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Modeling the flow of digesta through the ruminant reticulorumen

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Ruminants possess a specialized gastrointestinal (GI) tract that enables them to efficiently digest fibrous feeds. The first stomach compartment of the ruminant GI tract, the reticulorumen (RR), is the site of most fiber digestion due to the presence of cellulolytic microorganisms in conjunction with selective retention of feed particles; undigested fibrous feed particles are selectively retained and fermented by cellulolytic microorganisms in the RR until certain digestive processes are completed, enabling the particles to pass. Selective retention and the overall process of digesta flow in the RR affect feed digestibility, feed intake, and microbial efficiency—all important animal performance parameters in ruminant production. It is imperative to model digesta flow in the RR to better predict these animal performance parameters for use in ruminant production systems. Mathematical models have indeed been developed to describe the flow of digesta in the RR, typically with the RR represented as one or more mathematical compartments with flow between compartments defined by kinetic rate variables or constants. Mathematical models developed to the present use either fractional rate constants or rate variables based on the gamma distribution. The Yule distribution has also been suggested for modeling RR digesta flow kinetics, but its development has been cursory. It remains unseen what, if any, benefits may arise from applying the Yule distribution to describe the kinetics of RR digesta. In this study, a model incorporating the Yule distribution is fully developed. Physiological justification for using the Yule distribution is also provided on the basis of selective retention. A comparison between the model developed herein and a previously published model using the gamma distribution reveals that both models give similar mathematical results under certain cases. Still, it is suggested that the physiological relevance of the model treated here may make it superior. Animal feeding trials are currently being conducted to validate the structure of model. Additionally, mathematical models are being developed to describe small and large intestinal flow in ruminant and non-ruminant species, thereby expanding this modeling effort to include most of the GI tract.