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African Locust Beans: More than just a condiment (Review)

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Abstract

Several species of legumes have been enclave into the world of the underutilized, with some of their potentials undervalued and incognito. Underutilized legumes are legumes that are undervalued and have formerly not been classified as major legumes; these include some species of the genus *Acacia*, *Albizia*, *Caesalpinia*, *Gliricidia and Parkia*. African Locust Bean (*Parkia biglobosa* (Jacq.) R.Br. ex G.Don) is predominantly used in the production of the native condiment called *iru* amongst the Yoruba-speaking people of Nigeria. The most populated view of its use is as a condiment; however, efforts are being made by researchers to exploit the numerous benefits of this legume in the production of new value chains; this prompted a search into existing literatures for its divers uses. Its use as a genital wash against urinary tract infection, as an infant food formulae supplement, mosquito repellant, means of managing obesity and in treating asthma are Ethnobotanical reports of this plant. Its antibacterial, probiotic, hepatoprotective, antidiabetic, anti-inflammatory and wound healing potentials, antihypertensive, as a binder and thickener, pesticide and herbicide have been scientifically investigated. Research in process technology, new product development value chain addition and marketing will bring *P. biglobosa* and other underutilized legumes at par with major world crops.

Keywords: *Parkia biglobosa*, Underutilized Legumes, African Locust Bean

Introduction

Legumes (Family, Fabaceae) are the second most valuable plant source in nutrition to man and animal: second in importance only to Poaceae (Maphosa and Jideani, 2017; Starr *et al*., 2013; Starr *et al*., 2015). Despite their value, some species of legumes are used in relatively small degree to their potential and are thus underutilized (Mabhaudhi *et al*., 2016).

Underutilized legumes are legumes not in the forefront of world major crops, they are impoverish in process technology, marketing system and value chains with indistinct conservation schemes (Ofosu *et al*., 2017; Cullis and Kunert, 2016,). These crops are mostly indigenous species and have been found to exert less pressure ecologically in that little or no modification to the landscape and environment is needed for their growth and development (Mabhaudhi *et al*., 2016; Mabhaudhi *et al*., 2017).

World over, there has been a constant search for alternative and cheap protein source for both man and livestock (Henchion *et al*., 2017; Goulart *et al*., 2015; Bhat and Karim, 2009), one may wonder why these underutilized legumes have not found a significant utilization in solving this problem; moreover, there is a tendency for exotic species to be used in agricultural practice (Chivenge, 2015; Sprent *et al*., 2010).

Underutilized crops contribute positively to: food security in serving as a resort to hunger; human health in being rich in nutrients; as well as climate change (Ofusu *et al*., 2017; Mabhaudhi *et al*., 2016; Chivenge, 2015). They possess beneficial bioactive compounds alongside being rich in essential minerals and vitamins such as ascorbic acid and carotenoid found in fruit pulp of *P. biglobosa* (Udobi *et al*., 2012; Gernah *et al*., 2012; Bhat and Karim, 2009). Underutilized crops also create employment in poor and rural communities especially for women who have been documented to play a major role in their production and hence gainfully employed.(Ofusu *et al*., 2017; Mabuduahi *et al*., 2016; Chivenge, 2015). Several legume species have attained the status of underutilized and neglected, amongst which are some species of the genus *Parkia*: *Parkia roxburghii* G. Don, *Parkia biglobosa Parkia filicoidea* L.; *Mucuna*: *Mucuna monosperma* DC ex, *Mucuna urens* L. and *Mucuna flagellipes*; *Albizia* : *Albizia lebbeck* and *Caesalpinia*: *Caesalpinia pulcherrima* L.

Parkia biglobosa is a savannah tree belonging to the subfamily Mimosoidea. It combines two important qualities: food and shelter to human and animals (Amoako, 2012). It is processed into a local condiment popularly called *iru* amongst the "Yoruba" populace of Nigeria, other names of the condiment includes *Eyinowan* and *Ugba* amongst the Edo's; *Ogiri* amongst the Igbo's; *Dawadawa* amongst the Hausa's. The condiment is obtained from seeds of *P. biglobosa* that have been washed, de-hulled, fermented and molded into balls (Akande *et al*., 2010). Processing into *iru* is majorly done traditionally with rudiment technology in the processing line which is time-consuming and labour-intensive (Adejumo *et al*., 2013). Many a woman across the diverse ethnic groups in Nigeria feels her soup is not complete till *iru* is added: it is seen as a meat substitute (Sackey and Kwaw, 2013). However, the taste, smell and appearance of *iru* have stood as a deterrent in its use.

Other than being used as a condiment the multiple use of *P. biglobosa* is not so conspicuous and appreciated, there is therefore a need to investigate into its use and possible incorporation in the medical, and pharmacological and agricultural industries.

P. biglobosa in Nutrition

A large percentage of the world live in poverty with Nigeria being tagged home to the largest number of the world's poorest as at June 2018 (Sahara reporters, 2019). Poverty and malnutrition are two sides of a coin, where poverty exists, hunger follows suit; hungry persons are chronically undernourished (Webb *et al*., 2018). Poverty is a cause and consequence of malnutrition (UFS, 2015) which has a long lasting physiologic effect resulting in a high propensity of health challenges at one stage or the other (Vorster, 2010; Martins *et al*., 2011; Shrivastava *et al*., 2011). Thus, cheap source of food and its derivatives which can meet the nutritional requirement of man will be greatly appreciated by all and sundry. Plant sources may provide not only cheap and alternative source of protein but other nutrients required by man; seeds of *P. biglobosa* included as component of protein poor diet could make up for some of the protein deficiency (Koura *et al*., 2011). Presence of mineral components such as Calcium, Iron, Magnesium, Sodium, Copper, Potassium, Phosphorus, Manganese and Zinc have been reported by Ogunyinka *et al*.(2017); Oluwaniyi and Bazambo (2016); Ijarotimi *et al*. (2012). It is a good source of macronutrient, vitamins A and C and carotenoids (Marcel *et al*., 2015; Dahouenon-Ahoussi *et al*., 2012); an acceptable level of antinutrient was observed in a study of the nutritional composition of *P. biglobosa* by Gernah *et al*. (2012) where a phytic acid composition of 60.00mg/ l00g was recorded. In a bid to get the best out of the seeds, Ogunyinka *et al*. (2017) has revealed a higher percentage of protein for protein isolate of *P. biglobosa* than the fermented and defatted seeds. It is interesting to note that the fermented *iru* does not accumulate lead (Oluwaniyi and Bazambo, 2016) and there has been no report of food poisoning in the consumption of fermented *P. biglobosa* bean based condiments despite the detection of cerullude: an emetic toxin producing strains of *Bacillus cereus* (Thorson *et al*., 2010).

Pulp of *P. biglobosa* will make an ideal snack. It has been incorporated into wheat-based biscuit to make functional biscuit (Zakari *et al*., 2013) and its fruit pulp has been used in the production of wine (Dê and Okonofua, 2001). Its fruit hulls is also reported to be rich in linoleic acid, although its edibility by man is yet to be investigated (Sangodare *et al*., 2017).

Mother and child health

The use of medicinal plants during pregnancy by women have been documented (Ahmed, 2018). The potency of the traditional use of the stem bark decoction as genital wash against urinary tract infection experienced during pregnancy was reported by studies of Nordeng *et al*. (2013) and Nergard *et al*. (2015). Its fruit is reportedly used to treat abscess in children in south western Nigeria by studies of Aworinde, and Erinoso (2015).

Formulation of Infant formulae

The nutrition of the first 1000 days of infant life is crucial to her development, once this window period is missed, the infant's development and health may be in jeopardy (UNICEF, 2017). Despite the advice for infants to be on breast milk for the first 6 months of live by medical practioners, some mothers for one reason or the other are not able to keep to this routine and rely on complementary foods.

Animal based complementary food are quite expensive, thus prompting a probe into plant based resource that can deliver the basic nutrients required by infants at a cost friendly rate. Powdered form of the dried pulp of *P. biglobosa* is used as food supplement in porridges in Northern Benin of Benin Republic (Dahouenon-Ahoussi *et al*., 2012); high level of lysine, leucine and threonine has been found in the pulp flour which could also be pulverized and used as an ingredient to complement mineral content in infant based formulae (Chadare *et al*., 2017); moreover, its leaves could also contribute to the minerals content of complementary foods. Ijarotimi and Keshinro (2012) stated that incorporation of the seed which was shown in their study to contain high arginine and histidine content could enhance the growth and development of infants

***P. biglobosa* as antibacterial and probiotic agent**

The antibacterial efficacy of *P. biglobosa* has been validated by several authors (Osuntokun *et al*., 2018; Ibeabuchi *et al*., 2014; Akintobi *et al*., 2013). Phytochemical screening by Abioye *et al*. (2013) and Udobi *et al*. (2012) revealed the presence of alkaloids, flavonoids, tannins, saponins, steroids, glycoside and cardiac glycosides: some of which are responsible for its antibacterial properties. Akintobi *et al*. (2013) reported that the ethanolic extract of the stem bark of *P. biglobosa* had a concentration-dependent antimicrobial effect on *Pseudomonas aeruginosa*, *Escherichia coli*, *Klebsiella pnuemoniae*, *Proteus mirabilis*, *Aspergillus flavus* and *Aspergillus fumigatus.* The anti-bacterial activity against *Staphylococcus aureus and Pseudomonas aeruginosa* has been confirmed by investigations of Abioye *et al*. (2013); Udobi *et al*. (2012) and Adetutu *et al*. (2011).
The antibacterial properties exhibited by *P. biglobosa* may not only be associated with the constitutive phytochemicals but also to bacteriocin produced by some strain inherent in the fermented *P. biglobosa* shown to exhibit probiotic properties. Probiotics are live organism that confers health benefit on its host when administered in sufficient amounts (FAO, 2001). *Bacillus subtilis*, extensively studied for its probiotic properties and possible incorporation into the production of novel foods and prophylactic (Ayala, 2017; Elshaghabee *et al*., 2017; Cutting, 2011 and Hong *et al*., 2005) was isolated from *Soumbala*: a fermented product of *P. biglobosa*. The isolate was demonstrated to inactivate both gram positive and negative bacteria as well as Ochratoxin A producing fungi (Ouoba, 2006); In addition, a bacteriocin producing Lactic acid bacteria was also isolated from fermented seeds of *P. biglobosa* in a study by Olorunjuwon *et al*. (2018).

Treatment of Malaria and repellant of mosquito

Malaria, prevalent in malaria endemic regions is transmitted by the female anopheles mosquito Daily (2017); despite artemisinin-based combination therapy (ACT) being the best drugs for its treatment, plants still remain the key source for antimalarial drug discovery and development Pan *et al*. (2018). Ethnobotanical survey by

Oladeji and Agbelusi (2017) in Nigeria and Traore (2013) in Guinea reports *P. biglobosa* as one of the most cited plant used in the treatment of malaria. The stem bark decoction (Nergard *et al*., 2015; Traore *et al*., 2013; Nordeng *et al*., 2013) and smoke of the seed capsules (Innocent *et al*.,2008, Pâlsson and Jaenson 1999) is used to treat malaria and as a mosquito repellant respectively.

Treatment of Obesity and its disease complications

Body mass index (BMI) is mostly used to categorize underweight, normal, overweight and obese individuals. Worldwide, the prevalence of Obesity is expected to grow by 40% (Kovesdy *et al*., 2017). Obesity is a risk factor implicated directly and indirectly as a cause of the chronic as well as the degenerative forms of diseases of the kidney, liver and heart (Kovesdy *et al*., 2017; Pérez-García *et al*., 2017; Serafim *et al*., 2016; Sharma *et al*., 2010). The propensity for obese person to suffer from a range of disease that could be terminal prompted the search not only for effective measures to shed weight but for means of treating and perhaps curing the diseases associated with it.

Change in lifestyle through diet and weight loss therapy is a most guaranteed means of managing obesity and its associated complications. In an ethnobotanic survey by Pare *et al*. (2016) reported that in the Nomad and Hunter communities of Burkina Faso, a decoction of the root or stem of *P. biglobosa* is used for weight loss remedies. In the same study, the bark and seeds were said to have potentials in appetite suppression. These traditional claims needs to be scientifically analyzed to produce novel plant based product for weight loss reduction.

Disease outcomes of obesity from kidney, liver and heart could be managed and treated by *P. biglobosa*; this is demonstrated in a study by Sabiu *et al*. (2016) where its leaves were purportedly used in treating kidney disorders. In a study by Meraiyebu, *et al*. (2013), the activity of *P. biglobosa* is said to be comparable with Acetylycysteine: a standard reference hepatoprotective drug, in reducing serum Alkaline Phosphatase and Aspartate with a non-significant effect on Alkaline phosphatewhen the methanolic extract of its stem bark was used to assay its hepatoprotective effect on paracetamol induced liver damage in wistar rats. It is stated to be able to preserve liver functions (Ezekwe *et al*., *2013*) and protective against CCl_4 induced liver damage in combination with Negro pepper -*Xylopia ethiptica* (Patric-Iwuanyanwu *et al*., 2013).

***P. biglobosa* as treatment option for diabetics**

About 3.1 million people live with Diabetics in Nigeria, a global death toll of 3.8 million is recorded annually (Oguejiofor *et al*., 2014); this disease is characterized by high sugar levels in the blood and despite its management clinically, death occurs (WHO, 2016). Oral Hypoglycemic therapy, Insulin treatment and dietary modifications are the major component of treating Diabetics Melitus (WHO, 1992).

A keystone in obtaining a good glycemic control in DM patients can be achieved by modification in diet. Butanolic faction of Leafs of *P. biglobosa* has been used to stimulate β cells function, induce insulin production with a corresponding reduction in blood sugar level and also reduce other complication associated with Type 2 DM when administered to Type 2 DM induced rats (Ibrahim *et al*., 2016). Aqueous and Ethanolic extract of fermented *P. biglobosa* seeds was also shown to possess antidiabetic properties by Odetola *et al* .(2006) with the aqueous extract restoring weight lost associated with DM.

Lupeol a triterpene was isolated from *P. biglobosa* by Ibrahim *et al*. (2016). This compound and some of its ester derivatives whose major mechanism of action is inhibition of the enzyme α amylase, has been shown to possess antidiabiatetic prowess by Lakshmi *et al*. (2014 and Gupta *et al*.(2011)

Anti-inflammatory and wound healing properties

Inflammatory mediators released from damaged tissues stimulate nociceptors directly and this may cause pain, however this constitutes part of the wound healing process. Inflammatory pain is treated by nonsteroidal antinflammatory drugs and coxibs but their use are associated with adverse effects (Ikhimalo and Ugbenyen,

2019). Antinociceptive activity associated with the inhibition of inflammatory process is exhibited by lectin isolated from *Parkia biglobosa* (Silva *et al*., 2013).
The ground bark of this plant is used to make decoction for treating varying forms of wound (Grønhaug, 2008) and for making paste for wound dressing (Adetutu *et al*., 2011). The success portrayed by traditional healers may be the ability of *Parkia biglobosa* to stimulate the growth of fibroblast (Adetutu *et al*., 2011). Fibroblast is responsible for collagen and elastin synthesis which is important in the wound healing process, It is key in wound contraction where it provides the contractile force that brings the wound edges together (Darby *et al*., 2014; Bainbridge, 2013).

Asthma a lower respiratory disease affecting all ages, is characterized by a chronic airway inflammation culminating in the narrowing of the airways (Scherer and Chen 2016). The economic cost on patients is substantial and Its management contributes to societal health care cost (Onyedum *et al*., 2014; Desalu *et al*., 2013). Inhaled corticosteroid are mostly believed by physicians as the benchmark for the management of asthma but its use is attributed to some critical side-effects which has caused some patient to discontinue treatment and to the poor response of corticosteroid resistance asthma patients to its administration, thus requiring higher dosage (Panda and Mabalirajan, 2018; Barnes, 2013; Marandi, *et al*., 2013; Desalu *et al*., 2013).
In a survey conducted by Desalu *et al*. (2013), 85.7% of physicians and 56.0% of patients agreed on the need for new medication options that are more effective; this demand is also documented by Marandi *et al*. (2013). Alternative plant based treatment of asthma may be cheap compared to the conventional clinical management. *Parkia biglobosa* has been used by Togolese traditional healers to heal asthma (Gbekley *et al*., 2017). Other works such as Fadeyi *et al*. (2013); and Yapo *et al*. (2010) also cited its use in treating asthma.

P. biglobosa in treating hypertension

Hypertension, a blood pressure level that is ≥ 140mmHg or 90mmHg in the systole and diastole respectively doubles the prevalence of cardiovascular risk in an individual (Vargas-Uricoechea and Cáceres-Acosta, 2018; American Diabetes Association, 2018). It's often not detected and when diagnosed, often not adequately treated (Foêx*,* 2004) thus there is a need to forestall this silent killer.
A number of literatures such as Ouolouho *et al*. (2017), Alinde *et al*. (2014) and Assane *et al*. (1993) have attested to the antihypertensive properties of *P. biglobosa*. The Bogou group of Togo who consumed a high amount of the fermented seeds showed a significant decrease in blood pressure and heart beat compared to the a group who do not eat it at all: the Goumou-kope area, when Investigations into the antihypertensive prowess of *P. biglobosa* through anthropometrical, clinical and biochemical analyses were carried out in Togo (Ognatan, 2011). A Study by Ouédraogo *et al*. (2012) also revealed that seeds of *P. biglobosa* directly acted on smooth muscle via the endothelium to generate vasodilating prostaglandins in rat aorta, it iscited in an ethnobotanic survey by Gbekley *et al*.(2018) as one of the most commonly used plant in treating hypertension by Togoleses traditional healers.

P. biglobosa as an excipient in the pharmaceutical industry

Inert pharmaceutical ingredients used in product formulations called excipients could serve a specific purpose which could be: binder or adhesives, disintegrant, lubricants, glidant, flavors, colors and sweeteners and pH adjustment. (*Karthik*, 2016; Cha *et al*., 2014). A binder imparts cohesiveness and ensures a tablet remains intact after compression (Ghatage *et al*., 2014). The pulps of *P.biglobosa* has high water sorption potency which could be incorporated into the pharmaceutical industry, it also has potentials in being used as a binder and thickener (Marcel *et al*., 2015; Satyajit *et al*., 2015; Akegbejo-Samsons *et al*., 2005).

Control of witch weed

Striga gesnerioides (witch weed) is a parasitic weed that constrains the productivity of staple crops; complete crop loss could be experienced in *Striga* infestation (Sibhatu, 2016) which may stay viable in the soil for up to 20 years (AATF, 2012). A number of management techniques has been proffered by the scientific community with

crop rotation topping the list (Oswald and ransom 2001), others include intercropping with *Striga* host and non-host crops, improved fallow and soil fertility management, biological control (Sibhatu, 2016; NARO, 2015; KARI, 2006; Oswald 2005). Innovative management system that targets the eradication of witch weed will increase productivity of staple crops. The fruit powder of *P. biglobosa* reduced the number of *Striga gesnerioides* in cowpea cropping system with the basal application of the fruit pulp recoding a higher grain yield and lower *Striga* count (Lado *et al*., 2018).

***P. biglobosa* as a pesticide**

Dimethoate is an organophosphte acaricide that inhibits the enzyme cholinesterase responsible for lysing several ester based choline neurotransmitters in the nervous and cardiovascular system, lungs, plasma, red blood cell, skin and eyes (Ramon-Yusuf, *et al*., 2017; PPBD, 2018; Pohanish, 2015). Dimethoate synergizes with Cypermethrin: a known neurotoxic class II pyrethroid pesticide (Ramon-Yusuf *et al*., 2017; Singh *et al*., 2012; Kariuki *et al*., 2003). Aqueous, pod husk extract of *P. biglobosa* is comparative to plants treated with 2.5ml of the insecticide Dimethoate+ Cypermethrin when its ability to suppressed flea beetles in okro production was investigated (Fayinminnu *et al*., 2017).

Treatment of snake bite

Several plants are used either as a first aid to snake bite or as a permanent cure. Pharmacological basis of some of these plants may not have been established, this has however not stopped their usage. The potency of the methanolic extract of *P. biglobosa* stem bark against the cytotoxic, haemotoxic and neurotoxic, and effects of venoms of venomous snakes has been confirmed in a study by Asuzu *et al*. (2003).

Conclusion

P. biglobosa, though underutilized possess other potentials which could be incorporated into the medical, pharmaceutical and agricultural industries. It is imperative to develop and exploit this plant and its value chain through process technology for the development of new products.

Conflict of Interests

None

Tables, Figures and Charts

None

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