ISSN:0975-542X

Foliar Nutritional Composition of Four Indigenous Trees of the Sudan Savanna, Nigeria.

Umar T[1], A. G. Bello[2] and A.S. Kamba[3]

[1]Biology Dept., Shehu Shagari College of Education, Sokoto; [2]Forestry and Fisheries Dept., Usmanu Danfodiyo Univ. Sokoto; [3]Chemistry Dept. Institute for Quran and General Studies, Sokoto

Abstract:

A study was conducted to determine the Nutritional composition of the leaves of four indigenous trees of the Sudan savanna. Samples of fresh leaves of *Balanites aegyptiaca, Faidherbia albida, Parkia biglobosa and Vitex doniana* were randomly collected from some of the standing trees at the permanent site, Usmanu Danfodiyo University, Sokoto. The samples were separated, grouped and mixed thoroughly based on completely randomize design (CRD) procedure oven dried at 70°c for 72 hours, grounded with pestle and mortar, digested and analysed for nutrients concentrations. Three replicate samples, each of 2g were used in determining all the parameters. Nutrients concentration were found to be in the order NFE>Mtr>C/F>Ash > Ether > C/p in the leaves of the trees studied. Macro elements, concentration was in the order K>Ca>Mg>P in the leaves of the entire trees studied. Micro elements concentration varied in the following order; Fe>Mn>Cu>Cl_2>Zn for B. *aegyptiaca* and *V. doniana;* Fe>Mn>Zn>Cu>Cl_2 for *F. albida*, and Fe>Mn>Cl_2>Zn>Cu for *P. biglobosa*. ANOVA and LSD indicated significant effect and significant differences between the samples analysed. The leaves of these trees are therefore recommended to the users for better supply of these nutrient elements to the body.

Key Words: *Foliar; Indigenous trees; Sudan savanna; and nutritional analysis.*

Introduction:

Balanites aegyptiaca (Desert Date Tree or Egyptian Myrobolan Tree), *Faidherbia albida* (Apple Ring Acacia), *Parkia biglobosa* (Locust Bean Tree) and *Vitex doniana* (Black Plum Tree) are among the important trees which grow well in the savanna environment of Nigeria, due to their resistance to drought and ability for quick regeneration. They are acceptable browse and agro forestry species. They form the very basis of the diet of camels, goats and many wild herbivores and play a vital role as a complementary source of proteins, minerals and vitamins for cattle and sheep during the dry seasons. They are also important in erosion control, maintenance of soil fertility, provide fuel wood, various craft items, pharmacopea and food for people[1]. The leaves of these trees are generally used as forage for livestock but young leaves of *V. doniana* and *B. aegyptiaca* are consume by some local communities in the savanna regions of Africa especially during famine seasons.

For trees to produce both qualitative and quantitative leaves like other plants, they require nutrient elements for optimal growth and development that ensures this task. The elements needed are Carbon, Hydrogen, Oxygen, Nitrogen, Phosphorus, Potassium, Calcium, Magnesium, Sulphur, Iron, Manganese Zinc, Copper, Molybdenum, Boron and Chlorine. These elements are absorbed by plants from the soil and then converted in plants body into other tissues components and other major nutrients in the name of carbohydrates, Proteins, Ether, Fibre, Ash, Moisture, e.t.c through a number of chemical, physical and biological transformations. These nutrient elements are essential because each of them has a specific role to play in tree metabolism. They are also essential to growth and developments of an animal. If any is in limited supply, growth may be impaired or in their absence, the complete process of vegetative or reproductive life cycle is prevented and deficiency symptom specific to each element is developed and is corrected only by its supply or application. These nutrient elements form important constituent of plant and animal tissues, catalyst in various reactions, osmotic regulators of membrane permeability. For example Nitrogen is a constituent of Proteins, Phosphorus & Phospholipids and Nucleo-Proteins, while Copper, Iron and Zinc form prosthetic groups or co-enzymes of certain enzymes systems[2]

A large proportion of plant nutrients in a forest ecosystem are held in the foliage of the crown, therefore, a leaf is not just an organ of carbon assimilation but also a region of nutrient accumulation and subsequent dissipation. Therefore, differences between species in the longevity of leaves may be related to their role as sites of mineral storage and it may be relevant that the evergreen habit seems often to be characteristic of species living in environments in which mineral resources are scarce or rapidly leached.[3] However, in practice many factors other than nutrients supply to the tree may cause variation in foliar nutrient concentrations , or levels and includes effects of climate, season, time of day, aspect of the tree, crown of the tree, tree age, position of leaves in the crown, age of foliage, internal nutrient balance, effects of diseases, e.t.c [4]

There are reports that plant species show preference for certain ions over others. .[5; 6] had reported that, demonstrated that a cation of higher preference could replace one of the lower preference in plant cells and that many of the macro-elements are more directly involved in physiologically mature tissues than in younger ones. Similar results were reported by many researchers: [7] had reported higher concentration of N and K in both lettuce and cabbage than all the other macro-nutrients; higher N concentration in the fresh leaves (16%) *of Acacia albida* than in the dry leaves (0.4%) by and [8] higher N and K with Mg the least in young leaves *Adansonia digitata* than in the matured leaves by [9] and higher N concentration with Ca and Mg the least in both the fresh and dry leaves of *Azadirachta indica* and *Eucalyptus camaldulensis* by [10].). reported that the average water content of fresh leaves is about 88% with an average Carbohydrate content of 8.6%, 1.9% Protein, 0.3% Fat and 0.84% Ash, while other percentage composition of Vitamins, Nucleic Acids is generally less than 1%, This higher water content and the relatively low Carbohydrate and Fat content suggest that much of this water is in available form. Similar results were reported [12] by in a study conducted with 21 trees during the rainy seasons in Nigeria. He reported the following average values for nutrient contents: Crude Protein -17.3%, Crude Fibre 22.7%, Ether Extract 2.8%, Ash (Silica-Free*)* 4.3% and Nitrogen-Free Extract 51.0%. [13] had also reported the following results in a similar study, viz: 58.9% (Nitrogen Extract), 18.5% (Crude Fibre), 14.7% (Crude protein), 5.7% (Ash), 1.7% (Ether extract), and 0.5% (Silica) in the order Nitrogen Extract > C/Fibre > C/P > Ash > Ether Extract > Silica, all in *A. albida,* while that of B. *aegyptiaca* goes in the order Nitrogen Extract > C/Fibre > Ash > C/P > Ether Extract > Silica with the following values: 51.3% (Nitrogen Extract), 14.6% (Crude *Fibre)*, 13.4% (Ash), 12.3% (Crude Protein), 4.7% (Ether Extract) and 1.2% Silica.[4] had reported that some tree species, especially legumes (like most of those studied) have nutrient -rich leaves, which readily breakdown and release the nutrients to the organisms body or add to soil fertility. Personal observations revealed that trees have been disappearing at ever-increasing pace (trees understudy inclusive), due to indiscriminate felling by different agents, thus reducing their potentials for future use. Also, a lot of work has been done on these trees under study not only in Nigeria but the world over. But despite more than 100 years of research in plant nutrition, a cursory look at the available literature indicates that comparative data on foliar nutrient levels between trees under study is either totally absent or actually buried in a mass of literature. It was against this background that the study was undertaken to determine the trees with best nutrients concentration in their leaves in order to reveal their nutritional value in the area and hence for their conservation.

Materials and Methods:

Sample of fresh dark green leaves of B.aegyptiaca, F.albida, *P.biglobosa* and *V.doniana* were randomly collected from some of the standing tress at the permanent site, Usmanu Danfodiyo University, Sokoto for proximate analysis in the Agricultural laboratory of Usmanu Danfodiyo University, Sokoto. The samples were separated, grouped and mixed together thoroughly based on completely randomized designed (CRD) procedure, oven dried at 70^0c for 72 hours, grounded, digested and analyzed for nutrient and elements concentrations. Three replicate samples each of 2g were used in determining all the nutrients investigated. Moisture was determined by the Oven Drying Method, Ash by Muffle Furnace, Ashing Method, Ether Extract by Soxhlet Extraction Method using Petroleum Ether, Crude Fibre by Muffle Ashing Method and Crude Protein by Micro-Kjeldahl Method. The procedure used was that described by [14]. Nitrogen-Free Extract (NFE) levels were determined by Difference or the Nitrogen-Free Extraction (NFE) Method using procedure described [14]. All these were expressed in percentage. The mineral elements investigated were phosphorus by *colometric vanadomolydate* (yellow) method, potassium by flame *photomomtry* method, calcium and magnesium by *versenate* titration method (EDTA titration method). These are macro elements, the micro elements tested are manganese, copper, iron, zinc and chloride determined by atomic absorption *spectrophotometric* method. All these elements concentrations were determined using procedure described by [14]

The data collected were subjected to Analysis of Variance (ANOVA) using SAS (Statistical Analysis System). Least Significance Difference (LSD) was used to separate the means.

Results and Discussion:

The results of this study revealed that Moisture, Ash, Ether Extract, Crude Protein and Nitrogen–Free Extract contents of the leaves of the trees studied were generally significant but that of Crude Fibre was not significant (Appendix I), Also the results through group means ($\bar{X}$) was generally found to be in the order NFE>Mtr>C/F>Ash>Ether>C/P in the leaves of all the trees studied (Table I). Also the content of Nitrogen – Free Extract was observed to be the highest in all the leaves of the trees. Crude protein was the least (Table I). These observations were not uncommon in the plant world hence similar results were obtained by [7] working on Cabbage and Lettuce; and *Acacia albida* respectively. This finding could be due to the significance of the these nutrients to the trees in their metabolic activities in that order hence, [7]) had reported that plant species show preference for certain ions over others or a cat ion of higher preference could replace one of lower preference in plant cells. This probably explains the NFE content being significantly higher than Moisture, Crude Fibre, Ash, Ether Extract and Crude Protein the least, because the NFE components are significant to the trees metabolism hence they acts as sources of energy supply compounds and involves in some protoplasmic structures construction. Also higher concentration of this nutrients could be *due* to the effects of factors like climate, season, tree age, position of leaves in the crown, age of foliage, internal nutrient balance, effects of diseases, e.t.c [4]

The results of Moisture contents presented in Table I ranged from 41.93% in the leaves of *F.albida* to 50.98% in the leaves of *V.doniana*.

Table 1: Nutrients Contents in the Leaves of Four Indigenous Trees of the Sudan Savanna

Treatment	**Moisture (%)**	**Ash (%)**	**Ether Extract (%)**	**Crude Fibre (%)**	**Crude protein (%)**	**Nitrogen Free-Extract (%)**
B.aegyptiaca	44.88b	10.66a	9.16a	11.75	7.67a	60.76b
F.albida	41.93c	8.96b	8.96b	1.06	7.75a	61.77b
P.biglobosa	44.30b	10.17a	7.44c	12.98	6.64b	62.77b
V.doniana	50.98a	8.02c	7.30c	12.05	5.05c	67.58a
S.E Significance	0.57 S	0.25 S	0.22 S	0.39 'ns'	0.28 S	0.35 'S'

Means followed by the same letter in the superscript are not significantly different using LSD at 5%. 'S' – Significant, 'ns' not significant.

Table 2: Macro-elements Concentration in the fresh leaves of four indigenous trees of the Sudan Savanna.

Treatment	**P (PPM)**	**K (PPM)**	**Ca (PPM)**	**Mg (PPM)**
B. aegyptiaca	2.55	353.35	285.48	87.31
F. albida	3.21	298.91	222.89	73.13
P. biglobosa	3.21	289.11	235.90	73.63
V. doniana	1.18	4.6.42	198.70	64.54
S.E. Significance	0.42 'ns'	27.00 'ns'	15.60 'ns'	6.34 'ns'

Table 3: Micro-element Concentration in the fresh leaves of four Indigenous Trees of the Sudan Savanna

Treatment	**P (PPM)**	**K (PPM)**	**Ca (PPM)**	**Mg (PPM)**	**Cl_2 (PPM)**
B. aegyptiaca	1.67	1.20[a]	5.75[a]	0.49	0.74[a]
F. albida	1.71	1.12[a]	5.42[a]	1.50	0.70[a]
P. biglobosa	1.45	0.59[b]	4.34[b]	0.61	0.61[b]
V. doniana	1.62	0.61[b]	3.93[b]	0.44	0.51[c]
S.E. Significance	0.05 'ns'	0.07 S	0.26 S	0.19 'ns'	0.57 S

Means followed by the same letter in superscript are not significantly different using LSD at 5%; 'ns'-non-significant, S-significant.

Table 4: Significance of Leaves of *B. aegyptiaca* and *F. albida, P. biglobosa and V. doniana* on mineral elements concentration.

Treatments	Degree of Freedom	P (PPM)	K (PPM)	Ca (PPM)	Mg (PPM)	Mn (PPM)	Cu (PPM)	Fe (PPM)	Zn (PPM)	Cl_2 (PPM)
Leaves of the Trees	3	0.0017	0.0074	0.0010	0.0866	0.0023	0.0001	0.0001	0.001	0.0001
C.V. (%)		199.75	96.16	79.41	101.91	37.94	100.48	64.67	298.71	31.67

Table 5: Significance of leaves of *B.aegyptiaca, F.albida*, *P.biglobosa* and *V.doniana* on Nutrients contents.

Treatment	Degrees of freedom	Probability level of F					
		Moisture (%)	Ash (%)	Ether Extract (%)	Crude Fibre (%)	Crude Protein (%)	Nitrogen Free Extract (%)
Level of the trees C.V (%)	3	0.0001 14.97	0.0001 31.20	0.0001 33.61	0.0358 37.51	0.0001 49.22	0.0001 9.29

The results showed that the value of *V.doniana* leaves (50.98%) was significantly higher (P<0.05) than that of *B. aegyptiaca* (44.88%) and *P.biglobosa* (44.30%). Also the values for *B.aegyptiaca* and *P.biglobosa* were statistically the same but significantly higher than that of *F.albida*. This indicated that *F. albida* is more efficient in water usage and can resist water shortage than the other trees studied. This finding could be due to the effects of some factors causing variation in Foliar nutrient compositions such as climate, tree age, season, age of foliage, position of leaves while working on Lettuce and Cabbage.

The result values for Ash in Table I, were observed to be in the range of 10.66% in the leaves of *B.aegyptiaca* to 8.02% in the leaves of *V.doniana*. The values were statiscally the same in the leaves of *B.aegyptiaca* (10.66%) and *P.biglobosa* (10.17%) but significantly higher (P<0.05) than that of *F.albida* (8.96%) and *V.doniana* (8.02%) while the latter was the lowest statically. These values observed in all the trees under study were all greater than value obtained by [12], (4.3%) who carried out a study on nutrient contents of 21 forage trees during the rainy season in South-Eastern Nigeria, but the values were within the range of 7-12% as also observed by [16;17]. These observations indicated that the leaves of these trees under study were rich in concentration of this nutrient and hence the mineral elements in the leaves and therefore can support the dietary intake of the users.

The Ether Extract of the leaves of the trees (Table I) had shown that the levels ranged from 9.16% in the leaves *B.aegyptiaca* to 7.30% in the leaves of *V.doniana*. The level of Ether Extract in *B.aegyptiaca* leaves (9.16%) was significantly higher (P<0.05) than that of *F.albida* (8.46%) hence *B.aegyptiaca* is already discovered and recognized as oil tree species, that is why the natives are going for it [11] and the value in the latter spp (8.46%) was also significantly higher than that of *P.bibglobosa* and *V.doniana* (7.44%) which were statistically the same. All these values observed were greater than the value obtained by [12], (2.8%). These observations indicated that the leaves of the trees under study were high energy producers and could be used as fodder for animals. The significant difference in Ether Extract content in the leaves of the trees was possibly due to the effects of season, climate, tree age, position of leaves in the crown, age of foliage, generic differences, internal nutrient balance, effects of diseases e.t.c as also noted by [4].

The content of Crude Fibre (Table I) ranged from 11.75% in the *B.aegyptiaca* leaves, 13.06% in *F.albida*, 12.98% in *P.biglobosa* to 12.05% in *V.doniana*. The values obtained for *F.albida* and *P.biglobosa* were higher (P<0.05) and the result was non-significant statistically. These values did not agree with that of [11] (22.7%) and [18] (14.6%; and 18.5%). This observation could be due to preference for other nutrients over this one (Crude Fibre) as noted by [7] that plant species show preference for certain ions over others. This finding indicated that the leaves of these tree did not contain much required content of this energy source nutrient hence could be a reason why the values were not significant.

The range of Crude protein levels in Table I was from 5.05% in *V.doniana* leaves to 7.75% in the leaves of *F.albida* .The values of *B.aegyptiaca* (7.67%) and *F. albida* (7.75%)were significantly higher ($P<0.05$) than that of *P.biglobosa* (6.64%) and *V.doniana* (5.05%) but the content of the later was the lowest statistically. The values of this nutrient obtained in the leaves of these trees were not only below but almost twice below than the values obtained by [12; 18] (17.3%); (14.7%) for *F.albida* and 12.3% for *B.aegyptiaca* in their separate studies. This is also contrary to the report of [19] that the leaves of *F.albida* contains 12-15% digestible proteins. These observations may be accounted for by effects of geographical location, age of the leaves, climate or season, position of leaves in the crown, and the related factors as also noted by [4]. These results indicated that, even though the results were significant statistically, yet the leaves of these trees may not adequately support optimum growth and development of organisms in the provision of this nutrient.

The Nitrogen-Free Extract (NFE) levels in Table I ranged from 60.76% in the leaves of *B.aegyptiaca* to 67.58% in the leaves of *V.doniana* and the level of the latter (67.58%) was significantly higher ($P<0.05$) than the levels of all the other trees (60.76%, 61.77% and 62.77%), which were statistically the same. These NFE levels observed to be significant in the leaves of all the trees studied were all higher than the value obtained by [20] (8.6%) reported in [11]. This observation could be due to the effects of some factors like climate, age of the tree or leaves, season, position of leaves in the grown, genetic factors, stage of growth and other related factors as noted by [4] working on foliar nutrient concentration in *Gmelina arborea*. This result indicates that the leaves of these trees can supply the expected value of the nutrient energy requirement to the body when consumed by an organism.

The results of this study also indicated that phosphorous (P), potassium (K), calcium (Ca), Magnesium (Mg), Manganese (Mn), and Zinc (Zn) concentrations of the leaves of the study species (*B. aegyptiaca, F. albida, P. biglobosa* and *V. doniana*) were generally not significant but that of copper (Cu), Iron (Fe), and chloride (Cl_2) were significant (Table 2 and 3). Also, the results of macro elements through group means (x) were generally observed to be in the order K>Ca>Mg>P in all the leaves of the trees studied (Table 2). As for the micro-element concentrations, the result was observed to varied in the order $Fe>Mn>Cu>Cl_2>Zn$ for *B. aegyptiaca* and *V. doniana;* $Fe>Mn>Cl_2>Zn>Cu>Cl_2$ for *F. albida* while that of *P. biglobosa* was in the order $Fe>Mn>Cl_2>Zn>Cu$ (Table 3). Moreover, K element was observed to be the highest concentrated element and P the least for macro-elements, as for micro-elements Fe and Mn elements were the highest in concentration and Zn, Cl_2 and Cu the least in all the trees (Tables 2 and 3).

The observations of the non-significant effects of the leaves of the trees under study on the concentrations of P, K, Ca, Mg, and Zn, and the appearance of K as the highest, P the least in the macro-elements concentrations, and Fe and Mn elements the highest with Zn, Cl_2 and Cu the least in the micro-elements concentration are not uncommon among plant species, [10] made similar observation on *A. indica* and *E. camaldulensis* where P, K, Ca and Mg concentrations were all not significant. [7]reported high K concentration in both cabbage and lettuce with Fe and Zn the highest and Cu the least. Also, [9] found higher K concentration in the leaves of Baobab tree (*A. digitata*) with Mg the least. The observations may be accounted for by the effects of some factors that include climatic, seasonal, age of the tree, *edaphic*, genetic, stage of growth of the tree or leaves, position of leaves in the crown, age of leaves or foliage, and the like factors that cause foliar mineral elements variation as also noted by [21;4] . It may also be due to the significance of these elements in the physiological processes of the tree or their preference for certain ions over others as noted by many authors [7; 9;10]

Moreover, the significant effect of copper (Cu), Iron (Fe) and Chloride (Cl_2) concentration observed in the leaves of the trees under study was statistically better in the leaves of *B. aegyptiaca* and *F. albida* than in the leaves of *P. bigblobosa* and *V. doniana* but that of *P. biglobosa* was also better than that o f *V. doniana* for chloride (Cl_2) concentration (Table 3). This finding may be related to the preference of these elements by the trees based on their significant or importance to their lives or metabolic processes, hence it was evident from Table 3 that Fe concentration is significantly better than that of Cu and CL_2 the least in all the trees studied except for *P. biglobosa* where Cu was the least. Similar observation was reported by [7] that plant species show preference for certain ions over others notably with K/Mg, Fe/Cu, Zn/Cu in both lettuce and cabbage.

There are also reports of Fe/Mn; Mn/Cu; Fe/Zn and Fe/Cu [,9] These elements (Fe, Cu and Cl_2) are known to have some basic roles to play in the overall growth and development of plants. This funding suggests that these trees are rich in concentration of these mineral elements but that of *B. aegyptiaca* and *V. donaiana* is better than the other two tree species under study and can therefore support the nutritional requirement of the users.

Conclusion and Recommendations:

From the findings of this research, Moisture, Ash, Ether Extract, Crude Protein and Nitrogen Free Extract were significant but Crude Fibre was not significant (Table 5). Significant difference existed in the concentration of Moisture, Ash, Ether Extract, Crude Protein and Nitrogen – Free Extract in the leaves of the trees studied (Table I). All the leaves of the trees under study through group means (X) showed high NFE content with Crude Protein as the least. Hence, leaves of all the trees were recommended for higher NFE contents supply, *V.doniana* for high Moisture supply, leaves of *B.aegyptiaca* for both Ash and Ether Extract and leaves of *B. aegyptiaca* and *F.albida* for Crude Protein. , P, K, Ca, Mg, Mn and Zn concentrations were not significant; but Cu, Fe and Cl_2 concentrations were significant in the leaves of all the trees studied. Significant difference existed only in the concentrations of Fe, Cu and Cl_2 in all the leaves of the trees studied with higher concentration of these mineral elements in *B. aegyptiaca* and *F. albida.*

The non-significance of the macro and micro-elements studied (Table 2 and 3) suggest that the leaves of these trees may not make significant contribution of the elements to the dietary intake of the users, while as for those that are significant, the trees leaves are rich in the concentration of those elements and may therefore supply them in required quantity for growth and development. Therefore, leaves of all the trees are recommended for the supply of Cu, Fe, and Cl_2 but for better supply of these elements, leaves of *B. aegyptiaca* and *F. albida* were highly recommended to the users.

References:

[1] Baumer, M. (1990). The Potential Role of Agro-Forestry in Combating Desertification and Environmental Degradation with Special Reference to Africa, Netherlands: Technical centre for Agricultural and Rural Co-operation, G M. Drikkery, Giethoom/Meppel. Pp 14 - 19.

[2] Nwoboshi, L.C. (1982) Tropical Silviculture: Principles and Techniques, Ibadan, Nigeria: Ibadan University Press 333pp

[3] Harper, L, (1989). “Canopies as Populations” In: Russel, G., Marshall, B. and P.G. Jarvis (eds). Plant Canopies: Their growth, Form and Function. 1st published. Great Britain: Cambridge University Press. Pp 105 – 128.

[4] Evans, J. (1982). Plantation Forestry in the Tropics, New York: Oxford University Press Ltd, 170 pp

[5] Payne, W.J.A, (1994): An Introduction to Animal husbandry in the Tropics 4th edition. London: Longman Publishers pp 87 – 112

[6] John, C. (1992). Ruminant Nutrition: London: The Macmillan Press Ltd. 170pp

[7] Ajakaiye, C.0., Bako, S.P and J.B Abun (1995). “Concentrations of Macro and Micro Nutrients in the Leaves of Cabbage (Brassica oleraceae Var. Capitata) and Lettuce (Lactuca sativa) in Relation to Leaf Age, In: The Nigerian Journal of Botany. 8(2)pp 77-81.

[8] Boudhet, G.C, and B. Toutain (1980). “The integration of Browse Plants within Pastoral and Agropastoral Systems in Africa”. In: Le Houerou, H.N. (ed). Browse in Africa; The Current State of Knowledge. Paper presented at the International Symposium on Browse in Africa, Addis Ababa, April, 8 -12- pp 427.

[9] Umar, T., Maishanu, H.M and A. Singh (2006). "Foliar and Leaf Litter Mineral Element Concentration of Azadirachta indica (A. Juss) and Eucalyptus camaldulensis (Dennhardt)”. In: Badala Journal of Arts and Sciences: A multi-Disciplinary Journal of the School Arts and Socials Sciences, F.C.E Kano, Nigeria, Vol... 2(I): 25-31.

[10] Umar, T., Shinkafi, M.A and A.B Gwaram (2005). “Effect of Leaf Age on Mineral Elements Concentration in Baobab {Adansonia digitata Linn.). In: Bulletin of Science Association of Nigeria, 41st Annual Conference, Proceedings, Usmanu Danfodiyo University, Sokoto. Vol. 26: 265 – 269.

[11] Ahmad, S.R (2000). Investigation of the Mycoflora and the Nutritional Value of Stored Dry Leaves of Adansonia digitata (Kuka) obtained from Sokoto Central Market A.B.Sc Project Report submitted to the Department of Biological sciences, UDUS (unpublished) pp. 6

[12] Adegbola, T.A (1985). “Browse Plants: Propagation, Management and Utilization” In: Adu, I.F, Osinowo, B., Taiwo, BA, and W.S, Alhassan (eds): Proceedings of National Conference on Small Ruminants Production in Nigeria, N.A.P.R.I. Shika, Zaria, Kaduna, Pp 95 – 99.

[13] Udo, E.J, and J.A Ogunwale (1986). Laboratory Manual for the Analysis of Soil, Plant and Water Samples. 2nd edition London: Macmillan Publishers. Pp 67-137

[14] 16 AFRIS.(1980). Animal Feed Resource Information System Andropogon gayanus and Pennisetum pedicellatum htm. Pp-5.

[15] 17 Duke, A.J. (1983). Handbook of Energy Crops (unpublished) pp1-4

[16] 18 Agishi, B.C. (1985). “Forage Resources of Nigerian Rangelands” In: Adu, I.F, Osinowo, B., Taiwo, B.A, and W.S. Alhassan (eds): Proceedings of National Conference on Small Ruminants Production in Nigeria. N.AP.R.I Shika, Zaria, Kaduna. Pp 116-150.

[17] 19 Bernard, C. (2002). Faidherbia albida (Delite) A, cherv. In: Oyen, L.P.A., Lemmens, M.J. Daris, S.D. Chauvet, M. And J.S. Siemonsma (eds): Plant Resources .of Tropical Africa: Precursor. Wageningen, the Netherlands: PROTA programme pp 84-88.

[18] 20 Kealy, R.W.J. (1989). Trees of Nigeria. New York: Oxford University Press 438pp