Effects of Crude Glycerin on Ruminal Metabolism and Diet Digestibility of Flaked-Corn Finishing Diets

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Introduction

Expansion of the biodiesel industry has increased supplies of crude glycerin available for livestock feeding. Catalyzed reactions between methanol and triglycerides from vegetable oils, such as soybean oil, yield biodiesel and a coproduct, crude glycerin. Approximately 10% of the weight of soybean oil used to produce biodiesel becomes glycerin. Limited work has been conducted to understand metabolism of glycerin in ruminant livestock. In previous studies at Kansas State University, feeding crude glycerin at 8% or less of the diet improved cattle performance. Subsequent laboratory experiments indicated that low levels of glycerin may improve ruminal fermentation. This study was conducted to determine whether adding low levels of glycerin to feedlot diets could affect diet digestibility.

Experimental Procedures

Crossbred steers (n = 9; 1,373 ± 176 lb) fitted with ruminal cannulae were used to conduct a replicated, complete block experiment with three treatments and nine observations per treatment. Treatments consisted of steam-flaked corn diets containing 0%, 2%, and 4% crude glycerin (dry matter basis). Steers had ad libitum access to finishing diets fed once daily. Diets contained 6% alfalfa hay and provided 14% crude protein, 0.7% calcium, and 0.7% potassium (Table 1). Periods consisted of a 10-day acclimation phase followed by a 3-day collection phase. Chromic oxide (10 g/day) was used as an indigestible marker to estimate total fecal output and was dosed intraruminally prior to feeding each day beginning 7 days before the sampling phase. Starting on day 11 of each period, ruminal digesta were collected throughout a 3-day collection phase. Collection times were: day 1 at 0, 6, 12, 18 and 24 hours postfeeding; day 2 at 2, 8, 14, and 20 hours postfeeding; and day 3 at 4, 10, 16 and 22 hours postfeeding. Digesta were removed from the rumen via the ruminal cannulae and strained through eight layers of cheesecloth. Ruminal fluid was analyzed for volatile fatty acid profiles, pH, and ammonia concentration. Apparent total tract digestibilities were calculated for various nutrients.

Results and Discussion

Dry matter intake was similar among treatments (Table 2). Fecal output was 2.7, 2.8, and 2.8 lb/day when glycerin was fed at 0%, 2%, and 4%, respectively ($P>0.74$). Apparent total tract digestibilities of dry matter, organic matter, starch, crude protein, and crude fat were similar for cattle fed different levels of crude glycerin ($P>0.51$). Apparent total tract digestibilities of neutral detergent fiber were 60%, 52%, and 48% for cattle fed 0%, 2%, and 4% glycerin, respectively (linear effect, $P<0.01$; Table 2). No treatment-by-time interactions were observed for ruminal parameters (Table 3; $P>0.27$). Feeding glycerin linearly increased ruminal pH from 5.61 in control steers to 5.67 and 5.73 when glycerin was added at 2% and 4%, respectively ($P<0.06$; Figure 1). Butyr-

ate and valerate concentrations decreased as crude glycerin increased in the diet (linear effect; P<0.03), and acetate concentrations also decreased with increasing glycerin concentrations (linear effect; P=0.06). When fed at low levels in finishing diets, glycerin appears to alter fiber digestion but has little impact on other diet components.

Implications

Glycerin can be feed to finishing cattle without significantly altering digestibilities of most nutrients. However, changes that occur in volatile fatty acid profiles may relate to changes in fiber digestion.

Table 1. Composition of experimental diets (dry matter basis)

	Crude glycerin, %		
Ingredient, %	0	2	4
Steam-flaked corn	82.6	80.2	77.8
Corn steep liquor	5.7	5.7	5.7
Alfalfa hay	5.9	5.9	5.9
Soy-based crude glycerin[1]	0.0	2.0	4.0
Soybean meal	0.37	0.80	1.20
Limestone	1.45	1.45	1.45
Urea	1.15	1.14	1.14
Salt	0.28	0.29	0.28
Mineral premix[2]	0.35	0.34	0.34
Feed additive premix[3]	2.2	2.2	2.2

[1] Methanol content of glycerin was <0.01%.
[2] Formulated to provide 0.1 ppm cobalt; 10 ppm copper; 0.6 ppm iodine; 60 ppm manganese; 0.25 ppm selenium; 60 ppm zinc; 1,200 IU/lb vitamin A; and 10 IU/lb vitamin E.
[3] Feed additive premix was formulated to provide 300 mg monensin and 90 mg tylosin daily in a ground corn carrier.

Table 2. Apparent total tract digestibility of diets containing 0%, 2%, or 4% crude glycerin

	Crude glycerin, %				P-value	
Item	0	2	4	SEM	Linear	Quadratic
Feed intake, lb/day	17.7	17.5	17.7	0.86	0.99	0.76
Fecal output, lb/day	2.7	2.8	2.8	0.37	0.51	0.76
Apparent total tract digestion						
Dry matter, %	84.9	84.1	84.2	1.3	0.57	0.69
Organic matter, %	87.6	87.0	86.7	1.0	0.51	0.96
Neutral detergent fiber, %	60.4	51.8	48.1	3.6	<0.01	0.47
Starch, %	99.6	99.7	99.6	0.11	0.93	0.44
Crude protein, %	78.8	80.3	79.0	1.5	0.90	0.34
Crude fat, %	90. 9	91.6	90.4	1.3	0.81	0.27

Table 3. Ruminal concentrations of volatile fatty acids and ammonia in steers fed 0%, 2%, or 4% of diet dry matter as crude glycerin

	Crude glycerin, %				P-value	
Item	0	2	4	SEM	Linear	Quadratic
Volatile fatty acids, m*M*						
Total volatile fatty acids	120	116	116	4.7	0.23	0.31
Acetate	52.8	50.7	50.1	1.60	0.06	0.56
Propionate	50.8	48.7	50.7	3.50	0.76	0.32
Acetate:Propionate ratio	1.16	1.20	1.14	0.14	0.68	0.25
Butyrate	14.4	13.5	12.5	1.05	0.03	0.99
Isobutyrate	0.88	0.85	0.84	0.05	0.34	0.92
Valerate	5.45	4.85	3.74	0.73	<0.01	0.52
Isovalerate	2.25	1.85	2.35	0.37	0.80	0.20
Ammonia, m*M*	7.99	7.80	7.67	1.33	0.72	0.97

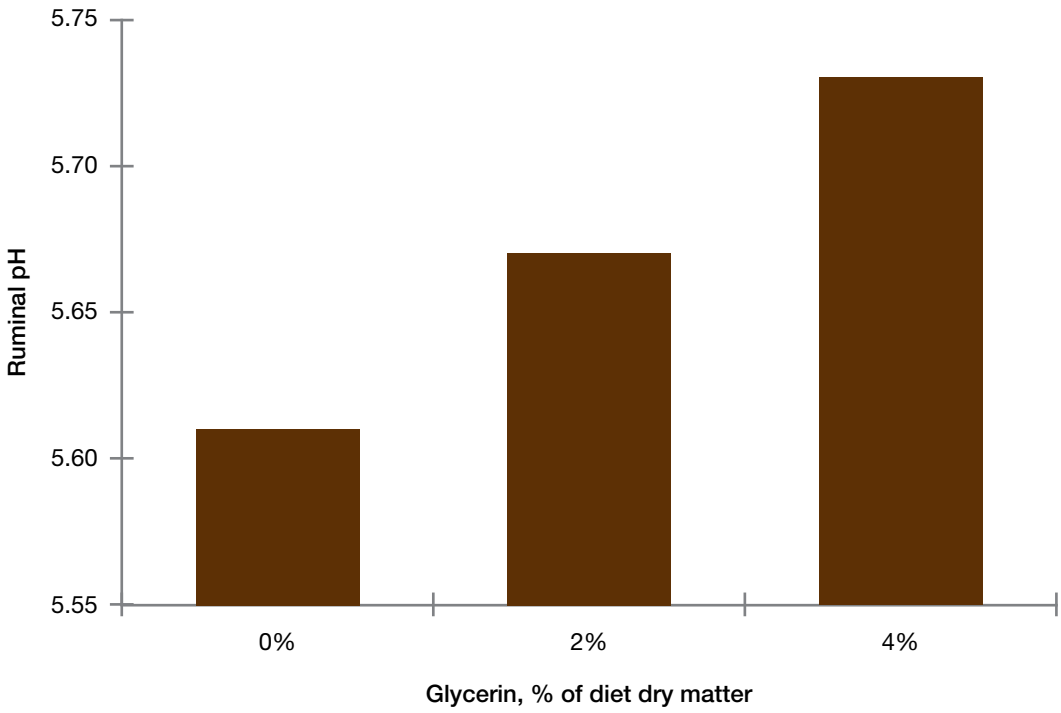

Figure 1. Effects of glycerin level on ruminal pH.