East Journal of Applied Science

ISSN: 3079-9392

Volume 1, Issue 1
Publisher: East Publication & Technology
DOI: https://doi.org/

Chemical Composition of Essential Oil of Ruta Chalepensis in Lattakia- Syria

Ali Nasser[1], Kenana Yousef[1], Lubana Hammoud[1], Aeham Yossef[1], Mohammad Nasser[1], Manal Darwish[1*], Ahmad Hanouneh[1,2]

[1]Faculty of Pharmacy, Al Andalus University for Medical Sciences, Tartous, Syria.
[2]Rustaq College of Education, University of Technology and Applies Sciences, Rustaq, Oman.
*Corresponding Author: md6@au.edu.sy

Received: 07/02/2025, **Revised**: 15/02/2025, **Accepted**: 20/02/2025, **Published**: 25/02/2025

Abstract:

The present study investigates the chemical composition of essential oil of aerial parts of Ruta chalepensis collected from fields of Lattakia, Syria. The oil was obtained by hydro-distillation in a Clevenger-type apparatus and investigated by gas chromatography–mass spectrometry (GC/MS). The yield of the oil was 1.23% on dry weight basis, and it contained 15 constituents. The oil was mainly constituted of ketones (69.2%), among which 2-undecanone (38.34%) and nonanone (21.23%) were the most prevalent. Smaller percentages of alcohols (7.72%), with β-elemol (4.8%) being predominant, and sesquiterpenes (5.8%) were also found, together with oxygenated terpenoids (0.52%), fatty acids (3.12%), hydrocarbons (1.54%), and esters (4.48%). Surprisingly, its chemical composition was quite different from those of northeastern Algerian Ruta chalepensis oils, which were dominated by 2-acetoxytetradecane (58.44%), 2-acetoxytritridecane (19.07%), and 2-tridecanone (6.39%). Discrepancies indicate that geographical and climatic conditions have a predominant influence on the chemical composition of the Ruta chalepensis essential oil.

Keywords: **Ruta chalepensis, Essential oil, Clevenger-type apparatus, Hydrodistillation, Chemical composition, 2-Undecanone, 2-Noonanone, Nonanone.**

1. Introduction

Plants are universally acknowledged as a valuable resource for human health, especially in the practice of alternative medicine. With the increasing importance of plant therapies, research into their medicinal properties is increasingly necessary. The subject of this research is Ruta chalepensis, a Rutaceae family medicinal plant with a characteristic camphor-like scent. R. chalepensis is native to the Mediterranean area. Ruta chalepensis grows in temperate and cooler climates, specifically in the mountainous coastal regions of Syria [1]. The leaves of the species have been used for a long time for their medicinal properties, whereas essential oil extracted from Ruta chalepensis has been indicated to have potent antibacterial activity, proposing its importance as a natural product in the formulation of antibacterial agents [2].

The genus Ruta comprises a number of species, including R. chalepensis, R. graveolens, and R. montana [3]. Typically, R. chalepensis is an 80 cm tall perennial herb [4] that grows in Europe, Asia, and North Africa [5]. The genus Ruta is full of coumarins [6], and their species have been traditionally used in various Mediterranean countries to treat diseases like worms and child fever [7], and to induce abortion [8]. Additionally, R. Montana has also been employed in the therapy of gastrointestinal disease, whereas R. graveolens is well known for its effectiveness against stomach and intestinal parasites [9].

Earlier reports have demonstrated a broad range of bioactive constituents of the essential oil of Ruta species, such as alkaloids, anthraquinones, cardiac glycosides, coumarins, flavonoids, saponins, tannins, and tetrapins (12-15 members) [10]. Pharmacological investigations have unveiled the therapeutic promise of these compounds, which display a range of biological activities including analgesic [11], anthelmintic, anti-acetylcholinesterase, anticancer, anti-inflammatory, antimicrobial, antioxidant, and antiparasitic activities [12,13]. The results reveal the medicinal value of Ruta chalepensis and its components in the formulation of novel therapeutic medications.

ISSN: 3079-9392
Volume 1, Issue 1
Publisher: East Publication & Technology
DOI: https://doi.org/

2. Materials and Methods

Plant collection:

The aerial parts (leaves and flowers) of the Ruta. chalepensis plant were collected from the Lattakia region in August 2018 and dried in a dark place at room temperature. The identity of the studied plant was confirmed by Prof. Dr. Zuhair Al-Shater, professor at the Faculty of Agriculture at Tishreen University

Extraction and isolation of the essential oil:

The essential oil was extracted by hydrodistillation using a Clevenger-type apparatus, where 250 g of the aerial parts of the dried plant sample were weighed in a 5-liter flask, 2 liters of distilled water were added to it, and the extraction continued for 4 hours. After cooling, the base oil was collected using a syringe and dried by adding sodium sulfate to remove water from the oil. The oil was collected after good mixing and separated by evaporation. The sample was transferred to a small brown bottle and n-hexane solvent was added to it. It was closed tightly and kept in the refrigerator at 4°C for the time of analysis. By gas chromatography with mass spectrometry (GC/MS), the concentration of the essential oil was expressed as the number of milliliters obtained from the essential oil in relation to the dry weight, which amounted to 1 ml/100 g of dry weight, and the dry weight of the analyte was determined by taking a specific weight of the plant material and drying it for 24 hours in an oven at 105°C.

Technology used in the analysis of essential oil GC/MS:

The chemical composition of the essential oil was determined in the central laboratory of the Higher Institute of Naval Research using a GC instrument with MS mass spectrometry (Agilent-7890A gas chromatograph). The layer thickness is 0.25 µm, and it is connected to a mass spectrometry detector. The heat program of the furnace starts from 70°C to 270°C at a rate of 1 degree every 4 minutes, the carrier gas is helium He and with a flow speed of 1.2 ml/min. Then, the components of the essential oil extracted from the aerial parts of sagebrush were identified by comparing the mass spectra of each peak of the GC/MS chromatogram with the mass spectra of the available libraries in the NIST and Wiley computer.

3. Results and Discussion

3.1. Subsection

The results of the analysis of the essential oil extracted from *Ruta.chalepensi*s using GC/MS technology showed the presence of 15 compounds that include hydrocarbons, ketones, semi-terpenes and oxygen terpenoids, in addition to fatty acids and esters. Figure 1 illustrates the chromatogram with the main components of the essential oil that were identified as a result of the analysis on the GC/MS device.

3.1.1. Subsubsection

East Journal of Applied Science
ISSN: 3079-9392
Volume 1, Issue 1
Publisher: East Publication & Technology
DOI: https://doi.org/

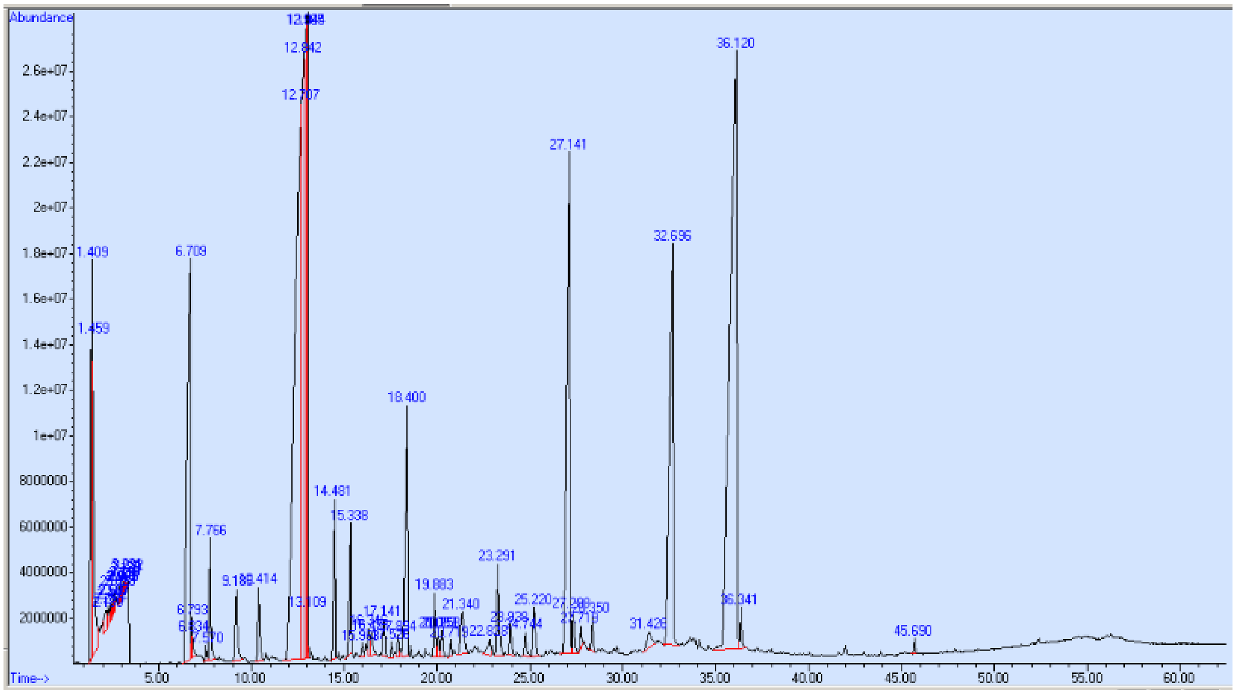

Figure 1. GC/MS chromatogram of the essential oil extracted from Ruta.*chalepensis*

Table 1. The chemical composition of the essential oil extracted from Ruta.*chalepensis* where RT: Retention time in minutes and Area%: the area under the peak for each peak comparing to the total area

Pk	Compounds	RT	Area%
1	2-Nonanone	6.708	21.23
2	2-Decanone	9.191	4.43
3	2-Undecanone	12.705	38.34
4	Caryophyllene	15.341	5.8
5	2-Tridecanone	17.142	1.2
6	Tricyclo[4.3.1.1(3,8)]undecane	17.530	0.48
7	Eudesma-4(14),11-diene	17.896	0.66
8	Beta-elemol,	19.881	4.8
9	Caryophyllene oxide	20.715	0.52
10	4-(3,4Methylenedioxyphenyl)-2-butanone	21.338	3.20
11	13-Tetradece-11-yn-1-ol	22.831	2.92
12	1,3-Benzodioxole-5-propanoic acid, ethyl ester	23.937	4.98
13	6,10,14-trimethyl -2-Pentadecanone,	27.722	0.80
14	n-Hexadecanoic acid	31.427	3.12
15	1-chloro-Heptacosane	45.691	0.40

As noticed in Table 2, the oil components from Ruta.*chalepensis* can be classified into 7 different groups depending on their chemical composition. The essential oil extracted from Ruta.*chalepensis* was distinguished by its containing of hydrocarbons by (1.54%). It contained a high percentage of ketones amounting to (69.2%) with the presence of the two compounds 2-Undecanone (38.34%) and 2-Nonanone (21.23%). Alcohol by (7.72%) with the compound Beta-elemol (4.8%), sesquiterpenes (5.8%) and oxygenated terpenoids at a lower percentage were also noted (0.52%). It also contained fatty acids with a percentage of (3.12%) and esters, but with a lower percentage of (4.48%).

East Journal of Applied Science
ISSN: 3079-9392
Volume 1, Issue 1
Publisher: East Publication & Technology
DOI: https://doi.org/

Table 2: The chemical groups 1n the essential oil extracted from the Ruta.*chalepensis* plant

The percentage	Compounds
1.54	Hydrocarbons
7.72	Alcohols
69.2	Ketones
5.8	Sesquiterpenes
0.52	oxygenated terpenoids
3.12	Carboxylic acids
4.48	Esters

Similar studies were carried out on the same plant in Algeria, Greece, Jordan, Italy, Turkey, Iran Lebanon, Morocco, Tunisia and Spain. the major compounds of the essential oil of Inula viscosa (L.) as well as from Syrian plant are shown in (Table 3).

Table 3: The Major components of the essential oil extracted from Ruta.*chalepensis* obtained from different locations.

Geographical Sources (Region)	Plant Parts (Yield)	Major Components	References
Lattakia-Syria	aerial parts (leaves and flowers) (1.23%)	2-Undecanone (38.43%), 2-decanone (4.43%), Caryophyllene (5.8%), 2-Nonanone(22.23%)	The current study
Algeria (Ain-delfa)	Air-dried aerial parts (0.90%)	2-Undecanone (67.0%), 2-decanone (9.0%), 6-(3′,5′-benzodioxyl)-2-hexanone (6.3%), and 2-dodecanone (4.0%)	[19]
Greece	Air-dried aerial parts (1.10%)	2-Methyloctyl acetate (44.0%), β-phellandrene (10.8%), 2-nonanol (7.2%), and β-pinene (6.4%)	[24]
Italy (San Alessio)	Fresh flowers (0.89%)	2-Nonanone (44.9%), 2-undecanone (44.9%), and limonene (1.8%)	[11]
Iran	Air-dried aerial parts (1.3%)	2-Undecanone (52.5%), 2-nonanone (24.1%), and nonyl acetate (9.1%)	[27]
Jordan	Air-dried (in the dark) aerial parts (0.83%)	2-Cyclohexen-1-one,3-[(2,3,4,9 tetrahydro-1H-pyrido[3,4 b]indole-1-yl) methyl] (45.9%) and 2-nonanone (19.5%)	[28]
Lebanon	Fresh leaves and stems (0.12%)	2-Nonanone (42.5%), 2-undecaone (41.4%), and terpen-4-ol (2.2%)	[29]
Morocco	Air-dried aerial parts (0.66%)	2-Undecaone (93.1%)	[32]
Spain	Shade-dried aerial parts (0.43%)	2-Undecanone (64.9%)	[35]
Tunisia (El Ala)	Air-dried aerial parts of wild plants (0.56%)	2-Nonanone (37.4%), 2-undecanone (20.5%), and 2-methyl-octyl acetate (19.0%)	[46]
Turkey	Fresh aerial parts (1.10%)	2-Undecanone (43.2%), 2-nonanone (27.9%), and 2-nonyl acetate (10.6%)	[47]

East Journal of Applied Science
ISSN: 3079-9392
Volume 1, Issue 1
Publisher: East Publication & Technology
DOI: https://doi.org/

The biological significance, pharmacological activity, and practical applications of 2-undecanone and 2-nonanon:

Compounds like 2-undecanone and 2-nonanon possess significant biological and pharmacological properties, with a wide range of applications in medicine and industry. 2-undecanone exhibits strong activity against bacteria such as Escherichia coli and Staphylococcus aureus, acting as a natural antibiotic. It also has antifungal properties against Candida albicans and shows insect-repellent effects, especially against harmful pests like mosquitoes.

On the other hand, 2-nonanon has antibacterial and antioxidant properties, helping protect cells from damage caused by free radicals. It also demonstrates antifungal activity against certain fungal species [24].

These compounds can be utilized in the development of antibacterial and antifungal drugs, particularly in response to the rising resistance to traditional antibiotics. They also have potential for use in topical treatments for skin infections and in combating insect-borne diseases such as malaria.

Industrially, 2-undecanone and 2-nonanon can serve as natural insecticides, offering a safer alternative to chemical pesticides. Their distinctive aromatic properties also make them suitable for incorporation into perfumes and cosmetic products. Furthermore, these compounds can be used as natural food preservatives and applied in agriculture as protective agents against pests, reducing the reliance on chemical pesticides [25].

4. Conclusions

In conclusion, the essential oil extracted from *Ruta chalepensis* collected in Lattakia, Syria, was characterized by a high concentration of ketones, with 2-Undecanone and 2-Nonanone being the major compounds. The oil's composition, including alcohols, sesquiterpenes, and fatty acids, showcases the distinctive chemical profile of this plant species compared to those from other regions such as northeastern Algeria, Egypt, and Iran. These variations in chemical composition can be attributed to environmental factors, such as soil characteristics and climatic conditions. The findings contribute to the understanding of *Ruta chalepensis* essential oil and suggest its potential for further pharmacological research, especially regarding its antibacterial and therapeutic properties. The study also highlights the importance of geographical origin in determining the chemical makeup of plant-derived essential oils.

Funding

This research was funded by AlAndalus University for Medical Science.

Acknowledgments

The authors would like to thank Prof. Zouher Alshater, from Faculty of Agriculture at the Tishreen University (Syria) for identification of the plant**.**

Conflicts of Interest

The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript, or in the decision to publish the results.

References

[1] M. A. Al-Qudah, "Chemical composition and antimicrobial activity of the essential oil of Linum pubescens growing wild in Jordan," Nat. Prod. Res., vol. 27, no. 12, pp. 1141–1144, 2013, doi: 10.1080/14786419.2012.715291.

[2] S. Chibani et al., "Composition and antibacterial activity of the essential oil of Ruta chalepensis subsp. Angustifolia from Algeria," Der Pharm. Lett., vol. 5, no. 5, pp. 252–255, 2013.

[3] A. Pollio, A. De Natale, E. Appetiti, G. Aliotta, and A. Touwaide, "Continuity and change in the Mediterranean medical tradition: Ruta spp. (rutaceae) in Hippocratic medicine and present practices," J. Ethnopharmacol., vol. 116, no. 3, pp. 469–482, 2008, doi: 10.1016/j.jep.2007.12.013.

[4] S. Al-Majmaie, L. Nahar, G. P. Sharples, K. Wadi, and S. D. Sarker, "Isolation and antimicrobial activity of rutin and its derivatives from Ruta chalepensis (Rutaceae) growing in Iraq," Rec. Nat. Prod., vol. 13, no. 1, pp. 64–70, 2019, doi: 10.25135/rnp.74.18.03.250.

[5] K. Günaydin and S. Savci, "Phytochemical studies on Ruta chalepensis (Lam.) Lamarck," Nat. Prod. Res., vol. 19, no. 3, pp. 203–210, 2005, doi: 10.1080/14786410310001630546.

[6] K. El Sayed, M. S. Al-Said, F. S. El-Feraly, and S. A. Ross, "New quinoline alkaloids from Ruta chalepensis," J. Nat. Prod., vol. 63, no. 7, pp. 995–997, 2000, doi: 10.1021/np000012y.

[7] A. Khadhri et al., "In vitro digestion, antioxidant and antiacetylcholinesterase activities of two species of ruta: Ruta chalepensis and ruta montana," Pharm. Biol., vol. 55, no. 1, pp. 101–107, 2017, doi: 10.1080/13880209.2016.1230634.

[8] A. S. Ansari, K. Sevliya, I. Mohammad, A. Badar, and N. K. Lohiya, "Plants for Female Fertility Regulation: A Review," J. Pharmacol. Toxicol., vol. 12, no. 2, pp. 57–75, 2017, doi: 10.3923/jpt.2017.57.75.

[9] E. Ortu, G. Sanna, A. Scala, G. Pulina, P. Caboni, and G. Battacone, "In vitro anthelmintic activity of active compounds of the fringed rue Ruta chalepensis against dairy ewe gastrointestinal nematodes," J. Helminthol., vol. 91, no. 4, pp. 447–453, 2017, doi: 10.1017/S0022149X16000419.

[10] M. S. Ali-Shtayeh and S. I. Abu Ghdeib, "Antifungal activity of plant extracts against dermatophytes," Mycoses, vol. 42, no. 11–12, pp. 665–672, 1999, doi: 10.1046/j.1439-0507.1999.00499.x.

[11] M. E. Gonzalez-Trujano, D. Carrera, R. Ventura-Martinez, E. Cedillo-Portugal, and A. Navarrete, "Neuropharmacological profile of an ethanol extract of Ruta chalepensis L. in mice," J. Ethnopharmacol., vol. 106, no. 1, pp. 129–135, 2006, doi: 10.1016/j.jep.2005.12.014.

[12] M. Kacem, G. Simon, R. Leschiera, L. Misery, A. ElFeki, and N. Lebonvallet, "Antioxidant and anti-inflammatory effects of Ruta chalepensis L. extracts on LPS-stimulated RAW 264.7 cells," Vitr. Cell. Dev. Biol. - Anim., vol. 51, no. 2, pp. 128–141, 2015, doi: 10.1007/s11626-014-9813-7.

[13] M. Hamdiken, S. Bouhalit, and Z. Kechrid, "Effect of Ruta chalepensis on Zinc, Lipid Profile and Antioxidant Levels in the Blood and Tissue of Streptozotocin-Induced Diabetes in Rats Fed Zinc-Deficient Diets," Can. J. Diabetes, vol. 42, no. 4, pp. 356–364, 2018, doi: 10.1016/j.jcjd.2017.08.239.

[14] Khadraoui A., Khelifa A., Boutoumi H., Hamitouche H., Mehdaoui R., Hammouti B., Al-Deyab S.S. Adsorption and inhibitive properties of Ruta chalepensis L. oil as a green inhibitor of steel in 1M hydrochloric acid medium. Int. J. Electrochem. Sci. 2014;9:3334–3348.

[15] Tzakou O., Couladis M. Essential oil of Ruta chalepensis L. from Greece. J. Essent. Oil Res. 2001;13:258–259. doi: 10.1080/10412905.2001.9699688.

[16] Tedone L., Costa R., De Grazia S., Ragusa S., Mondello L. Monodimensional (GC-FID and GC-MS) and comprehensive two-dimensional gas chromatography for the assessment of volatiles and fatty acids from Ruta chalepensis aerial parts. Phytochem. Anal. 2014;25:468–475. doi: 10.1002/pca.2518.

[17] Rustaiyan A., Khossravi M., Sultani-Lotfabadi F., Yari M., Masoudi S., Monfared A. Constituents of the essential oil of Ruta chalepensis L. from Iran. J. Essent. Oil Res. 2002;14:378–379. doi: 10.1080/10412905.2002.9699892.

[18] Althaher A.R., Oran S.A., Bustanii Y.K. Phytochemical analysis, in vitro assessment of antioxidant properties and cytotoxic potential of ruta chalepensis essential oil. J. Essent. Oil Bear. Plants. 2020;23:1409–1421. doi: 10.1080/0972060X.2020.1871078.

[19] Khoury M., Stien D., Quaini N., Eparvier V., Apostolides N.A., Beyrouthy M. Chemical composition and antimicrobial activity of the essential oil of Ruta chalepensis L. growing wild in Lebabon. Chem. Biodivers.

East Journal of Applied Science
ISSN: 3079-9392
Volume 1, Issue 1
Publisher: East Publication & Technology
DOI: https://doi.org/

2014;11:1990–1997. doi: 10.1002/cbdv.201400109.

[20] Abbad A., Kasrati A., Jamali C.A., Zeroual S., Mohamed T.B., Spooner-Hart R., Leach D. Isecticidal properties and chemical composition of essential oils of some aromatic herbs from Morocco. Nat. Prod. Res. 2014;28:2338–2341. doi: 10.1080/14786419.2014.936015.

[21] Alonso-Miguel H., Jose Perez-Alonso M., Cristina Soria A., Blanco Martinez M. Composition of essential oils of different species of "pepper" of the Piper, Pimenta, Lindera, Ruta, Schinus and Zanthoxylum genera. Bot. Complut. 2021;44:103–113. doi: 10.5209/bocm.73020.

[22] Conti B., Leonardi M., Pistelli L., Profeti R., Ouerghemmi I., Benelli G. Larvicidal and repellent activity of essential oils from wild and cultivated Ruta chalepensis L. (Rutaceae) against Aedes albopictus Skuse (Diptera: Culicidae), and arbovirus vector. Parasitol. Res. 2013;112:991–999. doi: 10.1007/s00436-012-3221-2.

[23] .Ali A., Demirci B., Kiyan H.T., Bernier U.R., Tsikolia M., Wedge D.E., Khan I.A., Baser K.H.C., Tabanca N. Biting deterrence, repellency, and larvicidal activity of Ruta chalepensis (Sapindales: Rutaceae) essential oil and its major individual constituents against mosquitoes. J. Med. Entomol. 2013;50:1267–1274. doi: 10.1603/ME12177.

[24] Julia Gibka , s , lina Kunicka-Styczyńska, Marek Gliński, Antimicrobial Activity of Undecan-2-one, Undecan-2-ol and Their Derivatives, 2013, Journal of Essential Oil Bearing Plants 12(5), pp.605-614.

[25] Lutfun Nahar , Hesham R El-Seedi , Shaden A M Khalifa , Majid Mohammad hosseini , Satyajit D Sarker ,Ruta Essential Oils: Composition and Bioactivities, Molecules, 2021 ,26(16).

.