UNEXPLORED AND UNDERUTILIZED LEGUMINOUS TREE SPECIES IN TRADITIONAL FARMING SYSTEMS OF TROPICAL WEST AFRICA

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INTRODUCTION

In the "Flora of West Tropical Africa" (Hutchinson and Dalziel, 1936) revised by Keay (1958), *Leguminosae* is treated as an Order comprising three distinct families: *Caesalpiniaceae*, *Mimosaceae* and *Papilionaceae*. However, the current name for the Order is *Leguminales* while *Fabaceae* has been indicated as an alternative name for *Papilionaceae* (Hutchinson 1973).

The Order *Leguminales* is composed of trees, shrubs or herbs; with simple to bipinnate leaves; actinomorphic to zygomorphic flowers; free or partially united petals; numerous to free stamens which are free or variously connate but often diadelphous; carpel solitary and superior; fruit often a legume or indehiscent, sometimes winged. The fruit, is therefore not always a legume, which strictly is defined as "a fruit formed from a single carpel and dehiscent by both the ventral and dorsal sutures so as to separate into two valves" (Hutchinson 1973). However, plant species belonging to any of the three families in the Order *Leguminales* are designated as legumes. The roots of such plants contain rhizobia which are capable of fixing atmospheric nitrogen.

Leguminous plants are also of great importance because of their dietary, nutritional, economic, soil conservation, timber, fuel, forage/fodder, and other non-wood values. These non-wood values include gums, drugs, oil, dyes, ornamentals and miscellaneous products. In addition to these uses, some legumes are also of cultural, religious and general ethnobotanical significance.

Despite the antiquity of their domestication and utilization, several leguminous tree species in Tropical Africa are virtually unexplored and clearly underutilized. This paper therefore reviews the roles of such trees:

(1) in the traditional farming systems

(2) as sources of food for man and animals and

(3) in rural economy.

The current prospects for the improvement and enhanced utilization of tree legumes are also highlighted.

2. ROLE OF LEGUMINOUS TREES IN TRADITIONAL FARMING SYSTEMS

2.1. Definition of Farming System

Having indicated the characteristics of legumes in the Introductory section of this paper, it is now necessary to define farming system. It is defined as a specific agricultural enterprise satisfying well defined objectives, including production of food, cash crops, livestock, raw materials for industries etc., and involving various kinds of inputs and resources (such as land, labour, capital) together with the practices and operations with which they are managed in different holdings and in a given environmental setting (Norman 1979, Okigbo 1979, Rutherberg 1971). In the complex traditional farming systems of tropical Africa, a specific farm system may therefore consist of one or more subsystems each of which is differentiated from others in terms of physico-chemical (soils, water, climate, nutrients), biological (crop, plant animal, pests), socioeconomic (labour, markets, preferences, religion) technological (tools, machines, practices) and managerial (knowledge, decision-making) elements involved in the agricultural production process (Okigbo 1979).

2.2. Maintenance of Soil Fertility

Against the above background, one of the important uses of leguminous trees is soil conservation and fertility maintenance, arising from the fact that legumes generally are able to fix nitrogen through symbiotic nitrogen fixation by the rhizobia in their roots. Leguminous trees can therefore fulfil this role as

components of fallows, and through organic manures and mulches. In this regard, the most widespread method of fertility maintenance in traditional farming systems of the humid tropics, as is well known, is the bush fallow system. This system normally relies on naturally grown fallow vegetation to recycle the nutrients and restore fertility after cropping cycle. A planted fallow of trees would also serve this role even more efficiently since the trees could serve as "nutrient pumps" by bringing up to the surface, nutrients leached to the deeper soil horizons, in the form of leaf litter and other plant residues (Grainger 1980). When such fallow tree species are legumes, they would also be of special importance because they would perform the dual roles of nitrogen fixation and nutrient recycling.

Some of the leguminous trees and shrubs that may be planted in fallows or which exist as dominant species in fallows in traditional farming systems of southern Nigeria for instance, include Anthonotha macrophylla, Dialium guineense, Afzelia bella var. bella, Berlinia grandiflora, Albizia zygia, A. glaberrima, A. adianthifolia, Baphia nitida, Dalbergia saxatilis, Lonchocarpus cyanescens, Millettia aboensis, M. thonningii, Gliricidia sepium, Leucaena leucocephala and Pentaclethra macrophylla.

Improvement of fertility status of agricultural land is thus possible through additional amounts of nitrogen that could be added to the farmland by the tree legume components such as those listed above. The Order Leguminales therefore offers by far the greatest choice of woody species for the traditional farming systems in terms of fertility improvement and maintenance. However, di-nitrogen fixation is not universally present in all members of the Order. As reported by Nair (1984) out of the three families the majority of both Mimosaceae and Papilionaceae are known to fix nitrogen as contrasted to only a smaller percentage of the members of Caesalpiniaceae. So far, very limited research has been carried out on the development of a few of these species and on efficient ways of managing them in more productive and permanent cropping systems (Okafor 1978, 1979, 1981c; Kang et al. 1984)

2.3. Other Uses of Tree Legumes in the Traditional Farming Systems

In addition to their role in maintenance of soil fertility, leguminous trees are also used in traditional farming systems as mulch materials, stakes and structural materials, farming implements and boundary plants (Okafor 1979).

Mulch Materials

Examples of tree legumes which are commonly used as mulch in the farms include Pentaclethra macrophylla, Dialium guineense. Tetrapleura tetraptera, Anthonotha macrophylla, Albizia adianthifolia and Berlinia grandiflora. Those species which shed their leaves quickly from branchlets are most popular. Yam mounds are often "capped" with the twigs of such species. Leaves of non-leguminous species such as Oil palm (Elaeis guineensis) are also used as mulch.

Stakes and Structural Materials

Various species of leguminous trees such as Afzelia africana, Parkia spp., Pterocarpus spp., Pentaclethra macrophylla, Dialium guineense, Erythrina senegalensis grown in farms and along boundaries are used as living stakes for support of different climbing food plants such as Dioscorea spp., Tetracarpidium conophorum, Mucuna sloanei, Vigna unguiculata, Gongronema latifolium. The poles of D. guineense and P. macrophylla are also used for construction of farm huts.

Farming Implements and Utensils

The woods of Erythrophleum suaveolens, Afzelia africana, Brachystegia spp., Dialium guineense, Berlinia spp. and Pentaclethra macrophylla, which are very durable, are used for manufacturing of tool handles (hoes and matchets) and household utensils (mortars and pestles, wooden spoons and forks).

Hedges and Boundary Plants

Leguminous trees and shrubs whose branch cuttings and twigs sprout easily are sometimes planted as hedges and living fences for keeping out domestic livestock and poultry from gardens and for demarcation of compound boundaries. Such boundary plants include

Pterocarpus santalinoides, Erythrina senegalensis, Gliricidia sepium and Bephia nitida.

3. TREE LEGUMES AS SOURCES OF FOOD FOR MAN AND ANIMALS

3.1. Human Food

Legumes as sources of protein of higher biological value than non-legumes make significant contributions to local diet in developing, non-industrialized countries, where consumption of animal protein is rather inadequate (Roche 1974). In such countries, tree legumes provide several items of food namely: (1) leafy vegetables (2) edible fruits and seeds (3) condiments for thickening and flavouring soups. The distribution of the species in compound, near farms and outlying farms (Okigbo 197[illegible], Okafor 1975b), is related to their roles as food. For example, those located in compound farms such as Pterocarpus spp., provide ready food materials while those in outlying farms may require processing before being used. Examples of these food items are indicated below:

(i) Leafy Vegetables

Young shoots and leaves of Pterocarpus soyauxii, P. mildbraedii, P. santalinoides are widely used as fresh vegetables. Leaves of Afzelia bella var. bella and Afzelia africana are both fermented and used also as vegetables.

(ii) Edible Fruits and Seeds

Fruit pulps of Dialium guineense and Parkia biglobosa, syn. P. clappertoniana (Hopkins 1983) Tamarindus indica are eaten fresh and also used in preparation of fruit drinks. The seeds of Pentaclethra macrophylla (oil bean) are boiled, sliced, fermented and used in preparation of native salads and as vegetable sauce for eating yam and cocoyam.

(iii) Condiments and Flavouring Agents

The seeds of Parkia biglobosa, Prosopis africana (both fermented), Afzelia africana, Brachystegia spp. and Detarium microcarpum are commonly used as flavouring and thickening agents in soups.

In addition to their dietary contributions, the above woody legumes contain appreciable amounts of protein, fats and vitamins (Okafor 1981c, Okigbo 1976) as indicated on Table I.

3.2. Animal Feed

Most households in the rural areas of the humid tropics of West Africa keep some goats, sheep and poultry. Feeds for these domestic livestock, especially those kept in pens, comprise browse plants, pastures, or cut fodder, kitchen and household refuse, and fruit residues. Several of the browse trees which have been identified are legumes. These include Dialium guineense, Baphia nitida, Millettia spp., Berlinia spp. In the semi-arid tropics, Parkia biglobosa, Acacia albida, Afzelia africana, Daniellia oliveri, Tamarindus indica are among the tree legumes also commonly used as browse or fodder (Okafor 1980b). A comprehensive account of tropical feeds including browses is available (FAO 1975).

Proximate composition of fodder sample, as percentage of dry matter, of Dialium guineense one of the above browse species is given on Table I.

4. LEGUMINOUS TREES IN RURAL ECONOMY

In addition to the uses of legumes in conservation of the soil and maintenance of soil fertility, and other roles in the traditional farming systems, as well as food for man and his animals, leguminous trees are also of great importance in terms of their contribution to the economy and culture of the rural people in the tropics. The protection and cultivation of some of the tree legumes are thus related to their general importance and great ethnobotanical significance, as sources of timber, fuel, chewing-sticks, tanning materials, gums, dyes, drugs, games, religious worship, artifacts, oracle, and ornamentals.

(i) Timber and Firewood

Important commercial leguminous timbers of the humid tropics are Brachystegia spp., Pterocarpus osun, Afzelia africana, Parkia bicolor, Berlinia spp., Pentaclethra macrophylla, Dialium guineense, Piptadeniastrum africanum and Stemonocoleus micranthus.

These species can also be used as firewood, especially Pentaclethra macrophylla and Dialium guineense. On the other hand, Dialium guineense, Afzelia africana, Prosopis africana and Daniellia ogea are good sources of charcoal which are suitable for iron smelting (Lucas 1977). The fruit pods of Pentaclethra macrophylla are also used as fuel. Some quick-maturing legumes e.g. Cassia siamea, Gliricidia sepium and Leucaena leucocephala are also grown for firewood.

(ii) Chewing Sticks

The tips of brenchlets of some leguminous trees and shrubs are chewed and used as tooth brush. These include Bephia natida, Dialium guineense, and Millettia spp.

(iii) Tannin Materials

Tannin is one of the important non-wood products of trees. It is essential in local leather industry, especially in the semi-arid tropics. Irvine (1961) has provided a general list of tannin producing trees. The legumes among them include Acacia albida, A. nilotica, A. polyacantha subsp. campylacantha, A. sieberiana, Pericopsis elata, Albizia coriaria, Burkea africana, Parkia biglobosa, Pterocarpus erinaceus, P. osun, P. soyauxii, Tetrapleura tetraptera, Tamarindus indica (Lucas 1977, Okafor 1981d).

(iv) Gum

Lists of some gum yielding species in Nigeria have also been compiled (Soladoye 1977 and Okafor 1981d). The legumes among them are Acacia seyal, A. sieberiana var. sieberiana, A. senegal, A. polyacentha subsp. campylacantha, Erythrophleum suaveolens, Brachystegia nigerica, B. eurycoma, B. kennedyi, Albizia zygia, A. adianthifolia, Afzelia africana, Burkea africana, Cynometra vogelii, Daniellia ogea, D. oliveri, Dialium guineense, Detarium senegalense, Isoberlinia doka, Piptadeniastrum africanum, Prosopis africana, Pterocarpus erinaceus, P. sentalinoides and Tamarindus indica.

(v) Dyes

The indigo dye which is widely used in local textiles is obtained mainly from Lonchocarpus cyanescens (Yoruba Indigo), which is often protected or cultivated for this purpose. The bark, leaves and twigs of another leguminous shrub, Indigofera arrecta, also provide dyes. The roots of Cassia alata are used in tattoo-like skin dyeing, while the heartwood of Baphia nitida, Pterocarpus osun, P. soyauxii yield camwood, which is ground to produce reddish dye used for cosmetic purposes. Leaves of Mucuna sloanei, a woody climber are used for colouring and beautifying mud walls and floors.

(vi) Drugs

Many leguminous plants found under cultivation or in the wild in the humid tropics are used in folk medicine or as sources of drugs and insecticides (Okigbo 1976, Oliver 1960). A more recent study (Okafor 1984) has identified 128 species of such medicinal plants, comprising 120 genera, representing 66 flowering plants, of which the families with the greatest number of species (i.e. those with 4 species and over) included Papilionaceae (with 10 spp.), Caesalpiniaceae (5 spp.) and Mimosaceae (4 spp.). It was also found that the following legumes provided cure for the ailments shown against them: Lonchocarpus cyanescens (ulcer; scabies) Pterocarpus santalinoides, (stomach ache) Tetrapleura tetraptera (convulsion), Cajanus cajan (measles), Cassia alata, (eczema), Pentaclethra macrophylla (malaria), Dialium guineense (diarrhoea). Also, according to Lucas (1977), the following legumes are also used locally as medicinal herbs: Pericopsis laxiflora (for teething troubles in children), Albizia zygia (skin diseases including yaws), Cylicodiscus gabunensis (vapour from bark inhaled for cure of cold and fever), Daniellia oliveri (tooth ache; colic), Distemonanthus benthamianus (skin rash), Parkia bicolor (pulverished bark used in dressing woulds), Piptadeniastrum africanum (used as an enema, tooth ache), Pterocarpus erinaceus (fever and diarrhoea). Plants of the

Tephrosia spp. and Erythrophleun suaveeleus are sometimes grown in compound farms for use as fish poison.

(vii) Games

Seeds of legumes are sometimes used for playing games, for example Caesalpinia bonduc and Mucuna sloanei.

(viii) Religious worship, artifacts and Oracle

Several species of legumes are also sources of traditional religious artifacts. Such species are frequently protected or grown, and are used as fetish in sacred groves. These species include Baphia nitida, Pterocarpus osun, P. soyauxii, P. mildbraedii, Detarium microcarpum, D. senegalense, Erythrina senegalensis. The articulated branches of Detarium spp. are of special significance in heathen worship. The shell of fruits (endocarp) of Detarium spp. are also used as items of oracle (soothe-saying).

(ix) Ornamental Plants

Many leguminous trees and shrubs are excellent ornamentals because of their beautiful flowers, colourful young leaves, and shade. Legumes of the tropicscommonly grown as ornamentals include Cassia nodosa, C. sieberiana, C. siamea, Bauhinia spp., Albizia spp., Delonix regia, Baphia nitida, Erythrina spp. Adenanthera pavoniana, Millettia spp., Afzelia africana, A. bella var. bella, Brachystegia spp., Parkia biglobosa, Pentaclethra macrophylla, Tamarindus indica, Pterocarpus santalinoides, Distemonanthus benthamianus (with red bole).

5. PROSPECTS FOR IMPROVEMENT AND ENHANCED UTILIZATION

5.1. Potential for Selection

The very great potential for selection and improvement of leguminous trees, which has been identified in the course of the work done on indigenous West African fruit and multipurpose trees in Nigeria (Okafor 1981c, 1982b) relates particularly to the following features:-

a) a great deal of variability observed within some of the species
b) phenological differences in their leaf flush;
c) the incidence of precocity in terms of early flowering.

(a) Species Diversity

The great range of species of tree legumes in tropical West Africa, and their corresponding multifarious classes of food items and other useful products and roles, as indicated earlier, illustrate one aspect of their diversity. The other aspect is the existence of discernible fruit forms, which owing to lack of correlation with other characters have, however, not been recognized as distinct taxa. For example, four fruit forms are discernible in Pentaclethra macrophylla namely (i) long + broad (ii) long + narrow (iii) short + broad and (iv) short + narrow. Similarly, a study of the local variation in Parkia biglobosa (syn. P. clappertoniana) and Prosopis africana has also shown continuous variation in the size and shape of pods and seeds, respectively (Okafor 1980b). The existence of intraspecific variation, such as in these species, increase their genetic base and is therefore useful in their selection, breeding and utilization (Whitmore 1976, Okafor 1978).

(b) Phenological differences

Some leguminous tree species exhibit distinctive patterns of leaf flush. For instance, it is a well known fact that trees of Acacia albida have the peculiarity of bearing new leaves only in the dry season while being more or less leafless during the rains. Some trees of Pentaclethra macrophylla are also leafless during the rainy season. As reported by Okafor (1980a) trees of Pterocarpus soyauxii and P. mildbraedii appear to differ in their patterns of leaf flush; the former sheds its old leaves and produces new flushes almost spontaneously, especially during the dry season, while

the latter does so intermittently throughout the year, including during the rainy season. The variability in the phenology of leaf flush in Acacia albida and Pentaclethra macrophylla is significant for agroforestry, while that of Pterocarpus spp. has both economic and utilization implications.

(c) Precocious Flowering

Early flowering within 2-3 years has been observed in a few seedlings of Tamarindus indica and Tetrapleura tetraptera. The potential value of such material in future improvement work remains to be explored.

5.2- Development of Propagation Techniques

One of the major aspects of the work on indigenous fruit trees, including legumes, referred to above, is the development of propagation procedures for the plants, in order to enhance their popularity, economic potentials and continued and regular production in traditional and future farming systems. The methods of propagation so far successfully developed pertain to the vegetative ones, consisting of budding (budgrafting) and stem cuttings (Okafor 1978).

For early flowering, it was considered crucial to collect budwood and cuttings material, used in the exercise, from the exposed crown of selected adult trees, which had commenced fruiting. This is in compliance with the phenomenon of cyclophysis (Oleson 1978). The corresponding phenomenon of topophysis could also be of practical value in developing cuttings which would develop plagio-tropic growth habit. For example, in Pterocarpus spp. it is possible to produce bushy, early flushing trees, that are convenient to harvest, at low heights. Apical pruning was preliminarily found to be useful in Parkia biglobosa, with some pruned trees fruiting in four years.

The results of the vegetative propagation investigations (Okafor 1981c) so far indicate that at least 26 species of indigenous food trees, in the humid tropics, are buddable using

adult scion. These include the following ten leguminous tree species:-

Afzelia africana
A. bella var. bella
Detarium microcarpum
Dialium guineense
Parkia biglobosa (syn. P. clappertoniana)
Pentaclethra macrophylla
Pterocarpus mildbraedii
P. santalinoides
P. soyauxii
Tetrapleura tetraptera

Out of these, budded trees of D. guineense and P. macrophylla have produced viable fruits in about 3 years. Similarly, out of the 17 species of woody food plants which have been successfully propagated by adult stem cuttings, the tree legumes include Detarium microcarpum, Dialium guineense, Pterocarpus mildbraedii, P. santalinoides and P. soyauxii. A leguminous non-food tree, Erythrina senegalensis, is also easily propagated by stem cuttings. Stem cuttings of D. guineense have produced flowers within two years.

5.3. Enhanced Utilization of Leguminous Trees

a) Convenience Foods

Fruits and seeds of some tree legumes can, because of their nutritional status, be used in production of enriched convenience food products. For example, processed fruit juice can be prepared from pulp of Dialium guineense, Parkia biglobosa (both rich in Vitamin C) and Tamarindus indica. Fruit jam and jelly can also be made from D. guineense. The protein rich seeds of Pentaclethra macrophylla can also be prepared into flour and explored in food fortifications. Vegetables of Pterocarpus spp. (also rich in protein) can be processed, and packaged, as in frozen spinach, to extend the period of availability and reduce wastage. The processed and fermented seeds of Parkia biglobosa and Prosopis africana, which are extensively used as flavouring agents

in soups, in all parts of Nigeria, can be more appropriately packaged as in "maggie cubes". These food products which have great economic and import substitution potentials, ought therefore to be more fully explored and utilized.

b) Agroforestry Applications

Intensified use of leguminous trees within the farming systems is justifiable because of their nitrogen fixation ability, as well as, their overall role in soil conservation and fertility maintenance. For instance, it is common knowledge that trees of Parkia biglobosa, Acacia albida, Prosopis africana make such significant contributions to the soil that crops grown close to them, in the farms, perform better than those grown farther away. Similarly, Anthonotha macrophylla and Dialium guineense are extensively used as fallow species in Southeastern Nigeria on account of their fertility restoration ability, as well as, their multifarious uses (Okigbo 1976). In this connection, trees of A. macrophylla which are associated with the development of a special mushroom, also provide wrapping leaves which are important, locally, in packaging of fermented food products.

Arising from the above features and capabilities of tree legumes, it is now necessary to develop cropping systems which should enhance their utilization and contributions in the farming systems in the tropics. Some of the species are promising for the Alley cropping system. They should therefore be used in addition, or in place of, Leucaena leucocephala and Gliricidia sepium (Kang et al 1984) as dictated by the prevailing edaphic, socio-economic and cultural conditions of the area. Examples of promising leguminous woody species, for alley cropping, include Pentaclethra macrophylla, Acacia albida, Parkia biglobosa, Prosopis africana, Anthonotha macrophylla, Cassia siamea, Dialium guineense, Berlinia grandiflora, Baphia nitida, Albizia glaberrima, A. zygia, Afzelia bella var. bella and Pterocarpus santalinoides. .../14

In addition to the use of such leguminous trees, in alley cropping, they should also be more intensively used as "farm trees" and planted fallows (Okafor 1982a, 1985b), within the traditional farming systems.

CONCLUSIONS AND RECOMMENDATIONS

6.1. General Conclusions

From the foregoing the following general conclusions can be drawn:-

1. Several leguminous tree species make significant contributions to the protein supplies and other essential nutrients of people in tropical West Africa.
2. It is widely acknowledged that leguminous trees also make substantial contributions to soil conservation and fertility maintenance, through nitrogen fixation, nutrient recycling, and supplies of organic manures and mulches.
3. Leguminous trees also provide various necessary materials for the traditional farming systems.
4. Innumerable miscellaneous useful products are also derived from tree legumes.
5. Many of the species exhibit great variability in plant types, of different yield potentials.
6. Techniques of vegetative propagation which have been developed for some of the trees, are capable of improving their yield and reducing their age and height to facilitate harvesting. For example budding of Pentaclethra macrophylla (oil bean) has reduced the period of bearing from 6-7 years to 3-4 years.
7. There are great potentialities for preparation of convenience food products from fruits, seeds and vegetables of tree legumes.
8. There are therefore great prospects for improvement, enhanced utilization, and realization of full potentials of legumes, towards improved standard of living, and well being of the people in tropical West Africa.

6.2. Research Needs

Despite the above prospects for development and potentialities of tree legumes, in the farming systems and rural economy in tropical West Africa, high priority should be given in research to the following:-

1. Economic appraisal of the leguminous tree species identified in this paper, is now necessary, since most of them, with exception of Parkia biglobosa, Tamarindus indica, and Acacia spp. are not yet fully explored and utilized.
2. Nitrogen fixation studies and use of tree legumes in soil conservation and fertility maintenance, including development of cropping systems eg. alley cropping.
3. Sexual propagation methods, including controlled pollination, to take advantage of the results of vegetative propagation studies.
4. Study of food values through proximate analysis of various edible parts.
5. Studies of processing and storage of convenience food products.
6. Germplasm collections and evaluation, of as many relevant species as possible.

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TABLE I: NUTRITIVE ELEMENTS IN SEED/LEAF OF SOME TREE LEGUMES IN NIGERIA

Species	%Protein	%Fat	Lysine 100g	Tryptophan per 100g	%Oil	%Starch	Iron	%Calcium	%Sulphur	%Phosphorus	Manganese mg/g	%Potassium	Copper mg/g	%Magnesium	Zinc mg/g	%Sodium	%Aluminium	Remarks
Detarium microcarpum (seeds)	12	-	0.7	0.2	12	35.4	-	-	-	-	-	-	-	-	-	-	-	-
Dialium guineense (fodder)	10.82	-	-	-	-	-	0.02	0.26	-	1.41	-	0.81	-	-	-	0.37	0.24	Aril very rich in Vit. C
Mucuna sloanei (seeds)	22.4	-	5.0	0.9	14.4	40.3	-	0.18	0.14	0.41	40	0.90	2	0.45	14	-	-	-
Parkia sp. (seeds)	26	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Pulp very rich in Vit. C
Pentaclethra macrophylla (seeds)	28	23	5.0	1.2	45.9	19.0	-	0.32	0.11	0.47	50	1.60	32	0.41	35	-	-	-
Prosopis africana (seeds)	17	-	-	-	-	-		-	-	-	-	-	-	-	-	-	-	-
Pterocarpus mildbraedii (leaf)	28.4	-	-	-	-	-		-	-	-	-	-	-	-	-	-	-	-

Species	% Protein	% Fat	Lysine 100g	Tryptophan per 100g	% Oil	% Starch	Iron	% Calcium	% Sulphur	% Phosphorus	Manganese mg/g	% Potassium	Copper mg/g	% Magnesium	Zinc mg/g	% Sodium	% Aluminium		Re
P. santalinoides (leaf)	28.19	7.92	--	--	--	-	(-	-	-	7.-	-	-	--	-	-	-	-		-
P. soyauxii (leaf)	32	7.12	0.4	0.5	--	-	100 ppm	0.5	0.23	0.40	80 ppm	2.5	--	0.30	-	-	-		-

Source: Okigbo (1977); Okafor (1981C); Okigbo & Okafor (unpublished)