Trop J Nat Prod Res, December 2025; 9(12): 6086 - 6091 **ISSN 2616-0684 (Print)**
ISSN 2616-0692 (Electronic)

Tropical Journal of Natural Product Research

Available online at https://www.tjnpr.org

Original Research Article

Comparative Chemotype Characterization and Antibacterial Activity of Essential Oils Obtained from the Leaves of Three Litsea species from Vietnam

Tran D. Dung[1,2], Nguyen Q. Binh[3], Nguyen H. Thuong[4], Nguyen N. Tuan[4], Tran D. Thang[4]*

[1] *Graduate University of Science and Technology, Vietnam Academy of Science and Technology Vietnam*
[2] *Pu Huong Nature Reserve, Nghe An, Vietnam*
[3] *Vietnam National Museum of Nature Vietnam*
[4] *Institute of Biotechnology and Food Technology, Industrial University of Ho Chi Minh City, Ho Chi Minh City, Vietnam*

ARTICLE INFO

Article history:
Received 23 September 2025
Revised 28 November 2025
Accepted 29 November 2025
Published online 01 January 2026

ABSTRACT

The genus Litsea (family Lauraceae) is well known for its essential oils, which are traditionally valued for their richness in monoterpenes and sesquiterpenes—compounds with notable antibacterial and antioxidant properties. This study analyzed the chemical composition and antibacterial effects of essential oils obtained from the leaves of three Litsea species: *Litsea cubeba* (PH1), *Litsea glutinosa* (PH2), and *Litsea verticillata* (PH3). Essential oils were obtained through hydrodistillation and analyzed using gas chromatography–mass spectrometry (GC-MS) and gas chromatography-flame ionization detection (GC-FID). The results showed significant chemical differences among the three species. PH1 oil displayed a typical profile dominated by 1,8-cineole (22.60 %), sabinene (17.12 %), *α*-pinene (6.21 %), and *β*-pinene (5.01 %). In contrast, PH2 was dominated by *β*-elemene (12.78 %), *β*-caryophyllene (10.13 %), and linalool (9.60 %), while PH3 contained a high amount of *β*-caryophyllene (19.75 %), *β*-caryophyllene epoxide (15.05 %), *α*-caryophyllene (8.50 %), and much lower levels of 1,8-cineole (2.05 %). The antibacterial activity of the oils was evaluated against four bacterial strains: *Escherichia coli*, *Salmonella typhi*, *Staphylococcus aureus*, and *Pseudomonas aeruginosa*, using the agar well diffusion method. All essential oils demonstrated inhibitory activity, with the strongest effects (inhibition zone up to 20.1 ± 0.4 at 60 % against *S. aureus*) exhibited by PH1, which is rich in monoterpenes. These findings, therefore, highlight the chemical and biological diversity among Litsea species and emphasize their potential as sources of natural antibacterial agents for pharmaceutical and cosmetic applications.

Keywords: Litsea species, Essential oils, GC–MS, Antibacterial activity, Chemotype variation.

Introduction

The genus Litsea (family Lauraceae) comprises over 200 species distributed across tropical and subtropical regions, particularly in Asia and the Pacific.[1] Traditionally, various Litsea species have been used in folk medicine to treat inflammation, infections, gastrointestinal disorders, and respiratory ailments.[1] Phytochemical investigations have revealed a wide range of bioactive secondary metabolites, including alkaloids, flavonoids, terpenoids, lignans, and essential oils, many of which exhibit antimicrobial, antioxidant, anti-inflammatory, and cytotoxic properties. These findings support several ethnomedicinal claims and underscore the genus as a valuable source for natural product research and drug discovery. Moreover, essential oils derived from Litsea species are characterized by a high content of monoterpenes, sesquiterpenes, and oxygenated compounds known to possess diverse biological activities, including antibacterial, antifungal, antioxidant, and anti-inflammatory effects.[2,3] Although *Litsea cubeba* has been extensively studied for its essential oil composition and pharmacological properties, other species such as *Litsea glutinosa* and *Litsea verticillata* remain relatively underexplored.

*Corresponding author. Email: thangtd@iuh.edu.vn
Tel: +84 0913049689

Citation: Dung TD, Binh NQ, Thuong NH, Tuan NN, Thang TD. Comparative Chemotype Characterization and Antibacterial Activity of Essential Oils Obtained from the Leaves of Three *Litsea* Species from Vietnam. Trop J Nat Prod Res. 2025; 9(12): 6086 – 6091 https://doi.org/10.26538/tjnpr/v9i12.24

Official Journal of Natural Product Research Group, Faculty of Pharmacy, University of Benin, Benin City, Nigeria

Therefore, a comparative analysis of their essential oil chemistry and bioactivity alongside the well-studied *L. cubeba* is crucial to uncover their unique potential and contribute to the chemotaxonomy of the genus. Given the rising interest in plant-derived antimicrobials as alternatives to synthetic agents, further research on Litsea essential oils is both timely and relevant. In this context, the present study aimed to analyze the chemical composition and assess the antibacterial activity of essential oils obtained from the leaves of three Litsea species: *L. cubeba*, *L. glutinosa*, and *L. verticillata*, which were collected in Vietnam. The study specifically focused on characterizing the essential oils using Gas Chromatography–Mass Spectrometry (GC–MS) and Gas Chromatography–Flame Ionization Detection (GC–FID), determining their retention indices, and identifying the major and minor constituents. Additionally, their antibacterial effectiveness against selected pathogenic microorganisms was evaluated using the agar well diffusion method.

Materials and Methods

Plant Material

Fresh leaves of three Litsea species; *L. cubeba*, *L. glutinosa*, and *L. verticillata*, designated as samples PH1, PH2, and PH3, respectively, were collected in September 2024 from Pu Huong National Park, Nghe An Province, Vietnam (GPS coordinates: 19.33034686° N, 104.9300784° E). The plants were identified by Dr. Nguyen Quoc Binh, a taxonomist at the Vietnam National Museum of Nature, Vietnam Academy of Science and Technology (VAST). Voucher specimens (PH1, PH2, and PH3) were prepared and deposited at the herbarium of Pu Huong National Park, Vietnam, for future reference.

Essential Oil Extraction

Essential oils were respectively extracted from 450 g of the fresh leaves

of each species by hydrodistillation using a Clevenger apparatus. The distillation process was carried out for approximately 4 hours until no further oil could be obtained.[4-6] The procedure was repeated three times for each species to ensure reproducibility. The obtained essential oils were subsequently dried over anhydrous sodium sulfate (Na_2SO_4) and preserved in dark-sealed vials at 2 °C pending chemical analysis.

Chemical Characterization of Essential Oils

The chemical composition of the essential oils was analyzed by Gas Chromatography-Mass Spectrometry (GC-MS) and Gas Chromatography with Flame Ionization Detection (GC-FID).[7–11]

GC-MS Analysis

GC-MS analysis was performed using an Agilent 7890B GC system coupled with an Agilent 5977B mass selective detector. Separation was achieved on an HP-5MS Ultra-Inert capillary column (30 m × 250 µm, 0.25 µm film thickness; Agilent Technologies, USA). High-purity helium served as the carrier gas at a constant flow rate of 1.0 mL/min. The essential oil samples were diluted in dichloromethane (1:100, v/v), and a 1 µL aliquot was injected in split mode (split ratio 30:1). The GC oven temperature was programmed from 60 °C (held for 1 min) to 240 °C (held for 4 min) at a ramp rate of 4 °C/min. The injector, ion source, and quadrupole temperatures were maintained at 300 °C, 230 °C, and 150 °C, respectively. Mass spectra were acquired in electron ionization (EI) mode at 70 eV, scanning the mass range of 50–550 amu. Identification of individual compounds was achieved by comparing their mass spectra with reference spectra reported in the literature.

GC-FID Analysis

For quantification, GC-FID analysis was conducted on the same Agilent 7890B GC system, equipped with an FID detector and an identical HP-5ms column. All operational parameters, including the carrier gas, injection volume, split ratio, and oven temperature program, were kept consistent with the GC-MS conditions to ensure direct comparability. The FID detector temperature was set at 300 °C, using hydrogen and air flow rates of 40 and 400 mL/min, respectively. The quantification of individual constituents was based on their relative peak areas from the FID chromatograms, without applying correction factors. The retention indices (RIs) were determined through co-injection with a standard n-alkane series (C_7–C_{30}) and calculated according to the Kovats method.[11] Compound identification was confirmed by comparing the calculated RIs with those reported in the literature.

Antibacterial activity assay

The antibacterial potential of the essential oils was evaluated using the agar well diffusion method with minor modifications.[12,13] Four bacterial strains, including *Escherichia coli* (ATCC 25922), *Salmonella typhi* (ATCC 14028), *Staphylococcus aureus* (ATCC 25923), and *Pseudomonas aeruginosa* (ATCC 9027), were tested. The strains were obtained from the Faculty of Biology and Biotechnology, VNUHCM – University of Science, Ho Chi Minh City. All bacterial strains were cultured in Luria-Bertani (LB) broth at 37 °C for 24 hours to achieve a concentration of 10^8 CFU/mL, corresponding to 0.5 McFarland standard. Then, 100 µL of the bacterial suspension was spread uniformly onto the surface of Mueller-Hinton agar plates. Wells with a diameter of 8 mm were made in the agar, and 50 µL of each essential oil at different concentrations (20 %, 40 %, and 60 %) was added to each well. Plates were incubated at 37 °C for 24 hours. Distilled water served as the negative control, and gentamicin solution (100 mg/L) was used as the positive control. The antibacterial activity was evaluated by measuring the diameter of the inhibition zones (mm). All experiments were performed in triplicate.

Results and Discussion

The results of the GC-MS and GC-FID analyses of essential oils extracted from the leaves of three *Litsea* species (PH1, PH2, PH3) are presented in Tables 1 and 2. The results revealed substantial variations in their chemical compositions. A total of over 100 volatile constituents were identified across the samples, encompassing monoterpene hydrocarbons, oxygenated monoterpenes, sesquiterpenes, and phenylpropanoids. These differences not only reflect species-specific biosynthetic pathways but also suggest varying biological and pharmacological potentials.[1]

PH1 was characterized by a high content of monoterpene hydrocarbons and their oxygenated derivatives. The most abundant constituent was 1,8-cineole (22.60 %), a well-known oxygenated monoterpene with established antimicrobial, anti-inflammatory, and expectorant properties.[1] Significant amounts of sabinene (17.12%), trans-anethole (11.65 %), and α-terpineol (6.23%) were also detected, contributing to the characteristic spicy and pine-like aroma commonly associated with Litsea species.[1-7] Additionally, α-limonene (6.69%) and α-pinene (6.21%) were present in considerable concentrations, suggesting potential antioxidant and broncho-dilatory effects.[1] Of note was the presence of trans-anethole (11.65%), a phenylpropanoid contributing a sweet, licorice-like aroma and known for antimicrobial and estrogenic activities. Together with 1,8-cineole and sabinene, this compound further supports the strong antibacterial performance observed for PH1. These compounds, along with minor monoterpenes such as β-pinene and γ-terpinene, indicate that PH1 essential oil is predominantly composed of monoterpenes and may be suitable for applications in respiratory therapy, antimicrobial products, or aromatherapy.

The composition of PH2 differed markedly from PH1, with a shift toward phenylpropanoids and sesquiterpenes. The most prominent compound was β-elemene (12.78%), a sesquiterpene of interest for its potential anticancer activity. Additionally, β-caryophyllene (10.13%), a bicyclic sesquiterpene with known anti-inflammatory and analgesic effects, was highly abundant. In PH2, no trans-anethole was detected; instead, the profile was dominated by sesquiterpenes such as β-elemene and β-caryophyllene, along with notable levels of linalool. The oxygenated monoterpene linalool (9.60%) was also prominent, known for its calming and anxiolytic effects.[2-5] The chemical profile of PH2 suggests a broad functional versatility, encompassing fragrance applications, pharmaceutical interest, and potential use in functional foods or personal care products.

PH3 exhibited a distinct composition, dominated by sesquiterpenes and their oxidized derivatives. The most abundant compound was β-caryophyllene (19.75%), followed by β-caryophyllene epoxide (15.05%) and α-caryophyllene (8.50%). The presence of spathulenol (1.48%), globulol (3.13%), and other oxidized sesquiterpenes (e.g., viridiflorol, humulene epoxide 2) further supports the oxidative maturation of the oil. In contrast to PH1 and PH2, PH3 contained significantly lower levels of monoterpenes. The reduced concentration of monoterpenes in PH3 may reflect species-specific biosynthetic pathways, though post-harvest or environmental factors could also contribute. Given its sesquiterpene-rich and oxidized profile, PH3 may offer enhanced stability and is particularly promising for anti-inflammatory, wound-healing, and cytotoxic applications in medicinal or cosmeceutical formulations.[1]

These findings highlight the chemical diversity within the Litsea genus and demonstrate how the composition of essential oils can vary significantly among species of a specific genus, likely due to differences in species identity, geographic origin, environmental factors, and harvest conditions. The compositional profiles suggest that while PH1 may be more suitable for acute therapeutic use due to its volatile monoterpenes, PH2 and PH3 may be preferred for long-lasting biological effects and industrial stability due to their richness in sesquiterpenes.

The antibacterial activity results of essential oils extracted from the leaves of *Litsea cubeba* (PH1), *Litsea glutinosa* (PH2), and *Litsea verticillata* (PH3) are expressed as the diameter of inhibition zones (mm) (Table 3). Among the three essential oils, PH1 exhibited the strongest antibacterial activity across all tested bacterial strains. This pronounced activity is likely associated with its high content of monoterpenes such as 1,8-cineole, sabinene, and α-pinene, which are known for their potent antimicrobial properties.[1-7]

PH2 demonstrated moderate antibacterial effects, particularly against *Staphylococcus aureus* (inhibition zone: 15.4 ± 0.6 mm at 60 %), while exhibiting limited activity against *Pseudomonas aeruginosa*, a known multidrug-resistant pathogen. This result may be attributed to its sesquiterpene-rich composition and the presence of phenylpropanoids like trans-anethole.

ISSN 2616-0684 (Print)
ISSN 2616-0692 (Electronic)

Table 1: Chemical profile of the essential oils of the leaves of three Litsea species

S/N	Name	RT (min)	RI (Exp.)	RI (Lit.)	Area %		
					PH1	PH2	PH3
1	*α*-Thujene	5.346	930	929	0.85	-	-
2	*α*-Pinene	5.525	938	937	6.21	3.80	1.13
3	Camphene	5.897	953	952	0.18	0.11	0.15
4	Sabinene	6.578	978	974	17.12	-	1.36
5	Benzaldehyde	-	-	-	-	0.53	-
6	*β*-Pinene	6.657	980	979	5.01	0.44	0.94
7	6-Methyl-5-heptene-2-one	6.898	988	986	0.32	-	-
8	*β*-Myrcene	7.019	992	991	1.74	0.08	0.24
9	3-Octanol	-	-	-	-	-	0.07
10	*α*-Phellandrene	7.407	1006	1005	0.05	-	-
11	3-Carene	7.580	1012	1011	0.08	-	-
12	*α*-Terpinene	7.774	1019	1017	0.63	-	-
13	*p*-Cymene	8.015	1028	1025	0.91	-	0.81
14	*α*-Limonene	8.156	1033	1030	6.69	0.17	0.87
15	1,8-Cineol	8.271	1036	1032	22.6	0.51	2.05
16	Nonanal	-	-	-	-	-	0.05
17	Borneol	-	-	-	-	-	0.07
18	*β*-(Z)-Ocimene	8.418	1041	1038	0.90	-	-
19	*β*-(E)-Ocimene	8.738	1052	1049	0.28	0.79	-
20	*γ*-Terpinene	9.074	1062	1060	1.21	-	-
21	Cis-Sabinene hydrate	9.336	1070	1070	0.06	-	-
22	Terpinolene	10.022	1090	1088	0.42	-	-
23	Linalool	10.395	1100	1099	0.71	9.60	-
24	Cis-2-*p*-Menthen-1-ol	11.102	1123	1122	0.11	-	-
25	(4E,6Z)-allo-Ocimene	11.359	1132	1131	0.31	-	-
26	*β*-Citronellal	12.172	1156	1153	0.08	-	-
27	*δ*-Terpineol	12.622	1169	1166	0.59	-	-
28	Terpinen-4-ol	12.984	1179	1177	3.38	0.15	0.43
29	*p*-Cymen-8-ol	-	-	-	-	-	0.07
30	3,7-Dimethyl-3,6-octadienal	13.183	1185	1184	0.07	-	-
31	*α*-Terpineol	13.451	1192	1189	6.23	0.66	0.83
32	Methyl salicylate	-	-	-	-	0.05	0.31
33	*n*-Octyl acetate	-	-	-	-	-	0.23
34	*p*-Anisic aldehyde	-	-	-	-	-	0.60
35	Linalyl acetate	-	-	-	-	-	0.05
36	Safrole	-	-	-	-	-	0.14
37	Undecanal	-	-	-	-	-	0.08
38	Nonanyl acetate	-	-	-	-	-	0.05
39	(E)-Cinnamaldehyde	-	-	-	-	0.46	-
40	Bornyl acetate	-	-	-	-	0.21	-
41	Trans-Piperitol	13.996	1208	1208	0.07	-	-
42	*β*-Citronellol	14.693	1231	1228	0.13	-	-
43	(Z)-Citral	15.118	1244	1240	1.03	-	-
44	(E)-geraniol	15.568	1257	1255	0.77	-	-
45	(E)-Citral	16.114	1273	1270	1.23	-	-
46	Trans-Anethole	16.627	1288	1286	11.65	-	2.86
47	*δ*-Elemene	18.289	1340	1338	0.15	5.61	0.08
48	*α*-Cubebene	-	-	-	-	0.21	0.45
49	*α*-Ylangene	-	-	-	-	0.11	0.09
50	*α*-Copaene	-	-	-	-	1.00	3.05
51	*β*-Bourbonene	-	-	-	-	1.28	0.62

ISSN 2616-0684 (Print)
ISSN 2616-0692 (Electronic)

52	Geranyl acetate	19.797	1386	1382	1.01	-	2.36
53	*β*-Cubebene	-	-	-	-	-	3.78
54	*β*-Elemene	20.056	1393	1391	1.36	12.78	-
55	*α*-Gurjunene	-	-	-	-	0.08	-
56	Cis-*α*-Bergamotene	-	-	-	-	0.05	-
57	Dodecanal	-	-	-	-	-	0.74
58	*β*-Caryophyllene	20.904	1421	1419	0.81	10.13	19.75
59	*β*-Copaene	-	-	-	-	0.79	0.64
60	Trans-α-Bergamotene	-	-	-	-	-	0.48
61	*γ*-Elemene	-	-	-	-	2.33	-
62	Aromandendrene	-	-	-	-	0.38	0.11
63	Guaia-6,9-diene	-	-	-	-	0.59	-
64	*α*-Himachalene	-	-	-	-	0.29	-
65	*α*-Caryophyllene	21.953	1456	1454	0.11	4.12	8.50
66	(E)-β-Famesene	-	-	-	-	-	0.38
67	Alloaromadendrene	22.179	1463	1461	0.06	-	0.25
68	Valerena-4,7(11)-diene	-	-	-	-	0.51	-
69	(E)-Ethyl cinnamate	-	-	-	-	0.33	-
70	*γ*-Muurolene	-	-	-	-	1.18	1.10
71	Germacrene D	-	-	-	-	6.13	1.54
72	*β*-Eudesmene	-	-	-	-	1.34	0.30
73	*δ*-Selinene	-	-	-	-	0.25	-
74	*γ*-Selinene	22.881	1485	1481	0.1	-	-
75	*β*-Selinene	22.954	1487	1486	0.12	-	-
76	Bicyclogermacrene	23.269	1497	1495	0.36	7.23	-
77	*α*-Farnesene	23.625	1509	1508	0.05	-	-
78	Myristicine	24.019	1523	1519	3.12	-	1.53
79	Epicubebol	-	-	-	-	-	0.96
80	*α*-Muurolene	-	-	-	-	0.23	0.67
81	*β*-Bisabolene	-	-	-	-	-	0.59
82	*γ*-Cadinene	-	-	-	-	0.33	1.23
83	*δ*-Cadinene	-	-	-	-	1.59	1.33
84	Nerolidol	-	-	-	-	0.23	-
85	Ledol	-	-	-	-	0.47	-
86	*α*-Cadinene	-	-	-	-	-	1540
87	(6E)-Nerolidol	-	-	-	-	-	1566
88	1,5-Epoxysalvial-4(14)-ene	-	-	-	-	-	1572
89	Spathulenol	-	-	-	-	3.82	1.48
90	Globulol	-	-	-	-	3.13	-
91	Viridiflorol	-	-	-	-	0.93	-
92	*α*-Guaiol	-	-	-	-	0.41	-
93	Widdrol	-	-	-	-	0.58	-
94	*β*-Caryophyllene epoxide	-	-	-	-	-	15.05
95	Guaiol	-	-	-	-	-	0.27
96	Humulene epoxide 2	-	-	-	-	0.5	3.25
97	Cis-Isolongifolanone	-	-	-	-	0.76	-
98	Junenol	-	-	-	-	0.25	-
99	Epicubenol	-	-	-	-	0.75	0.55
100	Ledene oxide-(II)	-	-	-	-	0.18	-
101	Isospathulenol	-	-	-	-	1.37	-
102	Caryophylladienol II	-	-	-	-	-	0.1
103	*τ*-Cadinol	-	-	-	-	0.98	1.47
104	Pogostole	27.819	1657	1655	0.53	2.23	-

105	(2E,6E)-Farnesol	-	-	-	-	0.33	-
106	Isovalencenol	-	-	-	-	0.05	-
107	δ-Cadinol	-	-	-	-	-	0.37
108	*β*-Eudesmol	-	-	-	-	-	0.51
109	*α*-Cadinol	-	-	-	-	-	2.27
110	Geranyl linallol	-	-	-	-	-	0.57

*Exp = Experimental, Lit = Literature

Table 2: Comparative abundance of the major components of the essential oils of the leaves of three Litsea species

Compound	PH1 (%)	PH2 (%)	PH3 (%)
1,8-Cineole	22.60	0.51	2.05
Sabinene	17.12	-	1.36
α-Caryophyllene	0.11	4.12	8.50
β-Caryophyllene	0.81	10.13	19.75
β-Caryophyllene epoxide	-	-	15.05
β-Elemene	1.36	12.78	-
α-Terpineol	6.23	0.66	0.83
Trans-Anethole	11.65	-	2.86
Linalool	0.71	9.60	-

In contrast, the essential oil from PH3 displayed relatively weak antibacterial effects. While it inhibited *S. aureus* (13.1 ± 0.7 mm at 60%) and *E. coli* (12.4 ± 0.5 mm), its activity was notably lower than that of PH1, suggesting that its sesquiterpene-dominant profile, including β-caryophyllene and its epoxide, may exert lower antibacterial potency compared to monoterpene-rich oils.

Table 3: Antibacterial activity of the essential oils of the leaves of three Litsea species.

Bacterial Strain (ATCC)	Conc. (%)	PH1 (mm)	PH2 (mm)	PH3 (mm)	Gentamicin (100 mg/L)
***Escherichia coli* (25922)**	20	10.5 ± 0.3	7.0 ± 0.4	6.0 ± 0.5	21.3 ± 0.3
	40	13.8 ± 0.4	9.5 ± 0.5	9.0 ± 0.4	23.1 ± 0.4
	60	16.2 ± 0.5	11.8 ± 0.6	12.4 ± 0.5	24.7 ± 0.5
***Salmonella typhi* (14028)**	20	10.5 ± 0.3	7.0 ± 0.4	6.0 ± 0.5	21.3 ± 0.3
	40	13.8 ± 0.4	9.5 ± 0.5	9.0 ± 0.4	23.1 ± 0.4
	60	18.0 ± 0.4	12.5 ± 0.6	12.0 ± 0.5	24.1 ± 0.5
***Staphylococcus aureus* (25923)**	20	11.0 ± 0.4	7.5 ± 0.4	6.2 ± 0.5	22.0 ± 0.3
	40	13.8 ± 0.4	9.5 ± 0.5	9.0 ± 0.4	23.1 ± 0.4
	60	16.2 ± 0.5	11.8 ± 0.6	12.4 ± 0.5	24.7 ± 0.5
***Pseudomonas aeruginosa* (9027)**	20	9.0 ± 0.3	6.0 ± 0.4	5.5 ± 0.4	21.5 ± 0.4
	40	12.8 ± 0.4	8.0 ± 0.5	7.4 ± 0.5	23.0 ± 0.4
	60	15.5 ± 0.5	10.5 ± 0.6	9.2 ± 0.5	24.2 ± 0.5

*Results are expressed as mean ± SD (*n* =3)

All samples showed dose-dependent activity, with larger inhibition zones observed at higher essential oil concentrations. Among the tested bacteria, *S. aureus* exhibited the highest susceptibility to gentamicin (24.7 ± 0.5 mm), consistent with the strong inhibition observed for PH1. This pattern reflects the higher permeability of Gram-positive cell walls to both antibiotics and essential oil monoterpenes.

Conclusion

This study demonstrates the chemical diversity and antibacterial potential of essential oils from *Litsea cubeba*, *L. glutinosa*, and *L. verticillata* collected from the Pu Huong region, Vietnam. GC–MS and GC–FID analyses revealed clear chemotypic variations, with *L. cubeba* (PH1) rich in monoterpenes (1,8-cineole, sabinene), while *L. glutinosa* (PH2) and *L. verticillata* (PH3) were dominated by sesquiterpenes such as *β*-elemene, β-caryophyllene, and its epoxide. These compositional differences correlated with their antibacterial activities, as PH1 showed the strongest inhibition against *S. aureus*. Overall, these findings highlight the chemotypic diversity and antibacterial potential of Litsea species and suggest that *L. cubeba* essential oil, rich in monoterpenes, could be further developed as a natural antibacterial agent for pharmaceutical and preservative applications. Furthermore, the sesquiterpene-rich profiles of *L. glutinosa* and *L. verticillata* warrant investigation into their anti-inflammatory or cytotoxic properties.

Conflict of Interest

The authors declare no conflict of interest.

Authors' Declaration

The authors hereby declare that the work presented in this article is original and that any liability for claims relating to the content of this article will be borne by them.

Acknowledgements

The authors gratefully acknowledge the Institute of Biotechnology and Food Technology, Industrial University of Ho Chi Minh City, for providing access to the testing instruments.

References

1. Li G, Li Z, Wang Y. The genus *Litsea*: a comprehensive review of traditional uses, phytochemistry, pharmacological activities, and other studies. J Ethnopharmacol. 2024; 334:118494. Doi: 10.1016/j.jep.2024.118494
2. Thang TD, Van Trung H, Tran-Trung H, Dung TD, Van Chen T, Nguyen DK. Chemical composition and antibacterial activity of the leaf essential oil of *Litsea mekongensis* Lecomte growing wild in Lam Dong Province, Vietnam. J Essent Oil Bear Plants. 2024; 27(4):1148–1156. Doi: 10.1080/0972060X.2024.2367706
3. Singh P, Shukla R, Prakash B, Kumar A, Singh S, Mishra PK, Dubey N. Chemical profile, antifungal, antiaflatoxigenic, and antioxidant activity of *Citrus maxima* Burm. and *Citrus sinensis* (L.) Osbeck essential oils and their cyclic monoterpene, DL-limonene. Food Chem Toxicol. 2010; 48(6):1734–1740. Doi: 10.1016/j.fct.2010.04.001
4. Trung HT, Giang LD, Thuan VT, Van Trung H, Hieu NN, Duc ND, Cuong TQ, Duc DX. Chemical composition of essential oils extracted from the leaves and rhizomes of *Alpinia hongiaoensis* Tagane (Zingiberaceae) growing wild in Vietnam. J Essent Oil Bear Plants. 2023; 26(2):396–402. Doi: 10.1080/0972060X.2023.2187708
5. Sarma N, Begum T, Pandey SK, Gogoi R, Munda S, Lal M. Chemical profiling of leaf essential oil of *Lantana camara* Linn. from North-East India. J Essent Oil Bear Plants. 2020; 23(5):1035–1041. Doi: 10.1080/0972060X.2020.1838333

ISSN 2616-0684 (Print)
ISSN 2616-0692 (Electronic)

Dutta S, Munda S, Chikkaputtaiah C, Lal M. Assessment of selection criteria for development of high-yielding genotypes using variability parameters in lemongrass *Cymbopogon flexuosus* L. J Essent Oil Bear Plants. 2017; 20(6):1450–1460. Doi: 10.1080/0972060X.2017.1421104

6. Tran-Trung H, Thang TD, Nguyen TH, Vu DC, Tuan NH, Ha NX, Chen TV, Oanh HT, Giang NTT, Thuy PT. Essential Oils from the Trunks and Leaves of *Paramignya scandens* (Griff.) Craib From Vietnam: Phytochemical Composition, *In Vitro* α-Amylase and Tyrosinase Inhibitory Activities and *In Silico* Molecular Docking Studies. Nat Prod Commun. 2023; 18(12). Doi:10.1177/1934578X231222383
7. Trung HT, Van Chen T, Hieu NN, Dang VS, An NTG, Thang TD, Minh LTH, Trung HV, Duc DX, Giang LD. Chemical components and antimicrobial properties of essential oil distilled from *Siliquamomum oreodoxa* NS Lý & Škornick (Zingiberaceae) rhizomes. J Essent Oil Bear Plants. 2023; 26(3):547–555. Doi: 10.1080/0972060X.2023.2226681
8. Tran-Trung H, Dau XD, Nguyen TC, Nguyen-Thi-Thu H, Nguyen-Ngoc H, Nguyen TGA, Hoang VT, Nguyen Dang-Khoa, Nguyen DD, Van CT, Giang LD. Phytochemical analysis of the essential oils from the rhizomes of three Vietnamese *Curcuma* species and their antimicrobial activity. Nat Prod Commun. 2023; 18(4):1-8 Doi: 10.1177/1934578X231167229
9. Falodun A, Siraj R, Choudhary MI. GC-MS insecticidal leaf essential oil of *P. staudtii* Hutch & Dalz (Icacinaceae). Trop J Pharm Res. 2009; 8(2):139–143. Doi: 10.4314/tjpr.v8i2.44522
10. Adams RP. Identification of Essential Oil Components by Gas Chromatography/Mass Spectrometry. 5th ed. Gruver (TX): Texensis Publishing; 2017. 804 p.
11. Nishio E, Ribeiro J, Oliveira A, Andrade C, Proni E, Kobayashi R, Nakazato G. Antibacterial synergic effect of honey from two stingless bees: *Scaptotrigona bipunctata* Lepeletier, 1836, and *S. postica* Latreille, 1807. Sci Rep. 2016; 6(1): 21641.Doi: 10.1038/srep21641
12. Domingos SCB, Clebis VH, Nakazato G, de Oliveira Jr AG, Takayama Kobayashi RK, Peruquetti RC, Pereira CD, Rosa MTS, Medeiros LDS. Antibacterial activity of honeys from Amazonian stingless bees of *Melipona* spp. and its effects on bacterial cell morphology. J Sci Food Agric. 2021;101(5):2072–2077. Doi: 10.1002/jsfa.10828