ASSESSMENT AND QUANTIFICATION OF SOME BIOACTIVE COMPONENTS AND MINERALS IN THE LEAVES AND ROOTS OF TWO *ACALYPHA* SPECIES

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ABSTRACT

The study assessed and quantified some bioactive constituents (proximate, vitamins, amino acids) and minerals in the leaves and roots of *Acalypha wilkesiana* L. and *Acalypha hispida* L. used in the treatment of some ailments. Standard procedures were followed in the assessment. The proximate composition varied in the leaves and roots of *A. wilkesiana* and *A. hispida.* The total water-soluble vitamins for the leaves and roots of *A. wilkesiana* were 14.26% and 33.29%, and fat-soluble vitamins were 8.63% and 19.86%, respectively, while for *A. hispida*, the water-soluble vitamins were 22.23% and 44.95% and the fat-soluble vitamins were 13.25% and 26.35%, respectively. The non-essential amino acids of *A. wilkesiana* leaves and roots were 0.98% and 1.79%, respectively, and the essential amino acids were 4.49% and 6.69% while for leaves and roots of *A. hispida*, 1.18% and 3.36% (non-essential amino acids) and 5.40% and 9.63% (essential amino acids) were recorded, respectively. The mineral composition varied in the leaves and roots of *A. wilkesiana and A. hispidia*. These bioactive compounds and minerals present in the leaves and roots of *A. wilkesiana* and *A. hispida* could be harnessed and used in addressing the challenging matrix in human nutrition.

KEYWORDS: Bioactive compounds, mineral elements, *Acalypha wikesiana*, *Acalypha hispida*

INTRODUCTION

In recent years, there has been a gradual revival of interest in the use of medicinal plants in developing countries because herbal medicines have been reported safe without any adverse side-effect especially when compared with synthetic drugs. Thus, a search for new drugs that serve as better and cheaper substitutes from plant origin should be encouraged. The medicinal value of these plants lies in some chemical substances that produce a definite physiological action on the human body (Edeoga *et al.*, 2005).

The genus *Acalypha* Linn belongs to the family Euphorbiaceae with 462 species. It is the fourth largest genus of the family and is found in tropical and warm temperate regions. Acalypheae is the largest tribe in the uniovulate subfamily Acalyphoideae. It consists mainly of trees and shrubs distributed in paleotropics. The tribe is made up of several economic, ecological and ornamental groups of plants (Govaerts *et al*., 2000). According to Hutchinson and Dalziel (1958), thirteen species are found in the West Tropical region. The plant *Acalypha* is a genus of flowering plants in the family Euphorbiaceae and it is the sole genus of the subtribe Acalyphinae (Ogundaini, 2005). It is one of the largest euphorb genera, the genus *Acalypha* comprises 570 species (Riley, 1963). The genus name *Acalypha* is from the Ancient Greek an alternative of '*Akelephe*' and was inspired by the nettle-like leaves. A large portion of the genus are weeds while others are ornamental plants. They are found in the tropics of Africa, America and Asia. Some of these species are well known in the traditional medicine usage and a few have actually appeared in homeopathic pharmacopoeia (Ogundaini, 2005).

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These species are monoecious or dioecious and are either herbs or shrubs, but rarely trees or lianas. The plant has contoured leaves which are curl-shaped, olive- green in colour with creamy margin, with the exception of *Acalypha wilkesiana* which is often copper-red in colour.

The species of *Acalypha* are prominent in the Traditional Medical Practice of most tribes in Africa and Asia (Duraipandiyan *et al.*, 2006; Mothana *et al.*, 2008). *Acalypha wilkesiana* is used in West Africa for the treatment of headache and cold and in Nigeria. The cold extract of the leaves is used to bathe babies with skin infection (Adesina *et al.*, 2000). The leaf poultice is deemed good for headache, swellings and colds in Trinidad. Its leaf extract is active against Gram +ve bacteria. The extracts from the seeds have immunomodulating properties that work against some tumors (Büssing *et al.*, 1999). *Acalypha ornata* has a wide range of uses and it is considered to be non-toxic. It is reported as having medicinal applications in Central Africa. The cooked leaf is taken to relieve post-partum pains and the root decoction is used as a laxative. *Acalypha ornata* has been reported to be used for cutaneous and subcutaneous parasitic infections (Sabrina *et al.*, 2005). The leaves are compounded with the leaves of other drug-plants into a drug for children with rabies in Southern Nigeria. *Acalypha hispida* has medicinal uses in South-Eastern Asia. Several *Acalypha* species are used for aesthetic purposes due to its ever-green nature and due to the several colours produced by its flowers and leaves. Some are used as medicinal plants in Africa and some islands in the Indian Ocean, east of Madagascar (Mascarene Islands). Almost all parts of the plant are used as traditional remedies to treat and manage diverse of ailments; the parts include the stem, leaves and roots.

In spite of the relevance of *Acalypha* species in traditional medical practice in Africa (Adesina *et al.*, 2000; Motsei *et al*., 2003; Wiart *et al*., 2004; Akinyemi *et al*., 2005), there has been very little work done on the quantification of some bioactive components and minerals of *A. wilkesiana* and *A. hispida*. Therefore, this work was aimed at assessing and quantifying some bioactive components and mineral content of *A. wilkesiana* and *A. hispida.*

MATERIALS AND METHODS

Source of material: The plants, *Acalypha wilkesiana* (Plate I) and *Acalypha hispida* (Plate II), were obtained from a horticultural garden along East West road, Port Harcourt, River State, Nigeria and were identified by the curator of the herbarium unit of the Department of Plant Science and Biotechnology of the University of Port Harcourt, Rivers State, Nigeria.

Plate I: *Acalypha wilkesiana* Linn.

Plate II: *Acalypha hispida* Linn.

Proximate analysis: Proximate composition (moisture, ash, protein, carbohydrate and lipid content) was determined using standard method (AOAC, 1990) while the crude fibre was determined by subtracting the value of others (moisture + ash + protein + carbohydrate + lipid) from 100.

Determination of vitamins: The extraction and determination of vitamins A, B_2, B_6, B_{12}, and E were according to the method described by Okonwu *et al.* (2018a, b) while vitamin C was determined using titrimetric method (Okwu, 2004).

Determination of Amino acids using waters 616/626 (HPLC) Instrument: The sample preparation and determination of amino acids were carried out in the following four stages according to the procedure described by Okonwu *et al*. (2018 a, b).

Mineral elements: The mineral contents (Mg, Cu, Mn, K, Zn, Ca, Na and Fe) of *A. wikesiana* and *A. hispidia* were determined using Atomic Absorption Spectrophotometer (AAS).

RESULTS AND DISCUSSION

Proximate composition: The proximate composition of leaves and roots of two *Acalypha* species are presented in Table 1. The study showed that the leaves and roots of the two *Acalypha* species contained a relatively high percentage of carbohydrate, followed by protein while crude fat was the lowest. The carbohydrate was higher in *A. wilkesiana* than in *A. hispida* while the reverse was the case for protein, moisture content, ash content, crude fibre and crude fat. The leaves of *A. wilkesiana* and *A. hispida* had higher proximate composition than the roots. The proximate composition of the leaves and roots of the two *Acalypha* species indicates that they can be ranked as carbohydrate-rich leaves due to their relatively high carbohydrate content when compared with other components of the leaves and roots. The low moisture content of the leaves could hinder the growth of microorganisms, thereby prolonging the shelf-life (Ihekoronye and Ngoddy, 1985; Adeyeye and Ayejuyo, 1994). On the other hand, high moisture content favours the spoilage of agricultural products by fungi (Chuku *et al*., 2004). The protein content of the leaves of the *Acalypha* species compare favourably with *Heinsia crinita* (14.70%), *Lesianthera africana* (13.10%) and *Momordica foecide* (4.60%) leaves consumed in some parts of the world especially Nigeria, but are relatively low when compared with *Amaranthus caudatus* (20.50% DW), *Manihot utilissima* (24.88%), *Annona muricate* (25.00%), *Piper guineense* (29.78% DW) and *Talinum triangulare* (31.00% DW) as reported by Etuk *et al*. (1998), Akindahunsi and Salawu (2005), Hassan and Umar (2006), Antia *et al.* (2006) and Usuobun *et al.*(2015). The results show that the protein content was higher in *A. hispida* than in *A. wilkesiana.* According to Tangka (2003), animal growth and subsequent milk production is associated with presence of high amount of protein in the animal system. The values for ash content were 3.90%, 7.78% and 3.55%, 8.13% for the leaves and roots of *A. wilkesiana* and *A. hispida*, respectively. The ash content of the leaves was lower than that of some leafy vegetables commonly consumed in Nigeria such as *T. triangulare* (20.05%) and other vegetables like *Occimum graticimum* (8.00%) and *Hibiscus esculentus* (8.00%) (Akindashunsi and Salawu, 2005). The ash content is a reflection of the mineral content preserved in the food material. According to Davison *et al*. (1975), ash in food largely determines the extent of mineral matters likely to be found in food substances. The result, therefore, suggests a low deposit or mineral content in the leaves (Antia *et al*., 2006). The values for fat in the leaves of the two species were low compared with those of *T. triangulare* (5.90%), *Basella alba* (8.71%), *Amarantus hybridus* (4.80%) and *Calchorus africanum* (4.20%) (Ifon and Bassir, 1980; Akindahunsi and Salawu,

2005). Dietary fat functions to increase the palatability of food and to absorb and retain flavours (Antia *et al*., 2006). A diet providing 2% of its caloric energy as fat is said to be sufficient to human beings as excess consumption has been implicated in certain cardiovascular disorder such as atherosclerosis, cancer and aging (Antia *et al*., 2006). The crude fibre contents of 7.00% and 9.63% for *A. wilkesiana* and *A. hispida* roots, respectively, were relatively high compared with those in the leaves (3.14% and 4.78%), in that order. Non-starchy vegetables are the richest sources of dietary fibre (Agostoni *et al*., 1995).

Table 1: Proximate composition of *Acalypha* species in the leaves and roots

Proximate Composition (%)	leaves		roots	
	A. wilkesiana	*A. hispida*	*A. wilkesiana*	*A. hispida*
Protein	10.17	13.68	17.52	19.52
Moisture content	8.73	10.17	14.05	13.04
Ash content	3.89	3.55	7.78	8.13
Crude fibre	3.14	4.78	7.00	9.63
Crude fat	1.23	2.90	5.79	6.14
Carbohydrate	72.84	64.92	47.86	43.54

Vitamins: The results showed that the leaves and roots of *A. wilkesiana* and *A. hispida* contained relatively high vitamin content which appeared to be deposited more in the roots of both species than the leaves (Table 2). Among the vitamins quantified, Vitamin B_9 had the highest value. The *Acalypha* species had higher concentrations of water-soluble vitamins than the fat-soluble ones. *Acalypha hispida* contained more vitamins than *A. wilkesiana.* The recommended dietary allowance for vitamin A is 900 µg/day for adult males and 700 µg/day for adult females (Institute of Medicine, 2002). According to Clifford and Kozil (2017), vitamin A requirements may be increased due to hyperthyroidism, fever, infection, cold and exposure to excessive amounts of sunlight while vitamin E benefits the body by acting as an antioxidant, and protecting vitamins A and C, red blood cells and essential fatty acids from destruction. The presence of Vitamin B complex (B_1, B_2, B_3, B_6 and B_{12}) in both species suggests that they play a role in converting nutrients into energy, thereby supporting cellular metabolism. Vitamin C also known as ascorbic acid promotes wound healing (Ojiako and Igwu, 2008), strengthens resistance to infections by boosting the immune system and improves absorption of iron (Gayatri *et al*., 2013). The presence of Vitamin E in both species suggests that it could be useful as an antioxidant in the human body; it could also help in the immune system including neurological functions as well as proper functioning of the cells. Sami *et al.* (2014) documented daily requirement of vitamins as follows: 15-20 mg for B_3, 2-3 mg for B_6, 2.4 mg for B_{12}, 60 mg for C, 8-10 mg for E, 0.08 mg for D_3, 0.8-1 mg for A, 2-7 mg for β-carotene and 80 µg for K_3. The water-soluble vitamins in the leaves and roots of *A. wilkesiana* and *A. hispida* were lower than that reported by Sami *et al.* (2014). Vitamin B complexes can be used for maintaining health in humans and animals (Ball, 2006). Dietary intake with low water-soluble vitamins such as B and C has the capacity to affect mitochondrial functions (Depeint *et al.*, 2006). The value obtained for vitamin B_3 was within the range of daily dietary intake of vegetables.

Table 2: Vitamin composition (%) of the leaves and roots of *Acalypha* species

Class of vitamins	Vitamins	leaves		Roots	
		A. wilkesiana	*A. hispida*	*A. wilkesiana*	*A. hispida*
Fat-soluble	A	8.468	12.904	18.890	26.008
	E	0.058	0.237	0.274	0.291
	K	0.103	0.109	0.022	0.051
Water-soluble	B_1	0.037	0.088	0.176	0.187
	B_2	0.099	0.234	0.467	0.495
	B_3	0.286	0.675	1.348	1.428
	B_6	0.176	0.415	0.827	0.876
	B_9	11.866	18.081	26.469	36.444
	B_{12}	0.385	0.587	0.859	1.182
	C	1.411	2.151	3.148	4.335
	Total vitamins	22.890	35.380	52.750	71.300

Amino Acids: Table 3 shows the amino acid constituents of the leaves and roots of *A. wilkesiana* and *A. hispida*, in that order. The results showed that the *Acalypha* species had more essential amino acids concentration than the non-essential amino acids. Also, the total amino acids content of *A. wilkesiana* leaves and roots were 5.47% and 9.47%, in that order, and 6.58% and 13.09% for *A. hispida*. Again, there was a higher concentration of amino acids in the roots than in the leaves in both species, with threonine being the highest while phenylalanine was the lowest in *A. wilkesiana* and *A. hispida*. The amino acids were higher in *A. hispida* leaves and roots than in *A. wilkesiana*. Arowora *et al.* (2017) reported the amino acid composition range of 1.26 – 8.745 % in pumpkin leaf with essential amino acids ranging from 2.11-5.95% and non-essential amino acids from 1.34-8.75%. The glutamine and asparagine values obtained from this study differed from the findings of Adeyeye and Kenni (2011), Adesina and Adeyeye (2013), Omoyeni *et al. (* 2015) and Arowora *et al.* (2017), who reported that glutamic acid and aspartic acid were the most concentrated amino acids in *Irvingia gabonensis, Cucurbita maxima, Amaranthus viridis, Basella alba, Amaranthus hybridus, Vernomia amygdalina, Telfairia occidentalis* and *Talinum triangulare*. This observation shows that the concentration and presence of amino acids vary from one plant to the other.

Table 3: Amino acids (%) content in the leaves and roots of *Acalypha* species

Group of amino acids	Amino acids	leaves		roots	
		A. wilkesiana	*A. hispida*	*A. wilkesiana*	*A. hispida*
Essential	Threonine	2.871	3.828	4.014	6.957
	Leucine	1.005	0.987	1.955	2.005
	Isoleucine	0.005	0.005	0.006	0.005
	Lysine	0.025	0.024	0.029	0.028
	Methionine	0.466	0.443	0.542	0.512
	Phenylalanine	0.007	0.006	0.008	0.007
	Tryptophan	0.022	0.043	0.098	0.093
	Valine	0.056	0.053	0.065	0.061
	Histidine	0.008	0.008	0.010	0.009
Non-Essential	Alanine	0.304	0.289	0.354	0.334

Aspartic acid	0.010	0.012	0.014	0.014
Asparagine	0.009	0.009	0.011	0.020
Glutamic acid	0.033	0.029	0.096	1.143
Glutamine	0.010	0.010	0.012	0.021
Glycine	0.385	0.468	1.369	1.143
Proline	0.007	0.018	0.030	0.026
Serine	0.023	0.028	0.075	0.063
Argine	0.023	0.022	0.027	0.025
Tyrosine	0.023	0.022	0.027	0.025
Cystine	0.174	0.278	0.732	0.611

Mineral elements: The mineral contents of *A. wilkesiana* and *A. hispida* are presented in Table 4. The roots of the *Acalypha* species had higher micro- and macro-mineral contents than the leaves. Among the species, *A. hispida* roots had more mineral concentration than *A. wilkesiana* roots while the reverse was the case for the leaves except for nitrogen. This may be due to the higher content obtained in the roots. This result corroborates the findings of Idris (2011), who reported that the leaves of *Telfairia occidentalis* are a good source of potassium, copper, iron manganese as well as magnesium and zinc, which are essential in human nutrition. Variation in the mineral content of *Acalypha* species could be due to the age of the plant. According to Eseyin *et al.* (2014), the proportions of the various minerals vary from one plant to the other and with the age of the plant. Iron is a crucial trace element involved in the synthesis of haemoglobin, proper functioning of the central nervous system and in the oxidation of carbohydrates, proteins and fats (Adeyeye and Otokiti, 1999). The large amounts of ingested iron can cause excessive levels of iron in the blood and high blood levels of free ferrous iron react with peroxides to produce free radicals, which are highly reactive and can damage DNA, proteins, lipids and other cellular components (Ding and Pan, 2003).

Table 4: Mineral constituents of leaves and roots of *Acalypha* species

Minerals	leaves		roots	
	A. wilkesiana	*A. hispida*	*A. wilkesiana*	*A. hispida*
Nitrogen (%)	1.627	2.189	2.804	3.123
Calcium (%)	1.557	1.419	3.110	3.251
Magnesium (%)	0.458	0.419	0.915	0.956
Potassium (%)	0.865	0.789	0.178	1.806
Sodium (%)	0.099	0.090	0.197	0.026
Manganese (ppm)	73.951	67.417	147.74	154.434
Iron (ppm)	46.406	42.580	93.314	97.537
Zinc (ppm)	31.137	28.387	62.209	65.025
Copper (ppm)	10.509	9.581	20.995	21.946

CONCLUSION

The leaves and roots of *A. wilkesiana and A. hispida* contain large quantities of bioactive constituents ranging from proximate composition, vitamins and amino acids to minerals. This indicates that the leaves and roots may serve as a constituent of human diet, supplying the body with minerals, protein and energy. Also, the two species of *Acalypha* are highly nutritious and provide sufficient amount of nutrients needed for normal body growth, development and maintenance. These inherent potentials of *A. wilkesiana* and *A. hispida* could be harnessed and used in addressing the challenges associated with human nutrition.

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