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Essential Oil Characterization of *Paeonia arietina* G. Anderson (*Paeoniaceae*)

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ABSTRACT

This study was conducted to determine the essential oil composition of *Paeonia arietina* G. Anderson. Plant samples were collected from the sloped areas near Dikme Village in Bingöl Province, and the essential oil was obtained through hydrodistillation. The resulting oil was analyzed using GC-MS, revealing 30 compounds comprising 82.70% of the total composition. The major constituent was methyl salicylate (27.34%), followed by palmitic acid (14.73%) and salicylaldehyde (10.0%). Additionally, biologically active compounds such as thymol (3.20%), stearic acid (6.82%), trans-myrtenal (2.20%), and α-methyl cinnamaldehyde (2.30%) were identified. Given the known antimicrobial, antioxidant, and anti-inflammatory properties of these constituents, the essential oil of *P. arietina* appears to have promising pharmacological and therapeutic potential. This research aims to contribute to the phytotherapeutic evaluation of this species.

Paeonia arietina G.Anderson (*Paeoniaceae*) Bitkisinin Uçucu Yağ Karakterizasyonu

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ÖZ

Bu çalışma, *Paeonia arietina* G. Anderson türünün uçucu yağ bileşimini belirlemek amacıyla gerçekleştirilmiştir. Bitki örneği, Bingöl İli Dikme Köyü yakınlarındaki yamaçlık alanlardan toplanmış ve su distilasyonu yöntemiyle uçucu yağı elde edilmiştir. Elde edilen yağ, GC-MS cihazı kullanılarak analiz edilmiş ve toplam %82,70 oranında 30 bileşik tespit edilmiştir. Majör bileşik %27,34 oranında metil salisilat olup, bunu palmitik asit (%14,73) ve salisilaldehit (%10,0) takip etmiştir. Ayrıca timol (%3,20), stearik asit (%6,82), trans-myrtenal (%2,20) ve α-metil sinnamaldehit (%2,30) gibi biyolojik olarak aktif bileşenler de tanımlanmıştır. Bu bileşiklerin antimikrobiyal, antioksidan ve antienflamatuar özellikleriyle bilindiği göz önüne alındığında, *P. arietina*'nın uçucu yağının farmakolojik ve terapötik potansiyel taşıdığı sonucuna varılmıştır. Çalışma, bu türün fitoterapötik açıdan değerlendirilmesine katkı sağlamayı amaçlamaktadır.

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Introduction

Paeonia arietina, a member of the Paeoniaceae family, is a plant species known for its showy flowers. This species is naturally distributed in mountainous regions of the Caucasus and the northeastern parts of Turkey (Davis, 1982).

Morphological studies have shown that *P. arietina* is generally a perennial herb with stem heights ranging from 50 to 80 cm (Davis, 1982). Its flowers are typically large and ornamental, reaching diameters of up to 8–10 cm, which also makes the plant a popular choice for ornamental horticulture (Hong, 2010).

Paeonia species gained great popularity and became widespread across Europe and North America, prompting extensive cross-breeding efforts during the 19th century. This surge in breeding activity contributed significantly to the emergence of numerous new cultivars, ultimately paving the way for the industrial development of *Paeonia*. Ecological assessments indicate that *P. arietina* prefers temperate climatic conditions and thrives in semi-shaded or fully shaded environments (Hong, 2020; Yang et al., 2020).

Studies on the population dynamics and conservation of the species emphasize that habitat loss and overharvesting pose significant threats to natural populations of *P. arietina* (Red Data Book of Turkish Plants, 2000). Accordingly, it is of utmost importance to implement strategies for conservation and protection of its natural habitats.

Paeonia species are known to contain tannins, essential oils, and alkaloids. Traditionally, they have been used for their sedative properties in the treatment of epileptic seizures and cough. Notably, peony has been reported to alleviate symptoms of endometriosis, polycystic ovary syndrome, menopause, and night sweats, as well as in the treatment of eczema, psoriasis, herpes, acne, and epilepsy. It is also suggested to regulate capillary permeability. The roots and flowers of the plant have been used as anti-inflammatory, antimicrobial, blood-purifying agents, and remedies for heart, stomach, and intestinal ailments (Zeybek, 1994; Dindaroğlu, 2014; Tarhan, 2016).

In a recent study, the essential oil of *Paeonia emodi* Royle roots collected from the Western Himalayas was analyzed using GC-FID, GC-MS, and NMR techniques. Twenty-four compounds, accounting for 97.4% of the oil, were identified, with salicylaldehyde (85.5%) being the main component. This represents the first detailed study on the root essential oil composition of *P. emodi* (Verma et al., 2015). In another study, the composition and antioxidant activities of essential oils obtained from the purple, red, and yellow flowers of *Paeonia delavayi* Franch. were investigated. GC-MS analysis identified 194 different compounds, and the antioxidant activities were found to vary depending on the flower color. While the essential oils

from purple and red petals showed similar profiles, the oil from yellow petals was distinctly different. The study suggested that *P. delavayi* could be considered a potential source of natural antioxidants and essential oils (Yu et al., 2022).

In recent years, scientific research on essential oils has increased considerably due to growing interest in their antimicrobial, antioxidant, and pharmaceutical potentials (Sancar et al., 2024; İnci et al., 2025; Sancar, 2025). Consequently, *Paeonia arietina* stands out as a remarkable plant in terms of both its biological attributes and ecological preferences. This study aims to determine the essential oil composition of *P. arietina*. The findings obtained will provide baseline data for future phytotherapeutic and economic utilization studies of this species and related taxa.

Materials and Methods

Plant Specimen

A plant specimen of *Paeonia arietina* G. Anderson was collected on 11 June 2023 from the hillside areas of Bingöl (Dikme) in Eastern Türkiye at an altitude of 1750–1800 m. The specimen was dried according to standard herbarium procedures and identified using the *Flora of Türkiye*. It was subsequently deposited in the herbarium of the Department of Plant and Animal Production at Bingöl University under accession number AD 3456. The general appearance of the plant is shown in Figure 1.

Essential Oil Extraction

The essential oil was extracted from 100 g of dried plant material by hydrodistillation using a Clevenger apparatus. The plant material was cut into small pieces and placed in a distillation flask with water. As the water boiled, the volatile oils were entrained by the steam and condensed on a cooling surface. The condensate separated into layers due to density differences, thus enabling the collection of the essential oil. The obtained oil was then transferred to glass vials for storage.

Essential Oil Analysis

Gas chromatography–mass spectrometry (GC-MS) was used to determine the composition of the essential oil, and analysis was performed on a Shimadzu GCMS-QP2010 system equipped with a Restek RTX®-5MS capillary column (30 m×0.25 mm, 0.25 µm film thickness) and an AOC-20 i/AOC-20s auto-sampler. The injection volume was 1 µL (split ratio 1:20), and helium was used as the carrier gas. The injector, detector, and interface temperatures

were set at 250°C, 220°C, and 250°C, respectively. Identification of the essential oil components was achieved by comparing their mass spectra with those in the NIST and Wiley mass spectral libraries. The results of the analysis are presented in Table 1.

Figure 1. General appearance of *P. arietina*

Table 1. Essential oil components of *P. arietina*

NO	Compound	RRI	*Paeonia arietina* (%)
1.	N-t-Butyl 3-pyrrolidinone	983	0.22
2.	2-Pentyl furan	992	0.10
3.	Undecane, 4,6-dimethyl-	1148	0.48
4.	Dihydroachillene	1134	0.10
5.	(E)-2-Nonenal	1152	0.10
6.	cis-Myrtanal	1175	1.0
7.	gamma-Nonalactone	1258	0.36
8.	trans-Myrtanal	1185	2.20
9.	Palmitic acid	1968	**14.73**
10.	Isopropyl palmitate	1985	1.63
11.	Nopinone	1992	2.20
12.	Stearic acid	2165	**6.82**
13.	Isopropyl stearate	2180	0.66

14.	Methyl benzoate	1036	0.10
15.	Myrtanal	1190	1.20
16.	Salicylaldehyde	1085	**10.0**
17.	α-Methyl cinnamaldehyde	1265	2.30
18.	Phellandral	1275	0.50
19.	Methyl salicylate	1198	**27.34**
20.	Erucic acid	2250	2.76
21.	Myrtenol	1250	0.20
22.	Perilla aldehyde	1260	0.60
23.	Ethyl salicylate	1285	0.10
24.	cis-Myrtanol	1175	1.50
25.	trans-Myrtanol	1185	0.70
26.	2-Ethyl hexanoic acid	1150	0.10
27.	Perilla alcohol	1180	0.30
28.	Thymol	1290	3.20
29.	Carvacrol	1298	1.10
30.	1-Hexadecanol	1850	0.10
	TOTAL		**82.70**

RRI: Relative Retention Index

Results and Discussion

In this study, the essential oil composition of *Paeonia arietina* was evaluated by GC–MS analysis, which identified 30 compounds accounting for 82.70% of the total oil content. The oil yield from the plant material was 2.1%. The essential oil was characterized by the presence of salicylate derivatives, fatty acids, and terpenoids. The major compound was methyl salicylate (27.34%), followed by palmitic acid (14.73%) and salicylaldehyde (10.00%). Other prominent constituents included stearic acid (6.82%) and thymol (3.20%).

The high content of salicylate derivatives, such as methyl salicylate (the methyl ester of salicylic acid) and salicylaldehyde (2-hydroxybenzaldehyde), indicates that this class of compounds is predominant in the essential oil of *P. arietina*. These aromatic compounds are known to be involved in plant defense and communication mechanisms (Janes and Kreft, 2008).

In our study, methyl salicylate was identified as the major constituent in the essential oil of *P. arietina* with a proportion of 27.34%, whereas in the study conducted by Orhan et al. (2010), this compound was found at a higher concentration of 52.2%. The cis-myrtanal compound was detected at a rate of 16.7% by Orhan et al. (2010), whereas in our study, cis-myrtanal was present at a significantly lower concentration of 1.0%. Common components such as methyl salicylate, salicylaldehyde, trans-myrtenal, palmitic acid, and thymol were identified in both studies. Among these, methyl salicylate and salicylaldehyde were major constituents in both analyses.

Saturated long-chain fatty acids such as palmitic acid (C16:0) and stearic acid (C18:0) made up approximately 21.5% of the total composition. The presence of these compounds, which are typically non-volatile, in the essential oil may be attributed to the high temperatures employed during GC–MS analysis. Although not typically associated with aroma, these fatty acids may influence the stability and biological properties of the oil.

In the present study, methyl salicylate was the major compound in the essential oil of *P. arietina*. This compound is also found in essential oils known as "wintergreen oil" and is recognized for its analgesic, anti-inflammatory, and rubefacient (blood flow-enhancing) properties. It has anti-inflammatory activity and is commonly used in oral care products and aromatherapy. Ivanova et al. (2002) also reported significant amounts of methyl salicylate in the root essential oils of *P. tenuifolia* and *P. peregrina*.

cis-Myrtenal is a compound that occurs in rare but notable quantities in the essential oils of certain aromatic plants. Although studies on its biological activity are limited, its aldehyde structure makes it a compound of interest in aromatherapy, and it is believed to possess antimicrobial potential (Al Abbasy et al., 2015).

Salicylaldehyde is both an aromatic and biologically active compound, known for its antiseptic, antioxidant, and aromatic properties. Several studies have demonstrated its antioxidant and antimicrobial effects (Lee et al., 2003).

A study conducted in Greece analyzed the root essential oils of *P. clusii* subsp. *clusii*, *P. mascula* subsp. *helenica*, and *P. parnassica* using GC-MS. Among the 12 volatile components identified, salicylaldehyde, paeonol, methyl salicylate, and benzoic acid were found to be the major constituents. Extracts from these species were tested against *Staphylococcus aureus*, *S. epidermidis*, *Pseudomonas aeruginosa*, *Enterobacter cloacae*, *Klebsiella pneumoniae*, *Escherichia coli*, *Candida albicans*, *C. tropicalis*, and *C. glabrata* strains. The results revealed high antifungal activity, particularly against pathogenic fungi (Papandreou et al., 2002).

Although terpenoids were found in smaller proportions, they are biologically significant. Thymol (3.20%), a monoterpene phenol, is widely recognized for its aromatic scent and well-documented antiseptic properties (Masyita et al., 2022). It exhibits broad-spectrum antimicrobial and antifungal activity and is likely to contribute to the antimicrobial activity of *P. arietina* essential oil (Orhan et al., 2010). Additionally, bicyclic monoterpene aldehydes such as trans-myrtenal (2.20%), though present in minor amounts, are of interest due to their antioxidant and antitumor potential (Masyita et al., 2024). These compounds may enhance the oil's biological activity through synergistic interactions with salicylate derivatives.

Conclusion

In conclusion, the essential oil of *P. arietina* exhibits an unusual chemical profile dominated by methyl salicylate, fatty acids, and other aromatic components. This composition reveals the biological basis underlying the plant's traditional uses and highlights *P. arietina* as a natural resource that warrants further pharmacological evaluation. In particular, the high content of methyl salicylate and thymol indicates analgesic and antiseptic potential, respectively, while compounds such as salicylaldehyde and trans-myrtenal support the oil's antimicrobial and antioxidant capacities. These findings support the potential of *P. arietina* as a natural source of compounds for the development of pharmaceutical or functional products.

Conflict of interest

The author declares no conflict of interest.

Author contributions

Author solely responsible for the entire work.

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