Bulletin of Environment, Pharmacology and Life Sciences
Bull. Env. Pharmacol. Life Sci., Vol 13 [10] September 2024: 42-47

Online ISSN 2277-1808
Journal's URL: http://www.bepls.com
CODEN: BEPLAD

ORIGINAL ARTICLE **OPEN ACCESS**

GC-MS Analysis of essential oils extracted from the leaves of *Pelargoniuem graveolens* L. Herit and *Murraya koenigii* (L.) sprengel

Mownika P R, Srikantha S N, Sudhakara B V, Chethan B M, Prajwala M and Sahana K M
Department of Botany, Nrupathunga University, Bengaluru 560001
For correspondence. Email: mownikapr1@gmail.com

ABSTRACT
Leaves of Pelargoniuem graveolens and Murraya koenigii were extracted from Clevenger method by hydro distillation, using Diethyl ether as a solvent and using $NaSO_4$ as a moisture content as remover. The extract was subjected to screen the phytochemical constituents through gas chromatography mass spectrometry (GC-MS) analysis. The GC-MS analysis of the leaf essential oil showed a total of 18 chemical compounds accounting for 99.976% of the oil in the leaves of Pelargoniuem graveolens the major compounds identified in the leaf oil of Pelargonium graveolens were, semicarbozone, caryophyllene oxide, citronellol and bicyclo [5.2.0] Nonane, 2-Methylene-4,8,8-Trimethyl-4-Vinyl. 22 chemical compounds accounting for 100% of the oil in Murraya koenigii, the major compounds identified in the leaf oil of Murraya Koenigii was caryophyllene, nicotinimidamide, linalool, pinene, ethyl ester, 1h-Indazole, 4,5,6,7-Tetrahydro-7-Methyl, cadinol and many other notable compounds were identified as in the range of less than 5%. From the present study it can be concluded that P. graveolens and M. koenigii leaves contain effective bioactive of pharmacological importance.
Key words: *Essential oils, Pelargonium graveolens, Murraya koenigii, GC-MS, bioactive compounds, NIST.*

Received 09.07.2024 Revised 17.08.2024 Accepted 20.09.2024

INTRODUCTION

Essential oils (Eos) are sweet-scented volatile liquids synthesised by oil secreting cells, cavities, canals, epidermal cells or glandular trichomes. They are synthesized in plants through secondary metabolic activity (1). Essential oils are most habitually produced from hydro distillation (2). Components present in EOs mostly comprise volatile terpenes and hydrocarbons (3). Essential oils have received increasing recognition to have natural additives for the shelf- life prolonging food products due to risk in making use of synthetic preservatives. Essential oils are good fount of bioactive compounds, which possesses antioxidative and antimicrobial properties, so the use of essential oils can be convenient to extend shelf-life in food products (4). *Pelargonium graveolens* commonly known as geranium which belongs to Geraniaceae family, is a bushy, aromatic plant, the stem and leaves are pubescent. The leaves are highly aromatic in nature. In the industries like perfumery, cosmetic and aromatherapy have a great extent use of *P. graveolens* essential oil in all over the world. It has since become a vital role in aromatherapy oil. Geranium oil reacts well to the effects of constipation, insomnia, restlessness, nervousness, anxiety, worry, high blood pressure, anger, frustration, emotional upsets, hypercholesterolemia, slow to lose weight and low metabolic forces (5). *Murraya koenigii* belongs to the family Rutaceae, is a shrub to small tree upto 8m in height**.** The main stem is dark green to brownish, with numerous dots on it. The leaves are usually with pellucid glands. Different examines were performed on the Bark, root, leaves, fruit and fruit pulp of *Murraya koenigii* for medicinal uses and in ayurveda (6). Hence the present work carried was to analyse the chemical composition of essential oils from leaves of *Pelargonium graveolens* and *Murraya koenigii* by GC-MS respectively.

Objectives of the study

1. To screen the phytochemicals through GC-MS analysis
2. To know the possible phytochemical compounds, present in the given plant samples.

MATERIAL AND METHODS

Collection of plant materials

The fresh leaves of *Pelargonium graveolens* and *Murraya koenigii* Sprengel were collected from Kolavanahalli village, Chikkaballapur. The plants were authenticated by Sri B. S. Chandrashekar, Scientist E, SFM Division, IWST, Bangalore.

Those leaves were washed through the distilled water and kept for shade-drying till the water droplets evaporate under room temperature. The leaves were chopped into small pieces.

For the extraction of essential oils from *Pelargonium graveolens* and *Murraya koenigii* Sprengel by hydro-distillation under optimal operating conditions and a quantity of 1Kg of plant material is added to round bottom flask and distilled water is added till the material immerse then the water inlet and outlet pipes are attached to the condenser of Clevenger and kept for 3 to 4 hours maintaining temperature of 45^0C- 50^0C.

The distillation two phases were observed: an aqueous phase- aromatic water and an organic phase-essential oil, which is less dense than water then the oil is separated and collected in test tubes or conical flask and sealed vials, as it is aromatic. Experiment is conducted till the required oil is obtained.

Separation of oil

The oil and water which forms two separate layers when the mixture is poured into separating funnel. Diethyl ether is added as a solvent so non polar compounds are generally soluble more than in alcohols such as ethanol, the solvents are shaken vigorously for 20-30sec, which greatly increases the surface area in contact between two liquids. After separating, the air is released through a stopper, the dense water collected at the bottom of the funnel and it is collected in a separate beaker. Then oil is collected, anhydrous sodium sulphate is added to absorb moisture content from oil and filtered using Whatman filter paper and then the oil is kept open under room temperature for solvent evaporation. The oil obtained was stored in vials at 40^0C in a refrigerator for further analyses.

Identification of Phytochemical compounds

GC-MS Analysis

GC-MS (Gas chromatography-Mass spectrometry) analysis of leaves of *Pelargonium graveolens* and *Murraya koenigii* essential oils was performed. The Clarus 680 GC was used in the analysis employed a fused silica column, packed with Elite -5MS (5% biphenyl 95% dimethylpolysiloxane, 30 m × 0.25 mm ID × 250μm df) and the components were separated using Helium as carrier gas at a constant flow of 1 ml/min. The injector temperature was set at 260°C during the chromatographic run. The 1μL of extract sample injected into the instrument the oven temperature was as follows: 60 °C (2 min); followed by 300 °C at the rate of 10 °C min−1; and 300 °C, where it was held for 6 min. The mass detector conditions were: transfer line temperature 240 °C; ion source temperature 240 °C; and ionization mode electron impact at 70 eV, a scan time 0.2 sec and scan interval of 0.1 sec. The fragments from 40 to 600 Da. The spectrums of the components were compared with the database of spectrum of known components stored in the GC-MS NIST (2008) library.

RESULTS

GC-MS analysis

GC-MS analysis showed the presence of 18 and 22 phytocompounds accounting for 99.976% and 100% in *Pelargonium graveolens*, *Murraya koenigii* (Table:1-2). The identification of phytochemical compounds was confirmed on the basis of retention time, peak area and molecular weight and formula. Thus, phytoconstituents obtained through GC-MS analysis was interpreted using the database of (NIST) library. The GC-MS chromatogram of oil extract of two different plants are shown in Figure 1-2.

Chemical composition of essential oil from leaves of *Pelargonium graveolens*

The GC-MS analysis of the leaf essential oil showed a total of 18 chemical compounds accounting for 99.976% of the oil (Figure 1). The major compounds identified in the leaf oil of *Pelargonium graveolens* were, semicarbozone (40.45%), caryophyllene oxide (22.58%), citronellol (13.06%) and bicyclo [5.2.0] Nonane, 2-Methylene-4,8,8-Trimethyl-4-Vinyl (6.335%). The other notable compounds found in the leaf oil in concentration less than 5% were, linalool, geraniol, rose oxide, eudermol, limonene.

Chemical composition of essential oil from leaves of *Murraya Koenigii*

The GC-MS analysis of the leaf essential oil showed a total of 22 chemical compounds accounting for 100% of the oil (Figure 2). The major compounds identified in the leaf oil of *Murraya Koenigii was caryophyllene (16.136%), nicotinimidamide (9.313%), linalool (8.429%), pinene (8.379%), ethyl ester (7.485%),* 1h-Indazole, 4,5,6,7-Tetrahydro-7-Methyl (6.424%) and cadinol (5.0253%). The other notable compounds found in the leaf oil in concentration less than 5% were, histamine, benzoic acid, phenethyl alcohol, Z-jasmone, viridifloral, neryl acetate, beta elemene, spathulenol, selinene, 2'-Ethylacetoacetanilide.

DISCUSSION

Essential oils are made up different components of volatile compounds biosynthesized by plants, containing a large number of components (7). GC-MS was used to separate chemical components, quantify components, identify unknown components. Gas chromatography (GC) coupled with mass spectrometry (MS) has been one of the most useful techniques of choice to identify variations in the composition of essential oil due to the volatility and polarity of its components (8). A new component Semi-carbazone was the major component found in *P. graveolens* in present studies and it is not found in any review of literature. Semi-carbazone was found in 40.45% in the present studies. Semi-carbazone is effective means for removing harmful metals from the environment has been studies through the use of thiosemicarbazone and semi-carbazone chelating resins (9).

Semi-carbazone show broad range of application in medicine, pharmacy, coordination chemistry, biological activities, industries, food packages, dyes, and polymer and also used as an O2 detector. Numerous applications in pharmacology such as antiviral, antifungal, antimicrobial, antimalarial, antituberculosis, anticancer, anti-HIV, catalytic application in oxidation of organic compounds, and nanotechnology (10). Caryophyllene oxide is the bicyclic sesquiterpene is one of the minor components found in the essential oil extracted from leaves of *P. graveolens* with 3.7% (11) where as in the present study 22.58% was found in the leaf oil of *P. graveolens* as second major component. Caryophyllene possesses anticancer activities, affecting growth and proliferation of numerous cancer cell, and analgesic properties (12). Citronellol (48.44%) was the major component present in the essential oil extracted from leaves of *Pelargonium graveolens* (13), 14% of citronellol as oxygenated monoterpene as a main representative (14), 27.53% (15), 37.55% (11) where as in the present study 13.06% was found in the leaf oil of *P. graveolens*. Citronellol contribute to various activities- antimicrobial, anthelmintic, antioxidant, anticonvulsant antitrypanosomal and wound healing and mosquito repellent action (16). Geraniol 50.2% (14), 25.85% (15) where as in the present study it is less than 5%. The other notable compounds found in the leaf oil in concentration less than 5% were, linalool, geraniol, rose oxide, eudermol, limonene was found. The variation in the chemical composition of geranium is may due to variations in geographical location, temperature, rainfall, soil, etc. (17). The essential oil of *P. graveolens* is one of the most expensive essential oil used in the perfumery, flavouring and cosmetic industries and therefore the plant is widely cultivated (11). Caryophyllene (9.5%) were the major components of *M. koenigii* (18), 6.5% from the plains of Northern India, 3.35% oil from the lower Himalayan range, 53.9%) from Eastern India, 53.9% Southern India (Kozhikode, Kerala) (19), where as in the present study 16.136%, the present investigation slightly varies with respect to the literature review. Nicotinimidamide primarily used as a nutritional supplement for vitamin B3. Supplementation of nicotinamide restores cellular NAD+ pool and mitochondrial energetics, attenuates oxidative stress and inflammatory response, enhances extracellular matrix and skin barrier, and inhibits the pigmentation process in the skin (20). Linalool was the major component present in the essential oil leaves of *M. koenigii* with 32.83% (21), 8.0% (22), 0.04% (23) where as in the present study 8.429% found in the leaves of *M. koenigii* essential oil. Linalool and linalool-rich essential oils are known to exhibit various biological activities such as antimicrobial, anti-inflammatory, anticancer, anti-oxidant properties and several in vivo studies have confirmed various effects of linalool on the central nervous system. The applications of linalool are specific scent to domestic products such as soaps, detergents and shampoos. Linalool also plays an import role in nature as a key compound in the complex pollination biology of various plant species to ensure reproduction and survival. Linalool is a key compound for the industrial production of a variety of fragrance chemicals such as geraniol, nerol, citral and its derivatives, as well as a lead compound in the synthesis of vitamins A and E. The repellent properties of linalool on various crop-destroying insects has been well documented accentuating the application of this molecule in eco-friendly pest management (24). Pinene 61.4% is obtained in the leaves of *M. koenigii* (25), 75.4% (26), 55.7% (27), where as in the present study 8.379% found in the leaves of *M. koenigii* essential oil. Pinene pharmacological activities are antibiotic resistance modulation, anticoagulant, antitumor, antimicrobial, antimalarial, antioxidant, anti-inflammatory, anti-Leishmania, and analgesic effects (28), (29).

CONCLUSION

Pelargonium graveolens and *Murraya koenigii*, are some important medicinal plants used to extract essential oils. Hydro-distillation of leaves of *P. graveolens* and *M. koenigii* yielded coloured oils with strong odour but the yield was not significant. GC-MS analysis showed that the major class of chemical constituent present in essential oil of *P. graveolens* was semicarbozone, caryophyllene oxide, citronellol and bicyclo [5.2.0] Nonane, 2-Methylene-4,8,8-Trimethyl-4-Vinyl. The chemical constituent present in essential oil of *M. koenigii* was caryophyllene, nicotinimidamide, linalool, pinene, ethyl ester, 1h-Indazole, 4,5,6,7-

Tetrahydro-7-Methyl and cadinol. The results of the present investigation will pave the way to identify other bioactive compounds in *Pelargonium graveolens* and *Murraya koenigii* to resolve their efficacy by *in vivo* studies and to develop novel safer drugs.

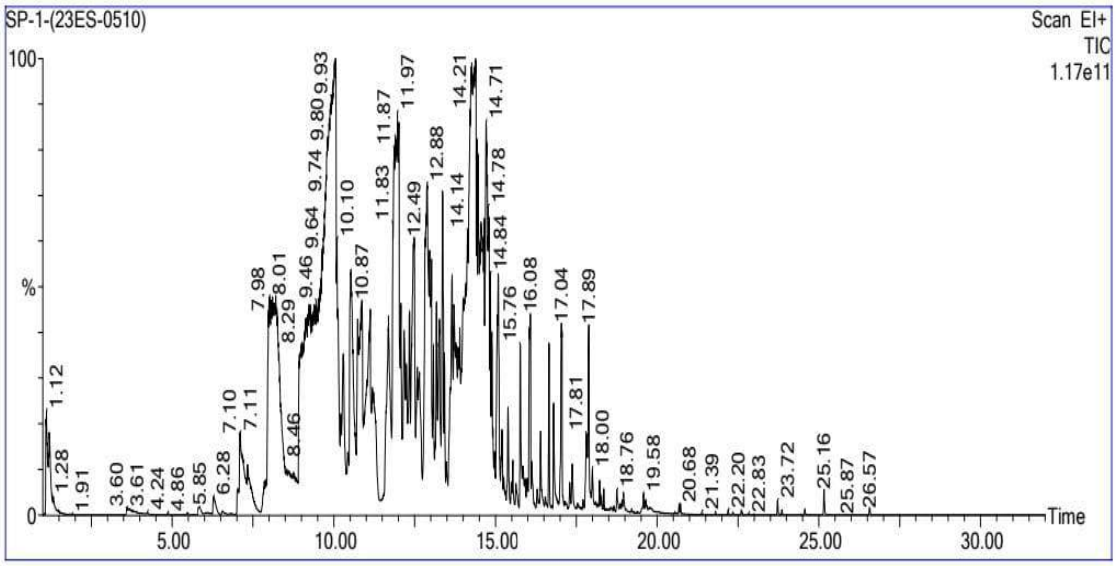

Figure 1: GC-MS chromatogram of essential oil of leaves of *P. graveolens*

Sl. No.	Compounds	Retention Time	Area %	Normality %
1	Z-(13,14-Epoxy) Tetradec-11-En-1-Ol Acetate	8.206	11.516	37.47
2	Ketone, 1-Cyclohexen-1-Yl Methyl, Semicarbazone	9.242	9.717	31.62
3	Ketone, 1-Cyclohexen-1-Yl Methyl, Semicarbazone	10.052	30.733	100.00
4	2-Pyridineethanol, 1-Oxide	10.102	1.785	5.81
5	2-Ethyl-5-N-Propylphenol	10.532	3.449	11.22
6	9,12-Octadecadien-1-Ol, (Z, Z)	11.132	2.480	8.07
7	Bicyclo [3.1.1] Heptane-2-Methanol, 6,6-Dimethyl	11.197	1.773	5.77
8	Bicyclo [5.2.0] Nonane, 2-Methylene-4,8,8-Trimethyl-4-Vinyl	11.693	2.582	8.40
9	Bicyclo [5.2.0] Nonane, 2-Methylene-4,8,8-Trimethyl-4-Vinyl	11.968	8.351	27.17
10	1,2,4-Metheno-1h-Indene, Octahydro-1,7a-Dimethyl-5-(1-Methylethyl) Trans-Anti-Trans-Tricyclo[7.3.0.0(2,6)]-7-Dodecene	12.488	2.879	9.37
11	Naphthalene, 1,2,3,4,4a,5,6,8a-Octahydro-7-Methyl-4-Methylene-1-(1-Methylethyl) Tricyclo[6.3.0.0(2,4)]Undec-8-Ene, 3,3,7,11-Tetramethyl	12.883	5.378	17.50
12	Not identified	12.963	2.255	7.34
13	Bicyclo [3.3.1] Nonan-9-Ol	13.363	1.858	6.04
14	Bicyclo [3.3.1] Nonan-9-Ol	14.389	6.335	20.61
15	1,4,7, -Cycloundecatriene, 1,5,9,9-Tetramethyl-, Z, Z, Z	14.709	3.390	11.03
16	1,4,7, -Cycloundecatriene, 1,5,9,9-Tetramethyl-, Z, Z, Z	15.084	2.421	7.88
17	5-Ethoxy-2-Methyl-Pyridine	16.079	1.533	5.05
18	6-[N-Aziridyl]-4-Methyl-2-Hexyn-4-Ol	17.040	1.544	5.02
Total			99.976%	

Table 1: Chemical composition of essential oil of leaf of *P. graveolens*

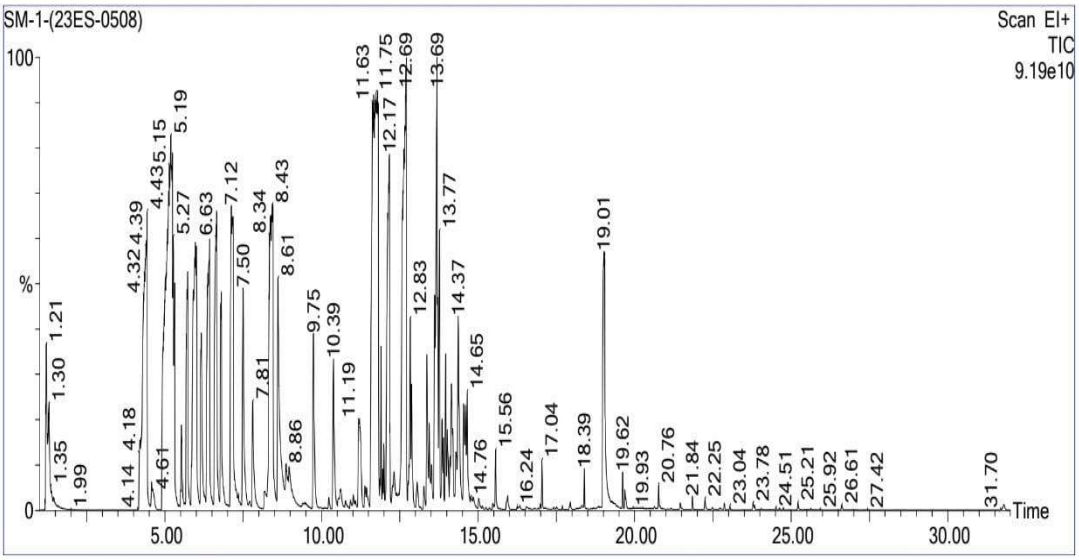

Figure 2: GC-MS chromatogram of essential oil of leaves of *M. koenigi*

Sl. No.	Compounds	Retention Time	Area %	Normality %
1	Silane, Dimethyldi-1-Propynyl	4.435	7.579	46.91
2	2-Amino-4-Methylpyrrole-3-Carbonitrile	5.190	9.313	57.65
3	Phenethyl Alcohol, P-Nitro- Alpha -Phenyl	5.730	2.588	16.02
4	1h-Indazole, 4,5,6,7-Tetrahydro-7-Methyl	5.975	6.424	39.76
5	2h-1b,4-Ethanopentaleno[1,2-B] Oxirene, Hexahydro Cyclopropane, Trimethyl(2-Methyl-1-Propenylidene)-	6.165	1.678	1039
6	Histamine, N-Benzoyl-2-Cyano	6.426	4.431	27.43
7	1-Cyclohexyl-1-(4-Ethyl cyclohexyl) Ethane	6.651	4.422	27.37
8	Benzoic Acid, 4-(1,3-Dioxo-3-Phenylpropylamino)-	6.806	1.796	11.12
9	(E, Z, Z)-2,4,7-Tridecatrienal	7.121	5.253	32.52
10	2-Cyclohexen-1-Ol, 1-Methyl-4-(1-Methylethyl)	7.496	1.987	12.30
11	1-Methyl-1h-Imidazole-2-Carboxylic Acid, Ethyl Ester	8.446	7.485	46.33
12	3-Cyclohexene-1-Methanol, Alpha., Alpha.4-Trimethyl	8.611	2.644	16.37
13	Bicyclo [3.1.0] Hexan-3-Ol, 4-Methyl-1-(1-Methylethyl) and Isobornyl Acetate	9.747	1.550	9.59
14	3-Cyclohexene-1-Methanol, Alpha., Alpha.4-Trimethylethylidene	10.387	1.321	8.18
15	Cyclohexane	11.217	1.550	9.59
16	Not identified	11.793	16.15	100.00
17	Azulene	12.173	5.332	33.01
18	Naphthalene	12.708	9.417	58.29
s19	2'-Ethylacetoacetanilide	13.688	2.675	16.56
20	Globulol	13.769	1.344	8.32
21	1-Naphthalenol, 1,2,3,4,4a,7,8,8a-Octahydro-1,6-Dimethyl-4-(1-Methylethyl) and Cadinol	14.369	1.387	8.59
22	1,10-Decanediol	19.011	3.669	22.71
			100%	

Table 2: Chemical composition of essential oil of leaf of *M. Koenigii*

REFERENCES

1. Bassolé IH, Juliani HR. (2012). Essential oils in combination and their antimicrobial properties. Molecules.;17(4):3989-4006. doi: 10.3390/molecules17043989. PMID: 22469594; PMCID: PMC6268925..
2. Thierry Regnier, Sandra Combrinck, and Wilma Du Plooy. (2012). "Essential Oils and Other Plant Extracts as Food Preservatives". J. Progress in Food Preservation. Pg. 539-579.
3. Richard Ansah Herman, Ellen Ayepa, Saidi Shittu, Sandra Senyo Fometu and Jun Wang. (2019). "Essential oils and their applications". A Review: Advances in Nutrition and Food Science. ISSN: 2572-5971
4. Juana Fernanbezdez-Lopez and Manuel Viuda-Martos. (2018). "Introduction to the special issue, Application of Essential oils in food systems". J. Foods 7(4), 56.
5. Jinous Asgarpanah and Fereshteh Ramezanloo, (2015); An overview on phytopharmacology of *Pelargonium graveolens* L. Indian Journal of Traditional Knowledge.14(4): 558-563

6. Manshu Jain, Ritu Gilhotra, Ravindra Pal Singh, Jitendra Mittal. (2017). "Curry leaf (*Murraya Koenigii*): a spice with medicinal property". J. MOJ Med. 2(3), 00050.
7. Pichersky E, JP Noel and N Dudareva. (2006). "Biosynthesis of plant volatiles: nature's diversity and ingenuity". Science Journal 311 (5762), Pg. 808-811.
8. Moustafa, A., El-Shenawy, Hoda, H., Baghadi., Lobna, S. and El-Hosseiny. (2015). Antibacterial activity of plants essential oils against some epidemiologically relevant food borne pathogens. The open public health Journal, 8:30-34.
9. Amanda J Crook, Edward C Lisic, Dale D Ensor (2012), Thiosemicarbazone and semicarbazone chelating resins and their potential use in environmental applications, Separation Science and Technology 47 :14-15.
10. M.S. More, P.G. Joshi, Y.K. Mishra (2019), Metal complexes driven from Schiff bases and semicarbazones for biomedical and allied applications: a review, J; Materials Today Chemistry V. 14.
11. Farukh S. Sharopov, Hanjing Zhang and William N. Setzer. (2014). "Composition of geranium (*Pelargonium graveolens*) essential oil from Tajikistan". J. American Journal of Essential oils and Natural Products 2(2): Pg.13-16.
12. Klaudyna Fidyt, Anna Fiedorowicz, Leon Strzadata and Antoni Szumny (2016), Beta Caryophyllene and Beta caryophyllene oxide- natural compounds of anticancer and analgesic properties; J: Cancer Medicine:5(10):3007-3017.
13. Elham Sadat Mousavi, Hamid Dehghanzadeh, Aida Abdali; (2014); Chemical Composition and essential oils of *Pelargonium graveolens* (Geraniaceae) by gas chromatography – Mass Spectrometry (GC/MS) J: Bull Environ Pharmacol Life Sci. 3, 182-4.
14. Sanja Cavar, Milka Maksimovic. (2011). Antioxidant activity of essential oil and aqueous extract of *Pelargonim graveolens L'Her*. J Food Control 23(2012)263-267.
15. Mnif, W., Dhifi, W., Jelali, N., Baaziz, H., Hadded, A., & Hamdi, N. (2011). Characterization of Leaves Essential oil of *Pelargonium graveolens* Originating from Tunisia: Chemical Composition, Antioxidant and Biological Activities. *Journal of Essential Oil Bearing Plants*, *14*(6), 761–769. https://doi.org/10.1080 /0972060X. 2011. 10644001
16. Ruchi Sharma, Rekha Rao, Sunil Kumar, Sheefali Mahant, Sarita Khatkar (2019). Therapeutic Potential of Citronella Essential Oil: A Review, J: Current Drug Discovery Technology.
17. Javed Ahamad and Subasini Uthirapathy.(2021). Chemical Characterization and Antidiabetic Activity of Essential Oils from *Pelargonium graveolens* Leaves. ARO-The Scientific Journal of Koya University Volume. IX, No.1, Article ID; ARO.10791.
18. Jasim Uddin Chowdhury,Md.Nazrul Islam Bhuiyan and Mohammed Yusuf. (2008).Cemichal composition of the leaf essential oils of *Murraya Koenigii* (L.) Spreng and *Murraya paniculate* (L.) Jack. A Journal of the Bangladesh Pharmacological Society (BDPS). Bangladesh J Pharmacol 2008;3: 59-63.
19. V. K. Raina,R.K.Lal, Savita Tripathi, M. Khan, K.V. Syamasundar and S.K. Srivastava. (2001). Essential oil composition of genetically diverse stocks of *Murraya Koenigii* from India. Flavour and FRAGRANCE JOURNAL. Flavour Fragr. J.2002;17: 144-146.
20. Yong Chool Boo (2021), Mechanistic basis and clinical evidence for the applications of nicotinamide (niacinamide) to control skin aging and pigmentation; J.: Antioxidants 10 (8), 1315.
21. Mini Priya Rajendran, Blessed Beautlin Pallaiyan, and Nija Selvaraj (2014). "Chemical composition, antibacterial and antioxidant profile of essential oil from *Murraya koenigii (L.)* leaves". J. Avicenna Phytomed. 4(3): Pg. 200–214.
22. KC Wong, SG Chee (1996). Volatile Constituents of *Murraya koenigii Spreng*; Journal of Essential Oil Research 8 (5), 545-547.
23. P Sankar Ganesh, Ravishankar Rai Vittal, (2015). In vitro antibiofilm activity of *Murraya koenigii* essential oil extracted using supercritical fluid CO2 method against *Pseudomonas aeruginosa* PAO1 J: Natural Product Research 29 (24), 2295-2298.
24. Guy PP Kamatou, Alvaro M Viljoen, (2021). Linalool–A review of a biologically active compound of commercial importance; J.; Natural product communications 3 (7), 100-105.
25. VS Rana, JP Juyal, M Amparo Blazquez, (2004). Chemical constituents of the volatile oil of *Murraya koenigii* leaves; J.: International Journal of Aromatherapy 14 (1), 23-25.
26. VK Raina, RK Lal, Savita Tripathi, M Khan, KV Syamasundar, SK Srivastava, (2002). Essential oil composition of genetically diverse stocks of *Murraya koenigii* from India, J.: Flavour and fragrance journal 17 (2), 144-146.
27. BR Rajeswara Rao, DK Rajput, GR Mallavarapu,(2011). Chemical diversity in curry leaf (*Murraya koenigii*) essential oils, J.: Food Chemistry 126 (3), 989-99.
28. Bahare Salehi, Shashi Upadhyay, Ilkay Erdogan Orhan, Arun Kumar Jugran, Sumali LD Jayaweera, Daniel A. Dias, Farukh Sharopov, Yasaman Taheri, Natália Martins, Navid Baghalpour, William C. Cho, Javad Sharifi-Rad, (2019). Therapeutic potential of α-and β-pinene: A miracle gift of nature J.: Biomolecules 9 (11), 738.
29. B. S. Ramesh and L. Rajanna. (2022). GC-MS and FTIR Analysis of The Leaf Extract of *Pseuderanthemum Bicolor* (Schrank) Radlk. Ex Lindau. The Journal of Cytology and Genetics, 23 (Ns): 73-81, 2022.

CITATION OF THIS ARTICLE

Mownika P R, Srikantha S N, Sudhakara B V, Chethan B M, Prajwala M and Sahana K M. GC-MS Analysis of essential oils extracted from the leaves of *Pelargoniuem graveolens* L. Herit and *Murraya koenigii* (L.) sprengel. Bull. Env. Pharmacol. Life Sci., Vol 13 [10] September 2024: 42-47.