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Ann. Rech. Vét. 1979, **10** *(2/3)*, 166-167.

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Undigested residues from a single meal appear in the faeces as if they flowed through two sequential compartments. Blaxter *et al.* (1956) suggested and Grovum and Williams (1973) concluded the faster turnover rate involved the rumen and slower rate involved post ruminal sites. These experiments were conducted to identify the intermediate sites within the tract causal of this two compartment like flow.

Material and Methods

Experiment 1 involved two mature Holstein steers with ruminal and abomasal cannulae fed unground grass hay. Ruminal digesta was obtained, extracted with neutral detergent solution, labelled with $^{141}CE\ Cl_3$, and together with cottonwood wood chips labelled with $^{169}Yb\ Cl_3$ dosed into the dorsal rumen immediately before feeding. Samples of rumen dorsal and ventral strata were obtained at six h intervals between 18 and 172 h and faeces between 0 and 172 h. Radioactivity was measured, expressed per unit dry matter (A) and fitted to a one compartment model:

$$Y = A_0\, e^{-k_2 t}.$$

Data from sites successive to introduction site were fitted to a two compartment model:

$$Y = A_0 \cdot \frac{k_2}{k_2 - k_1} \cdot (e^{-k_1 t} \cdot T \cdot e^{-k_2 t} \cdot T)$$

Experiment 2 involved eight cows grazing dormant grass pastures. Œsophageal samples of diet were extracted with neutral detergent solution, sieved into particles >1000 μm (labelled with $^{141}Ce(NO_3)_3$) and >425<1000 μm (labelled with $^{169}Yb(NO_3)_3$) and introduced into the rumen dorsal strata. Digesta and faecal samples were collected at eight h intervals between 8 and 112 h.

Results and Interpretation

Slower turnover rates of the two compartment model (2C) applied to faecal data were not significantly different from the same rate fitting abomasal and ventral rumen data for both ^{169}Yb and ^{141}Ce (table 1). Furthermore, these rates were not significantly different from the single exponential rates (1C) derived from rumen data suggesting outflow from the dorsal rumen and through the remaining gut segments acted as a single compartment. The failure of the 1C model to yield similar rates in the abomasum even when a time delay term was added and the better fit by the 2C model to ventral data, suggests a preceding compartment; presumably in the large particle strata of the dorsal rumen.

Similar data from larger number of individuals (expt. 2, table 2) provide further support for similarities between the single turnover rate of the 1C model (at the site of intro-

duction) and the slower turnover rates of 2C model (applied to successive sites). The faster turnover rate (k_1) of the 2C in rumen digesta can be interpreted as the rate meal introduced, labelled particles achieves uniformity by mixing with existing particles. The magnitude of k_1 is highly variable within site and between animal but generally decreased with particle size labelled and successive site sampled. The effect of successive site suggests mixing limitations at sites subsequent to the rumen as well (caecum?).

Conclusions

These results are interpreted to suggest the slower turnover compartment estimated from appearance of undigested residues in the faeces is the result of degradatory processes in the dorsal rumen digesta strata required for particle passage therefrom and through the successive sites. Mixing limitations encountered by newly injected particles is the suggested cause of the faster turnover and consequently smaller compartment.

Table 1. — Single (1C) or slower (2C) turnover rates by digesta site, expt. 1

Marker & Model	Rumen Strata		Abomasum	Faeces
	Dorsal h^{-1}	Ventral h^{-1}	h^{-1}	h^{-1}
^{169}Yb-Wood Chip				
1C	.0163	.0168	.0067[b]	—[c]
2C	—[c]	.0175	.0157	.0146
^{141}Ce-Forage Fiber				
1C	.0268	.0213	.0116[b]	—[c]
2C	—[c]	.0256	.0338	.0295

[a] Mean of 2 cows.
[b] Significantly lower ($P<.01$) than other rates for same marker.
[c] Not applicable.

Table 2. — Mean (N = 8) turnover rates by digesta site and compartmental model, expt. 2.

Dietary Particle Marked μm	Digesta Site	Turnover Rate	
		k_1 h^{-1}	k_2 h^{-1}
>1000	D. Rumen	—[a]	.0175[a]
		1.17	.0219[b]
	V. Rumen	—	.0203
		1.44	.0206
	Faeces	.21	.0226
>420<1000	D. Rumen	—	.0236
		1.43	.0259
	V. Rumen	—	.0214
		.83	.0259
	Faeces	.15	.0259

[a] k_2 = single rate for 1C model.
[b] Presence of two rates signifies 2C model.

References

BLAXTER K.L. *et al.*, 1956. Some observations on the digestibility of food by sheep on related problems. *Br. J. Nutr.*, **10**, 69-91.

GROVUM W.L., V.J. WILLIAMS, 1973. Rate of passage of digesta in sheep. 4. Passage of marker through the alimentary tract and the biological relevance of rate-constants derived from changes in concentration of marker in faeces. *Br. J. Nutr.*, **30**, 313-328.