flaked corn. Acetate, acetate:propionate ratio, butyrate, isobutyrate, isovalerate 2-methyl, and 3-mthyl isovalerate concentrations were greater for dry-rolled corn ($P<0.05$), but total volatile fatty acids (VFA) concentrations were not affected by grain processing. Propionate, lactate, and valerate concentrations were greater in cattle fed steam-flaked corn diets. Changes in ruminal pH were generally more

dramatic for cattle fed flaked grain rations compared with those fed dry-rolled rations. Prior to feed, ruminal pH actually was higher for cattle fed flaked grain, but pH dropped quickly after feeding, which reflects the high fermentability of flaked grains compared with dry-rolled grains.

Adding 25% DDGS to the diet decreased intake of starch and ether extract, but increased NDF intake. Actual fat content of DDGS was lower than projected, which led to a slight reduction in fat intake with diets containing DDGS. Apparent total tract digestibility of ether extract was decreased by feeding 25% DDGS vs. 0% DDGS. Digestibilities of dry matter and organic matter digestion tended to be lower when DDGS were included in the diet, but these differences were not influenced by the type of grain fed.

Feeding DDGS had no noticeable effect on concentrations of VFA. Ruminal lactate concentrations were increased with DDGS, and the increase tended to be greater when DDGS were added to flaked diets than when added to dry-rolled diets. In spite of the significant increases in lactate, the absolute amounts were relatively low (less than 5 mM).

Ruminal ammonia concentrations decreased substantially when cattle were fed diets containing 25% DDGS. This change is a direct consequence of replacing degradable forms of nitrogen, such as soybean meal and urea, with DDGS, which are less ruminally degraded. The low levels of ruminal ammonia that result from feeding DDGS, especially when fed in combination with flaked grain, might limit digestion of these diets.

Implications:

Ruminal ammonia could be a limiting factor in diets containing dried distiller's grains, especially when steam-flaked corn is the grain source. Decreases in ruminal pH at critical times when feeding dried distiller's grains might also contribute to decreases in animal performance by altering digestibility.

Table 1. Composition of Diets (dry matter basis) Fed to Cannulated Holstein Steers. Diets Contained Either Steam-flaked or Dry-rolled Corn and 0 or 25% Dried Distillers's Grains with Solubles (DDGS)

	Dry-rolled corn		Steam-flaked corn	
Item, % of dry matter	0% DDGS	25% DDGS	0% DDGS	25% DDGS
Steam-flaked corn	-	-	73.85	56.44
Dry-rolled corn	73.82	56.40	-	-
Corn silage	13.84	13.84	13.82	13.83
DDGS	-	25.24	-	25.21
Vegetable oil	2.18	-	2.18	-
Soybean meal	4.45	-	4.45	-
Urea	1.17	0.14	1.19	0.14
Limestone	1.62	1.65	1.62	1.65
Mineral/vitamin premix[1]	0.69	0.53	0.69	0.53
Feed additive premix[2]	2.19	2.20	2.19	2.20
Nutrients				
Ether extract	5.80	5.24	5.81	5.24
Starch	54.82	37.53	55.07	43.74
NDF	13.13	17.52	13.63	17.58
Organic matter	97.37	97.50	97.35	97.41
Crude Protein	15.48	15.35	15.00	14.99
Calcium	0.71	0.64	0.71	0.64
Phosphorus	0.30	0.46	0.30	0.46

[1]Mineral/vitamin premix formulated to provide (dry basis) 1200 IU/lb vitamin A, 0.15 ppm cobalt, 10 ppm copper, 0.5 mg iodine, 60 ppm manganese, 60 ppm zinc, and 0.25 ppm selenium.
[2]Premix provided 300 mg Rumensin and 90 mg Tylan per day in a ground corn carrier.

Table 2. Digestion Characteristics for Cannulated Holstein Steers Fed Diets Containing Steam-flaked or Dry-rolled Corn and 0 or 25% Corn Dried Distiller's Grains with Solubles (DDGS)

	Dry-rolled corn		Steam-flaked corn			P-Values		
Item	0% DDGS	25% DDGS	0% DDGS	25% DDGS	SEM	Grain	DDGS	Grain × DDGS
Intake, lb/day								
Dry matter	19.41	19.03	17.40	16.21	0.73	<0.01	0.10	0.40
Organic matter	18.90	18.57	16.94	15.79	0.70	<0.01	0.10	0.39
Starch	10.62	7.14	9.63	8.68	0.42	0.40	<0.01	<0.01
NDF	2.56	3.33	2.38	2.84	0.11	<0.01	<0.01	0.08
Ether extract	1.12	0.99	1.01	0.86	0.04	<0.01	<0.01	0.55
Fecal excretion, lb/day								
Dry matter	4.14	4.38	2.60	2.82	0.37	<0.01	0.34	0.99
Organic matter	3.88	4.05	2.25	2.53	0.35	<0.01	0.30	0.82
Starch	1.21	0.90	0.13	0.09	0.15	<0.01	0.17	0.35
NDF	2.11	2.44	1.28	1.54	0.22	<0.01	0.06	0.90
Ether extract	0.086	0.117	0.066	0.073	0.011	<0.01	0.03	0.12
Apparent total tract digestibility, %								
Dry matter	78.84	77.71	85.30	82.88	1.49	<0.01	0.11	0.56
Organic matter	79.80	78.88	86.88	84.20	1.44	<0.01	0.10	0.43
Starch	89.00	88.27	98.53	99.06	1.57	<0.01	0.94	0.65
NDF	17.09	29.14	47.10	46.42	6.28	<0.01	0.22	0.20
Ether extract	92.27	88.44	93.58	91.60	0.82	<0.01	<0.01	0.20

Table 3. Ruminal VFA Concentrations of Cannulated Holstein Steers Fed Diets Containing Steam-flaked or Dry-rolled Corn with 0 or 25% Dried Distiller's Grains with Solubles (DDGS)

	Dry-rolled corn		Steam-flaked corn			P-Values		
Item, Mm	0% DDGS	25% DDGS	0% DDGS	25% DDGS	SEM	Grain	DDG	Grain × DDGS
Acetate	50.55	47.39	41.07	40.89	1.81	<0.01	0.22	0.29
Propionate	29.03	23.76	35.02	35.28	2.87	<0.01	0.31	0.29
Acetate:propionate ratio	2.03	2.06	1.25	1.32	0.21	<0.01	0.79	0.92
Butyrate	11.57	11.18	8.19	8.00	0.98	<0.01	0.73	0.90
Lactate	0.22	0.36	0.74	1.54	0.20	<0.01	0.01	0.07
Valerate	2.20	1.59	2.76	3.01	0.64	0.07	0.68	0.36
Isobutyrate	0.78	0.76	0.52	0.59	0.05	<0.01	0.59	0.37
Isovalerate 2-methyl	2.53	1.90	1.30	0.99	0.48	0.03	0.28	0.70
Isovalerate 3-methyl	0.67	0.66	0.39	0.50	0.07	<0.01	0.39	0.37
Total VFA production	97.20	87.13	89.04	89.70	4.74	0.45	0.15	0.13

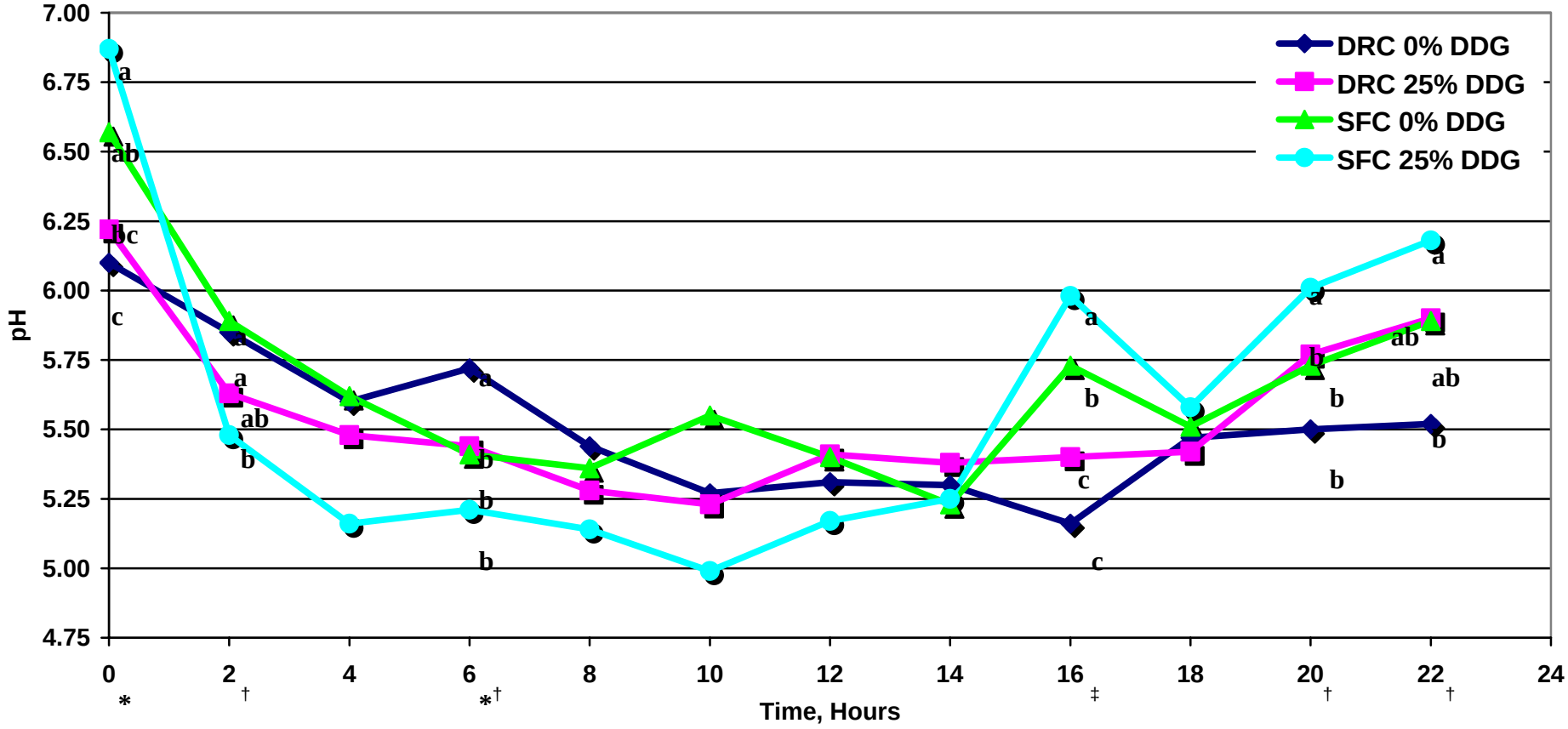

Figure 1. Ruminal pH of Cannulated Holstein Steers Fed Steam-flaked or Dry-rolled Corn Diets Containing 0 or 25% Dried Distiller's Grains with Solubles (DDGS).

[abc]Means within hour without a common superscript letter differ (P<0.05).
*Effect of grain processing method (P<0.05).
†Effect of DDGS (P<0.05).
‡Interaction between grain processing method and level of DDGS (P<0.05).

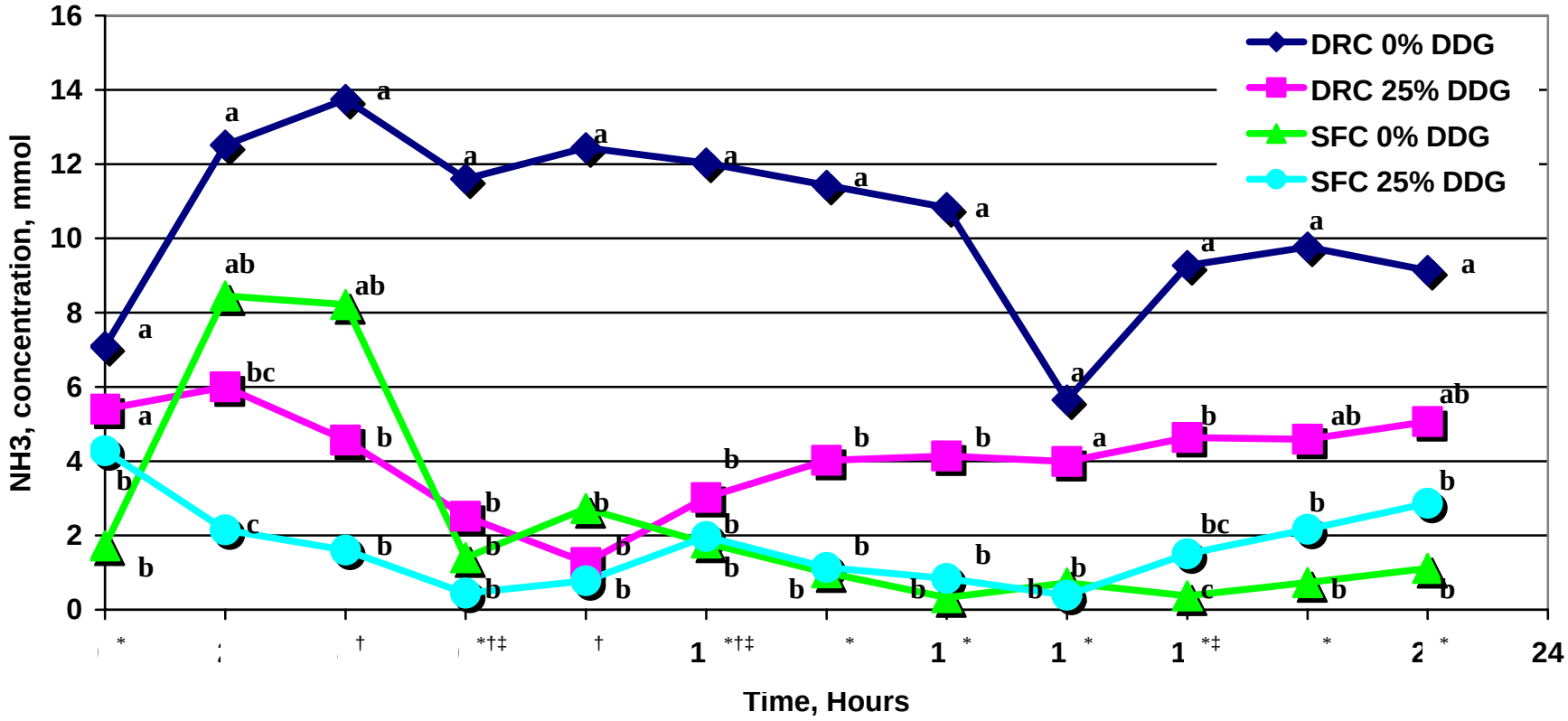

Figure 2. Ruminal Ammonia Concentrations of Cannulated Holstein Steers Fed Steam-flaked or Dry-rolled Corn Diets Containing 0 or 25% Dried Distiller's Grains with Solubles (DDGS).

[abc]Means within hour without a common superscript letter differ (P<0.05).
*Effect of grain processing method (P<0.05).
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‡Interaction between grain processing method and level of DDGS (P<0.05).