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# THE PHYSICAL BREAKDOWN OF FEED DURING DIGESTION IN THE RUMEN

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## SUMMARY

Preliminary results are presented describing the size, nature and composition of digesta particles in the rumen and abomasum of sheep fed lucerne hay either as chaff or, ground, as pellets.

## INTRODUCTION

The physical breakdown of the structure of plant materials is fundamental to the process of ruminant digestion. It contributes to digestion by increasing the surface area available for attack by rumen micro-organisms. In addition it has key roles in several alimentary functions, especially the passage of digesta residues out of the rumen, feed intake regulation and modulation of the tactile stimulus afforded by the gut contents (which affects activities such as salivation, rumination and rumen motility) (Reid, 1976; Baldwin *et al.*, 1977).

The principal means of feed breakdown are chewing during eating and rumination, microbial fermentation, and detrition caused by rumen movements.

Interest in the physical breakdown of feeds has been renewed by attempts to model ruminant digestion (Ulyatt *et al.*, 1976). These efforts have served to emphasize the critical importance of breakdown and also the limited amount of quantitative data available (Smith *et al.*, 1965; van Soest, 1966; Pearce, 1967; Troelsen and Campbell, 1968; Evans *et al.*, 1973). A systematic study of the fragmentation of feed in the ruminant digestive tract has therefore been undertaken.

## METHODS

Animals under various feeding regimens were slaughtered and the rumen and abomasum contents weighed and sampled. Particle-size spectra in the digesta samples were determined by a method similar to that of Evans *et al.* (1973). A modified asbestos wet-sieving machine (Turner and Newall Ltd, Manchester, U.K.), containing a cascade of rotating sieves of decreasing mesh size was used. Water was passed through the system at a constant rate, and additional agitation was provided by a

stirrer for each sieve. Sieving was carried out for a standard time, usually 2 min. The material retained on each sieve was transferred to a tared filter paper, dried and weighed. The morphology of the various fractions separated on the sieves was determined by microscopical examination, and their composition by chemical analyses (cellulose, hemicellulose, pectin, lignin, total N, ash) using the fractionation method of Bailey (1964).

### RESULTS AND DISCUSSION

Examples of the results of sieving, expressed as cumulative percentage of total sample DM retained as sieve size decreases, are shown in Fig. 1. They illustrate (1) the marked shift in particle-size spectrum as a result of digestion (*cf.* feed *vs.* rumen contents *vs.* abomasum contents); (2) selective passage out of the rumen (*cf.* rumen contents *vs.* abomasal contents); (3) the

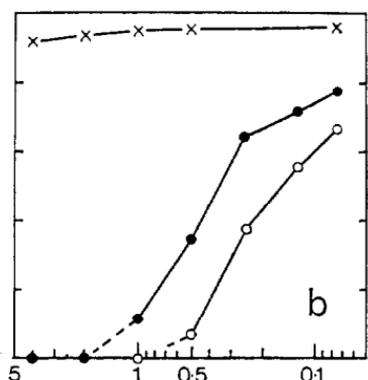
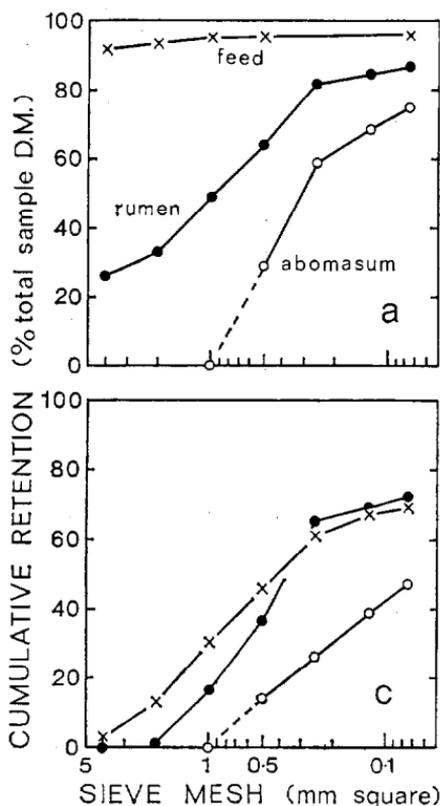


FIG. 1: Cumulative retention of sieved material, expressed as percentage of total sample dry matter.

(crosses, feed; dots, ruminal contents; circles, abomasal contents).

(a) Average of 3 wethers fed chaffed lucerne hay (62% OM digestibility) hourly at 900 g DM/day.

(b) One wether after 30 h fast following feeding as in (a).

(c) Average of two mature wethers fed pelleted ground lucerne hay once a day at 880 g DM/day. Killed 5 h after feeding.

effects of fasting (*cf.* Figs. 1a, 1b); and (4) the effects of grinding and pelleting the diet (*cf.* Figs. 1a, 1c).

The particle fractions separated by sieving were not individually homogeneous; nor as a series did they represent a simple progression in size. The particles tended to be elongated rather than cuboidal or spherical (also noted by Evans *et al.*, 1973). For lucerne chaff, there was a decreasing amount of recognizable leaf with decreasing sieve size; and fractions on smaller sieves included hairs, individual fibres, cell fragments, and protozoa. Hair (wool) balls were found in some samples of abomasal contents.

The chemical composition of the fractions also changed with decreasing sieve size. The proportion of pectin decreased in fractions below that retained by the 1.0 mm sieve, of cellulose and hemicellulose below 0.25 mm. By contrast, the proportions of total N and ash increased below 0.25 mm. These changes partly reflect the processes of chemical breakdown during digestion, partly the changing morphology of the fractions with decreasing size.

Particles that pass from the rumen to the abomasum in sheep fed these diets appear to be of a size that will allow them to pass through a 1.0 mm sieve. Since a large proportion of particles in the rumen are already below this size, size alone does not determine escape from the rumen.

The study is being extended to include a wide range of diets.

#### ACKNOWLEDGEMENTS

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