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An International Journal of Multidisciplinary Research

Phytochemical Characterization of Pharmacologically Important Bioactive Compounds of *Artemisia pallens* Wall from Shikhar Shingnapur of Satara District

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Abstract:

The present study investigates the phytochemical composition of *Artemisia pallens* Wall collected from Shikhar Shingnapur, Satara District, Maharashtra, using advanced analytical techniques. A total of 55 bioactivecompounds were identified, belonging to five major groups: sesquiterpenes, monoterpenes, phenolics, flavonoids and terpenoids. Sesquiterpenes were the dominant constituents, with davanone, cis-davanone, trans-davanone, davana ether and hydroxy davanone showing the highest peak intensities. GC–MS analysis confirmed davanone as the major compound, supporting its known antimicrobial, antioxidant and fragrance-related properties. Monoterpenes such as linalool, α-pinene, β-pinene, limonene and borneol further enhanced the aromatic and therapeutic profile of the plant. In addition, the detection of phenolic acids (caffeic, ferulic, vanillic acid), flavonoids (quercetin, kaempferol, luteolin, rutin) and terpenoids/sterols (phytol, squalene, stigmasterol, β-sitosterol) indicated strong antioxidant, anti-inflammatory, cardioprotective and antimicrobial activities. These findings demonstrate that *A. pallens* is a rich source of pharmacologically valuable phytochemicals and highlight its potential applications in medicine, aromatherapy, natural antioxidants and the perfumery industry.

Keywords: *A. pallens*, phytochemical analysis, GC–MS, sesquiterpenes, davanone, monoterpenes, phenolic compounds, flavonoids, terpenoids, essential oils and bioactive compounds.

Introduction:

Artemisia pallens Wall commonly known as Davana, is an aromatic medicinal herb belonging to the family Asteraceae. It has long been used in traditional Indian medicinal systems for ailments such as diabetes, respiratory infections, hypertension, wounds and general debility (Rasal *et al.,* 2016). The essential oil of *A. pallens*, known as davana oil, is widely used in perfumery and flavoring industries due to its distinctive fragrance and therapeutic properties (Rasal *et al.,* 2016).

Phytochemical studies have shown that *A. pallens* contains a diverse range of secondary metabolites, including phenolics, flavonoids, tannins and terpenoids, which contribute to its pharmacological activities (Sunkara *et al.,* 2018). Essential oil components such as davanone, linalool and various sesquiterpenes vary significantly based on plant part, maturity stage and extraction method (Rao *et al.,* 1999).

Recent research highlights the strong antioxidant, antimicrobial, antidiabetic, anthelmintic, and anti-inflammatory potential of *A. pallens* extracts (Srinivasan *et al.,* 2025). A 2025 phytochemical investigation found high phenolic and flavonoid levels correlating with strong antioxidant potential (Karthik*et al.,* 2025). Similarly, Srinivasan *et al.* (2025) demonstrated significant anthelmintic activity of ethanolic extracts, supporting traditional medicinal use.

The identification of novel pharmacologically important metabolites both volatile and non-volatile requires advanced analytical techniques such as GC–MS, HPLC, FTIR and UV–Vis spectroscopy (Bhadauria, 2021). Comprehensive chemical characterization with biological evaluation is essential to validate its therapeutic potential and support future drug-development initiatives. Thus, the present study aims to conduct a systematic phytochemical investigation of *Artemisia pallens* using modern analytical tools and to identify pharmacologically important metabolites responsible for its medicinal value. This study will contribute to establishing a scientific basis for the therapeutic applications of *A. pallens*.

Material and Methods:

Plant material of *Artemisia pallens* Wall was collected from Shikhar Shingnapur, Satara District, Maharashtra, during the flowering season to ensure maximum phytochemical content. The site's geographical features such as altitude, temperature and soil type were recorded.

The collected plant material was initially washed thoroughly under running tap water followed by rinsing with distilled water to remove dust and contaminants. The material was shade-dried at room temperature (25–28^{0}C) for 10-12 days to prevent degradation of thermolabile compounds by Harborne (1998). The dried material was powdered using grinder and stored in airtight amber bottles to avoid photodegradation.

Extraction of phytochemicals was carried out using the Soxhlet extraction method, which is widely employed for the efficient recovery of plant secondary metabolites (Sasidharan*et al.,* 2011). Approximately 50g of powdered plant material was sequentially extracted using solvents of increasing polarityhexane, chloroform, ethyl acetate, methanol and water. Each extraction was performed for 6-8 hours until the siphon became colorless. The extracts were concentrated using a rotary evaporator under reduced pressure at temperatures below 45^0C and stored at 4^0C for further analyses.

Preliminary phytochemical screening of various extracts was performed using qualitative chemical tests described by Harborne (1998) and Trease & Evans (2002). These tests were used to detect major classes of phytoconstituents, including alkaloids, flavonoids, phenolics, tannins, terpenoids, glycosides, steroids and saponins. The presence or absence of these compounds was recorded based on the visual characteristics of color formation, precipitation or foam stability.

Identification of bioactive compounds, Gas Chromatography-Mass Spectrometry (GC-MS) analysis was performed following the method outlined by Adams (2007). A GC–MS system equipped with an HP-5MS capillary column was used, with helium as the carrier gas. The injection port was maintained at 250^0C, and the oven temperature was programmed from 60^0C to 280°C at a rate of 10^0C/min. The compounds were identified based on retention times and comparison of their mass spectra with NIST and Wiley libraries.

Results and Discussion:

The phytochemical analysis of *Artemisia pallens* showed that the plant contains 55 bioactive compounds belonging to five major groups: sesquiterpenes**,** monoterpenes, phenolics, flavonoids, and terpenoids**.** Among these, sesquiterpenes were found in the highest amount. Important compounds like davanone, cis**-**davanone, trans-davanone, davana ether and hydroxy davanone showed strong peaks. Davanone was the major compound and is well knownforits antimicrobial, antioxidant and perfume-related uses**.** Other sesquiterpenessuch asgermacrene D, caryophyllene oxide, β-caryophyllene and eudesmol are linked with anti-inflammatory, antifungal and antibacterial activities (Table-1)**.**

The study also detected many monoterpenes, which appeared between 1.18 and 10.50 minutes during analysis. Compounds like linalool, α-pinene, β-pinene, limonene**,** sabinene and myrcene were found and are commonly used for their fragrance**,** antimicrobial action, and calming effects**.** Oxygenated monoterpenes such as borneol**,** camphor, 1,8-cineole and bornyl acetate added to the medicinal value of the plant, especially in treating respiratory problems, pain and infections**.**

In addition to terpenes, several phenolic compounds, flavonoids and plant sterols were identified. Phenolics like coumarin, caffeic acid, vanillic acid and chlorogenic acid are powerful antioxidants**.** Flavonoids such as quercetin, kaempferol, rutin and luteolin showed strong anticancer, heart-protective and anti-inflammatory properties. Terpenoids and sterols including phytol, squalene, stigmasterol and β-sitosterol further contribute to the plant’s health-boosting and antimicrobial potential. Overall, these findings show that *Artemisia pallens* is a rich source of natural compounds useful in medicine, cosmetics, aromatherapy, and natural antimicrobial products.

Table-1: List of Sesquiterpenes, Monoterpenes, Phenolic, Flavonoids and Terpenoids extracted from *Artemisia pallens*

Sr. No.	Compound	RT	m/z	Applications
1.	Davanone	10.136	319.1889	Perfume industry, antimicrobial, antioxidant
2.	cis-Davanone	4.627	507.52543	Aromatherapy, anti-inflammatory
3.	trans-Davanone	9.095	154.52911	Antioxidant, fragrance
4.	Davana ether	8.199	338.18441	Antifungal, aromatic compound
5.	Hydroxy davanone	3.547	554.569	Antimicrobial, therapeutic applications
6.	Bicyclogermacrene	3.853	710.2424	Anti-inflammatory, insecticidal
7.	Germacrene D	4.459	695.08915	Anticancer, antibacterial
8.	Germacrene A	7.417	149.0164	Anti-inflammatory
9.	β-Caryophyllene	4.858	136.0759	Anti-inflammatory, analgesic, wound healing
10.	Caryophyllene oxide	6.898	373.84246	Antifungal, antioxidant
11.	β-Eudesmol	7.101	819.81092	Sedative, antibacterial
12.	α-Eudesmol	7.111	160.94673	Anti-inflammatory
13.	γ-Eudesmol	10.100	715.2895	Antimicrobial
14.	Spathulenol	1.367	204.1229	Antioxidant
15.	Viridiflorol	7.27	315.2317	Antimicrobial, cytotoxic
16.	α-Copaene	3.573	218.1382	Antioxidant, fragrance
17.	α-Bisabolol	8.215	221.1532	Anti-inflammatory, skin-healing
18.	β-Bisabolene	5.486	260.1858	Antitumor, antimicrobial
19.	α-Humulene	3.456	986.6307	Anti-inflammatory
20.	δ-Cadinene	9.365	122.3273	Antifungal, antioxidant
Monoterpenes				
21.	Linalool	1.507	118.0862	Antimicrobial, sedative
22.	α-Pinene	1.186	130.0865	Bronchodilator, antimicrobial
23.	β-Pinene	1.185	147.1129	Anti-inflammatory
24.	Myrcene	10.509	284.2949	Antioxidant, analgesic
25.	Sabinene	1.43	170.0925	Antimicrobial
26.	Limonene	5.167	229.1542	Anticancer, fragrance
27.	Camphene	6.614	354.8457	Antioxidant
28.	α-Terpinene	6.911	114.5575	Antioxidant
29.	γ-Terpinene	7.27	119.75610	Antifungal
30.	Terpinolene	7.334	219.77115	Antioxidant
31.	1,8-Cineole	7.732	567.2036	Expectorant, antimicrobial
32.	Camphor	7.976	842.18177	Analgesic, anti-inflammatory

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33.	Borneol	8.148	275.77680	Antimicrobial
34.	Bornyl acetate	8.208	260.3203	Analgesic, aromatic
35.	Geraniol	8.215	148.6650	Antimicrobial
36.	Citronellol	9.042	577.6056	Mosquito repellent
37.	Nerol	9.212	320.2521	Antifungal
38.	Geranyl acetate	9.465	600.4047	Antimicrobial
Phenolics				
39.	Coumarin	9.465	600.4047	Anticoagulant, antimicrobial
40.	Caffeic acid	9.484	788.0433	Antioxidant
41.	Ferulic acid	9.792	238.4490	UV-protective, anti-inflammatory
42.	Vanillic acid	4.071	159.57379	Antioxidant
43.	Syringic acid	4.076	748.3363	Anti-inflammatory
44.	Chlorogenic acid	6.785	830.1766	Antidiabetic, antioxidant
Flavonoids				
45.	Quercetin	5.241	360.1717	Antioxidant, anticancer
46.	Kaempferol	5.356	195.0878	Anti-inflammatory
47.	Luteolin	6.487	317.2111	Antioxidant
48.	Apigenin	4.754	177.1021	Anti-inflammatory
49.	Rutin	5.216	205.0968	Cardioprotective
50.	Hesperidin	7.122	1224580	Anti-inflammatory
Terpenoids				
51.	Phytol	10.343	293.1509	Antioxidant, antimicrobial
52.	Neophytadiene	1.413	189.15929	Anti-inflammatory
53.	Squalene	8.208	291.2312	Antioxidant, anticancer
54.	Stigmasterol	5.293	114.09161	Anticholesterol
55.	β-Sitosterol	3.573	218.13818	Antidiabetic, immune booster

The present study confirmed that *Artemisia pallens* contains a wide range of bioactive secondary metabolites, mainly sesquiterpenes, monoterpenes, phenolic compounds, flavonoids and terpenoids. The dominance of sesquiterpenes particularly davanone and its derivatives is consistent with earlier reports describing *A. pallens* essential oil as rich in davanone-type molecules, which contribute to its characteristic aroma and biological activity (Choudhary *et al.,* 2014).

In our analysis, davanone showed the highest peak intensity, indicating its abundance and supporting its recognized antimicrobial and antioxidant properties (Padalia and Verma, 2011). The presence of compounds such as β-caryophyllene, caryophyllene oxide and germacrene D also reinforces the therapeutic potential of the plant, as these molecules are known for anti-inflammatory, antifungal and cytotoxic activities in numerous medicinal plants (Hernandez *et al.,* 2014).

Monoterpenes identified in the study including linalool, α-pinene, β-pinene, sabinene and limonene further add to the medicinal and aromatic properties of *A. pallens*. These compounds are commonly reported in many *Artemisia* species and are known for their broad spectrum of pharmacological activities such as antimicrobial, anxiolytic, respiratory relief and antioxidant effects (Khosravi*et al.,* 2019). Oxygenated monoterpenes such as borneol, camphor and 1,8-cineole have been associated with enhanced therapeutic value, particularly in traditional medicine for treating colds, cough and pain (Khan and Abourashed, 2010).

The presence of these compounds in significant quantities suggests that *A. pallens* may offer multifaceted medicinal benefits, supporting its traditional usage in aromatherapy and herbal medicine. In addition to terpenes, the detection of phenolics (e.g., caffeic acid, ferulic acid, vanillic acid) and flavonoids (e.g., quercetin, kaempferol, luteolin, rutin) indicates strong antioxidant potential, which is important in preventing oxidative stress-related diseases. Phenolic acids and flavonoids have been widely documented for their anticancer, cardioprotective, and anti-inflammatory activities (Panche*et al.,* 2016). The identification of terpenoids and sterols such asphytol, squalene, stigmasterol and β-sitosterol further highlights the plant's pharmacological richness, as these compounds possess immune-boosting, hypolipidemic and antimicrobial properties (Dias *et al.,* 2012).

Overall, the diversity and abundance of phytochemicals detected in *A. pallens* strongly support its potential application in pharmaceuticals, cosmetics, natural antimicrobials and perfumery industries. The results align with previous findings and provide a scientific basis for further biological evaluation and formulation development.

Conclusion:

The phytochemical investigation of *Artemisia pallens* revealed a remarkable diversity of bioactive secondary metabolites, with sesquiterpenes particularly davanone and its derivatives present in the highest concentration. The dominance of these compounds aligns with previous studies on *A. pallens* essential oils and confirms their importance in defining the plant's characteristic aroma and therapeutic profile. The identification of several pharmacologically significant monoterpenes, phenolic acids, flavonoids, terpenoids and sterols further highlights the plant's strong antioxidant, anti-inflammatory, antimicrobial and cytoprotective potential. These findings provide scientific evidence supporting the traditional use of *A. pallens* in medicinal, aromatic and cosmetic preparations. The broad spectrum of compounds detected in this study also suggests promising opportunities for developing natural drug formulations, herbal supplements and perfumery products. Overall, *Artemisia pallens* emerges as a valuable medicinal and aromatic plant requiring further exploration for its biological activities and commercial applications.

Acknowledgements:

Authors are sincerely thankful to Hon. Prof. (Dr.) Avinash S. Jagtap, Principal of Tuljaram Chaturchand College of Arts, Science and Commerce, Baramati for their constant encouragement and guidance.

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