Letter to the Editors

A correction for particulate matter loss when applying the polyester-bag method

The polyester-bag method has been used widely for many years to study the degradation (i.e. hydrolysis and fermentation) of basal forages and supplementary feeds in the rumen (Quin *et al.* 1938; Van Keuren & Heinemann, 1962; Schoeman *et al.* 1972). Feed samples suspended in a series of polyester bags are incubated in the rumen. Bags are removed sequentially at appropriate times after insertion and their contents washed and analysed. Typically, the disappearance curves of dry matter, organic matter, neutral-detergent fibre, N and other feed components so obtained are then accounted using a model based on simple, first-order kinetics and described by Orskov & McDonald (1979), with the lag effect incorporated as suggested by McDonald (1981) and Dhanoa (1988); for review see France *et al.* (1990). Mathematically the model may be summarized as follows:

$$y_t = A + B(1 - e^{-c(t-T)}), \quad t \geqslant T, \tag{1}$$

where y_t is disappearance (g loss/g initially incubated) to time t (h) and A, B, c, and T are constants. A represents the soluble fraction (assumed instantly degradable), B the degradable part of the insoluble fraction, c the fractional degradation rate (per h) and T the lag time (h) before the commencement of degradation of B. Estimates of these constants, used in conjunction with the estimate of ruminal rate of passage k (h) obtained using digesta-flow markers and either faecal or rumen sampling (Van Soest, 1982; France *et al.* 1985), permit the evaluation of the extent of ruminal degradation E (g degraded/g ingested) by applying the formula:

$$E = A + Bce^{-kT}/(c+k). \tag{2}$$

The method as applied makes no allowance for loss of particulate matter through the pores of a bag during incubation and subsequent washing (Lindberg & Knutsson, 1981; Lindberg, 1985; Nocek, 1988). The objective of this letter, therefore, is to suggest a correction for particulate matter loss when applying the polyester-bag method. The correction is as follows: let $y_t^{(c)}$ denote corrected disappearance, $y_t^{(o)}$ denote observed disappearance (i.e. the disappearance to time t actually measured) and Δ_t the particulate matter lost that would still be undegraded in the bag at time t had there been no particulate loss from the bag (all in units of g loss/g initially incubated). These three entities are related by

$$y_t^{(c)} = y_t^{(o)} - \Delta_t. \tag{3}$$

We further assume that this particulate matter lost is given by

$$\Delta_t = p\Delta_0, \tag{4}$$

where Δ_0 ($\geqslant 0$), the zero time value of Δ_t, is calculated as the difference between the washout value $y_0^{(o)}$ and the solubility of the feed $y_0^{(c)}$ measured after soaking and filtering (Donefer *et al.* 1963; Seoane *et al.* 1982; Hovell *et al.* 1986), i.e.

$$\Delta_0 = y_0^{(o)} - y_0^{(c)}, \tag{5}$$

and where p, the proportion of the particulate matter incubated remaining undegraded at time t, is given by

$$p = (1 - y_t^{(c)})/(1 - y_0^{(c)}). \tag{6}$$

Substituting for p in equation 4 using equation 6 then for Δ_t in equation 3 and rearranging gives an expression for corrected disappearance

$$y_t^{(c)} = (y_t^{(o)} - \lambda)/(1 - \lambda), \tag{7}$$

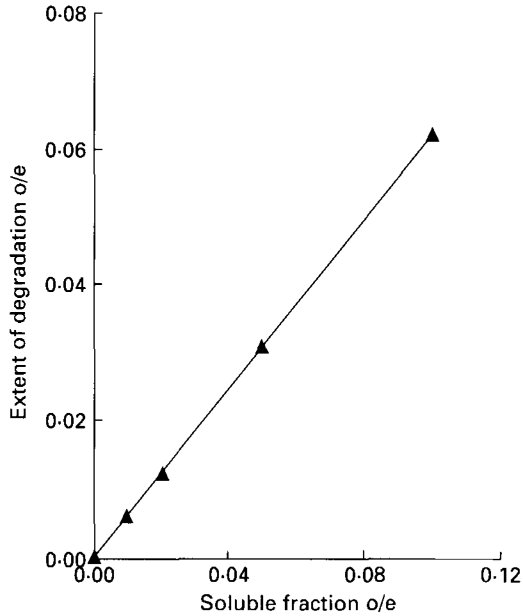

Fig. 1. The effect of overestimating (o/e) the soluble fraction on the calculation of extent of ruminal degradation (for numerical details, see below).

where

$$\lambda = \Delta_0/(1-y_0^{(c)}). \tag{8}$$

As an alternative to correcting the data before fitting, the estimates of the constants can be corrected after fitting. Expressions for correcting the estimates of the constants are obtained by using equation 1 to substitute for $y_t^{(o)}$ in equation 7, which yields

$$y_t^{(c)} = [(A-\lambda)/(1-\lambda)]+[B/(1-\lambda)](1-e^{-c(t-T)}), \quad t \geqslant T. \tag{9}$$

Thus, correcting for particulate matter loss does not affect the estimate of the fractional degradation rate c or the lag time T, only the estimates of constants A and B whose corrected and uncorrected values are related by

$$A^{(c)} = (A^{(o)}-\lambda)/(1-\lambda), \tag{10}$$

$$B^{(c)} = B^{(o)}/(1-\lambda). \tag{11}$$

An expression for correcting the extent of ruminal degradation is obtained by putting corrected values for A and B into equation 2 and simplifying, giving

$$E^{(c)} = (E^{(o)}-\lambda)/(1-\lambda). \tag{12}$$

We demonstrate the effect of not correcting for particulate matter loss from the bag by reference to a typical perennial ryegrass (*Lolium perenne*) hay with a solubility $y_0^{(c)}$ of 0·2 and an extent of ruminal degradation $E^{(c)}$ of 0·5. Different values of uncorrected extent of degradation $E^{(o)}$ of 0·5, 0·506, 0·513, 0·531 and 0·563 are generated by using washout values $y_0^{(o)}$ of 0·2, 0·21, 0·22, 0·25 and 0·3 and applying equations 5, 8 and 12. A plot of overestimate (o/e) of the extent of degradation ($E^{(o)}-E^{(c)}$) *v.* overestimate of the soluble fraction ($y_0^{(o)}-y_0^{(c)}$) is shown in Fig. 1, where each percentage point of error in the soluble fraction induces one-quarter of a percentage point of error in the extent. This suggests that not correcting for particulate matter loss when applying the polyester-bag method can significantly overestimate the extent of ruminal degradation.

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