Kansas Agricultural Experiment Station Research Reports

Volume 0
Issue 2 *Dairy Research (1984-2014)*

Article 234

2002

Diet digestibility and rumen traits in response to feeding wet corn gluten feed and a pellet consisting of raw soybean hulls and corn steep liquor (2002)

E. E. Ferdinand

John E. Shirley

Evan C. Titgemeyer

See next page for additional authors

Recommended Citation

Ferdinand, E. E.; Shirley, John E.; Titgemeyer, Evan C.; and DeFrain, J.M. (2002) "Diet digestibility and rumen traits in response to feeding wet corn gluten feed and a pellet consisting of raw soybean hulls and corn steep liquor (2002)," *Kansas Agricultural Experiment Station Research Reports*: Vol. 0: Iss. 2. https://doi.org/10.4148/2378-5977.3159

Diet digestibility and rumen traits in response to feeding wet corn gluten feed and a pellet consisting of raw soybean hulls and corn steep liquor (2002)

Authors

E. E. Ferdinand, John E. Shirley, Evan C. Titgemeyer, and J.M. DeFrain

DIET DIGESTIBILITY AND RUMEN TRAITS IN RESPONSE TO FEEDING WET CORN GLUTEN FEED AND A PELLET CONSISTING OF RAW SOYBEAN HULLS AND CORN STEEP LIQUOR

E. E. Ferdinand, J. E. Shirley, E. C. Titgemeyer, J .M. DeFrain, A. F. Park, D. E. Johnson[1], R. T. Ethington[2]

Summary

Four ruminally cannulated and two intact multiparous Holstein cows were used in a 3 × 3 replicated Latin square design to evaluate digestibility and rumen traits in lactating dairy cows in response to feeding wet corn gluten feed and a novel product containing raw soybean hulls and corn steep liquor. Three dietary treatments were fed in the experiment. The control contained (DM basis) 30% alfalfa hay, 15% corn silage, 32% corn, 9.3% whole cottonseed, 4.4% solvent soybean meal (SBM), 3.3% expeller SBM, 1.3% fish meal, 1% wet molasses, and 3.7% vitamins/minerals. Wet corn gluten feed replaced 10% alfalfa hay, 5% corn silage, 5% corn grain, and expeller SBM replaced solvent SBM to maintain diet rumen undegradable protein. The novel product replaced 10% alfalfa hay, 5% corn silage, 3% solvent SBM, and 2% corn. Diets were analyzed to have dietary crude protein percentage and energy density values (Mcal/lb, NE_L) of 18.7, 0.75; 18.7, 0.77; 18.7, 0.74; for control, wet corn gluten feed, and the novel product, respectively. Experimental periods were 14 days (10 days adaptation and 4 days collection). Acid insoluble ash was used to estimate fecal output. Dry matter intake averaged 37.9 lb/day and total tract digestibilities of dry matter (DM), organic matter, neutral detergent fiber (NDF), acid detergent fiber (ADF), and crude protein did not differ among diets: 71.7%, 73.2%, 63.1%, 58.5% and 73.0%, respectively. Diets affected liquid dilution rate, ruminal pH, and ruminal concentrations of total volatile fatty acids and ammonia similarly. The molar ratio of acetate to propionate was greater ($P<0.05$) for control (3.38) than for wet corn gluten feed (2.79) and the novel product (2.89). Inclusion of wet corn gluten feed and the novel product at 20% of dietary DM as a partial replacement for alfalfa hay, corn silage, corn grain, and SBM in diets fed to lactating dairy cattle supported lactational performance similar to the control diet. Additionally, combining wet corn gluten feed or the novel product with corn silage and alfalfa hay maintained milk fat yields and ruminal pH, thereby demonstrating that wet corn gluten feed and the novel product can serve as an effective source of fiber when fed at 20% of dietary DM. These results indicate that wet corn gluten feed and the novel product tested can serve as alternative feedstuffs in lactating dairy cattle diets.

(Key Words: Wet Corn Gluten Feed, Soybean Hulls, Corn Steep Liquor, By-product).

[1]Department of Statistics.
[2]Minnesota Corn Processors, Inc., Marshall, MN.

Introduction

By-product feedstuffs such as wet corn gluten feed (WCGF) and soybean hulls have been successfully fed to lactating dairy cows and provide a highly digestible source of fibrous carbohydrates without increasing ruminal acidity. Previous research at Kansas State University demonstrated that replacing a portion of alfalfa hay, corn silage, and corn grain with wet corn gluten feed increased dry matter intake (DMI), energy corrected milk (ECM), and production efficiency (ECM/DMI). Researchers at Kansas State University developed a novel pelleted product (SHSL) combining the highly digestible source of structural carbohydrates from raw soybean hulls (RSH) and carbohydrates, soluble protein, vitamins, and minerals of corn steep liquor (CSL) in a ratio of 75 to 25, respectively, on a DM basis. They observed that replacing a portion of alfalfa hay, corn silage, ground corn, and expeller soybean meal (SBM) with SHSL at a level of 20% of DM was possible because it improved milk, ECM, and protein yield. Furthermore, recent research at Kansas State University demonstrated that diets including WCGF or SHSL maintained performance during the first 13 weeks postpartum and improved milk, energy corrected milk (ECM), milk fat and protein production as well as production efficiencies during weeks 14 to 30 postpartum.

The objective of our experiment was to evaluate the effect of WCGF and SHSL on diet digestibility and rumen traits.

Procedures

Four ruminally cannulated and two intact multiparous Holstein cows in late lactation (168 ± 7 DIM) were used in a 3 × 3 replicated Latin square design to evaluate diet digestibility and rumen parameters in response to feeding WCGF and SHSL. Cows were housed in a tie-stall facility at the Kansas State University Dairy Teaching and Research Center. Treatment periods were 14 days and included a 10-day adaptation and 4-day collection period. Diets (Table 1) were fed as a total mixed ration twice daily (0700 and 1900 hr) for ad libitum consumption. Orts were removed and weighed once daily and used to adjust feeding levels to ensure 10% feed refusal. Samples of dietary components (alfalfa hay, concentrate, corn silage, SHSL, WCGF, and whole cottonseed) were collected, frozen, and composited by period. Fecal grab samples were collected every 6 hr advanced by 2 hr each day, beginning at 0700 on day 11 and ending at 0500 on day 14.

Cows were milked at 0630 and 1830 hr daily and individual milk weights recorded. Milk samples (AM, PM composite) were obtained once each period for analyses of protein, fat, lactose, SCC, and MUN.

Fermentation profiles were measured on day 11. Rumen fluid was collected with a suction strainer just prior to feeding (0 hr) and at 3, 6, 9, and 12 hr after feeding.

Cows were pulse dosed prior to the A.M. feeding on day 11 with CoEDTA to estimate liquid passage. Samples of rumen fluid were collected just prior to dosing (0 hr) and 3, 6, 9, 12, and 24 hr following dosing.

On day 14 at 0700 hr rumen contents were manually removed, weighed, mixed by hand, and sampled in triplicate to measure ruminal volume and solids passage rate.

Results and Discussion

Ingredient and chemical composition of experimental diets are reported in Table 1. Dietary treatments had no effect on DMI, milk production, production efficiencies, milk

component percentages and yield, and concentrations of MUN (Table 2).

Apparent total tract digestibilities of DM, organic matter (OM), CP, NDF, ADF, and starch were similar for all diets (Table 3). Similar energy densities (NE_L) of experimental diets (Table 1) as well as production responses (Table 2) support the similar digestibility coefficients.

Ruminal pH is an acceptable and accurate indicator of the effectiveness of fiber. As reported in Table 4, average ruminal pH was not different among diets, indicating that the partial replacement of corn silage and alfalfa hay with WCGF or SHSL produced levels of effective fiber similar to the control diet.

Similar concentrations of ruminal NH_3, free amino acids, and peptide N (Table 4) indicate that protein degradation and carbohydrate fermentation were not greatly different among diets. These findings were expected because diets in this study were formulated to have similar amounts of total crude protein and ruminally degradable protein.

Total volatile fatty acid concentrations did not differ among diets, but the WCGF and SHSL diets decreased ($P<0.05$) molar proportions of acetate and increased ($P<0.05$) molar proportions of propionate (Table 4), likely due to lower amounts of alfalfa hay in these diets. The molar ratio of acetate to propionate, often associated with milk fat depression, decreased ($P<0.05$) in cows fed WCGF or SHSL, but milk fat percentages and yield (Table 2) were not affected. No differences were observed in ruminal proportions of butyrate, isobutyrate, isovalerate, and valerate (Table 4). Rumen fill (total, DM, OM, and liquid) and solid and liquid passage rate (%/hr) were similar across treatments (Table 5).

Conclusion

Inclusion of WCGF or SHSL at 20% of dietary DM as a partial replacement for alfalfa hay, corn silage, corn grain, and SBM in diets fed to lactating dairy cattle supported performance similar to the control diet. In addition, combining WCGF or SHSL with corn silage and alfalfa hay maintained milk fat yields and ruminal pH, thereby demonstrating that WCGF and SHSL served as effective sources of fiber when fed at 20% of dietary DM. These results indicate that WCGF and SHSL can serve as alternative feedstuffs in diets fed to lactating dairy cattle.

Acknowledgments

Funding was provided by Minnesota Corn Processors, Inc., Marshall, Minnesota and the Kansas State University Agricultural Experiment Station. Sincere appreciation is expressed to C.K. Armendariz for laboratory assistance and personnel at the Kansas State University Dairy Teaching and Research Center and Feed Processing Center for their assistance during these experiments.

Table 1. Ingredient and Nutrient Composition of Diets

	Diet[1]		
Item	Control	WCGF	SHSL
Ingredient	----------% of dry matter----------		
Alfalfa hay	30.00	20.04	20.12
Corn silage	15.00	10.02	10.06
Corn grain	32.05	27.03	30.17
WCGF	-	20.04	-
SHSL	-	-	20.12
Whole cottonseed	9.30	9.30	9.34
Solvent soybean meal	4.39	-	1.40
Expeller soybean meal	3.30	7.71	3.32
Fish meal	1.30	1.31	1.31
Molasses	1.00	1.00	1.01
Dicalcium phosphate	0.88	0.59	0.18
Limestone	1.36	1.54	1.62
Sodium bicarbonate	0.75	0.75	0.67
Magnesium oxide	0.21	0.21	0.22
Trace mineralized salt[2]	0.32	0.32	0.32
Vitamin ADE premix[3]	0.11	0.11	0.11
Vit E premix	0.02	0.02	0.02
Sodium selenite premix[4]	0.01	0.01	0.01
Nutrient			
Dry matter, %	82.8	79.7	82.1
Crude protein, %	18.7	18.7	18.7
RUP, %	7.4	7.6	7.7
ADF, %	17.1	15.9	19.5
NDF, %	25.7	28.7	28.9
NE_L, Mcal/kg	1.65	1.69	1.64
NFC[5], %	44.8	42.2	41.9
Calcium, %	1.26	1.25	1.36
Phosphorus, %	0.61	0.60	0.56
Sulfur, %	0.52	0.45	0.48

[1]C= Control, WCGF= Wet corn gluten feed, SHSL= pellet containing 75% raw soybean hull, 25% corn steep liquor (DM basis).

[2]Composition: not less than 95.5% NaCl, 0.24% Mn, 0.24% Fe, 0.05% Mg, 0.032% Cu, 0.032% Zn, 0.007% I, 0.004% Co.

[3]Contributed 5,733 IU vitamin A, 2,866 IU vitamin D, 17 IU vitamin E per kg diet DM.

[4]Contributed 0.06 mg Se per kg of diet DM.

[5]NE_L, NRC, 2001.

[6]Nonfiber carbohydrate = 100 – (%NDF + %CP + %Ether Extract + %Ash).

Table 2. Effects of Diet on Performance of Cows

	Diet[1]			
Item	Control	WCGF	SHSL	SEM
DMI, lb/d	36.2	39.7	37.9	6.00
Milk, lb/d	48.4	58.9	53.1	9.00
ECM[2], lb/d	46.3	55.1	50.9	10.2
ECM/DMI	1.33	1.36	1.35	0.13
Milk fat, %	3.33	3.04	3.16	0.33
Milk fat, lb/d	1.60	1.83	1.74	0.42
Milk protein, %	2.82	2.88	2.87	0.07
Milk protein, lb/d	1.37	1.70	1.52	0.26
Milk lactose, %	4.81	4.77	4.74	0.19
Milk lactose, lb/d	2.34	2.80	2.54	0.49
MUN, mg/dL	15.1	13.9	14.7	1.00
SCC × 1000	200	144	189	80.5

[1]WCGF = Wet corn gluten feed, SHSL= pellet containing 75% raw soybean hull, 25% corn steep liquor (DM basis).

[2]Energy corrected milk.

Table 3. Percent Apparent Total Tract Digestibility of Diets

	Diet[1]			
Measurement	Control	WCGF	SHSL	SEM
Dry matter	71.3	71.3	72.2	2.1
Organic matter	73.2	73.0	73.4	2.0
Crude protein	72.2	72.9	73.9	2.1
NDF	62.6	63.7	62.8	2.7
ADF	57.9	57.6	60.0	3.6
Starch	89.6	91.4	87.8	2.2

[1]WCGF = Wet corn gluten feed, SHSL= pellet containing 75% raw soybean hull, 25% corn steep liquor (DM basis).

Table 4. Rumen Measurements

	Diet[1]			
Item	Control	WCGF	SHSL	SEM
PH	6.22	6.20	6.22	0.14
Ammonia, mM	8.83	8.83	9.04	1.17
Free amino acids, mM	1.80	2.48	1.72	0.51
Ruminal peptide N, mM	3.79	4.70	4.58	2.30
Total VFA, mM	104.6	97.6	98.8	8.07
VFA, mol/100 mol				
Acetate	66.1[a]	63.4[b]	64.1[b]	0.83
Propionate	19.5[b]	22.9[a]	22.6[a]	1.33
Butyrate	10.6	10.2	9.7	0.58
Isobutyrate	1.10	1.07	1.09	0.11
Isovalerate	1.38	1.23	1.24	0.11
Valerate	1.30	1.23	1.19	0.056
Acetate:propionate	3.38[a]	2.79[b]	2.89[b]	0.21

[1]WCGF = Wet corn gluten feed, SHSL= pellet containing 75% raw soybean hull, 25% corn steep liquor (DM basis).

[a,b] Means within item with dissimilar superscript letters differ ($P<0.05$).

Table 5. Rumen Kinetic Measurements

	Diet[1]			
Measurement	Control	WCGF	SHSL	SEM
Rumen fill, lb				
Total	156	173	158	9.4
Dry matter	20.1	22.3	21.6	2.0
Organic matter	17.6	19.8	19.0	2.0
Liquid	135	150	137	7.7
Passage rate, %/hr				
Solid	9.4	8.2	8.2	2.2
Liquid	13.2	12.7	13.1	1.5

[1]WCGF = Wet corn gluten feed, SHSL= pellet containing 75% raw soybean hull, 25% corn steep liquor (DM basis).