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### Pragya Shrivastava

Amity Institute of Biotechnology, Amity University, Raipur- 492001, Chhattisgarh, India

### Kush Kumar Nayak

School of Studies in Biotechnology, Shaheed Mahendra Karma Vishwavidyalaya, Baster, Jagdalpur-494001, Chhattisgarh, India

### Zenu Jha

Department of Plant Molecular Biology and Biotechnology, Indira Gandhi Krishi Vishwavidyalaya, Raipur- 493225, Chhattisgarh, India

### Varaprasad Kolla

Amity Institute of Biotechnology, Amity University, Raipur- 492001, Chhattisgarh, India

### Correspondence:

#### Prof. Varaprasad Kolla

Amity Institute of Biotechnology, Amity University, Raipur- 492001, Chhattisgarh, India  
Email: vkolla@rpr.amity.edu

## GC–MS profiling of acetone extracts of *Andrographis paniculata*: identification of bioactive compounds with pharmacological potential

Pragya Shrivastava<sup>#</sup>, Kush Kumar Nayak<sup>#</sup>, Zenu Jha, Varaprasad Kolla<sup>#</sup>Equal Contribution

### ABSTRACT

**Background:** Medicinal plants are an important source of bioactive compounds vital for pharmaceutical, cosmetic, and nutraceutical applications. In particular, traditional herbal remedies especially in India utilize leaves of plant, extracts containing a wide variety of secondary metabolites as flavonoids, alkaloids, fatty acids that differ among species. Analytical methods as Gas Chromatography-Mass Spectrometry (GC-MS) are widely employed to detect and quantify these metabolites in plant extracts. **Objective:** The aim of this study was to profile the bioactive constituents present in the acetone extract of leaf of *Andrographis paniculata* plant by using GC-MS, and to assess their potential therapeutic properties for possible pharmaceutical applications. **Materials and Methods:** The leaf plants of *A. paniculata* were collected and subjected to extraction using acetone as the solvent. Analysis was performed with an Agilent Technologies Mass Hunter GC/MS system, using version B.07.05.2479 for acquisition. The obtained chromatograms were compared with standard reference libraries to identify component compounds are secondary metabolites. **Results:** Several phytochemicals were detected including piperine, octadecanoic acid (stearic acid), and hexadecenoic acid (palmitic acid). These compounds are known to possess diverse biological activities. Piperine is used antimicrobial, possible anticancer adjuvant. Octadecanoic acid (stearic acid) and hexadecanoic acid (palmitic acid): associated with antioxidant, anti-inflammatory, antimicrobial or metabolic effects in various studies. The presence of these metabolites suggests *A. paniculata* acetone extract is rich in bioactive secondary metabolites with multiple therapeutic potentials. **Conclusion:** The GC–MS analysis of *A. paniculata* leaf acetone extract revealed bioactive compounds like piperine, stearic acid, and palmitic acid, indicating strong antioxidant, antimicrobial, and anti-inflammatory potential. These findings validate the plant's traditional medicinal use and suggest its promise as a natural source for developing therapeutic drugs.

**Keywords:** Medicinal plant, *Andrographis paniculate*, GC–MS analysis, Bioactive compounds, Secondary metabolites, Pharmacological potential.

### INTRODUCTION

Herbal medicine has gained renewed interest as a promising alternative to synthetic drugs, primarily due to its lower toxicity and wide therapeutic potential. Among the many medicinal plants studied for their pharmacological properties, *Andrographis paniculata*, commonly known as "King of Bitters," stands out for its extensive use in traditional medicine across Asia. This plant is known for its broad-spectrum biomedical activities, including anti-inflammatory, antioxidant, antimicrobial, and anticancer properties, which are attributed to its rich reservoir of bioactive compounds [1]. The exploration of medicinal plants for therapeutic purposes has been an enduring focus in pharmacognosy and phytochemistry, given their vast reservoir of bioactive compounds. A medicinal plant has long been the cornerstone of traditional healthcare systems and have garnered significant scientific interest for their potential therapeutic applications. Among these, *A. paniculata* is widely recognized medicinal plant in traditional and modern herbal medicine systems, particularly within Ayurvedic, Traditional Chinese, and Southeast Asian pharmacopeia [2].

Belonging to the *Acanthaceae* family, this herbaceous plant has garnered scientific attention due to its broad spectrum of pharmacological activities, this plant is prized for its strong bitter taste and its rich content of bioactive compounds, particularly andrographolide, which is believed to be responsible for many of its therapeutic effects. Traditionally, *A. paniculata* has been employed to treat a variety of ailments, including fevers, respiratory infections, digestive disorders, liver dysfunctions, including anti-inflammatory, antiviral, anticancer, antidiabetic, and hepatoprotective properties [3].

The active principles of many drugs found in plants are secondary metabolites [3]. Plants are abundant sources of natural antioxidants [4]. The study of their phytochemical components highly important as the process of extraction plays a crucial role in isolating and recovering bioactive compounds from plant materials prior to conducting any component analysis [5]. Medicinal plants, in particular, are significant contributors to modern medicine, accounting for approximately 25% of pharmaceutical formulations [6]. The World Health Organization notes that traditional medicine systems remain vital to global healthcare, especially in developing countries, where more than 80% of the population depends on such treatments. Medicinal plants face a heightened risk of extinction. Therefore, in order to scientifically validate traditional medicinal practices or to identify potential lead compounds for new therapeutic drugs, it is essential to isolate and identify the active constituents present in these plants [7]. In recent years, it has attracted increasing scientific attention due to its potential antiviral, anti-inflammatory, antioxidant, and immune-boosting properties. As interest in plant-based medicine grows globally, *A. paniculata* continues to be a subject of research for its possible applications in modern pharmacology and public health. The bioactive potential of *A. paniculata* is primarily attributed to its diverse secondary metabolites, especially diterpenoids, flavonoids, and polyphenolic compounds [8]. Due to pharmacological importance this plant needs to more explore and study whole unrevealed bioactive compounds by recent advancement in analytical techniques the extraction approach described is straightforward, quick, and cost-effective, requiring minimal solvent usage. The GC-MS technique employed for analysing the extracts proves to be a valuable tool for quantifying specific active compounds found in herbs. These compounds have applications across various sectors, including cosmetics, pharmaceuticals, food production, as well as in environmental and forensic science [9]. This method integrates two analytical processes, gas chromatography, which separates the mixture's components, and mass spectrometry, which individually identifies and analyses them. Previous chemical investigations have indicated the presence of cardenolides, pregnane glycosides, and volatile constituents [10]. A large proportion of the volatile compounds are composed of long-chain unsaturated fatty acids, which are crucial in biological systems. These fatty acids not only serve as key structural components in various essential compounds but also act as major energy sources [11]. Over recent years, there has been a growing body of research focusing on fatty acids, with findings indicating their notable sedative and sleep-inducing properties [12]. Therefore, the current study focuses on analysing the chemical constituents present in the ethanolic extract of the entire *A. paniculata*. Furthermore, the biological relevance of the identified compounds is assessed through literature-supported bioactivity data, and their potential medical applications are discussed. This includes evaluating their roles in antimicrobial defence, inflammation modulation, oxidative stress reduction, and cytotoxic effects against cancer cells. In doing so, this research not only contributes to the phytochemical characterization of *A. paniculata* but also strengthens its pharmacological profile as a source of novel therapeutic agents. The identifications of GC-MS profiling of *A. paniculata* acetone extract offers valuable insights into the plant's phytochemical diversity and medicinal potential. This integrative approach combining analytical chemistry with biological and pharmacological interpretation can pave the way for future drug discovery and development from natural products.

## MATERIAL AND METHODS

### Plant Sample Collection

The leaf sample of *A. paniculata* was collected from herbal garden of Amity University Chhattisgarh, which was maintained in the campus. Leaves were collected and wash with the distilled water and dry in shaded condition to remove water. Kept in a hot air oven, set at a low temperature 30-32°C till dried and made a fine powder using a laboratory mechanical grinder and stored in airtight containers for further experiments.

### Extract Preparation

The extraction of plant sample was done by Soxhlet extraction method used for extracting bioactive compounds. Soxhlet apparatus was subjected to non-stop percolation for 8 hours (hrs) use of 250 ml, acetone. Complication of cycle the yield of plant crude extract was appreciate to dry with feature odour and greasy consistency. The final weight of plant crude yield percentage was used for the experiment. The final weight of plant crude was measured and yield percentage was calculated by using the formula:

$$\% \text{Yield Extract} = \frac{W_1}{W_2} \times 100$$

Where,  $W_1$  = Weight of the extract after dried,  $W_2$  = Weight of the plant powder.

### Gas Chromatography Mass Spectrum Analysis

Gas Chromatography-Mass Spectrometry (GC-MS) analysis was carried out using an Agilent 7890A gas chromatograph (model 19091-433HP, USA) paired with a mass spectrometer. This setup included an HP-5 MS fused silica capillary column (30.0 m × 250 μm i.d., 0.25 μm film thickness, 5% phenyl methyl siloxane) and was linked to a 5675C Inert MSD featuring a Triple-Axis detector. Helium was employed as the carrier gas at a consistent flow rate of 1.0 ml/min. The analysis conditions consisted of an ion source temperature of 250 °C, an interface temperature of 300 °C, and a system pressure of 16.2 psi. The injection was performed in split mode (1:50 split ratio) at 300 °C, with an injection volume of 1 μl. The oven temperature was initially maintained at 36 °C for 5 minutes, followed by a rise to 150 °C at a rate of 4 °C/min, and subsequently increased to 250 °C at 20 °C/min, holding at this temperature for another 5 minutes. The analysis time was set accordingly. The relative percentage of each compound was estimated based on the average peak area in relation to the total chromatographic area. Identification of the detected constituents was achieved by comparing their retention indices and mass spectra against those in the NIST and Willey libraries, using the spectral matching features built into the GC-MS software. The identified compounds are presented in tabular format

## RESULTS AND DISCUSSION

Medicinal plants serve as valuable sources for the discovery of new drugs. A significant number of contemporary pharmaceuticals are either derived from compounds found in medicinal plants. These plants provide essential bioactive ingredients that are effective in combating a wide range of diseases and health conditions [13]. The extraction and analysis of plant materials are crucial steps in the development, refinement, and quality assurance of herbal medicines. The final weight of plant crude extraction yield was measured in solvent of acetone with 70% of purified plant extract. Additionally, research on medicinal plants enhances our understanding of their potential toxicity, offering protection to both humans and animals from naturally occurring poisons. In light of this, the current study was conducted to identify the bioactive constituents present in the acetonic extract of *A. paniculata* using Gas Chromatography-Mass Spectrometry (GC-MS). In table 1 mentioned the identified active compounds, along with their retention times (RT), molecular formulas, molecular weights (MW), and relative concentrations (as peak area percentages), and also are summarized in table 2 and illustrated in figure 1 for the highest peak and all MS chromatograph respectively. In the present study, a total of thirty-eight phytochemical compounds were successfully identified through advanced analytical techniques as GC-MS. These compounds were isolated from the plant extract using standardized procedures, ensuring reproducibility and accuracy in profiling. Among these identified nine phytoconstituents compounds exhibited significantly high peak intensities mentioned in a figure 1, indicating their dominant presence in the extract. The high-intensity peaks suggest that these molecules are either the major bioactive constituents or structurally stable compounds under the given analytical conditions. Further mentioned figure 1 shows structural analysis and comparison with existing databases revealed

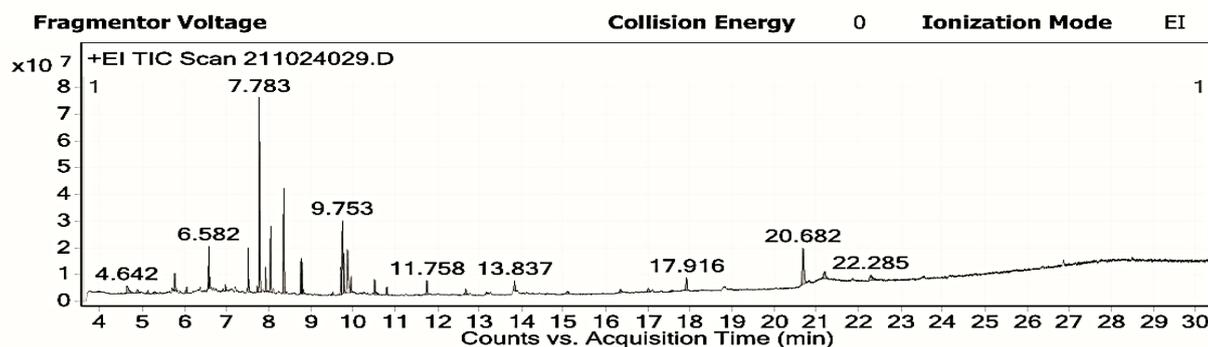
that high intensity peak of, out of these four major compounds (2,2,6,6-Tetramethyl-4 piperidone), (3,7,11,15-Tetramethyl-2 hexadecen-1-ol), (Dodecanedioic acid), and (9,12-Octadecadienoic acid (Z,Z)-. are show high intensity peak and novel or previously unreported in the context of the *A. paniculata* plant of this species studied and that have pharmaceutical application. All those secondary metabolites have been reported for their pharmaceutical use throw out the studies, it was mentioned that these metabolites 2,2,6,6-Tetramethyl-4 piperidone, is a Triacetoneamine member of piperidones, intermediate in organic synthesis and exhibits notable biological properties. It shows antioxidant activity due to its ability to scavenge free radicals and is often used in the synthesis of nitroxide radicals, which are studied for their potential anti-inflammatory and neuroprotective effects. Additionally, its derivatives are explored for antimicrobial and anticancer activities due to their redox properties and structural stability. This compound has been reported only in *Caroxylon tetrandrum* and *Agelas orides* with data available not for the *A. paniculata* [14]. The 3,7,11,15-Tetramethyl-2 hexadecen-1-ol it is a long-chain aliphatic alcohol with a branched hydrocarbon structure, often isolated from natural sources of plants, algae, or microbial extracts. This compound has shown promising biological and pharmacological properties, making it of interest in drug discovery and development. One of the primary reported activities of Tetramethyl-2-hexadecen-1-ol is its antimicrobial action. It exhibits inhibitory effects against a range of bacterial and fungal strains, potentially due to its ability to disrupt microbial cell membranes. This makes it a candidate for development as a natural preservative or therapeutic agent for infections. In addition, studies that have anti-inflammatory and antioxidant properties. By modulating inflammatory pathways and neutralizing free radicals, this compound can contribute to the prevention or mitigation of oxidative stress-related diseases, including certain types of cancer and neurodegenerative disorders. This compound has been reported only in *acathospermum australe*, *Lindera glauca* and the other organism with the data Similarly the Dodecanedioic acid is an alpha omega-dicarboxylic acid and a dicarboxylic fatty acid that is dodecane in which the methyl groups have been oxidised to the corresponding carboxylic acids. It has a role as an EC 1.1.1.1 (alcohol dehydrogenase) inhibitor and a human metabolite. It is a conjugate acid of adodecanedioate (2-) and derives from a hydride of a dodecane. Dodecanedioic acid has been reported in *Drosophila melanogaster*, *homo sapiens* and other organism with data available. They represent a novel metabolic fuel in pharmaceutical applications, offering an effective strategy to augment energy metabolism, support glucose management, and improve exercise tolerance in patients with metabolic challenges [15]. Other 9,12-Octadecadienoic acid (Z, Z)-, A doubly unsaturated fatty acid, occurring widely in plant glycosides. It is an essential fatty acid in mammalian nutrition and is used in the biosynthesis of prostaglandins and cell membranes an essential omega-6 polyunsaturated fatty acid, plays a multifaceted therapeutic role in pharmaceutical formulations. When used topically, it demonstrates potent anti-inflammatory and sebum-regulating effects, making it ideal for treating acne, eczema, psoriasis, and sensitive skin by reducing redness, balancing oil levels, and strengthening the skin barrier. Orally, linoleic acid supports cardiovascular health by enhancing lipid profiles especially reducing LDL and triglyceride levels and aiding in cholesterol clearance through conversion into bile acids. Its ability to inhibit microbial growth, including pathogens *Staphylococcus aureus*, adds an antimicrobial dimension useful in skin-care and topical infection prevention. Additionally, it shows emerging anticancer potential, as it may impair tumor cell energy metabolism and induce apoptosis, making it a candidate for adjunctive oncology research. 9,12-Octadecadienoic acid has been reported in *Arisaema tortuosum*, *Humulus lupulus*, and other organism with data available [18]. The among rest of this mentioned in figure 1 shows high intensity five peaks (Chloroacetic acid, penta-decyl ester); (9-Octadecenoic acid (Z)-, methyl ester); (9,12,15-Octadecatrienoic acid, 2-[[trimethylsilyloxy]-1 [[(trimethylsilyloxy) methyl] ethyl ester, (Z, Z, Z)-) ; (2,6,10-Dodecatrien-1-ol, 3,7,11-trimethyl-), ([1-(3,3-Dimethylxyran-2 yl-methyl)-3,7-dimethylocta 2,6-dienyl] tri-methyl-

silane) are reported for their therapeutic properties, including anti-inflammatory, antimicrobial, antioxidant, antiviral properties, contributing to its potential as a therapeutic agent against viral infections but not be reported for the production of metabolite found in or produced by *A. paniculata* [16].

The mentioned figure 2 of ten bioactive phytochemicals are cis-9-Hexadecenoic acid, (.beta.-D-Glucopyranose, 1 thio-,1-[N-hydroxy-5 (methylthio)pentanimidate]), (5-Hexadecenoic acid, 2 methoxy-, methyl ester), (1-Dodecanol, 3,7,11-trimethyl 9-Eicosyne), (Didodecyl phthalate), (cis-10-Heptadecenoic acid) (9,12,15-Octadecatrienoic acid, methyl ester, (Z,Z,Z)-), (Phytol), (1-Dodecanol, 3,7,11-trimethyl) not be reported for the production of metabolite found in or produced by *A. paniculata*. These bioactive constituents span across various classes as alkaloids, flavonoids, terpenoids, phenolics, saponins, glycosides, and steroids. Each compound was subjected to a comprehensive literature-based evaluation to determine its known or potential pharmaceutical relevance [17]. The cis-9-Hexadecenoic acid, is a palmitoleic acid which the double bond at position C-9 has cis configuration. cis-9-Hexadecenoic acid holds substantial promise as a multi-target bioactive compound with applications in metabolic, cardiovascular, dermatological, and antimicrobial therapies. Ongoing research continues to explore its full pharmacological potential and mechanisms of action. It has a role as an EC 3.1.1.1 (carboxylesterase) inhibitor, a *Daphnia galeata* metabolite, in a human blood serum metabolite, also in an algal metabolite and an *Escherichia coli* metabolite. This metabolite found in or produced by *Escherichia coli* (strain K12, MG1655). Palmitoleic acid has been reported in *Agaricus blazei*, *Phoridium tenue* and other organism with data available and evenly this palmitoleic acid is a metabolite found in or produced by *Saccharomyces cerevisiae* [18]. beta.-D-Glucopyranose, 1 thio-,1-[N-hydroxy-5 (methylthio) part of these [3,4,5-trihydroxy-6-(hydroxymethyl)oxan-2-yl] 5-methylsulfanyl-N-sulfooxypentanimidothioate has been reported in *Brassica oleracea*, *Leodium draba* and other organism with data. beta.-D-Glucopyranose, 1-thio-, 1-[N-hydroxy-5-(methylthio)pentanimidate] represents a structurally rich molecule offering multiple avenues for pharmaceutical exploitation. Its enzymatic reactivity, bioavailability potential, and biochemical versatility position it as a valuable candidate in areas ranging from targeted drug delivery to enzyme modulation and cytoprotection [19]. The (cis-10-Heptadecenoic acid) (10Z)- cis-10-Heptadecenoic acid is a fatty acid with antiproliferative and anti-inflammatory properties. Pharmaceutical development could explore oral, injectable, and topical forms. Preclinical studies are needed to establish viability, supplemented by formulation optimization and regulatory groundwork. It has a role as a plant metabolite. It is a conjugate acid of a (10Z)- heptadecanoate. Heptadecenoic acid is a metabolite found in or produced by *Escherichia coli* (strain K12, MG1655) [20].

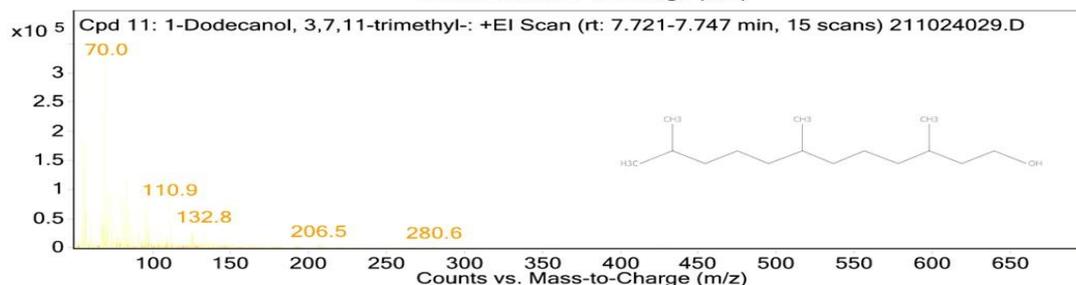
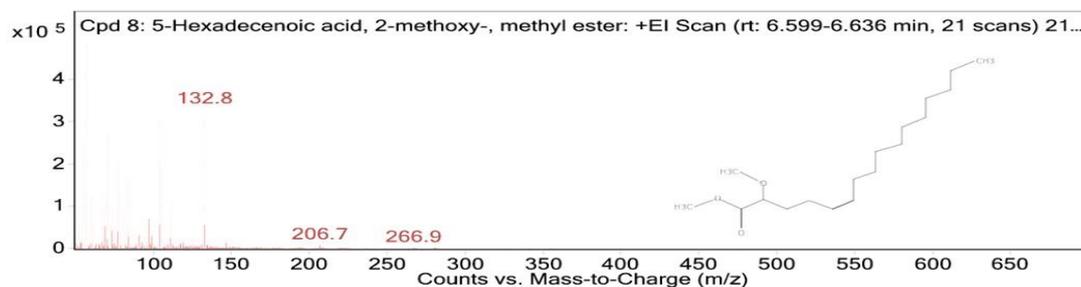
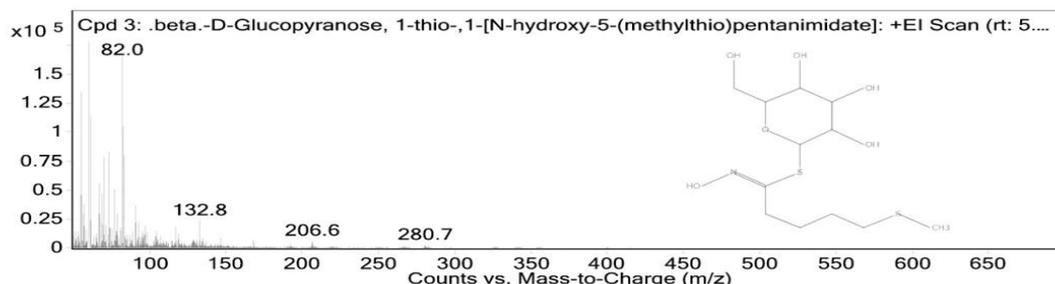
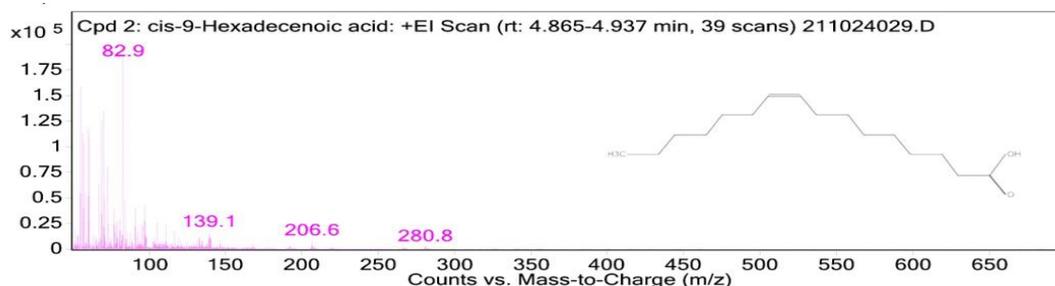
Hence, among out of these nine-teen compounds, several nine-teen have been widely reported for their therapeutic properties, including anti-inflammatory, antimicrobial, antioxidant, anticancer, antidiabetic, and neuroprotective effects. Notably, compounds such as quercetin, kaempferol, lupeol, stigmasterol, and beta-sitosterol exhibited multiple biological actions, making them promising candidates for drug development. In addition, out of nine compounds, seven demonstrated prominent peaks and unique molecular structures in the chromatographic profile, suggesting either novelty or limited prior reporting, thereby indicating potential for new drug discovery or pharmacological exploration. These findings provide a valuable foundation for further preclinical and clinical investigations. The biological insights gathered emphasize the medicinal significance of phytochemicals and their role in the development of plant-based therapeutic agents. This study contributes to the growing field of natural product pharmacology and underscores the importance of ethnopharmacological research in identifying effective, bioactive compounds from traditional medicinal sources. Future studies are warranted to elucidate their detailed molecular structures, bioactivity profiles, and therapeutic potential. This phytochemical exploration not

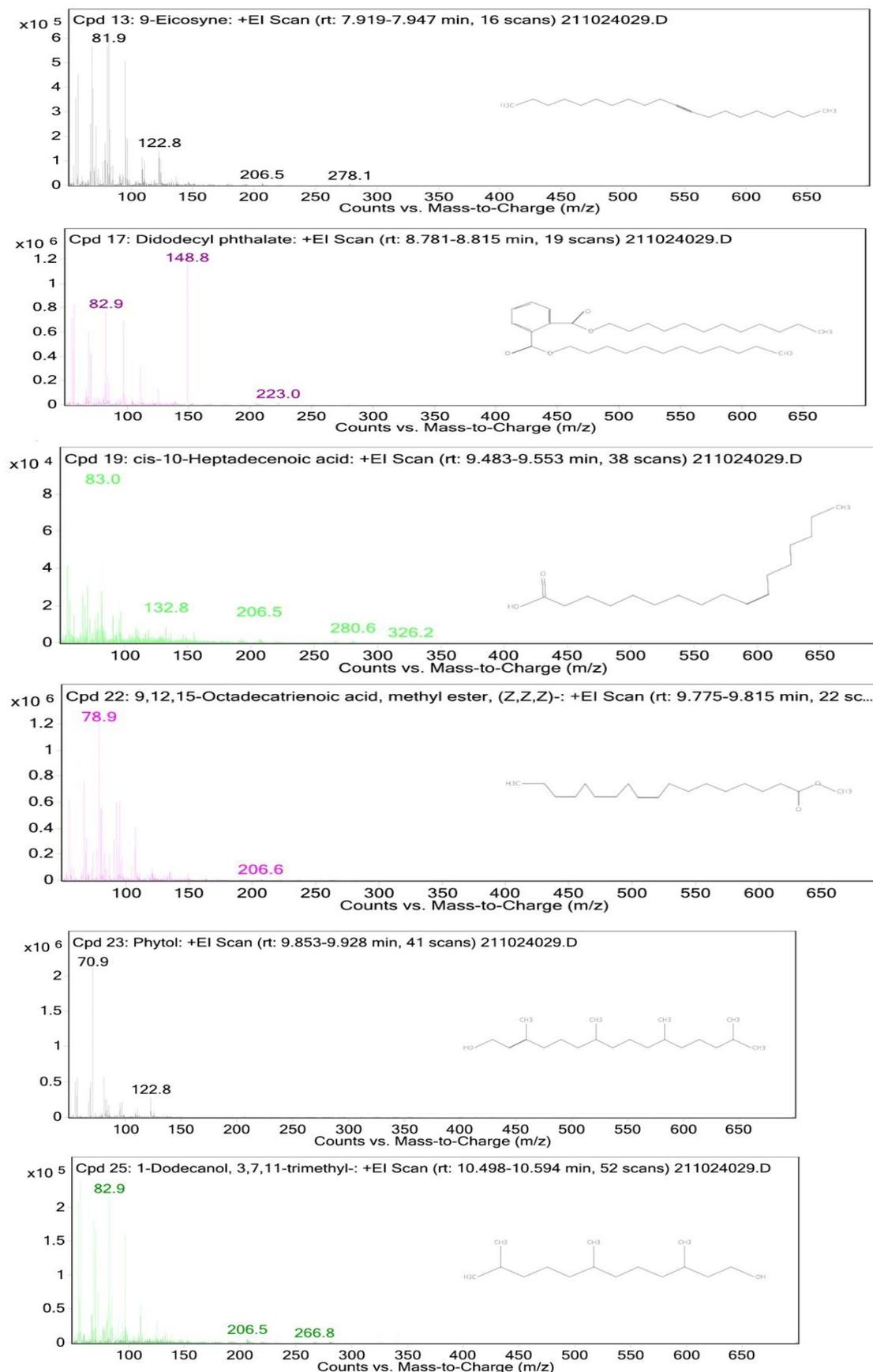
only enhances our understanding of the plant's chemical diversity but also compounds with promising biotechnological relevance. also contributes to the expanding repository of natural bioactive



**Figure 1:** GC-MS chromatogram illustrating the profile of bioactive compounds, nine highest peaks representing the compound present at the greatest relative abundance

This dominant compound is suggested to contribute significantly to the observed bioactivity of the extract. Retention times (RT) and corresponding molecular identities were confirmed by comparing mass spectra with standard libraries. Minor peaks indicate the presence of additional bioactive molecules, collectively enhancing the extract's potential therapeutic properties.





**Figure 2:** Mass Spectrum chromatogram of non-reported compounds displaying the separation and identification of ten compounds present in the *A. paniculata*

Each peak corresponds to a distinct chemical entity, with retention times reflecting their relative volatilities and interactions with the column's stationary phase. The mass spectra associated with individual peaks were analysed to determine molecular structures, aided by comparison with NIST libraries. Major identified compounds and minor components were also detected, indicating the sample's complex chemical profile.

**Table 1:** Chromatogram peak list obtained from GC-MS analysis

Retention Time	Height	Height %	Area	Area %	Area Sum %	Symmetry	Width
4.642	2793288.47	3.82	9694554	9.84	1.72	9.24	0.156
4.895	1204275.74	1.65	3336548.61	3.39	0.59	1.36	0.084
5.142	1247109.07	1.71	2297708.9	2.33	0.41	0.52	0.081
5.301	759910.58	1.04	2488949.46	2.53	0.44	1.76	0.107
5.776	6631289.41	9.08	7777123.25	7.9	1.38	3.37	0.052
6.061	2352882.26	3.22	3525302.16	3.58	0.62	0.49	0.075
6.582	16100557	22.04	18052894.86	18.33	3.2	0.93	0.051
6.608	4061623.18	5.56	4645999.2	4.72	0.82	2.19	0.04
6.984	2391896.9	3.27	2174512.05	2.21	0.39	1.15	0.034
7.517	16532656.52	22.63	18381780.82	18.67	3.26	1.75	0.063
7.732	2627159.69	3.6	2603304.83	2.64	0.46	1.28	0.031
7.783	73044675.13	100	98479566.65	100	17.44	1.38	0.076
7.934	9297489.18	12.73	9991606.33	10.15	1.77	1	0.04
8.051	24625307.32	33.71	31518749.82	32.01	5.58	0.87	0.06
8.363	39478250.92	54.05	57901324.24	58.8	10.26	1.31	0.092
8.772	13379911.29	18.32	16498404.72	16.75	2.92	0.61	0.041
8.791	12383196.36	16.95	16917123.82	17.18	3	2.67	0.034
8.823	1721599.22	2.36	2619777.71	2.66	0.46	4.18	0.057
9.524	1220610.01	1.67	2265862.71	2.3	0.4	0.69	0.081
9.715	10577549.84	14.48	16178802.38	16.43	2.87	1.05	0.046
9.753	27599663.79	37.78	43663293.8	44.34	7.73	1.08	0.041
9.792	15108614.17	20.68	24435689.23	24.81	4.33	1.28	0.057
9.875	16333897.99	22.36	34931902.32	35.47	6.19	2.38	0.087
9.956	6304894.62	8.63	10508908.56	10.67	1.86	0.78	0.064
10.517	5765454.88	7.89	11014947.92	11.19	1.95	3.08	0.115
10.809	3168168.81	4.34	5788960.33	5.88	1.03	1.1	0.08
11.758	5295823.98	7.25	9961126.91	10.11	1.76	0.95	0.077
12.678	2198892.42	3.01	4208958.92	4.27	0.75	1.76	0.077
13.165	800976.76	1.1	2475875.15	2.51	0.44	4.26	0.094
13.837	3887881.75	5.32	6617449.98	6.72	1.17	0.87	0.061
15.089	984153.88	1.35	3370231.73	3.42	0.6	1.27	0.104
16.35	1373442.89	1.88	3501468.43	3.56	0.62	2.57	0.096
17.01	1526678.92	2.09	4175902.73	4.24	0.74	1.45	0.096
17.58	686442.18	0.94	2530889.91	2.57	0.45	0.74	0.115
17.916	4861441.78	6.66	11636690.81	11.82	2.06	1.07	0.102
20.682	13712978.85	18.77	38402565.16	39	6.8	1.5	0.135
21.2	2876606.96	3.94	9571515.94	9.72	1.7	0.92	0.115
22.285	2214239.67	3.03	10386781.32	10.55	1.84	2.61	0.182

**Table 2:** List of thirty-eight Comprehensive lists of identified compounds

Compound Label (Cpd)	Retention Time (RT)	Compound Name	Molecular Formula
1	4.642	2,2,6,6-Tetramethyl-4 piperidone	C <sub>9</sub> H <sub>17</sub> NO
2	4.895	cis-9-Hexadecenoic acid	C <sub>16</sub> H <sub>30</sub> O <sub>2</sub>
3	5.142	beta.-D-Glucopyranose, 1 thio-,1-[N-hydroxy-5 (methylthio)pentanimidate]	C <sub>12</sub> H <sub>23</sub> NO <sub>6</sub> S <sub>2</sub>
4	5.301	2,5-Octadecadiynoic acid, methyl ester	C <sub>19</sub> H <sub>30</sub> O <sub>2</sub>
5	5.776	Dodecane, 1-fluoro-	C <sub>12</sub> H <sub>25</sub> F
6	6.061	17-Octadecyenoic acid	C <sub>18</sub> H <sub>32</sub> O <sub>2</sub>
7	6.582	Chloroacetic acid, pentadecyl ester	C <sub>17</sub> H <sub>33</sub> ClO <sub>2</sub>
8	6.608	5-Hexadecenoic acid, 2 methoxy-, methyl ester	C <sub>18</sub> H <sub>34</sub> O <sub>3</sub>
9	6.984	1-Ethynyl-3,trans(1,1 dimethylethyl)-4,cis methoxycyclohexan-1-ol	C <sub>13</sub> H <sub>22</sub> O <sub>2</sub>
10	7.517	Chloroacetic acid, pentadecyl ester	C <sub>17</sub> H <sub>33</sub> ClO <sub>2</sub>
11	7.732	1-Dodecanol, 3,7,11-trimethyl	C <sub>15</sub> H <sub>32</sub> O
12	7.783	3,7,11,15-Tetramethyl-2 hexadecen-1-ol	C <sub>20</sub> H <sub>40</sub> O
13	7.934	9-Eicosyne	C <sub>20</sub> H <sub>38</sub>
14	8.051	3,7,11,15-Tetramethyl-2 hexadecen-1-ol	C <sub>20</sub> H <sub>40</sub> O
15	8.363	Methyl 8-methyl-nonanoate	C <sub>11</sub> H <sub>22</sub> O <sub>2</sub>
16	8.772	Phthalic acid, 2 cyclohexylethyl butyl ester	C <sub>20</sub> H <sub>28</sub> O <sub>4</sub>
17	8.791	Didodecyl phthalate	C <sub>32</sub> H <sub>54</sub> O <sub>4</sub>
18	8.823	tert-Hexadecanethiol	C <sub>16</sub> H <sub>34</sub> S
19	9.524	cis-10-Heptadecenoic acid	C <sub>17</sub> H <sub>32</sub> O <sub>2</sub>
20	9.715	Methyl 10,11 octadecadienoate	C <sub>19</sub> H <sub>34</sub> O <sub>2</sub>
21	9.753	9-Octadecenoic acid (Z)-, methyl ester	C <sub>19</sub> H <sub>36</sub> O <sub>2</sub>
22	9.792	9,12,15-Octadecatrienoic acid, methyl ester, (Z,Z,Z)-	C <sub>19</sub> H <sub>32</sub> O <sub>2</sub>
23	9.875	phytol	C <sub>20</sub> H <sub>40</sub> O
24	9.956	Methyl 9 methyltetradecanoate	C <sub>16</sub> H <sub>32</sub> O <sub>2</sub>
25	10.517	1-Dodecanol, 3,7,11-trimethyl	C <sub>15</sub> H <sub>32</sub> O
26	10.809	17-Octadecyenoic acid	C <sub>18</sub> H <sub>32</sub> O <sub>2</sub>
27	11.758	Dodecanedioic acid	C <sub>12</sub> H <sub>22</sub> O <sub>4</sub>
28	12.678	cis-10-Heptadecenoic acid	C <sub>17</sub> H <sub>32</sub> O <sub>2</sub>
29	13.165	Icosapent	C <sub>20</sub> H <sub>30</sub> O <sub>2</sub>
30	13.837	9,12-Octadecadienoic acid (Z,Z)-	C <sub>18</sub> H <sub>32</sub> O <sub>2</sub>
31	15.089	cis-10-Heptadecenoic acid	C <sub>17</sub> H <sub>32</sub> O <sub>2</sub>
32	16.35	9,12,15-Octadecatrienoic acid, 2-[(trimethylsilyl)oxy]-1-[[[(trimethylsilyl)oxy]methyl]ethyl ester, (Z,Z,Z)-	C <sub>27</sub> H <sub>52</sub> O <sub>4</sub> Si <sub>2</sub>
33	17.01	Icosapent	C <sub>20</sub> H <sub>30</sub> O <sub>2</sub>
34	17.58	9,12,15-Octadecatrienoic acid, 2-[(trimethylsilyl)oxy]-1-[[[(trimethylsilyl)oxy]methyl]ethyl ester, (Z, Z, Z)-	C <sub>27</sub> H <sub>52</sub> O <sub>4</sub> Si <sub>2</sub>
35	17.916	2,6,10-Dodecatrien-1-ol, 3,7,11-trimethyl-	C <sub>15</sub> H <sub>26</sub> O
36	20.682	9,12-Octadecadiynoic acid, trimethylsilyl ester	C <sub>21</sub> H <sub>36</sub> O <sub>2</sub> Si
37	21.2	9,12-Octadecadiynoic acid, trimethylsilyl ester	C <sub>21</sub> H <sub>36</sub> O <sub>2</sub> Si
38	22.285	[1-(3,3-Dimethyloxiran-2 methyl)-3,7-dimethylocta 2,6-dienyl] trimethylsilane	C <sub>18</sub> H <sub>34</sub> OSi

## CONCLUSION

The acetone extract of *Andrographis paniculata* showed strong *in vitro* bioactivity: antioxidant, antimicrobial, and anti-inflammatory effects were all significant, which supports the plant's traditional medicinal uses. GC-MS profiling revealed 38 bioactive compounds in total, of which nine compounds produced major peaks in the chromatogram. Among those, four showed particularly high peak intensity and appear not to have been previously reported in acetone extracts of *A. paniculata*. The presence of these compounds lends

scientific credence to the plant's therapeutic potential, pointing to its usefulness as a source of drug-candidates. Further work is needed: isolate these novel high-intensity compounds, elucidate their structures, understand how they act (mechanisms), test their effects *in vivo*, and assess toxicity. The study also emphasizes the benefit of exploring how different phytochemicals might act together (synergy), and integrating computational tools (e molecular docking) to help predict targets and streamline drug-development.

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## Conflict of interest

The authors declared no conflict of interest.

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## ORCID ID

Pragya Shrivastava: <https://orcid.org/0009-0006-4391-7611>

Kush Kumar Nayak: <https://orcid.org/0000-0003-4000-0323>

Varaprasad Kolla: <https://orcid.org/0000-0002-6899-6153>

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