

Health Benefits and Medicinal Value of *Pentaclethra Macrophylla*

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Abstract

The *Pentaclethra macrophylla* tree is a presently underutilized medicinal plant despite its potentials. It has a wide range of medicinal uses (dyslipidaemia, antisickling, antimicrobial, wound healing, antihelminthic, analgesic, anti-diabetic, anti-diarrhea, antinoniceptive, fertility promoting properties etc) in different ethnobotanical settings. There is scientific evidence for the antisickling, antiulcerogenic, anti-inflammatory, antinoniceptive, antioxidant, analgesic, anti-hyperlipidaemic properties. These potential medical claims are not yet sufficiently studied and clinical studies have not been conducted on them. A major bioactive compound found in the leaf is extract is phenanthranone while a significant amount of 6-octadecanoic acid is found in the stem bark. *P. macrophylla* is also rich in oil (44-47% oil) made up of 75% saturated fatty acids and 25% unsaturated fatty acids (mainly linoleic and linolenic acids). The crude protein content is high (36.2-43.89%), and the essential amino acid profile is good except for sulphur containing amino acids. The seed oil contains a lot of sisosterol. Paucine and caffeoyl putrescine (harmful substances) found in the seeds are detoxified by the fermentation process. Several bioactive compounds in *P. macrophylla* such as bergenin and citronellol possess medicinal value (anti-cancer, anti-inflammatory, anti-oxidant and wound healing properties etc.). A lot of research input is still required to elucidate the health benefits and medicinal value of *P. macrophylla*. While the bioactive compounds in the stem bark and seeds have been, elucidated bioactive compounds in the roots have not been studied. Most of the medicinal uses of this plant are based on ethnobotanical practices and require studies with animal models as well as clinical studies for their authentication.

1. Introduction

The African oil bean tree (*Pentaclethra macrophylla* Benth) is a tropical perennial legume tree found in the West Africa's rainforest zone. It is found in the Eastern and Western regions of Nigeria and in some regions of Senegal, Angola, Cameroon and Gabon [1]. The outer bark is greyish to reddish brown, thin, and flakes irregularly, while the inner bark is fibrous. It has yellow to orange stellate-hairy twigs. The seeds are elliptical in outline, flattened and smooth, purplish brown when mature and lighter in colour when they are immature. The seedlings undergo hypogeal germination. *Pentaclethra macrophylla* can grow up to 21 m in height and approximately 60 cm in diameter [2]. Oil bean trees may be planted on the roadside as shade trees and around communities as cash crops [3].

They are usually planted away from homes because the dried pods explode to liberate the fruits and harm can be caused during the explosion. The ripe fruit is a black, hard and has a woody pod measuring about 35-36 cm long and 5-10 cm in width. When mature it splits open explosively to release about eight flat, glossy brown seeds measuring about 5-7 cm in diameter and weighing between 15-20 g. The mature seeds of *P. macrophylla* is often fermented after preliminary processing and used as food [4]. All the plant parts of *P. macrophylla* are said to have medicinal and economic values in different traditional settings. This paper is an update on the scientifically based health benefits and medicinal value of *P. macrophylla*. This plant requires extensive research input to maximize its use and potentials as a health promoting plant product. It also requires conservation in the environment [5,6].



Figure 1: Branch of *Pentaclethra Macrophylla* Tree Showing Leaves and Pods



Figure 2: Leaves, Unripe Pods and Mature Ripe Pods of P Macrophylla



Figure 3: Immature and Mature Seeds of *P Macrophylla*



Figure 4: Sliced *P Macrophylla* Seeds Before Fermentation Ready to Eat *P. Macrophylla* Food Product

1.1. Chemical Composition of Seeds

The oil bean seed contains 4-17% carbohydrate, 44-47% oil (rich in oleic acid and linoleic acid) [7]. It also contains high amounts of lignoceric acid (10% of the total fatty acids). The oil contains about 75% saturated fatty acids and 25% unsaturated fatty acids. Table 1 shows the fatty acid content of the seeds [8]. For the saturated fatty acids, lignoceric acid is present in the largest amount (constituting about 12%), while palmitic acid is the least amount (3.4%). Behemic acid is also present (5.2%). The major

unsaturated fatty acids in the seeds are: linoleic acid (42.8%); oleic acid (29.0%); linolenic (3.2%) and gadoleic acid (0.28%). The presence of appreciable amounts of behenic and lignoceric acids is not desirable for edible oils. However, believes that the high degree of unsaturation makes it suitable for cooking, and for use as a drying oil for cosmetics, paints and varnishes [7]. Detailed chemical composition of the roots has not been carried out and they are rich in tannins (1.42%; flavonoids (3.75%); alkaloids (1.30%) and saponins (2.40%) [9].

Saturated fatty acids	%	Unsaturated fatty acids	%
Palmitic acid	3.4	Oleic	29
Behenic acid	5.2	Linoleic	42.8
Lignoceric acid	12.0	Linolenic	3.2
		Gadoleic	0.28
Achinewhu			

Table 1: Fatty acid composition of African oil bean seeds

1.2. Amino Acid Content (g/100 g Protein) of African Oil Bean Seeds

African oil bean seeds contain 36.2-43.89% crude protein which contains the 20 essential amino acids. However, the sulphur containing amino acid content is much lower than those found in other plant proteins [7]. The high essential amino acid profile

makes the seeds a source of good quality protein, once there is complementation of the sulphur containing amino acids (Table 2 shows the amino acid profile of the seeds. Glutamic acid occurs in the largest quantity in the seeds. Aspartic acid, lysine and phenylalanine are also present in appreciable amounts.

Amino acid	<i>P. macrophylla</i> (g/100g protein)	FAO Standard
Aspartic acid	9.75-10.30	9.25
Threonine	3.27-4.17	3.10
Serine	4.80-5.54	3.29
Glutamic acid	9.32-11.60	12.51
Proline	2.90-5.77	3.02
Glycine	3.84-4.62	3.40
Alanine	3.81-4.70	4.02
Cysteine/Cystine	1.10-4.800	2.70
Valine	4.90-6.60	4.30
Methionine	0.90-1.80	2.70
Isoleucine	3.30-4.88	3.20
Leucine	5.30-6.68	6.60
Tyrosine	1.80-5.58	5.20
Phenylalanine	5.01-7.00	5.20
Lysine	5.46-6.97	5.7
Histidine	1.53-2.44	2.0
Arginine	4.70-6.53	-
Tryptophan	1.15-1.78	0.85
Mba et al and Achinewhu et al		

Table 2: Amino Acid Content of *P Macrophylla* Compared with FAO Standard

1.3. Ethnobotanical Uses

Pentaclethra macrophylla has many ethnobotanical uses. It is used for the prevention of cataracts and eye diseases. When mixed with honey, it is believed to prevent insomnia. It is used as an antibacterial. It is used in herbal medicine for treating heart failure and infertility. A decoction of its bark is used to treat leprosy sores while smoke from the burning leaves may be used to treat convulsion. It may be crushed and mixed with red ants to induce abortion. The bark, leaves and seeds may be used to treat gonorrhoea. It is said to correct neurologic disorders slowly

(after 2 to 3 years). The oil is good for treating diarrhea. It may be used to check obesity and overweight since it is a rich source of phytoestrogens. A decoction of the fermented extract is used in some traditional settings to manage dental caries, gastrointestinal disorders and malnutrition. The bark, fruits, seeds and the leaves are used as anthelmintics, and as analgesic. Extracted oil from the seeds is used as remedy against pruritus, worms, and dysentery. The seeds are used for the treatment of diabetes in traditional settings in Nigeria. It is also used to treat itching and pain in animals and man.

1.4. Bioactive Compounds in Fermented/Unfermented *Pentaclethra Macrophylla* Seeds and their Physiological Effects

Unprocessed African oil bean seeds are bitter and possess anti-nutritional factors among which are paucine, cyanide, oxalates, saponin, phytates. The saponins, sterols and alkaloids in African Oil bean possess antibacterial properties. Phytochemical screening of the extract from *Pentaclethra macrophylla* showed that the oil seeds contained terpenoids, cardiac glycosides and saponin while steroids, alkaloids, flavonoids, tannins, phlobatannins and anthraquinones were not detected.

The stem bark of *Pentaclethra macrophylla* contains 10 compounds: 1,2,3- benzenetriol (11.53%), 1, 4 - methoxy -3- (4- methyl phenoxy) phenyl ethanone (2.31 %), 1,2-benzenecarboxylic acid (2.31 %), 3-eicosene (2.31 %), hexadecanoic methyl ester, (4.62 %), n-hexadecanoic acid (20.77 %), 6-octadecenoic acid methyl ester (5.38 %), 6-octadecanoic acid, (25.77 %), octadecanoic acid (13.25 %) and naphtho [-1, 2, 6-] furan -2-one (10.38 %) as indicated by GC-MS analysis [10]. 13-Benzyl ethyl methyl abietate was isolated from the stem bark of *Pentaclethra macrophylla*, the structure was elucidated using spectrum obtained from ¹H and ¹³C NMR, IR and Mass Spectrometer.

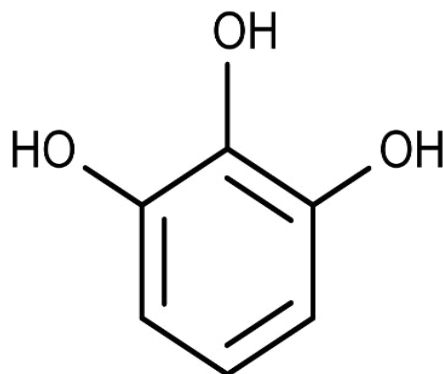
Analysis of the leaf of *Pentaclethra macrophylla* yielded 8 compounds ; 2, 15 —octadecadien - 1-ol acetate (6.90 %), hexadecanoic acid (3.14 %), n-hexadecanoic acid (10.69%), 6- octadecenoic acid (13.84 %), octadecanoic acid (8.18 %), (.2H) phenanthrene (42.14 %) ,Pregnan-2-one (6.29 %) and -4-methylene-1-methyl-2- (z-methyl 1-propene-1-yl) cyclo hexane (9.43. %) [11]. The compound 4, 15- chloestene -3-yl-benzoate was also isolated from the leaf of *Pentaclethra macrophylla* using similar analytical tools. 6-octadecanoic acid may be useful for therapeutic potency to diabetes, wound healing, stomatitis, and periodontitis [12].

The major bioactive components found in the seed oil of *P. macrophylla* (per 100 g of oil) were sitosterol (457.58 mg), campesterol (34.54 mg) and stigma-sterol (18.52 mg) (as the most abundant sterols). The oil contained 15.89 mg/100g β -carotene 10.32 mg/100g xanthophyll, 9.22 mg/100g lutein, and 5.46 mg/100g neo-xanthin as the major carotenoids. The oil also contained γ - tocopherol (43.83 mg/100g) and α -tocopherol (3.35 mg/100g). The main terpenes per 100 g in the oil were γ -elemene (17.28 mg/100g), α -caryophyllene (13.06 mg/100g), β -elemene (12.43 mg/100g) and D-limonene (6.11 mg/100g). Terpenoids such as β -amyrin, α -amyrin and lupleol were found in trace amounts [13]. The root of *P. macrophylla* is rich in tannins (1.42%), flavonoids (3.75%), alkaloids (1.30%) and saponins (3.40%) [9]. The leaves are rich in mineral elements [9].

Aqueous extract of fermented *P. macrophylla* seed (Ugba) contained citronellol; oxirone, tetradecyl (hexadecylene-oxide). A fermented product from *P. macrophylla* (Ugba) has been found to lower plasma cholesterol, [14]. It reduces the risk of ulcer and cancer [15,16]. The water extract from ugba reduced ALT and ALP (enzymes that are indices of liver function) non-significantly. Creatinine and urea decreased significantly. Serum levels of HCO₃⁻ decreased significantly, but there was no variation in serum electrolytes (Na⁺ and K⁺). Serum total cholesterol (TC), TG and LDL significantly increased after the extract was administered orally for 14 days. The serum VLDL level decreased significantly. The histopathology of the liver and kidney showed no hepatotoxic and nephrotoxic effects [17]. Citronellol possess anti-cancer, anti-inflammatory, anti-oxidant and wound healing properties [18]. Oxirane and tetradecyl possess anti-microbial properties. Fermentation also significantly reduced the level of a poisonous alkaloid (paucine) found in *P. macrophylla* seeds) and the level of a toxic compound —caffeoyl-putrescine- a growth depressant found in the seed [15]. Ugba and Aparara are fermented *Pentaclethra macrophylla* seed products of cultural Importance and do not demonstrate any toxic effect in the consumer indicating that the fermentation process detoxifies the raw seed. Efforts are still ongoing to use controlled starter culture fermentation to improve the health benefits of fermented *Pentaclethra macrophylla* seeds [19,20].

Ugba (the fermented product from *P. macrophylla* seeds) did not induce mortality or aberrant behavior in experimental rats, even at 5000mg/kg body weight. It enhanced the production of hormones that stimulate the production of red blood cells. It reduced cancer growth and is recommended for obesity control. It contains a number of phytoestrogens which can assist in controlling overweight and obesity. The saponins contained in the African oil bean seeds lowers the cholesterol content of the plasma making the heart function more effective.

The seeds contain mainly terpenoids, cardiac glucosides and saponins. Flavonoids, phenols, and alkaloids (4.04%, 2.92%, 2.23%) predominate in *X. aethiopica*. *P. guineense* and *X. aethiopica* are spices with antioxidant, antimicrobial and anti-inflammatory constituents [21-23]. Phytochemical investigation of the seeds of *Pentaclethra macrophylla* led to the isolation of a mixture of two new aromatic monoterpene glycosides, pentamacrophylloside A and pentamacrophylloside B, together with six known secondary metabolites. The extracts strongly inhibited the growth of seven selected pathogens; *Pseudomonas aeruginosa*, *Staphylococcus aureus*, *Escherichia coli*, *Salmonella typhi*, *Candida albicans*, *Penicillium* and *Aspergillus Niger*.



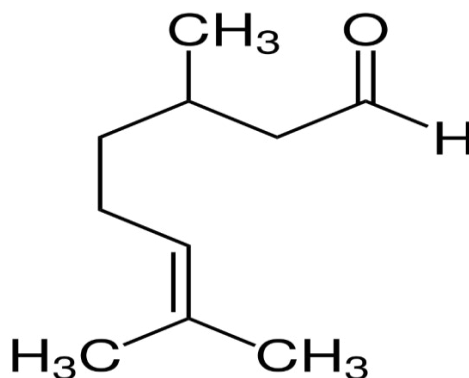
Schematic structure of pyrogallol (1, 2, 3- benzenetriol)

A decoction of fermented extract of seeds of this plant has been known to be effective in the management of malnutrition, gastrointestinal disorders and dental caries [11]. Natural phenols can mop up excess oxygen inside the cells thereby decreasing oxygen concentrations in the cells that promote cancer development [24]. They can intercept singlet oxygen, preventing initiation reactions by scavenging radicals such hydroxyl radicals. They bind metal ion catalysts, decomposing primary products of oxidation to non-radical species and breaking chains to prevent continued hydrogen reaction from substances. Phenolic compounds including flavonoids and condensed tannins present naturally in vegetables, fruits, grains, legumes and pulses possess the ability to reduce oxidative damage which cause many diseases.

The stem bark of *P. macrophylla* possess antiulcer properties [15]. It has also been associated with antidiabetic, anti-inflammatory, antigonorrhea, antimicrobial, antinociceptive, anticonvulsant

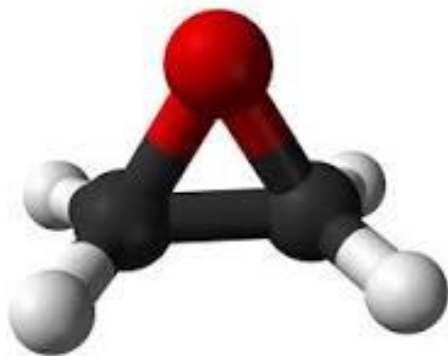
and antitussive properties [25,26]. In the Nigerian ethomedicine, the seeds have been reported as anticancer and an abortifacient. In Cameroon, it is used for infertility [25]. The root bark is used to treat dysentery, used as a liniment against itching, and as a laxative. The leaf is used to treat diarrhea, fever, stomachache and convulsion. The plant has also many health benefits. In Ghana, it has been reported as an anthelmintic for leprosy sores, antiepileptic, antidiarrheal, and for wound management [27-29]. Bergenin is an active constituent of the plant and has multiple biological activities, including anti-inflammatory and immunomodulatory activities. Flavonoids, polyphenols, vitamins C and E are the main bioactive compounds in this forest food.

Citronellol is an essential oil, which causes hypotensive action through direct vasodilation. Linalool, nerol, geraniol, alpha terpineol and 1.8-cineole also have similar action and can cause a 25% decrease in systolic pressure when administered to dogs (in dosages from 9.2-26.3mg/kg).

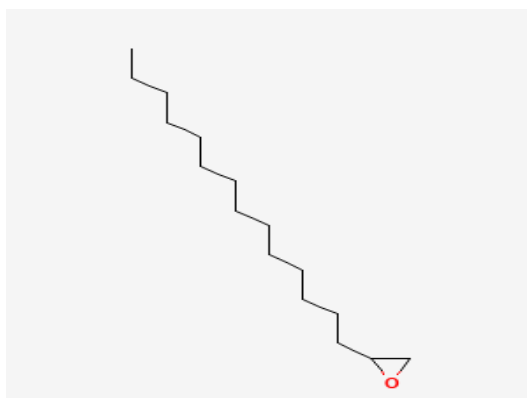


Citronellal

Oxirane (Ethylene oxide) which is present in natural products like *P. macrophylla* and cryptophycin A and B, possess anticancer properties. Ethylene oxide is a versatile compound used to make many products (including batteries, household cleaners, personal care items, etc). It is also a sterilizer for medical equipment



Ethylene oxide is a cyclic ether (formula C_2H_4O) and the simplest epoxide: it is a colourless flammable gas with a sweet odour and has a three-membered ring consisting of one oxygen atom and two carbon atoms.



<https://www.americanchemistry.com/industry-groups/ethylene-oxide/ethylene-oxide-benefits-applications>

Tetradecane is an alkane hydrocarbon containing 14 carbon atoms. It is found in *P. macrophylla* stem bark and serves as an external antifungal and antibacterial. It can therefore promote the healing of wounds and might be responsible for the use of the stem bark of *P. macrophylla* for the treatment of wounds [30].

1.5. Medicinal Properties of Pentaclethra Macrophylla

African oil bean seeds have antimicrobial properties. These seeds reduce cancer growth, treat gastrointestinal diseases, Oil beans seeds also treat leprosy, infertility, gonorrhoea, fever, and convulsion. The anthelmintic properties of African oil beans are essential in the treatment of parasitic worms. *Pentaclethra macrophylla* is traditionally used in Congolese folk medicine to treat Sickle Cell Disease [31].

1.6. Anti-Sickling Properties

Pentaclethra macrophylla possess antisickling properties [31]. The anthocyanin content of plant parts contributes significantly to their antisickling effects. Mpiana et al and Kakule et al have observed the antisickling properties of other plant products containing anthocyanins [32]. Ngbolua et al also observed the antisickling properties of *Garcinia punctata* [33]. The anthocyanin extract may

bind directly with deoxy-HbS molecules and may stabilize the sickle cells red blood cell membrane. *Ocimum canun* and *Annona senegalensis* leaves are other plant products with antisickling properties. The anthocyanin extract inhibits cell dehydration [31].

1.7. Anti-Hyperlipidaemic Activity

P. Macrophylla seeds given different processing treatments (raw, 1st cooking, 2nd cooking, fermented and fermented and salted), were administered (50:50 ratio with standard feed) to streptozotocin-induced diabetic rats for 8 weeks. Levels of plasma, total cholesterol, triglycerides and LDL-cholesterol and increased HDL-cholesterol compared to rats not feed with various processed *P. macrophylla* seeds [34].

1.8. Antimicrobial Activity

The antimicrobial efficacy of the ethanol, methanol and water extracts of *P. macrophylla* seeds was evaluated against seven selected pathogenic microorganisms (*Escherichia coli*, *Staphylococcus aureus*, *Pseudomonas aeruginosa*, *Klebsiella* species, *Salmonella typhi*, *Aspergillus niger* and *Candida albicans*). The growths of test organisms were inhibited by the extracts used and the minimum inhibitory concentration of the extracts ranged between 62.5 - 250

mg/ml. The antimicrobial potency of *P. macrophylla* seeds was more prominent against bacterial isolates than fungal isolates. The seed oil was also found to possess antimicrobial activity [29].

1.9. Antioxidant Activity

The antioxidant capacity of the extracts from three samples (raw, dried and autoclaved) of *P. macrophylla* seeds oil was evaluated using 2, 2-diphenyl-1-picrylhydrazyl (DPPH). For each sample three different solvents were used for extraction (70% ethanol, 80% acetone and acidic 70% acetone). The 70% ethanol extracted samples had the greatest antioxidant activity in the DPPH free radical assay [35].

1.10. Anti-Inflammatory and Analgesic properties

The leaves and seeds of *P. macrophylla* extracts show analgesic and anti-inflammatory activities in mice in-vivo and in-vitro models. The extracts exhibited analgesic activity and anti-inflammatory property using the flick and hot plate tests, acetic acid induced writhing test; and leucocyte counts, pulmonary oedema and oedema paw of mice in a dose-dependent manner (at 30 and 60 mg/kg) [36]. The result explains and justifies the ethno medical use of seeds of *P. macrophylla* for the treatment of itching (inflammatory response) and pain in animals and in man [25].

1.11. Antiulcerogenic Activity

Fermented Aqueous Extract of *Pentaclethra macrophylla* (Benth) seeds possess antiulcerogenic properties [11]. The aqueous extract of fermented *P. macrophylla* seeds possess antiulcerogenic activity. Rat models were studied using acetic acid, aspirin, ethanol, indomethacin and pyloric ligation of ethanol (at the doses of 400 and 800 mg/kg body weight), using omeprazole as standard. The different doses of the extract and the reference drug decreased ($p < 0.05$) the ulcer parameters in a dose-dependent manner in all the ulcer models. Result of the acute toxicity test showed that the extract did not cause any mortality of the animals possessing 5000 mg/kg body weight [11]. Therefore, the enhanced cessation of ulcers is as a result of the synergistic role of biochemicals and microbiomes found in fermented aqueous extract of *P. macrophylla* seeds; indicating that a decoction of fermented aqueous extract of the seeds of *P. macrophylla* could be used in ethnomedicine to treat peptic ulcer.

2. Conclusion

Major component of the stem bark of *P. macrophylla* Benth is 6-octadecanoic acid (25.77%) which was found as an inhibitor of COVID 19 and the major component of the leaf extract is phenanthranone (42.14%) which is used as an alternative to quinine and mefloquine to treat acute malarial attacks. Citronellol and oxirane, tetradecyl- (hexadecylene oxide) were found in the fermented seed extracts. The aqueous extracts from the fruit pericarp and stem bark of *P. macrophylla* are highly toxic and those of leaves and seeds are not. The leaves and seeds extracts demonstrated analgesic and anti-inflammatory properties to justify their usefulness in itching, pain and inflammatory reactions in

ethno veterinary and ethno medical practice. He seeds oil contains significant amounts of sitosterol which may help lower body cholesterol by reducing the amount of cholesterol that may enter the body and may improve symptoms of an enlarged prostate. Scientific information on the medicinal value of *P. macrophylla* despite its numerous ethnobotanical uses is still very limited. Both animal experiments and clinical studies are required to substantiate health claims [37-49].

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