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Therapeutic Potential of Mentha Spicata: Bridging Traditional Medicine and Modern Science

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Abstract

Mentha spicata (*M. spicata*), is one of the important medicinal plan from mint (Lamiaceae) family. This plant possess range of pharmacological properties due to diverse secondary metabolites, such as essential oils, phenolic compounds, and other bioactive components. The pharmacological characteristics and health related benefits of *M. spicata* are attributed towards the presence of these secondary metabolites, including anti-inflammatory, anti-cancer, anti-microbial, anti-oxidant, anti-diabetic, and anti-parasitic properties. Recently, this plant has gained the attraction of researchers. Furthermore, numerous studies have reported the pharmacological potential of *M. spicata*. The current project is designed and executed to write the comprehensive review on therapeutical potential of *M. spicata* along with bridging traditional medicine and modern science the basis of existanting knowledge through literature survey from different sources such as Google scholar, PubMed, researchgate, science direct, etc. The present study describes the thorough summary of nutraceutical and medicinal relevance of *M. spicata*, emphasizing its bio-functional components, pharmacological uses and possible related mechanisms. There is also dire necessity of bridging the link between conventional wisdom and contemporary scientific validation, as well as probable future directions for further use in functional food and pharmaceutical industries.

Keywords: *Mentha spicata*, traditional medicine, phyto-chemicals, anti-oxidant, nutraceutical

Highlights

- *M. spicata* enriched with bioactive compounds
- Exhibits strong anti-oxidant and anti-inflammatory effects
- Demonstrates anticancer and antidiabetic potential
- May serves as a bridge between modern science and traditional medicine
- Further clinical validation is required

1. Introduction

The global interest in medicinal plants as safer therapeutic alternatives is the results of an ever growing concerns associated with the adverse effects associated with synthetic drugs. Among these, *Mentha spicata*, (*M. spicata*) holds a significant position due to its extensive use in traditional medicine across Asia, Europe, and the Middle East (Ahluwalia & Kaur, 2022; El Menyiy et al., 2022).

Historically, spearmint has been utilized for managing digestive disorders, respiratory conditions, inflammation, and hormonal disturbances. In modern research, it is increasingly recognized as a functional food with promising applications in the prevention and management of chronic diseases with several health advantages, , including antioxidant, anti-inflammatory, anticancer, antidiabetic, antiparasitic, and antibacterial activities (El Menyiy et al., 2022; L.-L. Zhang, Chen, Li, Li, & Fan, 2022). Its wide range of pharmacological properties, such as antioxidant, anti-inflammatory, antibacterial, anticancer, and antidiabetic benefits, have been more strongly supported by scientific research in recent years (Saqib et al., 2022; Shahar & Chongtham, 2024; Tafrihi et al., 2021; Zhang et al., 2022). Taxonomy of *M. spicata* is shown in **figure 1.**

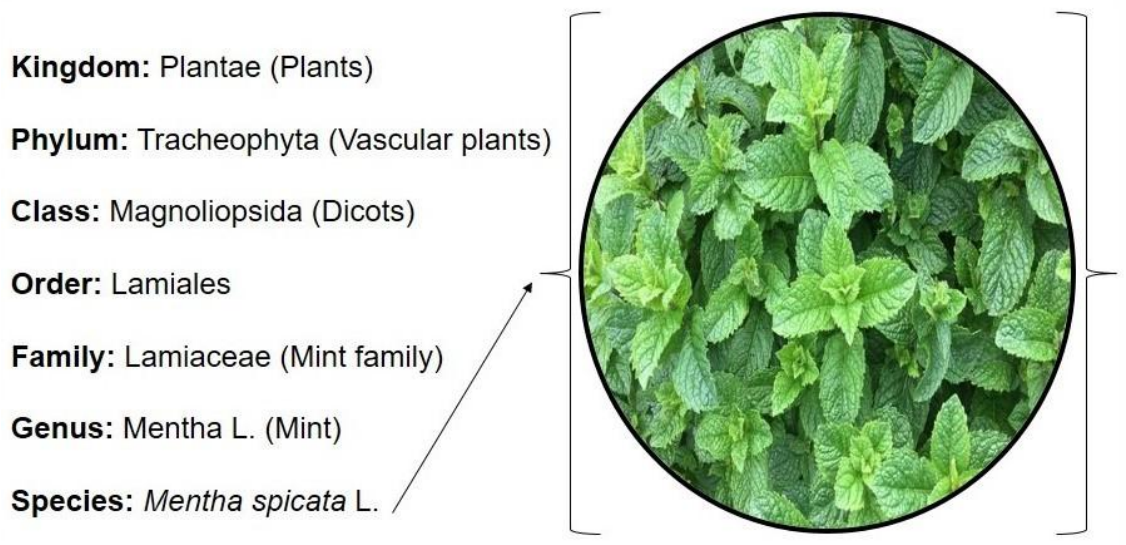

Figure 1. Morphological characteristics of M. spicata

The genus *Mentha* comprises over 30 species of aromatic perennial herbs that are predominantly distributed in temperate regions. These species exhibit considerable variation in morphology, aroma, and ecological adaptation (Anwar, Abbas, Mehmood,

Gilani, & Rehman, 2019; Brahmi, Khodir, Mohamed, & Pierre, 2017; Naseem et al., 2025; Song, Shao, Yu, & Sun, 2026). Many *Mentha* species have long been employed as flavoring agents and herbal remedies. Various constituents of essential oils are particularly rich in oxygenated monoterpenes, which are commercial and medicinally significant phytochemicals, especially phenolic acids, flavonoids, and components like limonene and carvone (Pluháčková et al., 2026; Zhang et al., 2022).

This plant is widely grown and utilized for industrial purposes, functional food and pharmaceutical industries. Particularly for its use in functional foods and essential oil in different formulations. As a natural reservoir of anti-microbial, anti-inflammatory and anti-oxidant potential of *M. spicata* been well documented, compelling its implication beyond conventional applications.

2. Phytochemical Composition

Phytochemical composition of *M. spicata* demonstared the presence of primary metabolites and is also rich in secondary metabolites which are associated with therapeutical and nutraceuticals potential. These constituents includes phenolic compounds, flavonoids, lignans, and essential oils. These substances are essential in defining pharmacological significance of this plant and described bellow,

2.1 Phenolic compounds

Phenolic acids such as Chlorogenic acid, caffeic acid, and rosmarinic acid are the most significant class of bioactive components in M. spicata that play a major role in the plant's defense against oxidative stress and are widely known for their potent antioxidant ability (Iordache et al., 2023; Sun & Shahrajabian, 2023; Zengin et al., 2022).

2.2 Flavonoids

Flavonoids are the significant type of polyphenols found in *M. spicata* , which include a number of subclasses such as flavones, flavonols, and flavanones. Apigenin, luteolin, diosmin, hesperidin, didymin, and linarin are among the chemicals that have also been identified. Numerous biological activities, including anti-inflammatory and antioxidant properties, are linked to these flavonoids (El Menyiy et al., 2022; Tavaszi-Sárosi, Sfaxi, Juhász, Radácsi, & Patonay, 2025).

2.3 Lignans

Despite being comparatively less prevalance Lignans add some valu to the total biological activity of *M. Spicata*. Substances like spicatolignan A and spicatolignan B have been found and are thought to have a significant role in its pharmacological profile (Umoyo & Eghianruwa, 2025).

2.4 Essential Oil

Essential oil of *M. spicata* is the most useful part, which is a complex blend of volatile chemicals of which carvone, limonene, pulegone, 1,8-cineole, β-caryophyllene, and menthol are among the main components (Prakash, Chandra, Pant, & Rawat, 2016). The composition of these oils is affected by geographical origin, environmental factors, and extraction methods, which may have an impact on their biological activity as well. This diversity reinforces the need for uniformity in both research and industrial applications of essential oil extracted from *M. spicata*.

2.5 Other Phytochemicals

Various other phytochemicals have also been reported in this plant including carotenoids, tannins.

3. Traditional and Therapeutic Uses

M. spicata has been extensively exploited in traditional medicine, particularly for gastrointestinal tract related disorders, and food uses. It has traditionally been used as herbal tea to treat abdominal pain, gastric inflammation, dyspepsia, and flatulence. Moreover, this plant is recommended in diet for weight management due to its role in bile secretions, ultimately accelerates the fat metabolism. In conventional formulations, this plant demonstrate diuretic properties.

Mint essential oil has been used widely to cure a number of diseases including inflammation associated disorders, muscle soreness, irregular menstruation, neuralgia, and stomatitis (Kazemi, Iraji, Esmaealzadeh, Salehi, & Hashempur, 2025). This plant is also known to have antimicrobial and analgesic properties, hence utilized in topical formulations (Hudz et al., 2023). Furthermore, there long history of mint use for oral healthcare to promote hygiene and fresh breath. Mouthwashes and chewing fresh leaves are two preparations that have been used to treat plaque buildup, gum bleeding, oral health and oral discomfort (Fayed, 2019).

3.1 Gastrointestinal Applications

3.1.1 Irritable Bowel Syndrome

Ethnobotanical study indicates that several parts of *M. spicata* are used in traditional medical systems to treat dysentery, diarrhea, and gastrointestinal distress (Degu, Abebe, & Gemeda, 2022). Essential oils produced from mint, especially from related species like peppermint, have demonstrated efficacy in reducing Irritable Bowel Syndrome (IBS) symptoms (Mahboubi, 2022). Enteric-coated formulations may lessen abdominal pain and enhance bowel function, according to clinical observations (Singh, Sharma, Mishra, Kandalkar, & Jain, 2024).

3.1.2 Indigestion and Flatulence

For a very long time, mint has been used as a carminative. It helps reduce gas buildup and indigestion by increasing bile flow and improving digestive efficiency(Kabiraj & Deshmukh, 2024). Mint extracts have been shown in experiments to affect intestinal motility and lessen spasmodic activity(Budriesi et al., 2024).

4. Anti-inflamatory and Anti-alergic Activities

Bioactive substances with anti-inflammatory and antihistaminic qualities include derivatives of luteolin and rosmarinic acid(Nenni & Karahuseyin, 2024). Furthermore, it has been noted that menthol inhibits the synthesis of inflammatory mediators such as prostaglandins and leukotrienes(Houglum, Harrelson, & Seefeldt, 2024; J. Zhang, Hu, & Wang, 2025). Seeds and essential oils of the plant have been traditionally used to alleviate symptoms of arthritis, possibly due to their anti-inflammatory properties (Ahluwalia & Kaur, 2022).

5. Anti-microbial Activities

Several in vitro studies have demonstrated the antibacterial potential of *M. spicata* extracts and essential oils against a wide range of pathogenic microorganisms(Sameena, Mukherjee, Pramanik, Chatterjee, & Dash, 2024). Agar diffusion and dilution experiments are commonly used to assess these effects and estimate inhibitory doses(Kowalska-Krochmal & Dudek-Wicher, 2021; Wiegand, Hilpert, & Hancock, 2008)

5.1 Other Therapeutic Applications

One of the main ingredients in mint, menthol, helps to remove mucus and functions as a natural decongestant. Cough, colds, asthma, and throat irritation have all been treated

with traditional *M. spicata* formulations(Mittu, Chaturvedi, & Singh, 2025). M. spicata is used traditionally in some areas to control blood glucose levels, indicating a possible function for it in the treatment of diabetes (Abu-Odeh & Talib, 2021). Various medicinal properties of *M. spicata* are shown in **figure 2.**

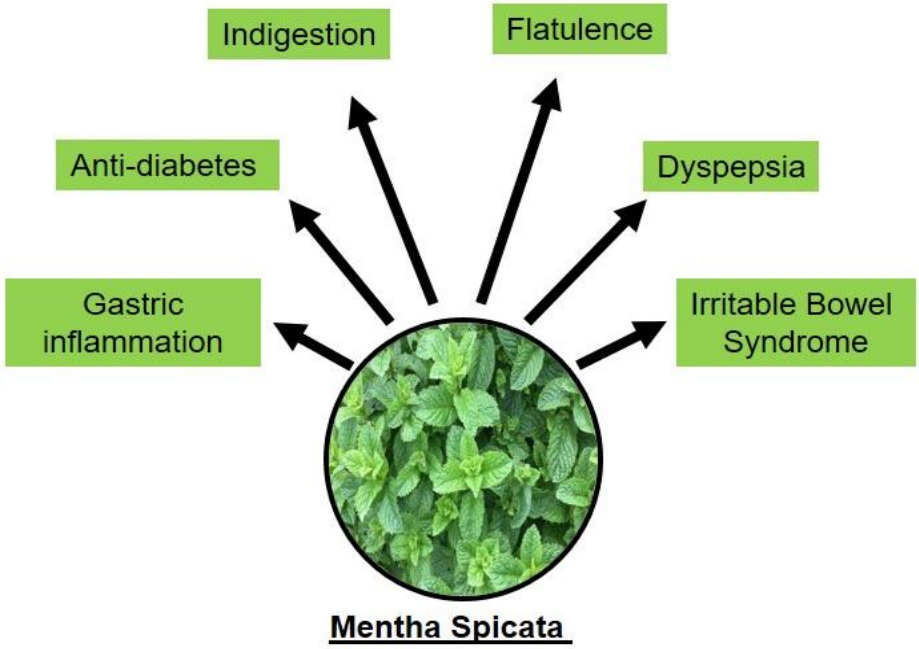

Figure 2. Medicinal properties and health benefits of M. spicata

6. Bridging Traditional Medicine and Modern Science

There is increasing scientific data is being published, which validate traditional use of *M. spicata*. Most importantly, its role as a digestive aid is compatible with its gastro-protective and antispasmodic properties (Julián-Flores et al., 2025). Likewise, mechanism based studies demonstrated inhibition of prominent inflammation related molecules and related molecular pathways which offers its anti-inflammatory use (Li et al., 2024). The implication of integrating ethno-medicinal into evidence-based healthcare approach is shown by this convergence of contemporary pharmacology and traditional knowledge.

M. spicata, or spearmint, is an outstanding example of how modern scientific approach may be utilized with traditional healing approaches to explore bio-active ingredients with therapeutical potential. This plant has been used extensively in traditional medicine for millennia in places such as Europe,the Middle East, and Asia,

especially for the management of inflammation related complications, respiratory, and digestive system associated issues (Ahluwalia & Kaur, 2022). Various bioactivities of leaves including anti-microbial, anti-spasmodic, and carminative haven been documented and this being explored for its significant ethnopharmacological uses (Karageçili & Gülçin, 2025).

The development of molecular research and phytochemical analysis has increased interest in methodically investigating its chemical constituents. These studies have shown that *M. spicata* has a wide range of bioactive components, such as phenolic compounds, flavonoids, terpenoids, and essential oils such as carvone, limonene and other (Ćavar Zeljković et al., 2021; Cirlini et al., 2016; El Menyiy et al., 2022; Pluháčková et al., 2026; Zhang et al., 2022). Many of its traditional uses are now attributed towards the presence of these bioactive chemicals. Prominently, anti-oxidant, anti-microbial, anti-cancer and anti-inflammatory properties(Tafrihi et al., 2021).

According to recent research, the therapeutic actions of *M. spicata* are mediated by a variety of biological processes. Its high phenolic content, which aids in neutralizing reactive oxygen species and fortifies the body's natural antioxidant defense systems, including enzymes like superoxide dismutase and catalase, is primarily responsible for its antioxidant potential (Tang et al., 2024). Its anti-inflammatory impact also includes controlling important signaling pathways including cyclooxygenases and nuclear factor kappa B (NF-κB), which reduces the generation of inflammatory mediators(Kim et al., 2021).

Furthermore, recent studies highlight its function in metabolic regulation, where it may modify lipid metabolism and improve insulin responsiveness, indicating potential benefits in conditions like diabetes and obesity (Winiarska et al., 2026). Additionally, by reducing oxidative stress and inflammatory responses in brain tissues, *M. spicata* has shown neuro-protective potential that may be crucial for controlling or avoiding neurodegenerative disorders (Avola, Furnari, Graziano, Russo, & Cardile, 2024; Hanafy, Burrows, Prenzler, & Hill, 2020). *M. spicata* has long been used to cure illnesses, and extracts and essential oils made from it have shown antibacterial action against a variety of bacterial and fungal diseases (Avola et al., 2024). Anticancer potential of *M. spicata* has also attracted a lot of attention because its phytochemicals have been shown to

promote programmed cell death, prevent tumor cell formation, and disrupt pathways related with the progression of cancer (Alsaraf, Hadi, Akhtar, & Khan, 2021). These effects are frequently associated with the regulation of molecular targets such p53, caspases, and mitogen-activated protein kinases (MAPKs), suggesting a potential role for supportive therapy and cancer prevention(Ali et al., 2025; Chang, Soo, Chen, & Shyur, 2019).

Additionally, *M. spicata* is increasingly being used in nutraceuticals, medicines, and functional foods (Arshad et al., 2023). However, despite these encouraging outcomes, a number of problems still need to be fixed before it may reach its full therapeutic potential. These include variations in phytochemical composition, the lack of standardized extraction methods, issues with bioavailability, and the need for the right dosage. Moreover, more comprehensive human clinical trials are needed to confirm preclinical results and develop reliable therapy recommendations.

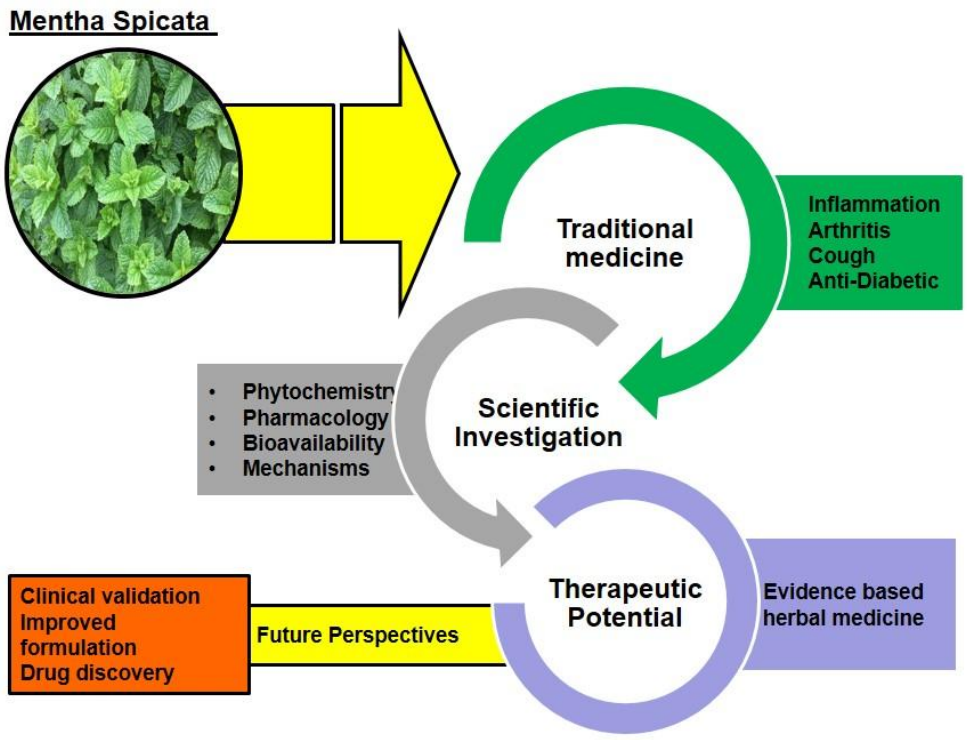

Figure 3. Bridging science and tradition: a model of therapeutic potential of M. spicata.

Over all, *M. spicata* serves as an excellent example of how modern science and traditional medicine may coexist. Because of its many targeted biological effects and

broad therapeutic potential, it is a promising choice for future medicinal applications. Further research in this area will not only increase our understanding of plant-based drugs but also contribute to the development of safer and more durable therapeutic strategies within the framework of integrative medicine.

7. Clinical Evidence and Limitations

Despite promising findings, several limitations persist such as most studies are based on *in vitro* experiments or animal models, human clinical trials are limited and variability exists in extraction methods, dosage, and bioavailability of bioactive components of this plant. The addressing of these research directions would be useful in bridging the gap of traditional knowledge and clinical approach, facilitating effective and safe use of *M. spicata* as a bio-functional sources.

Concluding Remarks

Based on existing knowledge and pharmacological properties, *M. spicata* has emerged as al important plant with noteworthy biological properties. Reservoir of phytochemicals and range of pharmacological properties offers a scientific basis for its traditional and industrial utilization. However, to bridge the gap between traditional use and clinical application, further detailed mechanism based *in vivo* studies on human, standardization, are needed. Generally, this plant holds significance not only as a functional food but also as a potential source of novel therapeutic agents for the food and pharmaceutical industries.

Declarations

Author Contributions

All authors made substantial contributions for this study and approved the final draft for submission.

Ethics Approval and Consent to Participate

Not applicable

Consent for Publication

All authors consented for publication of the manuscript.

Availability of Data and Material

All data is provided in the manuscript

Competing Interests

Not applicable

Funding

There is no any specific funding was received for this study

AI Declaration

AI tools (ChatGPT, Meta) were used for language editing. All scientific content was written and verified by the authors.

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