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Chemical Characterization of Selected Tree Legumes as Indices for Their Litter Quality

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Abstract: Leaf pruning from several legume species: *Gliricidia sepium*, *Cajanus cajan*, *Albizia zygia*, *Albizia ferruginea*, *Leuceena leucocephala*, *Dalbergia latifolia*, *Acacia auriculiformis* were analysed for some critical litter quality indices such as total carbon, nitrogen, lignin and polyphenols. Total C was estimated as 50% of its ash free dry weight and total N was determined by Kjeldahl method while lignin content was determined from the acid detergent fibre. The polyphenol content was extracted in 70% aqueous acetone after initial depigmentation with diethyl ether containing 1% acetic acid and determined as tannic acid equivalent using Folin Ciocalteu reagent. Total C ranged from 42.8% in *Albizia zygia* to 49.6% in *Acacia auriculiformis* while N ranged from 3.9% in *Acacia* and *Albizia ferruginea* to 4.8% in Gliricidia sepium. Gliricidia had the lowest polyphenol content (2.3%) while *Acacia* contained the highest value (7.7%). The lignin content varied from 23.9% in *Gliricidia* to 49.7% in *A. Auriculiformis*. Based on the leaf chemical constituents, *Gliricidia sepium* was rated as high quality litter while *Acacia auriculiformis* was rated as low quality litter.

Key words: Lignin, polyphenol, nitrogen, decomposition, mineralization

INTRODUCTION

Decomposition and nutrient release patterns of organic materials are determined by the organic constituents and nutrient content of the materials, the decomposer organisms present and the environmental conditions (Tenny and Waksman, 1929). Several plant quality parameters and indices have been proposed for predicting decomposition and nitrogen release patterns. These include lignin; soluble carbon; total nitrogen, ash free dry weight and soluble phenolics (Palm and Rowland, 1997). It is however apparent that the importance of certain parameters change with the types of plant material (Palm, 1995). Plant residues poor in N, but with large concentrations of lignin and polyphenols decompose and release N slowly, while residues rich in N, but with small lignin and polyphenol concentrations decompose rapidly (Giller and Cadish, 1995). The main drive in decomposition research has been to find ways of predicting the rate of litter decomposition or even more importantly, the rate of nutrient release, from the chemical composition of the resource. Therefore, the main objective of the present study is to screen selected tree legumes for the characterization of their litter quality as basis for their selection for decomposition and mineralization studies. It is also aimed in this study to characterize the litter quality of mixed proportions of high quality and low quality litter as indices for predicting the quality of wide spectrum of resource material.

MATERIALS AND METHODS

A preliminary investigation was carried out in 2001 at the Teaching and Research Farm of the Federal University of Technology, Akure Nigeria, to screen seven selected legumes species for initial carbon, nitrogen, lignin and polyphenolic contents in the fresh leaf sample as indices of the quality of the tree legume litter. The screened species include: *Gliricidia sepium*, *Cajanus cajan*, *Albizia zygia*, *Albizia ferruginea*, *Leucaena leucocephala*, *Dalbergia latifolia* and *Acacia auriculiformis*. For each of the screened species, ten stands were randomly selected for collecting fresh leaf samples from the plantation site of the Department of Forestry and Wood Technology, Federal University of Technology, Akure, Nigeria. The collections were made from the tree species at 5 m from the ground level. Composite samples were obtained from samples collected from ten trees per species so as to ensure that field variability was reduced in the sampling technique (Palm and Rowland, 1997). The collected fresh leaf samples were them analysed for C, N, lignin and polyphenols. Furthermore, rating of the selected species was carried out to select the species with the highest and the lowest litter quality. After the selection, the fresh leaves of the high quality litter was mixed with the low quality litter in various proportions comprising of 100:0 (*Gliricidia: Acacia*) ratio; 80:20; 60:40 50:50; 40:60; 20:80 and 0:100. The chemical analysis of the resultant mixtures

was then carried out for their lignin concentration; polyphenol concentration, nitrogen concentration and carbon contents.

Determination of legume quality parameters: The litter samples were dried at 40°C for 72 h, ground and analysed for C, N, lignin and polyphenol contents. Ash free dry weight of litter was obtained by combustion in a furnace at 550°C for 3 h (Cochran, 1991). Total C was assumed to be 50% of its ash free dry weight (TSBF, 1993) while total N was determined by Kjeldahl method (AOAC, 1990).

The polyphenol content of the litter was extracted with 70% aqueous acetone after initial depigmentation with diethyl ether containing 1% acetic acid. The total polyphenol (as tannic acid equivalent) in the extract was thereafter determined using Folin Ciocalteu reagent as described by Makkar and Good child (1996).

RESULTS AND DISCUSSION

Total C in the selected legumes (Table 1) ranged from 42.8% in *Albizia zygia* to 49.6% in *Acacia auriculiformis* while N ranged from 3.9% in *Acacia* and *Albizia ferruginea* to 4.8% in *Gliricidia* and *Cajanus cajan*. *Gliricidia* had the lowest polyphenol content (2.3%) while *Acacia* contained the highest value (7.7%). The lignin content varied from 23.9% in *Gliricidia* to 49.9% in *Acacia*. *Acacia* was rated the lowest quality litter while *Gliricidia* was ranked as having the highest quality. The N concentration of the legume leaf mixtures decreased with increasing proportion of *Acacia* to *Gliricidia* leaves (Fig. 1) where as the concentration of lignin, polyphenols, C-to-N ratio, polyphenols -to-N ratio and (lignin + polyphenols) - N ratio increased (Fig. 2).

The result of the present study indicated that tree legume litter differs with respect to chemical constituents (lignin, polyphenol, N, C) that regulates litter decomposition and mineralization. This findings agrees with earlier reports (Fox *et al*., 1990; Oglesby and Fownes, 1992) who reported the influence of polyphenol, lignin and nitrogen contents of several tropical legumes on chemical decomposition and nitrogen mineralization. In decomposition studies, a minimum set of parameters (N, C, polyphenol, lignin) should be measured to characterize plant quality so as to allow cross-site comparisons and synthesis of results from a broad range of studies. Thus, even though some of the parameters may not be essential for the objectives of a particular study, researchers are encouraged to provide the basic list of plant quality characteristics, in addition to information on the climate, ecosystem and soil type where the study is conducted.

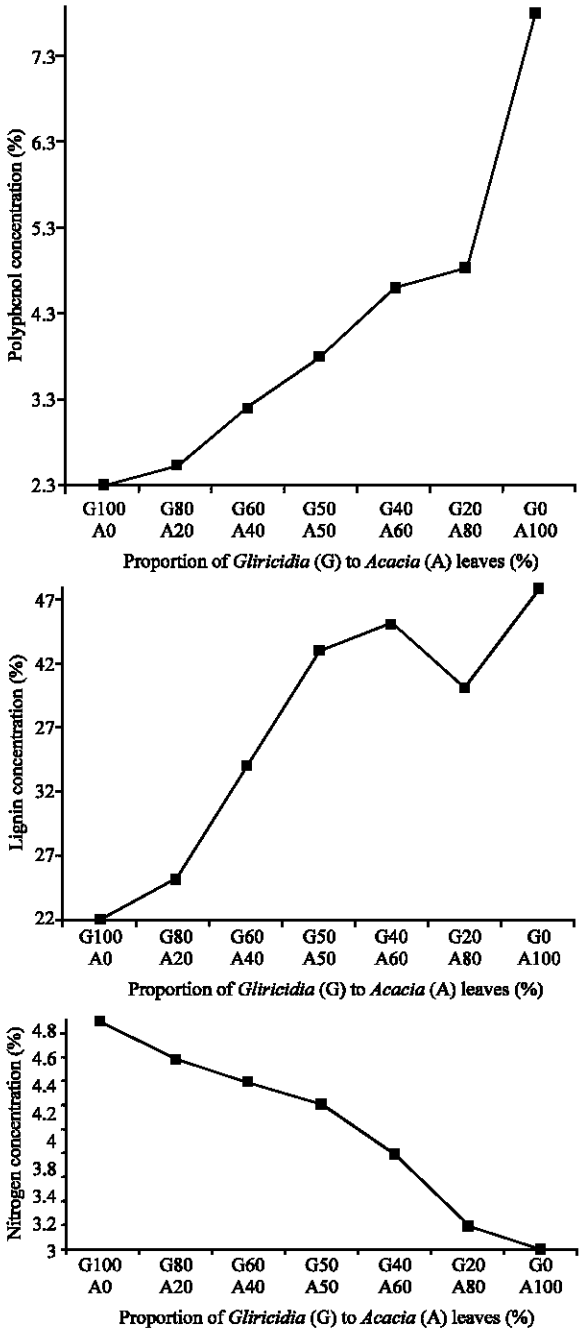

Fig. 1: N, Polyphenol and lignin concentration of mixed Gliricidia/Acacia leaves

The N concentration of the mixed Gliricidia/Acacia leaves deceased with increased proportion of *Acacia* in the mixture while other parameters for characterizing organic input quality increased. This pattern of changes in chemical composition corroborate earlier findings (Handayanto *et al*., 1997) upon mixing different proportions of *Gliricidia sepium* and

Table 1: Preliminary chemical characteristics of selected legumes

Legume species	Total C (%)	Total N (%)	Polyphenol (%) (TAE)	Lignin (%)	C/N ratio	Lignin/N ratio	Polyphenol/N ratio
**Gliricidia sepium*	47.2	4.8	2.3	23.9	9.8	5.0	0.47
Cajanus cajan	43.2	4.8	3.0	44.9	9.0	9.4	0.62
Albizia zygia	42.8	4.5	3.4	42.8	9.5	9.5	0.75
Albizia ferruginea	44.6	3.9	3.2	40.1	11.4	10.3	0.82
Leucaena leucocephala	43.5	4.5	3.8	25.2	9.6	5.6	0.84
Dalbergia latifolia	45.4	4.1	3.7	32.9	11.0	8.0	0.90
***Acacia auriculiformis*	49.6	3.9	7.7	49.7	12.7	12.7	1.97

* Highest quality litter,** Lowest quality litter, TAE = Tannic acid equivalent

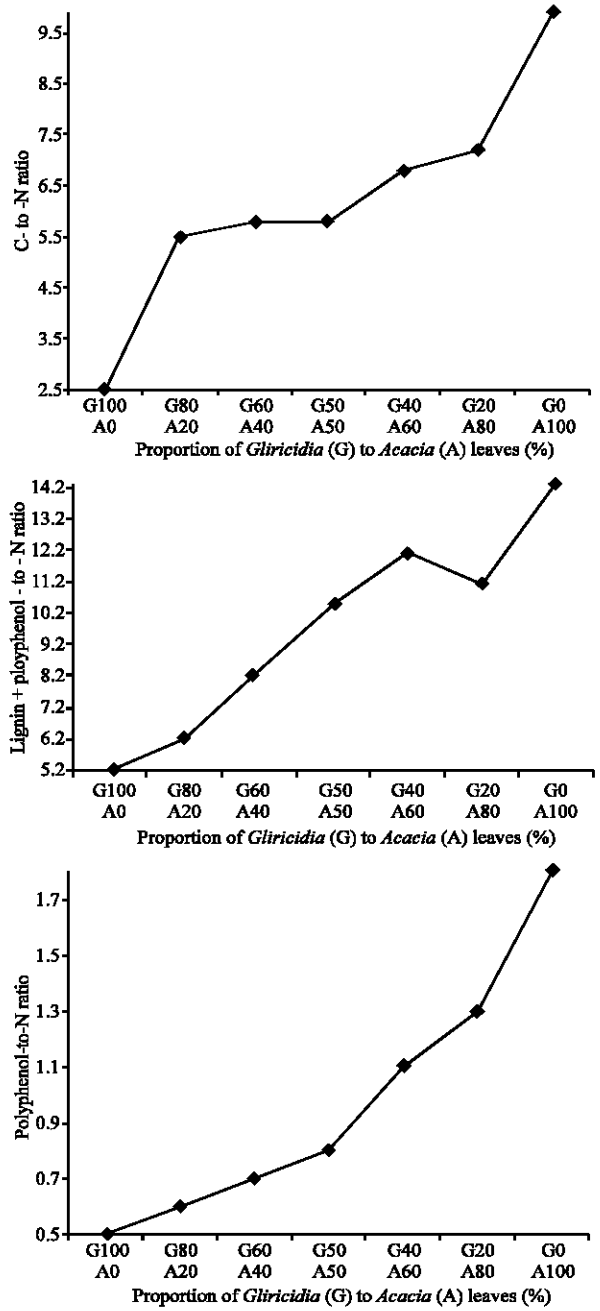

Fig. 2: N, Polyphenol-N; Lignin + Polyphenol-N and C-N ratio of mixed *Gliricidia/Acacia* Leaves

Peltophorum dasyrrachis. According to Manfogaya *et al.* (1998) the resource quality is defined by organic constituents and nutrient contents of material which in turn affect the rate of decomposition (slow or fast) and mineralization potential. As earlier reported (Tian *et al*., 1992; Mafongaya *et al*., 1998), *Gliricidia sepium* has low C:N ratios, low lignin and polyphenol contents whereas *Acacia* pruning are characterized by high C:N ratio and high lignin and polyphenol contents. This explained why the N concentration of the mixed pruning decreased with increase proportions of *Acacia* in the mixture while C:N ratio, lignin and polyphenol contents increased as observed in this present study. The change in chemical composition of the mixed pruning indicate the possibility of manipulating plant quality through mixing legume pruning from different species, thus providing the robust option for regulating decomposition and N mineralization of plant residue from high quality and low quality litter.

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