Medicinal and Aromatic Plant Science and Biotechnology ©2007 Global Science Books

Nigerian Medicinal Plants I

Donatus Ebere Okwu

Department of Chemistry Michael Okpara university of Agriculture, Umudike P.M.B 7267, Umuahia Abia State Nigeria

Correspondence: **okwudonatus@yahoo.com**

ABSTRACT

Nigerian medicinal plants (*Aspilia africana*, *Bryophyllum pinnatum*, *Garcinia kola*, *Spondias mombim* and *Uvaria chamea*) are used in herbal medicine to cure diseases, protect and regenerate liver cells, prevent alcoholic liver damage, viral liver damage and toxic liver damage. The plants contain proteins, carbohydrates, vitamins, minerals and phytochemicals. The phytochemicals comprise flavonoids, phenolic compounds, alkaloids, tannins and saponins. The flavonoids and phenolic compounds present in the plants exhibit antioxidant, anti-inflammatory, anti-tumor, anti-hepatotoxic, anti-microbial and anti-ulcer properties. Several epidemiological studies have suggested that micro-chemicals present in plants could be the most desirable agents for the prevention and /or intervention of human cancer. These plants have been extensively used to prevent colic disorders, suppress cough, heal injuries and used in the treatment of cirrhosis and hepatitis. There is a need to pool and conserve the genetic wealth available in these plants at a national and international level. The conservation of the genetic diversity of these plants is very essential and vital for their future use. Emphasis was placed on these plants in view of their popular use in herbal medicine. The importance of the chemical constituents available in these plants is discussed with respect to their role in herbal medicine in Nigeria.

Keywords: antioxidants, anti-tumor, conservation, ethnomedicine, herbal medicine, nutritive value, phytochemicals
Abbreviations: AFBI, aflatoxin B1; **AST**, aspartate amino transferase; **gamma-GT**, gamma glutamyl transferase; **LDL**, low density lipo-protein; **LPO**, lipid preoxidation; **LHP**, lipid hydroperoxide; **MDA**, malonialdehyde

CONTENTS

INTRODUCTION

Nigeria is richly endowed with indigenous plants, which are used in herbal medicine to cure diseases and heal injuries. Some of these plants are used as food or medicine. These plants exhibit a wide range of biological and pharmacological activities such as anti cancer, anti-inflammatory, diuretic, laxative, antispasmodic, anti-hypertensive, anti-diabetic and anti-microbial functions. It is generally assumed (Okwu and Ekeke 2003; Okwu 2004) that the active medicinal constituents contributing to these protective effects are the phytochemicals, vitamins and minerals.

Phytochemicals, which posses many ecological and physiological roles are widely distributed as plants constituents (Okwu 2005). Woody plants and herbs can synthesize and accumulate in their cells a large reservoir of phytochemicals including flavonoids, alkaloids, terpenoids, phenolic compounds, tannins, cynogenic glycosodes, saponins, lignins and lignans (Okwu 2004, 2005).

It has been highlighted that the additional role of flavornoids and other polyphenolic compounds of higher plants may act as antioxidants or agents of other mechanisms that contribute in their anti-carcinogenic or cardioprotective actions (Herlog *et al*. 1993). Extracts from the roots, barks, seeds and fruits of these plants are used in the preparation of syrups, infusions, teas and as cough suppressants and in the treatment of liver cirrhosis and hepatitis (Iwu 1989; Okwu 2003, 2005). These plants encompass *Aspilia africana*, *Bryophyllum pinnatum*, *Garcinia kola*, *Spondias mombin* and *Uvaria chamae* (**Fig. 1**). They are extensively used in herbal medicine in Nigeria.

Aspilia africana (Asteraceae)

Aspilia africana is a perennial herb varying in height from 60 cm to about 1.5 m, depending on rainfall. It is a common weed of field crops in West Africa and is sometimes found in fallow land, especially in forest zones (Akobundu 1987;

Received: 29 October, 2006. Accepted: 25 January, 2007.

Invited Mini-Review

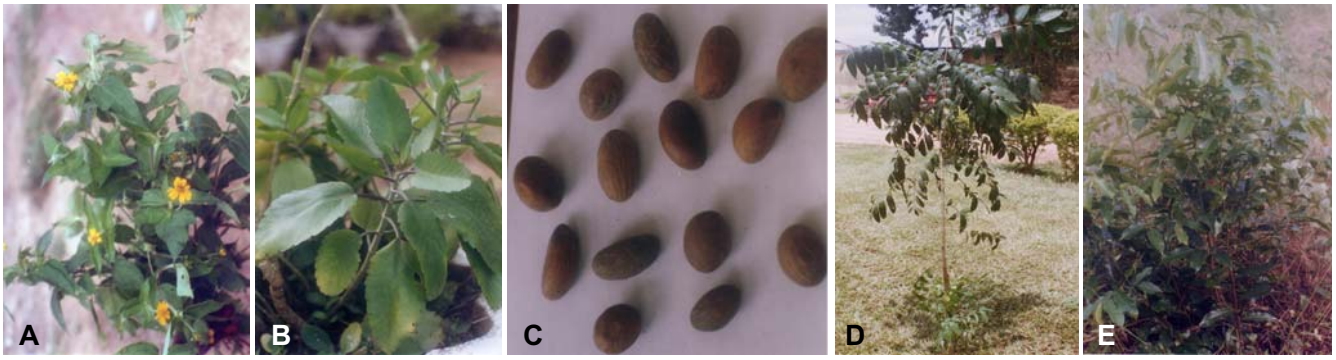

Fig. 1 (A) ***Aspilia africana*****, (B)** ***Bryophyllum pinnatum*****, (C)** ***Garcinia kola*****, (D)** ***Spondias mombin*****, (E)** ***Uvaria chamae*****.**

Okwu and Josiah 2006). The crushed leaves and flowers are used to stop bleeding and for treating wounds and sores (Agoha 1974). This may be due to high saponin (1.46 mg.100 g^{-1}) content (**Table 1**). The high saponin content in *A. africana* justifies the use of the extract from this plant to stop bleeding and in treating wounds (Okwu and Josiah 2006). Saponin has the property of precipitating and coagulating red blood cells. Some of the general properties of saponin include the formation of foams in aqueous solution, hemolytic activity and cholesterol binding properties and bitterness (Sodipo *et al*. 2000; Okwu and Ndu 2006). Plants saponins help humans fight fungal infections, combat microbes and viruses, boost the effectiveness of certain vaccines and knock out some kinds of tumor cells (Okwu and Josiah 2006; Okwu and Ndu 2006). Infusion of the leaves of *A. africana* is taken by children and can also be mixed with clay as a medicine for stomach troubles (Okwu and Josiah 2006). *A. africana* is grazed by cattle and sheep and is much used as food for rabbits and hares Egunjobi (1969).

Bryophyllum pinnatun (Crassulaceae)

Bryophyllum pinnatum is an erect, succulent, perennial shrub that grows about 1.5 m tall and reproduces via seeds and also vegetatively from leaf bulbils (Agoha 1974). It is an introduced ornamental plant that is now growing as a weed around plantation crops (Dalziel 1995; Okwu and Josiah 2006). *B. pinnatum* is used in ethnomedicine for the treatment of earache, burns, abscesses, boils, whitlow, ulcers, insect bites, diarrhea and lithiasis (Chopra *et al*. 1956; Agoha 1974; Ofokansi *et al*. 2005; Okwu and Josiah 2006). The crushed leaves as well as the extracted juice are mixed with shear butter or palm oil and rubbed on abscesses, whitlows, boils or other swellings. This is also applied on ulcers, burns and on the bodies of young children when they are ill (Agoha 1974; Okwu and Josiah 2006). Bryophyllin, potassium malate, ascorbic, malic and citric acids have been isolated from the leaves of *B. pinnatum* (Singh 1976; Soddiguluient *et al*. 1983; Mekenzie *et al*. 1985; Oliver 1989).

Garcinia kola Heckel (Guttiferae)

Garcinia kola (Bitter kola) *is* popular in Southern Nigeria. The plant is extensively used in herbal medicine and as food (Okwu 2005). It is usually found in the tropical rain forest region of West Africa. It prevails as a multipurpose tree crop in the home gardens of Southern Nigeria (Nzegbule and Mbakwe 2001). The tree is cultivated within villages in Southern Nigeria as an economic tree crop.

Bitter kola is seen as trees of 12 to 27 m with cylindrical slightly buttressed trunks (Gledhill 1972). The grayish brown bark is slightly scaly and the slash is thick, brownish and has a slow yellow exudates. The deep dense crown is composed of short whorled dropping branches with opposite leaves 15 cm long and 6 cm wide with pale midribs (Gledhill 1972). It produces reddish, yellowish or orange coloured fruits. Each fruit contains 2 to 4 yellow seeds and a sour tasting pulp. The seed, when chewed, has a bitter, astringent taste. The seed is chewed as a masticatory and it is readily served to visitors especially among the Igbo tribe of Eastern Nigeria, as a sign of peace and acceptance of visitors (Uko *et al*. 2001). The seed is also used in traditionnal hospitality, cultural and social ceremonies (Olaleye 2000). The flowering of the plant occurs between December and January while the fruits mature between June and August (Okwu 2003, 2005). The wood is termite-proof, while the tree grows very slowly under cultivation (Gledhill 1972).

G. kola is highly valued because of its medicinal use (Iwu 1989; Manimi *et al*. 1994; Chairungsrilerd *et al*. 1996). The seeds are chewed as an aphrodisiac or use to cure cough, dysentery or chest colds in herbal medicine (Irvine 1961; Okwu 2005). *G. kola* could serve as a raw material for pharmaceutical industries (Iwu 1989). The raw stem bark of *G. kola* is purgative. The powdered bark is applied to malignnant tumors. The sap is used for curing parasitic skin disease (Okwu 2003, 2005). The latex or gum (exudates) is used intensively against gonorrhea (Iwu 1989) and applied externally on fresh wounds. The seeds prevent or relieve colic disorders, cure head or chest colds, suppressed cough and is often use in the treatment of cirrhosis and hepatitis (inflammation of the liver) (Iwu 1989; Ogu and Agu 1995). The stem of *G. kola* is used to produce favourite bitter chewing sticks sold in small bundles. The seeds as well as chewing stick are important products often seen in West African markets, particularly in Nigeria (Irvin 1961). Chewing sticks when used without toothpaste is very effective, efficient and reliable in cleaning the teeth of many people in Southern Nigeria (Olabanji *et al*. 1996; Okwu and Ekeke 2003).

The chemical, brewing and anti-microbial properties of *G. kola* have been compared with hops in larger beer brewing because of their similarity in flavor and the availability of *G. kola* in West Africa (Aniche and Uwakwe 1990; Leaky 1995). Hops are the essential and universal flavoring ingredient for larger beer (Aniche and Uwakwe 1990; Ogu and

Table 1 Phytochemical composition of five Nigerian medicinal plants expressed as mg/100 g dry weight.

Medicinal plants	Family	Part screened	Alkaloids	Flavonoids	Tannins	Phenols	Saponins	References
Aspilia africana	*Asterceae*	Leaf	1.24 ± 0.11	1.46 ± 0.20	0.04 ± 0.10	0.06 ± 0.20	1.46 ± 0.11	Okwu and Josiah 2006
Bryophyllum pinnatum	*Creassulaceae*	Leaf	1.48 ± 0.02	1.72 ± 0.11	0.51 ± 0.20	0.06 ± 0.11	1.72 ± 0.20	Okwu and Josiah 2006
Garcinia kola	*Guttiferae*	Seed	0.36 ± 0.10	0.98 ± 0.20	0.26 ± 0.20	0.11 ± 0.20	11.48 ± 0.10	Okwu 2005
Spondias mombim	*Anacardiacceae*	Leaf	0.78 ± 0.20	0.32 ± 0.11	0.17 ± 0.21	0.09 ± 0.33	1.06 ± 0.30	Okwu and Okwu 2004
Spondias mombim	*Anacardiacceae*	Bark	0.50 ± 0.02	0.16 ± 0.21	0.36 ± 0.41	0.33 ± 0.23	3.90 ± 0.31	Okwu and Okwu 2004
Spondias mombim	*Anacardiacceae*	Root	0.36 ± 0.10	0.24 ± 0.22	0.26 ± 0.22	0.26 ± 0.22	3.76 ± 0.11	Okwu and Okwu 2004
Uvaria chamea	*Annonaceae*	Root	8.10 ± 0.02	5.70 ± 0.03	0.41 ± 0.03	0.10 ± 0.02	0.38 ± 0.01	Iroabuchi 2004

Data are means ± standard deviation of triplicate determinations on a dry weight basis.

Agu 1995). Hops are cultivated throughout the temperate regions of the world, mainly Germany, USA, England, The Czech Republic and Russia but do not grow in tropical climates (Little 1986). The prospect of indigenous production of hops in West Africa therefore does not exist. *G. kola* therefore could serve as an alternative source for the bitter principle for use as a hop substitute (Aniche and Uwakwe 1990; Ogu and Agu 1995).

Numerous reports are available which state that *G. kola* is a versatile medicinal plant in Nigeria and is effective against liver inflammation, as a cough suppressant and as an anti-tumor agent (Iwu 1989; Adaramoye *et al*. 2001; Okwu 2003; Adaramoye *et al*. 2005; Farombi *et al*. 2005)

In traditional medicine, *G. kola* is used for the treatment of varicose ulcers, hemorrhoids and frostbite (Okwu 2003). Furthermore, extracts of the plant have been traditionally used for ailments such as laryngitis, liver disease and cough (Ogu and Agu 1995). The seed protect and regenerate liver cells, prevent alcoholic liver damage, viral liver damage and toxic liver damage. The seed also has anti-inflammatory, anti-diabetic, anti-microbial and anti-viral as well as anti-ulcer properties (Ibironke *et al*. 1997). The main flavonoid content isolated from *G. kola* is kolaviron (Iwu *et al*. 1990). Kolaviron is a defatted ethanol extract from the seeds of *G. kola*. It is a mixture of three compounds encompassing garcinia-biflavonoids (C1B1, C1B2) and kolaflavanone in the ratio of 2:2:1 (Iwu 1986; Iwu *et al*. 1990). Also isolated from the seed is the kolaviron biflavonoid, flavornone glycoside 4^{I},5,7-trihydroxyflavonone rhamnoglucose that is responsible for the bitter principle of the seed (Okwu 2003). These compounds are responsible for the marked medicinal properties of the plant.

Spondias mombim Linn. (Anacardiaccae)

Spondias mombim Linn. is a medium-sized, occasionally large tree with long compound leaves. The tree is widely cultivated for its yellow, pleasantly acid fruit and as a live fence (Okwu and Okwu 2004). It grows abundantly in Nigeria, bears fruit in April-May and July-August. The pulp-like fruit are yellow and about 3.5 cm long (Keay 1989). *S. mombim* is native to Southern Mexico, throughout Northern Peru and Brazil.

The plant used to be cultivated in commercial quantities in Mexico (Morton 1987a). Spanish explorers carried this species to the Philippines where it was widely adopted and whose fruit was used as food (Morton 1987a). The tree is naturalized throughout Southern Nigeria for its fruit (Morton 1987a; Kozioe and Marica 1998). The small fruits are popular for eating, making juice, popsickles and ice cream. The wood is shaved and steeped in water. Women in rural areas use this concoction as a vaginal douche. The concoction is drunk to cure ailments in their reproductive system. They are anti-fungi and exhibit the inhibition of *Candida albicans* (Okwu and Okwu 2004).

S. mombin is a versatile African medicinal plant growing in Southern parts of Nigeria. Earlier studies of the plant isolated a series of phytochemicals comprising tannins and phenolic esters, which are found to be anti-viral (Corthout and Pieters 1979; Kozioe and Marica 1998; Okwu and Okwu 2004). In ethnomedicine, the fruits are regarded as a diuretic and antispasmodic. The fruit decoction is used to bathe wounds and heal sores in the mouth (Morton 1987a; Okwu and Okwu 2004). Syrup prepared from the fruit is taken to overcome chronic diarrhea. The astringent bark decoction is a remedy for ulcers, dysentery, hemorrhoids and a treatment for gonorrhea and leucorrhoea (Morton 1987b; Lanz 2000; Okwu and Okwu 2004). In herbal medicine, the bark is used to treat stomatitis in infants (Irvine 1961; Morton 1987a, 1987b; Kozioe and Marica 1998; Lanz 2000).

The juice of the fresh leaves is a remedy for thrush. A decoction of the leaves and bark is employed as a febrifuge. In Southeastern Nigeria, an infusion of shredded leaves is valued for washing cuts, sores and burns (Okwu and Okwu 2004). It has been found (Morton 1987a; Kozioe and Marica 1998) that an aqueous extract of the leaves has antibacterial action. This may explain why women in rural communities use it as virginal douche. An alcoholic extract of this plant is more effective as an anti-bacterial agent. The gum resin of the tree is blended with pineapple or sour-sop juice for treating jaundice (Okwu and Okwu 2004). The juice of the crushed leaves and powdered dried leaves are used as poultices on wounds and inflammations while the gum that exudes from the bark is employed as an expectorant to expel tapeworms (Martinez 2000).

In parts of Eastern Nigeria, the bark is used to cook for the mothers after delivery. The use of *S. mombin* leaves as a goat fodder supplement by farmers is well known in Igbo land (Onwuka 1992). The leaves are fed to goats to expel the placenta after delivery and this suggest that *S. mombin* have obortifactant properties (Nzegbule and Meregini 1999). This may be the reason for the use of the extracts from *S. mombin* in herbal medicine to accelerate labor in South Eastern Nigeria (Okwu and Okwu 2004).

S. mombim is a very useful food. The pulp is eaten fresh or made into juice, concentrates, jellies and sherbets. In the home, they are stewed whole with sugar and consumed as a dessert. They can be preserved for future use merely by boiling and drying. The strained juice of cooked fruits yields an excellent jelly and is also used for making wine and vinegar (Morton 1987a).

In agro-forestry, this multipurpose species easily regenerates in a floodplain environment. The tree can grow to be very large, but the canopy is very light, allowing crops to grow under it. It will grow from cuttings, so people use this species as living fencepost. The trees are spaced at least six to eight meters apart. The openings and fissures in the trunk normally attract termites, insects, birds and honeybees. The wood is useful for fuel and construction needs (Kozioe and Marica 1998).

In Nigeria, indigenous people traditionally use *S. mombim* to maintain their health. The *S. mombim* plant has enormous reservoirs of many secondary metabolites and nutriative compounds which exhibit some medicinal and nutritive properties.

Uvaria chamae Beav. (Annonaceae)

Uvaria chamae Beav. is a climbing plant. It is predominantly found in the tropical rain forest of West Africa (Irvin 1961; Okwu and Iroabuchi 2004). It is a terrestrial, perennial and evergreen plant that grows about 3.6 to 4.5 m high, cultivated as well as wild (Irvin 1961). The plant is extensively branched with sweet aromatic and alternate leaves (Shukda and Shital 1994).

U. chamae is a plant with both medicinal and nutritional values. It has been reported (Okogun 1985) that its extracts have mutagenic effects. The drug benzyl benzoate used in antifungal preparations has a mutagenic compound, chamuvaritin, a benzydihydrochalcone, which was isolated from *U. chamae* (Okogun 1985). The root is used in Nigeria as a purgative (Irvin 1961). The root bark is used for respiratory catarrh and the root extract is used in the treatment of piles, menrrhegia, epistaxis, haematuria and haemalysis (Oliver 1986).

A root infusion is used for severe abdominal pains. The juice from the roots, stems or leaves is commonly applied to wounds and sores (Irvin 1961). Okwu and Iroabuchi (2004) reported the antifungal and antibacterial inhibitory properties of the plant.

PHYTOCHEMICAL COMPOSITION

It is generally assumed that the active constituents contributing to these medicinal properties exhibited by plants are the phytochemicals, vitamins and minerals (Okwu and Ekeke 2003; Okwu 2004). These medicinal plants are rich in phytochemicals (**Table 1**).

Phytochemicals are widely distributed groups of substances in the plant kingdom. Woody plants synthesize and

accumulate in their cells a great variety of phytochemicals including low molecular phenolics (hydroxybenzoic and hydroxycinnamic acids, acetophenones, flavonoids, stilbens and lignans) and oligo- and polymeric forms (hydrolysable and condensed tannins and lignins; Close and McArthur 2002; Okwu 2004; Okwu and Omodamiro 2005).

Phenolic compounds

The phenolic group of phytochemicals includes ortho-and β-cyanins, flavonoids, lignans and lignins. They have anti-inflammatory, anticlotting, and antioxidant properties, and are immune enhancers and hormone modulators (Okwu 2004). Phenols have been the subjects of extensive research as disease preventives. Phenols protect plants and humans from oxidative damage. Perhaps of greatest interest is the ability of phenol to block specific enzymes that cause inflammation. They also modify the prostaglandin pathways and thereby protect platelets from clumping (Okwu 2004; Okwu and Omadamiro 2005).

Flavonoids

Flavonoids are known for their ability to enhance the effects of ascorbic acid, along with vitamin C. Flavonoids protect the vascular system by strengthening, maintaining and repairing capillaries (Teyssier *et al*. 2001). Plant flavornoids comprise anthocyanins, proanthocyanins, flavones, flavonols, flavonones, bioflavinoids, flavin-3-4-diol, isoflavones and catechins.

Flavonoids found in *G. kola* include kolaviron, bioflavonones, garcinia-flavonone, kolaflavanone and 4^{1} 5,7 trihydrixyflavanone rhamnoglucose. Bryophyllin is found in *Bryophyllum pinnatum*, while *U. chamae* contained chamuvartin, chamanetin and uvarinol (**Table 2**). The biological functions of flavonoids include action against allergies, inflammation, microbes, ulcers, hepatotoxin, viruses and tumors (Salah *et al*. 1995; Fahey *et al*. 1997; Okwu 2004, 2005). Flavonoids are potent water-soluble super antioxidants which prevent oxidative cell damage, have strong anti cancer activity, and inhibit all stages of carcinogensis (Salah *et al*. 1995; Okwu 2004, 2005). Flavonoids in the intestinal tract are known to lower the risk of heart disease (Okwu 2004; Adaramonye *et al*. 2005).

Free radical formation is associated with the normal natural metabolism of aerobic cells. The oxygen consumption inherent in cell growth leads to the generation of a series of free radicals of oxygen, leading to oxidative stress (del Rio *et al*. 1997). The interaction of these species with lipids produces new radicals, hydroperoxides and different radicals (del Rio *et al*. 1997; Adaramoye *et al*. 2005). These groups of radicals (super oxides) may interact with biological systems in a clearly cytotoxic manner (del Rio *et al*. 1997).

Research has been conducted on the principle that free radicals can be blocked and/or scavenged (del Rio *et al*. 1997; Adaramony *et al*. 2005).

The different radicals responsible for the cell oxidation process comprise the following: singlet oxygen ($^{1}O_2$), superoxide anion (O^{2-}), hydroxide radical (•OH) and peroxyl radical (ROO•) (del Rio *et al*. 1997). The hydroxyl radical is the most cytotoxic of all these radicals. Also polyunsaturated fatty acids present in cell membranes are easily oxidized by both enzymatic and oxdative preoxidation through free radical chain reaction (Aust and Svingen 1982). Initiation of lipid peroxidation can be induced by free radicals (superoxide, hydroxy and singlet oxygen) produced in biological systems (del Rio *et al*. 1997; Adaramoye *et al*. 2005). These electrically inert species have the ability to interact and alter genetic materials. They exhibit cytotoxic, mutagenic and carcinogenic actions. It has been reported (del Rio *et al*. 1997; Adaramoye *et al*. 2005) that lipid peroxidation can be inhibited by flavonoids acting as strong radical scavengers and singlet oxygen quenchers. It has also been proposed that flavonoids react with peroxyl radicals, thus bringing about the termination of the radical reaction (del Rio *et al*. 2005).

Aspilia africana, *B. pinnatum*, *S. mombim*, *U. chamae* and garcinia flavonoids show an anti-adhesive and anti-aggregation action against red blood cell clumping (Okwu 2003; Okwu and Okwu 2004; Okwu and Emenike 2006; Okwu and Josiah 2006)

Methoxylated flavonoids are much more active than hydroxylated compounds (del Rio *et al*. 1997). Oxidative damage has been suggested to be a contributory factor in the development and complication of thrombosis and recently the beneficial effects of antioxidants from *G. kola* seed against thrombosis and atherosclerosis have gained interest (Adaramoye *et al*. 2005). These researchers evaluated the protective effects of flavonoids from *G. kola* seeds on the oxidation of human low-density lipo-protein (LDL) and their ability to scavenge reactive oxygen species *in vitro*. They investigated the inhibitory effects of garcinia flavonoids (kolaviron, garcinia biflavonone and kolaflavonone) on Fe/ascorbate induced peroxidation in LDL. Also the scavenging effects of these flavonoids on superoxide radicals and hydrogen peroxide *in vitro* were examined (Adaramoye *et al*. 1993, 2005). Also kolaviron, garcinia biflavanone (GB1, GB2) and kolaflavanone showed marked activity as superoxide radical scavengers (Adaramoye *et al*. 2005). These researchers reported that 1 $mg.ml^{-1}$ kolaviron, garcinia-biflavanone (GB1, GB2) and kolaflavanone scavenged O_2 radicals by 71%, 52%, 66% and 48%, respectively.

In addition, kolaviron, garcinia biflavanone (GB1, GB2) and kolaflavanone exhibited pronounced reducing property on potassium ferricyanide *in vitro*. Kolaviron, garcinia biflavanone (GB1, GB2) and kolaflavonon were effective at preventing LDL lipid peroxidation (LPO) induced by the Fe/ascorbate system.

Vitamin composition

These plants are good sources of ascorbic acids, riboflavin, thiamin and niacin (**Table 3**). The vitamins are important in the body. Their deficiencies adversely affect the metabolism of the body. Lack of ascorbic acid impairs the normal formation of intercellular substance throughout the body, including collagen, bone matrix and tooth dentine. A striking pathological change resulting from their defect is the weakening of the endothelial wall of the capillaries due to a reduction in the mouth of intercellular substances (Hunt *et al*. 1980; Okwu 2005). The clinical manifestation of scurvy hemorrhage from the mucous membrane of the mouth and gastrointestinal tract, anemia, pains in the joint and defects

Table 2 Phytochemical substances in select Nigerian medicinal plants.

Medicinal plant	Family	Phytochemical substance/compounds	Reference
Aspilia africana	*Asterceae*	Phenolic compounds, tannins	Okwu and Josaih 2006
Bryophyllum pinnatum	*Creassulaceae*	Bryophyllin	Singh 1976; Mckenzie *et al*. 1985
Garcinia kola	*Guttiferae*	Kolaviron, bioflavanones, kolaflavonones	Etkin 1981; Iwu and Igboko 1982; Iwu
		4^{1},5,7-trihydroxyflavanone rhamnoglucose, guttiferin	1986; Okwu 2003; Adaramoye *et al*. 2005
Spondias mombim	*Anacardiacceae*	Caffeoyl esters	Carthout *et al*. 1979
		Ergometrine, oxytoxin, seotonin, acetylcholine, biorneol, cineole	Kozioe and Marcia 1998
Uvaria chamea	*Annonaceae*	Chamuvaritin, chamanetin	Okogun 1985
		Dichamanetin, dihydrochelcone, flav-3-ene	Oliver 1986
		Hydroxychalcone, pyrenes, 2-hydroxyflavones, uvarinol, isouvarinal	Achenbach 1997

Table 3 Vitamin composition of five Nigerian medicinal plants on mg/100g dry weight basis.

Medicinal plant	Family	Part screened	Ascorbic acid	Riboflavin	Thiamine	Niacin	Reference
Aspilia africana	*Asterceae*	Leaf	26.42 ± 0.01	0.20 ± 0.01	0.11 ± 0.20	0.09 ± 0.11	Okwu and Josiah 2006
Bryophyllum pinnatum	*Creassulaceae*	Leaf	44.03 ± 0.20	0.42 ± 0.01	0.18 ± 0.02	0.02 ± 0.10	Okwu and Josiah 2006
Garcinia kola	*Guttiferae*	Seed	23.10 ± 0.02	0.22 ± 0.01	0.54 ± 0.30	1.60 ± 0.01	Okwu 2005
Spondias mombim	*Anacardiacceae*	Leaf	8.80 ± 0.10	0.26 ± 0.23	0.60 ± 0.33	0.04 ± 0.04	Okwu and Okwu 2004
Spondias mombim	*Anacardiacceae*	Bark	2.20 ± 0.33	0.08 ± 0.11	0.32 ± 0.11	0.03 ± 0.12	Okwu and Okwu 2004
Spondias mombim	*Anacardiacceae*	Root	6.60 ± 0.12	0.83 ± 0.10	0.20 ± 0.11	0.04 ± 0.11	Okwu and Okwu 2004
Uvaria chamea	*Annonaceae*	Root	2.10 ± 0.06	0.06 ± 0.21	0.16 ± 0.01	0.40 ± 0.22	Okwu and Iroabuchi 2004

Data are means ± standard deviation of triplicate determinations on a dry weight basis.

in skeletal calcification can be related to the association of ascorbic acid and normal connective tissue metabolism (Hunt *et al*. 1980; Okwu 2004, 2005). This function of ascorbic acid also accounts for its requirement for normal wound healing (Okwu 2004, 2005).

The availability of ascorbic acid in *A*. *africana*, *B*. *pinnatum*, *G*. *kola*, *S*. *mombin* and *U*. *chamea* accounts for their utilization in herbal medicine for the treatment of common cold and other diseases like prostrate cancer (Okogun 1985; Okwu 2003, 2004).

The vitamins, though in trace amounts are very essential for the body's metabolism. Niacin is active in preventing the disease pellagra while a deficiency of thiamin in the diet is the cause of the disease beri beri (Okwu 2005). A deficiency of riboflavin does not result in any specific and identifiable disease and one is apt therefore to underestimate its importance. The symptoms are inflammation of the tongue, lesions at the eyes and lips, congestion of conjunctive blood vessels and desquamation of the skin (Tylor 1972; Okwu 2005). This explains some of the biochemical basis for the uses of these plants in ethnomedicine in Nigeria.

PHARMACOLOGICAL/BIOLOGICAL STUDIES

In pharmacological studies defatted alcoholic extract of *G*. *kola* seed (kolaviron) prevented liver damage in animals challenged with the deadly toadstool (*Aminita pholloids*) ethanol, ethionine, thioacetamide and glycosiamine (Ibronke *et al*. 1997; Adaramoye and Adeyemi 2001). Kolaviron has been extensively studied for its anti-hepatotoxic effects in various experimental models (Akintonwa and Essien 1990; Farombi *et al*. 2005).

Inhibition of aflatoxin B1 genotoxicity in the human liver-derived HCPG2 cells by kolaviron biflavonoids was studied by Nwankwo *et al*. (2000) and kolaviron biflavonoid demonstrated anti-hepatotoxic activity. Kolaviron administered orally at a dose of 200 $g.kg^{-1}$ once a day for the first 2 weeks and then 100 $mg.kg^{-1}$ twice a day for the next 4 weeks of aflatoxin B1 (2 $mg.kg^{-1}$, single dose) treatment reduced the aflatoxin B1-increased activities of aspartate amino transferase (AST), alanine amino transferase (ALT) and gamma glutamyl transferase [gamma]-GT by 62%, 56% and 72%, respectively (Farombi *et al*. 2005). Malonialdehyde (MDA) formation and lipid hydro-peroxide (LHP) accumulation were observed in the livers of aflatoxin B1 (AFB1)-treated rats, and kolaviron significantly reduced the AFBI-induced MDA and LHP formation (Farombi *et al*. 2005). These results indicate kolaviron as an effective chemo-preventive agent against AFBI-induced genotoxicity and hepatic oxidative stress (Farombi *et al*. 2005). Kolaviron might qualify for chemical trials in combating the menace of aflatoxicosis in endemic areas of aflatoxin-contaminated foods. The most active flavonoid component of kolaviron GB1 significantly altered the half-life of phenylbutazone in human subjects (Iwu and Igboko 1982). The active constituents of kolaviron are easily accepted as a pharmaceutical agent because of its close relationship with two commercial products used for the management of liver toxicity namely Silybin Legacon® and cyanidanol Catergen® (Iwu 1986). These drugs are believed to exert a specific action on the liver membrane and thereby prevent liver damage.

The anti-inflammatory and analgesic properties of kolaviron were investigated in mice (Olaleye *et al*. 2000). In their findings, kolaviron exhibited a weak analgesic but strong anti-inflammatory activity when compared with reference drug acetylsalicylic acid.

Histological alterations in the liver, kidney and duodenum of rats fed diets containing 10% *G*. *kola* seed have been reported (Bracide and Grill 1990). Furthermore, an increase of both basal and histamine-mediated gastric acid secretions of rats fed *G*. *kola* seed was observed (Oluwole and Obatomi 1992). Using growing rats as a model, Uko *et al*. (2001) conducted a study on possible alterations of the digestive, hematological and reproductive systems. There was a dose-related decrease in the size of the liver, lungs and heart of rats fed the plant extract. In contrast, the extract caused a mild, but consistent enlargement of the spleen and brain of experimental rats compared with those of the control rats (Uko *et al*. 2001). Among the organs (testes, kidney, liver, heart, lungs and brain) examined no microscopic alterations were observed in any of the treatment group (Uko *et al*. 2001). However, Orie and Ekon (1993) observed a bronchodilator effect of *Garcinia* seeds on normal Nigerians. During the course of a male-fertility trial, it was observed (Olaleye *et al*. 2000; Uko *et al*. 2001) that experimental rats fed with *G. kola* seed exhibited increased libido, which was demonstrated by frequent attempts of the males to mount females rats thus justifying the use of *G*. *kola* seed by the natives as an aphrodisiac.

The anti-bacterial and anti-fungal activity of the crude ethanolic extract of *G*. *kola* seed showed the successful inhibition compared to some reference antibiotics like streptomycin and clotrimazole (Okwu 2003). *G*. *kola* seed extracts successfully inhibited *Pseudomonas aeruginosa*, *Staphylococcus aureus* and *Candida albicans* (Okwu 2003). *G*. *kola* extract also exhibited the inhibition of *Streptococcus pyrogenes*, *Streptococcus pneumoniae* and *Hemophilus influenzae* (Akoachere *et al*. 2002). The observed inhibiting property explains the reason behind the utilization of *G*. *kola* extract in traditional medicine as a cough suppressant, an anti-tumor agent, its wound healing activity and as an aphrodisiac.

Both the aqueous and ethanolic root extracts of *U*. *chamea* inhibited *Staphylococcus aureus and Bacillius subtilis* (Okwu and Iroabuchi 2004). Also the extract from the leaves of *B*. *pinnatum* inhibited *Staph*. *aureus*, *Esterichia coli*, *Bac*. *subtilis*, *Pseudomonas aeruginosa*, *Klebsiella aerogenes*, *Kleb. pneunoniae* and *Salmonella typhi* (Ofokansi *et al*. 2005). The inhibitory activities of these plants are due to the phenolic constituents. Phenol and phenolic compounds have been extensively used in disinfections and remain the standard with which other bactericides are compared.

CONSERVATION

As a result of the advancement in plant breeding techniques coupled with the development of high yielding varieties, the tendency for land races and primitive cultivars of plants like *A*. *africana*, *B*. *pinnatum*, *S*. *mombim*, *G*. *kola* and *U*. *chamae* are fast being replaced. Improvement in agronomy and conservation of these plants are necessary to avoid genetic erosion. Farmers in Nigeria do not domesticate these plants except for *G*. *kola*. There is an urgent need to collect more seeds from wild species of *A*. *africana*, *B*. *pinnatum*, *G*. *kola*,

S. mombim and *U. chamea*. It should be emphasized that the rapid replacement of locally adopted varieties with high yielding and early maturing varieties should improve the economy of the nation in particular and that of the farmers in general. This will result in the elimination of old varieties selected by nature with the highly improved varieties. There is an urgent need to conserve the variability in these species. It is very important to formulate methods for regeneration and conservation of germplasm collections in long-term storage with little loss of aggregate diversity from natural land races, primitive cultivars and new breeding species when grown simultaneously. To check genetic drift and frequent regeneration, facilities should be developed for the long-term storage of germplasm in a national gene bank. Unfortunately, there is no medicinal plant conservation center in Nigeria and no national gene bank exists in the country. However, the three Universities of Agriculture in the country, namely the Michael Okpara University of Agriculture at Umudike, the Federal University of Agriculture at Markurdi, and the Federal University of Agriculture, at Abeokuta should be proposed as storage and conservation centers for Nigerian/African medicinal plants. Medicinal plants gardens should be establish in Ibadan, Nsukka and Zairia for *in situ* conservation. The germplasm collection from different parts of Nigeria should be evaluated and classified for various characters of economic importance. Plant breeders should undertake a detailed evaluation of morphological, physiological and biochemical traits including tolerance to disease, pests, adaptation to adverse climate and soil conditions. Finally, a gene bank should be established in these centers.

CONCLUSION

This review shows that information relating to seed research, propagation and conservation of these medicinal plants do not exist in Nigeria. A complete package for cultivating *U. chamea*, *A. africana*, *B. pinnatum*, *S. mombim* and *G. kola* and germplasm storage techniques is yet to be developed. High quality seeds of *G. kola* should be provided for the growers. There is a need to conserve protected areas, herbal gardens, sacred grooves and forest areas rich in medicinal plants. It is very necessary to conserve these plants for posterity.

REFERENCES

Adaramonye OA, Adeyemi OA (2001) Hepatoprotection of D-galactosamine-induced toxicity on mice by purified fractions from *Garcinia Kola* seeds. *Basic Clinical Pharmacology and Toxicology* **98**, 135-141

Adaramony OA, Faraombi EO, Adeyemi EO, Emerole GO (2005) Comparative study of the antioxidant properties of flavonoids of *Garcinia Kola* seeds. *Pakistan Journal of Sciences* **21**, 331-339

Agoha RC (1974) *Medicinal plants of Nigeria*, Offset Arakkenji, Faculfcider Wiskunde, The Netherlands, pp 33, 41

Akintonwa A, Essien AR (1990) Protective effects of *Garcinia kola* seed extract against paracetamol-induced hepatotoxicity rats. *Journal of Ethnopharmalogy* **29**, 207-211

Akoachere JE, Ndip RN, Chenwi EB, Nidip LM, Njock TE, Anong DN (2002) Antibacterial effect of *Zingiber officinale* and *Garcinia kola* on respiratory tract of pathogens. *East African Medical Journal* **79**, 588-592

Akobundu IO (1987) *Weed Science in the Tropics, Principles and Practices*, John Wiley and Sons, Chichester, UK, 522 pp

Aniche GN, Uwakwe GN (1990) Potential use of *Garcinia kola* as a hop substitute in larger beer brewing. *World Journal of Microbial Biotechnology* **6**, 323-327

Aust SD, Svingen BA (1982) The role of iron in enzymatic lipid peroxidation. In: Pryor WA (Ed) *Free Radicals in Biology* (Vol 1), Academic Press, New York, pp 1-28

Braide VB, Grill V (1990) Histological alterations by a diet containing seeds of *Garcinia kola* effect on liver, kidney and intestine in the rat. *Morphological Journal* **136**, 95-101

Chopra RN, Nayar SL, Chopra IC (1956) *Glossary of Indian Medicinal Plants* (Vol 1), CSIR, New Delhi, 330 pp

Close DC, McArthur C (2002) Rethinking the role of many plants phenolics protection from photodamage *Oikos* **99**, 161-172

Corthout JI, Pieters F (1979) Antiviral ellagitannins from *S. mombim*. *Phytochemistry* **30**, 1129-1130

Dalziel JM (1995) *The Useful Plants of West Tropical Africa*, Crown Agents for Overseas Government and Administrations, London, pp 28, 53, 415

del Rio A, Obuduilio BG, Castillo J, Marin FR, Ortuno A (1997) Uses and properties of citrus flavonoids. *Journal of Agriculture and Food Chemistry* **45**, 4505-4515

Egunjobi JK, Senn TL, Andrews FS, Halfacre RG (1997) *Fundamentals of Horticulture*, Tata Mcgraw Hill Publishers, New Delhi, pp 409-426

Fahey JW, Zhang Y, Talahya (1997) Broccoli sprouts, an exceptional source of inducers of enzymes that protect against chemical carcinogens. *Proceedings of the National Academy of Sciences USA* **94**, 10367-10372

Faromb EO, Tahntengy DG, Agboola AO, Nwakwo JO, Emerole GO (2000) Anti-hepatotoxic effects of kiloviron on rats. *Food and Chemical Toxicology* **38**, 535-541

Farombi EO, Adepoju BE, Ola-Davies OE, Emerole GO (2005) Chemeoprevention of aflatoxin induced genotoxicity and hepatic oxidative damage in rats by Kolaviron, a natural bioflavonoid of *Garcinia kola* Seeds. *European Journal of Cancer Prevention* **14**, 207-214

Foot CS (1997) Photosensitized oxidation consequences in biological systems. In: Pryor WA (Ed) *Free Radicals in Biology* (Vol 2), Academic Press, New York, pp 51-68

Gledhill D (1972) *West African Tress*, Longman, London, pp 19-25

Hertog MGL, Feskeens EJM, Hokman CH, Katan A (1993) Dietary antioxidant flavonoids and risk of coronary heart disease. *Lancet* **342**, 1007-1011

Hunt S, Groff JL, Holbrook J (1980) *Nutrition: Principles and Chemical Practices*, John Wiley and Sons, New York, pp 49-52, 459-462

Ibrronke GF, Olaleye SB, Balogun O, Aremu DA (1997) Antiulcerogenic effects of diets containing seeds of *Garcinia kola* (heckes). *Phytotherapy Research* **11**, 3122-313

Irvin FR (1961) *Woody Plants of Ghana with Special Reference to their Uses*, Oxford University Press, London, pp 19-20, 695

Iwu MM, Igboko O (1983) Flavonoids of *Garcinia kola* seeds. *Journal of Natural Products* **45**, 650-651

Iwu MM (1986) Research findings on the possible applications of Nigerian raw materials in the pharmaceutical industry. In: Onoh JK (Ed) *Industrial Potential of Nigeria Materials*, Imo State University Press, Owerri, Nigeria, pp 251-264

Iwu MM (1989) Food medicine. In: Iwu M (Ed) *Dietary Plants and Masticators as Sources of Biologically Active Substances*, Ife Press, University of Ife, Nigeria, pp 303-310

Iwu MM, Igboko OA, Elekwa OK, Tempesta MS (1990) Prevention of thioacetamide induced heaptoxicity by bioflavanones of *Garcinia kola*. *Phytotherapy Research* **4**, 157-159

Keay RWJ (1989) *Trees of Nigeria*, Clarendon Press, Oxford, pp 19-30

Kozioe MJ, Marcia MJ (1998) Chemical composition, nutritional evaluation and economic prospects of *Spondias purpurea* (Anarcardiacea). *Economic Botany* **52**, 373-380

Lanz C (2000) *Ethnovetinary Medicine in Trinidad and Tabago*, Wageningen University, PhD Thesis No 2992

Leaky RRB (1995) Farmers top priority fruit trees. *Agro Forestry Today* **2**, 11-15

Little BT (1986) Input of bottling and brewing industries and in prospect of local substitute. In: Onoh JK (Ed) *Industrial Potential of Nigeria Raw Materials*, Imo State University Press, Owerri, Nigeria, pp 158-164

Minami H, Kinoshita M, Fukuyama Y, Kodama M, Yoshizawa T, Sugiura M, Nakagawa K, Tago H (1994) Antioxidant xanthones from *Garcinia sunelliptica*. *Phytochemistry* **36**, 501-506

Minami H, Takahashi E, Kodama M, Fukuyama Y (1996) Three xanthones from *Garcinia sublliptica*. *Phytochemistry* **41**, 629-633

Martinez M (2000) Structural investigation of the polysaccharides of *S. mombim* gum. *Carbohydrate Polymers* **43**, 105-112

Mekenzie RA, Franke FO, Duster PJ (1985) Flavonoids and glycosides of *Bryophyllum pinnatum*. *Dutivet Journal* **64**, 10-15

Mead JR (1976) Free radical mechanisms of lipid damages and consequences for cellular membranes. In: Pryor WA (Ed) *Free Radicals in Biology* (Vol 3), Academic Press, New York, pp 51-68

Menson RP (1982) Free radical intermediates in the metabolism of toxic chemicals. In: Pryor WA (Ed) *Free Radicals in Biology* (Vol 5), Academic Press, New York, pp 161-222

Morton JF (1987a) *Purple Mombim Fruits of Warm Climates*, Mombim JF (Ed) Miami Publishers, New York, 245 pp

Morton JF (1987b) *Yellow Mombim Fruits of Warm Climates*, Mombim JF (Ed) Miami Publishers, New York, pp 245-248

Nzegbule EC, Mbakwe R (2001) Effect of pre-sowing and incubation treatment on germination of *Garcinia kola* Heckel. *Seed Fruits* **56**, 437-442

Nzegbule EC, Nmeregini A (1999) Applying indigenous knowledge in conserving biodiversity in Okigwe South, Imo State Nigeria. *Journal of Sustainable Agriculture and Environment* **1**, 95-100

Ofokansi KC, Esimone CO, Anele CK (2005) Evaluation of the *in vitro* combined antibacterial effects of the leaf extract of *Bryphylum pinnatum* (Fam. Crassulaceae) and *Ocimum gratissimum* (Fam: Labiatae). *Plant Root Research Journal* **9**, 23-27

Ogu EO, Agu RC (1995) A comparison of some chemical properties of *Garcinia kola* and hops for assessment of *Garcinia* brewing value. *Bioresource*

Technology **54**, 1-4

Okogun JI (1995) Drug production effort in Nigeria. Medicinal chemistry research and a missing link. Text of a lecture delivered to the Nigerian Academy of Science

Okwu DE (2003) Investigation into the medicinal and nutritional potentials of *Garcinia kola* Heckel and *Dennettia tripetala* (G. Baker). PhD Thesis, Michael Okpara University of Agriculture, Umudike, Nigeria, pp 5-10

Okwu DE, Ekeke O (2003) Phytochemical screening and mineral composition of chewing stick in South Eastern Nigeria. *Global Journal of Pure and Applied Sciences* **9**, 235-238

Okwu DE, Iroabuchi F (2004) Phytochemical analysis and antimicrobial activity screening of aqueous and ethanolic root extract of *Uvaria chamea* Beav and vitamin content of indigenous spices of south Eastern Nigeria. *Journal of Sustainable Agriculture and the Environment* **6**, 30-34

Okwu DE, Okwu ME (2004) Chemical composition of *Spondias mombim* Linn. plant parts. *Journal of Sustainable Agriculture and the Environment* **6**, 140-147

Okwu DE (2005) Phytochemicals, vitamins and mineral contents of two Nigerian medicinal plants. *International Journal of Molecular Medicine and Advanced Sciences* **1**, 375-381

Okwu DE, Emenike IN (2006) Evaluation of the phytonutrients and vitamin contents of citrus fruits. *International Journal of Molecular Medicine and Advanced Science* **2**, 1-6

Okwu DE, Josiah C (2006) Evaluation of the chemical composition of two Nigerian medicinal plants. *African Journal of Biotechnology* **5**, 357-361

Okwu DE, Ndu CU (2006) Evaluation of the phytonutrients, mineral content of some varieties of yam (*Dioscorea* sp.). *International Journal of Molecular Medicine and Advanced Science* **2**, 199-203

Okwu DE, Omodamiro OD (2005) Effect of hexane extract and phytochemical content of *Xylopia aethiopica* and *Ocimum gratissimum* on uterus of guinea pig. *Bio-Research* **3**, 40-44

Olabanji SO, Makanju OV, Ifaque DCM, Buoso MC, Ceccato D, Cherubini R, Moschini G (1996) PiGE-PIXE Analysis of chewing stick of pharmacological importance. *Nuclear Instruments and Methods in Physics Research* **113**, 368-372

Olaleye SB, Farombi EO, Adewoye EA, Owoyele BV, Onasanwo SA, Elegbe RA (2000) Analegesic and anti-inflammatory effects of kolaviron, a *Garcinia kola* seed extract. *African Journal of Biomedical Research* **3**, 171-174

Oliver B (1986) *Medicinal Plants of Tropical West Africa*, Cambridge University Press, London, pp 76-135

Oluwole RS, Obatomi AB (1992) The effect of *Garcinia kola* on gastric acid secretion in albino rats Nigeria. *Journal of Physiological Sciences* **8**, 115-119

Onwuka CF (1992) Saponin and tannin content of some tropical browse species fed to goats. *Tropical Agriculture* **69**, 176-180

Orie NN, Ekon EU (1993) The bronchodilator effect of *Garcinia kola*. *East Africa Medicinal Journal* **70**, 143-145

Salah N, Miller NJ, Paganga G, Tijburge L, Bolwell GP, Rice-Evans C (1995) Polyphenolic flavonols as scavenger of aqueous phase radical and as chain breaking antioxidants. *Biochemistry and Biophysical Journal* **2**, 339-346

Shukda P, Shital PM (1974) *An Introduction to Taxonomy of Angiosperms*, Vikas Publishing House, New Delhi, 204 pp

Siddigul SM, Bina SF, Sultan D (1983) Triterpenoids and phenanthrene triterpenoids from leaves of *Bryophylum pinnatum*. *Chemical Research* **88**, 45-51

Singh RCP (1976) Chemical analysis on *Valendo fluribunda* medicinal plants of India (Vol 1) Indian Council for Medical Research, New Delhi, pp 149-159

Sodipo OA, Akiniyi JA, Ogunbamera JV (2000) Studies on certain characteristics of extracts from bark of *Paninystalia macroceras* (K. Schum. Pierre Exbeille). *Global Journal of Pure and Applied Sciences* **6**, 83-87

Taylo OJ (1972) *Micronutrients*, A Unilever Educational Booklet, Unilever International Company London **9**, 10-25

Teyssier C, Amiot MJ, Mondy N, Auger J, Kahane R, Siess MH (2001) Effect of onion consumption by rats on hepatic drug metabolizing enzymes. *Food Chemistry and Toxicology* **39**, 981-987

Uko OJ, Usman AM, Ataja O (2001) Some biological activities of *Garcinia kola* in growing rats. *Verinary Archives* **71**, 287-297