SUBSTITUTING STEAM-FLAKED CORN WITH DISTILLER'S GRAINS ALTERS RUMINAL FERMENTATION AND DIET DIGESTIBILITY

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Introduction

Rapid expansion of fuel ethanol production in the High Plains, where feedlots commonly use steam-flaked corn diets, has popularized substituting dried distiller's grains with solubles (DDGS) for a portion of the steam-flaked corn. Most of the starch in corn is removed during ethanol production. The residual material is rich in fiber, ruminal undegradable protein, and fat. Adding roughage to high-concentrate finishing diets helps maintain ruminal function by stimulating salivation, rumination, and gut motility. The source and level of roughage can influence dry matter intake. Our objective was to examine ruminal fermentation characteristics and diet digestibility when steam-flaked corn-based finishing diets were fed with either 0 or 25% DDGS, using alfalfa hay or corn silage as roughage sources.

Experimental Procedures

Cannulated Holstein steers (n = 12) were used in a finishing study. Four dietary treatments based on steam-flaked corn were used: 0% DDGS with 6% alfalfa hay, 0% DDGS with 10% corn silage, 25% DDGS with 6% alfalfa hay, or 25% DDGS with 10% corn silage (dry matter basis). Steers were randomly assigned to each experimental diet. Diets were fed free choice and formulated to contain similar amounts of crude protein (Table 1). Weights of fresh feed provided and feed removed were recorded. Steers were housed in individual slatted floor pens measuring 49 ft^2. Pens were equipped with individual feed bunks and water fountains that allowed continual access to clean water. The study was conducted during two periods, each consisting of a 17-day adaptation phase and 3-day collection phase. Three animals were assigned to each diet in each period. Ruminal digesta samples were collected at 2-hour intervals after feeding during the collection phase and used to determine ruminal pH and ruminal concentrations of ammonia, volatile fatty acids, and lactate. Fecal samples were collected at each sampling point, composited per animal and period, and used to determine total fecal output and total tract digestibility of dry matter, organic matter, neutral detergent fiber (NDF), crude protein, starch, and fat. One animal became ill during the experiment and was removed from all analyses.

Results and Discussion

Ruminal pH for all dietary treatments was below 5.8 for more than half of the 24-hour measurement period. Cattle fed 25% DDGS had consistently lower ruminal pH throughout the 24-hour period when alfalfa hay was fed, but they had the highest pH when corn silage was used as a roughage source from 12 to 22

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hours after feeding. We hypothesized that feeding DDGS in steam-flaked corn-based diets would decrease fiber digestion due to low ruminal pH. Surprisingly, neutral degerent fiber digestibility was similar for cattle fed diets with and without DDGS (Table 2). However, feeding 25% DDGS resulted in 6.1% lower organic dry matter digestion compared with feeding no DDGS. This decrease seems attributable to a depression in digestibilities of starch and crude protein when DDGS replaces a portion of the steam-flaked corn. Additionally, ruminal ammonia concentrations were drastically lower in steers fed diets containing 25% DDGS than in those fed 0% DDGS for the majority of time. It is conceivable that replacing a portion of steam-flaked corn with DDGS limits nitrogen availability, which could reduce digestibility due to inadequate rumen microbial growth. Also, it is possible that low ruminal pH can depress activity of protein-degrading bacteria. Total volatile fatty acid concentration was lowest when 25% DDGS was fed using corn silage as roughage but was not affected by DDGS level when alfalfa hay was fed. When DDGS is added to steam-flaked corn diets, ruminal availability of protein might be a limiting factor for bacteria growth and subsequent fermentation.

Implications

Feeding DDGS at moderate levels in steam-flaked corn-based diets might require additional degradable intake protein supplementation to ensure adequate available nitrogen for bacterial growth and subsequent digestion of dietary organic matter.

Table 1. Composition of Finishing Diets Based on Steam-flaked Corn Containing Alfalfa Hay or Corn Silage With or Without DDGS

	Alfalfa Hay		Corn Silage	
Item	0% DDGS	25% DDGS	0% DDGS	25% DDGS
Ingredients, (% dry matter)				
Steam flaked corn	82.7	59.7	76.8	54.7
Dried distiller's grains with solubles	-	24.3	-	24.0
Alfalfa hay	5.6	5.6	-	-
Steep liquor	6.0	6.1	6.0	6.0
Corn silage	-	-	11.0	11.0
Supplement[1]	5.6	4.2	6.4	4.3
Analyzed Composition (%)				
Dry matter	80.0	81.2	70.1	70.5
Crude protein	15.9	16.4	14.2	15.9
Fat	3.1	4.8	2.9	5.1
Fiber	10.8	16.8	11.6	17.7
Calcium	0.7	0.7	0.7	0.7
Phosphorus	0.3	0.5	0.3	0.5
Potassium	0.7	0.7	0.7	0.7

[1]Formulated to provide 300 mg/day monensin, 90 mg/day tylosin, 1000 IU/lb vitamin A, 10 ppm copper, 60 ppm zinc, 60 ppm, manganese, 0.5 ppm iodine, 0.25 ppm selenium, and 0.15 cobalt.

Table 2: Digestion by Cannulated Holstein Steers Fed Steam-flaked Corn-based Diets Containing 0% or 25% DDGS with Alfalfa Hay or Corn Silage

	Alfalfa hay		Corn silage			P values		
Item	0% DDGS	25% DDGS	0% DDGS	25% DDGS	SEM[1]	Roughage source	DDGS level	Roughage source × DDGS level
Number of observations	5	5	6	6				
Digestibility,%								
Dry matter	83.6[ac]	76.9[b]	81.3[bc]	76.1[bd]	1.40	0.33	<0.01	0.64
Organic matter	84.9[ac]	78.5[b]	83.2[bc]	77.5[bd]	1.52	0.40	0.01	0.83
Starch	98.7[ac]	97.6[a]	98.1[ac]	96.8[bc]	0.30	0.07	0.01	0.73
NDF	39.8	37.8	30.5	32.8	6.71	0.31	0.98	0.74
Crude protein	79.8[ac]	72.6[ac]	74.0[c]	69.8[ac]	1.88	0.07	0.02	0.48
Fat	84.7	86.8	84.4	87.2	1.33	0.97	0.10	0.79

[1]When observations are missing, larger SEM is presented.
[abcd]Means within a row without a common superscript letter differ (P<0.05).

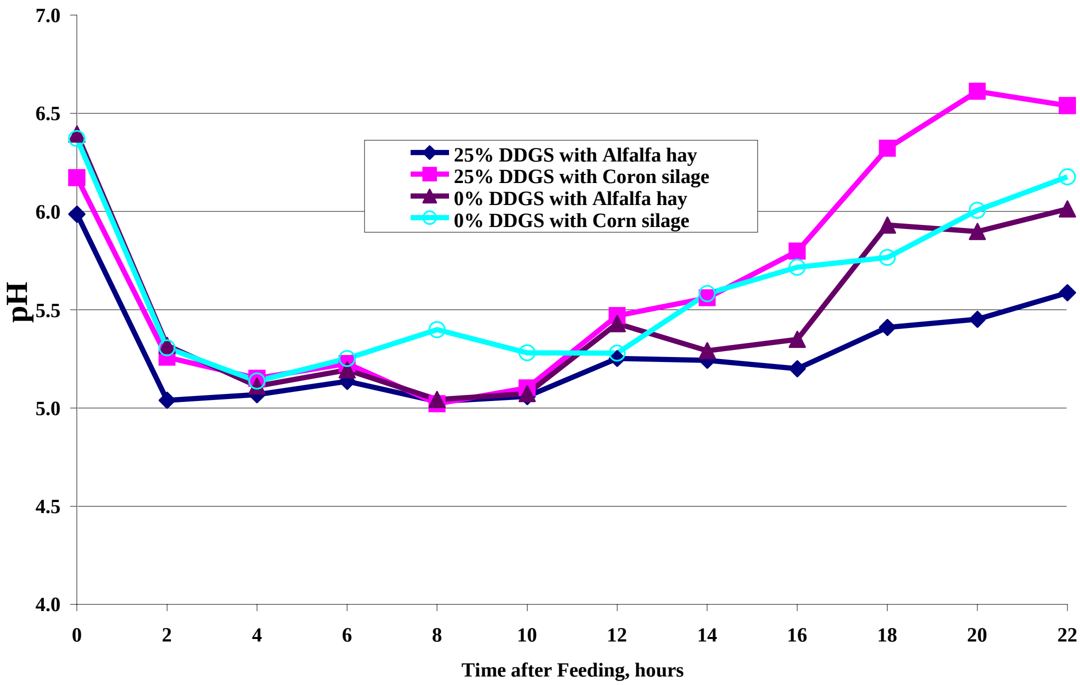

Figure 1. Ruminal pH of Steers Fed Steam-flaked Corn-based Diets Containing 0% or 25% DDGS with Alfalfa Hay or Corn Silage[ab]

[a]Interaction between roughage source, DDGS level, and Time post feeding (P<0.05)
[b]Interaction between roughage source and DDGS level (P<0.05)

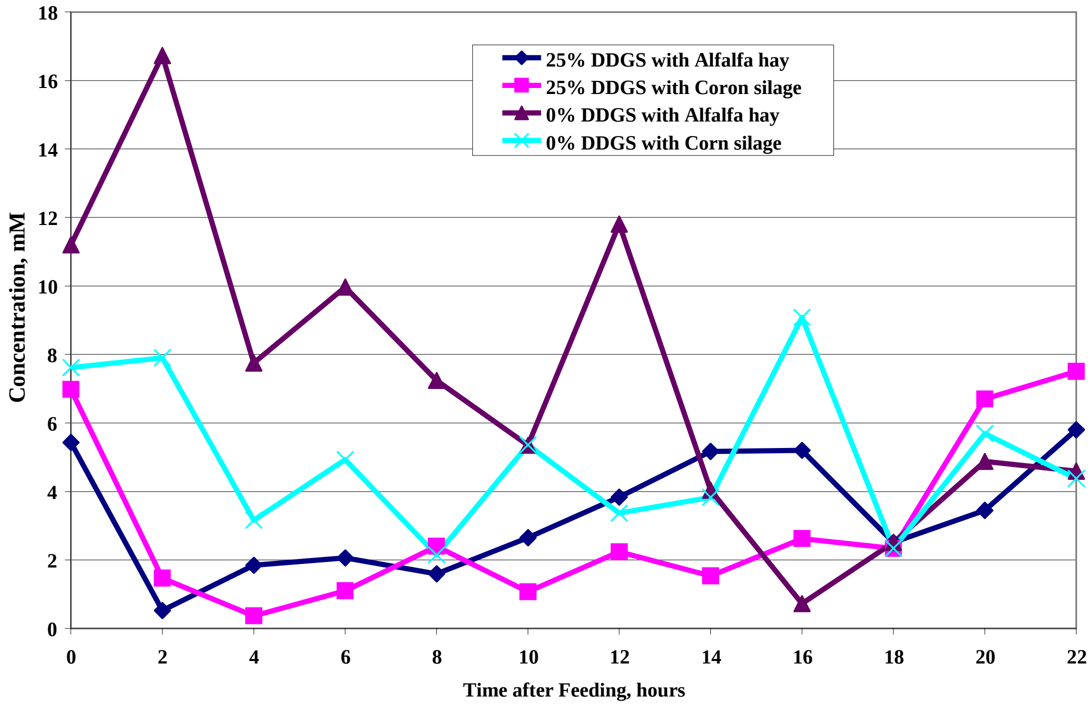

Figure 2. Ruminal Ammonia of Steers Fed Steam-flaked Corn-based Diets Containing 0% or 25% DDGS with Alfalfa Hay or Corn Silage [ab]

[a]Interaction between DDGS level, and time post feeding (P<0.05).
[b]Interaction between roughage source and DDGS level (P<0.05).

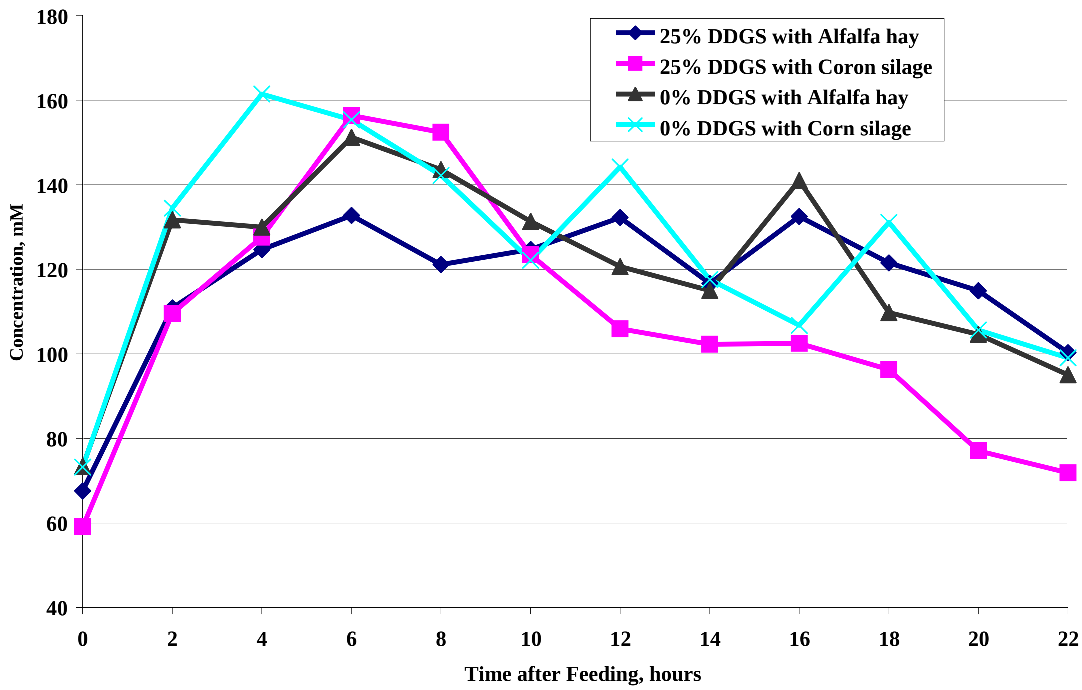

Figure 3. Ruminal Total Volatile Fatty Acid of Steers Fed Steam-flaked Corn-based Finishing Diets Containing 0% or 25% DDGS with Alfalfa Hay or Corn Silage[a b]

[a]Interaction between roughage source and DDGS level ($P<0.05$)
[b]Effect of time after feeding ($P<0.05$)