

## ALTERNATE FEEDING OF DIETARY CONCENTRATE FOR DAIRY COWS

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### Story in Brief

Four intestinally cannulated dairy cows received either a 65, 50, or 35 percent concentrate diet twice daily (65C, 50C and 35C) or the 65 percent concentrate diet was given in the morning and the 35 percent concentrate diet was offered in the afternoon (ALT). Animals were fed at 90 percent of ad libitum intake in a 4x4 Latin square experiment. Fluid passage rate was higher ( $P < .05$ ) for the 35C and 50C than for the 65C diet and greater for the 35C than the ALT diet ( $P < .05$ ). Ruminal organic matter digestion tended to decrease with increasing roughage level, while the ALT cows tended to have the lowest ruminal organic matter digestion. Ruminal starch digestion was slightly greater with the ALT than the 50C diet, while total tract starch digestion tended to be greater for the 50C diet than for the ALT diet. Ruminal N digestion tended to be lowest for 35C and ALT treatments though microbial efficiency tended to be greatest with the ALT diet. In a second study, two heifers equipped with ruminal cannulas were assigned to similar 50C and ALT treatments in a crossover experiment. Rate of in situ dry matter disappearance of ground alfalfa, rolled corn and soybean meal were all slightly greater when dacron bags containing substrate were introduced at the evening feeding, but rate constants of dry matter disappearance were similar with the two feeding methods.

### Introduction

Grain is added to diets for lactating dairy cows to a high enough level to increase energy intake and milk production, but excessive grain levels cause digestive disturbances (acidosis, displaced abomasum) or reduce the fat content of milk. Availability of forage in many areas of the country would permit more roughage to be fed if milk production could be maintained, whereas in other areas, good quality forage is scarce. Ruminal digestion tended to increase with twice daily feeding of 95, 88 or 65 percent concentrate diets to beef steers (Goetsch et al., 1984). The objectives of this study were to investigate effects of alternating the level of roughage twice daily on site of digestion and ruminal passage rates in lactating dairy cows.

### Experimental Procedures

#### In Vivo Trial

Four mature dairy cows (1056 lb) in late lactation fitted with duodenal cannulas were used in a 4x4 Latin square experiment with 14 day periods. During the first 8 days of each period, cows were ad libitum fed at 0300 and 1500 hr while during collection, intake was restricted to 90 percent of ad libitum. Cows were milked at 0430 and 1630 hr. Treatments consisted of 65, 50 or 35 percent concentrate diets (Table 1)

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**Table 1. Diet compositions, in vivo trial (% of dry matter).**

Ingredient	Diet		
	65C	50C	35C
Sorghum silage	46.7	66.7	86.7
Corn grain, ground	29.9	18.7	7.5
Soybean meal	12.3	7.7	3.1
Dicalcium phosphate	1.2	.7	.3
Salt, trace mineralized	.3	.2	.1

fed at 0300 and 1500 hr (65C, 50C and 35C) or the 65C diet offered at 0300 and the 35C diet fed at 1500 hr (ALT). Feeds were mixed once daily (0800 hr) in a cement mixer and feed refusals were weighed and discarded each day. Feed and ort samples were taken the last six days of each period. Amounts of the 65C and 35C diet fed for ALT treatment were equal.

Particulate markers (dysprosium labeled silage and ytterbium labeled concentrate) and a fluid marker (CoEDTA crystals) were mixed with the feed on day 10 (1500 hr) and day 11 (0300 and 1500 hr) for measuring passage rates. Duodenal and fecal samples were obtained on days 11 through 14. Individual fecal samples were analyzed for dry matter (DM), dysprosium, ytterbium and cobalt content. Compositd and ground feed, duodenal and fecal samples were subjected to all or part of the following analyses: DM, ash, kjeldahl nitrogen (N), acid detergent fiber (ADF), starch, acid insoluble ash (AIA), nucleic acid- N and ammonia N. Ruminal and total digestibility estimates are based on ratios of feed constituents to AIA concentration in feed, duodenal and fecal composite samples.

#### In situ trial

Two beef heifers, fitted with ruminal cannulas, were used in a crossover experiment. Animals received a 50 percent concentrate diet (Table 2) twice daily at 12 hr intervals (50C) or a 65 percent concentrate diet in the morning and a 35 percent concentrate diet in the evening at 1.25 percent of body weight (DM). Dry matter disappearance

**Table 2. Diet compositions, in situ trial (% of dry matter).**

Ingredient	Diet		
	65C	50C	35C
Corn grain, rolled	51.8	39.9	27.9
Alfalfa hay, chopped	12.5	25.0	37.5
Prairie hay, chopped	6.3	12.5	18.8
Alfalfa, dehydrated	4.9	3.8	2.6
Cottonseed hulls	11.4	8.8	6.1
Molasses, cane	4.1	4.1	4.1
Limestone	.40	.30	.20
Salt, trace mineralized	.40	.30	.20
Urea	.08	.06	.04

rate constants of ground alfalfa hay, dry rolled corn and soybean meal from dacron bags suspended in the rumen were measured for 12 hr after each feeding. Rate constants were calculated by regressing over time the natural log of residual substrate DM corrected both for the blank bag and indigestible feed (72 hr residues) and expressed as a fraction of the preceding residue.

## Results and Discussion

### In vivo trial

Ad libitum organic matter (OM) intake was lowest ( $P < .05$ ) for the 35C cows (11.4 versus 14.9, 15.0 and 14.6 kg/day for 35C versus 65C, 50C and ALT cows, respectively). Ruminal fluid passage rate was higher ( $P < .05$ ) with 35C and 50C diet than for the 65C diet and greater ( $P < .05$ ) for the 50C than the ALT diet. Fluid passage increased linearly ( $P < .06$ ) with decreasing concentrate level for the 65C, 50C and 35C treatments. Passage rates of concentrate and forage (Table 3) did not differ ( $P > .05$ ). All means are slightly lower than those reported by Colucci et al. (1982), but similar to those reported by Hartnell and Satter (1979). These two studies reported that passage rates of concentrate and forage increased when forage level increased, but their cows were at higher production levels and had greater feed intake than cows in our experiment. Colucci et al. (1979) suggested that concentrate level has less effect on passage rate when animals are limit fed.

Ruminal and total tract OM digestion tended to decrease with increasing roughage level and tended to be lowest for cows fed the ALT diet. Feeding diets of 80 percent concentrate in the morning and 40 percent in the evening had little effect on total tract OM digestion in sheep (Galyean, personal communication). With steers, ruminal and total tract OM digestion was slightly greater with alternately fed 95 and 65 percent concentrate diets than a mixed 80 percent concentrate diet (Goetsch et al., 1984).

Ruminal and total tract starch digestion coefficients (Table 4) tended to be greatest for 35C cows. A quadratic effect ( $P < .06$ ) for the 35C, 50C and 65C treatments of concentrate level on ruminal starch digestion was observed. Lower DM intakes and the high proportions of roughage consumed by cows fed the 35C diet probably increased ruminal pH and starch fermentation. Trends for lower ruminal starch disappearance with the 50C and ALT diets may be due to competition between starch and fiber digestion. Coupled with a slightly faster passage of concentrate (Table 3), reduced digestion rate would lower starch disappearance in the rumen. Concentrate passage rate (Table 3) and ruminal starch

Table 3. Passage rates, in vivo trial.

Item	Diet			
	65C	50C	35C	ALT
Fluid, %/h	4.9 <sup>a</sup>	5.8 <sup>bc</sup>	6.3 <sup>c</sup>	5.1 <sup>ab</sup>
Concentrate, %/h	5.0	5.2	4.9	5.4
Silage, %/h	4.2	3.9	4.1	4.3

a, b, c Means in a row with different superscripts differ ( $P < .05$ ).

digestion were negatively related ( $r = -.42$ ;  $P < .11$ ) and total tract starch digestion tended to be lowest for the ALT diet. Reduced microbial fermentation in the large intestine may be responsible. Microbes in the large intestine may adapt to specific substrates. When digesta greatly fluctuates in supply and composition as with the ALT diet, availability of time and substrate may limit microbial adaptation. Similar effects with meal-fed compared to nibbling animals might be expected.

Ruminal ADF digestion (Table 4) was similar for all treatments and correlated negatively with forage passage rate ( $r = -.50$ ;  $P < .05$ ). With chopped roughages and silages, this relationship might be expected. With long stemmed roughages which would need greater reduction in particle size to pass out of the rumen, passage rate should be longer and ruminal fiber digestion should be more extensive.

Ruminal N digestion (Table 4) was slightly greater for 65C and 50C than for 35C and ALT diets. Total tract N digestibility decrease linearly ( $P < .03$ ) with increasing roughage level. N digestibility was lowest for the ALT diet, probably due both to the high microbial N (MN) flow to the duodenum and the low quantities of OM fermented in the rumen. Duodenal flow of MN tended to increase with forage passage rate ( $r = .40$ ;  $P < .12$ ). Since forage requires more extensive microbial colonization for fermentation than does concentrate, MN flow would be expected to be more related to passage rate of forage than of concentrate.

Table 4. Site and extent of digestion at various sites, in vivo trial.

Item	Treatment			
	65	50	35	ALT
Organic matter, %				
Ruminal, apparent	53.5	54.4	51.9	47.0
Ruminal, true	61.0	59.9	58.3	54.8
Total tract	64.8	62.9	63.9	52.6
Starch, %				
Ruminal	58.2	40.4	74.0	46.2
Total tract	85.4	81.5	89.9	73.7
Fiber, acid detergent, %				
Ruminal	60.2	64.4	58.9	57.8
Total tract	85.4	81.5	89.9	73.7
Nitrogen, %				
Ruminal	58.1	59.0	47.7	47.4
Total tract	67.0	58.3	52.5	48.4
Microbial efficiency, g MN/kg organic matter fermented	12.2	9.0	12.3	17.1

#### In situ trial

In situ rate constants of DM disappearance were measured for ground alfalfa, rolled corn and soybean meal (Table 5). Disappearance rates for alfalfa were higher with the ALT than the 50C diet. This does not agree with the ruminal ADF digestion coefficients from the in vivo experiment (Table 4). Rate constants for DM disappearance for alfalfa

**Table 5. Dry matter disappearance, in situ trial.**

Diet	Item	50C <sup>a</sup>		ALT <sup>a</sup>	
		0800 <sup>b</sup>	2000 <sup>b</sup>	0800	2000
Alfalfa	4 h loss	34.8	35.2	36.3	35.8
	Rate, 4 to 12 h	.049	.080	.077	.089
Rolled corn	4 h loss	6.0	6.8	5.6	7.0
	Rate, 4 to 12 h	.027	.024	.022	.032
Soybean meal	4 h loss	31.1	32.1	31.0	31.6
	Rate, 4 to 12 h	.039	.052	.042	.055

<sup>a</sup>Treatment.

<sup>b</sup>Time in situ incubation started.

were higher for both treatments when bags were introduced at the 2000 hr feeding than at the 0800 hr offering, with a greater difference for 50C heifers. No treatment differences in soybean meal DM disappearance were detected. Animals, intake level and diet differed between the in situ and in vivo trials. A greater rate DM disappearance during the evening than the morning may relate to behavioral patterns. Greater resting and rumination at night could affect ruminal conditions. Differences in ruminal fluid volume and dilution rate have been previously observed between morning and evening meals in steers (Goetsch et al., 1984). No merit for alternation of the level of dietary concentrate level for dairy cows was shown in this study, as neither site, extent, nor rate of digestion was markedly altered. More drastic level changes and higher feed intakes might show more advantage to an ALT feeding system to reduce adverse associative effects.

#### Literature Cited

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