Proximate analyses, in vitro antioxidant activity and GC-MS analyses of fermented 
*Pentaclethra macrophylla* seeds

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**Authors contributions**

Ikechukwu Okoro conceived the idea, designed the work, acquired, analyzed, and interpreted the data, and drafted the paper. Victor Ogugua designed the work, interpreted the data, critically revised the paper for intellectual content, and supervised the research. Parker Joshua also designed the work, interpreted the data, critically revised the paper for intellectual content, and supervised the research. Parker Joshua also designed the work, interpreted the data, critically revised the paper for intellectual content. Christian Amah acquired and interpreted the data and critically revised the paper for intellectual content. Neamani Ikenna acquired and interpreted the data and critically revised the paper for intellectual content. Nene Chiaka-Onyemeze designed the work, interpreted the data, and critically revised the paper for intellectual content. Emeka Anaduaka designed the work and critically revised the paper for intellectual content. David Obasi interpreted the data and critically revised the paper for intellectual content. Prince Okoro and Daniel Orike interpreted the data and critically revised the paper for intellectual content. All authors approved the final version of the paper to be published and agreed to be accountable for all aspects of the work.

**Competing interests**

The authors declare no conflicts of interest.

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**Abbreviations**

GC-MS, Gas Chromatography-Mass Spectrophotometry; FPMSE, Fermented Pentaclethra macrophylla seeds extract; DPPH, 2,2-diphenyl-1-picrylhydrazl.

**Citation**


**Abstract**

The present study assessed the proximate composition, in vitro antioxidant activity and GC-MS analyses of fermented *Pentaclethra macrophylla* seeds extract (FPMSE). The in vitro antioxidant activity was assessed using 2,2-diphenyl-1-picrylhydrazl (DPPH) while Gas Chromatography-Mass Spectrophotometry (GC-MS) technique was used to identify the volatile compounds in FPMSE. FPMSE revealed a dose dependent percentage inhibition of the extract on DPPH assay. Proximate composition of FPMSE constitutes respectively; ash (0.33 ± 0.12%), protein (2.19 ± 0.08%), fats and oil (80.60 ± 0.00%), carbohydrate (16.88 ± 0.00%) while moisture and fibre were not detected. However, the pulsed sample constitute respectively; ash (1.27 ± 0.58%), protein (10.51 ± 0.60%), moisture (8.27 ± 0.12%), fats and oil (32.33 ± 0.12%), fibre (7.27 ± 0.12%) and carbohydrate (40.35 ± 0.00%). GC-MS analyses revealed fourteen (14) fatty acids including Octadecanoic acid (1.95%), Benzyloxyxymethylamine (43.89%), 2-Allylpent-4-enoic acid benzyl ester (26.25%), Hexadecaneoic acid, methyl ester (1.09%), Oleic Acid (0.25%), 9,12-Octadecadienoic acid, methyl ester (Omega-6-fatty acid) (1.52%). The bioactive compounds identified in FPMSE could contribute to the pharmacological properties of *P. macrophylla* seeds and hence, could be of considerable interest for the development of new drugs.

**Keywords:** *Pentaclethra macrophylla*; in vitro antioxidant; GC-MS; fatty acids

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**Background**

Recent epidemiological and experimental studies suggest that excessive free radicals and associated oxidative damage play a significant role in the etiology of various diseases, including asthma, diabetes, Parkinson’s disease, cancers, hypertension, liver disorders, aging, chronic kidney diseases, and other conditions [1, 2]. Free radicals such as the hydroxyl radical (HO•), superoxide radical (O2–), nitric oxide radical (NO•), and lipid peroxyl radical (LOO•) are implicated in cellular damage and, in severe cases, can lead to cell death. These radicals are predominantly generated during biological and physiological processes [3].

All living things have built-in defenses against free radicals that include enzymes, vitamins, and a variety of other additional antioxidants. Antioxidants are essential for sustaining good health and wellbeing since they serve as our first line of defense against free radical damage [4]. Free radical damage that typically occurs during cell metabolism has been observed to be lessened by natural antioxidants obtained from plant parts [5]. Some of the free radical-scavenging compounds found in plants included but not limited to terpenoids, phenolic acids, lignins, stilbenes, tannins, flavonoids, quinones, coumarins, alkaloids and amines [6].

The use of medicinal plants in the provision of healthcare has been since time immemorial. The annual market value for pharmaceuticals surpasses $100 billion worldwide [7]. Plants’ pharmacological or chemotherapeutic effects are caused by natural bioactive chemicals that are present in them [8].

*P. macrophylla* Benth (oil bean) commonly known as *ugba* or *ukpaka* in Igbo language and *Aparu* in Yoruba has been used as a source of raw materials in pharmaceutical industries and have been reported to be nutritious with medicinal effects [9]. African oil bean when processed is a popular condiment and meat analogue among consuming populations [10]. In Congo it is commonly known as “Congo acacia” while it is referred to as “Duala Kombola” in Cameroon [11]. Properly processed and fermented African oil bean seeds are used for the preparation of many delicious African delicacies including soup, African salad amongst others [10]. It has been documented that fermentation of *P. macrophylla* seed notably reduced the amount of paucine which is an alkaloid with detrimental effect [12].

*P. macrophylla* has been reported to contain some bioactive components which could be attributed to its therapeutic potentials [9, 13]. Extracts from different parts of the plant including the leaves, seeds, kernel, roots, bark and stem bark have been reported to serve for different medicinal purposes in Nigeria, Ghana and Cameroon [14]. Anioke reported that African oil bean seeds could protect against atherosclerosis [15] while its use in the treatment of peptic ulcer has been documented [16]. It’s anti-microbial, wound healing as well as antidiarrhea activities have been documented [17]. The ocular hypotensive potential of the oil bean extract has also been documented [18].

There is paucity of information on the in vitro antioxidant activities and GC-MS analyses of *P. macrophylla* seeds which warranted this research.

**Materials and methods**

Plant materials

Fresh seeds of *P. macrophylla* were procured from Ogige Market, situated in the central area of Nsukka Local Government, Enugu State, Nigeria. The seeds were authenticated by Mr. Alfred Ozioko from the Bioresources Development and Conservation Programme (BDCP) Research Centre in Nsukka, Enugu State. Following conventional processing, the seeds were air-dried and pulverized into powder. A voucher specimen bearing the herbarium number Intercedd/1572 has been deposited for reference (Figure 1).

**Chemicals and reagents**

The analytical grade chemicals and reagents utilized in this study were produced by Sigma Aldrich (United States); British Drug House (BDH) (England); Burugoyne (India); Harkin and Williams (England); Qualikems (India); Fluka (Germany) and May and Baker (England).

**Traditional production of Ugba**

Little alteration was made to the usual preparation technique [19]. After carefully removing any rotting seeds, the *P. macrophylla* seeds were properly sorted and washed. The seed was then cooked for two hours at 100 °C to soften the coat and improve peeling. Before dehauling, the boiled seed was allowed to cool for 10 minutes at 34 °C. The cotyledons were then washed and sliced longitudinally into 3.5–5.0 cm x 1.0–1.1 cm slices and boiled in water for an hour at 100°C. Thereafter, the slices were drained and soaked in water overnight. The following day, the slices were washed in several changes of water to reduce bitterness before letting them drain in a sieve. For two days, the seed was allowed to ferment within a covered bucket. The fermented seeds were then crushed and prepared for extraction after drying for three weeks (or 23 days) at room temperature (28 ± 2 °C) on an aerated basket.

The pulverized seeds (4 kg) were macerated in 7.5 liters of n-hexane for three days, filtered through a cotton towel into a flat-bottom flask, and further purified using Whatman No. 1 filter paper. The filtrate was concentrated at 45 °C using a rotary evaporator (Gongyi Yuhua Instrument Co., Ltd., China) to produce an oily extract, which was then stored in a refrigerator (Thermocool, England) until needed.

**Determination of proximate composition of fermented *P. macrophylla* seeds extract**

In accordance with the Association of Official Analytical Chemists, AOAC, proximate analysis was performed [20].

**Determination of 2,2-diphenyl-1-picrylhydrazl radical scavenging assay of FPMS**

The extract’s ability to scavenge radicals, specifically 2,2-diphenyl-1-picrylhydrazl (DPPH), was assessed utilizing the Brand-Williams et al method [21]. DPPH is a purple-coloured, stable free radical whose intensity may be detected by spectrophotometry at a wavelength of 517 nm. Antioxidants convert DPPH into a colourless substance called 1, 1-diphenyl-2-picrylhydrazine. A 0.1 mM DPPH solution in ethanol was made. The extract was mixed with this solution (3 ml) at several concentrations (2.5, 5.0, 7.5, 10, and 12.5 mg/ml). After giving the mixture a good shake and letting it stand at room temperature in the dark for 30 minutes, a spectrophotometer was used to measure the absorbance at 517 nm. Using the inhibition curve, the sample’s IC50 value—the concentration of the sample needed to inhibit 50% of the DPPH free radical—was determined.

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*Figure 1 The morphology of Ugba seeds viewed in Okoro et al [18]*

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Using different ascorbic acid (standard) concentrations, a linear graph of concentration vs. percentage inhibition was created, and IC\textsubscript{50} values were computed. The formula used below was used to calculate the percentage DPPH scavenging activity:

\[
\% \text{ Inhibition} = \frac{\text{Blank} - \text{Extract or standard}}{\text{Blank}} \times 100
\]

where Blank represented the absorbance of the control while the absorbance in the presence of the sample was represented by Extract or Standard.

**GC-MS analysis of N-hexane extract of FPMSE**

The characterization of volatile compounds in N-hexane extract of fermented \textit{P. macophylla} were carried out using GC-MS QP2010 Plus (Shimadzu, Japan). The ionization voltage was 70 eV. Gas Chromatography was conducted in the temperature programming mode with a Restek column (0.25 mm, 60m, XTI-5). The initial column temperature was 80 °C for 1 min, and then increased linearly at 70 °C min\textsuperscript{-1} to 220 °C, held for 3 min followed by linear increased temperature 10 °C min\textsuperscript{-1} to 290 °C for 10 min. The temperature of the injection port was 290 °C and the GC-MS interface was maintained at 290 °C. The sample was introduced via an all-glass injector working in the split mode, with helium carrier gas low rate of 1.2 ml min\textsuperscript{-1}. The identification of compounds was accomplished by comparison of retention time and fragmentation pattern, as well as with mass spectra of the GC-MS.

**Results**

Proximate composition of fermented pulsed sample and N-hexane extract of FPMSE

Table 1 presents the results of the proximate composition for both the fermented pulsed seeds and the n-hexane extract of FPMSE. The results are expressed as means ± standard deviation (SD) with n = 3. Mean values that have different letters as superscripts down the columns and different numbers as superscripts across the rows are considered significantly different at P < 0.05. The n-hexane extract contains ash (0.33 ± 0.12%), protein (2.19 ± 0.08%), fats and oil (80.60 ± 0.00%), and carbohydrate (16.88 ± 0.00%), with no detectable moisture or fiber. In contrast, the pulsed seeds contain ash (1.27 ± 0.58%), protein (10.51 ± 0.60%), moisture (8.27 ± 0.12%), fats and oil (32.33 ± 0.12%), fiber (7.27 ± 0.12%), and carbohydrate (40.35 ± 0.00%).

**DPHP scavenging activity of N-hexane extract of FPMSE**

The Table 2 below shows the DPPH scavenging activity of FPMSE. A dose dependent percentage inhibition of the extract on DPPH was observed. The DPPH percentage inhibition at higher concentrations of FPMSE was found to be significantly (P < 0.05) higher than lower concentrations. Meanwhile, the IC\textsubscript{50} of the extract was 24.74 while that of the standard was 1.88 (Table 2). Figure 2 shows the graphs of percentage inhibition against concentrations of both FPMSE and the standard (ascorbic acid) respectively.

**Volatile compounds identified in N-hexane extract of FPMSE using gas chromatography-mass spectrometry**

Table 3 below lists the volatile compounds identified in the N-hexane extract of \textit{P. macophylla} seeds. The compounds include Octadecanoic acid (1.95%), Benzyloxyethylamine (43.89%), 2-Allylpent-4-enolic acid benzy1 ester (26.25%), Methyl 10-methyl-hexadecanoate (0.60%), Hexadecanoic acid, methyl ester (1.09%), Oleic Acid (0.25%), 9,12-Octadecadienoic acid, methyl ester (Omega-6-fatty acid) (1.52%), 10-Heneicosenoic (c,t) (1.90%), Cyclopentadecanone, 2-hydroxy (3.2%), 11,14-Octadecadienoic acid, methyl ester (2.83%), 9-Octadecenoic acid, (E) - (2.54%), 6-Octadecenoic acid, methyl ester (Z) - (1.26%), and Heptadecanolide (5.32%). Figure 3 displays the chromatogram of fatty acids in FPMSE.

Table 1 Proximate composition of fermented pulsed sample and n-hexane extract of FPMSE

<table>
<thead>
<tr>
<th></th>
<th>Pulverised sample (%)</th>
<th>Extract (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ash</td>
<td>1.27 ± 0.58\textsuperscript{a}</td>
<td>0.33 ± 0.12\textsuperscript{a}</td>
</tr>
<tr>
<td>Protein</td>
<td>10.51 ± 0.60\textsuperscript{b}</td>
<td>2.19 ± 0.08\textsuperscript{b}</td>
</tr>
<tr>
<td>Moisture</td>
<td>8.27 ± 0.12\textsuperscript{c}</td>
<td>0.00 ± 0.00\textsuperscript{c}</td>
</tr>
<tr>
<td>Fats and oil</td>
<td>32.33 ± 0.12\textsuperscript{d}</td>
<td>80.60 ± 0.00\textsuperscript{d}</td>
</tr>
<tr>
<td>Fibre</td>
<td>7.27 ± 0.12\textsuperscript{e}</td>
<td>0.00 ± 0.00\textsuperscript{e}</td>
</tr>
<tr>
<td>Carbohydrates</td>
<td>40.35 ± 0.00\textsuperscript{f}</td>
<td>16.88 ± 0.00\textsuperscript{f}</td>
</tr>
</tbody>
</table>

Table 2 DPPH scavenging activity of fermented n-hexane extract of FPMSE

<table>
<thead>
<tr>
<th>Conc. (mg/ml)</th>
<th>DPPH % inhibition</th>
</tr>
</thead>
<tbody>
<tr>
<td>FPMSE</td>
<td>Conc. (mg/ml)</td>
</tr>
<tr>
<td>2.5</td>
<td>2.80 ± 0.88\textsuperscript{a}</td>
</tr>
<tr>
<td>5</td>
<td>5.66 ± 1.18\textsuperscript{b}</td>
</tr>
<tr>
<td>7.5</td>
<td>12.32 ± 0.83\textsuperscript{c}</td>
</tr>
<tr>
<td>10</td>
<td>16.18 ± 3.42\textsuperscript{d}</td>
</tr>
<tr>
<td>12.5</td>
<td>24.63 ± 1.32\textsuperscript{e}</td>
</tr>
</tbody>
</table>

Figure 2 The graphs of percentage inhibition against concentrations of both FPMSE and the standard (ascorbic acid) respectively.
Table 3 Volatile compounds identified in N-hexane extract of FPMSE and their biological activities using gas chromatography-mass spectrometry

<table>
<thead>
<tr>
<th>Peak No.</th>
<th>Compound identified</th>
<th>Retention time</th>
<th>Area (%)</th>
<th>Molecular formula</th>
<th>Molecular weight g/mol</th>
<th>Structures</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Octadecanoic acid</td>
<td>7.488</td>
<td>1.95</td>
<td>C_{18}H_{36}O_2</td>
<td>284.5</td>
<td><img src="image" alt="Octadecanoic acid" /></td>
</tr>
<tr>
<td>2</td>
<td>Benzyloxymethylimine</td>
<td>7.938</td>
<td>43.89</td>
<td>C_8H_9NO</td>
<td>135.16</td>
<td><img src="image" alt="Benzyloxymethylimine" /></td>
</tr>
<tr>
<td>4</td>
<td>2-Allylpent-4-enoic acid benzyl ester</td>
<td>7.984</td>
<td>26.25</td>
<td>C_{15}H_{18}O_2</td>
<td>230.3</td>
<td><img src="image" alt="2-Allylpent-4-enoic acid benzyl ester" /></td>
</tr>
<tr>
<td>5</td>
<td>Methyl 10-methyl-hexadecanoate</td>
<td>30.967</td>
<td>0.60</td>
<td>C_{18}H_{36}O_2</td>
<td>284.5</td>
<td><img src="image" alt="Methyl 10-methyl-hexadecanoate" /></td>
</tr>
<tr>
<td>6</td>
<td>Hexadecanoic acid, methyl ester</td>
<td>31.041</td>
<td>1.09</td>
<td>C_{17}H_{34}O_2</td>
<td>270.5</td>
<td><img src="image" alt="Hexadecanoic acid, methyl ester" /></td>
</tr>
<tr>
<td>9</td>
<td>Pentadecanoic acid, 14-methyl-, methyl ester</td>
<td>31.134</td>
<td>1.02</td>
<td>C_{17}H_{34}O_2</td>
<td>270.5</td>
<td><img src="image" alt="Pentadecanoic acid, 14-methyl-, methyl ester" /></td>
</tr>
<tr>
<td>10</td>
<td>Oleic Acid (octadec-9-enoic acid) Linoleic acid</td>
<td>36.329</td>
<td>0.25</td>
<td>C_{18}H_{34}O_2</td>
<td>282.5</td>
<td><img src="image" alt="Oleic Acid (octadec-9-enoic acid) Linoleic acid" /></td>
</tr>
<tr>
<td>11</td>
<td>9,12-Octadecadienoic acid, methyl ester (Omega-6-fatty acid) Linoleic acid</td>
<td>36.430</td>
<td>1.52</td>
<td>C_{18}H_{36}O_2</td>
<td>294.5</td>
<td><img src="image" alt="9,12-Octadecadienoic acid, methyl ester (Omega-6-fatty acid) Linoleic acid" /></td>
</tr>
<tr>
<td>12</td>
<td>10-Heneicosene (c, t)</td>
<td>36.490</td>
<td>1.90</td>
<td>C_{20}H_{42}</td>
<td>294.6</td>
<td><img src="image" alt="10-Heneicosene (c, t)" /></td>
</tr>
<tr>
<td>13</td>
<td>Cyclopentadecanone, 2-hydroxy</td>
<td>36.573</td>
<td>3.20</td>
<td>C_{17}H_{32}O_2</td>
<td>240.38</td>
<td><img src="image" alt="Cyclopentadecanone, 2-hydroxy" /></td>
</tr>
<tr>
<td>14</td>
<td>11,14-Octadecadienoic acid, methyl ester</td>
<td>36.616</td>
<td>2.83</td>
<td>C_{19}H_{38}O_2</td>
<td>294.5</td>
<td><img src="image" alt="11,14-Octadecadienoic acid, methyl ester" /></td>
</tr>
<tr>
<td>15</td>
<td>9-Octadecenoic acid, (E)-</td>
<td>36.674</td>
<td>2.54</td>
<td>C_{18}H_{32}O_2</td>
<td>282.5</td>
<td><img src="image" alt="9-Octadecenoic acid, (E)-" /></td>
</tr>
<tr>
<td>16</td>
<td>6-Octadecenoic acid, methyl ester (Z)-</td>
<td>36.709</td>
<td>1.26</td>
<td>C_{18}H_{32}O_2</td>
<td>310.5</td>
<td><img src="image" alt="6-Octadecenoic acid, methyl ester (Z)-" /></td>
</tr>
<tr>
<td>17</td>
<td>Heptadecanolide</td>
<td>36.748</td>
<td>5.32</td>
<td>C_{17}H_{32}O_2</td>
<td>268.4</td>
<td><img src="image" alt="Heptadecanolide" /></td>
</tr>
</tbody>
</table>
Discussion

Results of the proximate composition of both fermented pulvrisued sample and n-hexane extract of *P. macrophylla* benth seed showed that that n-hexane extract had highest percentage composition of fats and oil (80.60%) followed by carbohydrates (16.88%) while moisture and fibre were undetected. However, the fermented pulvrisued seeds had the highest percentage composition of carbohydrates (40.35%) followed by fats and oil (32.33%) with moisture content of 8.27% and fibre, 7.27%. The former compare well with previous studies [22, 23]. Eze et al reported the presence of protein, fats, fibre, carbohydrates, and ash in a fermenting seeds of oil bean [24]. The result also compares well with Okwu and Aluwo though with variation in terms of amount. This could be as a result of varied fermentation times and procedure [25].

When the oil bean seed was not extracted, it had high amounts of fat, protein, and carbohydrates. Since it has the ability to provide the basic energy requirements of both humans and animals, it should be of particular importance, especially now that finding enough food to feed the world’s expanding population has become a serious worry. Fats and oil commonly known as lipids are necessary for the production of hormones, the upkeep of cell membranes and blood vessels, and the delivery of energy for metabolic processes. They are essential for both physical and mental well-being. Lipids are also necessary building blocks for the creation of prostaglandins (PGs), which are active chemicals with short half-lives and ranges that regulate inflammatory processes, blood clotting mechanisms, blood arterial pressure, and other processes [26]. In addition to being the body’s means of storing energy, fats also serve as carriers of the vitamins A, D, E, and K [27]. The high content of these nutrients in the fermented seeds of *P. macrophylla* makes them a good source of energy and crude fat.

Carbohydrates are a significant class of naturally occurring organic molecules that are vital for the upkeep and nourishment of life in plants and animals as well as serving as raw materials for numerous businesses [28]. They also help regulate blood glucose. The primary energy source for the human body is carbohydrate. They support the energy needs of the central nervous system, muscles, kidneys, heart, and brain [29].

Fiber's function in diets is to give food bulk and promote peristaltic movement in the intestines. A high fiber diet is linked to a lower incidence of diabetes mellitus, colon cancer, and cardiovascular disorders in people. According to Onoja et al. [30] a high fiber diet is considered a hypocholesterolaenic and anti-tumorigenic agent. Fibers are components of fruits, cereals, and vegetables that the body is unable to absorb or digest. Contrary to popular belief, which holds that seeds are a source of indigestion and constipation, this component offers the bulk necessary for efficient peristaltic activity in the intestinal tract and hence promotes digestion [22].

The moisture concentration of the seed indicates that microbial or hydrolytic action could seriously degrade the fatty contents. Moisture content varies according to when they are harvested, when they mature, and the environmental factors. Food moisture needs to be analyzed and controlled because low-moisture foods typically inhibit the growth of microorganisms [29]. Therefore, a careful reduction in the moisture content would be necessary for the preservation of *P. macrophylla* seeds.

A food’s total mineral content can be determined by looking at its ash content [31]. The body needs minerals to function properly on a physiological level. A plant-based food’s ash level depends on the mineral components it contains. Dietary ash has shown promise in restoring and preserving the blood system’s acid-alkaline balance and in managing the condition known as hyperglycemia [32]. Fermented *P. macrophylla* seed had a significant number of inorganic materials, as shown by the ash content.

After water, proteins make up the second most common material in our bodies. They are essential for the growth and development of every bodily part as well as for sustaining overall health. They are biological macromolecules with a wide range of functions that serve as the primary building blocks for virtually all bodily tissues, and internal organs including the heart and brain [28]. Energy production and the proper quantity of necessary amino acids depend on protein [33]. Human body requires proteins for tissue growth and maintenance. Proteins also support biochemical reactions that occur both inside and outside of cells. Moreso, proteins are necessary for the production of minimum globulins, or antibodies, which are necessary to fight infection. Without these antibodies, bacteria and viruses would be free to proliferate and infect the body with diseases. The body needs proteins in order to produce blood plasma, hormones, and enzymes. They strengthen the immune system and aid in both cell division and proliferation [34]. The recommended daily allowance (NRC) for protein is 0.8 g/kg of body weight, hence the protein content in fermented *P. macrophylla* seed meet daily requirements. Hence, consumption of FPMSE could go a long way in supplying the required nutrients needed in the body while keeping the body fit for daily tasks.

Fermented *P. macrophylla* seed extract’s capacity to scavenge free radicals increased in a dose-dependent manner, according to its in vitro antioxidant activity using DPPH. The DPPH test is a simple and reliable technique to determine whether antioxidants can cause the stable free radical DPPH to decolourize [35]. The same trend was found with the standard (ascorbic acid). The result was not comparable to the findings of Koto-te-Niyama et al. [36] who worked on the bark extract which may be due to variation in concentration of the active ingredients in different part of the plants. The FPMSE may be employed as a main antioxidant because of its capacity to donate protons to free radicals, as demonstrated by their free radical scavenging activity [37]. Since antioxidants are our first line of defense against harm from free radicals, they are crucial for maintaining good health and wellbeing [4]. Oxidative damage is currently believed to be the underlying mechanism behind a wide range of human neurologic and other ailments, including inflammation, viral infections, autoimmune pathologies, and digestive system problems such as gastrointestinal inflammation and ulcers [38]. Hence, the antioxidant capacity of FPMSE could contribute in mopping up reactive oxygen species associated with diseases.

GC-MS analyses of FPMSE revealed the presence of fourteen volatile
compounds of which Benzylxoxymethylidine (43.89%) highest followed by 2-Allene-4-enolic acid benzyl ester (26.25%), among other important compounds including octadecanoic acid, oleic acid and 9,12-octadecadienoic acid, methyl ester (Omega-6-fatty acid).

Fatty acids are essential constituents of the human body, having biological, structural and functional roles. In addition to serving as an energy source, they are essential components of cellular membranes. Omega-3 and omega-6 polyunsaturated fatty acids (PUFAs) appear to be the most significant of these fatty acids because of their numerous biological functions, which include modulating the inflammatory cascade, lowering oxidative stress, providing neuroprotection, and protecting the heart [39].

The anti-inflammatory activities of octadecanoic acid have been documented [40]. Imines are vital components of many biological systems, including eyesight and a wide range of enzyme reactions. For instance, the biomolecule known as rhodopsin, which is responsible for vision, is the result of an imine synthesis. It is formed by the reaction between the lysine amino side chain of opsin and the aldehyde group of the retinal chromophore cis-retin. The imine undergoes isomerization in response to light, which eventually results in the transmission of an electrical impulse to the brain [41]. Benzylxoxymethylidine identified in high amount in FPMSE as an imine might contribute in the formation of rhodopsin thereby aiding vision. Moreso, the presence of Omega-6 fatty acid among other fatty acids as found in this study may have contributed in its capacity in mopping up free radicals implicated in diseases.

The GCMS composition of FPMSE was in concordance with the findings of Azi et al. who identified some volatile compounds such as acids, esters, alcohols, aldehydes, phenol, hydrocarbons, and furans which were also identified in this study [42]. These aromatic compounds contributed heavily to the flavoring agent properties of oil bean which makes it more acceptable a flavoring agent [43]. Similarly, Anowo et al reported the presence of fatty acids such as linoleic acid, hexadecanoic acid among others fermented seed extracts of oil bean which compared well to the current study [44]. An essential fatty acid that must be consumed through diet, linoleic acid is known to have the following therapeutic potentials such as lowering of blood pressure, prevention of cancer, treatment of cardiovascular conditions like atherosclerosis and coronary heart disease [45].

The following therapeutic benefits of hexadecanoic acid have been documented: hypocholesterolemia, antioxidant, antifungal, and antibacterial activity [46]. Diets high in unsaturated fatty acids have generally been shown to lower total cholesterol, which lowers the chance of developing chronic heart disease by a considerable amount [45]. These bioactive substances have the potential to greatly increase the nutritional and therapeutic benefits of P. macrophylla seed.

Conclusion

The findings from the present study revealed that FPMSE possess antioxidant activities which could be traced to the rich bioactive components identified using GC-MS. Hence, consumption of properly processed FPMSE will not only supply the desired nutrients but also serve as a therapeutic agent to the body and as a result should be encouraged.

References


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