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PROXIMATE, PHYTOCHEMICAL AND NUTRIENT COMPOSITIONS OF SOME FRUITS, SEEDS AND LEAVES OF SOME PLANT SPECIES AT UMUDIKE, NIGERIA

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ABSTRACT

Proximate, phytochemical and nutrient compositions of fruits, seeds and leaves of some plant species were studied at the University of Agriculture, Umudike, Nigeria. A total of 15 fruits/seeds and 16 leaves of some plant species were collected at the rainforest at Umudike, and the nearby forests to assess their suitability as food. The edible parts of each fruits/seeds of each plant species were collected in separately labeled and marked polythene bags. The proximate, phytochemical and nutrient compositions of each sample were analyzed. There were significant differences between the species in the percent carbohydrate, ash, protein, fat and fibre. All the fruits contained between 8.82 and 12.66 percent moisture, between 30.18 and 85.64 percentage carbohydrate and between 0.40 and 38.40 percent fat. Fat was highly represented in the family of Annonaceae. Calcium, manganese, potassium, sodium, phosphorous, iron, zinc and lead were at low concentration of less than 2.0 percent. The leaves had higher percent protein, carbohydrate, moisture content and higher concentration of saponin than those of the fruits. Generally improved varieties should be provided to farmers by Universities and Forestry Departments. It is recommended that farmers and industries should roast or boil these fruits/seeds and leaves to reduce the toxic elements in them. Such improved varieties of these plant species should be produced by Universities and sold to farmers at reduced prices.

Keyword: fruits, seeds, leaves, proximate composition, nutrients, chromium, cadmium, hydrogen cyanide.

INTRODUCTION

The tropical rainforest of Nigeria is located at the southern part of the country between latitudes $5^{0}30^{1}$ and $6^{0}40^{1}$N and longitudes $3^{0}45^{1}$ and $9^{0}85^{1}$E (Onochie, 1979). Within the rainforest are some plant species producing edible fruits, seeds or leaves (Keay, 1989). Presently, most of the original rainforest areas has been logged, cleared and cultivated with arable crops. During the weeding operations, coppice shorts and sprouts from roots were detached from existing stumps and roots. Also, seedlings resulting from germinated plant seeds were uprooted (Dike, 2003).The poor dispersal appendages of many rainforest trees species (Dike, 2000) have contributed to the observation made by Dike (2000) at Umudike, Nigeria that most fruits and seeds of the rainforest emergent, upper and lower canopy tree species could not fly into abandoned farmlands over 200 m away from the dispersing tree species.

Okafor, (1993) reported that some plant species were in the process of being lost. Recently, a total of 30 plant species producing edible fruits, seeds and leaves in south-eastern Nigerian rainforest have been reported as endangered (Meregini, 2005). Moreover, within the rainforest, 115 plant species whose uses were not classified have been reported as endangered (Oguntala, *et al.*, 2000). Many of these edible fruits/seeds and leaves are collected mainly from the wild and their habitats are currently threatened. There is paucity of literature on the proximate, phytochemical and nutrient compositions of these fruits/seeds and leave. There is need to understand their suitability for either food or fodder. A proper understanding of their proximate, phytochemical and nutrient compositions will lower the over dependence of many communities and industries on few known arable crops for fruits, seeds and vegetables. Also, knowledge of their composition would enable one to know the better type of fruits, seeds and leaves to eat or feed to animals at any given time. Some species due to their aroma and delicacy are eaten irrespective of their composition. There is the possibility that some fruits, seeds or leave could contain very small quantity of either anti-nutritional or poisonous chemicals. For example, *Anacardium occidentale* nut-shells contain vesicant poisons, 90 percent aracardic acid and 10 percent cardol (Ihekoronye and Ngoddy, 1985). Also *Lupinus albus* seeds contain erucic acid which is hazardous to health at high amount (Haq, 1993). There is the need to identify the poisonous chemicals and assess their cumulative adverse effects on the consumers. Presumably, if the chemicals are not removed during processing, the ill effects resulting from the poisonous chemicals consumed would manifest latter and pose a serious threat to life in future. This paper reports the proximate, phytochemical and nutrient compositions of 15 fruits/seeds and 16 leaves. The result of this study will provide additional information to nutritionists, health officers, industrialists, homestead and distant farmers for both raw material production and for local consumptions.

MATERIALS AND METHODS

Study area

The study areas are the 5-ha rainforest at the University of Agriculture Umudike, Nigeria and the near by forests. Umudike lies between latitudes $5^{0}27^{1}$ and $5^{0}32^{1}$N and longitudes $7^{0}32^{1}$ and $7^{0}35^{1}$E. The climate is of the equatorial type. The minimum and maximum top soil temperatures are 16.0 and 45^{0}C, respectively. There are

two seasons: a wet and dry season. The wet season starts from mid-March and end in mid-November. The dry season continues till the mid-march of the following year. In the month of August, there is a dry spell of between 5 and 10 days. In the months of December and January, the dry and dusty harmattan wind blows intermittently. The total annual rainfall ranges between 1500 and 3000 mm. Each year, there are two peaks in rainfall in the months of June/July and September. The humidity is high and often above 60 percent during the dry season (Dike, 2000; 2003). However, the humidity fluctuated between 1100 and 1500 GMT during the day and could be as low as 45 percent at the peak of the dry season.

The vegetation is tropical rainfall (White, 1983). Most of the rainforest areas outside forest reserves have been logged and farmed. Presently, the resultant secondary forest re-growths are in various stages of degradation. The abundant trees are *Alchornea cordifolia, Anthonotha macrophylla, Elaeis guineensis, Dialium guineense,Pentaclethra macrophylla and Piptadeniastrum africanum*. Some plant species such as *Chromolaena odorata* and *Raphia hookeri* are abundant at some localized areas such as abandoned farm lands and swampy areas, respectively. The topography is gentle. According to the Federal Department of Agriculture and Land Resources (FDALR, 1990), the soil in most places at Umudike is sandy clay loam. The soil is deep and without stones in many places. The soil parent material is the pre-Cambrian basement complex.

METHODOLOGY

The plant species whose fruits/seeds were studied were *Afzelia africana, Canarium schweinfurthii, Carpolobia lutea, Dacryodes edulis, Dennettia tripetala, Detarium macrocarpum, Dialium guineense, Gambeya albida, Garcinia kola, Landolphia hirsuta, Monodora myristica, Persea americana, Spondias mombin, Tetrapleura tetraptera, and Xylopia aethiopica*. The plant species whose leaves were studied include *Adansonia digitata, Afzelia africana, Elaeis guineensis, Gambeya albida, Gnetum africanum, Gongronema latifolium, Landolphia hirsuta, Lecaniodiscus cupanioides, Morinda lucida, Ocimum gratissimum, Piper guineense, Pterocarpus mildbraedii, Pterocarpus soyauxii, Talinum triangulare, Telfairia occidentalis* and *Vernonia amygdalina*. The distribution of most of these plant species have been described by Hutchinson and Dalziel (1954-1972) and Keay, (1989).

A reconnaissance survey was done to locate the fruit bearing plant species at both the 5-ha rainforest and the nearby forest at the University of Agriculture, Umudike, Nigeria. The positions of a total of 69 fruits bearing plant species were recorded using the Geographical Positioning Instrument. Out of these, a total of 15 plant species producing edible fruits/seeds and 16 plant species producing leaves were selected at random. Each plant species was marked with a numbered aluminum tags. For each plant species producing edible fruits/seeds, a total of 50 ripened fruits were collected from marked and numbered plant species. Leaves of each plant species were collected using a separately numbered polythene bag. These leaves were transported to the Ecological Center of the University where they were cleaned and their names confirmed at the Departmental Herbarium using the keys in the Flora of West Tropical Africa (Hutchinson and Dalziel, 1954-1972). The part of each plant species for analysis was labeled, numbered and put into a numbered envelope. Each envelope was carried to the laboratory for analysis of the proximate, phytochemical and nutrient compositions according to AOAC (2000) procedures.

The sample materials were dried at 60^{o}C for 6 hours. Each dried sample was milled with a Thomas Wiley Milling machine and sieved with 1.00 mm sieve. Each sample was stored in a labeled bottle. To obtain the moisture content of each plant sample, 5.0 g sample was dried for one hour in a Fisher Isotemp Oven (Model 175) at 110^{o} C. For a comparison, the moisture content of each fresh sample was also determined. The ash content of processed sample was done by the Murfle Furnace Ignition Method at 550^{o}C as is described by Pearson (1976). Fat was determined by the continuous solvent extraction method using a Sohxlet apparatus (James, 1995). Crude fiber was determined by the Weende method while semi-micro Kjedhalh method was adopted in protein determination. Calcium and magnesium were determined by the Versenate Complexometric titration method using Ethylene Diamine Tetracetic (EDTA) as indicator. Potassium and sodium were separately determined by the Flame photometer. Phosphorus was determined by the Vanado Molybdate-Yellow method (AOAC, 2000). The essential nutritive minerals and trace elements were determined on a dry matter bases (Pearson, 1976; James, 1995; AOAC, 2000).

RESULTS AND DISCUSSIONS

Of the 15 fruits/seeds studied, 80 percent of the plant species have edible fruit mesocarp and endocarp. The seeds having edible seed tegmen and endocarp formed 40 percent. The entire fruit and seed of two plant species *Dennettia tripetala and Xylopia aethiopica* in the family Annonaceae are edible. (Table-1). The percent moisture content, crude protein, fat, fiber, ash and carbohydrate vary between plant families and species both in the fruits/seeds and leaves studied (Tables 2 and 3). The percent moisture content for the fruits/seeds and leaves ranged between 8.82 and 12.66 and 5.28 and 9.29 percent, respectively. However, the moisture content obtained with the fresh samples prior to drying had wilder moisture content range of between 20.26 and 68.49 (Table-1.)

In the studied fruits/seeds, the family Annonaceae with 9.86 percent had the highest value of crude protein while the family of Guttiferae with 1.28 percent had the least value. The range is lower than between 16.0 and 35.1 percent recorded in legumes such as *Arachis hypogaea* and Soya beans, respectively (Aykroyd and Doughty, 1982). Within the species, the percent crude protein varied between 1.28 and 11.90 in *Garcinia kola and Xylopia aethiopica*, respectively (Table-2). The percent fat was least in the family of Anacardiaceae with 1.98 while the

family of Lauraceae had the highest value of 37.03. Within the species *Dialium guineense* had the least percent fat of 0.40, while *Dacryodes edulis* had the highest value of 38.40. The recorded 37.03 percent fat for *Persea americana* is higher than between 17 and 20 percent value reported for *Persea americana* (Ihekoronye and Ngoddy, 1985) presumably because of the adequate plant care given to this plant by the university. The percent fibre was least in the family of Anacardiaceae with 0.54, while the sub-family of Mimosoideae with 36.88 had the highest percent fibre. Aykroyd and Doughty (1982) recorded lower crude fibre values of between 2.1 and 7.6 in 23 legumes in human nutrition. Within the species, *Xylopia aethiopica* had the highest value of 38.60 percent while *Spondias mombin* had the least value of 0.54 percent. The percent ash was generally less than 11 percent. The least value was 2.82 percent in *Dialium guineense,* while the highest value was 10.36 percent in *Tetrapleura tetraptera.* The percent carbohydrate was the highest in the sub-family of Caesalpinidea with 90.02 but the least value of 35.03 was recorded in sub-family of Mimosoideae. The moisture content ranged between 8.82 and 12.66 and had the least value in *Persea americana.* The percent dry matter ranged between 87.34 and 91.18 and was highest in *Xylopia aethiopica* and least in *Detarium macrocarpum.*

The percent alkaloid, saponin, flavonoid, anithocyanoid, steroids, tannins, and stands were low and in most cases less than 2.0 percent (Table-2). Hydrogen cyanide had values of between 0.00 and 15.60. Mineral elements such as calcium, manganese, potassium, sodium, phosphorus were represented, although in quantities of less than 2.0 percent (Table-2). These elements should be reduced to two or three elements so that those allepic to the element removed could eat the fruits/seeds.

In the leaves, the percent crude protein had the highest value of 21.70 in the family of Asteraceae. The result agrees with Badra, (1993) who recorded crude protein values of between 21.03 and 29.70 for *Celosia laxa, Corchorus olitorius, Amaranthus caudatus and Talinum triangulare.* The family of Gnetaceae had the highest values in both the percent crude fat and fibre with 7.52 and 33.14 percent, respectively. The family of Piperaceae had the highest percent ash of 11.04. The percent carbohydrate had the highest and least values in the families of Euphorbiaceae and Gnetaceae, respectively. Also the high concentration of crude fat and fibre in the leaves of *Gnetum africanum* could have contributed to the wide range of acceptability of leaves of *Gnetum africanum* in the diet of most families in southern Nigeria. Okafor (1981) reported that leaves of *Gnetum africanum* were sold in bundles in most market places. Presently, sprouts from roots of *Gnetum africanum* are planted in compound farms to supplement the quantity of uncultivated *Gnetum africanum* leaves obtained from the rainforest. The moisture content ranged between 5.28 and 9.29 percent in the leaves of *Lecaniodiscus cupanioides* and *Elaeis guineensis,* respectively. High moisture content was also recorded in *Talinum triangulare* (Badra, 1993). The percent alkaloid in the leaves studied ranged between 0.21 and 4.14 in *Morinda lucida* and *Lecaniodiscus cupanioides,* respectively. *Adansonia digitata,* a savanna tree species planted at the nearby forest had the highest concentration of Hydrogen cyanide of 13.27. Many of these plant species such as *Gnetum africanum* have less than 0.01 mg/kg hydrogen cyanide. However, some plant species such as *Gongronema latifolium, Morinda lucida, Piper guineense, Pterocarpus mildbraedii* and *Vernonia amygdalina* had over 4.0 mg/kg Hydrogen cyanide. These plant species leaves needed processing to reduce the percentage concentration of hydrogen cyanide before they are consumed. Saponin, although in low concentration was available in all the leaves studied. However, washing of the leaves reduces its toxic effect in *Vernonia amygdalina*. The percentage of calcium, manganese, potassium, sodium, phosphorus, iron, zinc and lead were in low concentration of below ten percent. Few scientists such as Badra (1993). Dike (2009) also recorded low concentration of these minerals in *Amaranthus caudatus, Celosia laxa, Corchorus olitorius, Talinum triangulare, Uvaria chamae, Carpolobia lutea, Gmelina arborea* and *Allophyllus africanus* plant species.

In the sample studied, there were more protein, carbohydrate and moisture content in leaves than in the fruits/seed. However, the high moisture content of between 38 and 85 percent in fruits and leaves (Ojimelukwu *et al.,* 2005) was observed in all fruits and leaves analyzed in the fresh samples only (Table-1). Many elements were contained in both the leaves and fruits (Table-3). Some of these elements such as lead, chromium and cadium are likely to have cumulative side effects especially when large quantity of the fruits and leaves has been consumed. In this study, it was observed that the colour or aroma of luscious fruits such as *Gambeya albida, Dialium guineense* caused some people especially pregnant women to consume many fruits within 24 hours. Lead, chromium, cadium and other heavy metals (Tables 2 and 3) contained by these leaves and fruits/seeds could affect the young nervous system of the child thereby adversely affecting the intellectual development and subsequent behavior of the child. However, these metals at their concentration would have little or no serious effect on the mother. Ojimelukwe *et al.,* (2005) recorded that many food substitutes were toxic at reverse level but could be reverted at lower level nutritionally essential. Those allergic to some of these elements contained by the fruits/seeds such as lead could suffer because of poor knowledge of the composition of the fruits they eat.

Moreover, it takes some time after eating the fruits and leaves for the effects of the chemicals, to be felt. For example, the leaves of *Lecaniodiscus cupanioides* contain high percentage of zinc (15.78) and lead (5.40) (Table-3). These could have contributed to the death of some animals that fed on the leaves. The observation in similar to that of Williams (1993) who reported anti-nutritional substance such as Oxalic acid in some fruits and leaves. Williams (1993); Badra, (1993) were of the opinion that oxalic acid could be detrimental when it combines with calcium to form calcium oxalate and consequently stones in the blood tract. Simultaneously consumption of seeds of *Plukernetia conophora* (Syn.

Tetracarpidum conophorum) with high calcium content (Okafor, 1981) and a mixture of leaves of *Telfairia occidentale, Pterocarpus mildbraedii* and *Piper guineense* each with over 17 percent calcium (Table-3) and other substances having high oxalic acid, could trigger off the formation of stones in the blood tracts. The excess calcium binds with oxalic acid to form calcium oxalate which is insoluble. Stones in the body could cause Oxalaemia, Oxaluria or rot of the affected parts and consequently death to the person if the stones are not removed. A person could doubt how stones entered the body system not knowing that it was from the food one consumed.

CONCLUSIONS AND RECOMMENDATIONS

The high protein content in leaves could have supplementary effect for the daily protein requirement of the body. According to Oke (1966) vegetables, about 5.0g dry materials per meal are taken per family twice a day in southeastern Nigeria. With the rapid rate of over 1.4 percent population growth rate in Nigeria (Madu, 2001); most families presently take vegetables three times per day. Meregini (2005) also observed that many indigenous fruits and seeds are used for staple foods, hospitality and chewing at leisure times by people in southeastern Nigeria. The symptoms of protein energy malnutrition such as Kwashiorkor and Marasmus were rarely observed among dwellers of this region presumable because of the protein obtained from these fruits/seeds and leaves. However, these edible plant parts have many mineral elements in them that injurious to health. A similar observation has been reported in *Musa sapientum* fruits which contain at least 200 individual volatile compounds such as isoamyl acetate (Ihekoronye and Ngoddy, 1985). There is, therefore the need for genetic improvement of the edible parts of these fruits/seeds and leaves to reduce some of the toxic chemical contained by the edible parts of some of the plant species. When the species are genetically improved, it would result in the availability of the fruits/seeds and leaves at most time of the year and minimize the long time vegetables are stored in refrigerators and the adverse consequences. The use of improved species could make industries and people using these fruits/seeds and leaves to achieve maximum gain and have a steady business. It is recommended that modern propagation techniques should be taught to all communities that produce these plants by the Government and Universities. It also recommended that industries should make sure that toxic materials are not contained in their products either by roasting or boiling the materials to remove the toxic materials in them.

REFERENCES

AOAC. 2000. Official Methods of Analysis International. 17th edition. Association of Official Analytical Chemists, Washington DC. USA.

Badra T. 1993. Lagos spinach *(Celosia sp)*. In: Williams, J. T (Ed). Pulses and vegetables. Chapman and Hall Inc. New York, U.S.A. pp.131-163.

Dike M. C. 2000. Aerodynamics of some fruits and seeds of some tree families in Nigerian rainforest. Journal of Sustainable Agriculture and Environment. 2(2): 300-309.

Dike M. C. 2003. Early succession on mechanically cleared moist forestland in south-eastern Nigerian rainforest. Journal of Tropical Forest Resources. 19(2): 104 -116.

Dike M.C. 2009. Proximate and phytochemical compositions of some browse plant species of southeastern Nigeria. Global Journal of Agricultural science.

Haq N. 1993. *Lupins* (*Lupinus* species). In: Williams, J.T. (ed.) Pulses and Vegetables. Chapman and Hall, 2-6 boundary rows, London SEI8 HN. p. 245.

Hutchinson J. and Dalziel J.M. 1954. Flora of West Tropical Africa. Keay R.W.J. Crown Agent London, U.K.

Ihekoronye A.I and Ngoddy P.O. 1985. Integrated Food Science and Technology for Tropics. Macmillan Education Ltd. London and Oxford. p. 386.

James C.S. 1995. The Analytical Chemistry of Foods. New York: Chapman and Hall.

Keay R.W.J. 1989. Trees of Nigeria. Clarendo Press, Oxford. U. K. p. 476.

Madu I.A. 2001. Population and Environmental Problems. In: Ofomata, G.E.K. and Phil-Eze, P.O. (eds.) Geographical Perspectives on Environmental Problems and Management in Nigeria. pp. 80-95. Jamoe Enterprises (Nigeria). p. 327.

Meregini A.O.A. 2005. Some endangered plants producing edible fruits and seeds in southeastern Nigeria. Fruits. 60(3): 211-220.

Ojimelukwe P.C., Asumugha V.U. and Omerie G.C. 2005. Fundamental of Food Science and Nutrition. BEL'S Books, 38 University roads Nsuka, Nigeria. p. 149.

Okafor J.C. 1981. Edible indigenous woody plants in the rural economy of the Nigerian forest zone. Forest Ecology and Management. 3: 48-55.

Okafor J.C. 1993. Lost Crop of Nigeria- An Overview. In: Okojie J.A. and Okali D.U.U. (Eds.) Lost crop of Nigeria: Implication for Food Security. University of Agriculture, Abeokuta Conference proceedings. Series No.3 Gbemi Sadipo Press. Abeokuta, Ogun State, Nigeria. pp. 2-32.

Oke O.L 1966. Chemical studies on some Nigerian Vegetables. Tropical Science. 8: 128-31.

Omololu A. 1994. Human Nutrition of Tropical Africa. In: Loosli J.K., Onyenuga V.A. and Babatunde G.M. (Eds.).

Animal Production in the Tropics. pp.13-17, Heinemann Educational Books (Nigeria) PLC.

Onochie C.F.A. 1979. The Rainforest Ecosystem- An Overview. In: D.U.U. Okali (ed.) the Nigerian Rainforest Ecosystem. pp 1-13. Federal Ministry of Science and Technology MAB, Ibadan.

Pearson D. 1976. The chemical analysis of foods. Churchill Livinstone, Edinburgh.

White F. 1983. The Vegetation of Africa. UNESCO, Paris.

Williams J.T. 1993. Introduction: Underutilized Pulse and Vegetable. In: Williams J.T. (ed.) Pulses and Vegetables. pp. 1-9. Chapman and Hall Inc. New York, USA.

Table-1. Moisture content of some edible parts of fruits/seeds of some plant species collected at Umudike, Nigeria.

#	Family	Species	Edible parts of fruits			Edible parts of seeds			Percent moisture content of	
			Pericarp	Mesocarp	Endocarp	Testa	Tegmen	Edosperm	Fresh sample	Sample after sieving
1	Anacardiaceae	*Spondias mombin*	✓	✓	✓				67.7	8.94
2	Annonaceae	*Dennettia tripetala*	✓	✓	✓	✓	✓	✓	32.14	9.08
		Monodora myristica				✓	✓	✓	30.58	9.19
		Xylopia aethiopica	✓	✓	✓	✓	✓	✓	38.60	8.57
3	Burseraceae	*Canarium schweinfurthii*	✓	✓	✓				54.94	8.95
		Dacryodes edulis	✓	✓	✓				50.96	9.21
4	Caesalpinioideae	*Afzelia africana*					✓	✓	20.26	9.54
		Detarium macrocarpum,					✓	✓	22.40	12.66
		Dialium guineense		✓					20.60	10.60
5	Guttiferae	*Garcinia kola*					✓	✓	33.76	8.88
6	Lauraceae	*Persea americana*		✓	✓					
7	Mimosoidea	*Tetrapleura tetraptera*								
8	Moraceae	*Landolphia hirsuta*		✓	✓				34.24	8.90
9	Polygalaceae	*Carpolobia lutea*	✓	✓	✓				66.79	10.22
10	Sapotaceae	*Gambeya albida*		✓	✓				67.70	9.62
Percentage frequency of occurrence			**40**	**80**	**80**	**20**	**40**	**40**	**Range: 20.26 to 68.49**	**Range: 8.82 to 12.66**

Table-2. Proximate, phytochemical and nutrient compositions of edible parts of fruits/seeds of 15 plant species collected at Umudike, Nigeria.

	Anacardiaceae	**Annonaceae**			**Sapotacea**	**Burseracrae**		**Caesalpinioideae**			**Guttiferaee**	**Lauraceae**	**Mimosoidea**	**Moraceae**	**Polygalaceae**	**Range**
	Spondias mombin	*Dennettia tripetala*	*Monodora myristica*	*Xylopia aethiopica*	*Gamb-eya albida*	*Canarium schweinfur-thii*	*Dacryod-es edulis*	*Afzelia africana*	*Detarium macrocarpium*	*Dialium guineense*	*Garcinia kola*	*Persea ameri-cana*	*Tetraple-ura tetraptera*	*Landolphia hirsuta*	*Carpolo-bia lutea*	
Moisture content (%)	8.94	9.08	9.19	8.57	9.72	8.95	9.21	9.54	12.66	10.60	8.88	8.82	8.90	10.22	9.62	8.82-12.66
Dry matter (%)	91.06	90.90	90.81	91.43	90.28	91.05	90.79	90.46	87.34	89.40	91.12	91.18	91.10	89.78	90.38	87.34-91.45
Crude protein (%)	9.19	6.14	11.55	11.90	3.26	1.84	1.66	2.10	3.82	3.12	1.28	1.68	8.75	5.95	9.19	1.28-11.90
Fat (%)	1.98	9.66	14.46	10.64	3.94	29.62	38.40	4.96	14.64	0.40	6.04	37.03	8.98	9.11	1.99	0.04-38.40
Crude fibre (%)	0.54	10.42	29.88	38.60	13.40	1.88	2.46	3.12	7.20	3.64	5.32	1.72	36.88	5.80	1.04	1.88-36.88
Ash (%)	4.88	5.66	9.58	8.68	4.18	6.12	5.84	4.18	5.12	2.82	6.52	4.71	10.36	7.01	3.74	2.82-10.36
Carbohydrate (%)	83.41	68.12	34.53	30.18	75.22	60.54	51.64	85.64	69.22	90.02	80.78	54.86	35.03	72.13	84.04	30.18-90.02
Alkaloid (%)	0.96	1.21	1.32	1.44	0.64	0.28	0.18	1.38	1.22	1.38	0.42	0.14	1.46	0.21	1.31	0.21-1.46
Saponnin (%)	0.26	0.29	0.16	0.18	0.52	0.54	0.38	0.26	0.24	0.18	0.34	0.23	0.18	0.23	0.14	0.16-0.52
Flavonoid (%)	0.04	0.13	0.18	0.22	0.56	0.18	0.16	0.18	0.18	0.16	0.38	0.25	0.24	0.65	0.19	0.04-0.65
Anthocyanic (%)	0.24	0.17	0.21	0.18	0.07	0.12	0.06	0.08	0.06	0.08	0.10	0.06	0.20	0.08	0.07	0.04-0.21
HCN (mg/kg)	0.97	0.02	2.04	0.00	8.59	4.40	0.02	12.60	15.60	6.80	12.40	14.8	0.00	1.04	2.14	0.00-0.56
Sterols (%)	1.01	1.09	1.08	1.62	1.01	1.22	1.32	0.82	1.26	0.46	0.44	1.88	1.14	0.45	0.41	0.11-1.88
Tannin (%)	0.14	0.21	0.18	0.24	0.16	0.36	0.16	0.18	0.24	0.26	0.24	0.12	0.22	0.22	0.28	0.12-0.36
Stand (%)	0.01	0.00	0.00	0.00	0.02	0.00	0.01	8.42	18.20	0.00	15.44	1.22	6.40	0.09	0.00	0.00-18.20
Ca (mg/100mg)	802	261	194	186	120.4	140	210	196	173	199	241	218	136	227	180	
Mg	243	92	64	76	21.60	40										

K	128	239	508	412	230	241										
Na	103	47	42	56	38.2	49										
P	708	250	233	248	234	241										
Fe	96	90	112	99	94.8	93										
Zn	132	126	119	108	114.3	111										
Pb	0.01	0.02	0.04	0.01	0.04	0.01	0.04	0.04	0.02	0.01	0.01	0.04	0.04	0.01	0.02	0.01-0.04
Cd	0.01	0.02	0.01	0.01	0.02	0.02	0.01	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01-0.02
Cr	0.001	0.001	0.002	0.004	0.003	0.001	0.002	0.002	0.001	0.002	0.004	0.003	0.002	0.002	0.002	0.001-0.004

Table-3. Proximate, phytochemical and mineral compositions of some plant leaves collected at the rain forest of Umudike, Nigeria.

	Asclepiadaceae	**Bombacaceae**	**Caesalpinioideae**	**Rublaceae**	**Labiatae**	**Portulaceae**	**Cucurbitaceae**	**Gnetaceae**	**Moraceae**	**Palmae**	**Papilionoideae**		**Piperacea**	**Sapindaceae**	**Sapotaceae**	**Asteraceae**	**Range**
	Gongronema latifolium	*Adansonia-digitata*	*Afzelia africana*	*Morinda lucida*	*Ocimum gratissimum*	*Talinum triangulare*	*Telfairia occidentalis*	*Genetum africanum*	*Landol-phia hirsuta*	*Elaeis guineensis*	*Pterocar-pus mildbraedii*	*Pterocarpus soyauxii*	*Piper guineen-se*	*Lecaniodiscus. cupanioides*	*Gambeya albida*	*Vernonia amygdalina*	
Moisture content (%)	8.94	6.51	8.65	8.25	9.20	9.24	8.64	9.18	8.82	9.29	8.66	8.96	9.02	5.28	8.73	8.82	5..28-9.29
Dry matter (%)	91.06	93.49	91.35	91.73	90.80	90.76	91.36	90.82	91.18	90.71	91.34	91.04	90.98	94.72	91.27	91.18	92..50-94.72
Crude protein (%)	9.80	11.35	11.43	13.53	13.40	2.40	4.20	15.05	16.45	8.40	18.55	15.40	12.80	14.69	14.58	21.70	2.40-21.70
Fat (%)	6.18	1.15	5.29	4.29	3.04	0.40	0.68	7.52	5.42	4.08	4.26	6.18	2.86	3.94	4.71	2.74	0.40-7.52
Crude fibre (%)	8.74	4.97	31.11	22.51	8.66	1.00	2.32	33.14	16.08	21.46	21.32	18.98	3.24	4.84	18.15	10.96	1.00-33.14
Ash (%)	5.78	4.21	7.33	4.96	5.12	2.00	6.44	6.04	6.30	6.36	5.78	7.14	11.04	8.26	6.21	9.88	2.00-11.04
Carbohydrate (%)	69.50	78.32	44.84	54.71	69.78	94.20	86.36	38.25	55.75	59.70	50.09	52.3	70.06	68.27	56.35	54.72	38.25-94.20
Alkaloid (%)	1.38	1.53	0.37	0.21	1.28	0.96	1.54	2.12	1.26	0..46	1.22	1.36	1.62	4.14	0.43	1.52	0.21-4.14
Saponnin (%)	0.54	0.31	0.29	0.40	0.22	0.10	0.16	0.28	0.84	0.68	0.74	1.02	0.32	0.70	0.36	0.20	0.10-1.02
Flavonoid (%)	1.28	1.26	0.41	0.35	0.04	0.02	0.10	0.22	0.38	0.32	0.44	0.32	0.18	1.98	0.51	0.04	0.02-1.98
Anthocyanic (%)	0.08	0.04	0.02	0.02	0.08	0.04	0.06	0.06		0.04	0.02	0.05	0.12	0.02	0.04	0.02	0.02-0.12
HCN (mg/kg)	10.9	21.63	36.95	52.68	0.00	0.00	0.00	0.00	36	13.76	28.59	46.63	4.24	0.00	22.16	6.22	0.00-46.63
Sterols (%)	0.26	0.02	0.01	0.02	0.64	0.00	0.02	0.02		0.01	0.02	0.12	0.02	0.02	0.03	0.04	0.02-0.64
Tannin (%)	0.32	0.58	0.28	0.19	0.18	0.08	0.13	0.13	0.22	0.44	0.31	0.28	0.18	0.95	0.16	0.28	0.08-0.95
Stand (%)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00-0.00
Ca mg/100mg	16.03	8.45	28.72	42.75	21.00	24	17.1	13	40.08	60.12	56.11	0.21	20.80	19.0	25.38	10.80	0.21-60.12
Mg (mg/100g)	16.80	95.86	10.0	13.60	22.4	12.2	26.5	31	14.40	12.00	14.49	10.92	22.00	5.50	11.20	40.50	5.50-95.86
K (mg/100g)	244.8	280	410	392	344	610	24.5	80	330	428.30	265	496	390	112.5	250	375	80-610

Na (mg/100g)	11.32	12.46	11.92	9.57	42	10	17.1	8.0	14.8	13.34	11.8	13	7.0	5.3	9.07	30	5.3-42
P (mg/100g)	326.95	96.28	521.33	458.24	208	340	610	110	446	248	322	362	210	133	399.12	410	110-610
Fe (mg/kg)	7.83	22.6	66.32	8.24	8.4	4.10	10	16	42.4	22.8	68.2	11.20	22	10.20	11.38	34	4.10-68.20
Zn (mg/kg)	13.44	2.08	9.36	1.82	5.0	10	18	28.8	16.8	18.20	31.4	18.14	3.14	15.78	16.40	5.20	2.08-31.40
Pb (mg/kg)	0.20	0.53	20.08	0.02	0.26	0.18	0.20	0.66	0.06	0.11	0.21	0.10	0.52	0.55	0.14	0.82	0.06-0.82
Cu (mg/kg)	2.26	13.20	13.20	1.15	14.20	4.10	6.40	14.20	10.0	2.20	8.40	16.0	14.80	15.0	18.66	12.46	1.15-18.66
Cd (mg/kg)	0.07	0.03	0.01	0.02	0.02	0.01	0.04	0.01	0.01	0.01	0.03	0.01	0.03	0.01	0.01	0.05	0.01-0.07
Cr (mg/kg)	0.03	0.01	0.01	0.01	0.01	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.010.03