Int. J. Sci. R. Tech., 2025 2(4)
A Multidisciplinary peer-reviewed Journal
www.ijsrtjournal.com [ISSN: 2394-7063]

Original Article

Mentha: The Remarkable Herbal with Endless Healing and Culinary Benefits

Siddhi Sonawane*, Sakshi Sonawane

Department of pharmacognosy, K. V. N. Naik SP Sanstha's, Institute of pharmaceutical Education and Research, Canada Corner, Nashik, 422002, Maharashtra, India

ABSTRACT

The genus *Mentha*, a prominent member of the Lamiaceae family, encompasses a diverse group of aromatic herbs renowned for their multifaceted therapeutic and culinary applications. Traditionally utilised in various cultural healing systems, *Mentha* species have gained significant scientific attention owing to their rich phytochemical profiles and diverse pharmacological properties. This review explores the wide-ranging biological activities of *Mentha*, including antioxidant, antimicrobial, anti-inflammatory, anticancer, neuroprotective, and gastroprotective effects. These effects are largely attributed to essential oils, flavonoids, phenolic acids, and terpenoids found abundantly in the plant. Moreover, the paper highlights recent advances in clinical research, potential adverse effects, and commercial applications in pharmaceuticals, food preservation, and cosmetics. Despite growing evidence of their therapeutic promise, further clinical trials are warranted to validate their efficacy and establish safety profiles for standardised use. This review aims to consolidate current knowledge and encourage the integration of *Mentha*-based remedies into evidence-based therapeutic practices.

Keywords: *Mentha* species, essential oils, phytochemical constituents, therapeutic applications, antioxidant and antimicrobial activity

INTRODUCTION

The genus *Mentha*, commonly known as mint, is a well-established group of perennial herbs in the Lamiaceae family, encompassing an estimated 25 to 30 species. Notable representatives include *Mentha piperita* (peppermint), *Mentha spicata* (spearmint), and *Mentha arvensis* (wild mint). These aromatic plants have long been cultivated and valued for their versatility in traditional medicine, culinary practices, and the fragrance industry. *Mentha* species are characterised by their high content of essential oils and a diverse array of bioactive compounds such as phenolic acids (e.g., rosmarinic and caffeic acid), flavonoids (e.g., luteolin and apigenin), and terpenoids (e.g., menthol, menthone, and pulegone). These constituents contribute to the genus's wide spectrum of biological activities, many of which are supported by in vitro and in vivo studies [1]. Recent scientific investigations have expanded our understanding of *Mentha*'s pharmacological potential, uncovering promising roles in managing oxidative stress, inflammation, microbial infections, cancer progression, and neurodegenerative disorders. The pharmacodynamic effects are often synergistic, involving complex interactions between its numerous phytochemicals. The broad applicability of *Mentha* in pharmaceuticals, food technology, and cosmeceuticals underscores its importance in both modern and traditional health systems [2]. This review aims to provide a comprehensive overview of the chemical constituents, therapeutic applications, and clinical evidence supporting the use of *Mentha* species, while also addressing safety concerns and future research directions.

2. Chemical Composition of Mentha

The pharmacological activities of Mentha species are attributed to their complex chemical composition. The primary bioactive compounds include:

Essential oils: Menthol, menthone, limonene, and carvone.

Relevant conflicts of interest/financial disclosures: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Phenolic compounds: Rosmarinic acid, caffeic acid, and flavonoids such as luteolin and apigenin.

Terpenoids: Pulegone, piperitone, and menthofuran [3].

These compounds exhibit synergistic effects, enhancing the therapeutic potential of Mentha species.

3. Biological Activities of Mentha

3.1 Antioxidant Properties

Mentha species are renowned for their potent antioxidant activity, which is primarily attributed to their phenolic content. These compounds scavenge free radicals, reduce oxidative stress, and protect cellular components from damage [4]. For instance, Mentha piperita extract has been shown to inhibit lipid peroxidation and enhance the activity of antioxidant enzymes such as superoxide dismutase (SOD) and glutathione peroxidase (GPx) [5].

3.2 Antimicrobial Activity

The essential oils of Mentha exhibit broad-spectrum antimicrobial activity against bacteria, fungi, and viruses. Menthol and carvacrol are particularly effective against pathogens such as Escherichia coli, Staphylococcus aureus, and Candida albicans [6]. The mechanism involves disruption of microbial cell membranes and inhibition of biofilm formation [7].

3.3 Anti-inflammatory Effects

Mentha species possess significant anti-inflammatory properties, mediated by the inhibition of pro-inflammatory cytokines and enzymes such as cyclooxygenase-2 (COX-2) and lipoxygenase (LOX) [8]. Rosmarinic acid, a major constituent, has been shown to reduce inflammation in animal models of arthritis and colitis [9].

3.4 Anticancer Potential

Emerging evidence suggests that Mentha extracts exhibit anticancer activity by inducing apoptosis and inhibiting cell proliferation. For example, Mentha spicata essential oil has been reported to suppress the growth of breast cancer cells through the activation of caspase-3 and downregulation of Bcl-2 (10). Additionally, the antioxidant properties of Mentha contribute to its chemopreventive effects [11].

3.5 Neuroprotective Effects

Mentha species have shown promise in protecting against neurodegenerative diseases. The essential oils and phenolic compounds exert neuroprotective effects by reducing oxidative stress, inhibiting acetylcholinesterase (AChE), and modulating neurotransmitter levels [12]. Mentha piperita has been studied for its potential in alleviating symptoms of Alzheimer's disease [13].

3.6 Gastroprotective and Hepatoprotective Activities

Mentha extracts have been traditionally used to treat gastrointestinal disorders. They exhibit gastroprotective effects by reducing gastric acid secretion and enhancing mucosal defense mechanisms [14]. Additionally, Mentha species protect the liver from damage induced by toxins and oxidative stress [15].

3.7 Analgesic and Antispasmodic Effects

The essential oils of Mentha are widely used for their analgesic and antispasmodic properties. Menthol, a key component, acts as a natural analgesic by activating transient receptor potential (TRP) channels, providing relief from pain and muscle spasms [16].

APPLICATIONS OF MENTHA

The diverse biological activities of Mentha species have led to their widespread use in various industries:

Pharmaceuticals: Development of drugs for inflammation, infections, and neurodegenerative diseases (17).

Food industry: Use as natural preservatives and flavoring agents (18).

Cosmetics: Incorporation into skincare products for their antioxidant and antimicrobial properties [19].

5. Mentha Species

The genus *Mentha* comprises several species and hybrids, many of which are widely cultivated for their unique aroma and medicinal value. Below are some of the most pharmacologically and commercially significant species:

1. Mentha piperita (Peppermint)

A natural hybrid between *Mentha spicata* and *Mentha aquatica*, *M. piperita* is perhaps the most widely studied species. It is rich in menthol, menthone, and menthyl acetate, compounds known for their cooling sensation and therapeutic effects. Peppermint is widely used for gastrointestinal discomfort, headache relief, and as a flavouring agent.

2. Mentha spicata (Spearmint)

Spearmint contains carvone as its major constituent and is commonly used for its milder flavour and lower menthol content. It is often incorporated into dental products, culinary preparations, and herbal teas. Pharmacologically, it shows antioxidant, anti-androgenic, and antimicrobial properties.

3. Mentha arvensis (Field Mint or Wild Mint)

Native to Asia and known for its high menthol content, *M. arvensis* is frequently utilised in the commercial production of menthol crystals. It also exhibits anti-inflammatory and analgesic activities and is used traditionally for treating colds, coughs, and fevers.

4. Mentha longifolia (Horse Mint)

This species has a long history of medicinal use in European and Middle Eastern traditional medicine, particularly for gastrointestinal and respiratory ailments. It contains pulegone and 1,8-cineole and is less commonly used due to concerns over toxicity at high doses.

5. Mentha pulegium (Pennyroyal)

Known for its strong aroma and insect-repellent properties, *M. pulegium* contains significant amounts of pulegone, which has been associated with hepatotoxicity. Its use is restricted in many countries, particularly in internal medicinal preparations. Each species possesses a distinct phytochemical profile, resulting in unique therapeutic applications and safety considerations. Understanding the phytochemical diversity among *Mentha* species is crucial for their safe and effective use in both clinical and commercial contexts [20-22].

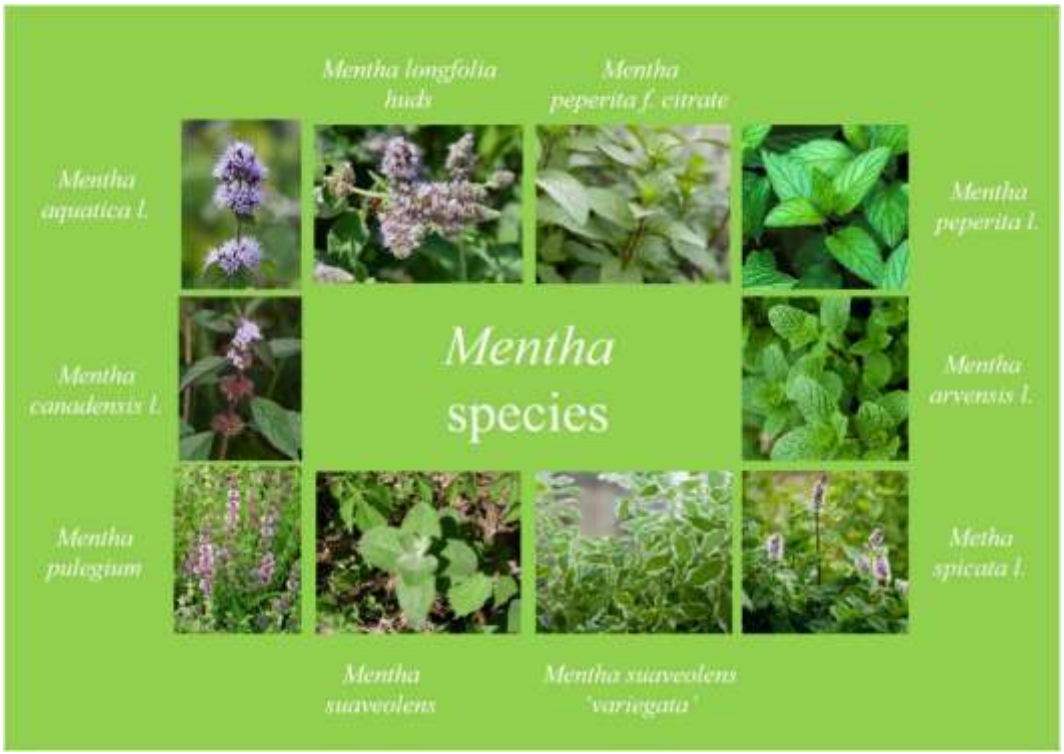

Figure 1 Mentha Species

6. Clinical Trials

There is limited information regarding clinical trials involving Mentha species in human subjects [23], with only two studies reporting on their use in cancer. The first study was a randomized, double-blind clinical trial involving 200 participants, aimed at assessing the effectiveness of volatile oils derived from Mentha piperita and Mentha spicata in preventing chemotherapy-induced nausea and vomiting (CINV). Participants were divided into four groups: control, placebo, M. piperita, and M. spicata. The findings indicated a notable decrease in both the severity and frequency of emetic episodes within the initial 24 hours for those treated with M. spicata and M. piperita, compared to the control group ($p < 0.05$), with no reported adverse effects. Additionally, the use of essential oils led to a reduction in treatment costs [24]. The second study was another randomized, double-blind, placebo-controlled trial conducted with 60 patients to assess the effects of Mentha piperita (and Matricaria recutita) on oral mucositis (OM) in individuals undergoing hematopoietic stem cell transplantation (HSCT) [25]. OM is a prevalent side effect of intensive chemotherapy in these patients. Those who utilized an herbal mouthwash three times a day for one week prior to HSCT experienced considerable improvements in pain intensity ($p = 0.009$), dryness ($p = 0.04$), and dysphagia ($p = 0.009$), indicating a potential therapeutic benefit of M. piperita in managing OM.

7. Adverse Effects of Mentha Species

While medicinal plants like Mentha species are generally regarded as safe, they are not without potential side effects, which can occasionally be serious. Additionally, individuals with sensitivities may experience allergic reactions to both natural and synthetic substances. Due to the absence of chronic toxicity research in humans, reports of toxicity concerning Mentha species are limited. Nevertheless, studies indicate that there have been no adverse effects observed from consuming 0.24 mL of pure M. spicata essential oil daily for three consecutive weeks in two separate clinical trials. [26] The leaves of Mentha spicata are known to cause contact allergies, such as contact cheilitis, when its essential oil is used as a flavoring in toothpaste. [27] Moreover, Mentha piperita essential oil (MPEO) has been linked to negative effects including vomiting, headaches, flushing, heartburn, and nausea. Excessive consumption of Mentha piperita and spearmint tea may lead to iron deficiency and anemia, with carvone and limonene identified as significant allergens. Research by Gürbüz indicated that pulegone, found in low concentrations in Mentha piperita oil extracts, may be hepatotoxic, with Douros et al. also noting potential liver damage caused by M. piperita. Additional studies have suggested that menthol and pulegone could possess toxic properties, particularly identifying pulegone and its metabolite menthofuran as hepatotoxic agents in Mentha pulegium, which are also present in smaller amounts in Mentha piperita. [28]

CONCLUSION

The genus Mentha offers a treasure trove of bioactive compounds with immense therapeutic potential. While its antioxidant properties are well-established, recent research highlights its role in addressing a wide range of health conditions. Future studies should focus on elucidating the mechanisms of action, optimizing extraction techniques, and conducting clinical trials to validate the efficacy and safety of Mentha-based therapies. The integration of traditional knowledge with modern scientific approaches will further enhance the utilization of this remarkable genus

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HOW TO CITE: Siddhi Sonawane*, Sakshi Sonawane, Mentha: The Remarkable Herbal with Endless Healing and Culinary Benefits, Int. J. Sci. R. Tech., 2025, 2 (4), 530-534. https://doi.org/10.5281/zenodo.15263715