ALTERNATING LEVEL OF ROUGHAGE FOR STEERS FED HIGH CONCENTRATE DIETS

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Story In Brief

Level of dietary roughage was altered twice daily and effects on site of digestion and passage rates in steers were measured. In experiment 1, 95, 80 or 65 percent concentrate diets were fed twice daily (95C, 80C or 65C) or the 95C diet was fed in the morning and the 65C diet was given in the evening (ALT). Ruminal digestion of both organic matter (OM) and acid detergent fiber (ADF) tended to be highest for the ALT treatment (71.7 and 52.4 vs 70.0 and 43.1, 69.7 and 34.6, 64.9 and 42.0 percent OM and ADF digestion for ALT vs 95C, 80C and 65C diets, respectively). Ruminal starch disappearance for ALT and 95C diets tended to be higher than for the 80C and 65C diets. Ruminal escape of feed nitrogen (N) for the ALT diet (38.5 percent) was slightly greater than for the 80C diet (33.4 percent). In the second trial, steers were fed an 80 percent concentrate diet by offering a mix of concentrate and roughage at 0900 and 2100 hr (M12) or at 0900 and 1200 hr (M3) or by feeding roughage at 0900 and concentrate at 1200 hr (RC) or vice versa (CR). Effects on site of digestion were negligible. Rate of passage from the rumen of fluid and particulate matter tended to be greatest for the CR diet.

Introduction

Roughages are fed to finishing cattle to prevent digestive disturbances. In some areas of the United States, availability and cost favor the use of higher levels of roughage in the diet. When mixed diets are fed, the mixture often has lower value than when the roughage and concentrate are fed separately. This is called an "associative effect". A negative associative effect may be due to presence of components of both fibrous and concentrate feeds, each of which requires a different type of microbial population for digestion. Optimal feeding methods for medium roughage diets could differ from those for high concentrate diets. The objective of this study was to investigate the effect of alternating dietary concentrate level on site and extent of digestion and passage rate.

Experimental Procedure

Experiment 1

Four beef steers (1181 lb) fitted with ruminal and duodenal cannulas, were used in a 4x4 Latin square experiment. Diets (Table 1) were fed at 1.25 percent of body weight (dry matter basis) at 12 hr intervals. Chromic oxide was included as an indigestible marker.

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Table 1. Diet compositions.

Trial	Experiment 1		Experiment 2
Diet	95C	65C	All
Ingredient, % of DM:			
Corn grain, rolled	83.3	53.8	67.3
Cottonseed hulls	5.0	5.0	0
Alfalfa hay,			
chopped	0	12.0	0
ground	0	0	8.7
Prairie hay, chopped	0	18.0	0
Sorghum silage	0	0	14.4
Soybean meal	5.0	5.0	4.3
Molasses, cane	5.0	5.0	4.3
Limestone	1.0	1.0	1.4
Salt, trace mineralized	.50	.50	.40
Dicalcium phosphate	.20	.20	.20
Chromic oxide	.20	.20	.20

Treatments consisted of the 95 percent and 65 percent concentrate diets fed at both feedings (95C and 65C), a mixture of the above diets offered at both meals (80C) or offering the 95 percent diet at 0900 hr and the at both 65 percent diet at 2100 hr (ALT).

Pulse doses of fluid (CoEDTA) and particulate markers (ytterbium and dysprosium labeled rolled corn) were administered at morning and evening meals to monitor passage rates. Feed, ruminal, duodenal and fecal samples were collected and subjected to all or part of the following analyses; dry matter (DM), ash, kjeldahl N-acid detergent fiber, (ADF), starch, chromium, nucleic acid-N, ammonia-N, cobalt, ytterbium and dysprosium.

Experiment 2

Four steers (876 lb), fitted with ruminal and duodenal cannulas, were used in a 4x4 Latin square experiment. Treatments consisted of a mixture of concentrate (rolled corn with 10 percent ground alfalfa) and sorghum silage (39.4 percent DM and approximately 25 percent grain; Table 1). Feeding methods included the mixed diet offered at 0900 and 2100 hr (M12) or 0900 and 1200 hr (M3), silage fed at 0900 hr with concentrate at 1200 hr (SC) and concentrate fed at 0900 hr with silage fed at 1200 hr (CS). Intake was limited to 63 g DM/kg metabolic body weight. Concentrate intake was 81 percent of the total daily allotment. Passage rates and digestibilities were measured by procedures similar to those in experiment 1.

Results and Discussions

Experiment 1

Ruminal and total OM and starch digestibilities differed little with feeding method (Table 2). Excluding the ALT treatment, a linear effect of concentrate level on total OM digestibility was observed. The

Table 2. Digestibilities, experiment 1.

Item	Diet 95C	80C	65C	ALT
Organic matter, %				
Ruminal	70.0	69.7	64.9	71.7
Total tract	81.3	78.9	73.2	80.9
Starch, %				
Ruminal	75.5	69.9	67.7	75.7
Total tract	96.5	96.1	94.7	97.4
Fiber, acid detergent, %				
Ruminal	43.1	34.6	42.0	52.4
Total tract	42.9	53.1	53.6	55.9
Nitrogen				
Ruminal bypass of feed N, %	41.7	33.4	31.5	38.5
Total tract digestibility, %	61.6	64.2	58.3	66.4
Microbial efficiency,				
g MN/kg organic matter fermented	22.4	23.6	26.9	22.1

80C and 65C steers tended to have lower ruminal digestibilities than 95C and ALT animals. Reasons for this difference with the 65C treatment may include greater competition for digestion of starch and fiber and slightly greater fluid and particulate passage rates (Table 3). Comparison of these factors for 80C and ALT which provided an equal level of roughage intake, reveals a slightly lower fluid dilution rate for the ALT diet but similar particulate passage rates (Table 3). Within a feeding cycle, microbial types, metabolism, enzyme levels and activity changes may have permitted more adaptation to digest the feed constituents. Ruminal and total tract ADF digestion tended to be highest for the ALT diet although postruminal ADF digestion was slightly greater for the 80C diet. Slower fluid passage rates in ALT steers (Table 3) and decreased competition among microbes for digestion of resistant substrates could be involved. No differences in N digestion were detected (Table 2). Microbial efficiency (MOEFF) also was similar for all treatments though tending to increase with increasing roughage level in parallel with fluid dilution rate (Table 3). Correlations of .37 and .48 ($P<.07$) existed between MOEFF and microbial OM (MOM) with fluid dilution rate.

Table 3. Digesta kinetics, experiment 1.

Item	Time, h	Diet 95C	80C	65C	ALT
Ruminal fluid					
dilution rate, %/h	0900	5.01	5.86	6.22	5.44
	2100	4.67	5.09	6.13	4.81
volume, liters.	0900	92.2	82.1	82.4	91.8
	2100	104.5	102.3	91.0	94.1
Particulate passage					
rate, %/h	Mean	2.74	3.22	3.31	3.19

Fluid dilution rate was higher and ruminal volume was lower (P <.05) when CoEDTA was administered at 0900 than at 2100 hr (Table 3). For the 95C, 80C and 65C steers, a linear effect on fluid dilution rate was noted. Dilution rates for the ALT diet were slightly lower than for the 80C diet. Ruminal fluid volume also tended to be greatest for ALT so that fluid outflow rate (liter/hour) did not greatly differ. Greater (P>.05) fluid volume with the ALT diet could increase the microbe/substrate ratio. Coupled with a slightly slower passage rate, this might facilitate more extensive digestion of starch and fiber. Particulate k_2, thought to represent rate of ruminal outflow, tended to be lowest for the 95C diet.

Ruminal fluid dilution rate and particulate k_2 were negatively correlated with ruminal starch digestion (-.72, P<.01 and -.47, P<.07, respectively). Within treatments, similar relationships were only observed for the 65C diet (-.92, P<.08 and -.90, P<.11, respectively). Competition between microbes digesting fiber and starch digestion may have been greater with the 65C diet than with other diets. This could increase the lag time before digestion began.

Experiment 2

Differences in digestibility of OM, starch or N among treatments were small (Table 4). Ruminal ADF digestion for CR was lower (P<.07) than for RC. Lower ruminal starch disappearance was expected with the CR diet. Silage consumption at 3 h after concentrate feeding should increase the quantity of undigested feed particles pushed out of the rumen. Silage was used as a roughage since it would not be subject to as extensive hydration as dry roughages and should immediately occupy space in the rumen. However, a less digestible, more fibrous roughage could give a more prolonged response and increase ruminal motility. A dry roughage could increase water consumption which may increase the rate of outflow of digesta from the rumen. Analysis of duodenal samples at various times after feeding could detect such an effect.

Fluid dilution rate tended to be lowest for the M12 diet (Table 5) while ruminal fluid volume was greater (P <.05) for M12 than for RC and CR diets. Fluid dilution rate and volume were negatively related

Table 4. Digestibilities, experiment 2.

Item	Diet			
	M3	M12	RC	CR
Organic matter digestion, %				
Ruminal	75.7	78.0	75.7	77.3
Total tract	81.2	83.6	84.4	83.1
Starch digestion, %				
Ruminal	78.0	81.1	78.5	80.3
Total tract	90.7	92.8	94.0	92.6
Acid detergent fiber digestion. %				
Ruminal	67.3	65.7	69.8	60.3
Nitrogen				
Ruminal bypass of feed N, %	37.2	36.3	41.1	36.4
Total tract digestion	72.3	73.1	74.4	72.8
Microbial efficiency,				
g MN/kg organic matter fermented	7.4	7.3	7.9	7.6

Table 5. Digesta kinetics, experiment 2.

Item	Diet			
	M3	M12	RC	CR
Ruminal fluid				
dilution rate, %/h	4.6	4.9	5.2	5.3
volume, l.	55.1	48.4	42.7	38.1
Particulate passage				
rate, %/h	2.3	2.5	2.8	3.5

(r=-.47; P<.07). Particulate k_2 paralleled fluid passage rate (r=-.47; P<.07). The low level of feed intake may have prevented differences in digestion in this trial. In conclusion, site of digestion tended to be altered by feeding method in the first experiment without concurrent changes in passage rate. Interval feeding slightly altered dilution rates but had little effect on digestion site. Results are inconclusive concerning any benefit from alternate or interval feeding of roughage and concentrate diets to increase animal performance.