SESSION 2 : THE ROLE OF PROTEIN WHICH ESCAPES RUMINAL DEGRADATION (BY-PASS PROTEIN)

INTRODUCTORY REMARKS

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The foundations of modern ruminant metabolism were laid by Sir Joseph Barcroft and his colleagues at Cambridge in the 'forties'. Sydney Elsden and Andrew Phillipson were largely responsible for the recognition of the overall significance of ruminal fermentation, but the elucidation of the special features of nitrogen metabolism started with the new classic studies of Ian McDonald (1948, 1952, 1954), first at Cambridge and then at the newly established ARC Institute of Animal Physiology at Babraham. Ian McDonald showed that dietary proteins are degraded to a variable extent in the rumen, and that the ammonia produced may be'absorbed and returned to the rumen as salivary urea; ,A few years later the nutritional significance of protein degradation in the rumen was elegantly demonstrated by Chalmers, Cuthbertson and Synge (1954), who showed that casein administered by duodenal fistula was much better. utilised than when fed, or given by rumen fistula. When the solubility of casein was reduced by heat denaturation, however, nutritive value was much improved, and this finding was the forerunner of the technique of "protection" of dietary proteins from ruminal degradation by physical or chemical means. Such products are now termed "by-pass proteins".

The ideal by-pass protein, although fully resistant to ruminal attack, would be completely hydrolysed post-ruminally to yield a mixture of essential amino acids appropriate for the productive needs of the animal. This session is largely concerned with the responses of the animal to protein which escapes ruminal degradation, but we must appreciate that in practice, by-pass proteins are degraded to some extent in the rumen. The effects on nitrogen metabolism in the rumen may be negligible when dry matter retention times in the rumen are low, as in high yielding dairy cows fed at much above maintenance, but on diets of low digestibility, rumen retention time of dietary protein may be appreciable (see Ørskov, Hughes-Jones and McDonald 1980). In this situation, by-pass proteins may act as a slow release source of peptides, amino acids and ammonia, each of which might be a first limiting nutrient for microbial growth. In this way dietary by-pass proteins may influence the efficiency and magnitude of microbial protein synthesis, and increase the post-ruminal supply of amino acids. The latter may increase feed intake when essential amino acids are rate limiting nutrients for production. In addition, there is good evidence that improved amino acid status in the rumen may increase both digestibility in the rumen, and . feed intake (see Oldham 1980).

The reported increases in the intake of roughage diets of low digestibility in response to by-pass protein are intriguing, since in some instances the supplementary protein was administered beyond the rumen (Egan 1980) . In these cases, possible effects on rumen metabolism by the products of protein degradation are ruled out. Furthermore, in experiments in which the post-ruminal administration of casein resulted in the increased intake of low quality roughages in sheep, the intake

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response was not due to the recycling of nitrogen to the rumen, but was attributed to the increase in volume of reticulo-rumen digesta (Egan 1980). The increased volume of digesta would not increase feed intake unless accompanied by an increased outflow of solids from the rumen, which may occur in proportion to the increase in digesta volume. Improved digestibility, or the more rapid comminution of solids by increased reticulo-rumen movements would also increase the outflow of rumen solids, and permit raised feed intakes. Absorbed amino acids may possibly trigger the release of gut hormones which increase rumen motility, but there are no data on this matter.

In animals fed diets of sufficiently high digestibility to ensure that energy content, and not the outflow of dry matter from the rumen influences intake, by-pass protein, by improving the supply of amino acids to the tissues will give a production response, and a concomitant increase in feed intake if essential amino acids, and not energy, are the rate limiting nutrients. This situation is analogous to that in non-ruminant, where the absence of a rumen permits close definition of amino acid and energy requirements. for given levels of production. At this time we have only rough estimates of amino acid requirements of ruminants, and except in the case of wool growth, essential amino acids limiting for production have not been identified. In the lactating cow, although microbial protein meets only part of the essential amino acid requirements, conventional dietary protein sources make up the balance. This implies that a high proportion of dietary protein escapes ruminal degradation. Factors which minimise dietary protein breakdown in the rumen include a high level of feed intake, which reduces residence time in the rumen, and the relative insolubility or degree of natural protection of many protein sources, particularly if included in pelleted rations. In these circumstances, by-pass protein supplements would be useful only if they allowed significant cost savings by reducing the level of conventional dietary protein. There is no evidence that one or more essential amino acids are limiting nutrients for milk synthesis: well documented responses to methionine appear to be mediated through effects on rumen metabolism (see Oldham 1980).

Much of animal production in Australia, however, is based on the grazing animal, where the overwhelming requirement is to increase the intake and efficiency of utilisation of low quality herbage. By-pass protein supplements have proved effective in some situations, but not in others, and the objectives of this session are to review the current position, and establishthe ground rules for future work.

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