HERBAGE DIGESTIBILITY IN SHEEP AND CORRESPONDING ESTIMATES OF DIGESTIBILITY *IN VITRO*

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Summary

The ***in vivo*** dry matter digestibility of 27 herbages, which ranged from 39% to 83%, was significantly related to ***in vitro*** estimates of organic matter digestibility in one equation and cellulose digestibility in a second equation. The inclusion of the independent variable cellulose percentage in the second equation significantly reduced the residual standard deviation. For herbages of below 65% dry matter digestibility, the relationship between ***in vivo*** and ***in*** vitro estimates was slightly improved by the addition of urea to the basal medium used in the ***in vitro*** technique.

I. INTRODUCTION

The *in vitro* digestion technique is a promising laboratory method for estimating the digestibility of herbage (Tilley and Terry 1963). Ground herbage samples are incubated firstly with a rumen inoculum and secondly with acid pepsin. In many studies the pepsin stage has been omitted and cellulose digestibility determined. Reid, Jung and Murray, (1964) found dry matter digestibility in *vivo* was closely related to *in vitro* cellulose digestibility, but anomalies in the relationship have been reported by Quicke et *al*. (1959) and Naga and el Shazly (1963).

The technique provides a means for estimating the digestibility of grazed herbage collected through an oesophageal fistula (Van Dyne and Weir 1964), but these samples will be contaminated with ash from saliva and there is a need to develop a relation between *in vivo* digestibility and *in vitro* organic matter digestibility. In the experiments reported here the relationships between cellulose digestibility and organic matter digestibility determined *in vitro* and dry matter digestibility *in vivo* were examined.

II. MATERIALS AND METHODS

Twenty-seven herbages, comprising cocksfoot (3), phalaris (3), ryegrass (5), cereal chaff (4), other grasses (6), clover (2), and lucerne (4), were examined. The dry matter digestibility of these herbages when fed to sheep ranged from 39 % to 83 % . Feed refusals were less than 15 % of the feed offered and all herbages contained more than 85% organic matter.

The *in vitro* digestion technique used was that of Tilley and Terry (1963) as modified by Wilkins (1966). Rumen liquor was withdrawn from a rumen-fistulated sheep maintained on lucerne. Determinations of digestibility were made in duplicate. When *in vivo* digestibility was less than 65 % , determinations were also made

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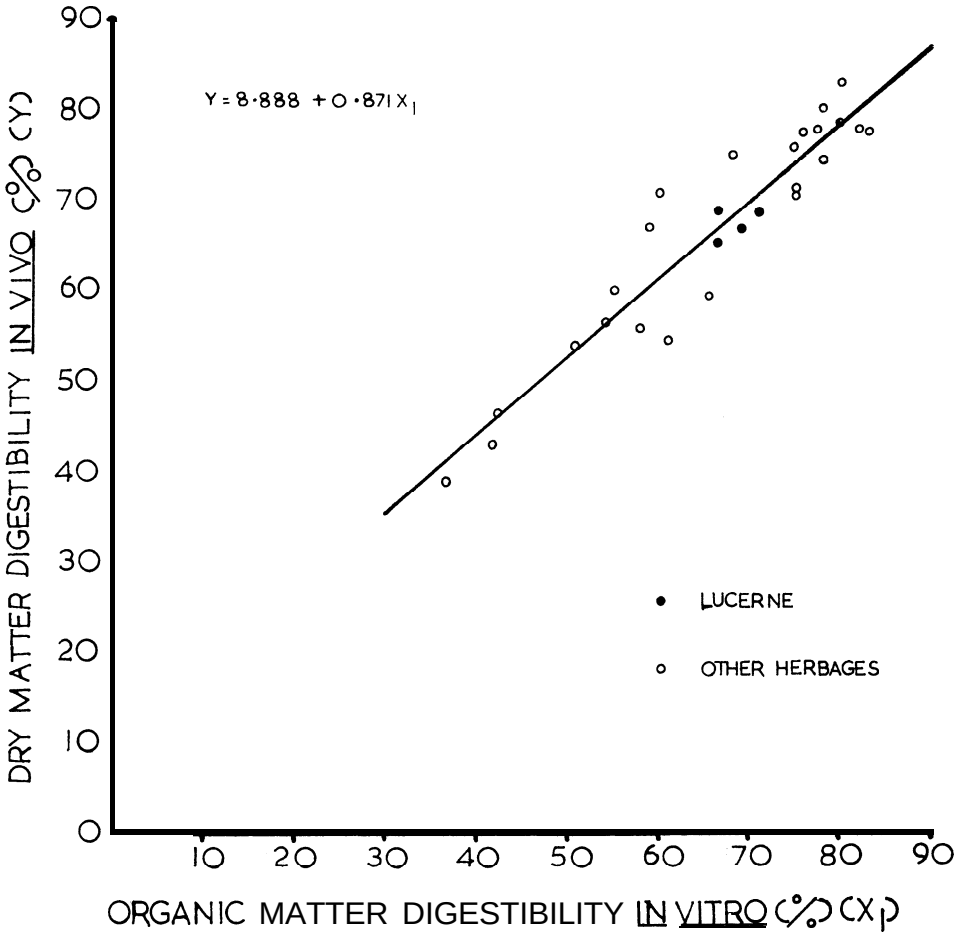

Fig. 1.—Relationship between organic matter digestibility ***in*** vitro and dry matter digestibility ***in vivo.***

with urea added to the medium at the rate of 9 mg per 0.4 g herbage. This increased the nitrogen content of the herbage by approximately 1%. Preliminary experiments indicated that the addition of urea did not influence the ***in vitro*** digestibility of samples of more than 65% digestibility. Additions of urea above 9 mg/0.4 g produced, in some cases, a depression in digestibility.

III. RESULTS

In vivo dry matter digestibility (Y) was significantly correlated with ***in vitro*** organic matter digestibility (X_1) and with *in vitro* cellulose digestibility (X_2) (Figures 1 and 2).

$$Y = 8.888 + 0.871\ X_1 \pm 4.19\ (r = 0.939^{***}) \quad . \ . \ . \ (1)$$

$$Y = 21.576 + 0.704\ X_2 \pm 3.83\ (r = 0.950^{***}) \quad . \ . \ . \ (2)$$

The error in predicting digestibility in the sheep was significantly reduced by including cellulose %(X_3) in Equation 2 but, not in Equation 1.

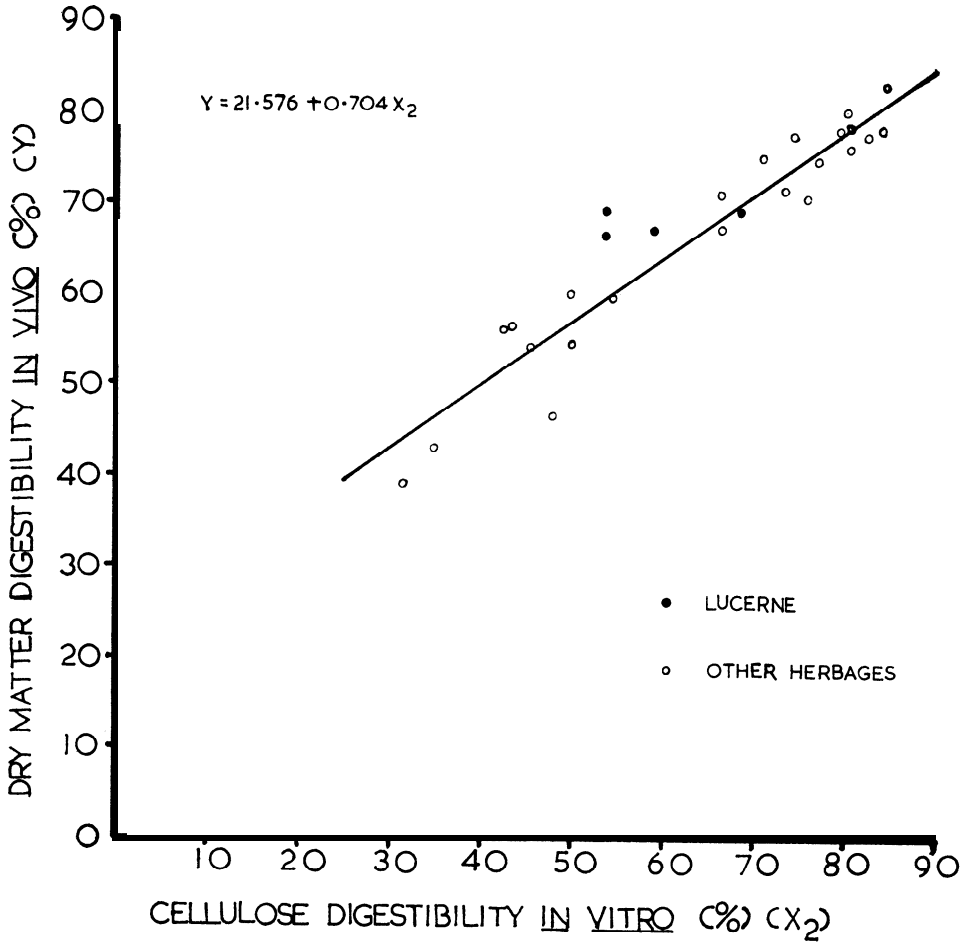

Fig. 2.-Relationship between cellulose digestibility ***in vitro*** and dry matter digestibility ***in vivo.***

$$Y = 53.342 + 0.492\ X_2 - 0.664\ X_3 \pm 2.99\ (r = 0.971^{***}) \quad . \ . \ . \ (3)$$

The individual digestibility figures are shown in Table 1.

Urea was added to the medium for the nine herbages of less than 65% dry matter digestibility ***in vivo.*** The addition resulted in small increases in digestibility (Table 2) but these were significant ($P < 0.05$) in only two cases for organic matter digestibility and five cases for cellulose digestibility. Urea addition produced some improvement in the correlation between digestibility ***in vivo*** and ***in vitro,*** but the increase in the correlation coefficient was not significant ($P > 0.05$).

III. DISCUSSION

The residual standard deviations of the regressions were higher than the value of about $\pm$ 2 reported by Tilley, Deriaz and Terry (1960) for the prediction of dry matter digestibility ***in vivo*** from dry matter digestibility ***in vitro.*** The accuracy of the regressions reported here could have been reduced by errors from two

TABLE 1

The digestibility of ***herbages in vivo and in vitro***

	Digestibility (%)			
	in vivo	*in vitro*		Cellulose
	Dry Matter	Organic Matter	Cellulose	(% Dry Matter)
Dried young pasture	83.0	79.9	84.3	22.0
White clover	80.0	77.8	80.0	24.2
Dried young pasture	78.3	80.0	80.7	25.3
Grass hay	78.0	77.6	79.4	24.6
Young oat leaf	78.0	82.1	84.2	21.0
Young oat leaf	77.7	83.1	82.7	22.7
Young ryegrass	77.4	76.1	74.6	23.8
Italian ryegrass	76.0	74.9	80.4	18.1
White clover	75.0	67.8	70.8	26.4
Young ryegrass	74.4	78.0	77.0	21.9
Cocksfoot	71.5	75.0	73.7	25.6
Cocksfoot	71.1	59.9	66.3	20.6
Cocksfoot	70.7	75.2	75.9	24.9
Lucerne hay	69.2	71.0	68.5	25.3
Lucerne leaf	69.1	66.4	53.8	26.2
Lucerne chaff	66.9	68.9	59.1	23.2
Wimmera ryegrass	66.8	59.0	66.5	32.0
Lucerne chaff	65.7	66.4	54.0	24.2
Mature ryegrass	59.9	55.2	50.2	30.8
Early seed Phalaris	59.5	65.6	54.3	27.1
Oat chaff	56.6	53.8	43.4	30.3
Wheat chaff	55.9	57.8	42.3	29.0
Wheat chaff	54.4	61.2	50.1	32.3
Wheat chaff	54.0	55.5	45.7	33.4
Mature herbage	46.6	41.8	47.8	44.1
Phalaris	42.8	41.6	35.0	46.4
Late seed Phalaris	38.8	36.4	31.7	44.9
S.E.		±0.96	±0.45	±0.30

sources. Firstly, the level of feeding in the ***in vivo*** trials varied from about half maintenance to maintenance. Waite, Johnston and Armstrong (1964) showed that differences in intake of this order could change the ***in vivo*** organic matter digestibility of ryegrass by up to six digestibility units. Secondly, differences in drying

TABLE 2

The influence of ***urea on digestibility in vitro for herbages*** of ***below 6.5% dry matter digestibility in vivo***

	Digestibility *in vitro* (%)		Correlation with Dry Matter Digestibility *in vivo* (r)	
	Without urea	With urea	Without urea	With urea
Organic matter digestibility *in vitro*	52.1	53.1	+0.913***	+0.931***
Cellulose digestibility *in vitro*	44.5	47.8	+0.812***	+0.880***

*** $P < 0.001$

procedures (Reid, Jung and Murray 1964) and milling (Baumgardt and Oh 1964) have been reported to influence *in vitro* digestibility and with the use of samples prepared in several laboratories some differences in preparation procedure were inevitable. It may be suggested that standardisation in the determination of *in vivo* digestibility and in the preparation of samples prior to *in vitro* digestion may have effected considerable reduction to the error in predicting *in vivo* digestibility.

The precision of estimates of *in vivo* digestibility based on the two measures of *in vitro* digestion were similar. The significant reduction in residual variation produced by the inclusion of cellulose content in Equation 3 suggests that variation in cellulose content could have been responsible, in part, for the poor relationships between *in vitro* cellulose digestibility and *in vivo* dry matter digestibility reported by Quicke *et al.* (1959) and Naga and el Shazly (1963). In addition to avoiding the pepsin stage of digestion, determination of cellulose digestibility has the advantage that this measure will not be directly influenced by losses of labile plant components during drying. In circumstances where losses may be particularly large, such as during the processing of extrusa collected through oesophageal fistulae (Grimes, Watkin and Gallagher 1966), cellulose digestibility may be the more suitable measure of *in vitro* digestion.

The increases in digestibility *in vitro* produced by urea supplementation were small, but as only nine samples were considered, the influence of urea on the overall relationship between digestibility *in vivo* and *in vitro* was not resolved.

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