

## Effects of particle size on digestion of hay by sheep

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### Abstract

The digestion and retention times of milled hay diets were first studied in three sheep fitted with rumen and abomasal cannulae. The hay was milled through 5, 20 or 40 mm screens. Solubility of dry matter (D.M.) in water and rate of loss of D.M. from hay in nylon bags suspended in the rumen increased with fineness of grinding. Apparent digestibility of D.M. within the gut tended to fall with fineness of grinding, as did mean retention time (MRT) of a particulate marker, [<sup>103</sup>Ru]phenanthroline ([<sup>103</sup>Ru]phen), within the gut and of [<sup>103</sup>Ru]phen and a liquid marker, [<sup>51</sup>Cr]EDTA, within the rumen. Dry-sieved abomasal particles were much smaller than particles of any of the hay preparations, most passing through a 0.6 mm screen.

A second experiment was made on four other sheep, fitted with rumen cannulae and given a similar hay, chopped to 50 mm or milled through 2, 5 or 20 mm screens. Apparent digestibility of D.M. within the gut fell significantly with fineness of grinding, from 55% with the chopped hay to 46% with the 2 mm hay, as did MRT, from 45 to 40 h respectively. Rumen pH at 1 h after feeding decreased with fineness of grinding.

In a third experiment, using the four sheep given chopped or 2 mm hay, retention times of particulate matter and of fluid in the reticulo-rumen and in the caecum-colon were measured. [<sup>103</sup>Ru]phen and [<sup>51</sup>Cr]EDTA were dosed together into either the rumen or the terminal ileum, and the rates of decline of marker concentration in rumen samples or faeces respectively were used to calculate the appropriate half times (*t*<sub>1/2</sub>). In the rumen particulate and fluid markers showed significantly shorter *t*<sub>1/2</sub> values with the 2 mm hay (20.8 and 12.4 h, respectively) than with the chopped hay (25.9 and 15.6 h, respectively) without a significant difference in rumen outflow (0.437 and 0.492 l/h, respectively). In the caecum-colon the corresponding *t*<sub>1/2</sub> values were 6.4 and 6.3 h, and 7.1 and 6.6 h, there being no significant difference either between markers or between diets. Samples of chopped hay and of 20, 5 and 2 mm hays were suspended in bags in the rumen of sheep given either chopped or 2 mm hay to eat. The fine hays lost D.M. more rapidly than the coarse hays but D.M. loss was slower when the sheep's diet was 2 mm hay than when it was chopped hay.

It is concluded that three factors accounted for the effect of milling on digestibility: retention time in the reticulo-rumen, D.M. degradation rate in the rumen, and the potential digestibility of the hay preparation (asymptotic D.M. loss as measured in the rumen bag studies). It appeared that fine grinding reduced the digestibility of the hay because the effects of shortened MRT in reducing duration of digestion and of lowered rumen pH in depressing cellulolysis outweighed the effects of grinding in accelerating digestion and increasing potential digestibility within the rumen.

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