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Effects of wet corn gluten feed and intake level on diet digestibility and rumen passage rate in steers

Abstract

Including 40% wet corn gluten feed (WCGF) in the diet increased total tract digestion of organic matter and neutral detergent fiber ($P < 0.01$), reduced total volatile fatty acid concentration ($P < 0.01$), increased rumen NH_3 concentration ($P < 0.01$), increased rumen pH, and tended ($P < 0.06$) to increase total tract digestion of starch. Furthermore, WCGF increased rumen passage rate of solid digesta ($P < 0.01$) compared to diets containing no WCGF. Limit feeding reduced total tract digestion of organic matter and neutral detergent fiber ($P < 0.01$), decreased total volatile fatty acid concentration ($P < 0.01$), increased rumen NH_3 concentration ($P < 0.01$), increased rumen pH at 0 and 12 hours after feeding, reduced rumen pH at 4 hours after feeding, and increased rumen liquid passage rate ($P < 0.02$).

Keywords

Cattlemen's Day, 2001; Kansas Agricultural Experiment Station contribution; no. 01-318-S; Report of progress (Kansas State University. Agricultural Experiment Station and Cooperative Extension Service); 873; Beef; Wet corn gluten feed; Limit feeding; Digestibility; Passage rate

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EFFECTS OF WET CORN GLUTEN FEED AND INTAKE LEVEL ON DIET DIGESTIBILITY AND RUMEN PASSAGE RATE IN STEERS

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Summary

Including 40% wet corn gluten feed (WCGF) in the diet increased total tract digestion of organic matter and neutral detergent fiber ($P < 0.01$), reduced total volatile fatty acid concentration ($P < 0.01$), increased rumen NH_3 concentration ($P < 0.01$), increased rumen pH, and tended ($P < 0.06$) to increase total tract digestion of starch. Furthermore, WCGF increased rumen passage rate of solid digesta ($P < 0.01$) compared to diets containing no WCGF. Limit feeding reduced total tract digestion of organic matter and neutral detergent fiber ($P < 0.01$), decreased total volatile fatty acid concentration ($P < 0.01$), increased rumen NH_3 concentration ($P < 0.01$), increased rumen pH at 0 and 12 hours after feeding, reduced rumen pH at 4 hours after feeding, and increased rumen liquid passage rate ($P < 0.02$).

(Key Words: Wet Corn Gluten Feed, Limit Feeding, Digestibility, Passage Rate.)

Introduction

When cattle are allowed *ad libitum* access to feed, they typically eat several small meals over a 24-hour period, establishing relatively steady-state rumen conditions conducive to optimal fermentation. In contrast, cattle that are limit-fed diets once daily generally consume their entire daily allotment of feed in large meals, at times consuming their entire ration in only a few hours. With high-energy diets, meal-eating behavior may negatively impact rumen fermentation due to rapid intakes of highly fermentable

carbohydrates. Our study was conducted to determine the effects of WCGF on diet digestibility when included in diets fed *ad libitum* or limit-fed once daily.

Experimental Procedures

Twelve ruminally cannulated steers weighing 1175 lb were used in an incomplete Latin square design experiment with a 2×2 factorial arrangement of treatments to determine the effects of WCGF and total intake level on diet digestibility and rumen passage rate. Treatments consisted of diets (Table 1) formulated to contain 20% alfalfa hay and steam-flaked corn, with either 40% *Sweet Bran*[®] WCGF (dry basis) replacing steam-flaked corn or no WCGF. Cattle were fed once daily, either *ad libitum* or limited to 1.6% of body weight (dry basis). Two consecutive 24-day periods were used; 18 days for adaptation, 4 days for collection, and a 2-day *in situ* period. Chromic oxide (digestion marker, 10 g/head) was top dressed daily beginning on day 11, and on day 19 steers were ruminally dosed with 100 g of ytterbium (Yb)-labeled alfalfa hay (solid phase marker) and 200 mL of a cobalt ethylenediamine tetraacetate (Co-EDTA) solution (liquid phase marker). Rumen samples were collected 24, 48, 72, and 96 hours later and analyzed for concentrations of Yb and Co. On days 19 to 22, rumens were sampled once daily at 0, 4, 8, or 12 hours after feeding, and fecal grab samples were obtained three times daily. On day 23, dacron bags containing 5 g of either steam-flaked corn, WCGF, or ground (2-mm) alfalfa hay were placed into the rumens of all

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steers and removed after 3, 6, 12, or 48 hours.

Table 1. Diet Composition (% of Dry Matter)

Ingredients	Treatments	
	WCGF	Corn
Steam-flaked corn	39.9	65.9
Alfalfa hay	19.9	19.4
Wet corn gluten feed	38.3	-
Soybean meal	-	7.4
Cane molasses	-	4.8
Urea	0.1	1.0
Limestone	1.2	0.8
Calcium phosphate	-	0.3
Sodium chloride	0.4	0.3
Potassium chloride	0.1	-
Vitamin/trace mineral premix ^a	0.1	0.1
Crude protein, analyzed	16.8	16.3

^aFormulated to provide (total diet dry matter): 1,200 IU/lb vitamin A, 0.1 ppm cobalt, 10 ppm copper, 0.6 ppm iodine, 60 ppm manganese, 0.2 ppm selenium, 60 ppm zinc, and 30 g/ton of Rumensin[®].

Results and Discussion

Digestibility and passage rate data are shown in Table 2. WCGF increased dry matter intake of *ad libitum* fed steers (P<0.01), increased total tract digestibility of

organic matter and neutral detergent fiber (P<0.01), and reduced ruminal total volatile fatty acid concentration (P<0.01)(Table 3). This reduced volatile fatty acid concentration may have contributed to the higher rumen pH at 8 and 12 hours after feeding (Figure 1) for WCGF. WCGF also increased rumen NH₃ concentration (P<0.01), suggesting its protein is rapidly degraded. Steers fed WCGF had higher rumen solid digesta passage rates (P<0.01) than those without WCGF. Limit feeding decreased total tract digestion of both organic matter and neutral detergent fiber (P<0.01), reduced total volatile fatty acid concentration (P<0.01), and increased rumen NH₃ concentration (P<0.01). The lower rumen pH at 4 hours after feeding, along with an increase in rumen liquid passage rate (P<0.02), may be responsible for the reduction in digestibility. Total tract starch digestion was not affected by intake level. During the *in situ* trial (data not shown) no differences in rate of dry matter disappearance for alfalfa hay, steam-flaked corn, or WCGF were observed. We conclude that inclusion of WCGF at 40% of dietary dry matter may increase organic matter and neutral detergent fiber digestion. Limit feeding of high-energy diets once daily may depress organic matter and neutral detergent fiber digestibility due to a lack of steady-state rumen conditions.

Table 2. Effect of Wet Corn Gluten Feed and Intake Level on Total Tract Apparent Digestibility, Rumen Passage Rate, and Rumen Volume

Item	Treatment				SEM	P-value ^a		
	WCGF		Corn			Diet	Intake	D × I
	Ad Lib	Limit-Fed	Ad Lib	Limit-Fed				
Intake, lbs								
Dry matter	30.2	19.5	24.6	19.5	0.97	0.03	<0.01	0.03
Organic matter	28.1	18.2	23.3	18.4	0.90	0.04	<0.01	0.03
Neutral detergent fiber	9.2	6.0	5.0	4.0	0.29	<0.01	<0.01	<0.01
Starch	9.6	6.1	11.6	9.0	0.43	<0.01	<0.01	0.40
Digestibility, %								
Organic matter	86.9	80.2	84.0	79.5	0.50	<0.01	<0.01	0.08
Neutral detergent fiber	76.1	62.7	58.4	47.9	2.1	<0.01	<0.01	0.51
Starch	97.2	96.9	93.1	94.5	1.4	0.06	0.70	0.59
Particulate kinetics								
Passage rate, %/hour	3.7	3.4	2.7	2.9	0.15	<0.01	0.58	0.11
Turnover time, hour	27.3	30.9	38.1	36.4	1.7	<0.01	0.62	0.18
Fluid kinetics								
Passage rate, %/hour	2.2	3.0	2.3	2.9	0.22	0.97	0.02	0.50
Turnover time, hour	47.3	33.3	46.1	38.2	3.8	0.65	0.03	0.46
Rumen volume, liters	209.2	100.1	146.4	99.5	16.9	0.11	<0.01	0.12

^aProbability that differences of the magnitude observed were due to random chance.

Table 3. Effect of Wet Corn Gluten Feed and Intake Level on Total VFA Concentrations, Acetate:Propionate Ratios, Molar Percentages of VFA, and Rumen Ammonia Concentrations

Item	Treatment				SEM	P-value ^a		
	WCGF		Corn			Diet	Intake	D x I
	Ad Lib	Limit-Fed	Ad Lib	Limit-Fed				
Total VFA, mM	111.7	96.8	127.8	111.3	4.1	co.01	co.01	0.77
Acetate, %	50.0	53.9	49.2	52.3	1.1	0.30	0.01	0.72
Propionate, %	28.0	24.5	36.1	29.5	1.9	0.01	0.01	0.41
Butyrate, %	15.9	13.4	11.1	11.8	0.82	co.01	0.16	0.03
Isobutyrate, %	1.2	2.1	0.7	1.1	0.21	0.01	0.01	0.31
Valerate, %	3.5	3.5	1.4	2.2	0.42	co.01	0.29	0.27
Isovalerate, %	1.4	2.6	1.5	3.1	0.49	0.45	0.02	0.65
Acetate:propionate	1.9	2.3	1.4	1.9	0.16	0.01	0.02	0.53
NH₃, mM	6.8	10.0	3.1	5.4	0.92	co.01	0.01	0.61

^a Probability that differences of the magnitude observed were due to random chance.

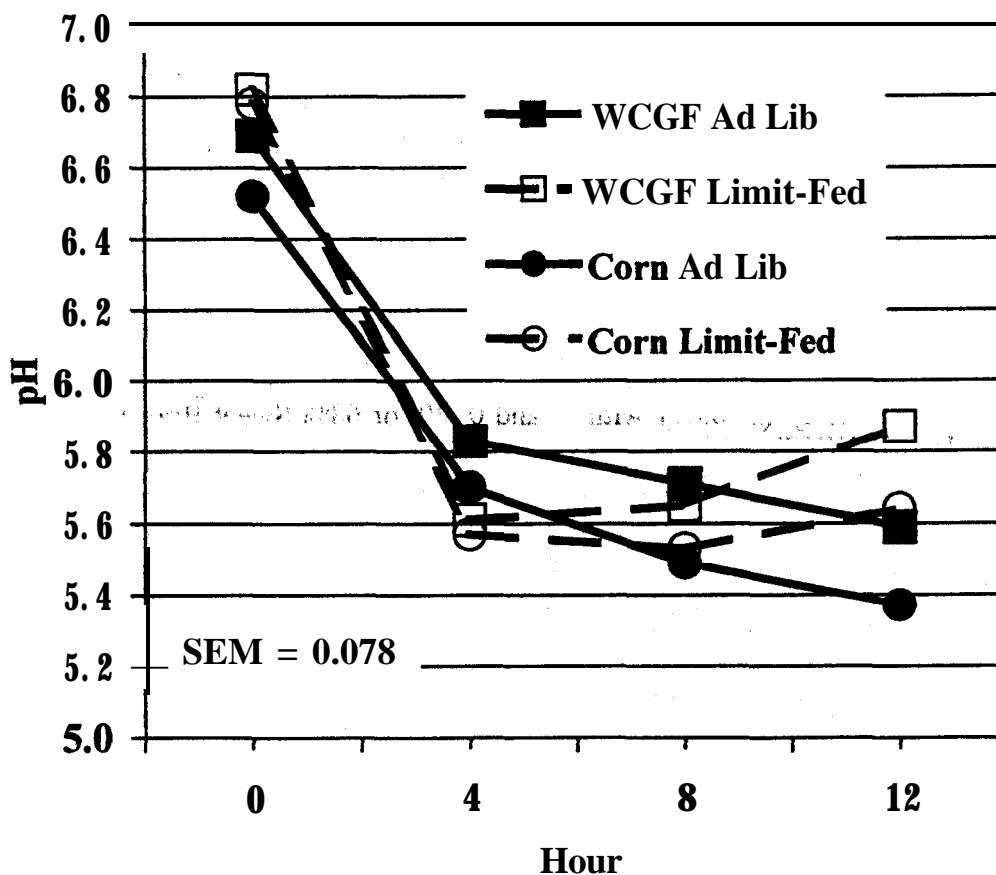


Figure 1. Effect of Wet Corn Gluten Feed and Intake Level on Rumen pH.