

PARKIA BIGLOBOSA (AFRICAN LOCUST BEAN TREE)**Modupe Iretiola Builders***Department of Pharmacology and Therapeutics, College of Health Sciences, Bingham
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2014***Correspondence for****Author****Dr. Modupe Iretiola
Builders,**Department of Pharmacology
and Therapeutics, College of
Health Sciences, Bingham
University, Jos, Nigeria.**ABSTRACT**

P. biglobosa (Jacq.) R.Br. ex G. Don (family fabaceae) popularly called the African locust bean tree have been used traditionally as food and medicine and are of high commercial value in the West African region. The plant is reported to contain carbohydrates, proteins, fats, minerals, vitamins, tannins and flavonoids. *P. biglobosa* possesses antimalarial, antihelminthic, antibacterial, antivenom, antidiabetic, and antihypertensive and antioxidant properties. The article covers its phytochemical and pharmacological properties.

Key words: *Parkia biglobosa*, African locust bean tree, Phytochemistry, Pharmacology, Toxicity.

INTRODUCTION

Parkia biglobosa tree is deciduous with a very broad crown that may reach a height of 20 m. The species grows under a wide range of conditions, where annual rainfall ranges from 600 to 1500 mm and the dry season lasts 5–7 months. It occurs in natural and semi-natural habitats such as savannahs and woodlands, sometimes on rocky slopes, stony ridges and sandstone hills. It is able to withstand drought because of its deep taproot. Together with the shea butter tree (*Vitellaria paradoxa*), African locust bean is one of the main components of agroforestry parklands in West Africa. ^[1]

Parkia biglobosa belongs to the genus *Parkia* which belongs to the tribe Parkieae. It consists of about 35 species with a pantropical distribution but there are five well recognized species besides African locust bean: *P. filicoidea*, *P. bicolor*, *P. roxburghii*, *P. biglandulosa* and *P. madagascariensis*. ^[2]

Geographical Distribution

P. biglobosa has a wide distribution across the Sudan and Guinea savanna ecological zones. The range extends from the western coast of Africa in Senegal across to Sudan. *P. biglobosa* is found in nineteen African countries: Senegal, Gambia, Guinea Bissau, Guinea, Sierra Leone, Mali, Côte d'Ivoire, Burkina Faso, Ghana, Togo, Benin, Niger, Nigeria, Cameroon, Chad, Central African Republic, Zaire, Sudan, and Uganda .^[3] In Nigeria, *P. biglobosa* is found everywhere.^[4]



Fig. 1: Distribution range of *P. biglobosa* ^[3]

Botanical Description

P. biglobosa belongs to the family Fabaceae ^[5,6] It is a perennial deciduous tree occurring in a belt between 5° N and 15° N 7 to 20 m tall, and in some cases it can reach up to 30 m. The fruit is a slightly curved, brown indehiscent pod, 30 to 40 cm long and 2 to 3 cm wide producing up to 20 seeds . ^[2] *P. biglobosa* seeds number 5 - 20 per pod. The individual brown, smooth seeds are oval, 0.9 –1.5 cm long by 0.8 – 1.1 cm wide and weigh 0.25 grams each. Each seed consists of 30% testa and 70% green cotyledons. ^[7] The seeds constitute 22% of the fruit, while the pod case is 42% and the pulp is 36% . ^[7] Taproot often present, lateral roots up to 10–20 m spreading from bole; bole usually straight and robust, cylindrical, up to 130 cm in diameter, often branching low. ^[1] Barks are distinctly longitudinally fissured, often with more or less regular scales between the fissures, thick, ash-grey to greyish-brown, slash fibrous and reddish-brown, exuding an amber gum; crown dense, wide spreading and umbrella-shaped, consisting of heavy branches. ^[8] Leaves are alternate, dark green and

bipinnate (doubly compound). They are up to 30 cm long and consist of up to 17 pairs of pinnae, with 13–60 pairs of leaflets on each .^[1]

Traditional Uses

The traditional uses for *P. biglobosa* can be defined as non timber forest products (NTFP), which include wood energy (fuel wood and charcoal) and all other tangible products other than timber.^[9] Non-timber forest products derived from *P. biglobosa* are food, medicine, animal fodder, soil amendments, charcoal, and firewood. The most significant product from *P. biglobosa* is food. The food products collected from *P. biglobosa* are especially important due to the seasonality of fruit maturation and food availability. The seeds are used in preparation of dawadawa, a protein and fat rich food. The yellow starchy pulp that surrounds the seed is an important food supplement rich in Vitamin C and carbohydrates. The dried powder is often mixed with water to produce a drink called dozim.^[1,4]

Table 1: Uses of different parts of *P. biglobosa*^[1]

Uses	Parts of plant
Food	Flowers, fruits , pods, pulp, seed
Fodder	Fruits, leaves
Fuel wood or wood production	Branches, stems
Soil production	Whole tree
Medicines	Flowers, fruits, leaves, barks, roots

Medicinal Uses

Several authors have reported on the medicinal uses and treatments summarized in Table 1^[3,4, 10-15]

Table 2: Medicinal uses of *P. biglobosa*

Parts	Vernacular name	Preparation	Medicinal uses	Country
Stem bark	<i>Dorowa, nèrè, dona (Bariba)</i>	Decoction, powder	Malaria, wounds, dysentery, rheumatism, headache, cough, pain, fungal infection, tonic, anti-diarrhoea, female sterility, skin infection, leprosy, blennorrhoea, <i>Schistosoma</i> infection , sores, ulcers, mumps, enema, antiemetic, severe colic and snake bites.	Nigeria. Senegal, Ivory coast, Burkina Faso, Mali.

Leaves	Iru, nèrè	Decoction, poultices	Malaria, pain, diabetes, palpitation eye lotion, toothache, burns, fever, hemorrhoids, constipation, anorexia, bronchitis, whooping cough, amenorrhoea, snake bites.	Nigeria, Senegal, Niger, Gambia, Mali, Togo, Burkina Faso.
Fruits	<i>Dowa (lobi, wale)</i>	Maceration	Skin eruption, abscess, stomach ache, yellow fever, conjunctivitis, snake bites.	Ghana, Benin, Mali.
Pulp	<i>Nere (Malinke)neri</i>		Sedative, diuretic, purgative, Malaria	Guinea Conakry.
Seeds	<i>Irugba, dorowa, orgiri</i>		Tension, wounds, mouth ulcers, wasp, bee sting.	Nigeria Mali.
Pods	<i>Dòó (Dagomba), porgu, yulo</i>	Pounded with salt, fermented	Stomach ache.	Ghana.
Roots		Decoction	Bronchitis, pneumonia, dysentery, diarrhoea.	Senegal.

Phytochemistry

The stem bark is reported to contain flavonoids, tannins, terpenes, saponins, sterols, phenols and reducing sugars. ^[16, 17] elemental analysis showed the presence of magnesium, calcium, iron, zinc, potassium, sodium and copper ^[16]. Leaf of African locust bean tree contains flavonoids, tannins, saponins, cardiac glycosides, alkaloids and reducing sugars. ^[18-20]. Long-chain ester of trans-ferulic acid, a mixture of long-chain cis-ferulates and different kinds of catechins (catechins and ferulates) were identified in the stem bark of *P.biglobosa*. ^[21]

Phytochemical results indicated that the root bark of the plant contained a lot of glycosides and tannins, appreciable amounts of saponins and traces of alkaloids. ^[17] Also saponins, carbohydrates, tannins and flavonoids were detected in the root of *P.biglobosa*. ^[17]

The chemical composition of the African plant *Parkia biglobosa* (Fabaceae) roots and barks by Liquid Chromatography - Electrospray Ionization and Direct Injection Tandem Mass Spectrometry analysis was also investigated. ^[22] Mass spectral data indicated that B-type oligomers are present, namely procyanidins and prodelphinidins, with their gallate and glucuronide derivatives, some of them in different isomeric forms.

The yellowish fruit pulp is very rich in carbohydrate (60%), 10-20% of which is sucrose, 291mg Vitamin C. ^[23] The seeds contain 35% proteins, 29% lipids, 16% carbohydrates, calcium and have good organoleptic properties. ^[7] A non-toxic oil of variable composition is also present. Some sources indicate arachidic acid as the most abundant fatty acid, accompanied by behenic, stearic, palmitic and linoleic acids. ^[1, 7, 24] The proximate analysis of the nutritive contents of *P.biglobosa* seeds indicated the presence of high amount of lipid, crude protein, pureprotein, carbohydrates, total soluble sugar and starch. ^[5]

Pharmacology

Antiplasmodial and antipyretic activity

The antiplasmodial activities of the methanol extract and methanol fraction of the stem bark of African locust bean tree were evaluated against malaria model *Plasmodium berghei berghei* and clinical isolates of *Plasmodium falciparum*. The crude extract and methanol fraction exhibited dose dependent reduction of parasitaemia at the different doses administered. Methanol fraction showed higher reduction of parasitaemia. ^[16] Antipyretic properties of the crude extract and methanol fractions were studied; reduction in yeast-induced hyperpyrexia was produced by the extract and the fractions. The methanol fraction exhibited a significant reduction in yeast induced elevated temperature. ^[16]

The antiplasmodial activity of the leaves of *P. biglobosa* was evaluated *in vivo* and *in vitro* against *Plasmodium berghei berghei* and clinical isolates of *Plasmodium falciparum* respectively. There was a dose dependent inhibition of parasitaemia in the *in vivo* antiplasmodial tests. The *in vitro* screening demonstrated a weak and concentration-dependent activity of the extract against *P. falciparum*. ^[18]

Analgesic and anti-inflammatory activity

The hexane extract from the bark of *P. biglobosa* had some analgesic and anti-inflammatory effects. ^[25] Intraperitoneal administration of the methanolic extracts of *P.biglobosa* stalk significantly antagonized the formation of croton pellet granuloma in a dose-dependent manner. The extract also showed a dose-dependent inhibition of the croton oil ear inflammation in test animals, there was also appreciable inhibition of carrageenin-induced rat paw oedema compared with controls. The extracts of *P.biglobosa* further inhibited the arachidonic acid induced paw oedema in a dose-dependent manner comparable to the dual-blocker, phenidone. Thus, suggesting that the observed anti-inflammatory activities may be

produced by the inhibition of the lipo-oxygenase pathways, the cyclooxygenase pathways or both which are involved in metabolism of arachidonic acid .^[26]

Antisnake venom

A water-methanol extract of *P. biglobosa* stem bark had been shown to possess antisnake venom activity. This extract also reduced the loss of responses to acetylcholine (Ach), carbachol and KCl, which are normally blocked by *N. nigricollis* venom, and significantly reduced the contractures of the preparation induced by venom.^[27]

Anti-diarrhoeal

Research showed that *P. biglobosa* had anti-diarrhoeal properties in mice.^[28] Anti-diarrhoeal activities of the aqueous stem bark extract of *P. biglobosa* and its fractions designated PF1-PF4 investigated in mice indicated that the extract and its column chromatographic fraction F3 significantly ($p < 0.05$) and dose-dependently reduced frequency of stooling in castor-oil-induced diarrhoea, castor-oil-induced intestinal fluid accumulation and intestinal transit .^[29]

Anti-bacterial

The anti bacterial activity of the stem bark and leaves of *P. biglobosa* has been conducted on four strains of *Staphylococcus aureus* isolated from patients in the National Hospital Yalgado Ouagadougou, Burkina Faso.^[30] Also Antibacterial evaluation of the methanolic extract and aqueous fractions of the leaf, stem bark and root of the African locust bean tree, *Parkia biglobosa* was carried out using the agar- well diffusion method. The extracts and their fractions were tested against two gram positive organisms – *Staphylococcus aureus* and *Bacillus subtilis* and two gram negative organisms–*Escherichia coli* and *Pseudomonas aeruginosa*. Results obtained confirmed a broad spectrum of activity as all the organisms used were inhibited by the extracts and their aqueous fractions.^[31]

Anti-microbial

Ethanollic extract of the *P. biglobosa* exhibited antimicrobial activities against the multi-drug resistant isolates.^[32] The antimicrobial screening of the leaves *P. biglobosa* was done using standard strains of microorganisms. The extracts exhibited a concentration dependent antibacterial, inhibiting the growth of the gram – positive bacteria used in the study.^[20] Anti-microbial activities of the aqueous stem bark extract of *P. biglobosa* and its fractions designated PF1-PF4 were investigated in against selected diarrhoea-causing micro-

organisms, the crude extract as well as fractions F3 and F4 strongly inhibited growth of selected microorganisms .^[29]

Antioxidant

Antioxidant activities of the leaves and stem barks were determined by the means of 1, 1-diphenyl-2-picrylhydrazyl (DPPH) assay.^[33] The result of the antioxidant activities of the methanol extract and methanol fraction indicated that the sensitivity of the antioxidant activity of the methanol fraction is higher than that of crude un-fractionated methanol extract.^[16] Study on the antioxidant properties of the stem bark of *P.biglobosa* showed that the radical- scavenging potential of *P.biglobosa* was dose-dependent; this activity was higher than that of standards (rutin, ascorbic acid, butylated hydro-anisole (BHA) and alpha-tocopherol).^[20] The stalk of *P.biglobosa* also showed *in vitro* anti-oxidant activities using the DPPH.^[26]

Anti-diabetic

The hypoglycaemic effect of fermented seeds of *Parkia biglobosa*, a natural nutritional condiment that features frequently in some African diets as a spice, was investigated in alloxan-induced diabetic rats.^[34]

Hypotension

An alcoholic extract of crude seeds of *P.biglobosa* showed anti-hypertensive activity and contractile effect on smooth muscles of the intestine, and increased the tonus and mobility of the uterus. Ichthyotoxic and molluscicidal activities have been recorded for the seeds due to the presence of saponins.^[35]

Hypolipidemia

The hypolipidemic effect and the improvement in serum lipid profile of triton-induced hyperlipidemic rats by *Parkia biglobosa* saponins were investigated. The result indicated that *P. biglobosa*-mediated therapeutic effects may be associated with its hypolipidemic components.^[36]

The cardioprotective effect of *P. biglobosa* stem bark used on isoproterenol (ISO) induced myocardial infarction in rats was evaluated. *P. biglobosa* ameliorated positively biochemical alterations, prevented oxidative stress and histological and morphological changes induced by isoproterenol.^[37]

Toxicity

The acute and sub acute toxicity profile of the water and alcohol extracts of the stem bark of *P. biglobosa* was investigated. The result of this study showed that the lethal dose (LD₅₀) was greater than 5000mg/kg per oral (p.o) for both extracts and the toxicity characteristics of the methanol and water extracts of the stem bark *P. biglobosa* in short time treatment with the extracts .^[38]

The result of acute toxicity study of the stem, leaf and root of *P. biglobosa* indicated that LD₅₀ fell within the range of 500 – 5000 mg/kg body weight confirming them to be only slightly toxic and hence not potentially dangerous .^[39] The toxicity of aqueous and ethanolic extracts of *Parkia biglobosa* pods on *Clarias gariepinus* was investigated. It was concluded that aqueous and ethanol extracts of *P. biglobosa* pods are toxic to *C. gariepinus* juveniles with the ethanol extract being more toxic, which shows that apart from the bark of *P. biglobosa*, the pods has piscicidal property and can be put into use in the control and management of fish ponds to eradicate predators by farmers.^[39,40]

REFERENCES

1. Shao M . *Parkia biglobosa*. Changes in resources allocated in Kandiga, Ghana. Master Thesis, Michigan Technologist University, United state of American, 2002.
2. Keay RWJ. Trees of Nigeria. Oxford University Press, New York: 1989, p.476.
3. Hall JB, Tomlinson HF, Oni PI, Buchy M, Aebischer DP .*Parkia biglobosa*: a monograph. Bangor, United Kingdom: School of Agricultural and Forest Sciences Publication No 9, University of Wales: 1997, p.107.
4. Abbiw DK. Useful Plants of Ghana. Intermediate Technology Publications and the Royal Botanic Gardens, Kew, UK, Britain: 1990, p.337.
5. Alabi DA, Akinsulire OR, Sanyaolu MA. Qualitative determination of chemical and nutritional composition of *Parkia biglobosa* (Jacq.) Afri J Biotechnol, 2005; 4 (8): 812-815.
6. Don G. Seed leaflet. *Parkia biglobosa* (Jack.). A tree species reference and selection guide, 2007; 1-4.
7. Campbell-Platt G. African Locust Bean (*Parkia* Species) and Its West African fermented food product, Dawadawa. Ecology of Food and Nutrition, 1980; 9: 123-132.
8. Burkill HN. (1995). The useful plants of West Africa, 2nd ed., Great Britain; White friar Press Ltd, 1995, pp.501-857.

9. Chandrasekharan C. Issues involved in the sustainable development of non-wood forest products. Paper prepared for the expert consultation on non-wood forest products for English-speaking African countries. Arusha, Tanzania, 1993.
10. Asase A, Alfred A, Yeboah O, Odamtten GT, Simmonds M J. Ethnobotanical study of some Ghanaian antimalarial plants. *Journal of Ethnopharmacology*, 2005; 99 (2):273-279.
11. Abo K A, Fred-Jaiyesimi AA, Jaiyessimi AE. (2008). Ethnobotanical studies of medicinal plants used in the management of *diabetes mellitus* in South Western Nigeria. *Journal of Ethnopharmacology*, 2008; 115: 67- 71.
12. Gronhaug TE, Glaesrud S, Skogsrud M, Ngolo B, Bah S, Diallo D, Paulsen BS. Ethnopharmacological survey of six medicinal plants from Mali, West Africa. *Journal of Ethnobiology and Ethnomedicine*, 2008; 4(26): 1746-1842.
13. Inngjerdingen KC, Nergard D, Diallo PP, Mounkoro BS. An ethnopharmacological survey of plants used for wound healing in Dogonland, Mali, West Africa. *Journal of Ethnopharmacology*, 2004; 92: 233 - 244.
14. Kayode J, Ige OE, Adetogo TA, Igbakin A. Conservation and Biodiversity Erosion in Ondo State, Nigeria: Survey of Plant Barks Used in Native Pharmaceutical Extraction in Akoko Region. *Ethnobotanical Leaflets*, 2009; 13: 665-67.
15. Tapsoba H, Deschamps JP. Use of medicinal plants for the treatment of oral diseases in Burkina Faso. *Journal of Ethnopharmacology*, 2006; 104:.68 – 78.
16. Builders MI, Tarfa F, Aguiyi JC. The potency of African locust bean tree as an antimalarial. *Journal of Pharmacology and Toxicology*, 2012; 7: 274-287.
17. Udobi CE, Onaolapo JA . Phytochemical analysis and antibacterial evaluation of the leaf stem bark and root of the African locust bean(*Parkia biglobosa*). *Journal of Medicinal Plants Research* , 2009; 3(5): 338-344.
18. Builders M, Wannang N, Aguiyi J. . Antiplasmodial activities of *Parkia biglobosa* leaves: *In vivo* and *In vitro* studies. *Annals of Biological Research*, 2011; 2 (4): 8-20
19. Adaramola TF, Ariwaodo JO, Adeniji KA. Distribution, phytochemistry and antioxidant properties of the Genus *Parkia* R.br. (Mimosaceae) in Nigeria. *International Journal of Pharmacognosy and Phytochemical Research*, 2012; 4(4): 172-178.
20. Ajaiyeoba EO. Phytochemical and antibacterial properties of *P.biglobosa* and *P.bicolor* leaf extract. *African Journal of Biomedicine Research* , 2002; 5:125-129.
21. Tringali C, Sparafora C, Longo, OD. Bioactive constituents of the bark of *Parkia biglobosa*. *Fitoterapia*, 2000; 71: 118-125.

22. Tala RS, Silva, CV, Rodrigues MC, Nkengfack AE, Santos LC, Vilegas W . Characterization of proanthocyanidins from *Parkia biglobosa* (Jacq.) G. Don. (Fabaceae) by flow injection analysis electrospray ionization ion trap tandem mass spectrometry and liquid chromatography/electrospray ionization mass spectrometry. *Molecules*, 2013; 18: 2803- 2820.
23. Bello MO, Falade OS, Adewusi RA, Olawore NO. Studies on the chemical composition and anti nutrient of some lesser known Nigeria fruits. *African Journal of Biotechnology*, 2008; 7(21): 3972-3979.
24. Elemo GN, Elemo BA, Oladunmoye OO, Ochuko LE. (2011). Comprehensive investigation into the nutritional composition of dehulled and defatted African locust bean seed (*Parkia biglobosa*). *African Journal of Plant Science*, 2011; 5: 291-295.
25. Kouadio F, Kanko C, Juge M, Grimaud N, Jean A, N.'Guessan YT, Petit JY. Analgesic and antiinflammatory activities of an extract from *Parkia biglobosa* used in traditional medicine in the Ivory Coast. *Phytotherapy Research*, 2000; 14: 635-637.
26. Nwaehujor CO, Ezeigbo I, Udeh NE, Ezeja MI, Asuzu IU. Anti-inflammatory and anti-oxidant activities of the methanolic extracts of the stalk of *Parkia biglobosa* (jacq.) Benth. *Hygeia Journal for Drugs and Medicine*, 2011; .3 (1): 34-40.
27. Asuzu IU, Harvey AL. The antisnake venom activities of *Parkia biglobosa* (Mimosaceae) stem bark extract. *Toxicon*, 2003; 42 (7): 763-768.
28. Agunu A, Yusuf S, Andrew Gabriel O, Zezi Abdulkadir U, Abdurahman EM. Evaluation of five medicinal plants used in diarrhoea treatment in Nigeria. *Journal of Ethnopharmacology*, 2001; 101 (1-3): 27-30.
29. Tijani AY, Okhale SE, Salawu TA, Onigbanjo HO, Obianodo LA, Akingbasote, JA, Salawu, OA, Okogun JE, Kunle FO, Emeje M. Anti-diarrhoeal and antibacterial properties of crude aqueous stem bark extract and fractions of *P. biglobosa* (Jacq) R.Br Ex G. Don. *African. Journal of Pharmacy and Pharmacology*, 2009; 7: 347-353.
30. Millogo-Kone H, Guissou IP, Nacouloma O, Traore AS. Study of antibacterial activity of the stem bark and leaf extract of *P. biglobosa*.(Jacq) Benth on *Staphylococcus aureus*. *African Journal of Traditional, Complementary and Alternative Medicine*, 2006 ; 3 (1): 74-78.
31. Udobi CE, Onaolapo JA . Cell kill pattern and acute toxicity studies of the aqueous fraction of the methanolic extract of parts of *Parkia biglobosa* . *African Journal of Biotechnology* , 2010; 8 (31), 4993-4998.

32. Adebayo – Tayo BC, Adegoke AA. Phytochemical and microbial screening of herbal remedies in Akwa Ibom State, South Southern Nigeria. *Journal of Medicinal Plant Research*, 2008; 2 (11): 306- 310.
33. Millogo-kone H, Lompo M, Kini F, Asimi S, Guissou IP, Naucoulma O. Evaluation of flavonoids and total phenolics content of stem bark and leaves of *P.biglobosa* (Jacq) Benth (Mimosaceae)-free radical scavenging and antimicrobial activities. *Phytotherapy Research*, 2009; 8: 635-642.
34. Odetola AA, Akinloye O, Egunfobi C, Adekunle WA, Ayoola OA. Possible antidiabetic and antihyperlipidemia effect of fermented *Parkia biglobosa* (Jacq) extract in alloxan induced diabetic rats. *Journal of Clinical and Experimental Pharmacology and Phytotherapy*, 2006; 9: 808 – 812.
35. Sina S, Traoré SA. *Parkia biglobosa* (Jacq.) R.Br. ex G.Don. Record from Protabase. Oyen, L.P.A. & Lemmens, R.H.M.J. (Editors). PROTA (Plant Resources of Tropical Africa/Ressources végétales de l’Afrique tropicale), Wageningen, the Netherlands. [http://database.prota.org/PROTAhtml/Parkia%20biglobosa_En.htm], 2002; [Accessed 15th February 2012].
36. Komolafe K, Olaleye MT, Fasan TI, Elekofehinti OO, Saliu JA, Akindahunsi AA . Lipid-Lowering Effect of *Parkia Biglobosa* Leaf Saponins in Triton-X 1339-Induced Hyperlipidemic Rats. *Research Journal of Pharmaceutical, Biological and Chemical Sciences*, 2013; 4(1); 576.
37. Adi K, Metowogo K, Mouzou A, Lawson-Evi P, Eklugadegbeku K, Agbonon A, Lamboni C, Essien K , Aklikokou K, Gbeassor M. Evaluation of cardioprotective effects of *Parkia biglobosa* (Jacq. Benth) Mimosaceae stem bark. *Journal of Applied Pharmaceutical Science* , 2013; 3 (02): 060-064.
38. Builders MI, Isichie CO, Aguiyi JC. Toxicity Studies of the Extracts of *Parkiabiglobosa* Stem Bark in Rats. *British Journal of Pharmaceutical Research* , 2012; 2(1): 1-16.
39. Abalaka SE, Auta J. Toxicity of aqueous and ethanol extract of *Parkia biglobosa* pods on *Clarias gariepinus* juveniles. *Journal of animal and veterinary advances* , 2010; 9 (6): 1068-1072.
40. Ojutiku RO, Avbarefe EP, Kolo RJ, Asuwaju FP. Toxicity of *Parkia biglobosa* pod extract on *Clarias gariepinus* juveniles. *International Journal of Fisheries and Aquaculture* , 2012; 4(7): 133-138.