Feeding Cows During Drought: Forage Substitute and By-Product Feeding

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Take Home Message: Use of forage substitutes in low starch / high byproduct diets can maintain good milk production and components in late lactation cows. Intakes increased, and feed efficiency and income over feed costs were lower than on a high forage/higher starch TMR. Dietary phosphorus contents were also greater than with the high forage TMR because of the byproducts used. There was a suggestion that feeding the highest amount of wheat straw may have increased mobilization of body tissues, so body condition should be watched carefully with these types of rations.

The drought has made this a challenging year. Feed prices are high and forage may be limited in both quality and quantity. So, what are our options for feeding cows? We know that dairy cows need fermentable and physically effective feeds to provide nutrients and maintain good rumen function. Common forage substitutes such as sugar beet pulp or straw provide either very fermentable or very physically effective fiber sources, respectively. In dealing with high feed prices, replacement of purchased corn grain or soybean meal with less expensive by-product feeds could reduce cost of the ration. However, a challenge is that formulating rations based largely on forage substitutes and byproducts has not been well explored. Do they need more effective fiber to keep byproduct fiber in the rumen to be digested? We ran an experiment to test some of the possibilities.

The objective of the feeding trial was to evaluate performance of lactating dairy cows offered different combinations of forage substitutes (wheat straw = more effective fiber, and sugar beet pulp = more fermentable) in diets that were relatively low in forage and supplemented solely with byproducts (no corn, no soy). Forty-eight late lactation cows, including 8 that were ruminally cannulated were used; cows averaged 1.3 lactations, 71 lb milk, 1442 lb body weight, and 280 days in milk at the start of the trial. Cows were offered a high forage TMR (covariate diet) in the first 2 weeks of the study, and then switched to 1 of 4 experimental diets for 4 straight weeks of feeding (Table 1). The experimental diets contained only 40% true forage (corn & alfalfa silages), and differed in the amount of chopped wheat straw or sugar beet pulp pellets they contained, ranging from 0% straw + 12% beet pulp to 9% straw + 3% beet pulp. All other ingredients were kept in the same proportions in all diets. Molasses was included to bind the rations together and reduce sorting. Diets contained monensin.

When analyzing the results, the cow responses from the initial 2 week feeding period on a common TMR was used to adjust the responses on the experimental diets so that results took into account the relative change in performance of individual cows. One of the cannulated cows was omitted from the performance evaluations because of low milk production (12 lb / day) and she was used only for rumen and fecal pH measures.

Results

Compared to the "normal" higher forage/higher starch TMR, the experimental rations contained a lower proportion of NDF from forage (NDF from corn & alfalfa silages, and chopped wheat straw). Ranges of 0.8 to 0.95 of bodyweight as forage NDF have been recommended; the experimental diets were below and above these values. Starch content of the experimental diets was

less than half as much as is commonly included in lactating dairy cow diets in the Midwest and Northeast and two-thirds higher in phosphorus (Table 1).

Dry matter intake was 9 lb greater overall on the high byproduct/low forage diets as compared to the high forage TMR (57.4 vs 48.4 lb, respectively, simple averages). Intake declined as straw replaced sugar beet pulp in the rations (Table 2). Milk production tended to decline, but the total decrease was 3 lb of milk as straw increased from 0 to 9%. Butterfat % tended to decline and then increased as straw increased; milk protein % did not change across diets. With the changes in milk and component production, fat yield did not change across diets, whereas milk protein yield declined. Milk urea nitrogen rose as straw increased; the MUN at 9% straw was or tended to be greater than the responses at lesser amounts of straw. Despite the slight increase at 3% straw, 3.5% fat- and protein-corrected milk production efficiency did not differ across diets. Milk nitrogen efficiency tended to

Table 1. Feed and chemical compositions of study diets (% of dry matter).

	Covariate	------Chopped Wheat Straw %-------			
Feed	Diet	0	3	6	9
Corn Silage	28.6	20	20	20	20
Alfalfa Silage	32.4	20	20	20	20
Chopped wheat straw	---	0	3	6	9
Sugar beet pulp	---	12	9	6	3
Distillers grains	4.0	8	8	8	8
Corn gluten feed	---	25.5	25.5	25.5	25.5
Whole cottonseed	---	5	5	5	5
Vitamin & Minerals	2.4	2.5	2.5	2.5	2.5
Molasses 80:20 cane:whey	---	7	7	7	7
High moisture corn	20.7	---	---	---	---
Roasted soy beans	7.9	---	---	---	---
High protein soybean meal	3.7	---	---	---	---
Sodium bicarbonate	0.25	---	---	---	---
Salt	0.13	---	---	---	---
Diet dry matter, %	45.8	52.6	54.8	53.8	54.0
As % of diet dry matter					
Crude protein	16.4	16.9	16.6	16.4	16.2
NDF	30.4	33.1	34.4	35.6	36.9
Starch	27.8	10.7	10.8	10.8	10.8
Nonfiber carbohydrate	41.5	33.1	31.8	30.6	29.3
Ca	1.06	0.98	0.95	0.92	0.90
P	0.38	0.60	0.60	0.60	0.60
K	1.72	1.63	1.67	1.70	1.73
Mg	0.44	0.46	0.45	0.45	0.44
S	0.24	0.36	0.35	0.34	0.34
Forage	61	40	43	46	49
Forage NDF/Diet NDF, %	80	51	56	61	66
Forage NDF % of BW	0.85	0.66	0.72	0.84	0.98

NDF = neutral detergent fiber analyzed with sulfite and amylase, BW = body weight

Table 2. Production performance and efficiency on experimental diets.

	------Chopped Wheat Straw %-------					*P*-values	
Measure	0	3	6	9	SED	linear	quadratic
Dry matter intake, lb	59.4	57.1	57.1	56.1	1.4	0.03	0.51
Dry matter intake, % BW	3.96	3.83	3.88	3.80	0.09	0.12	0.70
Milk, lb	70.9	72.0	69.4	68.0	1.95	0.08	0.37
Fat, %	4.26	4.17	4.19	4.53	0.16	0.11	0.06
Protein, %	3.31	3.27	3.27	3.27	0.05	0.44	0.65
3.5% FPCM, lb	78.7	79.2	76.3	75.7	2.9	0.20	0.79
MUN, mg/dl	10.0	10.9	10.6	12.0	0.46	<0.01	0.48
Fat, lb	3.04	3.04	2.91	3.02	0.14	0.67	0.58
Protein, lb	2.34	2.36	2.28	2.16	0.07	0.02	0.18
3.5% FPCM/DMI	1.34	1.41	1.34	1.35	0.052	0.83	0.48
Milk N/Intake N	0.23	0.24	0.24	0.23	0.008	0.97	0.08
Body weight change, lb	70	59	55	55	14	0.27	0.56

3.5% FPCM = 3.5% fat- and protein- corrected milk, DMI = dry matter intake, N = nitrogen, SED = standard error of the difference.

increase and then decrease with increasing wheat straw. Body weight increased on all diets, but we don't know to what extent this was due to increased gut fill; no major, obvious condition score changes were noted, but body condition was not monitored in this study.

Cows were fed the covariate and forage substitute/high byproduct diets a month apart, so the change in DIM had to be taken into account, but, even so, 3.5% fat- and protein-corrected milk did not differ between them (75.3 vs 76.2 lb, least squares means, P=0.48). Because of the large difference in dry matter intake, the efficiency of production for 3.5% fat- and protein-corrected milk (1.50 vs. 1.28, P<0.01) and milk N/feedN (0.27 vs 0.23, least squares means, P=0.02) were greater for cows on the covariate diet.

Speaking to the influence of effective fiber sources, the amount of time cows spent ruminating and eating increased as the amount of straw increased (linear increase in both, P<0.01; Figure 1).

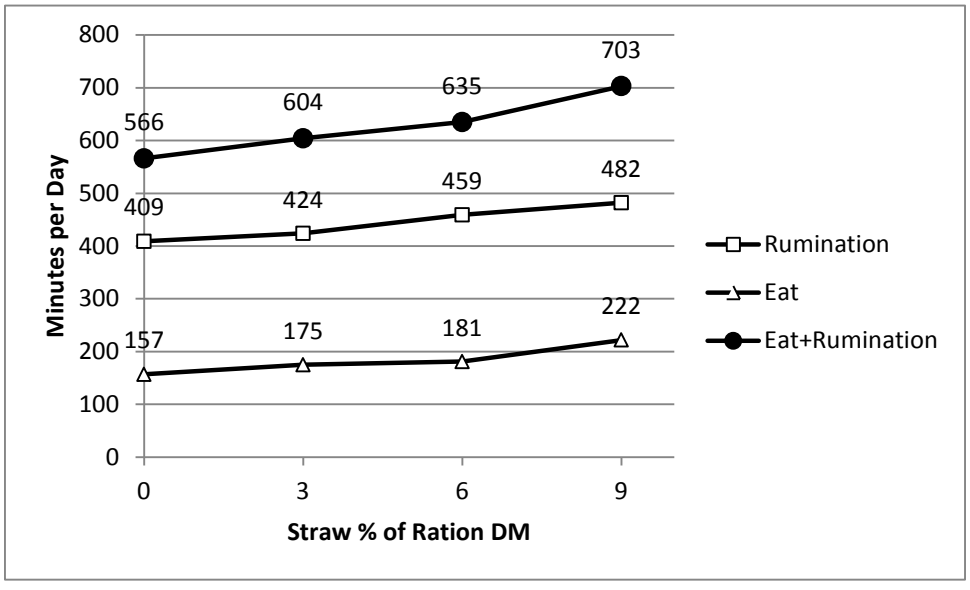

Figure 1. Minutes per day that cows spent ruminating or eating.

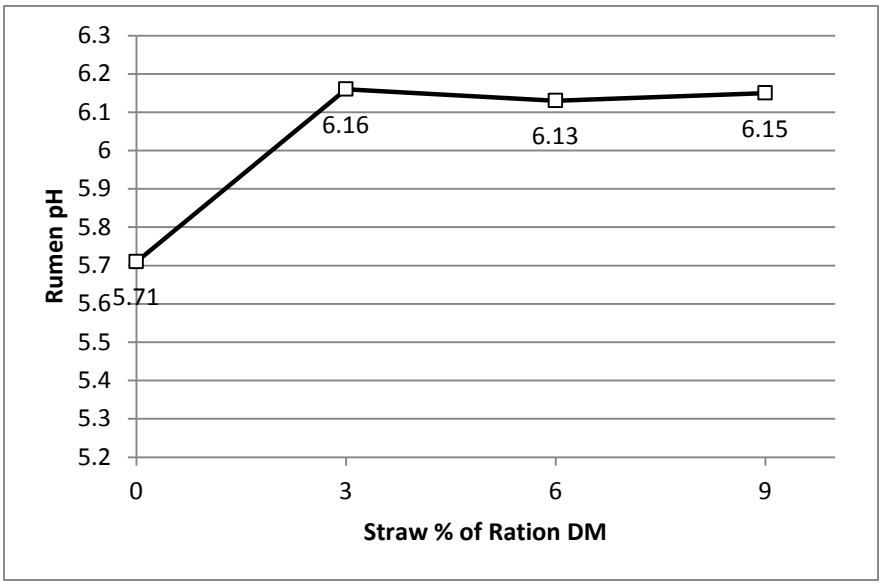

Figure 2. Rumen pH (average of 0 and 4 hour sampling times; these did not differ from each other).

Increased rumination/ chewing would deliver more saliva and buffer to the rumen. That affected ruminal pH (Figure 2), where the pH of the 0% straw diet was lower or tended to be lower than for the other diets (diet effect $P<0.01$; 0% straw different from other diets, $P<0.02$). What was strange was that rumen pH did not change between right before and 4 hours after feeding on the experimental diets ($P=0.73$). This is different than what we see with our common diets that are higher in starch; rumen pH declines after feeding and usually hits its low point within 6 hours (covariate diets had ruminal pH averaging 6.3 and 6.0 just before and 4 hours after feeding, respectively). The low pH noted on the 0% straw diet would likely slow down but not stop rate of fiber digestion, which would be important for digestion of fibrous byproducts. Fecal pH did not differ by diet ($P>0.24$) suggesting that ruminal escape of carbohydrates that would ferment appreciably in the hindgut were not an issue or different among diets (6.39, 6.52, 6.43, and 6.48 for 0, 3, 6, and 9% straw, respectively; 6.51 for covariate diet).

Income over feed costs increased as straw inclusion increased as cows largely maintained production and intakes declined; also, wheat straw is less expensive than sugar beet pulp. Although the 9% straw diet gave a $0.49 advantage over the 6% straw diet, caution is urged; the increase in butterfat % and MUN as intake declined on the 9% diet may suggest body condition mobilization greater than with the other diets. That could be a problem if done over an extended period of time.

Table 3. Income over feed costs for study diets.

Item	0% straw	3% straw	6% straw	9% straw	Covariate
DM Intake, lb	59.4	57.1	57.1	56.1	48.4
Ration DM $/cwt	14.44	14.14	13.84	13.54	14.57
Ration Cost, $	8.58	8.07	7.90	7.60	7.05
Milk, $/cwt	19.59	19.28	19.32	20.00	19.50
Milk value	13.89	13.88	13.41	13.60	14.08
Income/Feed	5.31	5.81	5.51	6.00	7.03

As fed feed prices/ton: corn silage, $60; alfalfa silage, $85; chopped wheat straw, $115; distillers grains with solubles, $287; sugar beet pulp, $293; corn gluten feed, $245; whole cottonseed, $359; molasses 80:20 cane:whey blend, $295; high moisture shell corn, $202; roasted soy, $530; high protein soybean meal, 492; vitamin and mineral mix, $900; salt, $98; sodium bicarbonate, $315.

Milk prices per hundredweight calculated on milkpay.com using milkfat and protein percentages from each treatment and Midwest area prices.

Verification of what was actually happening with the 9% straw diets is needed to understand whether the diet formulation needs to change to support late lactation production, reproduction, and maintenance or increase in body stores. Although the high forage covariate diet had the greatest ration cost per hundredweight, the milk production similar to cows on the forage substitute/high byproduct diets but at lower intakes combined to give the highest income over feed costs.

Summary

Late lactation cows maintained performance on the low forage, low starch diets based on byproduct feeds. Using up to 6% wheat straw gave good performance without noticeable body weight loss/condition change. If such diets are tried, cows should be carefully observed to assure that body weight is maintained. The high phosphorus content of the byproducts elevated phosphorus content in the diet; not desirable long term for nutrient management issues and impact on the environment. On the 60% forage "more standard" lactating cow diet, cows gave similar milk production performance, had lower intakes, more efficient production, and better income over feed costs than cows on the experimental diets. However, the forage substitute/high byproduct diets are viable substitutes to feed lactating dairy cows when other more traditional feeds are in short supply.

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