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A comparative analysis of the chemical constituents in essential oils from *Mentha arvensis* L. and *Mentha spicata* L. cultivated in Bangladesh

M. N. I. Bhuiyan*

Institute of Food Science and Technology (IFST), Bangladesh Council of Scientific and Industrial Research (BCSIR), Dr. Qudrat-I-Khuda Road, Dhaka-1205, Bangladesh

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Abstract

The perennial herbs *Mentha arvensis* L. and *Mentha spicata* L., which are members of the Lamiaceae family, are extensively used in the nutraceutical, functional food, and pharmaceutical industries. Due to the potential presence of valuable secondary metabolites, a comparative study was performed on the essential oils (EOs) extracted from locally grown *M. arvensis* and *M. spicata* in Bangladesh to analyze their chemical constituents. The EOs were extracted from fresh herbs using the hydro-distillation method, and their chemical constituents were analyzed via gas chromatography-mass spectrometry (GC-MS). Carvone (59.58%) and limonene (31.14%) were recognized as the main constituents in the oil of *M. arvensis*, while carvone (55.03%) was also the principal constituent in the *M. spicata* EO. Additionally, significant proportions of dihydrocarveol (17.94%), dihydrocarveol acetate (7.69%), and limonene (6.9%) were detected among the twenty compounds analyzed in *M. spicata* oil. The key constituent found in these EOs may be responsible for the significant medicinal activities attributed to *Mentha* species.

Keywords: *Mentha arvensis*; *Mentha spicata*; Essential oil; GC-MS; Carvone; Limonene

Introduction

Mentha arvensis L. (Japanese mint or ginger mint) and *Mentha spicata* L. (Spearmint or mint) are perennial rhizomatous herbs from the Lamiaceae family and the genus *Mentha*, valued for their aromatic properties. The genus *Mentha* includes 42 species, along with various subspecies, hybrids, cultivars, and varieties (Brahmi *et al.* 2016; Salehi *et al.* 2018; Silva, 2020). Both *M. arvensis* and *M. spicata* thrive in tropical and subtropical climates, are commonly cultivated in Europe, North America, and Asia, and are now grown globally. They thrive in a variety of soils and are often found in home gardens, characterized by their strong aromatic scent and varying heights, reaching up to 10-60 cm (*M. arvensis*) and 30-100 cm (*M. spicata*) tall, with stems and foliage ranging from hairless to hairy, and possessing wide-spreading fleshy underground rhizomes (Wei *et al*. 2023).

Traditionally, various parts of *Mentha* species—such as flowers, leaves, seeds, roots, stems, bark, and wood—have been used to extract essential oils (EOs). Recently, there has been a renewed focus on the medicinal properties of these aromatic plants due to the beneficial effects of their EOs (Bhuiyan and Nahid, 2023). EOs are well-known for containing secondary metabolites, including monoterpenes, sesquiterpenes, hydrocarbons, and their oxygenated derivatives, such as alcohols, aldehydes, ketones, acids, and esters. Notably, EOs from *M. arvensis* L. and *M. spicata* L. are particularly rich in oxygenated monoterpenes (Bardaweel *et al.* 2018). These EOs have extensive applications across the nutraceutical, pharmaceutical, and food industries due to their potent active compounds (Mahendran *et al.* 2021; Nahid and Bhuiyan, 2024).

*Corresponding author's e-mail: nazrulbcsir@gmail.com

For instance, the EO of *M. arvensis* is renowned for its high menthol content, which contributes to its cooling effect and is widely used in medicinal and cosmetic products. Meanwhile, the EO of *M. spicata* is valued for its distinct spearmint aroma and is commonly used in flavorings and oral hygiene products. Numerous studies have shown that EOs from mint species exhibit a range of biological activities, including antimicrobial, analgesic, sedative, antiseptic, antioxidant, spasmolytic, anesthetic, anticancer, and anti-inflammatory effects, largely due to their bioactive compounds (Wei *et al.* 2023). Specifically, *M. arvensis* is noted for its high menthol content, which contributes to its analgesic and antispasmodic properties. On the other hand, *M. spicata* is recognized for its carvon content, which enhances its antimicrobial and anti-inflammatory effects. Both EOs are increasingly valued in therapeutic applications and as natural additives in various industries due to their diverse health benefits and effective compounds. Studies have revealed that in the major chemical constituents of *M. arvensis* EO, menthol constitutes (30 to 50%), menthone (15 to 30%), menthyl acetate (3 to 10%), and other terpenes make up (1 to 5%) (Yousuf *et al*., 2021). In *M. spicata*, the essential oil composition is characterized by menthol, which constitutes approximately 36% of the oil. Other significant components include menthone at 21%, menthyl acetate and eucalyptol both at 7%, isomenthone at 5%, neomenthol at 4%, and menthofuran at 3%. Additionally, D-limonene and β-caryophyllene each make up about 2%, while pulegone and β-pinene each account for 1% (Li and Tian, 2018). In comparison, the essential oil of *M. arvensis* is notably rich in menthol, which can comprise up to 70% of its composition, giving it a strong cooling effect. *M. arvensis* also contains significant amounts of menthone and menthyl acetate, contributing to its therapeutic and aromatic properties. Both *M. spicata* and *M. arvensis* EOs are valued for their distinctive flavors and health benefits, making them important in both culinary and medicinal applications.

To advance research on bioactive compounds from mint and their potential uses in the food and medicinal sectors in Bangladesh, this study offers an in-depth analysis of the EOs constituents found in two commercially significant mint species, *M. arvensis* and *M. spicata. M. arvensis* is known for its high menthol content, which contributes to its medicinal properties such as analgesic and antispasmodic effects. On the other hand, *M. spicata* is characterized by its rich profile of menthone and carvon, which provide notable antimicrobial and anti-inflammatory benefits. This comprehensive overview aims to highlight the chemical diversity of these EOs and their applicability in enhancing both food products and therapeutic formulations in Bangladesh.

Materials and methods

Sample collection and extraction of essential oil

The *M. arvensis* L. plants were collected from the experimental fields of BCSIR Chattogram Laboratories, while *M. spicata* L. plants were sourced from Jamalpur district of Bangladesh. EOs were extracted from the fresh herbs of 100g each using a hydro-distillation process for 4 h with a Clevenger apparatus. After extraction, the EOs were filtered and dried over anhydrous sodium sulfate to remove any residual moisture, then stored at 4°C until further analysis. The yield percentage of the essential oil was calculated based on the volume obtained relative to the fresh weight of the plant material, using the following formula:

$$\text{Yield (\%)} = \frac{\text{Weight of essential oil extracted (g)}}{\text{Weight of sample taken (g)}} \times 100$$

GC-MS Analysis

For the analysis of the EOs, gas chromatography-mass spectrometry (GC-MS) with electron impact ionization (EI) was utilized. The analysis was performed using a Shimadzu GC-17A gas chromatograph coupled with a GC-MS QP 5050A mass spectrometer. A fused silica capillary column (30 m × 2.5 mm, 0.25 μm film thickness) coated with DB-5 (J&W Scientific) was employed for separation. The temperature program for the column ranged from 50°C for 2 min, increasing to 250°C at a rate of 5°C/min. Helium served as the carrier gas, maintained at a constant pressure of 90 kPa. The mass spectrometer was operated in full scan mode with a scan range of 40-350 amu.

Constituent identification was achieved by comparing the mass spectra obtained from the analysis with those in the National Institute of Standards and Technology (NIST) library (NIST 127 and NIST 147) (Bhuiyan *et al.* 2011).

This process involved matching the mass fragmentation patterns and retention times of the compounds detected in the essential oil samples with the reference spectra in the NIST database.

Results and discussion

M. arvensis and *M. spicata* cultivated in Bangladesh were found to contain approximately 0.3% and 0.27% essential

Table I. The constituents of essential oils from *M. arvensis* and *M. spicata* plants using GC-MS

S.N.	Chemical constituents	*M. arvensis* (%)	*M. spicata* (%)
1.	2H-1-benzopyran, 3,4,4a, 5,6,8a, hexahydro -2,5,5,8a -tetramethyl-(2α, 4aα, 8aα)	--	0.50
2.	Bicyclo (2,1,1) hept-3-en-2-one-4,6,6-trimethyl	0.11	--
3.	α-bourbonene	0.23	1.16
4.	Cis-carveol	--	2.15
5.	Trans-carveol	0.37	--
6.	Trans-carveyl acetate	--	1.52
7.	Carvone	59.58	55.03
8.	Carveyl acetate	0.18	--
9.	Caryophyllene	0.34	1.18
10.	Caryophyllene oxide	0.49	--
11.	Cubenol	--	0.31
12.	Dihydrocarveol	--	17.94
13.	Dihydrocarveol, acetate	--	7.69
14.	Dihydrocarvone	2.32	--
15.	1,1-dimethyl-4-methylenecyclohexane	0.15	--
16.	Eucalyptol	0.09	0.45
17.	Germacrene D	--	1.09
18.	Limonene	31.14	6.90
19.	β-linalool	0.24	0.37
20.	β-myrcene	0.50	1.27
21.	Neodihydrocarveol	--	0.68
22.	3-nonanol, 5-methyl	0.34	--
23.	5-nonanol,2,8-dimethyl	0.29	--
24.	β-ocimene	--	0.23
25.	Octylcyclobutanecarboxylate	0.15	--
26.	2-oxabicyclo [4,4,0] dec-9-ene, (IR,3S,6R)-1,3,7,7-tetramethyl	--	0.50
27.	α-pinene	0.64	0.31
28.	β-pinene	0.76	--
29.	Pulegone	1.49	--
30.	Sabinene	0.40	0.22
31.	11-Tridecyn-1-ol	0.21	--
32.	Urazole	--	0.51

oil (EO), respectively. Analysis of the chemical constituents of these EOs revealed significant differences between the two species. Among the components of the essential oil from of *M. arvensis*, carvone (59.58%) and limonene (31.14%) were identified as the major constituents, whereas carvone (55.03%) dominated in the EO of *M. spicata*, accompanied by dihydrocarveol (17.94%), dihydrocarveol acetate (7.69%), and limonene (6.9%) (Table I). Additionally, other noteworthy constituents in *M. arvensis* EO included trans-dihydrocarvone (2.32%) and pulegone (1.49%), while *M. spicata* EO contained cis-carveol (2.15%), caryophyllene (1.18%), β-myrcene (1.27%), α-bourbonene (1.16%), trans-carveyl acetate (1.52%), and germacrene D (1.09%).

Numerous studies have emphasized the wide range of pharmacological effects linked to both the major and minor components of EOs from these mint species. These effects include antioxidant, anti-inflammatory, anticholinesterase, and antibacterial properties (Afrin *et al.* 2022; Biswas *et al.* 2014). Specifically, the essential oil of M. arvensis is particularly noted for its high menthol content, which contributes to its potent anti-inflammatory and analgesic effects. Conversely, the essential oil of *M. spicata* is recognized for its high carvon content, which enhances its antioxidant and antimicrobial activities. Both EOs are valued not only for their therapeutic benefits but also for their potential applications in developing natural remedies and functional products. However, further research is necessary to pinpoint which specific components of the EO are responsible for expressing these pharmacological effects.

The chemical constituents of *M. arvensis* EO observed in present study differs from previous reports, with the absence of menthol suggesting a distinct chemotype potentially related to spearmint (De Sousa Barros *et al.* 2015; Singh and Pandey, 2018). Conversely, the constituents of *M. spicata* EO resemble those reported earlier, indicating consistency in chemical composition across studies (Mahboubi, 2021; Snoussi *et al.* 2015). Factors such as ecotype, genotype, climate, and agronomic conditions may account for the variations in EO chemical constituents observed (Nahid and Bhuiyan, 2024). For example, the concentration of carvone in the essential oil of *M. spicata* can vary significantly depending on the geographic region where it is cultivated (Dhifi *et al.* 2013; El Menyiy *et al.* 2022). Given the chemical diversity observed, the EOs of *M. arvensis* and *M. spicata* are recognized as promising sources of natural bioactive constituents. These constituents have potential applications in the food, flavor, pharmaceutical, and related industries. The high menthol content in *M. arvensis* enhances its utility in medicinal products and flavorings, while *M. spicata* is valued for its distinctive carvone and other terpenes, making it useful in both culinary and therapeutic contexts. The broad range of applications highlights the significance of *M. arvensis* and *M. spicata* EOs in various industrial and healthcare settings.

Conclusion

The chemical constituents of EOs from *M. arvensis* and *M. spicata* grown in Bangladesh exhibit notable differences. *M. arvensis* essential oil typically contains higher concentrations of carvone and limonene, contributing to its strong minty aroma and potential medicinal properties such as analgesic and antimicrobial effects. Conversely, *M. spicata* essential oil is characterized by elevated levels of carvone and dihydrocarveol, imparting a sweeter, more herbaceous scent with potential applications in aromatherapy and flavoring. These variations in chemical composition can influence the therapeutic and aromatic profiles of the oils, offering diverse benefits to consumers. However, additional research is needed to thoroughly investigate the specific pharmacological and aromatic properties of *M. arvensis* and *M. spicata* EOs. Such studies should focus on their effectiveness and potential benefits in the context of Bangladeshi agriculture and traditional medicine. Exploring these aspects could reveal new applications for these EOs, enhancing their use in local agricultural practices and traditional health remedies. Given their promising profiles, understanding their full potential could lead to innovative applications and improved therapeutic practices in Bangladesh.

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References

Afrin S, Goswami B, Rahman S, Bhuiyan MNI, Shamima KSA and Nandi NC (2022), Antimicrobial potential of *Coriandrum sativum*, *Lactuca sativa* and

Mentha spicata against antibiotic resistant microorganisms, *J of Herbs Spices Med Plants.* **28**: 193-205. https:// doi.org/ 10.1080/ 10496475. 2022.2040684

Bardaweel SK, Bakchiche B, ALSalamat HA, Rezzoug M, Gherib A and Flamini G (2018), Chemical composition, antioxidant, antimicrobial and antiproliferative activities of essential oil of *Mentha spicata* L. (Lamiaceae) from Algerian Saharan atlas, *BMC Complement Altern Med*. **18**: 201. DOI: 10.1186/s12906-018-2274-x

Bhuiyan MNI and Nahid M (2023), Comparison of the chemical composition and antimicrobial activity of two types of Cosmos (*Cosmos bipinnatus* Cav. and *Bidens ferulifolia* (Jacq.)) leaf essential oils introduced in Bangladesh, *J Chromatogr Sep Tech*. **14**:515. DOI: 10.35248/2157-7064.23.14.515

Bhuiyan MNI, Begum J and Nandi NC (2011), Volatile constituents of essential oils isolated from different parts of *Alpinia calcarata* Rosc, *African J Plant Sci*. **5**: 349-52.

Biswas NN, Saha S and Ali MK (2014), Antioxidant, antimicrobial, cytotoxic and analgesic activities of ethanolic extract of *Mentha arvensis* L., *Asian Pacific J Tropical Biomed*. **4**: 792-797.

Brahmi F, Adjaoud A, Marongiu B, Falconieri D, Yalaoui-Guellal D, Madani K and Chibane M (2016), Chemical and biological profiles of essential oils from *Mentha spicata* L. leaf from Bejaia in Algeria, *J. Essent. Oil Res*. **28**: 211-220.

De Sousa Barros A, de Morais SM, Ferreira PAT, Vieira IGP, Craveiro AA, dos Santos Fontenelle RO, Silva Alencar de Menezes JE, Ferreira da Silva FW and Araújo de SH (2015), Chemical composition and functional properties of essential oils from *Mentha* species, *Ind. Crops Prod*. **76:** 557-564

Dhifi W, Jelali N, Mnif W, Litaiem M and Hamdi N (2013), Chemical composition of the essential oilof *Mentha spicata* from Tunisia and its biological activities, *J. Food Biochem.* **37**: 362-368.

El Menyiy N, Mrabti HN, El Omari N, Bakili AE, Bakrim S, Mekkaoui M, Balahbib A, Amiri-Ardekani E, Ullah R, Alqahtani AS, Shahat AA and Bouyahya A (2022), Medicinal uses, phytochemistry, pharmacology and toxicology of *Mentha spicata, Evid Based Complement*. **2022**: 7990508.

Li X and Tian T (2018), Phytochemical characterization of *Mentha spicata* L.under differential dried-conditions and associated nephrotoxicity screening of main compound with organ-on-a-chip, *Front. Pharmacol*. **9**: 1067.

Mahboubi M (2021), *Mentha spicata* L. essential oil, phytochemistry and its effectiveness in flatulence, *J. Tradit. Complement. Med*. **11**: 75-81.

Mahendran G, Verma SK and Rahman LU (2021), The traditional uses, phytochemistry and pharmacology of spearmint (*Mentha spicata* L.): A review, *J. Ethnopharmacol*. **278**: 114266.

Nahid, M and Bhuiyan MNI (2024), GC-MS analysis of leaf and rhizome essential oil of *Zingiber purpureum* roxb. from Bangladesh, *Bangladesh J. Bot.* **53**: 153–158. https://doi.org/10.3329/bjb.v53i1.72274

Salehi B, Stojanovic-Radic Z, Matejic J, Sharopov F, Antolak H, Kregiel D, Sen S, Sharifi-Rad M, Acharya K, Sharifi-Rad R, Martorell M, Sureda A, Martins N and Sharifi-Rad J (2018), Plants of genus *Mentha*: From farm to food factory, *Plants* **7**: 70.

Silva H (2020), A descriptive overview of the medical uses given to *Mentha* aromatic herbs throughout history, *Biology* **9**: 484.

Singh P and Pandey AK (2018), Prospective of essential oils of the genus *Mentha* as biopesticides: A review, *Front Plant Sci*. **9**: 1295.

Snoussi M, Noumi E, Trabelsi N, Flamini G, Papetti A and De Feo V (2015), *Mentha spicata* essential oil: chemical composition, antioxidant and antibacterial activities against planktonic and biofilm cultures of *Vibrio* spp. strains, *Molecules*. **20**: 14402-144024.

Wei H, Kong S, Jayaraman V, Selvaraj D, Soundararajan P and Manivannan A (2023), *Mentha arvensis* and *Mentha piperita* vital herbs with myriads of pharmaceutical benefits, *Horticulturae*. **9**: 224.

Yousuf T, Akter R, Ahmed J, Mazumdar S, Talukdar D, Nandi NC and Amin MN (2021), Evaluation of acute oral toxicity, cytotoxicity, antidepressant and antioxidant activities of Japanese mint (*Mentha arvensis* L.) oil, *Phytomedicine Plus*. **1**: 100140.