RESEARCH ARTICLE

Analysis of volatile components in petals of three species of *Manglietia* by SPME-GC-MS

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***Manglietia* is considered one of the most basal genera within Magnoliaceae, and numerous species are currently classified as endangered. The flowers of this genus produce characteristic aromatic compounds. To investigate the composition and potential applications of floral volatiles, petals from three *Manglietia* species were analyzed using solid-phase microextraction (SPME) coupled with gas chromatography-mass spectrometry (GC-MS). A total of 211 volatile compounds were identified. The predominant compounds included terpenoids (sesquiterpenoids and monoterpenoids), esters, alcohols, and aromatic compounds. Specifically, 102, 96, and 100 volatile compounds were identified in the petals of the three respective *Manglietia* species. A total of 169 aromatic compounds were detected with 71, 85, and 88 compounds found in each of the three species, while 9, 14, and 10 major volatile constituents were identified in the petals of the three species, respectively. The composition and abundance of volatile and aromatic compounds varied among the three *Manglietia* species. Several major volatile compounds showed potential for application in fragrance and related industries. These findings revealed the aromatic profiles of three *Manglietia* species and offered foundational data for pollination biology, conservation efforts, and the development of aromatic products.**

Keywords: *Manglietia aromatica*; *Manglietia longipedunculata*; *Manglietia insignis*; petals; volatile components; protection and development.

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Introduction

Magnoliaceae is one of the most endangered families of angiosperms with the genus *Manglietia* experiencing an especially high extinction risk [1]. *Manglietia* as a basal lineage within the family provides key insight into the origin and evolutionary history of Magnoliaceae [2]. Several species within this genus are listed under national and international conservation categories. Due to their conspicuous flowers, strong fragrance, varied growth forms, and distinct foliage and fruits, *Manglietia* species are widely used in landscape horticulture [3]. These plants are also rich in monoterpenes and sesquiterpenes, compounds with reported antitumor and anticancer activity, contributing to their traditional medicinal value [4, 5].

Studies on the volatile constituents of Magnoliaceae petals remain limited at the international level. In China, current research has primarily targeted *Lirianthe* and *Michelia* with limited attention to *Manglietia*. *Manglietia aromatica* is designated as a Class II National Key Protected Plant in China and is distributed in southeastern Yunnan and southwestern Guangxi provinces at altitudes of 900 – 1,600 m in evergreen broad-leaved forests. It is valued for scientific research, horticulture, timber production, and as a source of essential oils due to its strong aromatic properties [6]. *Manglietia insignis*, classified as Vulnerable (VU) on the IUCN Red List, is mainly distributed in southwestern China including parts of Hunan province at altitudes of 900 – 1,200 m. It is cultivated as an ornamental tree for its distinctive shape and large, brightly colored flowers [7]. *Manglietia longipedunculata*, listed as Critically Endangered (CR), is restricted to Nankunshan, Longmen County, Guangdong Province, China where it inhabits evergreen broad-leaved forests at 700 – 800 m altitude [8]. Comprehensive studies on the volatile constituents of *Manglietia* species remain scarce, particularly comparative analyses across species with varying conservation statuses. Furthermore, conventional extraction methods for volatile compounds such as distillation, solvent extraction, and supercritical fluid extraction present methodological limitations. Distillation often requires high temperatures, which may degrade floral volatiles. Solvent extraction may lead to contamination, while supercritical CO_2 extraction is costly and more appropriate for essential oil isolation than compositional analysis.

To address this research gap, three *Manglietia* species representing different conservation statuses of *M. aromatica*, *M. insignis*, and *M. longipedunculata* were selected for comparative analysis of their petal volatile compounds in this study to explore the species-specific composition, relative contents, and functional properties of floral volatiles and evaluate their potential applications. Solid-phase microextraction (SPME) coupled with gas chromatography-mass spectrometry (GC-MS) was employed in this research. Compared with traditional extraction methods, SPME-GC-MS offered several advantages including minimal sample requirements, high sensitivity, good reproducibility, and rapid compound identification [9]. This study provided fundamental data for the conservation and sustainable utilization of endangered *Manglietia* species by establishment of a foundation for sustainable resource development through the association of chemical diversity with conservation status. Furthermore, this study contributed to the broader understanding of floral scent chemistry within the Magnoliaceae, especially for under-studied taxa like *Manglietia*.

Materials and methods

Plant sample resources and collection

Manglietia aromatica and *Manglietia insignis* were collected from wild populations in Luojiatian Village, Leye County, Baise City, Guangxi Zhuang Autonomous Region, China. *Manglietia longipedunculata* was collected from the Nankunshan Provincial Nature Reserve in Longmen County, Huizhou City, Guangdong, China. Species identification was performed at the Guangxi Institute of Botany, Chinese Academy of Sciences (Guilin, Guangxi, China). Petals from the three *Manglietia* species were collected during their respective flowering periods between the times of 10:00 and 14:00 on April 30, 2023.

Identification of volatiles from different Manglietia species

Total ion chromatograms of petal volatiles from three species of *Manglietia* plants were obtained using a manual solid-phase microextraction (SPME) sampler (Supelco Inc., Bellefonte, Pennsylvania, USA) coupled with an Agilent 6890N–5975B gas chromatograph – mass spectrometer (GC-MS) (Agilent Technologies Inc., Santa Clara, California, USA) (SPME-GC-MS). Samples were placed in 50 mL amber-threaded sampling vials and subjected to headspace extraction using a pre-conditioned SPME 50/30 μm fiber coated with a combination of polydimethylsiloxane (PDMS), carboxen, and divinylbenzene (DVB) (PDMS/CAR/DVB) (Agilent Technologies Inc., Santa Clara, California, USA). The extraction was performed at 40°C for 30 min. After extraction, the fiber was directly inserted into the GC-MS injection port for analysis. The chromatography employed an HP-5MS quartz capillary column of 30 m × 0.25 mm × 0.25 μm with high-purity helium (99.99%) serving as the carrier gas at a constant flow rate of 1 mL/min with no split mode. The inlet temperature was set at 250°C. The oven temperature program was set as initial temperature of 35°C held for 2 min followed by increasing to 80°C at 5°C/min. The temperature was further increased to 180°C at 8°C/min before eventually reaching 250°C at 8 °C/min. Mass spectrometry was performed with both the inlet and GC-MS transfer line temperatures being maintained at 250°C. The ion source temperature was 230°C. Electron ionization (EI) was employed at 70 eV, and the scan range was set from 30 to 500 amu. Each chromatographic peak was analyzed to acquire the corresponding mass spectrum. Compound identification was performed using Xcalibur 1.2 software (Thermo Electron Corporation, San Jose, California, USA) by comparing with the National Institute of Standards and Technology (NIST98) mass spectral library and reference data from published literatures. The relative content of each volatile compound was determined by calculating the ratio of its peak area to the total peak area of all identified compounds using the area normalization method. The relative content (%) was calculated as below.

$$\text{Relative content (\%)} = (A_i / \Sigma A_j) \times 100$$

where A_i was the peak area of compound i. ΣA_j was the sum of the peak areas of all n identified compounds. This method provided a semi-quantitative estimate of compound abundance without applying correction factors.

Results and discussion

Analysis of volatile components in petals of three *Manglietia* plants

Based on SPME-GC-MS analysis, a total of 211 volatile compounds with a match score of ≥ 80% in the mass spectral database were identified from the petals of *M. aromatica*, *M. insignis*, and *M. longipedunculata* as 102, 96, and 100 compounds, respectively (Table 1). A few compounds displayed relatively high abundance, while the majority were present in lower quantities. 26 volatile compounds including (1R)-(+)-α-pinene, (E)-1-methoxy-3,7-dimethylocta-2,6-diene, and β-selinene were common to all three species. 20 compounds including β-caryophyllene, (E)-β-farnesene, and caryophyllene oxide were detected in both *M. longipedunculata* and *M. insignis*, while 10 compounds including (+)-δ-cadinene, γ-terpinene, and α-muurolene were shared by *M. aromatica* and *M. longipedunculata*, and 14 compounds of γ-elemene, sabinene, and β-bisabolene were identified in the petals of *M. aromatica* and *M. insignis*. Species-specific volatiles included 56 compounds such as γ-selinene, β-elemene, and α-cis-limonene were detected exclusively in the petals of *M. aromatica*. 44 compounds such as (+)-γ-gurjunene, caryophylladienol II, and 4-thujanol were found only in the petals of *M. longipedunculata*, and 45 compounds such as (−)-guaiol, palustrol, and carbon dioxide were presented solely in the petals of *M. insignis*. The results demonstrated that, although some compounds in the petals of the three species of *Manglietia* were shared by three or two kinds of petals, their relative contents differed, and some compounds were unique to one type of petal. Therefore, there were distinct interspecific differences in both the composition and relative abundance of volatile compounds in the petals of the three *Manglietia* species.

Comparison of volatile components in petals of three species of Manglietia plants

Table 1. The category of volatile components in petals of three *Manglietia* plants.

Category	Petals					
	Cinnamomum camphora		***Cinnamomum burmannii***		***Magnolia liliiflora***	
	Components	**Content (%)**	**Components**	**Content (%)**	**Components**	**Content (%)**
Terpenes	3	0.72	5	0.89	8	3.82
Sesquiterpenes	33	23.33	42	56.89	39	31.23
Monoterpenes	19	19.43	24	18.91	15	40.4
Esters	17	12.85	3	8.63	11	8
Alcohols	15	18.07	6	10.74	10	6.98
Aromatic Compounds	10	5.84	8	2.06	3	0.9
Inorganic compounds	1	0.93	1	0.24	1	0.97
Ethers	1	17.56	—	—	1	0.08
Aldehydes	1	0.2	2	0.16	—	—
Phenols	1	0.3	—	—	—	—
Bicyclic compound	1	0.11	—	—	—	—
Alkenes	—	—	2	0.71	6	6.59
Amine	—	—	1	0.58	1	0.39
Ketone	—	—	1	0.05	1	0.08
Oxygen-containing cyclic compounds	—	—	1	0.09	—	—
Benzodiazepines	—	—	—	—	1	0.06
Cycloheptane Compounds	—	—	—	—	1	0.22
Cycloalkanes	—	—	—	—	1	0.21
Lactone	—	—	—	—	1	0.04

Note: The "—" indicated no detection.

A total of 211 volatile compounds were identified across the three *Manglietia* species. Although the number and composition of volatiles differed among species, all three *Manglietia* species contained terpenoids, esters, alcohols, and aromatic compounds. Terpenoids constituted the predominant class of volatiles, accounting for 43.48%, 76.69%, and 75.45% in *M. aromatica*, *M. insignis*, *M. longipedunculata*, respectively, with the highest relative abundance observed in the petals of *M. insignis*. Among the other volatile classes, the petals of *M. aromatica* contained 12.85% alcohols, 18.07% esters, and 5.84% aromatic compounds, while, in *M. longipedunculata*, the relative contents of alcohols, esters, and aromatic compounds were 10.74%, 8.63%, and 2.06%, respectively. In *M. insignis*, the contents of esters, alcohols, and alkenes were 8.00%, 6.98%, and 6.59%, respectively. In *M. aromatica*, 102 volatile compounds were identified including 55 terpenoids, 17 esters, 15 alcohols, 10 aromatic compounds, 1 inorganic compound, 1 ether, 1 aldehyde, 1 phenol, and 1 bicyclic compound. Excluding terpenoids, the relative contents of the other groups were 12.51% alcohols, 18.07% esters, 5.84% aromatic compounds, 0.93% phenol, 0.20% ether, 0.30% aldehyde, 0.11% bicyclic compound, and 17.56% unclassified or minor compounds. In *M. longipedunculata*, 96 volatile compounds were detected including 71 terpenoids, 8 aromatic compounds, 6 alcohols, 3 esters, 2 aldehydes, 2 alkenes, and one each of inorganic compound, amine, ketone, and oxygen-containing heterocyclic alkene. Apart from terpenoids, the relative contents were 10.07% alcohols, 8.63% esters, 2.06% aromatic compounds, 0.16% aldehydes, 0.71% alkenes, 0.24% inorganic, 0.58% amine, 0.05% ketone, and 0.09% heterocyclic alkene. In *M. insignis*, 100 volatile compounds were identified, comprising 62 terpenoids, 11 esters, 10 alcohols, 6 alkenes, 3 aromatic compounds, and one compound each from inorganic compound, ether, amine, ketone, benzoazepine heterocycle, cycloheptadecane, cycloalkane, and lactic acid ester. The relative

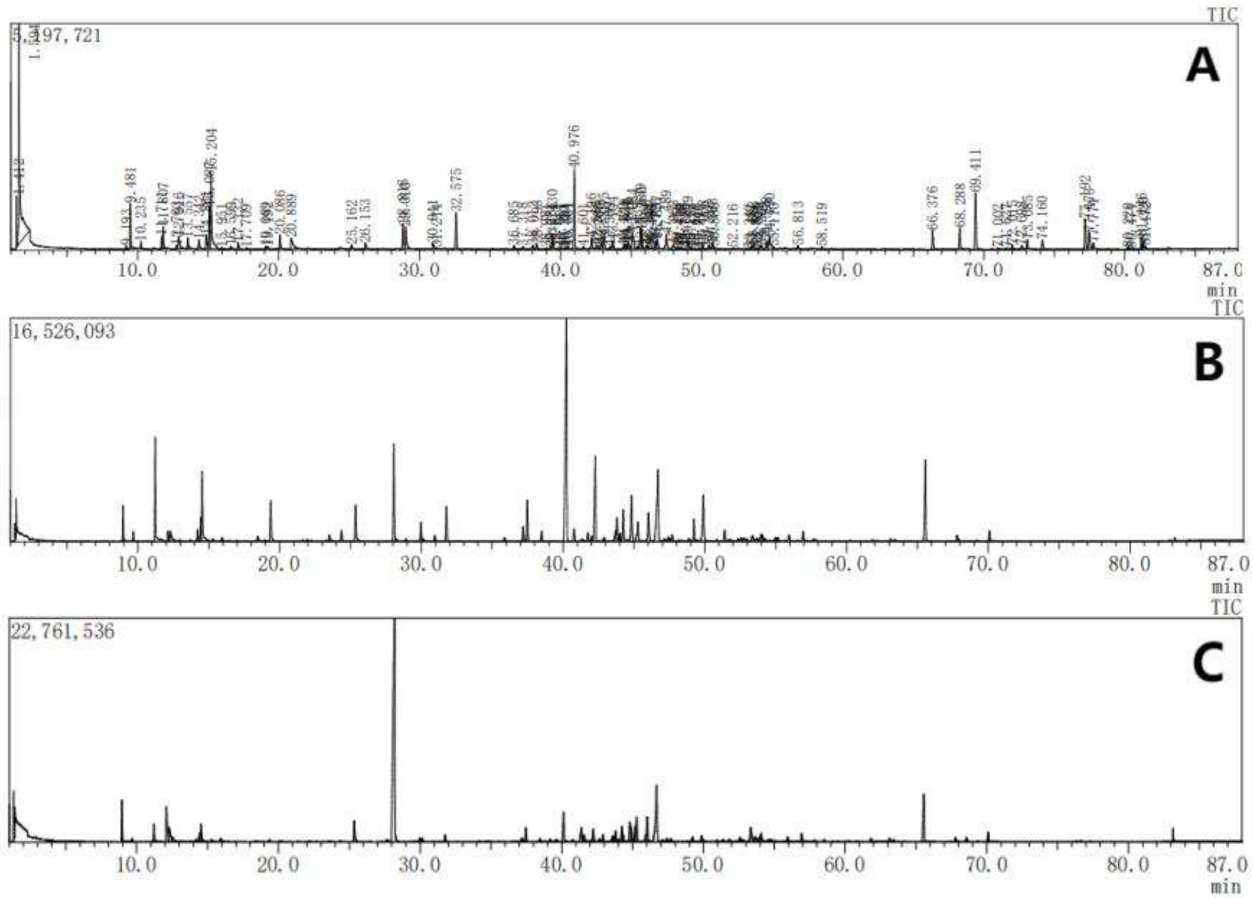

Figure 1. Total ion current (TIC) of volatile from flowers of 3 *Magnoliaceae* tree species. **A**. *M. aromatica*. **B**. *M. longipedunculata*. **C**. *M. insignis*.

contents of these non-terpenoid volatiles were 6.98% alcohols, 8.00% esters, 6.59% alkenes, 0.97% aromatic compounds, 0.90% benzoazepine, 0.08% inorganic, 0.39% ether, 0.08% amine, 0.06% ketone, 0.22% cycloheptadecane, 0.21% cycloalkane, and 0.44% lactic acid ester (Figure 1). These results demonstrated clear interspecific differences in both the composition and relative abundance of floral volatile compounds. The number of compound categories did not exhibit a consistent correlation with their total relative content, indicating that chemical richness and compound abundance were regulated independently across these species.

Aroma components in petals of three *Manglietia* plants

Among the 211 volatile compounds detected in the petals of the three *Manglietia* species, 169 were classified as aromatic substances. In the petals of *M. aromatica*, 102 volatile compounds were identified including 71 aromatic compounds, which accounted for 59.43% of the total volatile content. Among them, two dominant aromatic compounds were identified as 1,8-Cineole (6.92%) and (–)-Isocaryophyllene (6.66%), which were likely the major contributors to the floral aroma of *M. aromatica*, while the remaining aromatic compounds represented secondary contributors. In *M. longipedunculata*, 96 volatile compounds were detected including 85 aromatic compounds, accounting for 91.73% of the total volatile content. Five dominant aromatic components were identified including β-caryophyllene (19.27%), (+)-δ-cadinene (6.66%), (E)-1-methoxy-3,7-dimethylocta-2,6-

diene (5.75%), (1S)-(–)-β-pinene (5.41%), and α-caryophyllene (5.23%), which might be the principal aromatic constituents in the petals of *M. longipedunculata* with the remainder serving as secondary components. In the petals of *M. insignis*, 100 volatile compounds were detected including 88 aromatic compounds, representing 88.11% of the total volatile content. Two major aromatic compounds were identified as (E)-1-methoxy-3,7-dimethylocta-2,6-diene (33.01%) and β-cadinene (7.72%), suggesting that these were the primary contributors to the floral aroma of *M. insignis*, while the remaining compounds were secondary aromatic components. The comparative analysis of floral aroma components across the petals of three *Manglietia* species revealed significant differences in the composition and relative content of aromatic substances. Although terpenoids were the principal aroma contributors in all three species and several shared compounds were present, the specific profiles and relative proportions varied significantly. These differences likely explained the distinct aromatic characteristics observed among species despite a generally similar *Manglietia*-type scent. The observed variability might be due to differences in genetic background, biosynthetic pathways, and environmental conditions.

Difference analysis of main volatile components in petals of three species of Manglietia plants

In the petals of *M. aromatica*, 9 major volatile compounds were identified including ethylene glycol diisobutyl ether (17.56%), 1,8-cineole (6.92%), (–)-isocaryophyllene (6.66%), methyl palmitate (4.75%), 1-methylidene-4-prop-1-en-2-ylcyclohexane (4.07%), methyl linoleate (3.20%), L-bornyl acetate (2.85%), (1R)-(+)-α-pinene (2.62%), and citronellol (2.11%), which collectively accounted for 50.73% of the total volatile content. In *M. longipedunculata*, 14 major volatile compounds were identified as β-caryophyllene (19.27%), (+)-δ-cadinene (6.66%), diisobutyl phthalate (6.60%), (E)-1-methoxy-3,7-dimethylocta-2,6-diene (5.75%), (1S)-(–)-β-pinene (5.41%), α-caryophyllene (5.23%), 1,8-cineole (4.05%), caryophyllene oxide (3.67%), γ-cadinene (3.44%), γ-maaliene (3.09%), α-copaene (2.38%), linalool (2.35%), α-terpineol (2.23%), and β-selinene (2.03%). These compounds comprised 72.16% of the total volatile content. In the petals of *M. insignis*, 10 major volatile compounds were identified including (E)-1-methoxy-3,7-dimethylocta-2,6-diene (33.01%), β-cadinene (7.72%), diisobutyl phthalate (4.91%), 6-methyl-5-hepten-2-one (3.65%), γ-cadinene (3.47%), β-caryophyllene (2.69%), naphthalene,1,2,3,4,4a,5,6,7-octahydro-4a,8-dimethyl-2-(1-methylethenyl)- (2.51%), (1R)-(+)-α-pinene (2.43%), α-bergamotene (2.18%), and α-terpineol (2.04%). Together, these compounds accounted for 64.61% of the total volatile content. These findings indicated that, while certain compounds were shared among the three species, the composition and relative abundance of key volatile components differed significantly, contributing to the unique floral characteristics of each *Manglietia* species.

Development prospect of main volatile components in petals of three species of *Manglietia* plants

In addition to contributing to floral fragrance, many of the volatile components identified in the petals displayed significant chemical and pharmacological potential. Ethylene glycol diisobutyl ether, the most abundant volatile compound in the leaves of *M. aromatica*, has only a faint odor, therefore, unlikely to contribute to petal aroma, which is commonly used as a laboratory solvent with no additional biological activity being reported. On the other hand, 1,8-cineole has been extensively studied and shown to possess antibacterial, anti-inflammatory, analgesic, antitumor, antidepressant, neuroprotective, and hypolipidemic properties, as well as roles in preventing endothelial dysfunction and diabetic complications [10-13]. The relative contents of 1,8-cineole in the petals of *M. aromatica* and *M. longipedunculata* were 6.92% and 4.05%, respectively, while only 1.40% was detected in *M. insignis*. The sesquiterpene compound (–)-isocaryophyllene has broad application potential and is used to manufacture food products, cosmetics, emulsions, toothpaste, and other industrial goods. Furthermore, it exhibits anti-inflammatory, anticancer, antibiotic, antioxidant, and antibacterial properties and shows local anesthetic activity [14]. This compound was only detected in the petals of *M. aromatica*, where it accounted for 6.66% of the volatile content. Methyl palmitate, an intermediate product for surfactants and other fine chemical products, is used in the synthesis of emulsifiers, wetting agents, stabilizers, rust inhibitors, and plasticizers [15], which also serves as a biodiesel precursor [16] and has been reported to aid in the treatment of gastrointestinal dysfunction [17]. Its relative content in this study was 4.74% in the petals of *M. aromatica* while only 0.39% in the petals of *M. insignis*. 1-methylidene-4-prop-1-en-2-ylcyclohexane was only detected in *M. aromatica* at a relative content of 3.20%. Although it has not been studied specifically, as a terpenoid compound and structural isomer of limonene, it might possess anti-inflammatory and antimicrobial activity and possibly a lemon-like aroma, suggesting potential use in fragrance development. Methyl linoleate contains linoleic acid, an essential fatty acid that constitutes a major component of human cell membranes and plays an important role in human health and nutrition. Linoleic acid has been associated with reduced cancer risk and prevention of cardiovascular and skin diseases [18]. Methyl linoleate is also a promising biodiesel precursor [19]. Its relative content found in this study was 4.07% in the petals of *M. aromatica* but only 0.10% in *M. insignis*. L-bornyl acetate, an isomer of bornyl acetate, has been reported to exhibit peppermint and pine-like aromas and is known to display antibacterial and insecticidal effects [20]. It is used in perfumes, fragrances, food additives, and insect repellents. Furthermore, its antioxidant and anti-inflammatory properties are considered to have pharmacological relevance including applications in whitening products and the prevention and treatment of Alzheimer's disease [21]. Its relative content in this research was 2.85% in *M. aromatica* and 1.96% in *M. longipedunculata*, while only 0.56% was detected in *M. insignis*. (1R)-(+)-α-pinene is an isomer of pinene. Various studies have demonstrated that this compound possesses broad application potential including in the production of flavorings, insect repellents, cough suppressants, and agents for the prevention and treatment of parasitic infections, tumors, and diabetes [22–24]. It was detected in the petals of all three *Manglietia* species with relative contents of 2.62%, 1.37%, and 2.23% for *M. aromatica*, *M. insignis*, and *M. longipedunculata*, respectively. Citronellol, a major component of rose essential oil, has been reported for antitumor activity [25]. It was detected exclusively in the petals of *M. aromatica*, where it constituted 2.11% of the volatile profile. β-Caryophyllene was detected in *M. longipedunculata* and *M. insignis* with relative contents of 19.27% and 2.61%, respectively. As the primary volatile and aromatic compound in *M. longipedunculata*, β-caryophyllene not only contributed a unique scent but also exhibited a variety of pharmacological effects, which has been widely applied in medical formulations [26]. Moreover, this compound has been reported to act as an insect attractant, facilitating pollination [27]. (+)-δ-cadinene, which has an agarwood-like aroma and is a terpene compound, exhibits antibacterial and insect-repellent properties [28]. It was identified in the petals of *M. aromatica* and *M. longipedunculata* with relative contents of 1.59% and 6.66%, respectively. Diisobutyl phthalate, commonly used in the plastics industry, has been the subject of extensive toxicological research [29] and was detected in *M. longipedunculata* and *M. insignis* with relative contents of 6.60% and 5.00%, respectively. (E)-1-Methoxy-3,7-dimethylocta-2,6-diene is a methoxylated terpene compound with a characteristic terpenoid aroma and has not been well studied pharmacologically. However, its structural similarity to other bioactive natural products suggests possible antioxidant, anti-inflammatory, or neuroprotective activity. It was detected in the petals of all three *Manglietia* species and represented the predominant volatile component in *M. insignis* with a relative content of 31.68%, while the contents in *M. aromatica* and *M. longipedunculata* were 1.93%

and 5.75%, respectively. As an isomer of pinene, (1S)-(–)-β-pinene has demonstrated antibacterial activity and is used in the synthesis of optically active derivatives [30]. It was detected in the petals of all three species with relative contents of 5.41% in *M. longipedunculata*, 1.45% in *M. aromatica*, and 1.10% in *M. insignis*. α-caryophyllene and β-caryophyllene are structural isomers, while caryophyllene oxide is an oxidized derivative of caryophyllene. These compounds exhibit various biological activities including anti-inflammatory, analgesic, antioxidant, and neuroprotective effects [31]. In addition to their pharmacological relevance, they are used in the food and fragrance industries. α-caryophyllene was detected in all three species with relative contents of 1.05%, 5.23%, and 1.13% in *M. aromatica*, *M. insignis*, and *M. longipedunculata*, respectively. β-caryophyllene and caryophyllene oxide were present in *M. longipedunculata* and *M. insignis* with relative contents of 19.27%, 2.61% in *M. longipedunculata* and 3.67%, 0.69% in *M. insignis*, respectively. γ-cadinene, known for its spicy clove-like aroma, is commonly used in food and perfume formulations. Studies indicate that it has antibacterial potential, membrane-modulating effects, and neuroprotective properties [32]. It was identified in all three species with relative contents of 1.17%, 3.44%, and 3.49% in *M. aromatica*, *M. insignis*, and *M. longipedunculata*, respectively. γ-maaliene may possess antibacterial activity [33] and was only detected in the petals of *M. longipedunculata* with a relative content of 3.09%. α-copaene as a naturally occurring compound with a wide distribution in plants has demonstrated anti-inflammatory, antibacterial, antioxidant, anticancer, and insect-repellent activities [34, 35]. α-copaene has shown significant potential in plant protection and natural drug development and was detected in the petals of *M. aromatica*, *M. insignis*, and *M. longipedunculata* with relative contents of 0.38%, 2.38%, and 1.26%, respectively. Linalool is a natural monoterpene alcohol characterized by a pleasant floral or citrus aroma and is extensively used in fragrances and skincare formulations [36]. This compound exhibits multiple biological activities including sedative, anti-anxiety, antibacterial, anti-inflammatory, and antioxidant effects [37]. It was detected in the petals of *M. aromatica*, *M. insignis*, and *M. longipedunculata* with relative contents of 1.01%, 2.35%, and 0.15%, respectively. α-terpineol, another monoterpene alcohol, is widely found in essential oils and displays a distinct floral or citrus scent, which possesses several biological activities and is applied in diverse areas such as antibacterial, antifungal, anti-inflammatory, antioxidant, sedative, and insect-repellent applications. Beyond its calming properties, it may support skin and respiratory health. Its multifunctional characteristics offer broad utility across the fragrance, cosmetic, cleaning, and natural medicine industries. α-terpineol was detected in all three species with relative contents of 0.55%, 2.23%, and 1.96% for *M. aromatica*, *M. insignis*, and *M. longipedunculata*, respectively. β-cadinene exhibits antibacterial, antifungal, antioxidant, anthelmintic, and anti-inflammatory properties [38], which contributes to plant defense mechanisms and is used in natural medicines, essential oils, and aromatherapy. It was identified in the petals of *M. aromatica* and *M. insignis* with relative contents of 0.05% and 7.64%, respectively. Diisobutyl phthalate, a phthalic acid ester commonly applied as a plasticizer in plastics and rubber, has been associated with potential environmental and health risks [39]. Evidence suggests that prolonged exposure may disrupt endocrine function and affect reproductive health [40]. It was detected in the petals of *M. longipedunculata* and *M. insignis* with relative contents of 6.60% and 5.00%, respectively. 6-methyl-5-hepten-2-one is a naturally occurring monoterpene compound with a carbonyl group characterized by a fruity, herbaceous scent. It is widely employed in fragrances, food products, beverages, cosmetics, and as a natural preservative. It also displays potential antibacterial and insect-repellent activity [41, 42]. Although some pharmacological properties have been proposed, further investigation is required. It was detected in the petals of *M.*

longipedunculata and *M. insignis* with relative contents of 0.66% and 3.52%, respectively. The naphthalene 1, 2, 3, 4, 4a, 5, 6, 7-octahydro-4a, 8-dimethyl-2-(1-methylethenyl)- compound likely contributes aromatic qualities based on its structural characteristics and may be included in perfume and flavor formulations for its woody, floral, or sweet scent. While structurally similar compounds such as sesquiterpenoids and other naphthalene derivatives have demonstrated antibacterial, antioxidant, and anti-inflammatory activities, specific pharmacological data on this compound remain limited. It was detected in *M. aromatica* and *M. insignis* with relative contents of 0.43% and 2.53%, respectively. α-bergamotene, recognized for its distinct citrus aroma, is widely used in perfumery and flavor production [43]. It also shows a range of biological activities including antibacterial, antifungal, antioxidant, anti-inflammatory, and sedative properties [44, 45]. Furthermore, it has been reported to influence insect pollination behavior [46]. It was exclusively detected in the petals of *M. insignis* with a relative content of 2.13%.

Conclusion

In this study, solid-phase microextraction (SPME) coupled with gas chromatography–mass spectrometry (GC–MS) was employed to characterize the volatile compounds in the petals of three *Manglietia* species. The results demonstrated both qualitative and quantitative diversity in volatile profiles among the species, although several core compounds were consistently present. The results suggested the existence of a shared aromatic signature across the genus, while species-specific scent characteristics were shaped by distinct combinations and relative concentrations of individual volatiles. Notably, many of the identified compounds possessed known biological activities including antimicrobial, antioxidant, anti-inflammatory, and immunomodulatory functions. Such bioactivities not only enhanced the ecological roles of these volatiles but also highlighted their potential applications in pharmaceuticals, functional foods, and cosmetics. Furthermore, certain terpenoids detected in the samples might influence pollinator behavior, indicating possible ecological functions that warranted further investigation. Overall, the natural origin, multifunctional properties, and industrial relevance of these volatile compounds underscored their significance. This research provided foundational data for future studies on the ecological interactions and conservation of endangered *Manglietia* species, while also offering a scientific basis for the sustainable utilization of their floral volatiles in applied sectors.

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