STUDIES ON RUMEN METABOLISM

Being a Thesis Submitted to the Massey University of Manawatu in Partial Fulfilment of the Requirements for the Degree of Doctor of Philosophy

by

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ABSTRACT

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The present study has been concerned primarily with the effects of supplementary lipid on protein and carbohydrate metabolism in the rumen and with the degree of hydrolysis and hydrogenation of lipids by rumen microorganisms. In addition, *in vivo* and *in vitro* experiments were carried out to determine the effect of the addition of soluble carbohydrates on the concentrations of fermentation end-products.

In the early part of this work, the effect of lipid on protein and carbohydrate metabolism was investigated in rumen-fistulated twin cows fed freshly-cut pasture. Linseed and whale oil were used as supplementary sources of lipid. The infusion of either oil into the rumen resulted in reductions in feed intake and in the concentrations of acetic and butyric acids. Concentrations of propionic acid remained at or above those found during the pretreatment periods. Added linseed oil also resulted in increased concentrations of ammonia in the rumen. Further investigation led to the observation that lipid depressed cellulose digestion and inhibited rumen motility.

Lipid, incubated with rumen liquor obtained from animals fed freshly-cut pasture and with ryegrass juice extract, increased the concentrations of ammonia and propionic acid but had no consistent effect on gas production or on the concentrations of acetic and butyric acids. Following the replacement of the grass juice extract with grass fibre, lipid decreased

the formation of acetic acid and the digestion of fibre, increased the formation of propionic acid but had no effect on the concentration of ammonia.

The hydrolysis and hydrogenation of grass and clover lipids and of linseed oil were followed in conjunction with some of the above *in vivo* and *in vitro* experiments. Mono- and diglycerides, in addition to fatty acids, were found in the rumen liquor after infusion of linseed oil into the rumen. The proportions of linoleic acid found in rumen liquor 6.5 hr. after infusion of oil were above normal but the proportions of linolenic acid had returned to about the prefeeding level in this time. The free fatty acids were more saturated than the unhydrolyzed triglycerides but the proportions of unsaturated fatty acids in the partially hydrolyzed glycerides were not greatly different to those of the triglycerides. Rapid hydrogenation of the constituent unsaturated fatty acids of linseed oil also occurred *in vitro*.

In the *in vivo* experiments in which starch was added to the rumen of cows fed pasture containing one of two levels of nitrogen it was found that the added carbohydrate brought about marked reductions in ammonia concentrations but had no consistent effect on total volatile fatty acid concentrations.

Incubation of each of a series of soluble carbohydrates with rumen liquor and ryegrass juice extract for periods of up to 3 hr. showed that galactose, glucose, sucrose, lactose, galacturonic acid, xylose and L-arabinose were readily fermented but that D-arabinose was not. A close relationship was found between the rate of fermentation, the degree of ammonia utilization and the production of volatile fatty acids.

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TABLE OF CONTENTS