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Review

Comprehensive scientific demystification of *Kigelia africana*: A review

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Medicinal plant plays a vital role in the management of various diseases. *Kigelia africana* popularly known as the Sausage tree, *Kigelia pinnata* is a multipurpose medicinal plant with many attributes and considerable potentials. The plant has traditional uses which include anticancer, antiulcer, anti-aging, antioxidant, and anti malarial. It is also widely applied in the treatment of genital infections, gynaecological disorders, renal ailments, fainting, epilepsy, sickle-cell anaemia, psoriasis, eczema, central nervous system depression, respiratory ailment, skin complaint, body weakness, leprosy, impetigo, worm infestation, scalp, athlete's foot, tumours etc., especially in developing nations where orthodox medicine are meager, expensive or inaccessible. The various chemical constituents such as the naphthaquinones, iridoids, fatty acids, norviburtinal, sterols, lignans, terpenoid, and flavonoids are the essential building block responsible for its wide range of activities. This work represents the recent profile of applications of *K. africana* as examined by various modern scientific researches. This work was prompted as a result of lack of recent and sufficient scientific information on the use of *K. africana* as a viable medicinal plant.

Key words: *Bignoniaceae, Kigelia africana*, nahthaquinones, anticancer, anti-inflammatory.

INTRODUCTION

Human use of plants as medicine agent pre-dates recorded history. Ethno-medicinal plant-use data in many forms has been heavily utilized in the development of formularies and pharmacopoeias, providing a major focus in global healthcare, as well as contributing substantially to the drug development process (Graham et al., 2000).

Generally, natural drug substances often form vital and appreciable roles in the modern system of medicine thereby justifying their presence in the prevailing therapeutic arsenal, namely- serve as extremely useful natural drugs, provide basic compounds affording less toxic and more effective drug molecule, modification of inactive natural products by suitable biological and chemical means into potent drugs (Kan, 2006). Infectious diseases are important in public health for communities in Africa and the developing world (Sparg et al., 2000). These diseases and subsequent deaths have devastating consequences for developing economies. Meager health budgets and lack of adequate medical fertilities hinder efforts by poor African countries to match the overwhelming treatment and prevention burden presented by these diseases (Louw et al., 2002). Western or modern medicine has for many years been used, with varying degrees of success, in the treatment of infectious disease. Furthermore, improved sanitation, clean water, better living conditions and vaccines brought many infectious diseases under control (Wilson, 1995). Despite this, many obligate and opportunistic pathogens are becoming increasingly resistant to most available drugs at an alarming rate that is unmatched by the development of new drugs (New, 1992). Traditional knowledge to solve health problems of mankind and animals exists in all countries of the world (Rukangira, 2001). In most of the traditional medicine, the medicinal plant include the fresh or dried part, whole, chopped, powdered or an advanced form of the herb usually made via extraction by a solvent such as water, ethanol or an organic solvent play a major role and constitute the backbone of traditional medicine (Mukherjee, 2002). The exploration of the chemical constituent of the plants and pharmaceutical screening may provide us the basis for developing the lead for develop-

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ment of novel agents. Herbs have provided us some of the very important life saving drugs used in the armamentarium of modern medicine. Among the estimated 400,000 plant species, only 6% have been studied for biological activity and about 15% have been investigated phytochemically (Cragg et al., 1997). This inadvertedly shows a dare need for the in-depth dissertation of various chemical constituents, medicinal viability, pharmacological evaluation and biological activities of herbal medicine such as the *k. Africana* (Lam) Benth (or *K. pinnata*) of the family Bignoniaceae an exceptional indigenous medicinal plant in Africa.

GENERAL INFORMATION

K. Africana (Lam) Benth, (*K. pinnata*) belongs to the family Bignoniaceae. Its common names include sausage tree (Eng.); worsboom (Afr.); um vunguta, umfongothi (Zulu); modukguhlu (North Sotho); muvevha (Venda) (Coats-Palgrave, 1988) pandoro (West Nigeria) (Aiyelola et al., 2006) Saucissonnier; Faux baobab (Fr) Mvungunya, mwegea, mwicha, mranaa (sw) (Grace et al., 2002). It is a tree growing up to 20 m tall or more. The bark is grey and smooth at first, peeling on older trees. It can be as thick as 6 mm on a 15 cm branch. The wood is pale brown or yellowish, undifferentiated and not prone to cracking. (Roodot, 1992) The tree is evergreen where rainfall occurs throughout the year, but deciduous where there is a long dry season. The leaves are opposite or in whorls of three, 30 - 50 cm long, pinnate, with six to ten oval leaflets up to 20 cm long and 6 cm broad; the terminal leaflet can be either present or absent. The flowers (and later the fruit) hang down from branches on long flexible stems (2 - 6 m long).

Flowers are produced in panicles; they are bell shaped (similar to those of the African tulip tree but darker and more waxy), orange to reddish or purplish green and about 10 cm wide. Indivi-dual flowers do not hang down but are oriented horizon-tally (Joffe, 2003) some birds are attracted to these flowers and the strong stems of each flower make idea footholds. Their scent is most notable at night indicating their reliance on pollination by bats, which visit them for pollen and nectar. (Hoyo, 1997) Flowers are bisexual, very large; pedicel up to 11 (-13.5) cm long up curved at tip; calyx shortly tubular to campanulate, 2 - 4.5 cm long, suddenly widening and incurving upwards, limp 2-lipped, with the super or lip 2-lobed, the lower one 3-lobed and recurved (Grace et al., 2002).

The fruit is a woody berry from 30 - 100 cm long and up to 18 cm broad; weighs between 5 - 10 kg hangs down on a long rope-like peduncles (Joffe, 2003). The fruit is indehiscent, with woody wall and heavily marked with lenticels at the surface. It is grey- brown and many seeded when matured. Seeds are obovoid, ca.10 mm x 7 mm with leathery testa, embedded in a fibrous pulp (Grace et al., 2002). The fruit is eaten by several species of mammals, including Baboons, bush pigs, Savannah Elephants, Giraffes, Hippopotami, monkeys and porcupines. The seeds are dispersed in their dung. The seeds are also eaten by brown Parrots and Brown-headed parrots, and the foliage by elephants and Greater Kudu (Mukherjee, 2002).

Occurrence and distribution

The tree is found on riverbanks, along streams and on floodplains, also in open woodland, from Kwazulu-Natal to Tanzania. The plant is widely distributed in the south, central and West Africa (Burkill, 1985).

Ecology

K. africana grows along watercourses, in riverine fringes, alluvial and open woodland, high rainfall savanna, shrub land and in rain forest. It occurs on loamy red clay soils, sometimes rocky, damp or peaty, from sea level up to zoom altitude (Grace et al., 2002). This review highlights on the medicinal properties and chemical constituent of *K. africana*.

MEDICINAL PROPERTIES AND PHARMACOLOGY

Various pharmacological examinations such as antibacterial, antiviral and antioxidant activities have been carried out. The success story of chemotherapy lies in the continuous search for new drugs to counter the challenges posed by resistant strains of microorganism (Khan et al., 2003). There are increasing interest in plants as a source of agent to fight microbial diseases and treatment of several infections (Chariandy et al., 1999; Aburjai et al., 2001).

Antidiarrhoeal activity

The aqueous leaves extract of *K. africana* has been confirmed to possess antidiarrhoeal activity (Akah, 1996).

Antileprotic activity

The traditional use as antileprotic has also been reported (Lal, 1983).

Antimalarial activity

The plant has been reported for its antimalaria activities (Weenen et al., 1990). Wood extract possesses antimalarial activity against drug resistant strains of *Plasmodium falciparum* superior to chloroquine and quinine (Carvalho et al., 1988).

Anti-inflammatory activities

The ethanolic extract of the stem bark was examined to

show strong analgesic and anti-inflammatory activities. The extract components inhibited the synthesis of prostagladins and other inflammatory mediators which probably accounted for the analgesic and anti-inflammatory properties (Owolabi and Omogbai, 2007). The dried fruit and bark extract is established to be a strong pain-reliever when administered on painful joints, back and rheumatism (Hntching et al., 1996). The pharmacological basis for the use of *K. pinnata* ethanolic fruit extract in medicine for the treatment of pain and inflammations was further investigated and evaluated on formaldehyde-induced paw edema, acetic acid-induced vascular peritonitis models. The result obtained is well comparable to the respective standard drugs (Carey et al., 2008). The anti-inflammatory activity of verminoside 8, from *K. africana* was also carried out. It shows significant anti-inflammatory effects inhibiting both iNOS expression and NO release in the LPS-induced J774.A1 macrophage cell line (Picerno et al., 2005)

Anticancer activities

The root bark is recommended for the treatment of cancer of the uterus (Msouthi and Mangombo, 1983). The extract has been tested against melanoma cells (a tumour of pigmented skin cells, which can develop into malignant melanoma-the potentially fatal form of skin cancer). The extract inhibited the growth of cultured melanoma cells to a significant degree (Houghton et al., 1994). The extract of stem bark and fruit are reported for their cytotoxic activities and showed promising results in treating melanoma and renal carcinoma (Houghton et al., 1994). The extracts of the plant have been shown to possess various potential anticancer agents (Kolodziej, 1997; Owolabi and Omogbai, 2007; Carey et al., 2008; Msouthi and Mangombo, 1983; Khan, 2003).

Treatment of gynecological disorders and anti-implantation activities

K. africana is widely used to treat gynecological disorders. Aqueous preparation of the roots, fruits and flowers are administered orally or as a virginal pessary while the fruits and bark are used to promote breast development in young women or in contrast to reduce swelling and mastitis of the breasts (Grace et al., 2003). The plant has also been reported for its anti-implantation activities as well (Prakash et al., 1985).

Central nervous system (CNS) stimulant

The ethanolic stem bark extract was studied in mice using barbiturate induced sleeping time and Rota rod bar to check the extract' effect on muscle coordination. The result indicates that the extract has stimulant effect on the Central Nervous System (CNS) (Owolabi et al., 2008).

Anti-microbial activities

The plant has also been screened to show anti-molluscidal activity (kela et al 1989). In a research, the dried and powdered plant material was extracted successively with water, methanol and chloroform using the soxhlet extractor for 48 h at a temperature not exceeding the boiling point of the solvents. The extract was tested against *E.coli*, *Enterobacter aerogens, Klebsiella* (Gram-negative), *Staphylococcus aureus* and *Bacillus Cereus* (Gram-positve) by disc diffusion method. The methanol extract presented a higher activity than the aqueous extracts and chloroform extracts against all except *E. aerogens, Klebsiella Pneumoniae* and *Psedomonas aeruginosa* which presented less activity (Jeyachandran and Mahesh, 2007). The dichlomethane extracts of the root bark and stem bark exhibited antitrypanosomal activity against *Trypanosoma brucei brucei in vitro* (Moideen et al., 1999). The extract of the tree stem bark was also established to inhibit a number of harmful micro-organisms which include *E. coli* (responsible for abscesses), *P. aeruginosa* (which causes skin sepsis and infections), *S. aureus* (which causes impetigo and skin abscesses) and albican (a fungal organism that causes thrust) in another experiment (Akunyili et al., 1991). The antibacterial and antifungal test carried out on the crude ethanolic stem-bark extract revealed exhibited antibacterial and antifungal activities against *s. aureus* and *candida albicans*. The aqueous extract exhibited no antibacterial and antifungal activity whereas the activity of the crude ethanolic extract (20 mg/ml) is comparable to amoxicillin drug (Owolabi et al., 2007). Butanol extract of the stem bark exhibited *in vitro* antiamoebic activity when tested against HK-9 strain of *Entamoeba histolytica* (micro dilution method) using metronidazole as reference drug. It was found that verminoside (in the extract) has two fold antiamoebic activity as compare to the standard drug while specioside showed comparable activity with metronidazole (Kneeler et al., 2006).

The ethanolic bark extract of the plant have been shown to possess antimycobacterial against the growth of *M. aurum* A+ with mic values ranging between 0.19 and 1.5 mg/ml (Carvalho et al., 1988). Other antibacterial activity of the fruit has been reported as well (Grace et al., 2002b).

Miscellaneous medicinal properties

The extract of the plant has been shown to possess anti-oxidative property which apparently makes it useful in the treatment of diseases especially the liver-borne disease (Olaive and Rocha, 2007). The ethno medicinal plant bark is used for the treatment of rheumatism, dysentery and veneral diseases. It is also used as ringworm and tapeworm expellant, while other uses include treatment of haemorrhages, diabetes, pneumonia and toothache (Akunyili and Houghton, 1993; Kolodziej, 1997). The plant

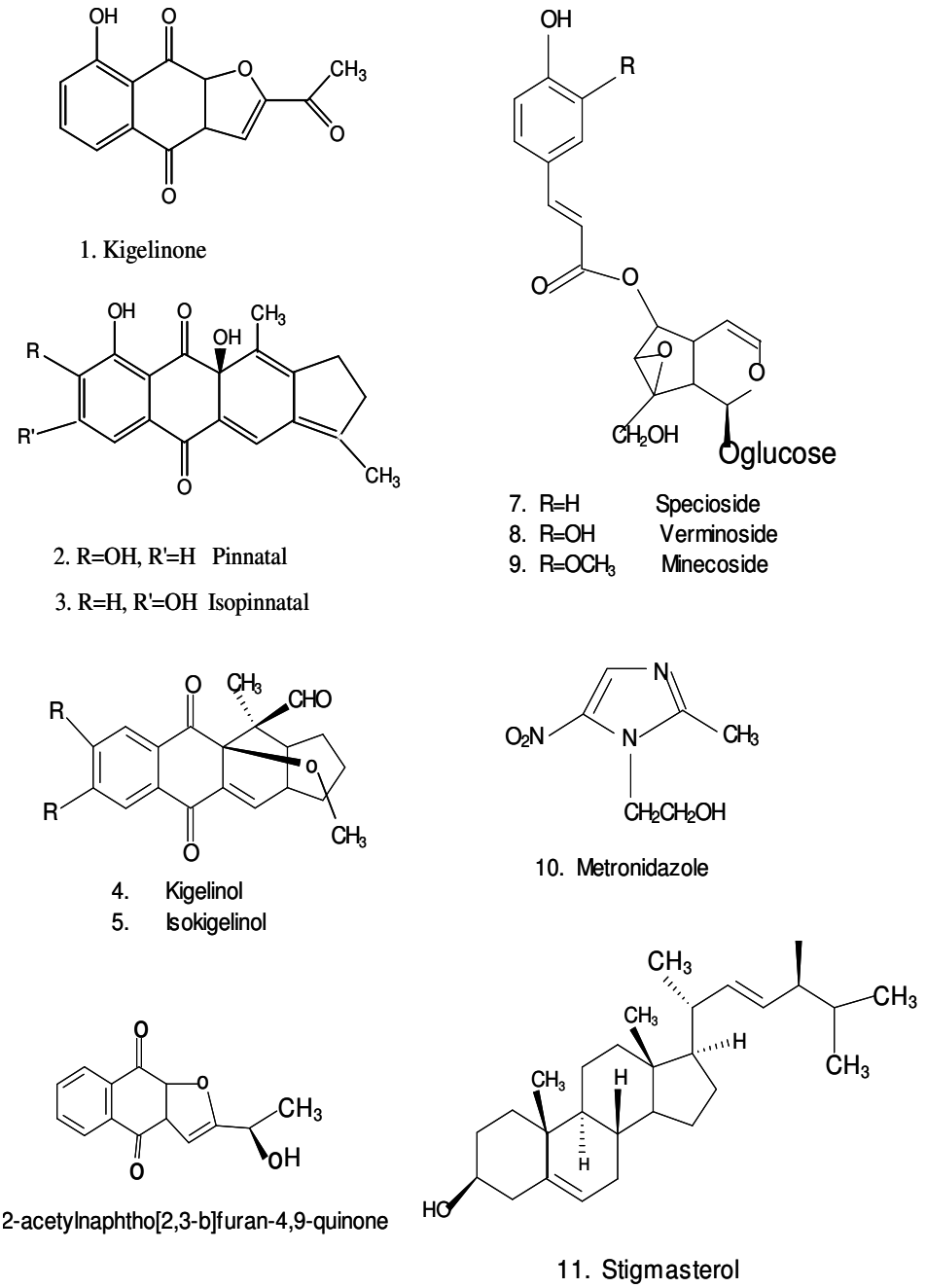
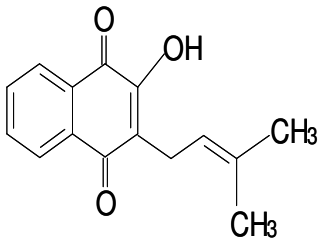


Figure 1. Compounds present in kigelia pinnata.

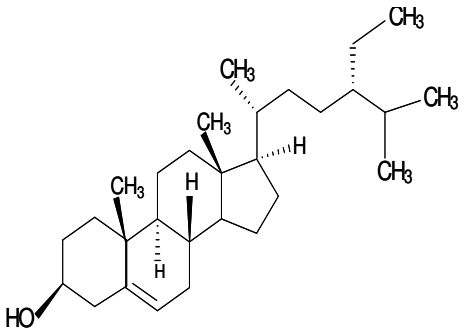
is also confirmed useful as herbal remedy for, rheumatism, retained placental and dizziness (Gill, 1992).

CHEMICAL CONSTITUENTS AND PHYTOCHEMISTRY

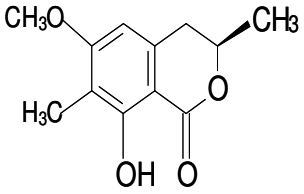
Various chemical investigations have been carried out on *K. africana* and many chemical compounds (Figures 1 and 2) mainly iridoids, naphthaquinones, monoterpenoid-napht-haquinones, isocoumarins, lignans sterols and flavonoids have been identified. An initial laboratory studies indicated the presence of two major naphthaquinones (kige-linone 1 and isopinnatal 3) in the aqueous extract of the stem bark. These show activities against *B. subtilis, E. coli, P. aeruginosa, S. aureus* and yeast *C.albicans* (Akunyili and Houghton, 1993; Akunyili et al., 1991). Qualitative tests for the presence of plant secondary metabolites such as carbohydrates, alkaloids, tannins, flavonoids, saponins and glycosides were carried out on the bark powdered (Owolabi and Omogbai, 2007). Chemical analysis of the polar extract of fruit indicated the



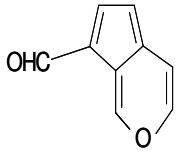
12. Lapachol



14. Sitosterol



13. Kigelin



15. Norviburtinal

Figure 2. Other compounds found in kigelia pinnata.

the presence of vermonosides 8 (Picerno et al., 2005). Further investigation of the fruits yielded a new phenylpropanoid derivative identified as 6-p-coumaroyl-sucrose together with other known phenylpropanoid deri-vatives and flavonoid glycoside (Gouda et al ., 2006). Four naphthaquinoids from *k. pinnata* rootbark were identified and assessed *in vitro* against chloroquine-sensitive (T9-96) and resistant (K1) plasmodium falciparium strains for cytotoxicity using KB cells. 2-(-hydroxyethyl) naphtho[2,3-b]furan-4,9-dione posed good activity against two strains. Isopinnatal, kigelinol 4 and isokigelinol 5 exhibited lower activity agains the strains (Weiss et al, 2000). Naphthaquinones; 2-(1-hydroxy ethyl)-naphtho[2,3-b]furan-4,9-quinone 6, isopinnatal, kigelinol and isokigelinol were isolated from the dichloromethane extracts of the root bark and stem bark. It shows antitrypanosomal activity (Moideen et al., 1999). 3b,19a -dihydroxyurs -12-ene-28oic acid, caffeic acid and chlorgenic were isolated from the fruits and 3b, 19a -dihydroxyurs -12-ene-28-oic acid, ferulic acid and p-coumaric acid have been isolated from the root of *k. pinnata* (Binutu et al., 1997).

Three known iridoids: specioside 7, verminoside 8 and minecoside 9 (Figure 1) were isolated, characterized and identified using UV, IR, and H-NMR Speetroscopic datas. The verminoside was found to be more active than the standard drug, while specioside shows activities comparable to metronidazole 10 (Neelam, 2006). Steriod, iridiods and coumarins have been isolated from the root bark (Akunyili and Houghton, 1993) and flavonoids and iridiods from the fruit and leaves (Guoda et al., 2003).

Dichloromethane extracts from the root and stembark of *k. pinnata* contains naphthaquinones (Jackson et al., 2000) which showed anti-trypanosomal (Moideen et al., 1999). Kiglin and 6-methoxymellein together with two known compounds, stigmasterol 11 and lapachol 12 have been isolated from the root (Govindachari et al., 1971), kigelin 13, β-sitosterol 14, 1,3-dimethylkigelin and ferulic acid were isolated from the bark (Desai et al., 1971), two non-quinonoid aldehydes, norviburtinal 15 and pinnatal were obtained from the root bark by Joshi et al., 1982). 7-O-glucoside were isolated from the leaves and fruits, three isocoumarins 6-methoxymellein, kigelin, 6-demethylkigelin from the roots, lignan kigeliol from wood and neoligan balanophonin was isolated from the stembark (Houghton, 2007). Sitosterol is isolated from *k. pinnata* fruit (Khan, 1998).

Conclusion

K. africana (Lam) Benth, a native of Africa is well known traditionally for varieties of medicinal purposes where it grows. This review confirms the therapeutic values of *K. africana*. It is well reported for the presence of naphthoquinones, fatty acids, Courmarins, iridoids, caffeic acid, norviburtinal, sterols and flavonoids. The plants is used traditionally for treating cancer of the breast, uterus and skin, digestive disorder, genitor-urinary tract, veneral diseases, gynaecological disorder, bladder ailments, sickle-cell anaemia, epilepsy, nutritional illness, leg oedemas, internal parasitic infestations (especially tapeworm), leprosy, rheumatism, boil, acne, cysts, whitlows, psoriasis

etc. There are inadequate reports on the phytochemical studies, phytoanalytical studies and pharmacological screening of the plant. Furthermore, explicit isolation of each chemical constituent using various methods including thin layer chromatography, column chromatography should be carried out. There is enormous scope for the future research of *K. africana* considering the many medicinal purposes it serves. It has a high potential for development into viable drugs as more facts emanates from its uses, especially as a strong anti-cancer agent. It is therefore recommended that more research work should focus on the anti-cancer properties. Studies should also be focused on its sustainability and its use as effective erosion control and riverbank stabilization in order to prevent its extinction. It has been reported that the plant extract is not toxic even at high concentration, but more work needed to be reported on its toxicity. Reports on the *in vivo* work done are scanty and require urgent attention. It is hoped that this report will serve as a basis of information for future project to be embark on in order to evaluate the potentials of *K. pinnata* (Lam) Benth as a strong medicinal plant in improving human health status.

REFERENCES

Aburjai T, Darwish M, Alkhalil S, Mahafzah A, AlAbbadi A (2001). Screening of antibiotic resistance inhibitors from local plant materials against two different strains of Pseudomonas aeruginosa. J. Ethnopharmacol. 76: 39-44.

Aiyelola AA, Bello OA (2006). Ethnobotanical potentials of common herbs in Nigeria: a case study of Enugu state. Educ. Res. Rev. 1(1): 16-22.

Akah PA (1996). Antidiarrhoeal activity of the aqueous leaf extract of kigelia africana experimental animal. J. Herbs Spices Med. Plants 4(2): 31-38.

Akunyili D, Houghton P (1993). Monoterpenoids and naphthaquinone from kigelia pinnata phytochemistry 32: 1015-1018.

Akunyili DN, Houghton PJ, Roman A (1991). Antimicrobial activities of the stem of kigelia pinnata, J. Ethnopharmacol. 35: 173-177.

Binutu OA, Adesogan K, Okogun JI (1997). Constituents of kigelia pinnata, Nig. J. Nat. Prod. Med. 1-68.

Burkill HM (1985). The useful plants of west Tropical Africa (use P.I WT Afr.) 1: 254-257.

Carey MW, Babud MJ, Rao VN, Mohan KG (2008). Anti-inflamatory activity of the fruit of kigelia pinnata DC. Pharmacol. Online J. 2: 234-245.

Carvalho LH, Rocha EMM, Raslan DS, Oliveira AB, Krettli AU (1988). *In Vitro* activity of natural and synthetic naphthoquinones against erythrocytic stages of the plasmodium falciparum. Braz. J. Med. Biol. Res. 21: 485-487.

Chariandy CM, Seaforth CE, Phelps RH, Pollard GV, Khambay BP (1999). Screening of medicinal Plants from Trinidad and Tobago for antimicrobial and insecticidal properties. J. Ethnopharmacol. 64: 265-270.

Coates-Palgrave K (1988). Trees of Southern Africa, edn. 2. Struik, Cape Town.

Cragg GM, Newman DJ, Sander KM (1997). Natural Products in Drug Discovery and Development. J. Nat. prod. 60: 52-60.

Del Hoyo J, Elliot A, Sargatal J eds. (1997). Handbook of the birds of the world, 4-415. Lynx Editions.

Desai HK, Gawad DH, Govindachari TR, Joshi BS, Kamat AN, Modi JD, Pathasarahy PC, Patanker SJ, Sidhye AR, Viswanathan N (1971). Convergent synthesis of Naphthylisoquinoline Alkaloids. Ind. J. Chem. 9-611.

Gill LS (1992). Ethomedical uses of plants in Nigeria. Uniben Press, Benin city p. 143.

Gouda YG, Abdel-Baky AM, Darwish FM, Mohamed KM, Kasai R, Yamasaky K (2006), Phenylpropanoid and phenylethanoid derivatives from Kigelia pinnata D.C. fruits. Nat. Prod. Res. 20(10); 935-9.

Govindachari TR, Patankar SJ, Vishvanathan N (1971). Phytochemistry 10-1603.

Grace OM, Davis SD (2002). Kigelia Africana (Lam.) Benth. Record from protabase. Oyen LPA, Lemmens RHMJ Wageningen, Netherlands. Inmagic DB/Text Webpublisher PRO: 1 records (http://database.prota.org/search.htm).

Grace OM, Light ME, Lindsey KL, Moholland DA, Staden JV, Jager AK (2002). Antibacterial activity and isolation of antibacterial compouds from fruit of the traditional African Medicinal plant, Kigelia africana. S. Afr. J. Bot. 68: 220-222.

Graham JG, Quinn ML, Fabricant DS, Farnsworth NR (2000). Plants used against cancer – an extension of the work of Jonathan Hartwell. J. Ethnopharmacol. (Elsevier) 73: 347-377.

Houghton PJ (2007). The sausage tree (Kigelia pannata), Ethnobotany and recent Scientific work. 2007, Afr. Botanicals 1-10.

Houghton PJ Photiou A, Uddin S, Shah P, Browning M, Jackson SJ, Retsas S (1994). Activity of extreets of kigelia pinnata against melanoma and renal carcinoma cell lines. Planta medica. 60(5): 430-433.

Hutching A, Scott AH, Lewis G, Cunningham AB (1996). Zulu medicinal plants. An inventory University of Natal press, pietermaritzburg pp. 53-54.

Jackson NJ, Houghton PJ, Retsas S, Photion A (2000). Planta Med. 06-758.

Jeyachandran R, Mahesh A (2007). Antimicrobial Evaluation of Kigelia Africana (Lam), Res. J. Microbiol. 8: 645-649.

Joffe P (2003). Kigelia Africana (Lam) Benth. Pretoria National Botanical Garden (www.plantzafrica.com).

Joshi K, Singh P, Taneja S, Cox PJ, Howie RA (1982). Phytochem. 21-2703.

Kan A (2006). Pharmacognasy and pharma Biotecnology. New Age International Ltd., New Delhi, 5-11.

Kela SL, Ogunsusi RA, Ogbogu N, Nwude VC (1989). Screening of some Nigerian plants for molluscidal activity. Revue. Elev. Med. Vet. Pays Trop. 42: 20-195.

Khan MR (1998). Cytotoxity assay of some Bignoniaceae. Fitoterapia, 69: 538-40.

Khan MR, Kihara M, Omoloso A (2003). Antimicrobial activity of the alkaloaidal constituents of the root bark of Eupamatia Laurina. Pharm. Biol. 41: 277-280.

Kolodziej H (1997). Protective role of kigelia Africana fruits against benzo (a) pyrene induced fore-stomach tumorigenesis in mice and against albumen induced inflammation in rats. Pharmacol. Lett. 213: 67-70.

Lal SD, Yadar BK (1983). Folk Medicines of Kurukshetra district (Haryana), India Econ. Bot. 37: 299-305.

Louw CAM, Reigner TJC, Korsten L (2002). Medicinal bulbous plants of South Africa and their traditional relevance in the control of infectious diseases. J. Ethanopharmacol. 82: 147-154.

Moideen SVK, Houghton PJ, Rock P, Croft SL, Aboagye-Nyame F (1999). Activity of extracts and naphthoquinones from kigelia pinnata against *Trypanosoma brucei brucei* and *Trypanosoma brucei rhodesiense*. Planta med. 65(6): 536-40.

Msouthi JD, Mangombo D (1983). Medicinal herbs in Malawi and their uses. Hamdard 26: 94-100.

Mukherjee P (2002). Quality Control of Herbal Drugs. Eastern Publishers (Business Horizons Ltd.) New Delhi, 816 pages, ISBN 81-900788-4-4.

Neelam B, Shailendra S, Fehmida N, Amir A (2006). Isolation and *in vitro* anti amoebic activity of iridoids isolated from Kigelia pinnata. General papers. ARKIVOC (x) 69-76.

New HC (1992). The crisis in antibiotic Resistance Science, 86: 882-894.

Olaive MT, Rocha JB (2007). Commonly used tropical medicinal plants exibit distinct *in vitro* antioxidant activities against hepatotoxins in rat liver. Exp. Toxical. pathol. 58(6): 433-8.

Owolabi OJ, Amaechina FC, Eledan AB (2008). Central nervous system Stimulant effect of the ethanolic extract of kigrlia Afr. J. Med. Plant

Res. 2(2): 20-23.
Owolabi OJ, Omogbai EK (2007). Analgesic and anti-inflammatory activities of ethanolic stembark extract of kigelia Africana (Bignoniacea). Afr. J. Biotechnol. 6(5): 582-585.
Owolabi OJ, Omogbai KI, Obasuyi (2007). Antifungal and antibacterial activities of the ethanolic and aqueous extract of kigelia africana (Bignoniaceae) Stembark. Afr. J. Biotechnol. 6(15): 1677-1680.
Picerno P, Autore G, Marzocco S, Meloni M, Sanogo R, Aquino RP (2005). Anti-inflammatory activity of verminoside from kigelia Africana and evaluation of cutaneous irritation in cell cultures and reconstituted human epidermis. J. Nat. Prod. 68(11): 1610-4.
Prakash AO, Saxena V, Shukla S, Tewari RK, Mathur S. Gupta A, Sharma S, Mathur R (1985). Anti-implantation activity of some indigenous plants in rats. ACTA Europaea Fertilitatis 16: 441-448.
Roodt V (1992). Kigelia Africana in the shell Field Guide to the common Trees of the Okarango Delta and Moremi Game reserve. Gaborone, Botswana; shell Oil Botswana.LCCN: 9398015, LC: QK402.B6 R66 1992, Dewels: 582.1609883: 20-110.
Rukangira E (2001). The Africa herbal industry: constraints and challenges. Conserve Afr. Int. p. 1-23.
Sparg SG, Van SJ, Jager AK (2000). Efficiency of traditionally used South African Plants against Schistosomiasis. J. Ethnopharmacol. 73: 209-214.
Weenen H, Nkunya MHH, Bray DH, Mwasumbi LB, Kinabo LS, Kilimali VAEB (1990). Antimalaria activity of Tanzanian medicinal plants. Planta Medica 56: 368-370.
Weiss CR, Moideen SV, Houghton PJ (2000). Activity of extacts and isolated naphthoquinones from kigelia pinnata against *plasmodium falsiparium*. J. Nat. Prod. 63(9): 1306-9.
Wilson ME (1995). Infectious diseases: an ecological perspective. Br. Med. J. 311: 1681-1684.