©IDOSR PUBLICATIONS
International Digital Organization for Scientific Research ISSN: 2579-0781
IDOSR JOURNAL OF EXPERIMENTAL SCIENCES 5(1) 1-7, 2020.

A Review of *Pentaclethra macrophylla* (African Oil Bean) Seed

Kwesi Afia

Department of Agricultural Economics and Agribusiness, University of Ghana.

ABSTRACT

Pentaclethra macrophylla is a leguminous tree whose seeds can be fermented to produce different delicacies across some African countries. Prominent among such delicacies is Ugba which is popular among the Igbo of the South Eastern Nigeria. The fermentation is a mixed culture alkaline process involving a variety of microorganisms among which *Bacillus spp.* has been found to be necessary for the development of the aesthetic and organoleptic appeal in the daily diet. *P. macrophylla* contains the twenty (20) essential amino acids and essential fatty acids that make up over 10% of the fatty acids in the oil. *P. macrophylla* seed have medicinal and therapeutic effects because it contains phytochemicals which include alkaloids, saponins, flavonoids, and tannins. Certain phytochemicals may help prevent the formation of potential carcinogens (substances that cause cancer), block the action of carcinogens on their target organs or tissue, or act on cells to suppress cancer development. *P. macrophylla* have antisickling activity due to the presence of polyphenols known for their antioxidant properties and also to other metabolites such as triterpenoids that can easily pass through the dichloromethane fraction. *P. macrophylla* significantly decrease low density lipoprotein cholesterol (LDL-C) level and could potentially reduce cardiovascular risk and prevent atherosclerotic.

Keywords: *Pentaclethra macrophylla,* Phytonutrients, Antioxidant, Free Radicals, Antinutrients.

INTRODUCTION

Pentaclethra macrophylla is a multipurpose tree from Africa with potential for agro forestry in the tropics [1]. It belongs to the family leguminosae and sub-family mimosoideae. It is the sole member of the genus occurring naturally in the humid lowlands of West Africa [2]. It is a leguminous tree and recognized by peasant farmers in the south east of Nigeria for its soil improvement properties [3].

It has been cultivated in Nigeria since 1937 [4]. The tree grows to about 21m in height and about 6 m in girth [5]. The bark is grayish to dark reddish brown. The compound leaves possess a stout angular petiole. The local names include "Congo acacia" in Congo, "Duala Kombola" in Cameroon. It is popular in Nigeria where it is known as Apara in Yoruba, Ukana in Efik, and, the most prominent, Ugba or Ukpaka in Igbo in local parlance [3], in South Eastern part of Nigeria, [6]. It is generally called "African Salad" in Nigeria.

Ugba, an indigenous Nigerian fermented food, is the Igbo name for the fermented seed of African oil bean, estimated to be consumed by about 15 million people in the south-eastern Nigeria. It is a popular Igbo condiment and delicacy made from traditional household solid state fermentation of African oil bean seed. The fermentation is a mixed culture alkaline process involving a variety of microorganisms among which *Bacillus spp.* has been found to be necessary for the development of the aesthetic and organoleptic appeal in the daily diet.

Prominent among the Igbo ethnic group in Nigeria, it is served as snacks, side dish or as a food condiment. However, due to increase in integration and change in food habit, the "African Salad" as it is called is

increasingly gaining popularity across every region in Nigeria [7]. It is an essential food item for various traditional ceremonies where it is mixed with slices of boiled stock fish garnished with boiled vegetables and consumed by all socioeconomic classes. The fermentation methods are not standardized and that may be responsible for different nutritional qualities and flavours in the food.

Fruits are available at most periods of the year because the large woody pods are persistent. Fruits split open explosively with valves curling up. Common uses of *P. macrophylla* include food, salt substitute, edible oil, seed craft, dye, fencing and palings, charcoal, carving bowls, medicine [8]; [9]. Some parts of the plant have medicinal values. The seed, when crushed and eaten with red ants, can induce abortion [10] [11] [12].

P. macrophylla seed contains phytonutrients which include alkaloids, saponins, flavonoids, and tannins, as such have been reported to be effective in the treatment of diarrhea and anemia while the pod and leaf extracts are used in the treatment of convulsion. Fermented African oil bean seed (AOBS) also known as Ukpaka is one of several plants products commonly used in Nigeria as food. The edible seeds require tedious but careful processing and fermentation before they can be eaten as food supplement.

The flat glossy brown edible seeds, averaging 8 (6-10) in number, are contained in a brownish flattened pod [13], which explodes at maturity and disperses the seeds. The number of seeds in the pod depends on the length of the pod and the size of the seeds. The mature dispersed seeds are harvested by gathering them manually from around the tree. The kernel (a dicotyledon), which is gray in color, is embedded in a glossy brownish seed coat. The seeds may be said to be irregular and oval and lies flat in its natural position. [14] identified *P. macrophylla* as a minor food supplement, while other workers [15] [16]; [17] have investigated and found that this oil seed contains 23% – 28% protein. It also contains the twenty (20) essential amino acids and essential fatty acids that make up over 10% of the fatty acids in the oil.

Medicinal Uses of *P. macrophylla*

Some parts of the plant have medicinal values. In Cameroon, the seeds are used to treat infertility while the pods are used to treat convulsion. In Nigeria comparative study of cancer risks and cancer levels have been carried out between the Easterners who ate fermented oil bean and those who did not. An improvement index was also measured between cancer patients who ate ugba as a meal supplement and those who did not, the result indicated that the fermented form of *P. macrophylla* seed as a food supplement has greatly reduced the risks of cancer and some tobacco related diseases. It was discovered that cancer patients who regularly ate fermented oil bean seed as food supplement showed marked improvements in regaining quality health [18].

In Ghana the smoke from burnt leaf is used to treat convulsion, the leaf/stem bark are used to treat diarrhea. The bark as ointment is used to treat itching, the bark decoction is used to treat lactogenicity, and the bark as lotion is used in the treatment of wounds. The seed, when crushed and eaten with red ants, can induce abortion [7].

Phytochemical Contents of *P. macrophylla*

The term “Phytochemicals” refers to a wide variety of compounds produced by plants. They are found in fruits, vegetables, beans, grains and other plants. Scientists have identified thousands of Phytochemicals, although only a small fraction has been studied closely. Some of the more commonly known Phytochemicals include Ascorbic acid (vitamin C), folic acid and vitamin E among others. Some Phytochemicals have either antioxidants or hormone-like actions.

Phytochemicals are promoted for their use in the prevention and treatment of many health conditions, including cancer, heart disease, diabetes, and high blood pressure. There is some evidence that

certain phytochemicals may help prevent the formation of potential carcinogens (substances that cause cancer), block the action of carcinogens on their target organs or tissue, or act on cells to suppress cancer development. Many experts suggest that people can reduce their risk of cancer significantly by eating more fruits, vegetables, and other foods from plants that contain phytochemicals [4].

There are several major groups of phytochemicals. Tannin is a good anti-oxidant, but it reduces the digestibility of legume protein [5]. The polyphenols include a large subgroup of chemicals called flavonoids. Flavonoids are plant chemicals found in a broad range of fruits, grains, and vegetables. They are being studied to find out whether they can prevent chronic diseases such as cancer and heart disease [4]. The is flavones found in foods and supplements such as soy products, red clover, garbanzo beans and licorice, and the lignans found in flaxseed and whole grains may mimic the actions of the female hormone estrogen. These estrogen-like substances from these plant sources are called Phytoestrogens. They may play a role in the development of and protection against some hormone-dependent cancers such as some types of breast and prostate cancer [4]. Other polyphenols (including some flavonoids) act as antioxidants.

The phytochemical screening of *P. macrophylla* revealed the presence of carbohydrates, oleic acid, linoleic acid, lignoceric acid, palmitic acid, polyphenols such as anthocyanins, leucoanthocyanins, quinines and tannins. Saponins, alkaloids, terpenes were also present while flavonoids, coumarines and sterols were not found in the plant. The presence of various secondary metabolites in the plant could justify its medicinal use. Indeed, *P. macrophylla* is reported to treat some gastrointestinal diseases including chronic diarrhea, dysentery and intestinal parasitoids.

Moreover, polyphenols compounds, which are significantly present in the plant, are well known for their large spectrum of pharmacological properties, including antimicrobial, antifungal, antiprotozoal, antiviral and antioxidant activities [2]. Therefore, there is more evidence that these plant's extracts contain some metabolites which inhibit the sickling process of erythrocytes. The promising candidates responsible of this biological activity are anthocyanins and organic acids since besides their remarkable well-known antioxidant properties they have shown *in vitro* antisickling activity [9]. The processed *Pentaclethra macrophylla* seeds have negligible amounts of cyanogenic glycosides and cardiac glycoside that have been reported to stimulate cardiac functions [11].

Free radical scavenging activity of *P. macrophylla*

There is more evidence that the antisickling activity of extracts from *P. macrophylla* could be due not only to the presence of polyphenols known for their antioxidant properties but also to other metabolites such as triterpenoids that can easily pass through the dichloromethane fraction [17]. It has recently been reported over the last decades that reactive oxygen species (ROS) play a key role in the pathophysiology of various ischemic diseases including Sickle cell disease (SCD). Indeed, it is postulated that in SCD, the sickling leads to the modification of the membrane flexibility, which makes it more sensitive and fragile towards free radicals or oxidants.

The oxidative stress is likely due to intravascular sickling and transient vaso-occlusive event that lead to the decrease of nitric oxide (NO), as result of hemolysis [16]. There is evidence that the antisickling and scavenging effects of *P. macrophylla* makes it an attractive potential candidate for SCD therapy for improving the quality life of sicklers. As an antioxidant plant, *P. macrophylla* could prevent hemoglobin from oxidizing into methemoglobin, and therefore could inhibit the oxidative reactions by scavenging ROS before they can damage cells.

Biochemical Effects of Fermented *Pentaclethra macrophylla* Seeds

Fermented seeds of *P. macrophylla* in the diet demonstrated beneficial role in lipid, bilirubin and liver enzyme status *in vivo* in studies on rats. The fermented seeds of *P. macrophylla* is traditionally claimed to be rich in protein [14]. Raw seeds in the diet increased cholesterol lipids, including triglycerides. Raw seeds are not edible and bitter until local fermentation is achieved [10]. Studies on chemical composition of raw seeds found higher concentration of antinutritional factors, in comparison to fermented sample, including saponins, alkaloids, tanins, and phytate, which may be involved in the hyperlipidemic effect of the raw diet, although saponins have been reported to have bitter taste and lowers plasma cholesterol.

On the other hand, fermented seed diet yielded significantly reduced levels of plasma lipids. Fermentation process of *P. macrophylla* seed has been reported to reduce anti-nutritional factors, improve taste, digestibility, and produce flavor which plays an important role in consumer acceptability. Fatty acid analysis found that seeds contain 44-47% oil which has been found to contain mainly unsaturated oleic acid and linoleic acid [3] a polyunsaturated fatty acid associated with lower total and low density lipoprotein cholesterol [17] and reduce risk for coronary heart disease [28]. Conceivably, lipoprotein cholesterol reduction by fermented seed may be associated with the unsaturated fatty acids and reduced level of anti-nutritional factor. A report has previous associated consumption of fermented seeds (Ugba) with lower level of plasma cholesterol [9].

Raw seed increased total protein and albumin while fermented seed decreased the proteins, significantly. Tannin in food depresses growth by depressing protein quality, digestibility and utilization. Although *P. macrophylla* seeds losses about 73.49% of tannin content on fermentation, the residual amount may have important role in protein digestion and absorption. Currently, investigations on the presence or absence of these toxic substances in the fermented beans are lacking. Poor performance and low digestibility of protein found in an experimental rat study were attributed to toxic components in the seeds which impair protein utilization. The effect of fermented seed on liver enzymes enhanced hepatic status as evidenced by their significantly reduced activities in plasma.

Nutritional Potentials of Fermented *P. macrophylla* Seed

P. macrophylla was identified as a minor food supplement by [15], while other workers have investigated and found that this oil seed contains 23-28% protein. It also contains the twenty (20) essential amino acids and essential fatty acids that make up over 10% of the fatty acids in the oil [6]; [7]. The oil content and carbohydrate contained in raw *P. macrophylla* seeds are 53.98 0.99% and 19.16 0.76% dry wt, respectively [17]; [18]. The seed when boiled, processed and fermented for about 3-4 days (72 hours) is called *Ugba or ukpaka* in Igbo language of Eastern Nigeria. In Fulani language of Northern Nigeria, it is called Ataa or Atawa. In Zaire, it is known as Twa Bobala. In Wolof language of Senegal, Gambia and Mauritania, it is called Ataa or Atawa.

The fermented seeds are used traditionally as condiments and seasonings to add flavour to food [6] [7] [8] and used for the preparation of many delicious African delicacies and snacks including, African salad, soups and sausages for eating different staples. It is rich in vitamins and mineral and in high demand for both local consumption and for export. It is a low acid food which could be prepared into flour and explored in food fortification and confectionaries. The seed is a source of edible oil and used for candle making, cooking and soap.

The seeds of *P. macrophylla* which are rich in nutrients (protein, fatty acids and minerals have been found to be a highly nutritive animal feed when fortified [18]. Ingestion of *P. macrophylla* can help to ameliorate the incidence of protein deficiency in Nigeria is high because many people cannot afford meat, fish and

other proteinous animal products due to their astronomic costs [17]. *P. macrophylla* is consumed by many people especially the Igbo. Those who cannot afford conventional sources of animal protein like meat, fish, eggs and so on to go for the cheaper *P. macrophylla* as an alternative plant source of protein using the best identified level of fermentation for maximum utilization and benefit.

Proximate Analysis of fermented *P. macrophylla* Seed

The proximate analysis of fermented *P. macrophylla* seed has shown that the longer the duration of fermentation the higher the percentage protein and lipid content. Fermentation is associated with microbial activities which stimulates better nutrient availability (particularly protein) and digestibility with significant softening of the cotyledons [3]. Fermented *P. macrophylla* seed has been established to produce better nutritional quality products compared to the raw seeds [10]. The microbial enzymes from the fermenting organism aid in hydrolysis of the seed macromolecules. [1] reported that due to the successive processing steps during the fermentation process there was progressive softening of the cotyledons with increased palatability of fermented *P. macrophylla* seeds.

Antinutrient fermented *P. macrophylla* Seed

The anti-nutritional factors of *P. macrophylla* seed such as phytate, cyanide, and oxalate reduce with increased duration of fermentation. Therefore, the longer the duration of fermentation the lesser the quantity of antinutritional factors in the fermented seed. Anti-nutrients have been established to interfere with digestive processes by binding with nutrients and making them unavailable for efficient body utilization.

The presence of anti-nutrients like Tannin interferes with digestive processes by binding the feed proteins, vitamins, minerals and digestive enzymes. The presence of cyanide and oxalate could lead to poisoning. Phytate reduces the availability of dietary phosphorus. It also forms complexes with dietary protein and reduces their availability. The mineral elements of *P. macrophylla* seed such as calcium, magnesium, potassium, sodium and phosphorus increased with longer duration of fermentation.

Effects of *P. macrophylla* Seed on Lipid Profile

Phytochemical and nutritional constituents have been recognized as the basis for using plant or its products in herbal medicine [17]. For instance, the intake of flavonoids in any plant products such as fruit and vegetable tends to decrease cancer risk [18]. *P. macrophylla* seed has been shown to be a good source of dietary nutrients with carbohydrate (10.6%), protein (13.4%) and fat (52.8%) and a good source of important phytochemical components. Fermented *P. macrophylla* contains about 2% of fiber.

Studies report that [11], plant fiber exerts a physiological effect on the lipid metabolism, in that, it prevents the reabsorption of bile acids and also absorption of dietary cholesterol in the intestine thereby leading to the reduction in the quantity of cholesterol entering the circulation. Also the presence of some phytosterols and phytostanols (e.g. steroids) found in many plant sources including fermented *P. macrophylla* seed can inhibit cholesterol absorption. The efficacy and safety of these phytochemicals as plasma cholesterol-lowering agents have been reported by many studies [5] [6]. Any plant product possessing lipid-lowering and antioxidants properties plays a key role in the anti-atherosclerotic process.

P. macrophylla has emerged as one of many dietary herbal products with the potential to reduce cholesterol as well as enhance the safety profile by increasing HDL-C levels in plasma. [3] reports that the administration of *P. macrophylla* seed extract significantly increased HDL-C. Although, the mechanism by which HDL-C increased is not completely understood; however, *P. macrophylla* seeds may have influenced a variety of molecules involved in HDL metabolism and the Reverse cholesterol transport (RCT) system. The first speculation involved in HDL increase may be attributed to the

increase in the amount of ApoA-1 level in the liver which is the main component protein of HDL. ATP-binding cassette transporter A1 (ABCAI) in the hepatocytes, which transports cholesterol within cells to Apo A-1 forming pre-HDL, may have leveraged on those phytonutrients of *P. macrophylla* seed to drive the increase in HDL fraction.

Secondly, HDL containing a reduced level of phospholipids is prone to decomposition and is easily metabolized by endothelial lipase (EL). EL is one of the factors promoting HDL catabolism due to its phospholipase activity and the ability to hydrolyze phospholipid in HDL particles. Thus, it appears that the extract may have decreased the serum endothelial lipase (EL) mass or activity thereby decreasing the HDL catabolism. Therefore, inhibition of EL activity by the extract may have resulted in the elevated level of HDL.

Inhibition of cholesteryl ester transfer protein (CETP) which regulates the transfer of cholesteryl ester from HDL to other fractions of plasma cholesterol is another mechanism that could explain this. As such, HDL fraction may have been elevated through the inhibition of CETP by *P. macrophylla* seed extract. The increase in HDL fraction is clinically significant in the maintenance of good cardiovascular health, in that increase in the concentration of HDL-C have been demonstrated to correlate inversely with coronary heart diseases. HDL-C transports cholesterol from peripheral tissues to the liver for metabolism and excretion thereby decreasing the amount stored in the tissue and the possibility of developing atherosclerotic plaques. As such, HDL-Cholesterol is considered to possess antiatherogenic properties and hence regarded as the good cholesterol.

P. macrophylla significantly decrease low density lipoprotein cholesterol (LDL-C) level. *P. macrophylla* seeds contain a moderate and abundant amount of saponins and tannin, respectively. These phytochemical components have been reported to reduce cholesterol levels [18]. *P. macrophylla* contribute to the inhibition of lipid absorption from the gut due to the presence of saponins and tannins. The significant decrease in serum LDL-C is quite understandable since an increase in serum total cholesterol could be an indirect effect of the increase in serum HDL-C [5]. LDL-C acts as the primary transporter of plasma cholesterol to the peripheral tissues through the arterial walls. It is, therefore, considered the bad cholesterol as it may build up, forming plaques with progression to atherosclerosis and increasing the risk of high blood pressure and stroke [9].

CONCLUSION

P. macrophylla (African oil bean) seed is composed of carbohydrate, protein, fat, ash, moisture and crude fibre which makes it a good source of food for humans. *P. macrophylla* has demonstrated to possess good anti-atherogenic potential evidenced by the reduction in Atherogenic index as it increases the concentrations of HDL-C fraction and decreases the LDL-C fractions. Therefore, consumption of fermented *P. macrophylla* seeds could potentially reduce cardiovascular risk and prevent atherosclerotic process because of it elevates the HDL content of the serum lipid.

REFERENCES

1. Balogun, B. I. (2013). Evaluation of the Nutritional Potentials of Fermented Oil Beans Seed *Pentaclethra macrophyllah* Benth. *PAT*, **9** (2): 73 – 87.
2. Akindahunsi, A. A. (2004). Physicochemical studies on African oil bean (*Pentaclethra macrophylla* Benth.) seed. *Journal of Food Agriculture and Environment*, **2**: 14 - 17.
3. Alinnor, I. J. and Oze, R. (2011). Chemical Evaluation of the Nutritive Value of *Pentaclethra macrophylla* (African Oil Bean) seed. *Pakitan Journal of nutrition*, **10**: 355 - 359.
4. Omeh Y. N., Garuba, O., Adiele, I. P., Ejiofor, U. E. (2014). Some

kidney function parameters of wistar albino rat fed *Pentaclethra macrophylla* seeds meal. *European Journal of Biotechnology and Bioscience*, **2** (3): 17 - 20.

5. Enujiugha, V. N. (2003). Nutrient changes during the fermentation of African oil bean (*Pentaclethra macrophylla* Benth) seeds. *Pakistan Journal of Nutrition*, **2**(5): 320 - 323.
6. Eze, V. C., Onwuakor, C. E. and Ukeka, E. (2014). Proximate composition, biochemical and microbiological changes associated with fermenting African oil bean (*Pentaclethra macrophylla* Benth) seeds. *American Journal of Microbiological Research*, **2**(5): 138 - 142.
7. Nwokeleme, C. O. and Ugwuanyi, J. O. (2015). Evolution of volatile flavour compounds during fermentation of African oil bean (*Pentaclethra macrophylla* Benth) seeds for ''Ugba'' production. *Int J Food Sci*, **2**: 156 – 166.
8. Ogueke, C. C., Nwosu, J. N., Owuamanam, C. I. and Iwouno, J. N. (2010). Ugba, the fermented African oil bean seed; its production, chemical composition, preservation, safety, and health benefits. *Pak J Biol Sci,* **13**(10): 389 - 496.
9. Okorie, C. P. and Olasupo, N. A. (2013). Controlled fermentation and preservation of UGBA – an indigenous Nigerian fermented food. *SpringerPlus*, **2**: 470 – 478.
10. Monago, C. C., Ogbomeh, P. A. and Joshua, P. E. (2004). Effect of African oil bean seed (*Pentaclethra macrophylla*) on blood cholesterol level in rats. *Global J Pure Applied Sci,* **10**(1): 165 - 168.
11. Omeh, N. Y., Ekwerike, E., Ejiofor, U. E. (2014). Oxidative stress status of Wistar albino rats fed *Pentaclethra macrophylla* seeds meal. *American International Journal of Contemporary Scientific Research*, **1**(3): 44 - 48.
12. Omeh, N. Y., Omosun, G., Adiele, I. P. and Ejiofor, U. E. (2014). Some kidney function parameters of wistar albino rat fed *Pentaclethra macrophylla* seeds meal. *Eur J Biotech Biosci*, **2**(3): 17 - 20.
13. Khan, H., Khan, M. A. and Dullah, A. (2015). Antibacterial, antioxidant and Cytotoxic studies of total saponins, alkaloids and sterols contents of decoction of Joshanda: Identification through thin layer chromatography. *Toxicol Ind Health*, **31**(3): 202 - 208.
14. Zhang, L., Zhang, Y., Pei, S., Geng, Y., Wang, C. and Yuhua, W. (2015). Ethnobotanical survey of medicinal dietary plants used by the Naxi People in Lijiang Area, Northwest Yunnan, China. *Journal of Ethnobiology and Ethnomedicine*, **11**: 40 - 56.
15. Leonti, M. (2014). Herbal teas and the continuum of the food-medicine complex: field methods, contextualisation, and cultural consensus. *Journal of Ethnobiology and Ethnomedicine*, **151**: 1028 – 1030.
16. Beyene, B. and Deribe, H. (2016). Review on application and management of medicinal plants for the livelihood of the local community. *Journal of Resources Development and Management*, **22**: 33 - 39.
17. Kamal-Eldin, A. and Moazzami, A. (2009). Plant sterols, and stanols as cholesterol-lowering ingredients in functional foods. *Recent Pat Food Nutr Agric*, 1: 1 - 14.
18. Anioke, I. C. (2019). Effect of Fermented *Pentaclethra Macrophylla Benth* (African Oil Bean) Seed Extract on Plasma Lipid Profile in Healthy Rat Model-A Preliminary Study. *South Asian Research Journal of Natural Products* **2**(1): 1 – 9.