REVIEW ARTICLE

A systematic review of domestication, ethnopharmacological use, phytochemistry, nutritional composition, and biological activities of *Parkia biglobosa* (Jacq.) R.Br. ex G.Don

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ABSTRACT

Medicinal plants are an unceasing source of herbal medicine from which many molecules are being isolated for the treatment of various diseases. *Parkia biglobosa* (family; Mimosaceae), commonly known as African locust bean is an economically vivacious plant of tropical and subtropical regions, cultivated in many countries across the world. *Parkia biglobosa* contains a broad spectrum of phytochemicals, including polysaccharides, vitamins, minerals, enzymes, proteins, tannins, saponins, glycosides, sterols, triterpenes, saponosides, tannins, reducing compounds, coumarins, anthocyanosides, flavonosides. These bioactive components are responsible for the pharmacological properties of this auspicious plant and demonstrate its importance in daily intake and alimentation. Traditionally, different parts of the plant are used as anticancer, anti-oxidant, anti-diabetes, antibacterial activity, antifungal activity, anti-inflammatory activity. In the current review, pharmacological attributes, the nutritional value of *Parkia biglobosa*, and the medicinal properties of its various parts have been elaborated to provide collective information on this multipurpose commercial plant.

Keywords: *Parkia biglobosa*, Traditional medicines, Phytochemistry, Nutrition, ethnopharmacology,

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1.0 INTRODUCTION

Medicinal plants have significantly supported primary health care all over the world. Plants have been used for thousands of years as food and to treat health disorders and to prevent diseases [1,2]. The knowledge of their healing properties has been transmitted over the centuries within and among human communities [3,4]. The bioactive metabolite from the medicinal plants is responsible for their biological properties [5,6]. In addition, medicinal plants are known to be active and toxicologically safe [7-10] as opposed to conventional therapy.

Parkia biglobosa (Jacq.) R.Br. ex G.Don is a dicotyledonous angiosperm belonging to the family Fabaceae (Caesalpinioideae - Mimosoid clade). It is categorized under spermatophytes, vascular plants. It is a deciduous perennial that grows between 7 and 20 meters high, in some cases up to 30 meters [11]. In West Africa, the bark, roots, leaves, flowers, fruits, and seeds are commonly used in traditional medicine to treat a wide diversity of complaints, both internally and externally, sometimes in

combination with other medicinal plants [12]. The bark is most important for medicinal uses, followed by the leaves. Medicinal applications include the treatment of parasitic infections, circulatory system disorders, such as arterial hypertension, and disorders of the respiratory system, digestive system, and skin. An alcoholic extract of crude seeds 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. The bark, leaves, and pod husks are rich in tannins, which in general have anti-diarrhoeal and activities. In tests with mice, analgesic and anti-inflammatory activities have been demonstrated for bark extracts. The aglycone flavonoids in the leaves have spasmolytic activity on smooth muscles, and also vasodilatory and antiseptic effects. Coumarin derivatives in leaf extracts have anticoagulant activity. The wood is relatively hard and solid, but not very durable, whitish to yellowish or dull brown. The sapwood is often indistinctly demarcated from the slightly darker heartwood. The density is 550–650 kg/m³ at 15% moisture content.

Agunu et al. [13] reported that *P. biglobosa* showed anti-diarrhoeal properties in mice. Kouadio et al. [14] showed that the hexane extract from the bark of *P. biglobosa* had some analgesic and anti-inflammatory effects. Asuzu and Harvey, [15] reported the methanol extract of *P. biglobosa* has shown significant protection against the neurotoxic, haemotoxic, and cytotoxic effects of venoms of poisonous snakes. Studies have been done to identify the chemical constituents of the bark, Araujo et al. [16] found sterols and triterpenes in the petroleum ether extract, and Tringali et al. [17] identified long-chain ester of *trans*-ferulic acid, a mixture of long-chain *cis*-ferulates and different kinds of catechins. Catechins and ferulates are antioxidants, and their antioxidant properties may be responsible for some of the medicinal effects seen for this plant [12]. Here we carry out a systematic review to present an up-to-date overview of studies on domestication, ethnopharmacological use, phytochemistry, nutritional composition, and biological activities of *P. biglobosa*.

2.0 *Parkia biglobosa* (Jacq.) R.Br. ex G.Don

Parkia biglobosa is a dicotyledonous angiosperm belonging to the family Fabaceae (Caesalpinioideae - Mimosoid clade). also known as the African locust bean (West African names: néré, dodongba, doruwa, netetou, sumbala, or iru) is a perennial deciduous tree of the family Fabaceae, in the genus Parkia. It is found in a wide range of environments in Africa and is primarily grown for its pods that contain both a sweet pulp and valuable seeds [11]. Where the tree is grown, the crushing and fermenting of these seeds constitute an important economic activity. Various parts of the locust bean tree are used for medicinal and food purposes [18]. As a standing tree, locust bean may have a positive effect on the yield of other nearby crops.

2.1 Synonyms

Parkia biglobosa has 12 synonyms including Inga biglobosa (Jacq.) Willd, Inga faeculifera Ham, Inga faroba Mérat & Lens, Inga senegalensis DC, Mimosa biglobosa Jacq, Mimosa taxifolia Pers, Parkia africana R.Br, Parkia clappertoniana Keay, Parkia intermedia Oliv. Parkia oliveri J.F.Macbr, Parkia uniglobosa G.Don and Prosopis faeculifera Desv.

2.2 Origin and geographic distribution

Parkia biglobosa occurs in a belt between 5°N and 15°N, from the Atlantic coast in Senegal to southern Sudan and northern Uganda. The belt is widest in West Africa (maximum 800 km) and narrows to the east. It was probably introduced to São Tomé and Principe. Trial plantations have been established in Tanzania, and African locust bean was introduced to the Caribbean region over 200 years ago, probably as a consequence of the slave trade, and later possibly to Guyana. The use of the fermented beans of African locust bean dates back many centuries and was already described in the 14th Century.

2.3 Botanical Description

Medium-sized tree up to 20(–30) m tall; 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; bark 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 [19].

Leaves alternate, bipinnately compound, up to 30(–40) cm long; stipules absent; petiole 4–12.5 cm long, swollen at the base and there with an orbicular gland; rachis with a caducous awn at apex, bearing up to 17 pairs of pinnae, with a gland between the terminal pinnae; pinnae with 13–60 pairs of leaflets; leaflets sessile, oblong, 8–30 mm × 1.5–8(–10) mm, very unequal at the base with a proximal auricle, rounded or obtuse at apex, glabrous but slightly ciliate near the apex. Inflorescence a pendulous head arranged racemosely; peduncle 10–35 cm long; turning salmon-pink, many-flowered [19].

Flowers bisexual, male or sterile, sessile but pseudopedicellate by the fusion of the bases of the calyx, corolla and stamens, calyx and corolla tubular, 5-lobed; bisexual flowers in the distal portion of the capitulum, 10–17 mm long, with 10 stamens long exserted and a superior, 1-celled ovary, style filiform, stigma cup-shaped; male flowers in the basal portion of the capitulum, 6–7 mm long, with stamens were not exserted, nectariferous; sterile flowers at the extreme base of the basal portion of the capitulum, 6–7 mm long, with rudimentary stamens. Fruit a linear-oblong pod 12–35 cm × 1.5–2.5 cm, slightly falcate, with stipe of 1–4 cm at base, subcylindrical, glabrous, and smooth, usually brown when ripe, 5–23-seeded. Seeds embedded in yellowish endocarp, globose-ovoid, slightly compressed, 0.5–1.5 cm long, with distinct pleurogram on the lateral face, testa hard, smooth, glossy dark brown (figure 1) [19].

Figure 1: *Parkia biglobosa*

2.4 Uses of *Parkia biglobosa*

2.4.1 Source of food

African locust bean is a multipurpose tree that is as highly valued as shea butter tree (*Vitellaria paradoxa* C.F.Gaertn.). Fermented seeds (‘soumbala’, ‘dawadawa’, ‘netetu’)

serve primarily as a condiment for seasoning sauces and soups [20]. Roasted seeds are used as a coffee substitute known as 'Sudan coffee' or 'café nègre'. Ground seeds are mixed with *Moringa oleifera* Lam. leaves to prepare a sauce and are also used to make doughnuts [21].

The mealy pulp from the fruits is eaten or is mixed with water to make a sweet and refreshing drink rich in carbohydrates. Boiled pods are used to dye pottery black; the ash is applied as a mordant [20]. The bark is rich in tannins and may be used for tanning hides, but the resulting leather is often of moderate quality especially with regard to color, which is often reddish, uneven, and darkens when exposed to light [20]. The leaves are sometimes eaten as a vegetable, usually after boiling and then mixed with other foods such as cereal flour. Young flower buds are added to mixed salads.

2.4.2 Nutritional composition

The seeds of the locust bean are the most valuable part of the plant. They are high in lipids (29%), protein (35%), carbohydrates (16%), and are a good source of fat and calcium for rural dwellers. The yellowish fruit pulp is very rich in carbohydrates (ca. 80%), which makes it an excellent energy source [21]. The seeds of African locust bean contain antinutritional factors and have to be processed before use as food or livestock feed. Boiled and fermented seeds contain 35% proteins, 29% lipids, 16% carbohydrates, and have good organoleptic properties and a positive effect on intestinal flora [20]. The seeds are good sources of protein, fat, and calcium, but contain a non-toxic oil of variable composition. Some sources indicate arachidic acid as the most abundant fatty acid, accompanied by behenic, stearic, palmitic, and linoleic acids; other sources mention oleic acid as the most important component (35–50%) with, in addition, equal amounts of behenic, oleic, palmitic and stearic acids.

2.4.3 Use as Medicine

In West Africa, the bark, roots, leaves, flowers, fruits, and seeds are commonly used in traditional medicine to treat a wide diversity of complaints, both internally and externally, sometimes in combination with other medicinal plants. The bark is most important for medicinal uses, followed by the leaves. Medicinal applications include the treatment of parasitic infections, circulatory system disorders, such as arterial hypertension, and disorders of the respiratory system, digestive system, and skin. In veterinary medicine, a root decoction is used to treat coccidiosis in poultry. Green pods are crushed and added to rivers to kill fish.

2.4.4 Economic activity

The cultivation of this tree can be seen as an important economic activity for many in Africa, including a large portion of women. Néré fruits are highly commercialized in Burkina Faso; "over 50% of respondents in a nation-wide survey said they participated in its trade. In general, women are wholly responsible for the sale of fermented seeds (*dawadawa*) even though both men and women are equally responsible for the sale of dry seeds.

2.4.5 Other activities

The fruit pulp is used as an ingredient of feed for pigs and dogs. The seeds are added to poultry feed after treatment to remove their antinutritional properties. The leaves are useful, but not very palatable fodder. They should be mixed with other feed because the concentrations of phosphorus, magnesium, and sodium are too low. The wood is suitable for making kitchen implements, such as mortars, pestles and bowls, and handles of hoes and hacks, and it is occasionally also used for house building, mainly for indoor construction. It is also used as firewood and may be suitable for paper production [22]. The fibers of pods (husks) and roots are used as sponges, strings of musical instruments, and for the production of small baskets. Burnt pod husks are used in Senegal as an adulterant of, or additive to, tobacco (adding pungency). African locust bean has a reputation for soil improvement; its leaves are applied as green manure. It is also important in apiculture, being a good source of nectar and suitable for the placement of hives. It may serve as a decorative avenue tree. African locust bean is very important in West African culture. It plays a role in all major rituals, including those associated with birth, baptism, circumcision, marriage, and death.

2.5 Socio-economic importance of *P. biglobosa*

The study of Houndonougbo et al. [22] provided a detailed review of the socio-economic importance of P. biglobosa. According to their study, the main economic importance of P. biglobosa relates to its seeds, which are subject to trade in local markets. The soumbala—a highly valued food product from plant seeds—is widely consumed in West Africa; it is used in one daily meal for up to 90% of the year in some areas [23]. As a result, the seed with its derived products are traded in local markets; for example, about 200,000 tons of P. biglobosa seeds are collected every year in northern Nigeria for both commercial and domestic purposes [24]. The harvesting of P. biglobosa fruits and extraction of seeds are lucrative activities for farmers who commercialized the seeds as raw material to the processors (especially women) to make the food condiment (the most marketed food product). As a result, the marketing chain of P. biglobosa is at two stages including the sale of the dry seeds and that of the processed seeds (food condiment) [24]. A study by Vodouhê et al. [25]in the Pendjari Biosphere Reserve in Benin, revealed that P. biglobosa can contribute up to 53% to family net income during its fructification period. However, the processing and production of condiments from the seeds have remained very tedious and traditional with little or low technology input [22]. Therefore, future investigations should focus more on the economic botany, processing technology of derived products as well as prerequisites for its further packaging and commercialization. Such knowledge will provide valuable insights for developing the African locust bean value chain, promoting its sustainable utilization and conservation, and hence enhancing its contribution to local livelihoods [22].

2.6 Phytochemistry:

Secondary metabolites present in the Parkia bigladulosa provide a basis for its traditional uses. Previous studies revealed the presence of secondary metabolites such as carbohydrates, alkaloids, tannins, flavonoids, saponin, and glycosides. Chemicals compounds were isolated and identified from Parkia bigladulosa like flavonoids, tannins, cardiac glycosides, alkaloids, saponins, and steroids [26]. Kaur et al., [27] isolated and characterized two mannose/glucose specific seed lectins from Parkia biglandulosa and

Parkia roxburghii. By means of ammonium sulphate fractionation and affinity Chromatography technique purification of parkia lectins was performed. Mohammed et. al., [28] isolated flavonoid glycosides from the Fruit Pulp Extract of *Parkia biglobosa*. The methanolic extract of fruit pulp partitioned with n-hexane, Chloroform, Ethyl acetate, and n- butanol. Using data of spectral analysis compound was concluded as 4, 6, 4' trihydroxy – aurone – 4 – 6 – di – O – β – D – glucopyranoside. Villegas et al., [29] investigated the chemical composition of *Parkia biglobosa* (Fabaceae) roots and barks by Liquid Chromatography – Electrospray Ionization and Direct Injection Tandem Mass Spectrometry analysis. Mass spectral data indicated that B-type oligomers procyanidins and prodelphinidins were present, with their gallate and glucuronide derivatives, along with different isomeric forms. The analysis proved the occurrence of up to 40 proanthocyanidins in the plant. Sangodare, et al., [26] investigated the chemical constituents of different extracts from P. Biglobosa fruit hull. The methanolic extract of P. Biglobosa fruit hull contain 1,2,3-Benzenetriol, Pentadecanoic acid, Hexadecanoic acid, Linoleic acid, 11-octadecenoic acid, Octadecanoic acid, Oleic acid Hexadecanoic acid, 1,11,13-octadecatriene, Decane, 1-fluoro, 9-octadecenal, 13-octadecenal, 2-methyl-3,13-octadecadienol. Different saturated, monosaturated, and polyunsaturated fatty acids like palmitic acid, stearic acid, oleic acid, and linoleic acid were detected along with organic aromatic compounds like 1,2,3-benzenetriol.

2.7 Biological Activities activity of P. biglobosa

2.7.1 Antioxidant activity:

Komolafe et al. [30] reported the scavenging abilities and the reducing powers of 1,1-diphenyl-2-picrylhydrazyl radical and 2,20-azino-bis (3- ethylbenzothiazoline-6-sulfonic acid) diammonium salt radical cation against Fe3þ of P. biglobosa. Furthermore, Komolafe et al. [31] evaluated the antioxidant value of aqueous-methanolic extract of *Parkia biglobosa* leaf. by measuring its total flavonoid and total phenol content, 1,1-diphenyl-2-picrylhydrazyl (DPPH) radical scavenging activity, and ferric reducing property. The extract showed considerably high and dose-dependent DPPH radical scavenging and ferric reducing properties comparable with the respective standards, Quercetin and Ascorbic acid [31].

2.7.2 Antimicrobial activity:

Aiyegoro et al., [32] evaluated the antibacterial activity of methanolic crude extract and fractions of *Parkia biglobosa* against Escherichia coli and Pseudomonas aeruginosa. The extract and fractions were found to possess antimicrobial properties compared with streptomycin [32]. Millogo-Koneet al.,[33] tested Hydroalcoholic and aqueous extracts of leaf and stem bark of *Parkia biglobosa* against Escherichia coli, Salmonella typhi, Shigella dysenteriae and Enterococcus faecalis. Results revealed that for all the tested microorganisms, the hydroalcoholic extract of the bark is more active than the aqueous extract of the leaf. The hydroethanolic extract of the leaves is as effective as the aqueous extract of the stem bark.

Ologundudu et al., evaluate the antimicrobial activity of hexane, chloroform, ethanol, and aqueous extracts of leaf and bark of *Parkia biglobosa* against Gram-positive bacteria and gram-negative bacteria. Hexane extracts showed greater antimicrobial activity against K. Pneumoniae bacteria. The bark extracts also showed better bactericidal properties than

the leaf [26]. Bukar et al., [34] evaluate the antimicrobial activity of aqueous and ethanol extracts of *Parkia biglobosa* leaf and pod using the disc diffusion method. The extracts were tested against Staphylococcus aureus, Enterobacter aerogenes, Escherichia coli, Salmonella typi, Salmonella typhimurium, Shigella spp, and Pseudomonas aeruginosa (bacteria), and Mucor spp and Rhizopus spp (fungi) isolated and characterized from some selected food samples [34].

Ajaiyeobaet al., [35] evaluate the antimicrobial activity of ethanolic extract of *Parkia biglobosa* leaves. The extract was most active against Bacillus cereus and the growth of Staphylococcus aureus was moderately inhibited. Udobi and Onaolapo [36] tested the methanolic extract and aqueous fractions of the Leaf, Stem Bark, and root of the African locust bean tree, and found that extracts and their fractions were tested against two ram positive organisms – Staphylococcus aureus and Bacillus subtilis and two-gram negative organisms–Escherichia coli and Pseudomonas aeruginosa. It was confirmed that the high activity of aqueous fraction of the methanolic extract of the stem bark against Staphylococcus aureus and Pseudomonas aeruginosa [36]. According to Afolabi et al., [37], 70% ethanolic extract of the leaf, stem, root bark extract of P. biglobosa was particularly effective against gram-positive bacteria [37]. A previous study also reported that aqueous, ethanol ethyl acetate and dichloromethane extract of *Parkia biglobosa* exhibited antibacterial activity against 10 reference strains and 9 meat isolated Staphylococcus and P. biglobosa. The observed antimicrobial activity of the plant parts is indicative of the therapeutic potentials of the secondary metabolites inherent in these plants [38].

2.7.3 Antihypertensive activity:

The antihypertensive activity of P. biglobosa seeds has been reported in both humans and animals. In a study conducted in 2 regions of Togo to compare indices of hypertension among human populations that consumed the fermented seeds of P. biglobosa (test group) and those that did not (control group), blood pressure and heartbeat were significantly decreased among the test group compared to the control group. In addition, the lipid profile of the test group significantly improved compared to the controls. Furthermore, the P. biglobosa seeds lowered the levels of electrolytes including calcium, potassium, and chloride, and increased the level of magnesium which are important indicators for reducing the risk of cardiovascular diseases [39]. Ayo-Lawal et al. [40] also reported that P. biglobosa fermented seeds exhibited significant hypolipidemic effect in tyloxapol-induced hyperlipidemia in rats. In another study to investigate the vascular properties of both roasted and fermented seeds of P. biglobosa on aorta isolated from rats, both roasted and fermented seeds induced relaxation in the aorta precontracted with phenylephrine in a contraction-dependent manner [41]

2.7.4 Anti-anaemic activity:

Treatment of Wister rats with fermented seeds of P. biglobosa exhibited anti-anemic properties by increasing the red blood cells, white blood cells, packed cell volume, and hemoglobin concentration [42]. In support of these findings, the fermented seeds of P. biglobosa have been shown to be a rich source of essential minerals such as Calcium, Phosphorus, Iron, thiamine [43] which are important in ameliorating both iron deficiency and non-iron deficiency anemia.

2.7.5 Anti-diabetics Activity:

Both the crude methanol extract as well as the n-hexane and chloroform fractions of the fermented seeds have been reported for anti-diabetic activities in rats [44]. Similar findings were reported by Odetola et al. [45], who studied the anti-diabetic and anti-hyperlipidemia activities of the aqueous and methanol extracts of the fermented seeds of P. biglobosa.

2.7.6 Analgesic activity:

Lectin isolated from P. biglobosa significantly ameliorated the acetic acid-induced pain in mice, the compound significantly reduced the number of contortion and migration of leukocytes to the site of the inflamed site via an indirect chemoattractant [46]. Lectin at 1 mg/kg, exhibited 58% inhibition of writhes induced by acetic acid [47].

3.0 CONCLUSION:

The P. biglobosa is a medicinal plant that is used traditionally by the tribal people for the treatment of various diseases. The present study gives comprehension information about *Parkia biglobosa* as of its several pharmacological activities like Antimicrobial, Antioxidant, Antidiabetics, Anti-anemic, analgesic, etc. The P. biglobosa not only use as food but it is loaded with vitamins, Phytochemicals, and several mineral compounds which help to treat a health problem. A significant number of experiments on its biological activity and promising application of P. biglobosa have been executed. Hence, an extensive investigation on its kinetics, pharmacodynamic properties, proper standardization as well as clinical trials is direly needed to exploit its therapeutic utility and effectiveness to fight against various maladies and conquer deficiency symptoms.

Conflict of Interest

The author declared no conflict of interest exist

Authors contributions

The work was conducted in collaboration of all authors. All authors read and approved the final version of the manuscript.

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