TRANSIT TIME MEASURED BY RARE EARTH ELEMENTS IN DAIRY COWS FED THREE DIETS OFFERED AT TWO LEVELS OF FEED INTAKE

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Introduction

Rate of passage of digesta affects both extent and site of digestion. However, there are few studies on dietary factors that influence retention time in high producing dairy cows. The objectives of this study were to compare the transit of 3 forages and associated concentrate in 3 diets distributed at 2 levels of feed intake in dairy cows in mid lactation.

Materials and Methods

Eleven cows in mid lactation (24 kg/d fat corrected milk, 580 kg LW) fitted with rumen fistula were used. Four cows were fed a maize silage based diet (MS) with a forage: concentrate ratio (F:C) of 65:35, 5 other cows were fed a grass silage based diet (GS) (F:C = 55:45) and 6 cows were fed a grass hay based diet (H) (F:C = 55:45). Two levels of feed intake (*ad libitum* and 80% of *ad libitum*) were compared in a crossover design with 24 day periods (14 d adaptation). Animals were fed twice a day (8 and 17 h). Forages were labelled by Ytterbium and concentrates by Europium as follows: cell contents of feedstuffs were extracted with EDTA (1 h at 90°C), then residues (approximately 850 g NDF/kg DM) were soaked 24 h in marker solution (20 g rare earth + 10 g citric acid/kg DM) and pH was maintained near 2.2. Labelled forages (0.9 kg) and concentrate (0.5 kg) were offered on day 15 before the morning meal and any uneaten fraction was placed into the rumen via the fistula after 30 min. Total faeces collections were performed during 9 days at 6, 9, 12, 16, 24, 28, 32, 36, 48, 54, 60 hours, then every 12 hours. The mean retention time (TMRT) of marked particles in the whole alimentary tract was calculated from the total quantities of markers excreted at each interval. Faecal concentration data were also fitted to a two compartment time independant model (Grovum and Williams, 1973) ($y = A\ e^{-k1(t-TT)} - A\ e^{-k2(t-TT)}$) where y and A are marker concentration, TT is time of first appearance of marker, k1 is the fractional rate constant of marker in the reticulorumen (T1 = 1/k1) and k2 is for a second compartment (T2 = 1/k2, rising part of the curve). Liquid ruminal turnover rate (k liq) was estimated at day 15 using Polyethylene glycol (PEG). After dosing into the rumen via the fistula, natural logarithm of marker concentration in rumen juice was regressed on time during 24 hours. Data were analysed with SAS program using separately for F and C the statistical model: $y = mean + F + L + C_{(F)} + FxL + C_{(F)}xL + E$ where F = feed (n = 3), L = level of intake, C = cow nested in feed and E = random residual.

Results and Discussion

The sum of T1 + T2 + TT gave an estimation of the total transit time very similar and well correlated (r = 0.98) to TMRT which can be considered as a reference value (table 1). Thus if T2 and TT separately are not very meaningful due to uncertain adjustment of the beginning of the curve, their sum and T1 are useful measures for partitioning TMRT in different part of the alimentary tract.

Total retention time of Ytterbium and Europium were slightly longer than values generally reported for rare earths in literature with the same kind of diets and cows (Hartnell and Satter, 1979; Shaver et al., 1986). The difference may be related to the special care taken during binding procedure of rare earths to avoid migration of markers.

Concentrate (39.4 h) moved faster than forages (56.3 h) in the total digestive tract. This difference was partly due to the reticulorumen (T1 = 29.1 h for F and 23.0 h for C) but also to the

TABLE 1. EFFECTS OF DIETS(D), FEED(F/C), FEEDING LEVEL(FL)(H/L) AND INDIVIDUAL COW(IC)

Item		Diet MS		Diet GS		Diet H		Cow effect	Random error
		H	L	H	L	H	L		
DM intake(kg/d)		18.4	15.4	17.0	14.0	18.0	14.6	1.5	0.9
k liq (%/h)		12.5	12.2	11.6	11.8	12.9	13.8	1.8	1.3
TMRT(h)	F	46.3	52.2	58.1	60.7	63.9	51.1	5.6	4.2
	C	35.0	36.3	40.0	43.2	41.8	37.0	3.4	3.1
T1+T2+TT(h)	F	47.8	52.2	57.4	62.4	65.0	50.2	6.6	5.4
	C	35.8	36.5	40.3	44.8	42.1	36.0	3.9	3.3
T1(h)	F	24.1	26.2	28.5	33.7	33.7	26.6	4.7	6.5
	C	19.4	19.8	24.3	28.0	25.1	20.1	3.6	2.8
T2(h)	F	10.9	13.3	12.3	13.4	15.3	12.2	2.4	1.7
	C	5.3	5.2	6.4	6.3	5.8	6.5	2.1	1.1
TT(h)	F	12.8	12.7	16.6	15.3	16.0	11.4	2.8	3.9
	C	11.1	11.5	9.6	10.5	11.2	9.4	2.2	2.3

second compartment of the model and to the delay (T2 + TT = 27.2 for F and 16.4 h for C). For concentrates, T2, TT and their sum were not correlated to kliq and so they probably describe postruminal transit. As the solute and particle phases do not behave independently in the hindgut (Faichney et Boston, 1983) it might be expected that postruminal transit of F anc C particles are not very different and that the difference observed between F and C in the sum T2 + TT (noted dFC) reflect some delay for foregut mixing and particle size reduction of forages. Transit of concentrate in the rumen was highly dependant on transit of the associated forage ($T1_{conc} = 6.2 + 0.34\ T1_{for} + 0.57$ dFC (n = 30, r = 0.81, RSD = 3.0)) ; C particles being probably entrapped between large and smaller F particles.

Effect of feeding level was quite low. TMRT slightly increased with reduced feed intake for maize and grass silage but the reverse occurred with hay. Apart from H diet, transit of concentrate and liquid ruminal turnover rate did not change significantly with level of intake. These results were probably related to the small variation in feeding levels used. Correlations between feeding level and transit time are generally obtained with larger variations of intake and often confounded with stage of lactation or level of milk production (Hartnell and Satter, 1979; Shaver et al., 1986).

Between cow variation for liquids and solids transit was large, often greater than mean treatment effects (table 1) and could not be related to variation in DM intake. Total retention time of F and C was shorter for MS diet compared to GS and H diets but difference was hardly significant for the compartments.

(Key Words: Transit Time, Rare Earth Elements, Dairy Cows)

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