

Research Article

Phytochemicals and Selected Elemental Analysis of *Dioscorea bulbifera* Bulbils: An Uncommon Yam in Nigeria

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Abstract

The objective of the study was to investigate the biochemical content of *Dioscorea bulbifera* bulbils, commonly known as Aerial yam, collected from Agbura, Yenagoa, Bayelsa State, Nigeria. Proximate analysis showed 26% moisture content, which is moderate and slightly higher than amount reported in the literature. Ash content was 15.41%, indicating a moderately high mineral content compared to previous reports. The bulbils contained 2.6% protein, 24% carbohydrates, 0.12% fat, and 31.87% fiber respectively. The carbohydrate content suggests that the bulbils can be a good source of energy, and the high fiber content is beneficial for digestive health and weight management. Mineral analysis showed 105.48 mg/l Potassium (K), 1.30 mg/l Iron (Fe), 108.11 mg/l Sodium (Na), 11.00 mg/l Copper (Cu), 0.01 mg/l Magnesium (Mg), 0.327 mg/l Zinc (Zn) and 0.02 mg/l Phosphorus. GC-MS spectrum of hexane extract of the bulbils showed 48 different peaks, indicating the presence of 48 bioactive compounds. Some of these bioactive compounds, such as Prenol and 2H-Pyran, 2-(3-butynyloxy)tetrahydro, exhibit antimicrobial properties. This research also revealed that *D. bulbifera* bulbils contain toxic compounds, such as 2-Propenoic acid, 2-propenyl ester, Benzene, 2,4-Hexadiyne, and Toluene. These compounds can be hazardous to the environment and human health, causing irritation, respiratory issues, and other health concerns. Hence, it is crucial not to underestimate the potential toxicity of *D. bulbifera* bulbils. It is imperative to exercise caution and engage in thorough deliberation before considering their use.

Keywords

Dioscorea Bulbifera Bulbils, Elements, Proximate, Phytochemicals, Toxins

1. Introduction

Root crops, cultivated for their enlarged underground parts, have historically been associated with providing sustenance to economically disadvantaged populations. One such example is the yam, which belongs to the *Dioscorea* genus and is an edible tuber. *Dioscorea* encompasses several species, and

these tubers are revered as essential dietary staple in numerous tropical nations, including Cote d'Ivoire, Ghana, Togo, Burkina Faso, and Nigeria [1, 2]. Yam is a major contributor to food security in West Africa [3], but of the over 600 known yam species, only seven are mostly consumed [4].

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Dioscorea bulbifera commonly known as Aerial yam belongs to the genus of *Dioscorea* in the family of *Dioscoreaceae* [5]. In full sunlight, this plant exhibits vigorous growth, potentially outcompeting and endangering indigenous plant species [6]. Its vine-like structures can grow at an astonishing rate of up to 20 centimeters per day, swiftly twining their way to the uppermost branches of trees, ultimately creating dense clusters that obstruct sunlight and pose a threat to the survival of these trees. This yam species has established itself as an invasive presence in numerous tropical areas, including Florida [7, 8]. *Dioscorea bulbifera* is also characterized by its large ovate leaves with prominent veins, and potato-like aerial tubers (bulbils) in the leaf axils [9, 10]. *Dioscorea bulbifera* has been extensively dispersed through human actions and has successfully established itself in numerous tropical and subtropical regions globally, where it has become naturalized [11, 12].

Dioscorea bulbifera (*D. bulbifera*) is a less-known variety of edible yam. The tubers are not widely utilized in commercial cultivation but are known and eaten by rural communities in various regions of western and Eastern Nigeria [13]. Bulbils of *D. bulbifera* are bitter in taste and all parts of the plant are used in ethnomedicine as analgesic, aphrodisiac, diuretic and rejuvenative tonic. It is also effective in treating cardiovascular diseases, conjunctivitis, diarrhea and dysentery [5, 14]. A paste made from the bulbils of *D. bulbifera* treats piles, dysentery, syphilis swelling from snake bites and scorpion stings in Africa and central Asia [15, 16]. In China, *D. bulbifera* is used for the treatment of sore throat, struma, remedy diabetes, treat leprosy and tumors [17].

Scientific research has validated the aforementioned therapeutic assertions. Aqueous and methanol extract of dry *D. bulbifera* bulbils (300 and 600 mg/kg) induced pain and inflammation in experimental animals. Potent analgesic and anti-inflammatory activities of the extracts was attributed to inhibition of inflammatory mediators such as histamine, serotonin and prostaglandins present within the bulbils [18, 19].

Wang and others [20] have proven that isolated dihydrodioscorin from *D. bulbifera* at 0.1% concentration could inhibit the growth of fungi. Vasanthi and colleagues [21] reported that myricetin, epicatechin, isovanilic and vanillic acids are important bioactive components of *D. bulbifera* bulbils that protected the immune system of rats against cardiovascular diseases. *D. bulbifera* bulbils are a good source of essential dietary nutrients, carbohydrate, vitamins, minerals and protein [22].

Cui and others [23] investigated the effect of *D. bulbifera* bulbils on the immune system of mice and reported that high dose *D. bulbifera* administration could considerably suppress the phagocytosis of the mononuclear macrophages. Kuncari [24] extracted steroid diosgenin, an active component of birth control pills from *Dioscorea bulbifera* plant. *Dioscorea bulbifera* contains diosgenin used for the commercial synthesis of cortisone [25].

But, in spite of the considerable medical benefits and

therapeutic impact of the *D. bulbifera* species on various ailments, there exist evident research regarding its toxicity and the assessment of its safety. Studies have shown that *Dioscorea bulbifera* possesses significant toxicity attributes, underscoring the need for cautious handling and administration [26, 27]. Sun [28] reported that *Dioscorea bulbifera* rhizomes extract worsened the pirarubicin-induced cardiotoxic effects in the liver of mice.

Hepatotoxicity stands out as the prevalent type of toxicity associated with *Dioscorea bulbifera*, manifesting as symptoms like jaundice, vomiting, nausea, and impaired liver functionality [29]. Poison released by grated tubers of *D. bulbifera* placed in a stream acted as stun to fish [30]. Tan and others [31] reported that chloroform fraction derived from the methanolic extract of *Dioscorea bulbifera* was toxic when administered to Sprague-Dawley (SD) rats. Song and colleagues [32] also affirmed the toxicity of *D. bulbifera*, but attributed the degree of toxicity to the dosage and time of administration.

Obviously, scientific reports on various parts of *D. bulbifera* plant abound in the literature. However, the aim of this research is to ascertain the biochemical content of *Dioscorea bulbifera* bulbils (Aerial yam), gathered from Mr. Isikima Okpara's farm in Agbura Community, Bayelsa State, Nigeria.

2. Methodology

Samples of *Dioscorea bulbifera* bulbils, Figure 1, were collected from Mr. Isikima Okpara's farm in Agbura, Yenagoa Local Government area, Bayelsa State, Nigeria, and properly identified at the Department of Biological Sciences, University of Africa, Toru-Orua, Nigeria. Bulbils were peeled with a sharp knife and the white interior sliced into tiny chunks and air dried for 21 days. The dried samples were pulverized into powder with an electric blender and stored in an air cupboard for analysis.



Figure 1. *Dioscorea bulbifera* bulbils.

2.1. Proximate Analysis

The levels of moisture (water content), fat, ash, carbohydrates, protein and non-fat nutrients were determined using the established techniques described by the association of Official Analytical Chemists [33].

2.2. Elemental Analysis

The established methodologies provided by the Association of Official Analytical Chemists [33] were employed to analyze the elemental composition of manganese, iron, Copper, Phosphorus, Sodium, Potassium and Zinc.

2.3. Gas Chromatography-Mass Spectroscopy (GC-MS) Analysis of Bioactive Components

GC-MS analysis of the hexane extract derived from air-dried *D. bulbifera* tubers was conducted using an Agilent 6890 gas chromatograph (GC) coupled to an Agilent 5973N Mass Spectrometer (MS), both of which are products of Agilent Technology located in Palo Alto, CA, USA. The GC-MS system was equipped with an Agilent 7683 Series Automatic Liquid Sampler injector. The analysis employed a META X5 coated fused capillary column measuring 30 meters in length and 0.25mm in diameter, with a film thickness of 0.25 μm . The maximum temperature of the column was set at 325 $^{\circ}\text{C}$. The temperature profile of the oven was programmed to start at 70 $^{\circ}\text{C}$ and remain constant for 2 minutes before ramping up to 300 $^{\circ}\text{C}$ at a rate of 20 $^{\circ}\text{C}/\text{min}$. As the carrier gas, ultra-high purity helium (99.99%) was employed, flowing consistently at 1.0 mL/min.

For sample injection, a 1 μl volume was introduced in the split mode at a ratio of 20:1. The temperatures for the MS source and MS Quad were maintained at 230 $^{\circ}\text{C}$ and 150 $^{\circ}\text{C}$, respectively. Additionally, the injection, transfer line, and ion source were all held at a temperature of 280 $^{\circ}\text{C}$. Throughout the analysis, mass spectra were recorded within a scan range of 50 – 550 atomic mass units (amu), utilizing an ionizing energy of 70 electronvolts (eV). The electron multiplier voltage was established through the autotune process.

2.4. Identification of Components

The analysis and description of chemical compounds within the sample extract relied upon the retention time in gas

chromatography. The mass spectra were cross-referenced with a library of known spectra using computer algorithms. The interpretation of the gas chromatography-mass spectroscopy (GC-MS) mass spectrum was conducted by referencing the extensive database maintained by the national institute of Standards and technology (NIST), encompassing over 590,000 patterns. To elucidate the properties of the components in the sample extract, the mass spectrum of the unidentified compound was matched against the spectra of established components stored in the NIST library (version 2014). This process allowed for the determination of the components' names, molecular weights, molecular formulas, structures, and the fragmentation patterns of their masses.

3. Results

Results of the various analyses carried out on the tubers of *Dioscorea bulbifera* are presented as follows:

3.1. Proximate and Elemental Analyses Results

Proximate and elemental analyses of *D. bulbifera* tubers were triplicated and the results are presented in Table 1.

Table 1. Proximate and elemental analyses results of *D. bulbifera* tubers (100 g).

| Proximate | Mean \pm SD (%) | Elemental | Mean \pm SD (mg) |
|--------------|-------------------|----------------|--------------------|
| Moisture | 26.00 \pm 0.01 | Potassium (K) | 105.48 \pm 0.02 |
| Protein | 2.60 \pm 0.02 | Iron (Fe) | 1.30 \pm 0.02 |
| Carbohydrate | 24.00 \pm 0.01 | Sodium (Na) | 108.11 \pm 0.03 |
| Ash | 15.41 \pm 0.01 | Copper (Cu) | 11.00 \pm 0.02 |
| Fat/Oil | 0.12 \pm 0.02 | Magnesium (Mg) | 0.01 \pm 0.01 |
| Fibre | 31.87 \pm 0.01 | Zinc | 0.327 \pm 0.02 |
| | | Phosphorus | 0.02 \pm 0.01 |

3.2. GC-MS Analysis Result

The analysis outcome of the hexane extract of *D. bulbifera* tubers using GC-MS is detailed in Table 2, while Figure 2 displays the corresponding chromatogram.

Table 2. Compounds identified from the hexane extract of *Dioscorea bulbifera* tubers by gas chromatography-mass spectrometry (GC-MS).

| S/N | Retention Time (min) | Name of compound | Area X 106 | Probability (%) | Molecular formula | Molecular weight | Exact mass (g) |
|-----|----------------------|------------------------------------|------------|-----------------|--|------------------|----------------|
| 1. | 1.278 | 2-Propenoic acid, 2-propenyl ester | 2612 | 92.6 | C ₆ H ₈ O ₂ | 112 | 112.0524297 |

| S/N | Retention Time (min) | Name of compound | Area X 106 | Probability (%) | Molecular formula | Molecular weight | Exact mass (g) |
|-----|----------------------|--------------------------------------|------------|-----------------|---|------------------|----------------|
| 2. | 1.336 | 1,3-Butadiene, 2-fluoro | 1795 | 97.0 | C ₄ H ₅ F | 72 | 72.0375285 |
| 3. | 1.388 | trans-3-Penten-2-ol | 1376 | 91.1 | C ₅ H ₁₀ O | 86 | 86.073165 |
| 4. | 1.411 | Oxirane, propyl | 2213 | 96.8 | C ₅ H ₁₀ O | 86 | 86.073165 |
| 5. | 1.452 | 1-Butene, 4-methoxy | 2159 | 93.4 | C ₅ H ₁₀ O | 86 | 86.073165 |
| 6. | 1.515 | Prenol | 1059 | 90.0 | C ₅ H ₁₀ O | 86 | 86.073165 |
| 7. | 1.598 | 2-Pentyn-1-ol | 5027 | 87.5 | C ₅ H ₈ O | 84 | 84.0575147 |
| 8. | 1.768 | Benzene | 1350 | 81.9 | C ₆ H ₆ | 78 | 78.0469503 |
| 9. | 2.148 | 2,4-Hexadiyne | 2687 | 86.5 | C ₆ H ₆ | 78 | 78.0469503 |
| 10. | 2.178 | 1-Nonanol | 2084 | 61.4 | C ₉ H ₂₀ O | 144 | 144.151415 |
| 11. | 2.314 | 1-Pentene, 2,4-dimethyl | 8433 | 80.7 | C ₇ H ₁₄ | 98 | 98.1095505 |
| 12. | 2.650 | Toluene | 9846 | 80.5 | C ₇ H ₈ | 92 | 92.0626 |
| 13. | 2.870 | Pent-2-ynal, 4,4-dimethyl | 7974 | 90.8 | C ₇ H ₁₀ O | 110 | 110.073165 |
| 14. | 2.916 | Cyclooctane | 8010 | 63.7 | C ₈ H ₁₆ | 112 | 112.1252007 |
| 15. | 3.253 | trans-2,3-Epoxyoctane | 8307 | 88.3 | C ₈ H ₁₆ O | 128 | 128.120115 |
| 16. | 3.303 | 2H-Pyran, 2-(3-butynyloxy)tetrahydro | 1407 | 92.5 | C ₉ H ₁₄ O ₂ | 154 | 154.09938 |
| 17. | 3.594 | Benzenepropanamine | 3273 | 92.0 | C ₉ H ₁₃ N | 135 | 135.104799 |
| 18. | 3.793 | 8-Thiabicyclo[3.2.1]oct-2-ene | 7432 | 97.5 | C ₇ H ₁₀ S | 126 | 126.050321 |
| 19. | 3.830 | Cyclopropane, 1-methyl-2-pentyl | 4952 | 52.0 | C ₉ H ₁₈ | 126 | 126.1408505 |
| 20. | 3.868 | 1,6-Heptadien-3-yne, 5-methyl | 6777 | 83.7 | C ₈ H ₁₀ | 106 | 106.0782504 |
| 21. | 3.884 | Bicyclo[2.1.1]hex-2-ene, 2-ethenyl | 3998 | 83.1 | C ₈ H ₁₀ | 106 | 106.0782504 |
| 22. | 4.000 | Cyclohexane, 1,2,3-trimethyl | 7990 | 77.8 | C ₉ H ₁₈ | 126 | 126.1408505 |
| 23. | 4.075 | 1-ethoxy-2,4-hexadiene | 6067 | 96.5 | C ₈ H ₁₄ O | 126 | 126.104465 |
| 24. | 4.126 | Cyclohexanone, 2-ethyl | 7161 | 90.1 | C ₈ H ₁₄ O | 126 | 126.104465 |
| 25. | 4.189 | 1-(1-Propynyl)cyclohexanol | 1614 | 89.2 | C ₉ H ₁₄ O | 138 | 138.1044655 |
| 26. | 4.254 | (Z)-4-Decen-1-ol, trifluoroacetate | 9934 | 67.4 | C ₁₂ H ₁₉ F ₃ O ₂ | 252 | 252.133715 |
| 27. | 4.339 | Benzeneacetaldehyde | 6712 | 88.9 | C ₈ H ₈ O | 120 | 120.0575147 |
| 28. | 4.339 | Benzene, 1-ethyl-2-methyl | 1534 | 63.6 | C ₉ H ₁₂ | 120 | 120.0939 |
| 29. | 4.339 | Benzaldehyde, 2-methyl | 3576 | 70.5 | C ₈ H ₈ O | 120 | 120.0575147 |
| 30. | 4.456 | 2,3-Heptadien-5-yne, 2,4-dimethyl | 2351 | 76.0 | C ₉ H ₁₂ | 120 | 120.0939 |
| 31. | 4.599 | Mesitylene | 4746 | 68.6 | C ₉ H ₁₂ | 120 | 120.0939 |
| 32. | 4.642 | Benzene, 1-methyl-3-propyl | 6919 | 70.4 | C ₁₀ H ₁₄ | 134 | 134.10955 |
| 33. | 4.669 | Decane, 4-methyl | 6313 | 62.3 | C ₁₁ H ₂₄ | 156 | 156.1878 |
| 34. | 4.699 | Benzene, 1-methyl-3-(1-methylethyl)- | 3684 | 58.6 | C ₁₀ H ₁₄ | 134 | 134.10955 |
| 35. | 4.726 | Benzene, 1-ethyl-3-methyl | 9411 | 61.7 | C ₉ H ₁₂ | 120 | 120.0939 |
| 36. | 4.764 | Cyclohexane, butyl | 5807 | 82.7 | C ₁₀ H ₂₀ | 140 | 140.156501 |
| 37. | 4.817 | Benzene, 2-propenyl | 1549 | 54.4 | C ₉ H ₁₀ | 116 | 118.0782504 |
| 38. | 4.853 | Decane, 5-methyl | 2312 | 85.2 | C ₁₁ H ₂₄ | 156 | 156.1878 |
| 39. | 4.904 | Benzene, 1,4-diethyl | 5600 | 71.4 | C ₁₀ H ₁₄ | 134 | 134.10955 |

| S/N | Retention Time (min) | Name of compound | Area X 106 | Probability (%) | Molecular formula | Molecular weight | Exact mass (g) |
|-----|----------------------|---------------------------------|------------|-----------------|---|------------------|----------------|
| 40. | 4.944 | Naphthalene, decahydro | 5865 | 66.8 | C ₁₀ H ₁₈ | 138 | 138.140851 |
| 41. | 5.033 | o-Cymene | 3640 | 61.8 | C ₁₀ H ₁₄ | 134 | 134.10955 |
| 42. | 5.065 | Benzene, 1-ethyl-2,3-dimethyl | 1568 | 53.7 | C ₁₀ H ₁₄ | 134 | 134.10955 |
| 43. | 5.096 | Undecane | 1139 | 55.0 | C ₁₁ H ₂₄ | 156 | 156.1878 |
| 44. | 5.218 | 2(3H)-Benzoxazolone | 5924 | 92.2 | C ₇ H ₅ NO ₂ | 135 | 135.032028 |
| 45. | 5.240 | Naphthalene, decahydro-2-methyl | 1372 | 74.9 | C ₁₁ H ₂₀ | 152 | 152.156501 |
| 46. | 5.325 | 1-Methyldecahydronaphthalene | 1151 | 71.0 | C ₁₁ H ₂₀ | 152 | 152.156501 |
| 47. | 5.577 | Dodecane | 1402 | 92.2 | C ₁₂ H ₂₆ | 170 | 170.203451 |
| 48. | 6.018 | Tridecane | 2422 | 61.6 | C ₁₃ H ₂₈ | 184 | 184.219101 |

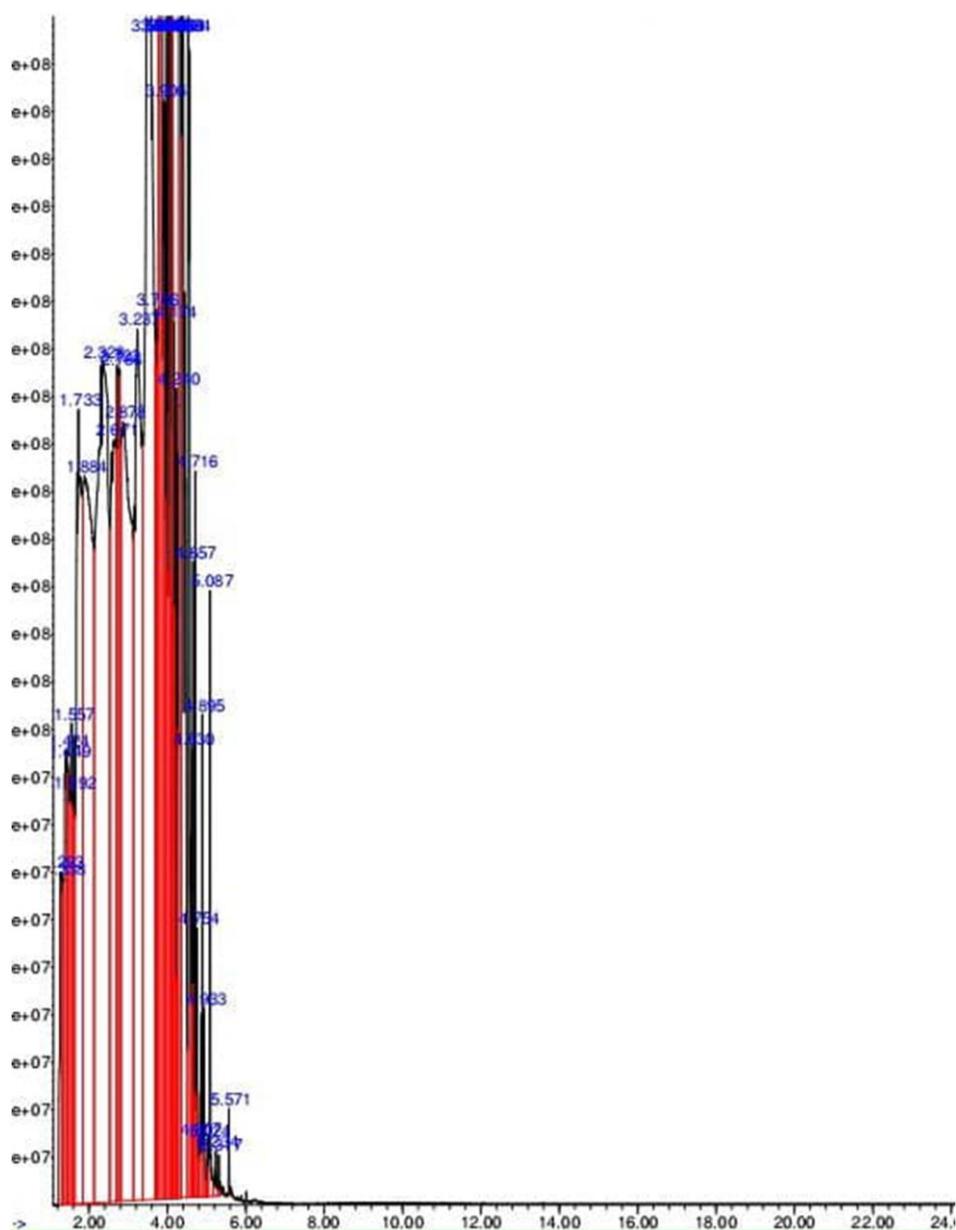


Figure 2. GC-MS chromatogram of hexane extract of *Dioscorea bulbifera* tubers.

4. Discussion

Table 1 summarizes the results of proximate and selected elemental content of dried *D. bulbifera* bulbils from Agbura, Nigeria. Moisture content, 26%, was moderate. Lower amount was reported in the literature [34]. Ash content was moderately high, 15.41%. Lower values were reported in the literature [35]. Protein, carbohydrate, fat and fibre contents were 2.6%, 24%, 0.12%, 31.87% respectively. Carbohydrate content indicates that *D. bulbifera* bulbils could be a good source of energy. Fibre is important for digestive health, as it promotes regular bowel movement, helps prevent constipation, and supports a healthy gut microbiome. Dietary fibre can also contribute to a feeling fullness and assist in weight management [36].

Mineral levels in the bulbils were minute. Zinc, Copper, Magnesium, Iron, Phosphorus, Sodium and Potassium contents were 0.327 mg, 11.00 mg, 0.01 mg, 1.30 mg, 0.02 mg/l, 108.11 mg and 105.48 mg respectively. The concentrations of Sodium and Potassium in the bulbils were moderately high compared to the concentrations of the other elements. Sodium plays a crucial role in maintaining fluid balance, supporting nerve function, facilitating muscle contraction, regulating pH balance, and aiding in nutrient transport within the body [37]. The amount of sodium 108.11 mg/100g is much lower than the daily recommended intake [38]. Potassium stands as a vital mineral with numerous functions within the human body, encompassing roles in maintaining fluid balance, supporting nerve impulses, facilitating muscle contractions, promoting heart well being, regulating blood pressure, balancing acid-base levels, and managing the equilibrium of nutrients and waste [39, 40]. Interestingly, the current research has demonstrated that air-dried *D. bulbifera* bulbils do not possess a high mineral content. However, they do contain noteworthy quantities of sodium and potassium. It has also shown that proximate content of the bulbils is low. Nevertheless, they do contain notable amounts of carbohydrates and dietary fiber.

Gas chromatography-mass spectrometry (GC-MS) analysis of the hexane extract of *D. bulbifera* bulbils showed forty eight (48) bioactive phytochemicals with their retention time, molecular weight, molecular formula and probability percentage as presented in Table 2 and the chromatogram in Figure 2. The phytochemicals include: 2-Propenoic acid, 2-propenyl ester (92.6%, 1.278 min), 1-Butene, 4-methoxy (93.4%, 1.452 min), Prenol (90.0%, 1.515 min), Benzene (81.9%, 1.768 min), 2,4-Hexadiyne, 86.5%, 2.148 min, Toluene (80.5%, 2.650 min), 2H-Pyran, 2-(3-butynyloxy)tetrahydro (92.5%, 3.303 min), Benzenepropanamine (92.0%, 3.594 min), Bicyclo[2.1.1]hex-2-ene, 2-ethenyl (83.1%, 3.884 min), Benzeneacetaldehyde (88.9%, 4.339 min), Mesitylene (68.6%, 4.599 min), Benzene, 1-ethyl-3-methyl (61.7%, 4.726 min), Undecane (55.0%, 5.096 min), 2(3H)-Benzoxazolone (92.2%, 5.218 min), Dodecane (92.2%, 5.577 min) and Tridecane

(61.6%, 6.018 min). Maximum peak, 97.5%, 3.793 min, was shown by 8-Thiabicyclo[3.2.1]oct-2-ene and the lowest peak, 52.0%, 3.830 min, was shown by Cyclopropane, 1-methyl-2-pentyl.

Prenol, 90.0%, is a terpenoid, colorless oil with a fruity odor and used occasionally in perfumery [41]. 2H-Pyran, 2-(3-butynyloxy)tetrahydro, 92.5%, has been reported to exhibit antimicrobial activity against the bacteria *Pseudomonas aeruginosa*, *Escherichia coli* and *Staphylococcus aureus* [42]. Bicyclo[2.1.1]hex-2-ene, 2-ethenyl exhibits antifungal characteristics [43]. The bulbils were seen to contain a substantial amount of Benzeneacetaldehyde. National Library of Medicine describes Benzeneacetaldehyde as an oily liquid with a sweet smell of hyacinth type (National Library of Medicine, 2023). Tridecane is a major chemical secreted by some insects for defense from predators. It is also used in the paper processing and rubber industries [44]. Result showed that the bulbils contain 61.6% Tridecane. Surely the bulbils contain very useful phytochemicals.

Nonetheless, analysis also showed toxic and hazardous compounds in moderately high amounts. 2-Propenoic acid, 2-propenyl ester, 92.6%, is a flammable and hazardous liquid that causes eye and skin irritation, and might cause respiratory irritation [45]. Benzene, 81.9%, has been reported to obstruct plants photosynthesis process. It replaces the carbon dioxide that plants breathe, hence, choke the plants. Also exposure to benzene can damage the respiratory tract, immune and blood systems and increase the risk of leukemia [46]. The European Chemicals Agency (ECHA) classified 2,4-Hexadiyne, 86.5%, as an irritant [47]. Toluene, 80.5%, possesses anthelmintic properties [48]. However, the Australian Government, Department for climate change, Energy, the Environment and Water has reported that, Toluene is moderately acute and moderately chronic toxic to aquatic life, causes membrane damage to the leaves in plants. Exposure to high levels of toluene results in unconsciousness, permanent brain damage and even death [46]. Benzenepropanamine is a Combustible liquid that causes eye, skin, and respiratory tract irritation [49]. Mesitylene is toxic to aquatic life and has long-lasting effects [50]. Undecane is a mild sex attractant for moths and cockroaches [51]. Contact can cause eye and skin irritation, and breathing the chemical is likely to cause irritation in the nose, throat and lungs [52]. 2(3H)-Benzoxazolone is harmful if in contact with the skin, inhaled or swallowed [53]. Dodecane, 92.2%, is a combustible liquid and may damage lungs and the central nervous system if swallowed [54].

Interestingly, the current research has once again confirmed that *Dioscorea bulbifera* bulbils possess a combination of medicinal and toxic compounds.

5. Conclusion

Findings of the study on air-dried *D. bulbifera* bulbils in Agbura, Nigeria, contained various nutritional and mineral

contents. The moisture content in the bulbils is 26%, which is moderate and slightly higher than reported in the literature. The ash content is 15.41%, indicating a moderately high mineral content compared to previous reports. The bulbils contain 2.6% protein, 24% carbohydrates, 0.12% fat, and 31.87% fiber. The carbohydrate content suggests that the bulbils can be a good source of energy, and the high fiber content is beneficial for digestive health and weight management. The mineral levels are relatively low zinc, copper, magnesium, iron, phosphorus, sodium, and potassium contents. Sodium and potassium concentrations are notably higher than other minerals and play essential roles in various bodily functions. Gas chromatography-mass spectrometry (GC-MS) analysis of a hexane extract of the bulbils identified 48 bioactive phytochemicals. Some of these compounds, such as Prenol and 2H-Pyran, 2-(3-butynyloxy)tetrahydro, exhibit antimicrobial properties. Others, like Benzeneacetaldehyde and Tridecane, have various industrial and chemical applications. The analysis also revealed the presence of toxic compounds, including 2-Propenoic acid, 2-propenyl ester, Benzene, 2,4-Hexadiyne, and Toluene. These substances can be hazardous to the environment and human health, causing irritation, respiratory issues, and other health concerns.

6. Recommendation

Although *Dioscorea bulbifera* bulbils have a history of use in traditional medicine, it is crucial not to underestimate their potential toxicity as the current research has shown. It is imperative therefore, to exercise caution and engage in thorough deliberation before considering their use.

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Conflict of Interest

The authors declare no conflicts of interest.

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