The death of plants in animals

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Introduction It is necessary first to understand some of the basic concepts associated with the digestion of the plant biomass within the rumen when considering mechanisms for altering/enhancing N-conversion efficiency in the forage-fed ruminant. Although it is generally assumed that breakdown of plant proteins in the rumen is mediated by microbial enzymes, there is increasing evidence to suggest that both plant and microbial proteases are active during degradation of ingested fresh forage (Beha *et al.,* 2002; Kingston-Smith & Theodorou, 2000; Kingston-Smith *et al*., 2003, 2004). After fresh plant biomass enters the rumen and prior to extensive plant cell-wall degradation, there is often a phase of rapid proteolysis in excess of that needed to maintain the rumen microbial population and we now believe that plant enzymes largely mediate this initial proteolysis. Recent evidence also suggests a role for plant lipases in the rumen (Lee *et al*., 2003). An understanding of the mechanisms that underlie these processes is essential if we are to devise plant-based strategies to manipulate them. This paper presents a new rumen model which, by taking account of the plants biological attributes, provides us with a novel framework for describing the plant contribution to rumen function in grazing livestock.

Materials and methods Data from *in vitro* and *in vivo* experiments was used in provision of evidence upon which to base the model. The experiments involved freshly harvested (living) plant biomass which was (a) incubated *in vitro* with and without populations of rumen micro-organisms (b) incubated in the rumen in bags of varying pore size or where (c) ingested boli were retrieved prior to entering the rumen of recipient animals, placed in Dacron bags and incubated for timed intervals in donor animals. The methodologies associated with these experiments can be found in publications by Beha *et al*. (2002) and Kingston-Smith *et al,* (2003, 2004).

Results Taken collectively, the experiments referred to have enabled us to a construct rumen model which provides a conceptual framework of how plant status (on entering the rumen) can contribute to rumen function. According to the model, upon mastication and ingestion, plant cells are either intact (IC), partially damaged (PD) or entirely destroyed (ED). In each case the processes that occur subsequent to ingestion has a major impact on rumen function and the efficiency by which ruminants degrade and digest plant tissues. In the case of IC, for example, evidence suggests that plant cells respond to ruminal stresses by entering autolytic processes and begin to degrade their own proteins and membranes (plant-mediated proteolysis and lipolysis). Plant enzymes liberated from PD and ED cells may contribute to rumen function via the digestion processes in rumen fluid. Furthermore, evidence suggests that certain plant defence mechanisms active in herbivory, such as protein protection via the polyphenol oxidase reaction, are invoked when damaged cells undergo decompartmentation in the rumen. In light of this model and in terms of PD and ED cells, the relationship between tannins in tanniniferous forages and the possible inactivation of plant and microbial enzymes is worthy of further consideration.

Conclusions The model proposed in this paper suggests that on entering the rumen the biological status of plant cells can contribute significantly to rumen function. We anticipate that the concepts underlying the model will assist in elaborating new criteria to breed forage plants that are pre-disposed to behave in particular ways, or cause particular behaviour(s) during their ingestion, digestion and passage through the ruminant digestive tract.

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