SCHOLASTIC:
Journal of Natural and Medical Education
Volume 5, Issue 2, Year 2026
https://univerpubl.com/index.php/scholastic

Article

GC–MS Study of the Composition of Volatile Constituents of the Essential Oil Obtained from the Aerial Parts of *Rindera Oblongifolia M. Popov* Growing in the Flora of Uzbekistan

U.Kh. Kurbanov[1], Zh.M. Abdurakhmanov[2], N.I. Mukarramov[3]

1. S. Yu. Yunusov Institute of the Chemistry of Plant Substances, Academy of Sciences of the Republic of Uzbekistan, 77 Mirzo Ulugbek Street, Tashkent 100170, Uzbekistan
2. S. Yu. Yunusov Institute of the Chemistry of Plant Substances, Academy of Sciences of the Republic of Uzbekistan, 77 Mirzo Ulugbek Street, Tashkent 100170, Uzbekistan
3. Research Institute of Plant Quarantine and Protection, 4 Bobur Street, Kibray District, Tashkent Region 111215, Uzbekistan

Abstract: This study investigates the chemical composition of the volatile components of the essential oil obtained from the aerial parts of *Rindera oblongifolia* M. Popov growing in the flora of Uzbekistan. The essential oil was isolated by hydrodistillation using a Clevenger-type apparatus. The qualitative and quantitative composition of the volatile constituents was determined by gas chromatography–mass spectrometry (GC–MS). As a result of the analysis, 45 components were identified, representing 89.7% of the total composition. The major components were found to be fatty acids and their esters, as well as oxygen-containing compounds. It was established that the essential oil exhibits moderate antibacterial and antifungal activity against a range of test microorganisms; however, its effectiveness is lower compared to standard drugs. The obtained results indicate the potential for further pharmacological investigation of this plant.

Keywords: Rindera Oblongifolia, Boraginaceae, Essential Oil, Volatile Components, GC–MS, Chemical Composition, Fatty Acids, Antibacterial Activity, Antifungal Activityключевые Слова

Citation: Kurbanov, U. Kh., Abdurakhmanov Zh. M., and Mukarramov N. I. GC–MS Study of the Composition of Volatile Constituents of the Essential Oil Obtained from the Aerial Parts of Rindera Oblongifolia M. Popov Growing in the Flora of Uzbekistan. Scholastic: Journal of Natural Methodological Foundations for Organizing Organic Chemistry Laboratory Classesi Schools Based on Virtual Technologies and Medical Education. 2026, 5(2), 40-44.

Received: 11th January 2026
Revised: 19th February 2026
Accepted: 27th March 2026
Published: 26th April 2026

Copyright: © 2026 by the authors. Submitted for open access publication under the terms and conditions of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/)

1. Introduction

The genus *Rindera*, belonging to the family *Boraginaceae*, is widely distributed across Eurasia and is characterized by a high content of biologically active compounds, particularly pyrrolizidine alkaloids [1]. Due to the pharmacological and toxicological significance of these compounds, the study of the chemical composition of representatives of this genus is a relevant area in the search for natural bioactive substances[2].

Approximately 30 species of the genus *Rindera* are known in the world flora, of which 17 occur in the CIS countries, 15 in Central Asia, and 8 in Uzbekistan[3]. In Central Asia, including Uzbekistan, these species are predominantly distributed in mountainous and foothill regions [4].



Figure 1. General appearance of the plant Rindera oblongifolia M. Popov

Rindera oblongifolia M. Popov is a perennial herbaceous plant growing at an altitude of 1800–2000 m above sea level on mountain slopes. The stem is simple or branched in the upper part and is covered with dense gray hairs. The leaves are oblong-ovate, pointed, 7–20 cm in length, with 1–3 prominent veins, and densely pubescent on both sides [5].

The scientific literature reports that essential oils and their volatile components of representatives of the *Boraginaceae* family exhibit various types of biological activity [6]. Their study makes it possible to determine the chemotaxonomic characteristics of plants and to evaluate their pharmacological potential [7]. At the same time, data on the volatile components of the essential oil of *R. oblongifolia* are insufficiently represented in the literature.

The aim of this study is to determine the chemical composition of the volatile components of the essential oil obtained from the aerial parts of *R. oblongifolia* growing in the flora of Uzbekistan using the GC–MS method, as well as their identification[8].

2. Research Methodology

The plant material was collected in 2025 during the flowering period on mountain slopes of the Uzun District, Surkhandarya region. The essential oil was isolated by hydrodistillation for 3 hours using a Clevenger-type apparatus under atmospheric pressure.

The obtained distillate was extracted with n-hexane. The yield of essential oil was 0.024% based on the dry weight of the plant material. The oil was a light-yellow liquid with a characteristic odor[9].

The qualitative and quantitative composition of the volatile components of the essential oil was determined by gas chromatography–mass spectrometry (GC–MS) using an Agilent 7890A gas chromatograph coupled with an Agilent 5975C inert mass selective detector (MSD).

Separation was carried out on a fused silica capillary column HP-INNOWax (30 m × 250 μm × 0.25 μm) under the following temperature program: 60 °C (2 min), then increased to 220 °C at a rate of 4 °C/min (held for 10 min), followed by heating to 240 °C at 10 °C/min (held for 20 min)[10].

The injection volume was 0.2 μL, and the carrier gas (H_2) flow rate was 1.0 mL/min. Mass spectra were recorded in the range of m/z 10–550.

Identification of the components was performed by comparing their mass spectra with those from the Wiley (9th edition) and NIST (2017) libraries, as well as by using retention indices (RI) calculated relative to a homologous series of n-alkanes (C6–C32) and literature data [11].

3. Results and Discussion

As a result of the GC–MS analysis of the volatile components of the essential oil obtained from the aerial parts of *R. oblongifolia*, 45 components were identified, representing 89.70% of the total composition (Table 1)[12].

The major components include: isoamyl alcohol (4.47%), cyclohexanone (5.32%), 2-furanmethanol (1.23%), cetene (1.05%), α-terpineol (1.44%), γ-muurolene (1.23%), azulene

(3.23%), n-decanoic acid (6.73%), methyl (2.05%) and ethyl (3.56%) esters of hexadecanoic acid, tricosane (1.56%), dodecanoic acid (3.42%), methyl ester of 9,12-octadecadienoic acid (2.69%), ethyl ester of (E)-9-octadecenoic acid (1.20%), ethyl ester of linoleic acid (10.28%), 1-naphthalenepropanol (6.19%), tetradecanoic acid (1.63%), n-hexadecanoic acid (11.13%), cis-7-hexadecenoic acid (1.56%), octadecanoic acid (1.04%), 9-octadecenoic acid (2.97%), conjugated linoleic acid (4.46%), and 9,12,15-octadecatrienoic acid (1.53%)[13].

The antibacterial and antifungal activities of the essential oil were evaluated using the agar diffusion method [9,10]. The following test organisms were used: *Bacillus subtilis* (RKMUz-5), *Staphylococcus aureus* (ATCC 25923), *Pseudomonas aeruginosa* (ATCC 27879), *Escherichia coli* (RKMUz-221), and *Candida albicans* (RKMUz-247).

Ampicillin/sulbactam, gentamicin, and fluconazole were used as positive controls, while DMSO served as the negative control[14].

The results showed that the essential oil exhibits moderate antibacterial and antifungal activity against all tested strains. The most sensitive microorganisms were *Bacillus subtilis* (10.03 ± 0.10 mm), *Staphylococcus aureus* (9.07 ± 0.12 mm), and *Pseudomonas aeruginosa* (11.06 ± 0.13 mm) (Table 2)

Table 1. Composition of volatile components of the essential oil of Rindera oblongifolia (GC–MS analysis).

№	Compound	RI	%
1	Isoamyl alcohol	1148	0.67
2	(E)-2-Hecenal	1182	4.47
3	2,3-Dicyclohexylbutane	1195	0.84
4	Cyclohexanone	1239	0.91
5	Nonanal	1250	5.32
6	2-Undecanone	1320	0.78
7	Hexadecane	1529	0.42
8	2-Furanmethanol	1600	0.72
9	Cetene	1607	1.23
10	α-Terpineol	1638	1.05
11	γ-Muurolene	1654	1.44
12	α-Calacorene	1666	1.23
13	Benzyl alcohol	1801	0.63
14	(E)-3-Octadecene	1810	1.03
15	Azulene	1840	0.78
16	2-Methoxy-4-vinylphenol	1962	3.23
17	Hexahydrofarnesyl acetone	2036	0.57
18	Pelargonic acid	2096	0.62
19	4-Vinylguaiacol	2110	0.53
20	n-Decanoic acid	2118	0.58
21	Methyl hexadecanoate	2122	6.73
22	Ethyl hexadecanoate	2137	2.05
24	Heptadecane	2190	0.36
25	Tricosane	2198	0.25
26	Dodecanoic acid	2301	1.56
27	Methyl octadecanoate	2337	3.42
28	Methyl (Z,Z)-9,12-octadecadienoate	2350	0.65
29	Ethyl (E)-9-octadecenoate	2384	2.69
30	Tetracosane	2393	1.20
31	Ethyl linoleate	2399	0.55
32	Methyl 9,12,15-octadecatrienoate	2425	10.28
33	1-Pentacosene	2437	0.51
34	1-Naphthalenepropanol	2500	0.99

35	Tetradecanoic acid	2518	6.19
36	Hexacosane	2549	1.63
37	Pentadecanoic acid	2598	0.33
38	Heptacosane	2656	0.43
39	n-Hexadecanoic acid	2701	0.57
40	cis-7-Hexadecenoic acid	2757	11.13
42	1-Docosene	2799	0.39
43	Octadecanoic acid	2899	0.74
44	9-Octadecenoic acid	2969	1.04
45	Conjugated linoleic acid (10E,12Z)	2988	2.97
46	9,12,15-Octadecatrienoic acid	3069	4.46
47	3-Penten-2-ol	3131	1.53
	Σ		89.70

Table 2. Antimicrobial activity of the essential oil of R. oblongifolia, evaluated by the diameter of the inhibition zone (mm) using the agar disk diffusion method

Samples	**Diameter of the inhibition zone (mm)**				
	Gram-positive bacteria		Gram-negative bacteria		Opportunistic fungus
	Bacillus subtilis	*Staphylococcus aureus*	*Pseudomonas aeruginosa*	*Escherichia coli*	*Candida albicans*
Physalis angulata	10.03±0.10	9.07±0.12	11.06±0.13	7.01±0.10	6.03±0.10
Ampicillin/Sulbactam (20 μg disc)	26.07±0.10	26.04±0.12	nt*	nt	nt
Gentamicin (10 μg/disc)	nt	nt	25.11±0.13	26.08±0.10	nt
Fluconazole (25 μg/disc)	nt	nt	nt	nt	31.02±0.10

nt — not tested

At the same time, the activity of the essential oil was lower compared to standard pharmaceutical preparations[15].

4. Conclusion

Thus, it was established that the essential oil obtained from the aerial parts of Rindera oblongifolia contains a significant amount of biologically active compounds, represented mainly by fatty acids and their esters.

Despite exhibiting antibacterial and antifungal activity, its effectiveness is lower compared to standard pharmaceutical agents. Nevertheless, the obtained results confirm the feasibility of further pharmacological investigations of this plant.

References

[1] E. Roeder, "Medicinal plants in Europe containing pyrrolizidine alkaloids," *Pharmazie*, vol. 50, pp. 83–98, 1995.

[2] B. L. Stegelmeier, J. A. Edgar, S. M. Colegate, D. R. Gardner, T. K. Schoch, and R. A. Coulombe, "Pyrrolizidine alkaloid plants, metabolism and toxicity," *Journal of Natural Toxins*, vol. 8, pp. 95–116, 1999.

[3] K. Sh. Tojibaev and N. Yu. Beshko, "Conspectus of the genus Rindera (Boraginaceae) in Central Asia," *Botanical Journal*, vol. 100, no. 6, pp. 645–654, 2015.

[4] A. I. Vvedensky, *Flora of Uzbekistan*, vol. 5. Tashkent, Uzbekistan: Academy of Sciences, 1961.

[5] A. E. Al-Snafi, "The pharmacological importance of plants belonging to the family Boraginaceae: A review," *Int. J. Pharm. Rev. Res.*, vol. 6, no. 2, pp. 123–138, 2016.

[6] B. Singh and R. A. Sharma, "Plant terpenes: defense responses, phylogenetic analysis, regulation and clinical

applications," *3 Biotech*, vol. 5, pp. 129–151, 2015.

[7] R. P. Adams, *Identification of Essential Oil Components by Gas Chromatography/Mass Spectrometry*, 4th ed. Carol Stream, IL, USA: Allured Publishing, 2007.

[8] A. V. Tkachev, *Atlas of Mass Spectra and Retention Indices of Volatile Compounds of Plants*. Novosibirsk, Russia: SB RAS, 2008.

[9] Clinical and Laboratory Standards Institute (CLSI), *Performance Standards for Antimicrobial Susceptibility Testing*, 28th ed. Wayne, PA, USA, 2018.

[10] DIN, *Medical Microbiology and Immunology Standards*, Berlin, Germany: Beuth Verlag, 2004.

[11] P. J. Marriott, R. Shellie, and C. Cornwell, "Gas chromatographic technologies for the analysis of essential oils," *J. Chromatogr. A*, vol. 936, pp. 1–22, 2001.

[12] K. H. C. Baser and G. Buchbauer, *Handbook of Essential Oils: Science, Technology, and Applications*. Boca Raton, FL, USA: CRC Press, 2010.

[13] H. Van Den Dool and P. D. Kratz, "A generalization of the retention index system including linear temperature programmed gas–liquid partition chromatography," *J. Chromatogr.*, vol. 11, pp. 463–471, 1963.

[14] NIST, *Mass Spectral Library (NIST 17)*, National Institute of Standards and Technology, Gaithersburg, MD, USA, 2017.

[15] Wiley, *Wiley Registry of Mass Spectral Data*, 9th ed. Hoboken, NJ, USA: Wiley, 2010.