Characterization of Chemical Composition of *Bryophyllum pinnatum* Leaf Ethyl Acetate Fraction

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**Authors’ contributions**

There was total collaboration among all authors in the execution of this study. Authors CUI, ESA, VAO, KMEI and JNI designed the study and wrote the protocol, while authors CUI, ESA, JNI and KMEI performed the statistical analysis and interpretation of study data. Authors ESA and JNI did the literature searches, while author ESA wrote the first draft of the manuscript and incorporated all corrections from co-authors. Authors CUI, VAO and KMEI critically revised the manuscript for intellectual content. All authors read and approved the final manuscript.

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**ABSTRACT**

**Aims:** To characterize the chemical composition of *Bryophyllum pinnatum* leaf ethyl acetate fraction.  
**Methodology:** Quantitative phytochemical composition was assessed using gas chromatography fitted with flame ionization detector (GC-FID), while chemical characterization was via gas chromatography-mass spectrophotometry (GC-MS) analysis. The mass spectra peaks were matched with those found in the National Institute of Standard and Technology (NIST) spectral database.  
**Results:** Results revealed a rich presence of proanthocyanin, rutin, quinine, flavan-3-ol, anthocyanin, lunamarin, sapogenin, phenol, flavonones, steroids, epicatechin, kaempferol, phytate, oxalate, resveratol, catechin, flavones, tannin, ribalinidine, naringin, and spartein in varying proportion in *B. pinnatum* leaves ethylacetate fractions. GC-MS analysis of the fractions revealed

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1. INTRODUCTION

Plants have been widely applied in traditional medicine for management of diseases or as adjuvants to promote drug action. They are identified as important source of phyto-active compounds with verifiable medicinal properties. Plants have the ability to synthesize a wide variety of chemical compounds used to perform important biological functions, defend against attacks from predators such as insects, fungi and herbivorous mammals, and as well serve as nutrient source for humans [1, 2]. At least twelve thousand (12000) of such compounds have been isolated so far; a number estimated to be less than 10% of the total [3]. Many of the pharmaceuticals currently available to physicians have a long history of use as herbal remedies or where produced as analogues of plant products [4]. The World Health Organization (WHO) estimates that 80% of Asians and Africans living in the suburbs and rural communities depend largely on herbal medicine for their primary healthcare [5]. The importance of traditional system of medicine and of certain traditional medical practices are widely recognized all over the world. Recently, some authors have suggested that traditional medical system should be integrated into the mainstream of healthcare services due to their easy accessibility, availability, cultural acceptability, therapeutic potential and minimal cost [6, 7]. Medicinal properties of plant and plant products are associated with their phytochemical composition.

Phytochemicals, also known as phytonutrients, are grouped into several classes according to their chemical structure and biological activity. They have been widely applied for their medicinal properties as pure compounds, fruit and vegetable crude extracts. Phytochemicals such as phenolic compounds, terpenoid compounds, and alkaloids have been investigated for their beneficial effect in various disease conditions [8].

The presence of at least 50 constituents. The major constituents were Hexadecanoic acid, methyl ester (24.88%), 10,13-Octadecadienoic acid, methyl ester (29.69%), Tetracosanoic acid, methyl ester (7.84%), Methyl stearate (6.97%), cis-Methyl 11-eicosenoate (6.26%), Methyl 18-methylnonadecanoate (4.99%), Docosanoic acid, methyl ester (3.71%) and 4,7-Methano-1H-indene, octahydro- (2.43%).

**Conclusion:** This rich array of chemical compounds presents *B. pinnatum* leaves as an important source of potential lead compounds with biological and pharmacological benefits and hence a potential candidate for drug discovery.

**Keywords:** Phytochemicals; GC-MS; methyl esters; medicinal plant; Bryophyllum pinnatum.

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**B. pinnatum** (*Crassulaceae*) commonly known by names such as air plant, love plant, miracle leaves, life plant, etc. [9], grows primarily in the rain forest belt but is widely distributed worldwide [10]. Among the Igbo of southeastern Nigeria, it is known as ‘odaa opue’, and ‘ewe abamoda’ or ‘odundun’ by the Yorubas [11]. The leaves, stem and roots of the plant have been traditionally known to be beneficial in the treatment of a number of conditions in Africa, Asia, Australia and tropical America [12, 13]. The leaves and stem of *B. pinnatum* are applied in ethno-medicine for management of a plethora of disease conditions; ranging from inflammation, analgesic, wound healing, facilitation of the dropping of placenta of newly born baby, diarrhea, coughs, bronchial infections, gastric ulcers etc [14, 15]. Recent works have focused on beneficial properties such as free radical scavenging activity [16, 17, 9], hepatic-protective activity [18], and anti-ulcer activity [11, 19]. The proximate composition, mineral, lipids and amino acid compositions of of *B. pinnatum* have been reported [20-22]. Extensive understanding of the chemical compositions of medicinal plants is important in drug discovery and design. The present study is aimed at quantitation of phytochemicals and characterization of the specific bioactive compounds of *B. pinnatum* leaves ethyl acetate fraction by gas chromatography - mass spectrum (GCMS) analysis. This study will elucidate the active principles responsible for its numerous reported medicinal properties and provide a template for identification, isolation and purification of these compounds for further analysis and drug design.

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**2. MATERIALS AND METHODS**

**2.1 Plant Materials**

Fresh leaves of *B. pinnatum* were collected from a garden at Umunam village, Ngor Okpala L.G.A., Imo State. The plant materials were authenticated by Prof. F. N. Mbagwu a plant
taxonomist at the Department of Plant Science and Biotechnology, Imo State University, Owerri, Imo State. Plant specimens were deposited in the institution’s herbarium with voucher number IMSUH 0225.

2.2 Preparation of Extract

Fresh leaves of *B. pinnatum* were carefully shed from the stem; this was dried at 30°C and ground to fine powder using a blender (Kenwood BL357). The powder (800g) was extracted with 2 L of 80% ethanol using a Soxhlet extractor. The ethanol extract was partitioned between ethyl acetate and water to recover ethyl acetate soluble component of the extract. The extract was recovered by distillation under reduced pressure at 49°C in a Buchi rotavapour (Switzerland), then dried to solid forms in vacuum desiccators, and stored in a freezer (≤ 4°C ) until when needed.

2.3 Quantitative Phytochemical Content Determination

One gram (1g) of processed sample was weighed into a test tube and 15ml ethanol and 10ml of 50%/m/v potassium hydroxide were added. The mixture in the test tube was allowed to react in a water bath at 60°C for 60mins. Later, the reaction product was transferred to a separation funnel. The tube was washed successfully with 20ml of ethanol, 10ml of cold water, 10ml of hot water and 3ml of hexane, which were all transferred into the funnel. The combined extracts were washed three times with 10ml of 10%/v/v ethanol aqueous solution; and dried with anhydrous sodium sulfate. The extract was solubilized in 1000µl of pyridine of which 200µl was transferred to a vial for analysis [23]. The analysis of free steroids was performed on a BUCK M910 Gas chromatography equipped with a flame ionization detector. A RESTEK 15 meter MXT-1 column (15m x 250µm x 0.15µm) was used. The injector temperature was 280°C with split less injection of 2µl of sample and a linear velocity of 30cms-1, Helium 5.0 Pa s was the carrier gas with a flow rate of 40 ml min-1. The oven operated initially at 200°C, was heated to 330°C at a rate of 3°C min-1 and was kept at this temperature for 5min. The detector operated at a temperature of 320°C; phytochemicals were determined by the ratio between the area and mass of internal standard and the area of the identified phytochemicals. The concentrations of the different phytochemicals were expressed in µg/g.

2.4 Characterization of Bioactive Compounds

Characterization of plant extract bioactive compounds was carried out using GC-MS analysis on a Varian 450-GC and 240-MS system (Varian, Salt Lake City, USA) fitted with an electron impact mode injector (70 eV) and a Varian data system.

The compounds in the GC-MS chromatogram of *B. pinnatum* leaves ethyl acetate fraction analysed were identified using mass spectrometry. The interpretation of mass spectra peaks of detected unknown compounds was done by matching with database of known component stored in NIST. Major components were identified with authentic standards obtained from computerized libraries. The compound name, molecular formula, peak area, retention time and mass/charge ratio were ascertained. The relative percentage amount of each component was determined by matching its average peak area to the total area.

3. RESULTS AND DISCUSSION

3.1 Phytochemical Content of *B. pinnatum* Leaves Ethyl Acetate Fraction

Results of quantitative phytochemical composition of *B. pinnatum* leaves ethyl acetate fraction showed a rich presence of important phytochemicals such as proanthocyanin, rutin, quinine, flavan-3-ol, anthocyanin, catechin, sapogenin, phenol, flavonones, steroids, epicatechin, kaempferol, phytate, oxalate, resveratol, flavones, tannins, biberidin, naringin, and spartein (Table 1). *B. pinnatum* leaves fraction contains 0.15 ± 0.15, 2.34 ± 0.19, 1.68 ± 0.08, 2.18 ± 0.26, 23.65 ± 1.18, 6.18 ± 0.25, 10.25 ± 0.92, 13.75 ± 0.96, 20.65 ± 0.83, and 6.86 ± 0.26 µg/g of proanthocyanin, rutin, quinine, flavan-3-ol, anthocyanin, catechin, sapogenin, phenol, flavonones, steroids, and epicatechin respectively. Others include kaempferol, phytate, oxalate, resveratol, flavones, tannins, biberidin, naringin, and spartein in concentrations of 19.86 ± 1.59, 25.78 ± 1.55, 30.62 ± 1.84, 28.91 ± 2.89, 34.65 ± 3.12, 40.44 ± 3.24, 1.54 ± 0.06, 0.03 ± 0.00 and 0.15 ± 0.01 µg/g respectively.

Table 1 also shows that among other phytochemicals, *B. pinnatum* leaves ethyl acetate is relatively rich in Tannin (40.44 ± 3.24
µg/g), Flavone (34.65 ± 3.12 µg/g), Oxalate (30.62 ± 1.84 µg/g), Resveratrol (28.91 ± 2.89 µg/g), Catechin (23.65 ± 1.18 µg/g), Phytate (25.78 ± 1.55 µg/g) and Kaempferol (19.86 ± 1.59 µg/g).

3.2 Chemical compositions of B. pinnatum leaves ethyl acetate fraction analyzed by GC-MS

The GC-MS chromatogram (Fig. 1) of B. pinnatum leaves ethyl acetate fraction showed presence of about 50 bioactive compounds. The major constituents in the extract were quantified as Hexadecanoic acid, methyl ester (24.88%), 10,13-Octadecadienoic acid, methyl ester (29.69%), Tetracosanoic acid, methyl ester (7.84%), Methyl stearate (6.97%), cis-Methyl 11-eicosenoate (6.26%), Methyl 18-methylnonadecanoate (4.99%), Docosanoic acid, methyl ester (3.71%) and 4,7-Methano-1H-indene, octahydro (2.43%) (Table 2).

Phytochemical analysis of ethyl acetate fraction of B. pinnatum leaves indicated the presence of important phytochemicals such as proanthocyanin, rutin, quinine, flavan-3-ol, anthocyanin, lunamarin, sapogenin, phenol, flavonones, steroids, catechin, epicatechin, kaempferol, phytate, oxalate, resveratrol, flavones, tannin, ribalinidine, naringin, and spartein. B. pinnatum leaves was found to be relatively rich in flavan-3-ols (catechin), flavonols (kaempferol), flavone, resveratrol, tannin, oxalate, and phytate. Phytochemicals are produced as secondary plant products of predominantly teas, honey, wines, fruits, vegetables, nuts, olive oil, cocoa, and cereals; normally inducible through physical or chemical micro environmental triggers, usually a stress factor [24]. These inducers elicit secondary product formation in nature, by activating otherwise dormant biochemical pathways [24]. Polyphenolic phytochemicals such as flavonoids are known for their important biological activities which include free radicals scavenging [25,26], free radical mediated cellular signaling, inflammation, allergies, platelet aggregation, antioxidant effect [27,28], antimicrobial activity, antiulcer properties, antiviral [29],

Table 1. Quantitative phytochemical content of B. pinnatum leaves

| Phytochemical components (µg/g) | B. Pinnatum |
|-------------------------------|-------------|
| Proanthocyanin                | 0.15 ± 0.01 |
| Rutin                         | 5.13 ± 0.31 |
| Quinine                       | 2.34 ± 0.19 |
| Flavan-3-ol                   | 1.68 ± 0.08 |
| Anthocyanin                   | 2.18 ± 0.26 |
| Sapogenin                     | 6.18 ± 0.25 |
| Phenol                        | 10.25 ± 0.92|
| Flavonones                    | 13.75 ± 0.96|
| Steroids                      | 20.65 ± 0.83|
| Epicatechin                   | 6.86 ± 0.41 |
| Kaempferol                    | 19.86 ± 1.59|
| Phytate                       | 25.78 ± 1.55|
| Oxalate                       | 30.62 ± 1.84|
| Resveratrol                   | 28.91 ± 2.89|
| Flavones                      | 34.65 ± 3.12|
| Tannin                        | 40.44 ± 3.24|
| Ribalinidine                  | 1.54 ± 0.06 |
| Naringin                      | 0.03 ± 0.00 |
| Spartein                      | 0.15 ± 0.01 |
| Catechin                      | 23.65 ± 1.18|

Results are presented as Mean ± standard deviation of triplicate determinations
Table 2. Chemical compositions of *B. pinnatum* leaves ethyl acetate fraction analyzed by GC-MS

| Peak | Retention time | Area (%) | M/Z value | Compound name | Molecular formula |
|------|----------------|----------|-----------|---------------|------------------|
| 1    | 8.3056         | 0.0357   | 112       | 2-Heptenal, (E)- | C₇H₁₀O         |
| 2    | 10.9031        | 0.0307   | 144       | Heptanoic acid, methyl ester | C₈H₁₆O₂ |
| 3    | 12.4538        | 0.0232   | 98        | 1-Pentene, 2,3-dimethyl- | C₅H₁₀ |
| 4    | 14.2371        | 0.0317   | 321       | Sulfurous acid, nonyl 2-pentyl ester | C₁₇H₃₀O₃S |
| 5    | 15.6328        | 0.8631   | 158       | Octanoic acid, methyl ester | C₇H₁₄O₂ |
| 6    | 21.9908        | 0.0232   | 98        | 3-Hexenal | C₃H₈O        |
| 7    | 23.6191        | 0.0577   | 152       | 2,4-Decadienal, (E,E)- | C₁₀H₈O₂ |
| 8    | 24.7821        | 0.1319   | 110       | 2,4-Heptadienal, (E,E)- | C₁₀H₈O₂ |
| 9    | 28.0387        | 0.0321   | 156       | 2,3-Pentadiene | C₈H₆ |
| 10   | 30.4811        | 1.0557   | 186       | Nonanoic acid, 9-oxo-, methyl ester | C₁₀H₁₀O₃ |
| 11   | 33.7376        | 0.882    | 214       | Dodecanoic acid, methyl ester | C₁₁H₂₀O₂ |
| 12   | 36.8778        | 0.0722   | 172       | 7-Nonenoic acid, methyl ester | C₁₀H₁₄O₂ |
| 13   | 38.0796        | 0.0352   | 114       | 2-Furfurylthiol | C₆H₈O |
| 14   | 38.8378        | 0.025    | 96        | 3-Octenonic acid, methyl ester, (E) | C₉H₁₄O₂ |
| 15   | 40.9873        | 0.0402   | 96        | cis-1-Methyl-2-(2'-propenyl)cyclopropane | C₇H₁₂ |
| 16   | 41.6851        | 0.0375   | 242       | Methyl tetraccanoate | C₁₅H₃₀O₂ |
| 17   | 42.3441        | 0.029    | 110       | 1,5-Hexadiene, 2,5-dimethyl- | C₁₀H₁₄ |
| 18   | 49.4           | 24.8795  | 270       | Hexadecanoic acid, methyl ester | C₁₇H₃₄O₂ |
| 19   | 50.6793        | 0.0796   | 152       | 3-Oxatricyclo[3.2.1.0(2,4)]octane, 1.alpha.,2.beta.,4.beta.,5.alpha.- | C₁₀H₁₆O |
| 20   | 51.4547        | 0.0681   | 55        | (E)-2-Butenylcyclopropane | C₇H₁₂ |
| 21   | 53.2768        | 0.0418   | 256       | n-Hexadecanoic acid | C₁₆H₃₂O₂ |
| 22   | 54.4786        | 29.6858  | 295       | 10,13-Octadecadienoic acid, methyl ester | C₁₉H₃₄O₂ |
| 23   | 56.0294        | 6.9745   | 299       | Methyl stearate | C₁₉H₃₈O₂ |
| 24   | 56.4946        | 0.483    | 283       | trans-13-Octadecenoic acid | C₁₈H₃₈O₂ |
| 25   | 56.8047        | 0.4115   | 295       | 9,11-Octadecadienoic acid, methyl ester, (E,E)- | C₁₉H₃₄O₂ |
| 26   | 57.5801        | 0.0455   | 250       | cis,cis,cis-7,10,13-Hexadecatriena | C₁₆H₃₂O₂ |
| 27   | 57.7352        | 0.2071   | 279       | Methyl 6-cis,9-cis,11-trans-octade catrienoate | C₁₈H₃₂O₂ |
| 28   | 58.0453        | 0.9202   | 293       | Methyl 9.cis.,11.trans.t,13.trans. octadecatrienoate | C₁₉H₃₄O₂ |
| 29   | 58.2004        | 0.1044   | 156       | 3-Decen-1-ol, (E)- | C₁₀H₁₆O |
| 30   | 58.8207        | 6.2636   | 325       | cis-Methyl 11-eicosenoate | C₂₀H₃₄O₂ |
| 31   | 59.092         | 1.0702   | 126       | 9-Oxabicyclo[6.1.0]nonane, cis- | C₁₀H₁₆O |
| 32   | 59.3247        | 4.9873   | 327       | Methyl 18-methylnonadecanoate | C₂₁H₄₀O₂ |
| 33   | 59.8674        | 1.3813   | 282       | (S)(+)-Z-13-Methyl-11-pentadecen-1-ol acetate | C₁₆H₃₂O₂ |
| 34   | 60.1388        | 0.457    | 170       | 8-Nonenoic acid, 9-(1,3-nonadienyl oxy)-, methyl ester | C₁₀H₁₆O₂ |
| 35   | 60.9142        | 0.3395   | 282       | 9 – Octadecenoic acid | C₁₉H₃₈O₂ |
| 36   | 61.4569        | 2.4256   | 136       | 4,7-Methano-1H-indene, octahydro- | C₁₀H₁₆ |
| 37   | 61.6508        | 0.1235   | 228       | Dodecanoic acid, ethenyl ester | C₁₁H₂₀O₂ |
| 38   | 62.1935        | 0.0247   | 244       | 1,6-Dibromo-2-cyclohexylpentane | C₁₀H₁₂Br₂ |
| 39   | 62.5037        | 3.7073   | 355       | Docosenoic acid, methyl ester | C₂₃H₄₄O₂ |
| 40   | 62.775         | 0.0546   | 255       | Dimethylmalonic acid, 4-chlorophenyl decyl ester | C₁₂H₁₄ClO₂ |
| 41   | 63.3178        | 0.4096   | 127       | 2H-Azepine, 3,4,5,6-tetrahydro-7-methoxy- | C₉H₁₃NO |
| 42   | 63.8218        | 1.4687   | 268       | 9-Hexadecenoic acid, methyl ester, | C₁₇H₃₉O₂ |
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| Peak | Retention time | Area (%) | M/Z value | Compound name | Molecular formula |
|------|----------------|----------|-----------|---------------|-------------------|
| 43   | 64.0932        | 1.4704   | 116       | (Z)-2-Ethylbutyric acid, 2-hexyl ester | C_{6}H_{12}O_{2} |
| 44   | 64.4033        | 0.1964   | 283       | cis-Vaccenic acid | C_{18}H_{33}O_{2} |
| 45   | 65.295         | 7.8351   | 383       | Tetracosanoic acid, methyl ester | C_{25}H_{50}O_{2} |
| 46   | 65.6439        | 1.0862   | 383       | Lauric anhydride | C_{24}H_{48}O_{3} |
| 47   | 65.9153        | 0.0672   | 240       | Oxirane, tetradecyl- | C_{16}H_{32}O |
| 48   | 66.1479        | 0.0348   | 299       | Stearic acid hydrazide | C_{18}H_{36}N_{2}O |
| 49   | 66.458         | 0.066    | 649       | Docosanoic acid, isobutyl ester | C_{44}H_{90}O_{2} |
| 50   | 67.2334        | 0.0241   | 285       | Myristic acid isobutyl ester | C_{18}H_{36}O_{2} |

Fig. 1. Gas chromatography-mass spectrometry profile of *b. Pinnatum* leaves ethylacetate fraction

Tumors suppressing effect and hepatoprotective effect [30-35]. Mechanisms by which flavonoids provide health benefits in addition to being direct chemical protectants involve modulatory effects on a variety of metabolic and signaling enzymes. Flavonoids have been shown to block the angiotensin converting enzyme that raises blood pressure [36,37]; inhibit cyclooxygenase, which forms prostaglandins [38,39] and they block enzymes that produce estrogen. The implications of these in vitro inhibitory actions are that certain flavonoids could prevent platelet aggregation reducing heart disease and thrombosis [40-42] and inhibit estrogen synthase; thus decreasing the risk of estrogen related cancers [43]. Antiplatelet activity of red wine and grape juice reported in human and animal systems has been associated with synergy of flavonoids including anthocyanins [44,45]. Rutin pretreatment has been shown to protect against ethanol-induced cellular necrosis, restoration in the levels of glutathione peroxidase along with ‘anti-lipoperoxidative effect’ [46]. Flavan-3-ols (catechins, epicatechin gallate and epigallocatechin gallate) abundant in grapes,
berries, cocoa and green tea are considered to be responsible for part of the protective effect of red wine against atherosclerotic cardiovascular disease [31,47]. Resveratrol, kaempferol, naringenin, luteolin and quercetin [48-50] have been shown to exert anti-adipogenesis activity and improve insulin sensitivity/glucose intolerance, mediated by the adenosine monophosphate-activated protein kinase (AMPK) and mitogen-activated protein kinases signaling pathways (MAPK) respectively in premitogen activated protein kinase (AMPK) and mediating by the adenosine monophosphate-insulin sensitivity/glucose intolerance, anti-quercetin [48]

kaempferol, naringenin, luteolin and cardiovascular disease [31,47]. Resveratrol, effect of red wine against atherosclerosis, to be responsible for part of the protective berries, cocoa and green tea are considered to be responsible for part of the protective effect of red wine against atherosclerotic cardiovascular disease [31,47]. Resveratrol, kaempferol, naringenin, luteolin and quercetin [48-50] have been shown to exert anti-adipogenesis activity and improve insulin sensitivity/glucose intolerance, mediated by the adenosine monophosphate-activated protein kinase (AMPK) and mitogen-activated protein kinases signaling pathways (MAPK) respectively in premitogen activated protein kinase (AMPK) and mediating by the adenosine monophosphate-insulin sensitivity/glucose intolerance, anti-quercetin [48].

Furthermore, the GC-MS analysis profile included highly complex glycosides, ketone, saturated and unsaturated fatty acids and esters in the fraction. About 8 major constituents were identified in the ethylacetate fraction of B. pinnatum leaves; quantified as Hexadecanoic acid, methyl ester (24.88%), 10,13-Octadecadienoic acid, methyl ester (29.69%), Tetracosanoic acid, methyl ester (7.84%), Methyl stearate (6.97%), cis-Methyl 11-eicosenoate (6.26%), Methyl 18-methylnonadecanoate (4.99%), Docosanoic acid, methyl ester (3.71%) and 4,7-Methano-1H-indene, octahydro (2.43%). Other relatively abundant components included Nonanoic acid, 9-oxo-, methyl ester (1.06%), 9-Oxabicyclo[6.1.0]nonane, cis-(1.07%), (S)(+)-Z-13-Methyl-11-pentadecen-1-ol acetate (1.38%), 9-Hexadecenoic acid, methyl ester (1.47%), 2-Ethylbutyric acid, 2-hexyl ester (1.47%) and Lauric anhydride(1.09%). Hexadecanoic acid, methyl ester and 10,13-Octadecadienoic acid, methyl ester were predominantly present with a relative abundance of 24.88% and 29.69% respectively. Gas chromatography (GC) and Mass spectrometry (MS) have been widely applied in the identification of bioactive constituents of long chain hydrocarbons, alcohols, acids, esters, alkaloids, steroids, amino and nitro compounds, etc [51,52]. Most of the identified constituents of B. pinnatum leaves ethyl acetate fraction have been reported to possess beneficial biological and pharmacological activity. Hexadecanoic acid, methyl ester [53] and 9,12-octadecadienoic acid [54] have been reported to possess antioxidant, antibacterial/antifungal and anti-inflammatory/anticancer properties respectively. The presence of this characteristic array of compounds may be responsible for the usefulness of the plant in treatment of various ailments in ethno-medicine.

4. CONCLUSION

The present study has characterized the bioactive components of B. pinnatum leaves ethyl acetate fraction to include phytochemicals such as proanthocyanin, rutin, quinine, flavan-3-ol, anthocyanin, catechin, sapogenin, phenol, flavonones, steroids, epicatechin, kaempferol, phytae, oxalate, resveratrol, flavones, tannin, ribalinidine, naringin, and spartein. The GC-MS analysis indicated a predominance of Hexadecanoic acid, methyl ester and 10,13-Octadecadienoic acid, methyl ester. The presence of these bioactive compounds presents B. pinnatum leaves as an important source of potential lead compounds with biological and pharmacological benefits and hence a potential candidate for drug discovery.

DISCLAIMER

The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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