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Combinations of wet corn gluten feed and steam-flaked corn in finishing cattle diets: effects on acid-resistant E. Coli and coliforms, VFA Profiles and pH (2001)

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COMBINATIONS OF WET CORN GLUTEN FEED AND STEAM-FLAKED CORN IN FINISHING CATTLE DIETS: EFFECTS ON ACID-RESISTANT *E. COLI* AND COLIFORMS, VFA PROFILES AND PH

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Summary

Finishing beef steers (615 head) were used in a 152-day experiment to evaluate the effects of feeding 80:0, 60:30 or 30:60 ratios (dry basis) of steam-flaked corn and wet corn gluten feed (WCGF, 30WCGF, 60WCGF) on acid-resistant *E. coli* and coliforms. On days 114 to 118 ruminal and fecal samples were collected from 180 steers and analyzed for pH, VFA, and total and acid-resistant *Escherichia coli* (*E. coli*) and coliforms. Ruminal (P=0.13) and fecal (P=0.10) VFA tended to decrease linearly as CGF increased. Consequently, there was a corresponding numerical linear increase in ruminal pH and a significant linear increase in fecal pH (P<0.05). Total and acid-resistant *E. coli* and coliforms, however, were not affected (P>0.10) by dietary treatment.

(Key Words: *E. coli*, Food Safety, Finishing Cattle.)

Introduction

Recent research has indicated that adding hay to the diets of grain-fed cattle 4 days prior to slaughter can impact fermentation patterns and alter the acid-resistant microbial population in the feces, specifically *E. coli*. Feedlot diets typically contain a large portion of starch from grain sources. In highly processed grains, the rumen is the main site of starch digestion and volatile fatty acid production. However, some of this grain starch passes to the lower gastrointestinal tract and is fermented in the cecum and colon. This passage of starch and the resulting acid production may cause *E. coli* to develop acid-resistance.

Wet corn gluten feed (WCGF) is a high energy, low-starch feedstuff that has been used as an energy source in high-grain diets. We hypothesized that the fibrous, low-starch characteristics of WCGF, could be utilized to manipulate ruminal and fecal organic acid concentrations, thus preventing development of acid resistance among coliform bacteria.

Experimental Procedures

Six hundred fifteen crossbred beef steers (average wt 649 lb) were fed diets containing either 80:0 (WCGF), 60:30 (30WCGF), or 30:60 (60WCGF) ratios of steam-flaked corn and WCGF throughout a 152-day finishing experiment. Diet compositions are shown in Table 1. Steers were blocked by previous treatment and randomly allocated to the three diets (four pens per diet with 48 to 53 steers per pen). Rumen fluid (collected via rumenocenteses) and feces were obtained from 180 steers (three animals per pen on each sampling day) on days 114 to 118. Samples of rumen fluid and feces were incubated for 1 hour in citric acid/sodium phosphate buffer solutions at pH 2, 4, and 7 for determination of total and acid-resistant *E. coli* and coliforms. After incubation the samples subjected to the pH 2 and 4 buffers were neutralized with 1 M NaOH solution and placed on ice. Samples were serially diluted, plated onto Petrifilm™ plates, incubated at 37°C for 24 to 48 hours, and enumerated.

[1]Department of Statistics.

Results and Discussion

Ruminal volatile fatty acid (VFA) concentration and fecal VFA concentrations tended to decrease linearly as WCGF was added to the diet (Figure 1). Consequently, there was a corresponding linear increase for ruminal and fecal pH ($P<0.05$) (Figure 2). Despite the shift in fermentation patterns, *E. coli* and coliform counts in ruminal fluid and fecal samples of cattle fed different diets were similar ($P>0.10$) at pH buffer treatments 2, 4, and 7 (Table 2). This suggests that ruminal and fecal acid concentrations, which were all above pH 6, were not acidic enough for coliform bacteria to develop acid resistance. The molar proportion of ruminal and fecal acetate increased linearly ($P<0.05$), and the molar proportion of ruminal and fecal propionate decreased linearly ($P<0.05$) as WCGF was added to the diet, suggesting that fermentation of fiber replaced that of starch in both the rumen and hindgut as more WCGF was fed (Figures 3 and 4).

Addition of WCGF to finishing diets altered VFA concentrations and increased pH; however, no differences were observed with respect to numbers of *E. coli*, total coliforms, acid-resistant *E. coli*, or acid-resistant coliforms.

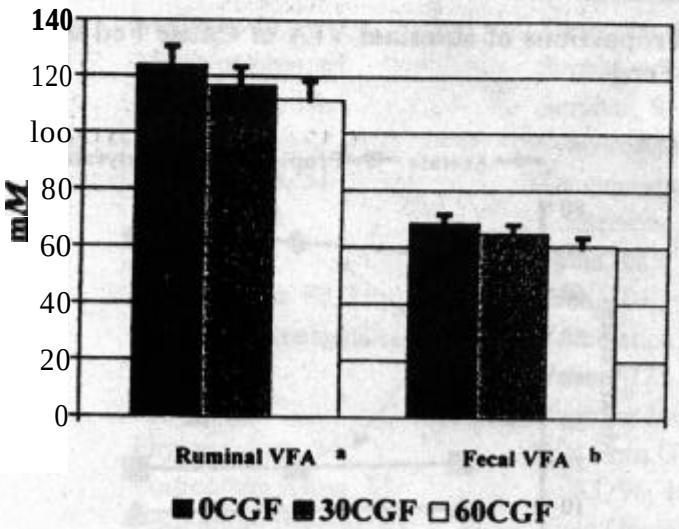
Table 1. Composition of Experimental Diets (% of diet dry matter)

	Dietary Wet Corn Gluten Feed		
Ingredient	0%	30%	60%
Flaked corn	81.60	58.37	30.21
Alfalfa hay	6.71	-	6.97
Molasses	3.72	-	-
Tallow	2.01	2.05	2.09
Wet corn gluten feed	-	28.64	58.51
Soybean meal	2.83	1.44	-
Urea	1.21	0.79	0.36
Limestone	1.18	1.28	1.39
Sodium chloride	0.29	0.29	0.30
Potassium chloride	0.04	0.02	-
Ammonium sulfate	0.19	0.10	0.10
Calcium phosphate	0.12	0.06	0.06
Vitamin/trace mineral premix[1]	0.10	0.10	0.10
Nutrient, analyzed			
Dry matter, %	83.4	65.0	53.0
Crude protein, %	14.9	15.2	15.4
Calcium, %	0.66	0.70	0.75
Phosphorus, %	0.29	0.35	0.41
Thiamin, ppm	-	7.5	15
Copper, ppm	8.3	12.2	16.0

[1]Vitamin/trace mineral premix formulated to provide (total diet dry matter): 1,200 IU/lb vitamin A, 0.10 ppm cobalt, 0.52 ppm iodine, 50 ppm manganese, 0.25 ppm selenium, 50 ppm zinc, 30 grams/ton Rumensin®, and10 grams/ton Tylan®.

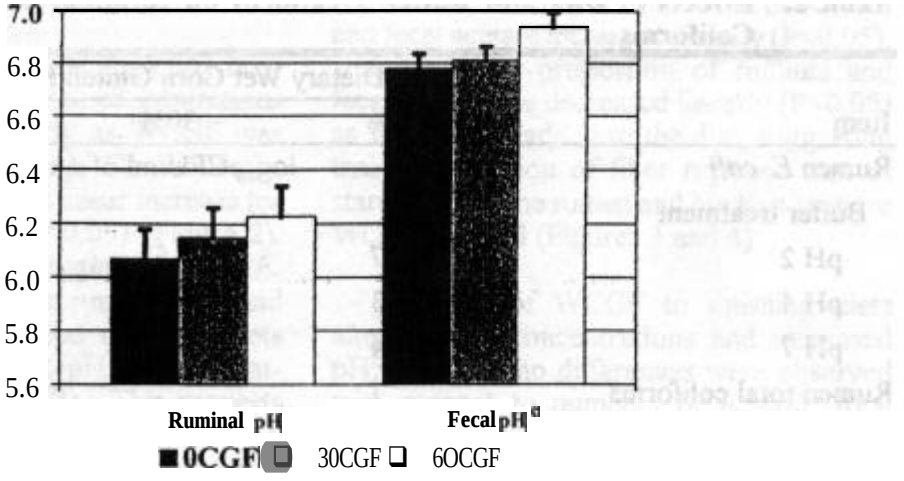
Table 2. Effects of Diet and Buffer Treatment on Ruminal and Fecal *E. coli* and Coliforms

item	Dietary Wet Corn Gluten Feed 0%	30%	60%	SEM
Rumen *E. Coli*	----------log_{10} CFU/ml of rumen fluid----------			
Buffer treatment				
pH2	1.7	1.5	1.5	0.27
pH4	3.3	3.9	3.2	0.29
pH7	4.4	4.6	4.5	0.25
Rumen total coliforms				
Buffer treatment				
pH2	1.8	1.6	1.6	0.29
pH4	3.8	4.4	3.8	0.30
pH7	4.6	4.8	4.8	0.25
Fecal *E. coli*	----------log_{10} CFU/g of dry feces----------			
Buffer treatment				
pH2	7.1	8.8	9.0	1.90
pH4	34.6	37.4	36.5	2.14
pH7	38.1	39.9	40.2	2.30
Fecal total coliforms				
Buffer treatment				
pH2	7.1	9.4	9.9	2.18
pH4	35.2	38.4	37.5	2.12
pH7	38.8	40.8	41.1	2.32



[a]Linear Effect of CGF (P=.13).
[b]Linear Effect of CGF (P=.10).

Figure 1. Total Ruminal and Fecal VFA Concentrations of Cattle Fed 0, 30, or 60% Wet Corn Gluten Feed.



'Linear effect of CGF (P<.05).

Figure 2. Ruminal and Fecal pH of Cattle Fed 0,30, and 60% Wet Corn Gluten Feed.

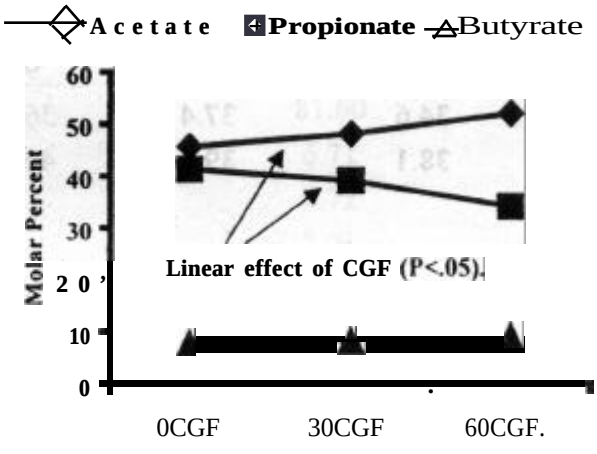


Figure 3. Molar Proportions of Ruminal VFA of Cattle Fed 0, 30, or 60% Wet Corn Gluten Feed.

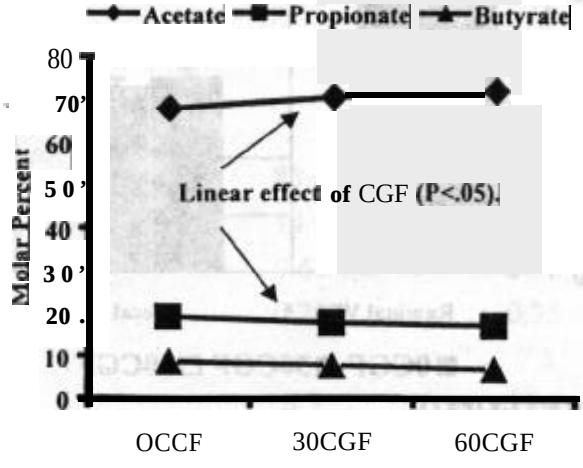


Figure 4. Molar Proportions of Fecal VFA of Cattle Fed 0,30, or 60% Wet Corn Gluten Feed.