In Vivo and in Vitro Digestibility of Four Tropical Grass Species Growing at Ibadan

By

F. O. OLUBAJO AND V. O. TENABE
Department of Animal Science,
University of Ibadan,
Ibadan, Nigeria

ABSTRACT

Digestibility trials carried out in November and December, 1971 with twelve West African dwarf rams fed *Cynodon nlemfuensis* var. *robustus; Cynodon nlemfuensis* var. *nlemfuensis; Pennisetum purpureum* Schum; and *Panicum maximum*, Jacq, each at 4 weeks and 8 weeks of regrowth showed that the differences that may exist between methods and among treatments in organic matter digestibility were not statistically significant ($P > 0.05$. Similarly, analysis showed no significant differences among animals or between periods within each treatment except for *Cynodon nlemfuensis* var. *nlemfuensis* where differences between period were significant ($P < 0.01$).

There were high positive correlations between *in vitro* and *in vivo* organic matter digestibilities as well as between *in vitro* organic matter digestiblity and Total Digestible Nutrients (TDN).

It is suggested that *in vitro* organic matter digestibility can be used to predict the digestibility of these tropical grass species and, may be, other similar grass species.

INTRODUCTION

THE search for suitable grasses and legumes with high feeding value for animal production particularly in the tropical countries continues. A number of methods are in use for assessing the nutritive value of pasture herbage but the one in current use for the most rapid results is the *in vitro* digestibility technique. The technique has been employed widely to assess the nutritive value of temperate forages (Alexander and McGowan, 1961; Armstrong, Alexander and McGowan, 1964; Baumgardt, Taylor and Cason, 1962; Shelton and Reid, 1960; Tilley, Deriaz and Terry, 1960; Tilley, Terry, Deriaz and Quten, 1962/63; Tilley and Terry, 1963; Van Soest, Wine and Moore, 1966). This method is also gaining prominence in assessing the nutritive value of tropical forages (Wilkinson, Adams and Jackson, 1970; Van Soest, Abruna and CaroCosta 1969; Olubajo, Van Soest and Oyenuga, 1974; Minson and McLeod, 1970; Johnson, Guerrero and Pezo, 1973; Marshall, Long and Thornton 1969; Long, 1967).

This paper reports on the *in vivo* and *in vitro* organic matter digestibilities of grass species fed at two stages of regrowth at the University of Ibadan Experimental Farm.

MATERIALS AND METHODS

The four species of grass used in this experiment namely: *Cynodon nlemfuensis* var. *robustus; Pennisetum purpureum* (Schum); *Cynodon nlemfuensis* var *nlemfuensis* (*Cynodon* 1b8); and *Panicum maximum* (Jacq) were planted as pure stands between August and September, 1968 at the University of Ibadan Experimental Farm.

The experimental area was made up of 3.64 ha which was divided into four equal plots of approximately 0.91 ha each. Each plot was further divided into four equal strips of approximately 0.23 ha each and each strip was subdivided into six subplots of approximately 0.04 ha each. The resulting 96 sub-plots were randomized and planted to the four grass

species such that the grasses could be grazed or harvested at three different stages of maturity namely: 4, 6 and 8 weeks of regrowth.

At the onset of the rainy season, about the middle of April 1969, the grasses were mown so as to allow for uniform regrowth. At four, six and eight weeks of regrowth the pasture were rotationally grazed by White Fulani (Zebu) steers. Each treatment sub-plot was cut back to allow for uniform regrowth when the steers moved to a new sub-plot.

The tests grasses (regrowths) were cut and fed green when they were between 4 and 5 weeks, and 8 and 9 weeks, to 12 West African dwarf rams. Random samples were cut from each treatment sub-plot at the appropriate stage of regrowth, bulked, weighed and chopped to pieces before they were fed. Representative samples were taken from the wet mixed chopped materials for dry matter determination. Two indoor digestion trials were carried out in November and December 1971. One in November, 1971 with the 4 weeks of regrowth and the other in December, 1971 with the 8 weeks of regrowth. The experimental rams whose liveweights ranged from 18.1kg to 27.2kg were randomized into four groups of three animals per treatment. Each ram was harnessed with a collection bag attached for total collection of faeces. 4.08kg of freshly-cut chopped grasses were fed to each animal thrice daily, approximately 1.36kg each at 08.00 hr, 12.00 hr and at 17.00 hr. The collection period which lasted for nine days was preceded by a fourteen day preliminary period in each trial. Faeces were collected at 08.00 hr. and 16.30 hr. The morning and evening faecal collections for each ram were bulked, weighed, thoroughly mixed and representative samples taken for dry matter determination and for chemical analysis. Each day's refusals by each ram was similarly treated.

Samples meant for dry matter determinations were dried in the electric oven at 105°C to constant weight (48 hours) and those meant for proximate analysis were dried in a forced-drought oven at 70°C for three days, milled in a Christy-Norris hammer mill to pass 1.66 mm mesh, labelled and stored in air-tight plastic bottles until ready for analysis. Sub-samples of milled grass samples meant for *in vitro* digestibility determinations were milled using 0.6mm screen and stored in tightly-stoppered bottles.

Chemical Analysis

Poximate analyses were as described by Olubajo and Oyenuga (1970) except that the crude fibre was determined by the trichloro-acetic acid method (University of Newcastle upon Tyne, 1967). *In vitro* digestiblity was determined as described by Tilley and Terry (1963).

RESULTS

The results of the chemical composition of the grass species at between 4 and 5, and 8 and 9 weeks of regrowth are summarised in Table 1 while the digestibility of the various components are shown in Table 2. Table 3 summarised the results of the *in vivo* and *in vitro* organic matter digestibilities of the grass species at the two stages of regrowth studied.

DISCUSSION

The data in Table 1 indicate that the mean CP content of the grass species ranged from approximately 12.2 % for *Pennisetum purpureum* at 4 weeks of regrowth to approximately 5.2 % at 8 weeks of regrowth for the same grass species while the C.F. content ranged

TABLE 1

Mean Chemical Composition of Grass Species

Treatment	*Age (weeks)*	*O.M.* %	*Total ash* %	*Crude fibre* %	*Crude protein* %	*Ether extract* %	*N-free extract* %
C. nlemfuensis var. *robustus* *Penn. purpureum*	4	89.6	10.45	28.75	9.70	1.15	49.95
	8	94.4	5.62	31.74	5.51	0.63	56.50
	4	87.7	12.27	29.15	12.15	1.80	44.63
	8	91.9	8.13	31.47	5.23	1.44	53.73
C. nlemfuensis var. *nlemfuensis* *P. maximum*	4	91.8	8.22	30.24	10.16	1.70	49.68
	8	93.9	6.12	32.34	5.39	0.77	55.35
	4	89.4	10.57	32.03	8.32	1.25	47.83
	8	92.6	7.38	34.03	5.64	0.67	52.28

TABLE 2

Digestibility of Proximate contents of Grass Species at Two Stages of Growth (O.M. Basis)

Treatment	*Age (weeks)*	*Crude protein* %	*Crude fibre* %	*N-free extract* %	*T.D.N.* %
C. nlemfuensis var. *robustus* *Penn purpureum*	4	64.3	72.6	55.1	50.8
	8	55.0	73.9	66.3	64.0
	4	56.2	66.6	52.4	51.9
	8	53.5	53.9	52.3	47.3
C. nlemfuensis var. *nlemfuensis* *P. maximum*	4	45.4	67.3	60.3	57.2
	8	31.2	47.2	25.3	29.6
	4	36.4	58.8	34.6	36.7
	8	21.4	57.5	53.2	48.8

TABLE 3

***In Vivo* and *in Vitro* Organic Matter Digestibility of Grass Species at Two Stages of Regrowth**

Treatment	*Age (weeks)*	*In vivo*[a] %	*In vitro* %
C. nlemfuensis var. *robustus* *Penn. purpureum*	4	67.6	64.2
	8	62.0*	39.4*
	4	57.7	57.0
	8	51.4	47.3
C. nlefuensis var. *nlefuensis*[b]) *P maximum*	4	61.2	60.4
	8	32.5	51.6
	4	53.1	52.6
	8	41.8	46.2

a Mean of three animals per treatment.
b Not included in data for calculating regression equations.

from approximately 28.8 % for *C. nlemfuensis* var. *robustus* at 4 weeks to approximately 34 % for *Panicum maximum* at 8 weeks of regrowth. Oyenuga (1959; 1960) reported means of 11.4 % and 10.5 %; 28.1 and 29.5 % for the CP and C.F. content respectively for *Penn. purpureum* harvested at 6 and 8 weeks of regrowth over a twelve month period, while for *P. maximum* the corresponding values for C.P. and C.F. content over the same period were 8.5 and 7.0 %, and 28.2 and 31.0 % respectively. The lower CP. content obtained in this experiment at between 8 and 9 weeks of regrowth for *Penn. purpureum* and *P. maximum* was probably due to the fact that the grass samples were harvested at the end of the rainy season and at the onset of the dry season period. Similar decline in the CP content of tropical grass species had been reported in this country (Chheda and Akinola 1971) and elsewhere (Johnson, Guerrero and Pezo, 1973; Minson, 1971; Marshall *et al.*, 1969; Long, 1967).

The data in Table 3 show that the *in vivo* organic matter digestiblity varied between 67.6 % for *C. nlemfuensis* var. *robustus* when cut and fed at 4 weeks to 32.5 % for *C. nlemfuensis* var. *nlemfuensis* cut and fed at 8 weeks of regrowth with *Penn. purpureum* and *P. maximum* having 57.7 and 51.4 %; and 53.1 and 41.7 % OM. digestibility for the 4 and 8 weeks of regrowths respectively. These values are essentially in agreement with the results previously obtained by Olubajo, Van Soest and Oyenuga (1974) and with the digestiblility values of 68.2, 61.7, 60.8 and 55.8 % reported by Ademosun (1970) for *Pennisetum purpureum* cut at four stages of growth and fed to sheep and goats.

The *in vitro* organic matter digestibility results shown in Table 3 were as expected. Exact agreement between *in vivo* and *in vitro* digestibility coefficients is not to be expected in these trials because the *in vitro* measurements were carried out on the feed offered while the results of the *in vivo* measurements were based on feed selected. The refusals varied between approximately 21 and 33 % of the dry matter offered. Brendon and Marshall (1962) observed similar lower *in vitro* digestibility than for the corresponding *in vivo* digestibility results for the same grass species when fed *ad libitum* with no allowance made for rejected material. It is suggested that grasses used in these trials were far less homogenous than those found in temperate climates and selection is more marked under these conditions. Long (1967) observed that the mean *in vitro* digestibility coefficients for *Penn. purpureum* was approximately 7 10 digestibility units lower than the *in vivo* digestibility values for the same species of grass while that for *Panicum maximum* was about 8 digestibility units lower than that of the *in vivo* results.

Joint analysis of variance showed no statistically significant differences either between treatments or between the two methods ($P>0.05$), but the differences between periods were statistically significant ($P<0.05$).

Similarly the analysis of variance passed on each treatment showed no statistically significant differences either among animals or between periods within the same treatment except in trials with *C. nlemfuensis* var *nlemfuensis* where the differences between periods were significant ($P<0.01$).

When the *in vivo* organic matter digestibility data were regressed on *in vitro* organic matter digestibility values the following regression equation was obtained.

$$Y = 1.1756\ X - 8.76\ (S.E. \pm 1.52).$$
$$r = 0.91, (P<0.01)$$

where Y = *in vivo* OM. digestibility coefficient, and X = *in vitro* OM. digestibility coefficient.

Similar regression equations with high correlation coefficients have been reported in the literature (Van Soest *et al.*, 1966; Deinum and Van Soest, 1969; Long, 1967). In an earlier work (Olubajo *et al.*, 1974) no correlation was found to exist between the *in vivo* and *in vitro* apparent dry matter digestibility derived from the "summative" equation based on chemical analysis (Van Soest, 1965). Since the grass species used in the present studies were not analysed for their cell contents, the cell-wall constituents and the lignin content of the acid detergent fibre, it is difficult to ascertain whether similar results could be obtained.

Values of the total digestible nutrients (TDN) correlate with the values of the *in vitro* organic matter digestibility ($r = 0.88$; $P<0.01$). The regression equation calculated and fitted to the data is

$Y = 1.2104\ X - 15.14$ (S.E. $= \pm 0.99$), where Y = TDN and X = % *in vitro* OM digestibility.

The actual values of organic matter digestibility coefficient, calculated from regression equations do not have any precise meaning since the digestibility of feeds is related to intake and to the individual animal characteristics. Nevertheless the relation is sufficiently close for the results of *in vitro* measurements to provide a good relative assessment of a forage. Raymon (1965) stated that the technique is particularly suitable for herbage breeding studies, the assessment of new varieties, and for studies in digestibility changes with advancing maturity. It is also considered that the technique holds considerable future for the rapid assessment of many indigenous grass species found in tropical Africa (Long, 1967).

It would appear from the results obtained in the present studies that the results of *in vitro* digesstibility of some local grasses can be used to predict their digestibility *in vivo*.

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