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Growth, nutritive value and dry matter degradability of three Tephrosia species

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Abstract

Two trials were carried out to evaluate the potential of Tephrosia bracteolata (TB), Tephrosia candida (TC) and Tephrosia linearis (TL) for animal feed. In an 18-week growth experiment, Tephrosia species differed ($P<0.05$) in leaf number (LN) and stem height (SH). TB and TL had apparent ($P<0.05$) early and persistent growth than TC until weeks 12 – 18 when all retarded in growth at the commencement of flowering. TC however, increased geometrically in LN and SH. There were significant ($P<0.05$) differences among the species in dry matter (DM) and acid detergent fibre (ADF). The DM, CP, NDF, ADF, EE and ash range from 30.0 – 41.8, 24-26.5, 62.3 – 68.5, 45.8 – 48.4, 2.3 – 2.6 and 5.6-6.2% respectively. Calcium and sodium were highest ($P<0.05$) in TB and TL species but had similar composition in P, Mg and K. In the second trial, dry matter disappearance and CP release were determined. The Tephrosia species were not significantly ($P>0.05$) different in degradation characteristics. Lower amount of crude protein (10 – 14.81%) was released in the three Tephrosia species. As a result of rapid growth, high nutritive value and easily rumen degradable dry matter of Tephrosia shrubs, ruminants could benefit immensely from the plants.

Key words: Nutrient, utilization, dry matter degradation *Tephrosia* species

Introduction

Tephrosia plants are tropical shrub legumes with over 300 species distributed worldwide. They are notably dispersed throughout the tropics, sub-tropical Australia and North America (Dutta, 1979). One of the species, *Teprosia candida* (TC) has been enlisted with suitable multipurpose trees (MPTS) and shrub species for alley farming systems in humid and sub-humid zones of Africa (Daniel, 1971, Bansh and Paul, 1992).

In Nigeria, among the commonest species found in the wild of the drier part of the west and middle belt zones are *Tephrosia bracteolata* (TB), *Tephrosia linearis* (TL) *Tephrosia vogelli* (TV), *Tephrosia purpureum* (TP) and *Tephrosia candida* (TC). However, TB and TL occur frequently than other species in those ecological areas. It was reported that some of these legume trees are used locally as firewood in Cameroon (Fomunyan and Mboni, 1987).

The tephrosia species especially TB and TL are locally called "roro" in the western part of Nigeria and highly valued by rural dwellers. The local farmers especially old women are preoccupied with it by adventuring into the bush to cut the shrubs for goats and sheep while excess of their need is marketed on daily basis. An unreported observation showed that the ubiquitous goat and sheep reared on extensive system go to mountaintops and valleys to browse on the legume.

Apparent digestibility has been reported (Fomunyan and Mbomi, 1987) for TV and suggested that its crude protein value can be utilized like cotton seed cake for protein supplementation. Some tephrosia legumes were also established to be relishing to cattle (IBPGR, 1984) and goats (Ayoade *et al.*, 1998). There is limited documented information on tephrosia species pertaining to growth, and nutritive value. Grazing animals will benefit little from a weak, too short or too tall legume tress/shrubs. The reports (Caren *et al.*, 1987; Addlestone *et al.*, 1999) showed that successful stand establishment of forage is highly dependent on seedling vigour as measured by seedling height, stem diameter and herbage yields. The present study was undertaken to determine the nature of growth and nutritive value of three tephrosia species.

Materials and methods

Site and land preparation

The growth experiment was conducted at International Institute for Tropical Agriculture (IITA) and rumen degradability study at International Livestock Research Institute (ILRI), Ibadan ($7^0$3ON, $3^0$54'E), 200m above sea level. The study was carried out late dry season (March) by irrigation and early rainy season (July), 2000. Existing shrubs were removed from the site. A polythene sheet was spread out upon which the soil filled polythene pots were placed. Soil sample was randomly taken and analysed as presented in table 1. Polythene pots were watered to saturation for consecutive 3 days until water was observed to seep out from the drainage holes of the pots.

Seed treatment and planting

The seeds of the tephrosia species used were sourced for as reported and allowed to pre-culture treatment of 30 seconds in boiled water (Babatunde, 2000). The treated seeds were counted and divided in a completely randomized design into five batches of 50 seeds per species. Each batch of 50 seeds was further sub-divided into five of 10 seeds sown into the pots at the depth of 2mm.

Plant height and leaf number

The plant height (PH) and leaf number (LN) of the shrubs at 20% minimum survival were taken at 4 weeks post planting. The subsequent measurements and counting were effected at 2 weeks interval for upward of 18 weeks using the method as reported elsewhere (TAGRP, 1997).

Sample collection and dry matter determination

Samples were collected at 12 weeks old. Leaves were separated from the stem and the former were freshly weighed and dried in a drought oven at 65^0C for 48 hours to a constant weight for dry matter (DM) determination. The dried samples were then milled in a micro-miller using a 1-mm diameter screen and 2.5mm sieve for rumen degradation.

Rumen degradability

In order to evaluate DM disappearance, the samples were incubated in the rumen of fistulated sheep using the nylon bag technique (Qrskov and McDonald, 1979). Three grams of the milled (2mm screen) samples were weighed into nylon bags measuring 140 x 75 mm with pore size of 41mm. The bags were incubated in the rumen of the sheep in duplicates for 24, 48, 72 and 96h. The evacuated bags from the rumen were rinsed immediately under a running tap to terminate fermentations. The residues in the bags were oven dried at 65^0C for 48h to a constant weight to determine DM loss. The results for DM disappearance were fitted to the exponential equation $P = a + b\,(1 - e^{-ct})$ as reported (Qrskov and McDonald, 1979) where a=water-soluble fraction; b=insoluble but degradable fraction; c=rate of degradation; and P= the degradation at time t.

Chemical analysis

The dry matter (DM), crude protein, ether extract and ash of the samples were determined according to AOAC (1980). The neutral detergent fibre (NDF) and acid detergent fibre (ADF) were analysed as reported (Goering and Van Soest, 1970). Mineral elements were determined by atomic absorption spectrophotometer (AAS) model 490 Gallenkamp, London.

Statistical analysis

Data generated were subjected to analysis of variance using the general linear model procedure of statistical analysis (SAS, 1995). Statistical differences among treatment means were declared at 5% level of significance. Means were separated using Duncan (1955) multiple range test.

Results and discussion

Physical and chemical characteristics of soil for trial one are shown in Table 1. Although much has not been established but scanty information showed that tephrosia plants could do well in a slightly acidic soil (AFNETA, 1992). The N level of the soil (0.66%) obtained for the present study is much higher than 0.07 – 0.11% reported (Tening *et al.*, 1994) for the establishment of Stylosanthes.

Table 1 *Physical and Chemical Properties of Soil for Tephrosia species*

Parameters	Values
pH (H_2O) (1:1)	5.6
Nitrogen (%)	0.66
Phosphorus (μg/g)	28.22
Calcium (meg/100g)	2.52
Sodium (meg/100g)	0.61
Magnesium (meg/100g)	0.75
Potassium (meg/100g)	0.50
Sand (%)	83.60
Silt (%)	10.00
Clay (%)	6.40

The average leaf number (LN) and stem height (SL) are presented in Tables 2 and 3 respectively. There was a rapid increase in both LN and SH from weeks 4 – 8 and then followed by an increase at a decreasing production in weeks 10 – 18 for the legumes TB and TL. It was observed that TC improved (P<0.05) in LN and SH for weeks 10 – 18 than either TB or TL.

Table 2 *Mean leaf number of the Tephrosia species*

Species	Week							
	4	6	8	10	12	14	16	18
Tephrosia bracteolata	16^{a}	27^{a}	48^{a}	66^{a}	83^{a}	88^{a}	90	90
Tephrosia candida	11^{ab}	23[illegible]	3[illegible]	48^{c}	65^{b}	74^{b}	86	98
Tephrosia linearis	12^{b}	25[illegible]	41	56	81^{a}	87^{a}	91	90

a,b,c = means on the same column with similar superscripts are not significantly (P>0.05) different.

Table 3 *Mean stem height (cm) of the tephrosia species*

Species	Week							
	4	6	8	10	12	14	16	18
Tephrosia bracteolata	22.5^{c}	32.2^{a}	53.9^{a}	70.6^{a}	88.9^{a}	90.2^{a}	93.0^{a}	94
Tephrosia candida	14.7^{b}	21.4^{c}	33.3^{c}	45.1^{c}	54.8^{b}	58.1^{b}	68.5^{b}	82
Tephrosia linearis	20.7^{a}	24.2^{b}	42.3^{b}	63.9^{b}	88.4^{a}	88.3^{a}	91.6^{a}	92

a,b,c = means on the same column with similar superscripts are not significantly (P> 0.05) different.

Tephrosia candida is suspected to be a perennial plant as it outgrew other species in week 18 and remained green till the end of the dry season. Although leaf: stem ratio was not determined, optimum production of leaf coincided between 12 – 16 week of growth. Higher leaf content of browse tree than its stem is desirable for livestock production. It was reported that the nutrient composition in leaf materials of tropical legumes is higher than that of the stem or mixture of it (ILCA, 1994). In a grazing trial, Hamilton (1970) stressed the role of green leaf content of a pasture demonstrated and discovered that milk, meat and wool production deteriorated significantly with low leaf content of the pasture. The multiple productions of leaflets exhibited by the three shrubs legumes of our study are similar to some reports (Tarawali *et al.*, 1999; Addlestone *et al.*, 1999) for tropical legumes.

The nutritive value of the shrubs is presented in Table 4.

Table 4 *Nutrient Composition of Tephrosia species*

Species	Composition					
	DM	CP	NDF	ADF	EE	Ash
Tephrosia bracteolata	31.9^{b}	24.3	63.2^{b}	48.4	2.4	5.8
Tephrosia candida	41.8^{a}	26.5	68.5^{a}	45.8	2.6	6.2
Tephrosia linearis	30.1^{b}	24.0	62.3^{b}	47.9	2.3	5.6

a.b.c = means on the same column with different superscripts differ (P<0.05) significantly.

Tephrosia candida had higher DM and NDF than what TB and TL contained. However, the composition of ADF in TB and TL was more apparent (P<0.05) than that of TC. Crude protein, ether extract and ash constituents for the three-tephrosia species are similar (P>0.05). The level of crude protein (24 – 26.5%) in the present study was higher than 22.8% reported (Ayodele *et al.*, 1998) and 15.8% established by Le Houerou (1980). Crude protein for *Tephrosia purpureum* (15.4%), *Cajanus cajan* (18.6%) was much lower than those of the present study but is favourably compared with 25% *Gliricidia sepium* and 25.3% *Leucaena leucocephala* (Little *et al*, 1989). Higher protein could be obtained in tephrosia species if harvested at a much lower age as the age of harvest nutrient composition (Norton, 1994). Neutral detergent fibre was observed to be significantly higher in TC than that of TB and TL. The reason for the difference is not known but the textural leaves of TB and TL are smoother and tender than that' of TC. The NDF values are however, within the range of 25-71% reported for some valuable multipurpose trees in Nigeria (Bayer, 1990; Larbi et al, 1993). High ADF content were obtained in the legumes, which is comparable to 49.2% for *Ficus capensis* but higher than 31.0% for *Alchornea cordifolia* as reported (Akinlade et al, 2001).

Table 5 shows the calcium, phosphorus, magnesium, potassium and sodium composition of the forages.

Table 5 *Some mineral composition of tephrosia species*

Species	Nutrient Composition (%)				
	Ca	P	Mg	K	Na (ppm)
Tephrosia bracteolata	1.52[a]	0.27	0.64	1.23	269.1[a]
Tephrosia candida	1.26[b]	0.29	0.58	1.31	140.9[b]
Tephrosia linearis	1.54[a]	0.25	0.61	1.24	260.3[a]

a,b,c = means on the same column with similar superscripts are not signficiantly (P> 0.05) different.

There were significant (P<0.05) differences among the shrubs in Ca and Na. *T. bracteolata* and TL are apparently higher in Ca and Na than TC. No significant variation was noticed in P, Mg and K among the legumes. The amount of minerals in the study is comparable to those of Indonesian forages (Little et al, 1989). Without mineral fortification in the diets, the amounts present in the three forages are high enough to meet the requirement for ruminant animals (Akinsoyinu and Akinyele, 1979; Afolabi, 1995; Babayemi et al., 1999).

Rumen degradability characteristics of the three-tephrosia species are in Table 6.

Table 6 *Dry matter degradability characteristics (48h) Tephrosia bracteolata, T. candida and T. linearis in rumen of sheep*

Parameters	TB	TC	TL
a(%)	37.5	36.9	37.4
b	48.2	49.3	48.6
p	85.7	86.2	86.0
c(%h^{-1})	3.27	3.80	3.21

a = soluble fraction, b = degradable fraction, p = potentially degradable fraction, c = rate of degradation of b.

In all the plant species, no differences were observed in DM losses (48h). The degradability increased as the incubation period was increasing (Adama and Lapeyronie, 1997). The values (85.7 – 86.2%) in the present study are higher than reported for *Ficus capensis* and

Alchornea cordifolia (Akinlade *et al*, 2001) and of *Chromolaena odorata* (Apori *et al.*, 2000). The DM release is also higher than 25.44 – 42.93% reported (Keyserlingk et al., 1996) for alfalfa. The rumen degradable protein in this study is low when compared with CP degradation of 41% guinea grass, 60% ruzi, 69% leucaena and 79% gliricidia (Ibrahim et al., 1995). Such low CP release could indicate undegradable intake protein (UIP). According to Bohnert *et al.*, (1998), greater N degradation per hour resulted in less ruminal escape N. Tephrosia species could then be used as UIP. As reported elsewhere (Zinn *et al.*, 1981; Titgemeyer et al, 1989), that supplying of ruminants with UIP can increase the flow of N and amino acids to the small intestine. It will also result in appreciable growth and efficiency of N utilization (Stock *et al.*, 1981; Goedeken *et al.*, 1990).

Conclusion

Tephrosia species are shrub legumes, early maturing and possess high nutritive values. Dry matter degradability is high with a low release of crude protein. The implication of this is that the use of *Tephrosia bracteolata, candida* and *linearis* would not only enrich the soil but also improve the performance of livestock when fed. Further work needs to be carried out on the factors that could limit their ingestion and utilization as various tropical browse plants contain some anti-nutritional factors.

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