Higher Ruminal pH Increases In Vitro Digestion of Diets Containing Dried Distillers Grains with Solubles

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Introduction

Advantages of steam flaking grain are less with respect to growth performance and diet digestion when a portion of distillers grains is substituted for grain. Ruminal pH typically is lower in cattle fed flaked-grain diets than in cattle fed rolled-grain diets. Ruminal pH for cattle fed finishing diets based on steam-flaked corn is observed below pH 6.0. Previous research observed a 5% decrease in digestion of organic matter when 13% distillers grains (dry-matter basis) was added to steam-flaked corn finishing diets. A decline in ruminal pH below 6.2 reduces activity of ruminal fiber-digesting organisms. Furthermore, ruminal protein digestion declines with pH below 5.5. It is plausible that low ruminal pH may restrict digestion of distillers grains in flaked-grain diets. The objective of this study was to examine effects of pH on in vitro fermentative activity of ruminal contents from cattle adapted to a finishing diet containing 25% dried distillers grains (dry-matter basis).

Experimental Procedures

We conducted an in vitro study to investigate effects of three pH levels (5.0, 5.5, or 6.0) on fermentative activity of ruminal contents from cattle adapted to a finishing diet containing 25% (dry-matter basis) dried distillers grains with solubles at three incubation times (6, 12, and 24 hours). A 50:50 mixture of distillers grains and dry-rolled corn was fed to the test tube cultures. We reached our targeted pH levels by using citric acid to measure in vitro dry-matter disappearance or phosphoric acid to determine volatile fatty acids. Because citric acid is broken down in the rumen, it is conceivable that citrate degradation may produce some volatile fatty acids; hence, phosphate buffer was used as a control, especially for analysis of volatile fatty acids. There were two tubes containing substrate and two tubes without substrate for each of the buffer types, each of the three fermentation times, and each of the three pH levels. The experiment was repeated on three separate days (six observations/treatment for each buffer type). Whole ruminal contents were obtained from a ruminally cannulated steer fed a steam-flaked corn finishing diet with 25% dried distillers grains (dry-matter basis). The diet composition is further described in Table 1. After each time point, tubes were immediately placed in an ice water bath to cease fermentation rapidly while measuring final pH. After cooling, tubes were centrifuged at 30,000 × *g* for 20 minutes. Supernatant was decanted, and a portion was kept for subsequent analyses of volatile fatty acids. Pellets which remained in the tubes were dried at 100°C overnight and weighed to measure in vitro dry-matter disappearance.

Results and Discussion

In vitro dry-matter disappearance increased with increasing pH ($P<0.01$) and fermentation time ($P<0.01$, Figure 1). The linear increase of in vitro dry-matter disappearance as

pH increases may indicate that fiber digestion by fiber-digesting bacteria declines at pH levels below 6.0, which might affect digestion of distillers grains present in substrate.

There was an interaction between pH and fermentation time ($P<0.01$) with respect to total volatile fatty acid concentrations (Figure 2). Concentrations increased with increasing pH for the first 12 hours, but after 24 hours of incubation, volatile fatty acid concentrations decreased as pH increased. Volatile fatty acids are the end products of bacterial fermentation in the rumen. They represent the primary source of energy for cattle, so higher levels indicate more energy is available for cattle growth. The fact that volatile fatty acid concentration at 24 hours is higher at pH 5.0 than at pH 5.5 and 6.0 may indicate that fiber digestion and protein digestion are compromised at lower pH levels because fiber-digesting bacteria and protein-digesting bacteria struggle to survive at below pH 6.0. It is thus conceivable that it would take longer to digest feedstuffs rich in fiber, such as dried distillers grains with solubles, at such a low pH level. Because the bulk of ruminal content is digested during the first 6 hours after feeding, when pH is below 5.5, as shown in previous research, it is probable that low ruminal pH is a limiting factor for bacterial growth and subsequent digestion.

Implications

Higher pH levels led to greater dry-matter disappearance in vitro. These results may help explain decreases in cattle performance and diet digestibility when distillers grains are combined with grain that results in low ruminal pH, as is the case with flaked grains. Feeding strategies aimed at increasing ruminal pH may be a logical approach for improving digestion of dried distillers grains in flaked-grain finishing diets.

Table. 1. Composition of the diet fed to the cannulated steer donor of the ruminal fluid

Ingredients	Percentage of diet (dry-matter basis)
Steam-flaked corn	58.3
Corn dried distillers grains	25.1
Alfalfa hay	5.8
Corn steep liquor	6.3
Urea	0.1
Limestone	1.7
Supplement[1]	2.7
Analyzed composition, %	
Dry matter	79.2
Crude protein	16.0
Ether extract	5.4
Neutral detergent fiber	15.6
Calcium	0.7
Phosphorus	0.5
Potassium	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 ppm cobalt.

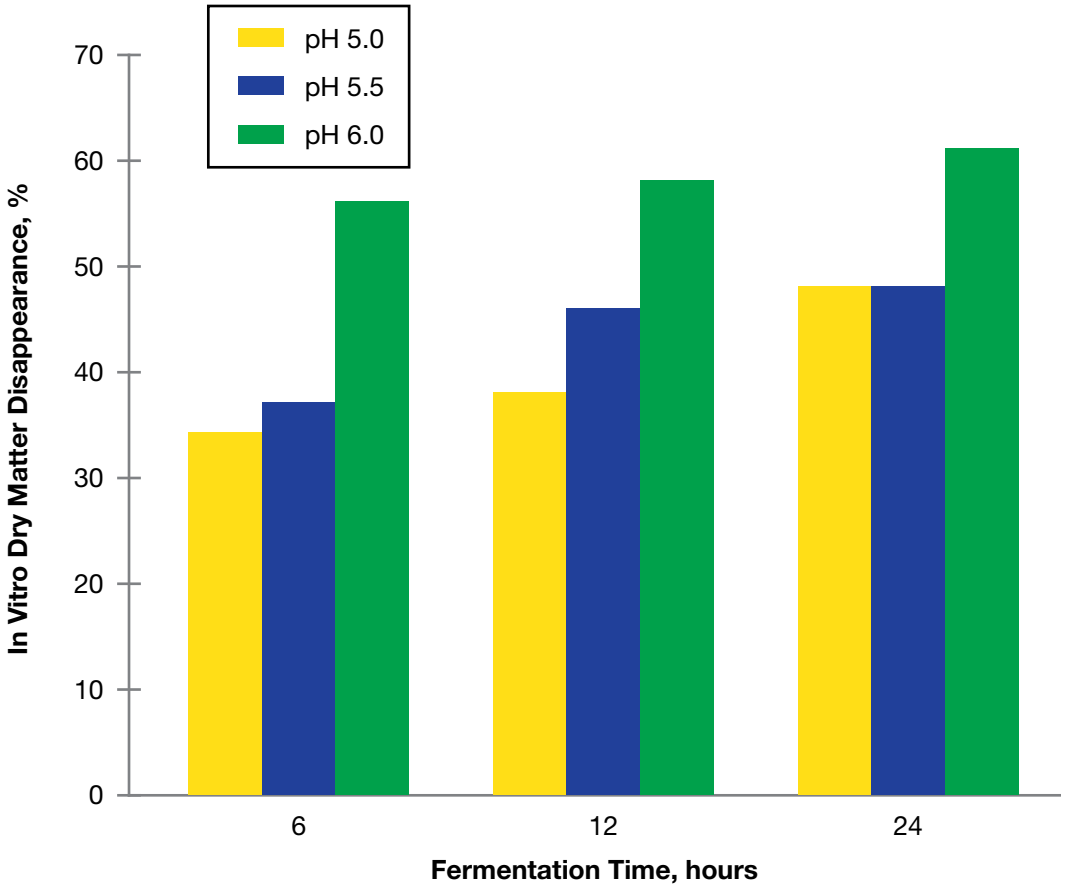

Figure 1. Effect of pH on in vitro dry-matter disappearance due to fermentation by ruminal contents from a steer adapted to a finishing diet containing 25% (dry-matter basis) dried distillers grains with solubles.

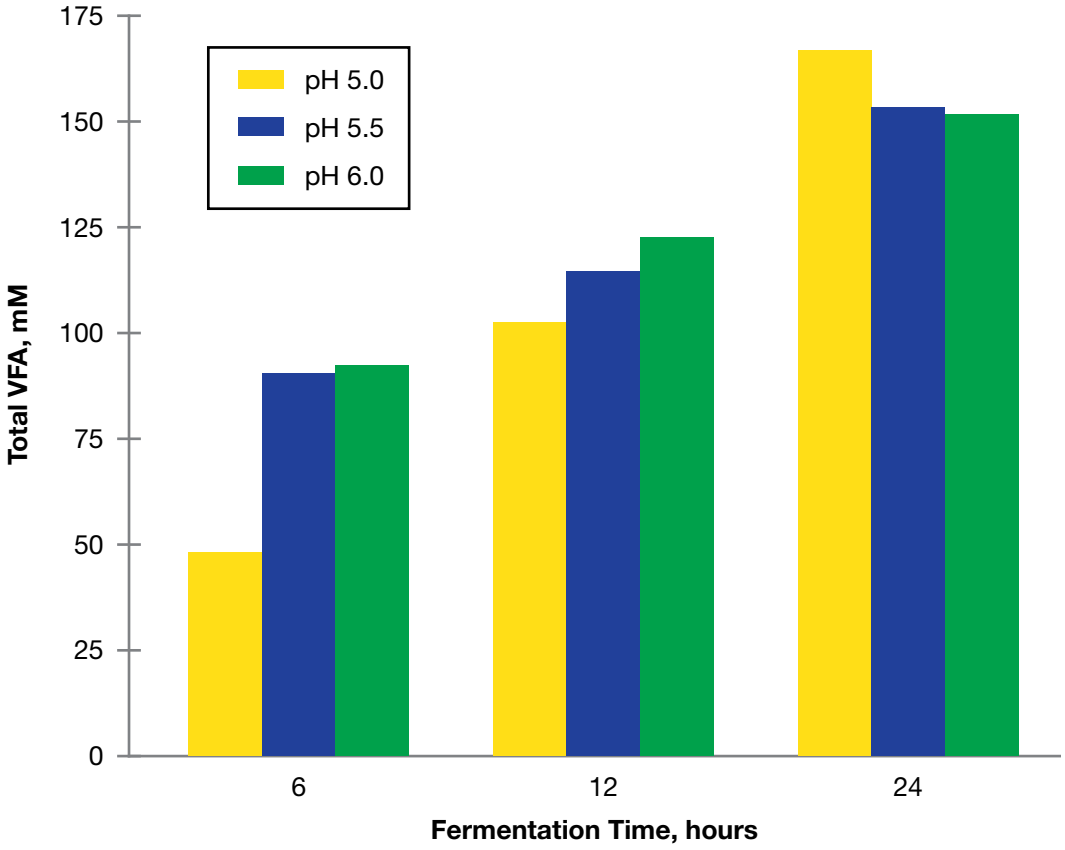

Figure 2. Effect of pH on total volatile fatty acid concentrations from in vitro fermentation by ruminal contents from a steer adapted to a finishing diet containing 25% (dry-matter basis) dried distillers grains with solubles.