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Effects of Wet Corn Gluten Feed and Dietary Particle Size on Ruminal Fermentation and Milk Production

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Summary
Wet corn gluten feed (**WCGF**) was included in 4 diets at 0, 11, 23, and 34% of diet dry matter. Alfalfa hay was used to maintain at least 10% of particles ≥ 0.71 inches in length (the top screen of the Penn State Particle Separator) in all diets. Ruminal probes were placed in the rumens of 7 ruminally cannulated lactating Holstein dairy cows to measure ruminal pH. As WCGF increased in the diet, dry matter intake and milk production increased quadratically with 23% WCGF supporting the highest feed intake and milk yield. Ruminal pH and milk fat content were similar across all diets.

Key words: alfalfa, dry matter intake, milk yield, wet corn gluten feed

Introduction
As the competition for corn grows, dairy producers continue to look for alternative approaches to feeding cows while maintaining animal performance, health, and profitability. One option is the inclusion of wet corn gluten feed (**WCGF**) in the ration. The energy provided by WCGF is comparable with that of corn, making it a viable substitute in a lactating cow diet.

Many studies have been conducted to investigate responses to WCGF in lactating cow rations. Most dairy cattle studies have focused on the effects of replacing corn grain, corn silage, and alfalfa hay with WCGF, which can potentially reduce ruminal pH (Mullins et. al., Dairy Research 2009, Report of Progress 1021, pp. 34-40). The previous work showed that as feed intake increased, milk production also increased, whereas ruminal pH declined. One reason for this response could have been the small particle size of the diets in that study; small particle size limits salivary buffer secretion as well as rumen fill. No studies have been performed looking directly at the effects of feeding WCGF while maintaining a minimum particle size in lactation diets.

The objective of this study was to investigate the impacts of WCGF (0, 11, 23, and 34% of diet dry matter) on ruminal pH, feed intake, and milk production while maintaining particle size of the diets. We hypothesized that by maintaining at least 10% of particles ≥ 0.71 inches in length, ruminal pH would be consistent across all diets, whereas feed intake and milk production would increase as WCGF inclusion rate increased.

Experimental Procedures
Four multiparous and 3 primiparous ruminally cannulated, lactating Holstein cows were assigned randomly to 1 of 4 diets in an incomplete 4 × 4 Latin square design to evaluate the effects of WCGF on feed intake, productivity, and ruminal pH. One cow was removed from the study after the completion of the second period because of unrelated health problems. The study consisted of 4 periods, each lasting 21 days with 17 days of adaptation and 4 days for sample collection. Diets included WCGF at 0, 11, 23, or 34% of diet dry matter and were formulated and mixed to have at least 10% of particles ≥ 0.71 inches. The purpose of fixing the particle size was to maintain adequate effective neutral detergent fiber (**eNDF**) in the diet. Particle size goals were achieved by grinding alfalfa for 2 minutes in a horizontal mixing wagon

(Roto-mix, Dodge City, KS). The formulations of the 4 diets, which were identical to those used in the 2009 study, are shown in Table 1. Cows were fed twice daily at 11:00 a.m. and 3:00 p.m. and milked thrice daily at 2:00 a.m., 10:00 a.m., and 6:00 p.m. Animals were housed in a tie stall barn with an evaporative cooling system from June to August 2010 at the Kansas State University Dairy Teaching and Research Center.

On days 18 to 21 of each period, components and yields of milk were collected at each milking. Ruminal fluid and fecal samples were collected every 8 hours from days 18 to 20. Free-floating ruminal pH probes were calibrated and inserted into the rumen through the cannula, and ruminal pH was recorded every 5 minutes on days 17 to 20. Feed and water intake were recorded daily during the sampling period and feed ingredients, total mixed rations, and feed refusals were collected for analyses.

Results and Discussion

Intake and milk component responses are presented in Table 2. A quadratic effect ($P = 0.02$) on dry matter intake was detected, with the greatest intake for the 23% WCGF diets. Milk production responded in quadratic fashion ($P = 0.02$), with the 23% WCGF diet again yielding the greatest response. No differences were detected among diets for 3.5% fat-corrected milk yield, body condition score change, or body weight change. In contrast, energy-corrected milk yield tended to increase linearly as WCGF was added to the diet.

Milk fat content, lactose content, and milk fat yield did not differ among diets (Table 3). Milk protein yield increased linearly ($P < 0.01$) with WCGF inclusion, whereas milk lactose yield and milk urea nitrogen (MUN) concentration both increased quadratically. The quadratic increase in milk lactose yield was a result of the increase in milk production, because no differences in lactose content were observed among diets.

The study was designed to maintain eNDF across all diets by utilizing alfalfa hay to achieve consistency in particle size between diets. This may help to explain the similarity in mean and variation of ruminal pH across diets (Table 4). Although ruminal pH was lower than desirable, cows did not meet the standard criteria for diagnosis of sub-acute ruminal acidosis at any point during the study. Neither time under nor area under pH 5.8 or pH 5.6 were affected by treatment.

When dietary inclusion of WCGF was increased to 23% of the dry matter while maintaining a minimum dietary particle size, dry matter intake, milk yield, and protein yield were increased and ruminal pH was maintained. The quadratic increase observed in this study indicates that including WCGF at 23% of diet dry matter results in the greatest production response for the types of diets fed in this study.

Table 1. Ingredient and nutrient composition (% of dry matter) of dietary treatments containing increasing amounts of wet corn gluten feed (WCGF)

	Dietary WCGF			
Item	0%	11%	23%	34%
Ingredient, % of dry matter				
Corn silage	25.2	25.5	22.1	18.4
WCGF	--	11.4	23.2	33.6
Alfalfa	24.4	24.6	21.2	17.7
Cottonseed	6.1	6.2	6.2	6.1
Corn grain	23.5	19.9	17.3	14.6
Soybean meal 48	8.6	4.9	2.2	2.2
Molasses	0.4	0.4	0.4	0.4
Soybean hulls	5.0	---	---	---
Limestone	1.0	1.08	1.28	1.36
Expeller soybean meal	3.3	3.7	4.0	3.6
Magnesium oxide	0.26	0.24	0.21	0.17
Micronutrient premix	1.33	1.32	1.33	1.31
Nutrient				
Dry matter, % as-fed	65.4	60	61.3	61.2
Crude protein	19.3	18.8	19.1	20.1
Neutral detergent fiber	28.8	28.8	30.4	31.0
Starch	24.3	27.9	25.5	24.2
Non-fiber carbohydrate	39.1	40.9	38.6	37.6
Ether extract	3.4	3.3	3.6	3.6
Ash	9.4	8.3	8.3	7.7

Table 2. Effects of dietary wet corn gluten feed (WCGF) on intake and performance of lactating cows

	Dietary WCGF[1]					*P* value	
	0%	11%	23%	34%	SEM	Linear	Quadratic
Dry matter intake (DMI), lb/day	55.6	58.7	59.5	58.4	2.6	0.02	0.02
Water intake, gal/day	34.1	34.1	37.1	36.7	2.1	0.11	0.88
Milk, lb/day	83.1	90.0	91.3	89.7	8.0	0.01	0.02
3.5% fat-corrected milk, lb/day	76.7	82.2	80.9	81.1	6.7	0.19	0.18
Energy-corrected milk (ECM), lb/day	77.8	83.6	82.9	83.1	6.7	0.08	0.14
ECM/DMI	1.39	1.43	1.39	1.42	0.08	0.60	0.92
Body weight change, lb/21 days	-5.9	-24.5	-30.3	-13.9	19.4	0.58	0.14
Body condition score change/21 days	-0.10	-0.05	-0.08	0.03	0.052	0.14	0.56

[1] Inclusion rate of WCGF on a dry matter basis.

Table 3. Effects of dietary wet corn gluten feed (WCGF) on milk components

	Dietary WCGF[1]					*P* value	
	0%	11%	23%	34%	SEM	Linear	Quadratic
Milk fat, %	3.05	2.99	2.83	2.97	0.16	0.24	0.17
Milk protein, %	2.94	2.92	2.93	3.01	0.12	0.10	0.09
Lactose, %	4.84	4.87	4.86	4.84	0.07	0.93	0.29
Milk urea nitrogen, mg/dL	13.2	12.6	12.9	13.6	0.82	0.30	0.04
Yield, lb/day							
Milk fat	2.51	2.67	2.56	2.60	0.24	0.73	0.53
Milk protein	2.40	2.60	2.65	2.67	0.20	< 0.01	0.09
Milk lactose	4.01	4.37	4.39	4.32	0.35	0.03	0.02

[1] Inclusion rate of WCGF on a dry matter basis.

Table 4. Effects of dietary wet corn gluten feed (WCGF) on rumen pH

	Dietary WCGF[1]					*P* value	
pH response	0%	11%	23%	34%	SEM	Linear	Quadratic
Mean	6.05	6.13	6.00	6.00	0.07	0.26	0.45
Standard deviation	0.42	0.40	0.40	0.44	0.02	0.58	0.19
Time under 5.8 (min/day)	434	304	467	465	72.9	0.31	0.24
Area under 5.8 (pH x min/day)	130	87.6	144	138	28.5	0.50	0.46
Time under 5.6 (min/day)	257	175	290	293	56.4	0.33	0.39
Area under 5.6 (pH x min/day)	61.6	39.2	73.2	61.1	16.6	0.65	0.74

[1] Inclusion rate of WCGF on a dry matter basis.