Phytochemical, Mineral Contents and Proximate Compositions of the Stem Bark of Erythrophleum Suaveolens Brenan (Guill. & Perr.)

AKANJI OLUFUNKE CHRISTY[1], ADEWUMI BAMIDELE[2]

[1] *Department of Plant Science and Biotechnology, Adekunle Ajasin University Akungba-Akoko, Ondo State, Nigeria.*

[2] *Department of Animal and Environmental Biology, Adekunle Ajasin University Akungba-Akoko, Ondo State, Nigeria.*

Abstract- This study is aimed at evaluating (using ethanol as solvents) the phytochemical constituents, minerals elements and proximate compositions present in the stem bark of Erythrophleum suaveolens. Standard methods were adopted in analyzing the phytochemicals, minerals and proximate compositions present. The results of the phytochemical screening showed the presence of flavonoids, alkaloids, saponins, cardiac glycosides, phenols, steroids, and tannins. The mineral analysis yielded 26.18 mg/100g magnesium, 22.34 mg/100g potassium, 20.82 mg/100g zinc, 20.72 mg/100g calcium, 14.34 mg/100g sodium, 5.90 mg/100g iron, 4.36 mg/100g manganese, 0.04 mg/100g copper, but lead was not detected. The proximate analysis revealed 41.17% carbohydrates, 16.30% ash, 14.87% proteins, 11.72% crude fibres, 7.45% moisture content and 6.25% crude fat. Nutrients and mineral elements that are of high nutritional value present suggest that if consumed in sufficient amount, it would contribute significantly to the nutritional requirements of human. Also, the presence of the secondary metabolites observed suggests that Erythrophleum suaveolens will contribute immensely toward drugs development.

Indexed Terms- Erythrophleum suaveolens, Phytochemicals, Minerals, and Proximate compositions.

I. INTRODUCTION

Majority of the world's population in developing countries still depend on herbal medications to meet their health needs. Herbal medicines are often used to offer first-line and basic health services, both to people living in remote areas where it is the only available health service and to people living in poor areas where it provides the only affordable remedy. Even in areas where recent medicine is obtainable, the interest in herbal medications and their use have been increasing rapidly in recent years. Deriving potential benefits from plants has always been a field of speculation for researchers and has made the basis for the development of drugs to treat countless ailments screening of plants for the occurrence valuable properties presents themain path.

Some herbs contain nutrients that have therapeutic properties and are nutritionally important because of their high contents of minerals, essential fatty acids, fibres and proteins (Jabeen *et al.,* 2010; Ghani *et al.,* 2012). The efficacy of medicinal plants for therapeutic purposes is often based on their organic constituents such as saponins, flavonoids, tannins, alkaloids and essential oils. Of recent, several authors reported that the chronic accumulation of different elements caused various health problems as a result of prolonged ingestion or overdose of the medicinal plants (Arceusz *et al.,* 2010; Ghani *et al.,* 2012). Mineral nutrients are usually present in plants in low concentrations which fluctuate greatly in both space and time due to environmental factors such as weather, climate and physicochemical properties (Maathuis and Diatloff, 2013). In this context, determination of the elemental composition of the medicinal plants is very important since some essential metals induce toxic effects when their intake is in high concentration. Also, the non-essential metals are toxic even in very low concentrations (Basgel and Erdemoglu, 2006; Jabeen *et al.,* 2010).

E. suaveolens (red water tree) is used traditionally for a variety of diseases and also cultivated for ornamental purposes. In traditional medicine, the stem bark decoction is used for the treatment of malaria, as emetic and purgative, as an anesthetic, analgesic, anthelmintic and disinfectant. The extracts are used in cases of skin disease, oedemas, gangrenous wound, rheumatism, and arthritis. It is also reported to be used as poison or repellant against rodent, insects and some aquatic animals (Neuwinger, 1996). The therapeutic efficacy of these herbs has mainly been ascribed to the occurrence of various phytochemicals such as saponins, phenolic acids, tannins, lignin, flavonoids,terpenoids, quinones, alkaloids, coumarins, and other secondary metabolites. Studies have attested that many of these phytochemicals act as antibacterial, antitumor, anti-inflammatory, antiviral agents, antioxidants, anti-mutagenic, anti-carcinogenic and anti-atherosclerotic (Sala *et al.,* 2002). Therefore, concern in medicinal plants is now on the rise with the aim of getting a substitute for the excessive cost of prescription drugs in view of sustaining personal health and well-being as well as the bio-prospecting of new plant-derived drugs. This research was therefore aimed at the evaluation of the various phytochemical, proximate and mineral contents of the stem bark of *Erythrophleum suaveolens*.

II. MATERIALS AND METHODS

- Plants Materials

The stems of *E. suaveolens* were plucked from Ibadan, Oyo State, Nigeria and identified by a certified botanist at the herbarium unit of the Department of Plant Science and Biotechnology, Adekunle Ajasin University, Akungba Akoko, Ondo State, Nigeria.

- Preparation of plant extracts for Extraction

The stems were gently and thoroughly washed with sterile distilled water to avoid any form of contamination and then air-dried at room temperature for about two weeks to ensure that the samples lose most of their moisture content. The extractions were carried out using ethanol. 250g of dried stems were weighed into conical flasks containing 750ml of ethanol; the mixtures were initially shaken rigorously and left for 9 days. The mixtures were later filtered using sterile Whatman filter papers and the filtrates were collected directly into sterile crucibles. Filtrates obtained were introduced into sterile reaction tubes and heated continuously in a water bath at the 78^0C ethanol. The residues gotten were kept at room temperature (Osuntokun, 2015).

- Phytochemical Screening

Qualitative and quantitative phytochemical tests were conducted on the stems of *E. suaveolens* using standard methods adopted by Oyoyede (2005), Ogboru *et al.* (2015) and Owoeye *et al.* (2016) for the presence of tannins, saponins, flavonoids, cardiac glycosides, phenols, alkaloids, steroids, oxalate and phytate.

- Mineral Analysis

The mineral contents of the samples were estimated by wet digestion method (AOAC, 1995). Briefly, 0.5 g of the powdered plant sample was mixed with a mixture of perchloric acid, $HClO_4$ (60%, 2 cm^3), nitric acid, HNO_3(69.7%, 5 cm^3) in a Kjeldahl digestion tube. Digestion was initially carried out at low heat until the brown fumes had been given off, and heating continued until all the solids dissolved and the appearance of white fumes. After cooling, the digest was filtered and transferred into 100 cm^3 volumetric flask and made up to the mark with distilled water. The solution was used for the estimation of minerals. The elements, K, Na and Ca were estimated by the flame photometer, while Zn, Fe, Mg, Mn, Cu, P, and Pb were determined using atomic absorption spectrophotometer

- Proximate Analysis

Proximate composition of the leaf powder of *E. suaveolens* was analyzed following methods of AOAC (2005). Each parameter was determined for three replicates. Nitrogen content determination was done using the Kjeldahl method and protein content was calculated by multiplying nitrogen conversion factor (6.25). Moisture was determined by heating 5g of the powdered sample in a hot air oven at 100 ± 2^0C until constant weight was obtained. Determination of crude fat was done by acid digestion which was further extracted with petroleum ether in a Soxhlet apparatus. Ash value was determined by incinerating the sample at 550 ± 5^0C for 5-6 h. Crude carbohydrate was calculated using the formula: 100 – (moisture – protein – fibre – fat – ash).

III. RESULTS

The qualitative screening of phytochemicals present in the stem bark of *E. suaveolens* is presented in Table 1. The phytochemical study revealed the presence of flavonoid, alkaloid, saponin, cardiac glycoside, phenol, steroid, and tannin while anthraquinone was absent. Table 2 shows the quantitative estimation of phytochemicals present in thestem bark of *Erythrophleum suaveolens*. A considerable amount offlavonoid, alkaloid, tannin, phytate, saponin, oxalate andphenol were present with phenol recording the highest value(16.59%), followed by oxalate (11.89%), the least value wasfound in flavonoid (1.26%).

Elemental compositions present in thestem bark of *E. suaveolens* is summarized in Table 3. The existence ofessential minerals and their contents levels analyzed showedthat *E. suaveolens* contains sodium (20.34mg/100g), potassium (24.34 mg/100g), calcium (20.72mg/100g), magnesium (26.18mg/100g), zinc (20.82 mg/100g), iron (5.90 mg/100g), copper (0.04 mg/100g), manganese (4.36 mg/100g) and phosphorus (26.91 mg/100g) respectively. Lead was not detected.

Proximate composition of *E. suaveolens* stem bark is tabulated in Table 4. Proximate analysisrevealed that the stems contain macronutrient like carbohydrates and protein to be 41.17% and 16.45% respectively. Other macronutrients were also relatively high. Crude fat had a small content level of 6.25%. Proximate analysis for ash, crude fibreand moisture also revealed their contents levels to be 16.30%, 11.72%, and 7.47% respectively.

Table 1: Qualitative screening of phytochemicals present in the ethanol stem bark of *Erythrophleum suaveolens*.

Flavonoid	+
Alkaloid	+
Saponin	+
Cardiac glycoside	+
Phenol	+
Steroid	+
Anthraquinone	-
Tannin	+

KEY: + = present, - = absent

Table 2: Quantitative estimation of phytochemicals present in the Ethanol stem bark of*Erythrophleum suaveolens*

Phytochemical Constituent	Amount present (%)
Flavonoid	1.26
Alkaloid	1.92
Tannin	3.20
Phytate	3.69
Saponin	9.53
Oxalate	11.89
Phenol	16.59

Table 3: Elemental composition of *E. suaveolens*

Elements	Amount (mg/100g)
Sodium	14.34
Potassium	22.34
Calcium	20.72
Magnesium	26.18
Zinc	20.82
Iron	5.90
Lead	ND
Copper	0.04
Manganese	4.36

KEY: ND = Not Detected

Table 4: Proximate composition of *E. suaveolens*

Parameters	Amount (%)
Carbohydrate	41.17
Crude protein	14.87
Moisture content	7.45
Crude fibre	11.72
Crude fat	6.25
Ash	16.30

IV. DISCUSSION

Phytochemical analysis conducted on the *Erythrophleum suaveolens* stem bark revealed the presence of constituents which are known to exhibit medicinal as well as physiological activities. Analysis of the plant extracts revealed the presence of phytochemicals such as phenols, flavonoids, alkaloids, saponins, Cardiac glycoside,steroids, anthraquinone,and tannin. The phenolic compounds are the largest groups of plant constituent (Edoga *et al.*, 2005). They possess biological properties such as antiapoptosis, antiaging, anticarcinogen, antiinflammation, antiatherosclerosis, cardiovascular protection, and improvement of endothelial function, as well as inhibition of angiogenesis and cell proliferation activities (Han *et al.*, 2010). Some studies have described the properties of antioxidant of medicinal plants which are rich in phenolic compounds (Brown and Rice-Evans, 1998). The activity of flavonoids is due to their ability to complex with extracellular and soluble proteins and to complex with bacterial cell wall (Marjorie, 1996). They are also effective antioxidant and display strong anticancer activities (Salah *et al.,* 1995). Ojokuku *et al*. (2010) pointed out that flavonoids have been shown to have antibacterial, anti-thrombotic, antiallergic, anti-inflammatory, antimutagenic, antioxidant, antineoplastic, and antiviral activities. Flavonoids have also been reported to be a potent antioxidant and free radicals scavengers capable of protecting cell membranes from damaging (Noda *et al*., 2000). Alkaloids have been associated with medicinal uses for centuries and one of their common biological properties is their cytotoxicity (Okwu and Okwu, 2006). Several researchers have reported the analgesic (Nobori *et al.*, 1994), antispasmodic and antibacterial (Stray, 1998) properties of alkaloids. The presence of alkaloids in plants is known for reducing blood pressure and balancing the nervous system in case of mental ailment. The plant extracts were also shown to contain saponins which are known to produce an inhibitory effect on inflammation (Just *et al.,* 1998). Saponins have the property of precipitating and coagulating erythrocytes. Some of the characteristics of saponins include hemolytic activity, cholesterol binding properties, and bitterness, the formation of foams in aqueous solutions (Sodipo *et al.,* 2000). Saponin has the property of precipitating and coagulating the red blood cell and also binding bad cholesterol (Dewole *et al.,* 2013, Mir *et al.,* 2013). Glycosides are known to lower the blood pressure according to several reports (Nyarko and Addy, 1990). Bandyopadhyay *et al*. (2002) referred to glycosides as the main bioactive constituent that offers anti-ulcerative and anti-secretory effects. Plant glycosides, which are not normally lethal when ingested orally, are known to prevent chloride passage in the stomach. Tannins are used in the dyestuff productions as caustics for cationic dyes (tannin dyes) and also inks (iron gallate ink). In the food industries, tannins are used to clarify wines, beer and fruit juices. It can also be used as coagulants in rubber production (Gyamfi and Aniya, 2002). Tannins have been known generally as anti-nutritional but it is now identified that their beneficial properties be liable upon their dosage and chemical structure. The presence of tannins in plants could also show that it is an effective astringent, that is, aids in wound healing and an anti-parasitic. Steroids have been stated to have antibacterial properties (Raquel, 2007) and they are very significant compounds especially due to their relationship with compounds such as sex hormones. Anthraquinones and steroids constituents promote the plant in the treatment and therapeutic applications as arrow poisons or cardiac drugs as laxatives. The presence of anthraquinones wasdescribed to have antimicrobial, anti-oxidant, anti-malaria, anti-viral and anti-tumor activities. Phytochemicals recorded in this study corroborate with the findings of Ogboru *et al.* (2017), who confirmed the presence of flavonoids, alkaloids, steroids, saponins, cardiac glycosides and phenols in the bark of *E. ivorense.* Adeoye and Oyedapo (2004) also confirmed the presence of alkaloids, saponins, tannins, glycosides, and flavonoids in stem-bark of *E. suaveolens.* An absence of a particular phytochemical in some plants can be ascribed to the several physiological and biosynthetic reactions taking place in the plant, the role environment plays should not be ignored as the environment always alter or modify their components.

Sodium is one of the mainelectrolytes in the blood. The body uses sodium to regulate acid-base balance, blood volume and control blood pressure. The stem bark of *E. suaveolens* gave the moderate source of sodium (14.34mg/100g) which could help lower blood pressure, amino acid, energy production, and glucose conveyance into the body cells. This amount is slightly lesser than the amount found in *Carissa spinarum* (33.77 mg/100g) and *Buchananiacochinchinensis* (21.22 mg/100g) reported by Abhishek *et al.,* (2017), but higher than 0.02 mg/100g found in *Bryophyllum pinnatum* (Okwu and Josiah, 2006). However, the surplus of sodium in the food may lead to high blood pressure in some people, a serious buildup of fluid in people with congestive heart failure, kidney disease or liver cirrhosis (Aronow *et al.,* 2011). The recommended safety limit for sodium is set at 0.4-0.5 mg/g (WHO, 1996). Potassium is a multi-functional nutrient, which is an essential part of many important enzymes. The potassium content reported in this study was 22.34 mg/100g. Compared to other medicinal plants such as *Indigofera astragelina* leaves (14.55 mg/100g) (Gafar *et al.*,2011) and *Securinega virosa* leaves (3.67 mg/100g) (Uzama *etal.*, 2012), stem bark of *E. suaveolens* contained highest potassium content. The recommended safety limit for potassium is set amid 10-100 μg/g (WHO, 1996). Sodium and potassium are closely related in the body fluids. A diet high in potassium and low in sodium content has added advantage because of the direct relationship of sodium intake with hypertension in humans (Njoku and Akumefula, 2007). The calcium concentration of *E. suaveolens* was found to be 20.72 mg/100g compared with those in *Opuntia dillenii* (19.54 mg/100g), *Aporosa cardiosperma* (20.11 mg/100g) and *Semecarpus anacardium* (26.11 mg/100g) (Abhishek *et al.*, 2017). High concentration of calcium in the body is very important because of its role in the formation of bones and teeth, clotting of blood, muscle contraction and synaptic transmission of nerve impulses (Brody, 1994; Ghani *et al.*, 2012). Calcium is an importantfunctional and structural element in living cells. It participates in cell division and the regulation of cell proliferation and differentiation. The intake of calcium has been found to be very important for cancer patients. It helps in building and maintaining bone mass, and strength because some chemotherapeutic agents cause osteopenia and osteoporosis (Lipkin and Newmark, 1999; Naga Raju *et al.*, 2013). Thus, the high concentration of calcium contained in *E. suaveolens* may be of high therapeutic value. *E. suaveolens* showed high accumulation of magnesium. Theconcentration of Mg in the stem bark was 26.18 mg/100g. The value was high when compared with *Syzygium jambos* (4.93 mg/100g) and *Opuntia dillenii* (10.73 mg/100g) (Abhishek *et al.*, 2017).Magnesium aids to sustain normal muscle and nerve function which keeps the heartbeat steady, also supports a healthy immune system, and makes bones remain strong. It also assist in the control of blood glucose levels and helps in the production of protein, and energy. Deficiency ofmagnesium may lead to severe complaints such ascardiovascular ailments, hypertension, and diarrhea. The concentration of microelements in the stem bark of *E. suaveolens* is in the order ofZn > Fe > Mn>Cu. The zinc content of *E. suaveolens* was 20.18 mg/100g which is more than thecontent in *Mucuna sloanei* (0.25 mg/100g) (Gafar *et al.*, 2011); *Semecarpus anacardium* (0.16 mg/100g) and *Carissa spinarum* (0.57mg/100g) (Abhishek *et al.*, 2017). Zinc is essential forgrowth and development. It is essential for the function ofthe cells of the immune system. It is used in theprevention and treatment of diarrhoea, pneumonia, cold,respiratory infections and malaria (Ghani *et al.*, 2012;Deshpande *et al.*, 2013).The recommended safety limits for zinc is 0.15-20 mg/g (WHO, 1996). Iron is veryimportant in the formation of haemoglobin and in transporting oxygen in the body. The concentration of iron in *E. suaveolens* was found to be 5.90 mg/100g compared with those in *Syzygium jambos* (1.22 mg/100g), *Aporosa cardiosperma* (1.78 mg/100g) and *Elaeocarpus tectorius*(4.16 mg/100g) reported byAbhishek *et al.*, (2017).Deficiency of iron may lead to anaemia (Cook, 2005).The permissible limit set by the Food and Agricultural Organization (FAO)/WHO (1984) in edible plants was 20 ppm. However, for medicinal plants, it was found that all plants accumulated Fe above this permissible limit (FAO/WHO, 1984), including *E. suaveolens*. The Manganese concentration of *E. suaveolens* was 4.36 mg/100gcompared to that of *Securinega virosa* (1.50 mg/100g) (Uzama *et al.*, 2012), *Mucuna sloanei* (0.65 mg/100g) and green leafy vegetable (0.98 mg/100g) (Gafar *et al.*, 2011).Manganese acts as a catalyst and co-factor in many enzymatic processes, involved in the synthesis of fatty acids and cholesterol. It is an important co-factor in the enzymes, necessary for mucopolysaccharide and glycoprotein syntheses (Shomar, 2012).Zinc, manganese, and copper are involved in biochemical reactions in the body. The elements also serve as constituents of biological molecules and co-factors for various metabolic processes (Brody, 1994). Deficiency or excess of these elements may cause many metabolic disorders.

One of the most vital compositions of many nutrients is the carbohydrate which is seen as an essential source of energy. The percentages of available carbohydrate in the stem bark of *E. suaveolens* was 41.17% which was higher than that of*Cassia nigricans*, 22.37% *(*Rachael, 2013), *Jatropha gossypifolia*, 34.18% (Faokunla *et al.*, 2017) and *Syzygium caryophyllatum*, 24.09% (Abhishek *et al.*, 2017). The percentage of crude protein in the stem bark of *E. suaveolens* was 14.87% which was higher than that recorded in stem bark of *Cassia nigricans*, 10.51% (Rachael, 2013), Balsam apple, 11.29% (Hassan and Umar, 2006). This indicates that stem bark of *E. suaveolens* contained moderate concentration of crude protein. Moisture content is amid the most important and frequently used measurement in the processing, preservation, and storage of food. The moisture content of *E. suaveolens* was 7.45% which was lower than that of *Acalypha maginata* (10.83%), A*calypha huspida* (11.02%), *Acalypha recemosa* (11.91%), (Iniaghe *et al.,* 2009). This revealed a relatively high shelf life for the fresh plant thus long storage of the plant would not lead to microbial degradation. The ash content of the stem bark of *E. suaveolens*; that is, the total mineral content of the plant was considerable of high amount. This is particularly true when the ash content in the stem bark of the plant is compared with the reported values in some medicinal plants such as *Maerua angolensis and C. siamea,* whose values are 12.90% and 10.61% respectively (Hassan and Ngaski, 2007; Tairo *et al.,* 2011). The ash content of *E. suaveolens,* 16.30% showed that the stem bark contained high amount of mineral elements. The crude fat content of *E. suaveolens* (6.25%) obtained in the present study was higher than *M. angolensis* (3.12%) (Tairo *et al.,* 2011), but lower than the stem bark of *Cassia nigricans*, 9.81% (Rachael, 2013). Lipids are essential nutrients since they provide the body with maximum energy. Lipids are also known to be insulators as well as the defense to internal tissues, helping several cellular processes and signaling systems. The consumption of most plants relatively high in crude fibre, has been shown to reduce serum cholesterol level, a risk of coronary heart diseases and hypertension. It also increases glucose tolerance and insulin sensitivity (Araya *et al.,* 2003). The crude fibre content in the stem bark of *E. suaveolens* obtained in the present study was 11.72% which was lower than that stem bark of *Cassia nigricans* 41.36% reported by *(*Rachael, 2013). This low level is considered suitable. The low content gotten in this study is inline with the observation of Oladiji and Mih (2005) that even though crude fibre improves digestibility, its occurrence in high amount can declinenutrient usage and cause intestinal irritation.

CONCLUSION

Plants used have attested to be very significant in drug research and development, because of the secondary metabolites present. Nutrients and mineral elements that are of high nutritional value present suggest that if consumed in sufficient amount, it would contribute significantly to human nutritional requirements. Hence, it could be surmised that the presence of the secondary metabolites observed, will contribute immensely toward drugs development. Therefore, it is suggested that further work should be carried out to authenticate the ethnopharmacological importance of *Erythrophleum suaveolens* and a further confirmation of the pharmacological basis for its exploration in folklore medicine for the treatment of infectious diseases.

REFERENCES

[1] Abhishek, M., Thangadurai, D., Shivanand, B. and Sangeetha, J. (2017). Proximate analysis and mineral composition of potentialminor fruits of western ghats of India Scientific Papers. Series A. *Agronomy*, 50:340-346.

[2] Adeoye, B.A. and Oyedapo, O.O. (2004). Toxicity of *Erythrophleum guineense* stem bark: Role of alkaloidal fraction. *Africa Journal of Traditional, Complementary and AlternativeMedicines*, 1:45-54.

[3] AOAC. (1995). Official Methods of Analysis (15th Ed.), Washington D.C., pp. 600–792.

[4] AOAC.(2005). Official Methods of Analysis ofAssociation of Official Analytical ChemistsWashington D.C. 777-784.

[5] Araya, H., Pak, N., Vera, G. and Alviña, M. (2003). Digestion rate of legume carbohydrates and glycaemic index of legume-based meals. *Int. J. Food Sci. Nutr,* 54(2): 119–126.

[6] Arceusz, A., Radecka, J. and Wesolowski, M. (2010). Identification of diversity in elements content in medicinal plants belonging to different plant families. *Food Chem.* 120(1):52–58.

[7] Aronow, W.S., Fleg, J.L. and Pepine, C.J. (2011). Expert consensus document on hypertension in the elderly: a report of the American College of Cardiology Foundation Task Force on Clinical Expert Consensus documents developed in collaboration with the American Academy of Neurology American Geriatrics Society American Society for Preventive Cardiology American

Society of Hypertension American Society of Nephrology Association of Black Cardiologists and European Society of Hypertension. *Journal of American College of Cardiology,* 2 (57):20-37.

[8] Bandyopadhyay, U., Biswas, K., Chatterjee, R., Bandyopadhyay, D., Chattopadhyay, I., Ganguly, C.K., Chakraborty, T., Bhattacharyya, K. and Banerjee, R.K. (2002). Gastroprotective effect of Neem *(Azadirachta indica)* barkextract: Possible involvement of H+- K+ -ATPaseinhibition and scavenging of hydroxyl radical. *Life Science,* 71:2845-2865.

[9] Basgel, S. and Erdemoglu, S.B. (2006). Determination of mineral and trace elements in some medicinal herbs and their infusions consumed in Turkey. *Sci. Total Environ,* 359(1-3):82–89.

[10] Brody, T. (1994). Nutritional Biochemistry. San Diego, CA, Academic Press, p. 658.

[11] Brown, J.E. and Rice-Evans, C.A. (1998). Luteolin rich artichoke extract protects low density lipoprotein from oxidation in vitro. *Free Radical Res,* 29:247-255.

[12] Cook, J.D. (2005). Diagnosis and management of irondeficiency anaemia. *Best Pract Res Clin Haematol,* 18:319-332.

[13] Deshpande, J.D., Joshi, M.M. and Giri, P.A. (2013). Zinc: The trace element of major importance in human nutrition and health. *Int. J. Med. Sci. Publ. Health,* 2(1):1–6.

[14] Dewole, E.A., Dewumi, D.F.A., Alabi, J.Y.T. and Adegoke, A. (2013). Proximate and Phytochemical of *Cola nitida* and *Colaacuminata*. *Pakistan Journal of Biological Sciences,* 16:1593-1596.

[15] Edoga, H.O., Okwu, D.E. and Mbaebie, B.O. (2005). Phytochemicals constituents of some Nigerian medicinal plants. *Afr J Biotechnol,* 4(7):685-688.

[16] FAO/WHO. (1984). FAO/WHO, Food Contaminants. In: Codex Alimentarius, Vol. XVII, Edition 1, FAO/WHO, Codex Alimentarius Commission,Rome.

[17] Faokunla, O., Akinloye, O.A., Ugbaja, R.R. and Adeogun, A.I. (2017). Phytochemical and Nutritional Status of*Jatropha gossypifolia* Leaves *Imperial Journal of Interdisciplinary Research,* 3 (4):1877-1895.

[18] Gafar, M.K., Itodo, A.U., Atiku, F.A., Hassan, A.M. and Peni, I.J. (2011). Proximate and mineral composition ofthe leaves of hairy indigo (Indigofera astragalina). *Pakistan Journal of Nutrition,* 10(2):168-175.

[19] Ghani, A., Ali, Z., Ishtiaq, M., Maqbool, M. and Parveen, S. (2012). Estimation of macro and micro nutrients in some important medicinal plants of Soon Valley, District Khu- shab, Pakistan. *Afr. J. Biotechnol,* 11(78):14386-14391.

[20] Gyamfi, M. A. and Aniya, Y. (2002). Antioxidant properties of Thonningianin A, isolated from the African medicinal herb, Thonningiasanguine. *Biochemical Pharmacology,* 63:1725-1737.

[21] Han, X., Shen, T. and Lou, H. (2010). Dietry polyphenols and their biological significance. *Int J Mol Sci,* 950-988.

[22] Hassan, L.G. and Umar, K.J. (2006). Nutritional valueof Balsam Apple (*Momordica balsamina L.*) leaves.*Pakistan Journal of Nutrition.* 5(6):522-529.

[23] Hassan, L.G. and Ngaski, M.M.A. (2007). Nutritional evaluation of *Cassia siamea* leaves. *J. Chem. Soc. Nig,* 32: 137–143.

[24] Iniaghe, O.M., Malomo, S.O. and Adebayo, J.D. (2009). Proximate composition and Phytochemicalconstituents of leaves of some Acalyphaspecies. *Journal of Nutrition,* 8(3):256-258.

[25] Jabeen, S., Shah, M.T., Khan, S. and Hayat, M.Q. (2010). Determination of major and trace elements in ten important folk therapeutic plants of Haripur basin, Pakistan. *J. Med. Plant Res,* 4(7):559–566.

[26] Just, M.J., Recio, M.C., Giner, R.M., Cueller, M.U., Manez, S., Billia, A.R. and Rios, J.L. (1998). Antiinflammatory activity of unusual lupine saponins from Bupleurum fruticescens, 64:404-407.

[27] Lipkin, M. and Newmark, H.L. (1999). Vitamin D, calcium and prevention of breast cancer: A review. *J. Am. Coll. Nutr,* 18(5): 392S–397S.

[28] Maathuis, F.J.M, and Diatloff, E. (2013). Roles and functions of plant mineral nutrients. In: Plant Mineral Nutrients: Methods and Protocols,

Methods in Molecular Biology, FJM Maathuis, Ed, 953:1–21.

[29] Marjorie, C. (1996). Plant products as antimicrobial agents. *Clincal Microbiol Rev*, 12:564-582.

[30] Mir, M.A., Sawhney, S.S. and Jassal, M.M. (2013). Quanlitative and quantitative analysis of phytochemicals of *Taraxacumofficinale. Wudpecker J of Pharm. & Pharmacognosy,* 2(1):1-5.

[31] Naga-Raju, G.J., Sarita, P., Rao, J.C.S., Rao, K.C.B. and Reddy, S.B. (2013). Correlation of trace elemental content in selected anticancer medicinal plants with their curative ability using particle-induced X-ray emission (PIXE). *J. Med. Plants Res*, 7(16):1081–1086.

[32] Neuwinger, H.D. (1996). In: African Ethnobotany: Poisons and Drugs- chemistry, pharmacology and toxicology. Chapman and Hall, London, pp 1-941.

[33] Njoku, P.C. and Akumefula, M.I. (2007). Phytochemical and nutrient evaluation of *Spondias mombin* leaves. *Pak. J. Nutr*, 6(6):613–615.

[34] Nobori, T., Miurak, K., Wu, D.J., Takabayashik, L.A. and Carson, D.A. (1994). Deletion of cyclin-dependent kinase-4 inhibitor gene in multiple human cancers. *Nature*, 46:753-756.

[35] Noda, Y., Kneyuki, T., Igarashi, K. and Packer, M. L. (2000). Antioxidant activity of nasunin, an anthocyanin in eggplant peels. *Toxicology,* 148:119-123.

[36] Nyarko, A.A. and Addy, M.E. (1990). Effects of aqueous extract of Adenia cissampeloides on blood pressure and serum analyte of hypertensive patients. *Phytotherapy Res*, 4(1):25-28.

[37] Ogboru, R.O., Okolie, P.L. and Agboje, I. (2015). Phytochemical Screening and Medicinal Potentials of the Bark of *Dacryodesedulis* (G.Don) HJ Lam. *Journal of Environmental andAnalytical Chemistry*. Doi: 10.4172/2380-2391.1000158.

[38] Ogboru, R.O.L., Akideno, O. and Owoeye, E.A. (2017). Chemical composition and medicinal potentials of the bark of *Erythrophleum ivorense. Journal of Bioscience and Biotechnology Discovery,*2:15-20.

[39] Ojokuku, S.A., Okunowo, W.O., Apena, A. (2010). Evaluation of the chemical composition of *Khayagrandifoliola* and *Ficuscapensis*. *Journal of Medicinal Plants Research*, 4(12):1126-1129.

[40] Okwu, D.E. and Josiah, C. (2006). Evaluation of thechemical composition of two Nigerian medicinal plants.*African Journal of Biotechnology*, 5(4):357-361.

[41] Okwu, D.E. and Okwu, M.E. (2007). Chemical composition of Spondias mombin linn. plant parts. *J Sustain Agric Environ,* 6(2):140-147.

[42] Oladiji, A.T. and Mih, F.O. (2005). Proximatecomposition mineral and phytochemical constituents of *Eleusine coracana* (finger millet). *African Journal of Biotechnology,* 4(12):1440-1441.

[43] Owoeye, E.A., Ogboru, R.O., Agboje, I. and Arabambi, I. D. (2016). Chemical composition and health potentials of theleaves of *Treculia africana* Decne. *International Journal of Applied Research and Technology,* 5(6):79-83.

[44] Oyoyede, O.L. (2005). Chemical profile of unripe pulp of *Carica papaya*. *Pakistan Journal of Nutrition*, 496:379-381.

[45] Rachael, G.A. (2013). Proximate and mineral compositions of the leaves and stem bark of *Cassia nigricans* Vahl. *International Journal of Medicinal Plants Research*, 2(7):242-246.

[46] Raquel, F.E. (2007). Bacterial lipid composition and antimicrobial efficacy of cationic steroid coppounds. *Biochemica Biophysica Acta*, 2500-2509.

[47] Sala, A., Recio, M.D., Giner, R.M., Manez, S., Tournier, H., Schinella, G. and Rios, J.L. (2002). Antiinflammatory and antioxidantproperties of Helichrysum italicum. *J Pharm Pharmacol*, 54(3): 365-371.

[48] Salah, N., Miller, N.J., Pagange, G., Tijburg, L., Bolwell, G.P., Rice, E. and Evans, C. (1995). Polyphenolic flavonoids as scavenger of aqueous phase radicals as chai breaking, antioxidant. *Arc Biochem Broph*, 2:339-346.

[49] Shomar, S. (2012). Major and trace elements in *Nigella sativa* provide a potential mechanism for its healingeffects, *J. Med. Plants Res,* 6(34):4836–4843.

[50] Sodipo, O.A., Akiniyi, J.A. and Ogunbamosu, J.U. (2000). Studies on certain on certain characteristics

of extracts of bark of *Pansinystalia macruceras*. *Global J Pure Appl Sci*, 6:83-87.

[51] Stray, F. (1998). The Natural Guide to Medicinal herbs And Plants. Tiger Books International, London, pp. 12-16.

[52] Tairo, T.V., Jesse, T.N., Lukhoba, W.C. and Herbert, V.M.L. (2011). Nutritive and antinutritive qualities of mostly preferred edible woody plants in selected drylands of Iringa District, Tanzania. *Pak. J. Nutr,* 10(8):786–791.

[53] Uzama, D., Bwai, M.D. and Sunday, A.T. (2012). The phytochemicals proximateand elemental analyses of Securinega virosa leaf extracts. *Research Journal in Engineering and Applied Sciences,* 1(6):351-354.

[54] WHO. (1996). Guidelines for elemental concentration.Trace elements in health and human Nutrition. pp. 50-228.