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GC–MS Profiling and Phytochemical Characterization of Bioactive Constituents in *Macaranga peltata* Leaf Powder

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Abstract
Macaranga peltata (Roxb.) Müll.Arg. is an ethnomedicinal plant belonging to the family Euphorbiaceae widely distributed in tropical forests of India and Sri Lanka. Traditionally, the plant is used in indigenous medicine for the treatment of fever, wounds, ulcers, and inflammatory disorders. Recent studies report antioxidant and anticancer potential of *M. peltata* leaf extracts. The present study aimed to characterize the phytochemical constituents present in *Macaranga peltata* leaf powder using Gas Chromatography–Mass Spectrometry (GC–MS). GC–MS analysis revealed twenty-nine phytochemical constituents with diverse retention times and peak area percentages. The major compounds identified were 2-Chloroethyl methyl sulfoxide (22.73%), Ginsenol (6.67%), 2,6-Dibromo-3-trifluoromethyl-4-nitrophenyl-.beta.-phenylpropionate (5.15%), and Z,Z-3,13-Octadecedien-1-ol (4.96%). The presence of alcohols, esters, phenolics, fatty acids, and heterocyclic compounds indicates the medicinal importance of *M. peltata* leaves. These findings support the traditional therapeutic applications of the plant and suggest its pharmaceutical potential.

Keywords: *Macaranga peltata*, GC–MS, phytochemical analysis, leaf powder.

1. Introduction

Medicinal plants have long served as valuable sources of natural therapeutic agents and continue to play a vital role in modern pharmaceutical research. Plant-derived secondary metabolites such as alkaloids, flavonoids, tannins, terpenoids, and phenolics are known to exhibit diverse biological activities including antioxidant, antimicrobial, anticancer, and anti-inflammatory effects. (Jeffrey B. Harborne, 1998; George E. Trease and William C. Evans, 2009). *Macaranga peltata* (Roxb.) Müll.Arg., belonging to the family Euphorbiaceae, is a fast-growing tropical medicinal tree commonly distributed in the Western Ghats of India. It is traditionally used in folk and Siddha medicine for treating fever, cough, wounds, ulcers, and skin disorders (Honnesh and Saha, 2024). Phytochemical screening of *M. peltata* has shown the presence of flavonoids, tannins, phenolics, stilbenes, and terpenoids (M. Megha, D. K. Kavana, K. Rithin and R. Bhat, 2025; T. Rathimeena and S. Kalidass, 2025). However, detailed chromatographic profiling of leaf powder remains limited. Gas Chromatography–Mass Spectrometry (GC–MS) is a highly reliable analytical technique widely employed for the identification of volatile and semi-volatile phytochemicals in plant extracts and has become an important tool in plant metabolomics studies (Natalia Frolova, Anna Orlova, Valeria Popova, Tatiana Bilova and Andrej Frolov, 2025). Therefore, the present study was undertaken to evaluate the phytochemical composition of *Macaranga peltata* leaf powder using GC–MS analysis

2. Materials and Methods

2.1 Collection of Plant Material

Fresh mature leaves of *Macaranga peltata* were collected from Phansad wild life sanctuary Raigad Maharashtra. The plant specimen was taxonomically authenticated using standard regional floras and herbarium methods.

2.2 Preparation of Leaf Powder
Collected leaves were thoroughly washed with distilled water to remove dust and foreign particles, shade dried at room temperature and pulverized into fine powder using a sterile mechanical grinder. The powdered material was stored in airtight containers until further analysis. (George E. Trease and William C. Evans, 2009).

2.3 Extraction Procedure
Approximately 10 g of dried leaf powder was subjected to solvent extraction using methanol by Soxhlet extraction method for 8 h. The extract was filtered through Whatman No. 1 filter paper and concentrated using rotary evaporator under reduced pressure (Harborne, 1998).

2.4 GC–MS Analysis
GC–MS analysis was performed using Gas Chromatography coupled with Mass Spectrometry equipped with capillary column and electron ionization mode. Helium was used as carrier gas at a constant flow rate of 1 mL/min. Injector temperature was maintained at 250°C. Oven temperature was programmed from 60°C to 280°C at a gradual rate. Mass spectra were recorded over 40–600 m/z range. The phytochemical constituents were tentatively identified by comparison of their mass spectra with NIST spectral library database (George E. Trease and William C. Evans, 2009; M. Al-Hatami *et al*., 2023; P. Kavya, R. C. Theijeswini and M. Gayathri, 2024).

3. Results
GC–MS chromatographic analysis of *Macaranga peltata* leaf powder revealed the presence of 29 phytochemical constituents.

Table 1: GC–MS profile of *Macaranga peltata* leaf powder

Peak No.	RT (min)	Compound Name	Area %	Role/Medicinal Use
1	1.409	2-Chloroethyl methyl sulfoxide	22.7358	Potential antimicrobial; chemical intermediate with limited direct medicinal use
16	32.920	Ginsenol	6.6762	Anti-inflammatory, antioxidant, adaptogenic
17	33.144	Dibromo nitrophenyl propionate	5.1536	Possible antimicrobial activity
20	34.141	Z,Z-3,13-Octadecedien-1-ol	4.9680	Anti-inflammatory; skin-conditioning bioactive
6	30.805	Heptaethylene glycol monododecyl ether	4.0407	Drug delivery enhancer; improves solubility of drugs
24	34.740	Methyl 10-oxo-8-decenoate	3.4840	Antimicrobial and anti-inflammatory
21	34.395	i-Propyl tricosanoate	3.3953	Skin protective; emollient with mild antimicrobial effect
27	35.449	Phosphonic acid derivative	3.2989	Antimicrobial; antiviral potential
15	32.835	N-cyclohexyl-3-aminopropanesulfonic acid	3.0491	Biological buffer; maintains physiological pH in studies
5	30.470	Dimethylmalonic acid, 4-acetylphenyl undecyl ester	2.9817	Possible antioxidant activity
11	31.665	Fluorobenzoic acid ester	2.9345	Antibacterial and anti-inflammatory potential
25	34.820	Succinic acid ester	2.7187	Metabolic intermediate; antioxidant role
4	30.135	5,6-Dihydro-2,4,6-trimethyl-4H-1,3,5-dithiazine	2.6529	Antimicrobial and antifungal activity
9	31.246	cis-11,12-Epoxytetradecen-1-ol	2.6494	Bioactive lipid; possible antimicrobial role
19	34.070	2-Nonenoic acid	2.4572	Antibacterial and antifungal
7	30.870	2,4-Di-tert-butylthiophenol	2.3556	Antioxidant; protects against oxidative stress
28	35.846	Acetic acid ester derivative	2.3464	Mild antimicrobial activity
14	32.784	Triazole derivative	2.2467	Antifungal, antibacterial
8	31.035	Hexahydropyridine derivative	2.1800	Central nervous system activity; potential neuroactive compound
10	31.525	2,4-Di-tert-butylthiophenol	2.0860	Antioxidant activity
29	35.950	Oxazol derivative	2.0402	Antibacterial, antifungal, anticancer potential
3	29.650	Ethanone, 1-(2,2-dimethylcyclopentyl)-	1.8280	Mild antimicrobial and anti-inflammatory potential
26	35.170	Methyl 16-acetoxyheptadecanoate	1.8231	Anti-inflammatory; bioactive fatty acid derivative
13	32.070	Benzimidazole derivative	1.8006	Antifungal, anthelmintic, anticancer potential
12	31.990	1,2-Benzenediol derivative	1.7629	Strong antioxidant; antimicrobial
2	28.215	l-Gala-l-ido-octose	1.6939	Involved in metabolic studies; potential role in glyco-biology
23	34.504	Carbonic acid ester	1.6610	Drug formulation component; low direct medicinal activity
22	34.460	Pyrazolotriazine derivative	1.5097	Possible anticancer and antimicrobial activity
18	33.255	Formic acid, 10-chlorodecyl ester	1.4698	Antimicrobial; preservative-like action

Source: GC MS analysis done at MIT Centre for Analytical Research and Studies, Department of Agricultural Engineering, Aurangabad.

4. Discussion
In Gas Chromatography–Mass Spectrometry (GC–MS), each compound present in a sample appears as a distinct peak in the chromatogram. The area under each peak is directly proportional to the amount of that compound detected by the instrument. Therefore, larger peak areas indicate higher concentrations of a compound, while smaller peaks represent compounds present in lower quantities. This allows for the estimation of the relative abundance of different constituents within the sample. Among the identified compounds, 2-Chloroethyl methyl sulfoxide exhibited the highest abundance (22.73%), indicating it as the predominant phytochemical constituent. Other major compounds identified include Ginsenol, Z,Z-3,13-Octadecedien-1-ol, and Heptaethylene glycol monododecyl ether.

The identified phytoconstituents belong to several important chemical classes such as alcohols, esters, fatty acid derivatives, sulfur-containing compounds, and phenolics. Phenolic compounds and fatty acid derivatives may contribute to antioxidant and antimicrobial activity, consistent with prior studies reporting antioxidant activity in M. peltata leaves (Rathimeena and Kalidass, 2025). The presence of diverse bioactive metabolites supports the ethnomedicinal importance of Macaranga peltata and indicates its potential use in pharmaceutical and nutraceutical development.

The GC–MS analysis revealed 29 compounds exhibiting a wide spectrum of potential medicinal activities. Collectively, these compounds are known to possess significant antimicrobial (including antibacterial and antifungal) properties, helping to inhibit the growth of pathogenic

microorganisms. Many constituents also demonstrate strong antioxidant activity, which plays a crucial role in neutralizing free radicals and preventing oxidative stress-related disorders. Several identified compounds, such as benzimidazole, triazole, and oxazole derivatives, are associated with anticancer and anti-inflammatory activities, contributing to their therapeutic importance. Additionally, certain fatty acid derivatives and alcohols present in the extract may exhibit anti-inflammatory and skin-protective effects, while others contribute to metabolic regulation and cellular protection. Some compounds also act as bioactive intermediates that enhance drug delivery or improve pharmacological efficacy. Overall, the presence of these diverse phytoconstituents suggests that the sample possesses promising medicinal potential, supporting its possible use in the development of therapeutic agents for treating infections, inflammation, oxidative stress, and other health-related conditions.

Phytochemicals play a crucial role in plant physiology and defence mechanisms, acting as protective agents against environmental stress, pathogens, and herbivores. Compounds such as phenolics and flavonoids are known to scavenge reactive oxygen species, contributing to antioxidant defense and maintaining cellular integrity. Fatty acid derivatives and esters often serve as structural components of cell membranes and play roles in signaling pathways involved in plant stress response. Sulfur-containing compounds like 2-Chloroethyl methyl sulfoxide may enhance plant resistance by exhibiting antimicrobial and detoxifying properties. Furthermore, many of these phytochemicals exhibit pharmacological potential in humans, including anti-inflammatory, anticancer, hepatoprotective, and antimicrobial effects. Their presence in M. peltata suggests that the plant could serve as a valuable natural source of therapeutic agents for drug development and health-promoting applications.

Conclusion

The present GC–MS investigation revealed that *Macaranga peltata* leaf powder is a rich reservoir of diverse phytochemical constituents, underscoring its potential biological and pharmacological significance. A total of twenty-nine compounds were tentatively identified, with 2-Chloroethyl methyl sulfoxide emerging as the dominant constituent. The detection of such bioactive molecules not only validates the traditional medicinal applications of *M. peltata* but also highlights its promise as a source of novel therapeutic agents. The phytochemical diversity observed suggests that *M. peltata* may exert multifaceted biological activities, ranging from antioxidant and antimicrobial effects to possible anti-inflammatory and cytoprotective roles. These findings provide a scientific foundation for future in-depth pharmacological studies, including bioassays to confirm specific activities and mechanistic investigations to elucidate pathways of action. Furthermore, the study emphasizes the importance of integrating modern analytical techniques with ethnomedicinal knowledge to bridge traditional practices and contemporary drug discovery. By establishing a chemical profile of *M. peltata*, this research opens avenues for the isolation of lead compounds, formulation of herbal therapeutics, and exploration of synergistic effects among its constituents. In conclusion, the GC–MS analysis of *Macaranga peltata* leaf powder not only supports its ethnopharmacological relevance but also positions it as a promising candidate for further phytochemical and pharmacological exploration, potentially contributing to the development of plant-based medicines and nutraceuticals.

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