



## GC - MS Analysis and Phytochemical Constituents in *Anthocleista vogelii* and *Leuceana leucocephala* obtained from Calabar, Cross River State, Southern Nigeria

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### Abstract

Most plants contain groups of chemicals known as phytochemicals. These have been directly linked to diverse and beneficial bioactivities. *Anthocleista vogelii* and *Leucaena leucocephala* are among the plants documented as containing bioactive compounds. This study aimed at detecting and identifying the phytochemical constituents in *A. vogelii* and *L. leucocephala* leaf extracts from Calabar, Cross River State using Gas Chromatography-Mass Spectrometry (GC-MS) methods. Extraction for GC-MS phytochemical screening of *A. vogelii* and *L. leucocephala* was carried out by weighing five (5) g of processed sample into the extraction thimble of a Soxhlet extractor.

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50 ml of dimethyl-sulfuroxide was poured into a round bottom flask attached to a Soxhlet extractor, and refluxed three times. Extract was transferred into a Rotary Evaporator and concentrated to 2 ml for phytochemical screening. An Agilent 5890 N Gas Chromatography equipped system with an auto sampler connected to an Agilent Mass Spectrophotometric Detector was used. One (1)  $\mu$ l of sample was injected in the pulsed spitless mode. The column temperature was gradually increased from 55 °C to 300 °C at correspondingly increasing retention time. Identification was based on retention time since each of the active ingredients has a unique retention time in the column. Components with lower retention time were eluted before the ones with a high retention time. Results show the presence of alkaloids, tannins, alcohol, aldehydes, terpenes, ketones and phenols. A major finding showed the presence of seven

groups of phytochemicals in both plant extracts. Nine and sixteen volatile/semi-volatile chemical compounds respectively are found in *A. vogelii* and *L. leucocephala*. The most abundant compounds were tridecane (21.61%) followed by tetradecane, and Undecane, 2, 6-dimethyl (24.36 %) by tridecane (20.62 %) respectively. These groups of bioactive components have been associated with antimicrobial, insecticidal, anti-inflammatory, antitumor, antidiabetic and cytotoxic activities.

**Keywords:** Analysis; *Anthocleista vogelii*; Gas Chromatography; *Leucaena leucocephala*; Mass Spectrometry; Phytochemical

## 1. Introduction

Phytochemicals also regarded as secondary metabolites are chemical compounds produced within plants. They are not known to be directly involved in the normal growth, development, or reproduction of an organism. Some of them act as defense compounds against diseases, predators, ultraviolet radiation, parasites, and oxidants, to facilitate reproductive processes (e.g., serve as attractive smells and coloring agents), and for interspecies competition (Zhao *et al.*, 2015). Bioactive compounds of plant origin are secondary metabolites possessing desired health benefit effects in man and animals (Kaur and Das 2011).

Researchers like Zhao *et al.*, (2015) have reported that the development of analytical techniques such as gas chromatography (GC), mass spectrometry (MS), high-performance liquid chromatography (HPLC), and nuclear magnetic resonance spectrometry (NMR) has enhanced the isolation, purification, and structure determination of single compounds from plant extracts. These advanced techniques have been found helpful to identifying a wide range of biologically active compounds.

Evidently, thousands of phytochemicals have been identified and studied for their nutritional

functions and antimicrobial activities. They can be categorized into various groups including saponins, carotenoids, phytosterols, glucosinolates, flavonoids, terpenes, sterols, alllicins and polyphenols. Phytochemicals extracted from different plants have been reported to be effective in the control of plant diseases caused by a range of pathogenic organisms, where they act as plant-based pesticides. This is phenomenal in the quest for an eco-friendly substitute for synthetic pesticides. Among plants documented as containing bioactive compounds are *Anthocleista vogelii* and *Leucaena leucocephala*

### *Anthocleista vogelii* (Planch)

*A. vogelii* is an evergreen tree/shrub-like tropical plants in the Gentianaceae family (Jensen and Schripsema, 2002). *A. vogelii* grows from 6-20 metres tall, with mature leaves usually up to 40 cm long. Young plant leaves may be up to 150 cm long and 45 cm wide (Plate 1). According to Anyanwu *et al.*, (2015); and Owolabi *et al.*,(2011), while the species is commonly known as the cabbage tree in English, in Nigeria and it is called Sapo or Apaoro (Yoruba), Kwari (Hausa), Orimi (Benin) and Odogwu (Igala). It is mostly used for the treatment of diabetes, fever, piles and stomach aches in Nigeria. The leaves and stem bark are used for the treatment of leprosy, jaundice, bronchitis and venereal diseases. A root decoction of this plant is used as a purgative and to induce labour. In Cameroon, Sudan, Sierra Leone and Ghana, *A. vogelii* is used for the treatment of different diseases (Anyanwu *et al.*, 2015).

In Sierra Leone, the decoction of the root is taken to alleviate chest pain and for the treatment of hepatitis when taken with lemon. In Ghana the root decoction of *A. vogelii* and *Combretum mucronatum* with pepper and ashes is taken to treat chest pain (Jegade *et al.*, 2011).

In the Southwestern part of Nigeria, traditional medicine practitioners use the leaves and root of *A. vogelii* for the treatment of stomach aches, piles, hepatitis and diabetes (Osadebe *et al.*, 2014). *A. vogelii* was reported to show much preference for terrestrial habitat with a supportive role for epiphytes (Edwin-Wosu *et al.*, 2015). Regardless of the method of preparation, it is reported to be potent in the treatment of laxation, purgation, constipation, malaria, typhoid fever, diabetes mellitus, sexually transmitted diseases (STDs) stomach aches, hypertension etc. (Kadiri, 2009; Musa *et al.*, 2010; Olubomehin *et al.*, 2013; Atuefack *et al.*, 2014; Anyanwu *et al.*, 2015).

The chemical constituent validating their pharmacological properties were earlier

reported to be found in their roots, stem and leaves and various bioactive compounds notably alkaloids, saponins, terpenoids, anthraquinone, tannins, flavonoids, steroids and phenolics with the exception of glycosides were scientifically revealed (Jegade *et al.*, 2011; Gboeloh *et al.*, 2014; Anyanwu *et al.*, 2015; Apiamu *et al.*, 2017). To this end the aerial part of the plant distinctly and evidently exhibits antidiabetic, antihypertensive, antihypotensive, antiplasmodial, antimicrobial, spasmolytic, spasmogenic, antiobesity and antioxidant property respectively (Alaribe *et al.*, 2012; Okokon *et al.*, 2012; Olubomehin *et al.*, 2013; Atuefack *et al.*, 2014; Anyanwu *et al.*, 2015; Christopher *et al.*, 2015; Sunday *et al.*, 2016).



**Plate 1:** *Anthocleista vogelii* (Source: Wikipedia, 2022)

### ***Leucaena leucocephala* (Lam) de Wit**

*L. leucocephala*, commonly known as the White Lead Tree (Okwu and Nnamdi, 2009), is a tree belonging to the family *Fabeaceae* (plate 2). It is native to Southern Mexico and Northern Central America and spreads across many tropical and subtropical locations. It is a miracle tree due to its worldwide success as a long-lived, healthful tree couple with its medicinal usefulness and versatile nature, such as its utilization as wood fuel, timber, fodder,

and green compost, as well as providing shade cover and checking soil erosion (Abdelhady and Abdallah, 2017). Medically, *L. leucocephala* has a lot of biological effects, including anti-microbial, anti-helminthic, antibacterial, anti-proliferative, anti-diabetic, anti-cancer, cancer preventive, diuretic, anti-inflammatory, antioxidant, antitumor, antihistaminic, nematicide, pesticide, antiandrogenic, hypocholesterolemic, and hepatoprotective activities (Meena Devi *et al.*,

2013; Zayed and Samling, 2016). The entire plant species has been consumed as food and also used traditionally as medicine (Zayed and Samling, 2016).

Similarly, the flowers, young leaves and pods serve as nutritious ingredients for soups and salads for the people of Indonesia, Thailand,

and Central America. The people of the Philippines use the young pods as a vegetable, and the roasted seeds as substitutes for coffee. While the seeds are utilized as non-conventional protein sources (Zayed and Samling, 2016).



**Plate 2: *L. leucocephala* (Source: Wikipedia, 2022)**

Extensive phytochemical screening of *A. vogelii* has been carried out and documented for species from Cameroun, Abuja, Imo State, Nigeria. In Cameroun, a new rearranged nor-secoiridoid, anthocleistenolide, along with the known 1-hydroxy-3,7-dimethoxyxanthone, 1-hydroxy- 3, 7, 8- trimethoxyxanthone, 7- $\alpha$ -hydroxy sitosterol and sitosterol 3-O- $\beta$ -D-glucopyranoside have been isolated from the stem bark of *A. vogelii* (Tene *et al.*, 2008). In Abuja, Nigeria, Jegede *et al.*, (2011) established the presence of carbohydrates, polyphenols, saponins, and carotenoids in the powdered leaves and stem bark of *A. vogelii*. Anyanwu *et al.*, (2013) reported the presence of alkaloids, saponins, tannins, steroids and cardiac glycosides in the ethanolic root bark extract of *A. vogelii* in Umuekwune community of Imo State, Nigeria. Elsewhere, Apiamu *et al.*, (2014) documented a phytochemical

screening of *A. vogelii* showing the presence of alkaloids, flavonoids, saponins, tannins, steroids, phenolics and anthraquinones, which were quantitatively elucidated with considerable preference for the dry sample compared to the fresh sample.

Similarly, phytochemical screening of *L. leucocephala* has been widely documented for species from other parts of the world like Malaysia, Egypt, China and Mexico. A study conducted to detect and identify the bioactive constituents of *L. leucocephala* leaf extract from Malaysia, using gas chromatography mass spectrometry (GCMS) methods revealed the presence of four major chemical constituents of the leaves of *L. leucocephala* from Malaysia including, squalene (41.02 %), Phytol (33.80 %), 3, 7, 11, 15-Tetramethyl-2-hexadecen-1-ol (30.86 %) and 3, 7, 11-Tridecatrienitrile, 4, 8, 12-trimethyl (25.64 %), (Zayed and Samling,

2016). Whereas Salem *et al.* (2011) and Deivasigamani (2018) documented the principal constituents of the same species from Mexico to include 2(H)-benzofuranone-5, 6, 7, 7a-tetrahydro-4, 4, 7a-trimethyl, pentadecanoic acid-14-methyl-methyl ester and 6, 10, 14-trimethyl-2-pentadecanone, a ketone. Ficaprenol-11 (polyprenol), squalene, lupeol-sitostenone, trans-coumaric acid, cis-coumaric acid, pheophytin-a, pheophorbide a methyl ester, methyl - 132 - hydroxyl - (132-S) - pheophorbide-b and aristophyll-C were found present in *L. leucocephala* from China (Chen and Wang, 2010).

Leaves of species in Egypt have been screened and found to contain 49 phytocomponents, of which the major components were 1, 2-benzenedicarboxylic acid, mono (2-ethylhexyl) ester (17.7 %), betulin (15.7 %), lupeol (14.7 %), androstan-17-one,3-ethyl-3-hydroxy-, (5 $\alpha$ )- (12.3 %), 9, 12, 15-octadecatrienoic acid, methyl ester, (Z, Z, Z)- (11.6 %), betamethasone (9.7 %), and  $\beta$ -sitosterol (9.1 %). Although phytochemical screening of *A. vogelii* and *L. leucocephala* have been widely documented in other parts of the world, species in the Southern part of Nigeria, particularly Calabar in Cross River State have not been screened for purpose of further study of unique constituents and bioactivities. Hence, this present research aimed at detecting and identifying the phytochemical constituents in *A. vogelii* and *L. leucocephala* leaf extracts from Calabar, Cross River State, Southern Nigeria using Gas Chromatography-Mass Spectrometry (GC-MS) methods.

## 2. Materials and methods

### 2.1 Overview of Study area

The research was carried out in Calabar, the capital city of Cross River State, Nigeria which lies between latitudes 5<sup>o</sup> 45 and 5<sup>o</sup> 75 North of the Equator and longitude 8<sup>o</sup> 30 and 8<sup>o</sup> 42 East of the Greenwich Meridian. Temperatures are

relatively constant throughout the year with the average high temperature ranging from 25.8 <sup>o</sup>C (78.5 <sup>o</sup>F) and a low temperature of 23.8 <sup>o</sup>C. The annual rainfall is 3306 mm/130.2 inches with 7.2 pH. All laboratory investigations were done in the Graduate Research Laboratory of the Department of Plant and Ecological Studies, University of Calabar, Calabar.

### 2.2 Extraction for GC-MS analysis

Fresh leaves of *A. vogelii* and *L. leucocephala* were collected from their stands located behind the Biological Science Complex, University of Calabar, Calabar, Cross River State, Nigeria. Extraction for GC-MS phytochemical screening of *A. vogelii* and *L. leucocephala* was carried out as follows: The bioactive compounds were extracted following a modified method of Zygmunt and Namiesnik (2003). Five (5) g of processed sample was measured into the extraction thimble of a Soxhlet extractor. Exactly 50 ml of the solvent was poured into the round bottom flask, attached to the Soxhlet extractor, and refluxed three times. The resulting extract was moved into the Rotary evaporator, concentrated to 2 ml and then poured into a well labeled Teflon screw-cap bottle. 200 mm mesh silica gel and 3 g of anhydrous sodium sulfate in a well packed column were deployed to clean up the extract. The obtained extract was then used for phytochemical screening.

The bioactive molecules were identified using a modified method of Kumar (2014). An Agilent 5890 N Gas Chromatography system supported by an auto sampler linked to an Agilent Mass Spectrophotometric Detector was used. One  $\mu$ l of the extract was injected in the pulsed spitless mode onto a 30 m x 0.25 mm id DB 5MS coated fused silica column with a film thickness of 0.15 micrometer. Using Helium as the carrier gas, the column head pressure was maintained at 20 psi to give a constant of 1ml/min. The column temperature was initially held at 55 <sup>o</sup>C for 0.4min, and gradually increased to 200 <sup>o</sup>C at

a rate of 25 °C/minutes, then subsequently increased of to 280 °C at a rate of 8 °C/minutes and to a final temperature of 300 °C at a rate of 25 °C/minutes, held for 2 minutes. The identification of phytochemicals was based on retention time, taking advantage of the unique retention time of the active ingredients in the column. Those components with lower retention time were eluted before the ones with high retention time.

### Identification of chemical compounds

The database of the National Institute of Standard and Technology (NIST) was used to interpret the mass spectrum of GC-MS. The spectrum of the unknown component was compared with the spectrum of known components stored in the NIST Library, which has more than 62,000 patterns (Duke, *et al*; 2003). The molecular weight, molecular formula and number of hits used to identify the name of the compound from the NIST spectra Library were recorded.

### Quantitative phytochemical analysis

Quantitative evaluation of the phytochemical components in the samples were determined as described below:

Alkaloid content in each sample of plant material was estimated by adopting the method reported by Madhu *et al.* (2016). Five (5 g) of the processed sample was weighed and 100 ml of acetic acid was added and this covered and allowed to stand for 24 hours. After 24 hours, mixture was filtered and made up to 25 ml using a rotary evaporator. Ammonium-hydroxide was added drop wise to the extract until precipitate was formed. The solution was allowed to settle and precipitate was collected, washed with ammonium hydroxide and then filtered. The residue was dried and weighed and alkaloid content was computed as a percentage of the dried residue in the sample.

The method reported by Padma *et al.* (2013) was used to estimate the Phenols content in the

sample of the plant material. According to this method, five grams (5 g) of processed sample were measured with an electronic weighing balance into the extraction thimble of a soxhlet extractor. 100 ml of solvent (methanol, with dimethyl sulfuroxide to enable dissolution of the sample) was poured into the round bottom flask attached to a Soxhlet extractor. This was refluxed three times. The extract was cleaned up with 100-200 mm mesh silica gel and 3 g of anhydrous sodium sulfate in a well packed column. With the use of a rotary evaporator, the sample was concentrated to dryness and subsequently dissolved in 1 ml of water and mixed with 2.5 ml of folin-Ciocalteu reagent (0.2 N). After 5 minutes, 2 ml of sodium carbonate was added, and allowed to stand for 1hour. In the dark; the optical density was measured at 750 nm against a blank and the total phenolic content was calculated from the calibration curve equation in percent (%) per gram of the sample.

The tannin content in the sample was estimated by adopting the Colin Denis method reported by Padma *et al.* (2013). Five grams (5g) of the sample were extracted following the method described for phenols above. The extract was concentrated to 1.5 ml with a rotary evaporator. The concentrated extract was dissolved in a standard solution of tannic acid (1000 ppm) and made up to 7.5 ml with distilled water. 0.5 ml of Folin Denis reagent and 1ml sodium carbonate solution were added then made up to 10 ml with distilled water. Absorbance was measured colorimetrically at 700 nm. The total tannic acid content was calculated as a percentage of the total sample.

To estimate terpenes content in the sample of the test plants, the modified method of Malik *et al.* (2017) was adopted. Two grams (2g) of the sample was measured and soaked in 50 ml of 95 % ethanol for 24 hrs. The extract was filtered, and with the use of petroleum ether,

between 60-80 °C, filtrate was extracted and concentrated to dryness. The dried ether extract was weighed and total terpenes calculated as a percentage of the total sample.

The Alcohol content in the sample of plant material was estimated following the method reported by Sayyad *et al.* (2015) with modifications. Two grams (2g) of the sample was weighed into a test tube and 20 ml of Tri-n-butyl phosphate was added to the sample in the tube. This was shaken vigorously for 5 minutes and allowed to stand for 1hr for equitable extraction. 5 ml of the extract was mixed with 3ml of dichromate reagent, then shaken at 150 rpm for 10 minutes with a rotatory shaker. The lower layer containing alcohol was read off at 595 nm (absorbance) using a spectrophotometer and recorded as a percentage of the total study sample.

Lastly, the Ketones and Aldehydes content in the sample were estimated adopting the method

of Pesez and Bartos (1974). 10 ml of 0.1 % 2,4-dinitrophenylhydrazine and 10 ml 0.5 % hydrochloric acid in glacial acetic acid were added to two grams (2g) of the sample into a beaker. A yellow-orange colour indicates the presence of carbonyl compound. This was read off (absorbance) spectrophotometrically at 412 nm, and the absorbance was compared to known calibration curves for quantitation of the concentration of the carbonyl group in the sample.

### 3. Results

Results in Table 1 on the quantitative evaluation of phytochemical compounds in the leaf extracts of *A. vogelii* and *L. leucocephala* showed that alkaloids, tannins, alcohol, aldehyde, terpenes, ketones and phenols were present in the plant material. Terpenes were the most abundant, followed by phenols, while tannins were the least abundant.

**Table 1:** Phytochemical composition analysis of leaf extracts of *Antocleista vogelii* and *Leucaena leucocephala*

S/N	Bioactive compounds	Phytochemical composition (mg/g)	
		<i>Antocleista vogelii</i>	<i>Leucaena leucocephala</i>
1	Alkaloid	1.3	0.9
2	Tannins	0.5	0.8
3	Alcohol	4.5	3.8
4	Aldehyde	3.2	1.9
5	Terpene	10.8	8.5
6	Ketone	4.1	2.9
7	Phenols	6.8	5.2

LSD (P≤0.05)

Values are means of three replicates.

### Volatile and semi-volatile active ingredient in leaf extracts of *A. vogelii* and *L. leucocephala*.

The chemical compounds in leaf extract of *A. vogelii* and *L. leucocephala* using GC-MS showed 13 (Figure 1) and 20 (Figure 2) peaks respectively.

The retention time (RT) ranged between 9.42 and 50.36 minutes for *A. vogelii* and 6.62 and 23.08 minutes for *L. leucocephala*. When compared with the information on National Institute of Standard Technology library, the results revealed the presence of 9 (Table 2) and 16 (Table 3) different chemical compounds in the extracts of *A. vogelii* and *L. leucocephala* respectively. The most abundant compound in *A. vogelii* was tridecane (21.61 %); with a

retention time of 15.27 minutes followed by tetradecane (20.11 %) and a retention time of (18.05 minutes) whereas the most abundant compound in *L. leucocephala* was Undecane, 2,

6-dimethyl (24.36 %) with retention time of 12.42 minutes followed by tridecane (20.62 %) and retention time of (12.30 minutes).

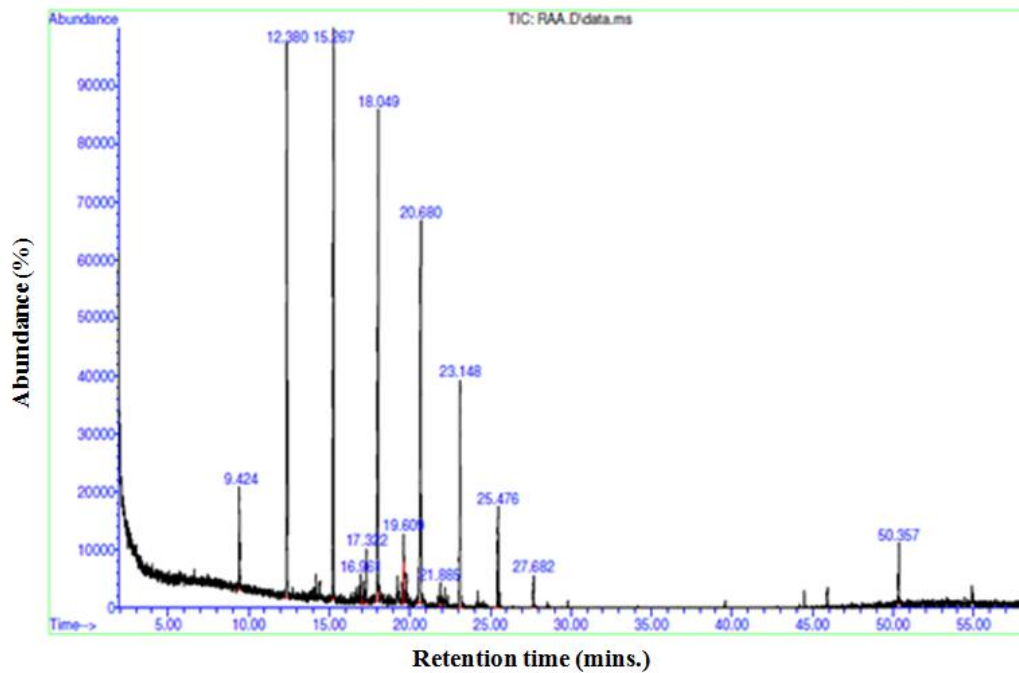


Figure 1: GC-MS Chromatogram for *Anthocleista volgelii*

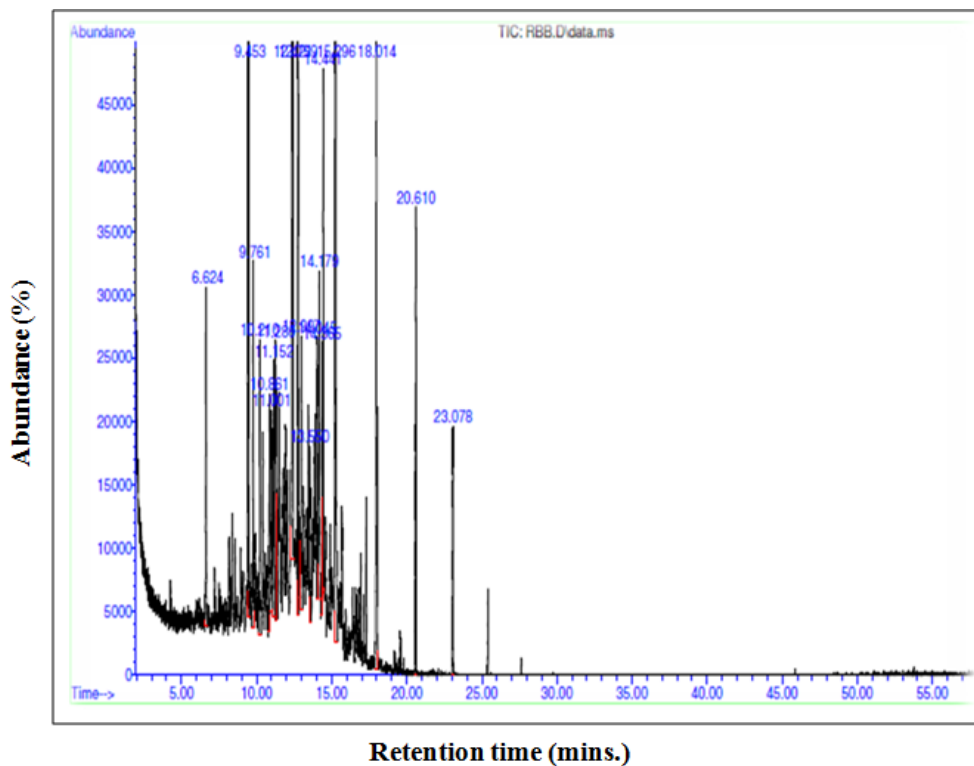


Figure 2: GC-MS Chromatogram for *Leucaena leucocephala*.



**Table 2:** Bioactive components of *Anthocleista volgelii*

RT (min)	Chemical group	Compound	Molecular formula	Rate (%)	Reviewed bioactivity
9.424	Alkane	Octane, 3,5-dimethyl	C <sub>10</sub> H <sub>22</sub>	2.408	
12.380	Alkane	Dodecane	C <sub>12</sub> H <sub>26</sub>	17.432	Anti-oxidant
15.267	Alkane	Tridecane	C <sub>13</sub> H <sub>28</sub>	21.605	
18.049	Alkane	Tetradecane	C <sub>14</sub> H <sub>30</sub>	20.106	Antimicrobial and diuretic
20.680	Alkane	Dodecane, 2-methyl	C <sub>11</sub> H <sub>24</sub>	17.126	
23.148	Alkane	Hexadecane	C <sub>16</sub> H <sub>34</sub>	9.297	Antimicrobial and anti-oxidant activity
25.476	Alkane	Decane, 2,4,6-trimethyl	C <sub>13</sub> H <sub>28</sub>	3.205	
27.682	Alkane	Hexane, 2,4-dimethyl-	C <sub>8</sub> H <sub>18</sub>	0.827	
50.357	Tocopherol	Vitamin E	C <sub>29</sub> H <sub>50</sub> O <sub>2</sub>	2.198	Antibiotics

LSD(P≤0.05)

Values are means of three replicates. RT= Retention time

**Table 3:** Bioactive components of *Leucaena leucocephala*

RT (min)	Chemical group	Chemical Compound	Molecular formula	Rate (%)	Reviewed bioactivity
6.624	Alkane	Decane	C <sub>10</sub> H <sub>22</sub>	1.979	
9.453	Flavonoid	Naphthalene, decahydro-2-methyl	C <sub>11</sub> H <sub>20</sub>	12.811	
10.861	Allylic alcohol	2-Tridecen-1-ol, (E)	C <sub>13</sub> H <sub>26</sub> O	1.818	
11.152	Alkane	Undecane, 2-methyl	C <sub>12</sub> H <sub>26</sub>	1.839	
11.280	Alkane	Dodecane	C <sub>12</sub> H <sub>26</sub>	1.692	Anti-oxidant
12.421	Alkane	Undecane, 2,6-dimethyl		24.357	
12.759	Alkene	4-Tridecene, (Z)-	C <sub>13</sub> H <sub>26</sub>	4.344	
12.997	Allylic alcohol	Z-10-Pentadecen-1-ol	C <sub>15</sub> H <sub>30</sub> O	2.218	
13.550	Fatty acid	Oxalic acid, allyl hexadecyl ester	C <sub>21</sub> H <sub>38</sub> O <sub>4</sub>	1.659	
14.179	Alkaloid	Hydroxylamine, O-decyl	C <sub>10</sub> H <sub>23</sub> NO	2.208	
14.365	Alkane	Tridecane, 4-methyl-	C <sub>14</sub> H <sub>30</sub>	1.466	
14.441	Alkane	2,6-Dimethyldecane	C <sub>13</sub> H <sub>28</sub>	2.941	
12.296	Alkane	Tridecane	C <sub>13</sub> H <sub>28</sub>	20.622	
18.104	Alkane	Tetradecane	C <sub>14</sub> H <sub>30</sub>	7.054	Antimicrobial and diuretic
20.610	Alkane	Hexadecane	C <sub>16</sub> H <sub>34</sub>	3.232	Antimicrobial and antioxidant
23.078	Alkane	Nonadecane	C <sub>19</sub> H <sub>40</sub>	1.532	

LSD(P≤0.05)

Values are means of three replicates, RT= Retention time

#### 4. Discussion

Phytochemical screening of leaf extracts of *A. vogelii* and *L. leucocephala* was carried out using the GC-MS method. The choice of this method is based on the exceptional sensitivity of GC-MS, which allows for the detection of compounds at very low concentrations, which is particularly beneficial when analyzing trace amounts of target analytes in samples. Groups of phytochemicals detected in both plant extracts have been linked with different categories of bioactivities. Alkaloids and their synthetic derivatives have been used medicinally as analgesic, antiplasmodial and antifungal products (Cowan, 1999). They have therapeutic significance as plant chemicals and exhibit marked antimicrobial activity when administered to micro-organisms. Phenols and phenolic compounds have been widely used in decontaminations and currently utilized as a standard with which other fungicidal substances are compared (Gurjar *et al.*, 2012). They are constituents of various ranges of pesticides. These compounds are found to be inhibitory to cell division, retard cellular growth and elongation and hamper sporangia formation, spore development and impair wide range of microbial enzyme, (Enyiukwu and Awurum, 2012).

Tannins have stringent properties that make them toxic to insects and pathogens (Grija *et al.*, 2014). Plant protection against fungal and bacterial attack has also been recorded (Nandini *et al.*, 2015). Similarly, alcohols, ketones and carbonyl groups exert insecticidal, fungi-toxic and antimicrobial activities on insect pests and diseases. Flavonoids are phenolic compounds distributed in the vascular bundle. Besides their main activity as antioxidants, flavonoids also possess many diverse anti-inflammatory, antiulcer, antiiral, anticancer, antidiabetic and cytotoxic properties as corroborated by Styczyuska and Gbika (2010). An earlier report by Awurum and Ogbonna (2013) on

phytochemical studies done on the ethanol root and, bark extract of *A. vogelii* revealed the extract contains alkaloids, saponins, tannins, steroids and cardiac glycosides. Bassey *et al.* (2023) have established antimicrobial activities of extracts from *A. vogelii*. Phytochemicals found in extracts of *A. vogelii* were found to be effective on the control of the wet rot disease of *Vigna unguiculata* caused by *Choanophora cucurbitarium*.

Also, a report by Jegede *et al.* (2011), who screened the leaf, stem bark and root bark of *A. vogelii* showed the same phytochemicals in their study. Awe *et al.* (2013) reported the presence of different bioactive compounds such as alkaloids, cardiac glycosides, tannins, flavonoids in the leaf extract of *L. leucocephala*. Findings are equally supported by Deivasigamani (2018), who identified flavonoids, saponins, phenols, tannins, cardiac glycosides, phlobatannin and terpenoids on various extracts of the plant leaves.

GC-MS analysis of *A. vogelii* and *L. leucocephala* also led to the identification of different chemical compounds, with diverse bioactivities. Among the identified chemicals, hexadecane acid is a fatty acid ester and can be used as an antioxidant, antimicrobial, and larvicidal agent. This is in line with findings of Bodoprost and Rosemeyer, 2007; Falodun *et al.*, 2009; and Yogeswari *et al.*, (2012). Studies have also revealed the effectiveness of Dodecane (a hydrocarbon) as an antioxidant (Nandini *et al.*, 2013), Tetradecane as an antimicrobial agent (Girija *et al.*, 2014), Vitamin E (a tocopherol) as an antibiotic, antifungal, antidote and antitumor, which also functions as a parasiticide, emmenagogue, and expectorant (Duke *et al.*; 2003; Umaru *et al.*, 2018). Vitamin E is particularly protective because it helps reduce the oxidation of lipid membranes and prevents the breakdown of nutrients by oxygen (Gibka *et al.*, 2009). As reported (Duke *et al.*, 2003), 2-Tridecen-1-ol,

(E) is an alcoholic compound with anticancer, antidote, antitumor, emollient, parasiticidal and expectorant activities, while Hydroxylamine, O-decyl has anticancer, antitumor, antidote; and antioxidant properties.

## 5. Conclusion

The quantitative phytochemical screening of *A. vogelii* and *L. leucocephala* using GC-MS determined the presence of alkaloids, tannins, alcohols, aldehydes, terpenes, ketones and phenols. These groups of bioactive components have been implicated in antimicrobial, parasiticidal, insecticidal, antiinflammatory, antiulcer, antiiral, anticancer, antidiabetic and cytotoxic activities. Other chemical compounds identified have been linked to diverse bioactivities. These include Hexadecane acid, Dodecane, Tetradecane, Vitamin E, 2-Tridecen-1-ol, Hydroxylamine, O-decyl, which act generally as antimicrobial and antitumor agents.

## Conflict of interest

Authors have declared that no conflict of interests exists.

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