CHAPTER 17

METHODOLOGY FOR ESTIMATING DIGESTION AND PASSAGE KINETICS OF FORAGES

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INTRODUCTION

The nutritive value of a feedstuff is determined by its content of chemical entities and their transformations to nutrients required by the animal. Digestive transformations are determined by intrinsic attributes of the forage and by their interactions with the kinetic processes of digestion. Quantitative expressions of the kinetics of digestion and passage are needed to more precisely estimate the quantity and composition of nutrients digested from forages and their subsequent efficiency of utilization by the animal.

The objective of this chapter is to review methodology for estimating parameters describing the kinetics of physical and chemical digestion in ruminants. The kinetic processes of primary concern are: 1) flow of digesta through segments of the ruminant's digestive system, several of which involve fermentative digestion; and 2) digestion of specific entities in the forage. Recent reviews of this subject by Allen and Mertens (1987), Sauvant and Ramangasovina (1991), and Mertens (1993a,b) have emphasized deterministic, age-independent kinetics of this flow and digestion. This review will additionally emphasize age-dependent models of digestion and passage of fragments derived from mastication during ingestion and rumination. The need to simultaneously consider the fragmentation process has been emphasized by Sauvant and Ramangasovina (1991).

PASSAGE AND DIGESTION OF FORAGE FRAGMENTS

The prehended forage is fragmented by mastication during its ingestion (Pond et al., 1984) and subsequent rumination (Pond et al., 1987) to yield the array of forage fragments which undergo digestion in the rumen. These fragments are highly varied with respect to their mass, size, shape, origin with respect to plant anatomy, plant physiology and chemical composition. Chemical entities within the individual tissues of the masticated fragments of forage are highly varied with respect to their chemical and physical nature, solubility, buoyancy, accessibility to colonizing microbes, and potential for digestion.

Certain chemical entities, i.e., some proteins, may be rapidly solubilized by saliva and ruminal fluids, and are rapidly digested external to the fragment. Other