

Chapter 12

Peppermint Essential Oil: A Tropical Remedy

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ABSTRACT

Essential oils are known to be the concentrated oils, containing substantial compounds due to which a plant takes its particular aroma and flavor. Peppermint oil is also one of the many significant essential oils. Peppermint herb also gains its popularity as it is a natural cross between two different types of mints. Its occurrence expands to many origins including the entire regions of Asia, North America and Europe. The leaves of peppermint are used for many purposes but its oil stands at another level in therapeutics. Peppermint oil is highly effective against gastrointestinal complexities. The use of this oil is quite well known for irritable bowel syndrome (IBS), but it also treats several other medical conditions including digestion, bloating, fatigue, anxiety, memory and spasms. The role of peppermint essential oil as an anti-inflammatory and antimicrobial agent has also been unveiled. The broad spectrum of usage of this oil is given to its efficient pharmacodynamics. It can be used by numerous ways considering the proper way of application in accordance with the suitability and safety of the applicant. A significant amount of research work has been done to disclose the tendencies of this amazing oil but still there is a lot to discover.

KEYWORDS

Essential oils, Peppermint oil, Anti-inflammatory, Gastrointestinal, Irritable bowel syndrome.

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INTRODUCTION

Essential oils (EOs) are basically a concoction of volatile oils extracted from natural aromatic plants (Sattayakhom et al., 2023). Since the ancient times of various cultures including Egyptians, Persians, Greeks, and Chinese, essential oils have been used as a common remedy throughout the world. Till this day, EOs are being used in traditional as well as complimentary medicines, massage therapies, aromatherapy, perfumes, cosmetics, and food industries (Lr, 2021). Some common plants from which essential oils are extracted include cinnamon, basil, eucalyptus, oregano, thyme, sage, camphor tree, peppermint, lavender, lemongrass, and others (Sakkas and Papadopoulou, 2017; Yanakiev, 2020; Lee et al., 2022). EOs extracted from citrus fruits have a great significance as well in the food, beverage, and perfume, industries, in addition to being used in aromatherapy and as potent medicinal agents (Dosoky and Setzer, 2018). These vital oils are also found in a range of other products such as food flavoring, lotions, soaps, shampoos, colognes, hair styling products, laundry detergents, as well as in several insect repellents (Ramsey et al., 2020). Over the past decades, essential oils have greatly risen in their popularity. This might be due to the fact that EOs extracted from numerous plant species contain over 200 constituents. The application of such oils as anti-inflammatory anticancer, antioxidant, antimicrobial, anti-viral, antiparasitic, antiaging, and neuroprotective agents, in addition to other pharmacological responses of nervous system thus leading to anxiolytic, sedative, antidepressant, and anticonvulsant effects are due to their effective properties (Aziz et al., 2018). Currently, the clinical study data available regarding the immunomodulatory effects of essential oils is not enough (Sandner et al., 2020). However, different studies have confirmed that EOs interfere with crucial biological processes via interacting certain biological targets, at both cellular and multicellular levels (de Sousa et al., 2023). Therefore, the therapeutic tendencies of several essential oils are enough to make them a substantial ingredient in novel drugs and modern products.

Background of Peppermint Essential Oil (PEO)

Occurrence

Over the decades, certain plants have made a great mark in the world history due to their remarkable tendencies (Diniz do Nascimento et al., 2020). One of such plants is peppermint. Peppermint (*mentha*), is a genus belonging to the

taxonomic family Lamiaceae (*Mentha piperita* L.) and a cross between two different types of mints (spearmint and water mint) (Fig. 1). It is broadly distributed throughout the temperate regions of the world including Asia, specifically India, Europe, United States, and Mediterranean countries because of their distinct aroma and commercial value (Mahendran and Rahman, 2020). Peppermint is generally a perennial, strongly scented, and glabrous herb. It contains innumerable constituents which are further categorized as PEO and non-essential components (Zhao et al., 2022).

Table 1: Pharmacological significance of some common essential oil extracting plants

Sr. no.	Plant name	Scientific name	Biological activities	References
1	Cinnamon	<i>Cinnamomum verum</i>	Anti-inflammatory, antimicrobial, anticoagulant, analgesic, anticancer	(Bhattarai et al., 2021)
2	Basil	<i>Ocimum basilicum</i>	Antifungal, antibacterial, antiparasitic, antioxidant	(Sakkas and Papadopoulou, 2017; Tavallali et al., 2019)
3	Eucalyptus	<i>Eucalyptus cinerea</i>	Antioxidant, antimicrobial, antiseptic, wound healing, insecticidal, nematicidal, acaricidal	(Dhakad et al., 2018)
4	Peppermint	<i>Mentha piperita</i> L.	Anti-inflammatory, antimicrobial, effective against gastrointestinal disorders, anti-spasmodic activity, antidepressive	(Kehili et al., 2020; Scarpellini et al., 2023; Matsueda et al., 2024)
5	Sage	<i>Salvia officinalis</i>	Antimicrobial, anti-inflammatory, anticancer	(Poulios et al., 2020)
6	Caraway	<i>Carum carvi</i>	Anti-tumor, antimicrobial, antioxidant	(Aly et al., 2023)
7	Lavender	<i>Lavandula angustifolia</i>	Antifungal, antibacterial, antidepressive, sedative	(Cavanagh and Wilkinson, 2002)
8	Lemongrass	<i>Cymbopogon citratus</i>	Antioxidant, antifungal, antibiofilm, hypersensitive potential	(Rhimi et al., 2022)
9	Camphor tree	<i>Cinnamomum camphora</i>	Antioxidant, anti-inflammatory, allelopathic, insecticidal, algicidal	(Lee et al., 2022)
10	Rosemary	<i>Rosmarinus officinalis</i>	Antioxidant, antitumor, anti-inflammatory, antimicrobial	(de Oliveira et al., 2019)

Cultivation Zone

Peppermint is indeed one of the most crucial aromatic crops that is cultivated around the world for the sake of its EOs (Ghotbi-Ravandi et al., 2023). This plant is also widely cultivated in India. This vital plant is expansively cultivated in Himalayan hills, Uttar Pradesh, Haryana, Bihar and Punjab. Out of these regions, Uttar Pradesh is known to be the largest producing state of the country, thus contributing about 80% to 90% of the total production, It is then followed by the regions of Punjab, Bihar, Haryana, and Himachal Pradesh (Muthukumar, 2013).



A



B

Fig. 1: Peppermint plant (A) and peppermint essential oil (B)

Therapeutic Efficacy of Peppermint Oil

PEO has long been used to treat innumerable ailments. This oil is specifically known for its gastrointestinal problems, but it also shows several curative abilities in the diseases including abdominal pain, nausea, irritable bowel syndrome, anti-inflammatory activity, antioxidant activity, anti-microbial effects, in addition to the modulation of psychosocial distress and fatigue (Chumpitazi et al., 2018; Wińska et al., 2019; Scarpellini et al., 2023). Some of the basic therapeutic properties of peppermint essential oil have been described (Fig. 2).



Fig. 2: Health benefits of peppermint essential oil

An Anti-inflammatory and Antimicrobial Agent

PEO is a promising anti-inflammatory agent. About 23 compounds have been identified in this oil, with the core chemical component being menthol (approximately 53.29%), thus making it an effective anti-inflammatory and wound healing oil (Kehili et al., 2020). Various studies have showed that such EOs reduce inflammation *in vitro* by inhibiting the production of pro-inflammatory cytokines, including IL-6 and TNF- α , and also by *in vivo* methods. Therefore, herbal preparations of peppermint are potent cosmetic and medicinal preparations in case of their use in different products with anti-inflammatory, wound-healing and antimicrobial properties (Hudz et al., 2023).

The widespread use of peppermint is generally related to its pleasant minty flavor and a feeling of coolness that it gives, however, it is supposed that an elevated menthol content in peppermint oil shows increased antimicrobial activity (Orchard and van Vuuren, 2017; Wińska et al., 2019). More recent data involving peppermint oil demonstrate its antimicrobial effects and a capability to downregulate inflammation. Antimicrobial properties of peppermint oil have been determined by the application on various microorganisms by adding in variable amounts to the film samples made of different components. The biodegradable films thus obtained have an increased potential for practice in different fields, especially in food packaging industries (Koşarsoy Ağçeli et al., 2022).

Settles IBS and Gastric Irritation

Around the world, herbal therapy containing PEO is broadly used for patients suffering with irritable bowel syndrome (IBS). This oil is an effective and safe remedy for gastroenterology, thereby having promising scientific standpoints and rapidly escalating practice in clinical trials. PEO as well as its constituents exert anti-spasmodic and muscle relaxant effects on the stomach, lower esophageal sphincter, and duodenum, in addition to large bowel. Moreover, this oil has tendency to modulate visceral sensitivity. These effects suggest the use of peppermint oil for better endoscopic performance and also for IBS (Scarpellini et al., 2023).

As various mechanisms of action described for PEO include relaxation of smooth muscles; modulation of visceral sensitivity; anti-inflammatory activity, anti-microbial effects, and modulation of psychosocial distress, placebo controlled data significantly support the use of this oil in IBS, childhood functional abdominal pain, gastric irritation, postoperative nausea, and functional dyspepsia (Matsueda et al., 2024).

Supports Digestion

Since ancient times, PEO has been used to cure many digestive disorders as it helps to improve digestion (Kligler and Chaudhary, 2007). Drinking a glass of water mixed with few drops of this oil after meals reduce flatulence and helps

digestion by relaxing the muscles. It is mainly used to treat issues in the upper digestive system like cramps, indigestion, and nausea for many people (Zhao et al., 2022). There are several evidences showing that PEO exerts effective actions against many gut diseases. It improves stomach and intestinal movements (Matsueda et al., 2024) and relieves feelings of fullness and discomfort, especially in case of functional dyspepsia (Acker and Cash, 2017).

Reduces Gastrointestinal Spasms

PEO has been proved as effective smooth muscle relaxant, and due to this property peppermint oil delivered through enema has been examined in two trials to help ease symptoms of gastrointestinal spasms during different GI procedures like flexible sigmoidoscopy, colonoscopy, administration of barium enema etc. (Asao et al., 2003). During procedure like outpatient flexible sigmoidoscopy, traditional practices cause many problems. Attention has been drawn to the use of peppermint oil as it is a safe substance to produce smooth muscle relaxation (Scarpellini et al., 2023).

Relieves Headaches

Recent research has uncovered specific ways in which PEO can relieve pain. When it is applied directly to the skin, it creates a long-lasting cooling sensation by steric alteration of calcium channels of the cold receptor as well as antagonizes serotonin-induced contraction (Chumpitazi et al., 2018). Moreover, applying PEO to the skin of the forehead increases blood flow, as measured by laser doppler (Kehili et al., 2020).

Tension-type headaches are the most common type of headaches. Solutions containing about 10% peppermint oil in alcohol have been approved for treating tension-type headache in adults and children over 6 years age (Mahendran and Rahman, 2020).

Fight Fatigue and Anxiety

In a recent research study using mice as a model, it has been concluded that injecting PEO into mice can make them walk more, and menthol might help boost energy by stimulating the nervous system and lowering lactate level in the blood (McKay and Blumberg, 2006). It is expected that PEO might help healthy people breathe better by increasing lung capacity, giving their brains more oxygen and reducing tiredness and anxiety (Li et al., 2017). Moreover, PEO fights against anxiety by increasing body alertness and improving mental refreshment. PEO can relieve anxiety, reduce pain and impulse, modify the olfactory pathway of the brain, as well as promote sleep quality, contributing to its antifatigue activity (Mahdavi et al., 2021).

Improves Memory

PEO is noted to protect brain and nerves. Menthol and menthone in PEO are neuroactive substances. They can block cholinesterase and attach to nicotine and also GABAA receptors, making neurons more active. Using PEO regularly can really help reduce mental tiredness (Lv et al., 2022).

Additionally, PEO has neuroprotective property. Peppermint aroma has been shown to improve tasks related to attentional processes, working memory, virtual recognition memory, as well as visual-motor response (Fang et al., 2019). Administering drugs through the nose to the brain is a promising method because it bypasses the blood-brain barrier and increases the bioavailability for the treatment of different brain diseases (Kiran Vaka and Narasimha Murthy, 2010). Besides, PEO can ease bronchospasm, by boosting nitric oxide production and opening of K⁺ channel (de Sousa et al., 2010).

Pharmacodynamics of Peppermint Oil

The key pharmacodynamic effect of PEO related to the gastrointestinal tract is a dose-related antispasmodic impact on its smooth musculature, given to the interference of menthol component with calcium moving across the cell membrane.

Mode of Action

The numerous preclinical investigations impart light on the possible applicability of peppermint oil to gastrointestinal and other problems and the physiology of the gastrointestinal tract as shown in the Fig. 3.

- a) The core mechanism of action of PEO in functional gastrointestinal diseases is thought to be its antispasmodic properties. However, it is unclear how much peppermint oil gives therapeutic benefits (Kearns et al., 2015).
- b) PEO relaxes smooth muscles. It inhibits calcium channels in guinea pig ileal smooth muscles in vitro. Menthol has been shown to cause circular smooth muscle relaxation in the human colon by directly preventing contractility by blocking Ca²⁺ inflow via sarcolemma L-type Ca²⁺ channels (Amato et al., 2014).
- c) The enteric nervous system may potentially be directly impacted by this oil. It has been demonstrated that menthol functions via transient receptor potential cation channel to generate membrane potential depolarization in a concentration-dependent manner (Kim et al., 2016).
- d) Despite being widely recognized topical analgesic, when taken orally or intraperitoneally, PEO can reduce visceral discomfort (Adam et al., 2006). The transient receptor potential cation channel superfamily's TRPM8 and/or TRPA1

receptors, which are found in the gut, are thought to be involved in the alleviation of visceral discomfort (Harrington et al., 2011).

e) Menthol inhibits human monocytes' ability to produce inflammatory mediators in vitro. Peppermint oil's anti-inflammatory properties are thought to be mediated because its activation reduces the symptoms of chemically induced colitis (Ramachandran et al., 2013). Anti-inflammatory property of this oil is also achieved by involvement of certain cytokines.

f) In healthy adults, the impact of PEO upon esophageal function has been investigated. It reduces esophageal spasms utilizing double contrast esophageal barium tests (Mizuno et al., 2006).

g) According to hydrogen breath tests, it has been discovered that this oil slows down orocecal transit (Goerg and Spilker, 2003). Using PEO solution combined with barium reduces intestinal spasm during barium enema treatments (Asao et al., 2003). Peppermint oil has been successfully employed for its anti-spasmodic qualities during ERCP operations as well as upper GI endoscopies and colonoscopies.

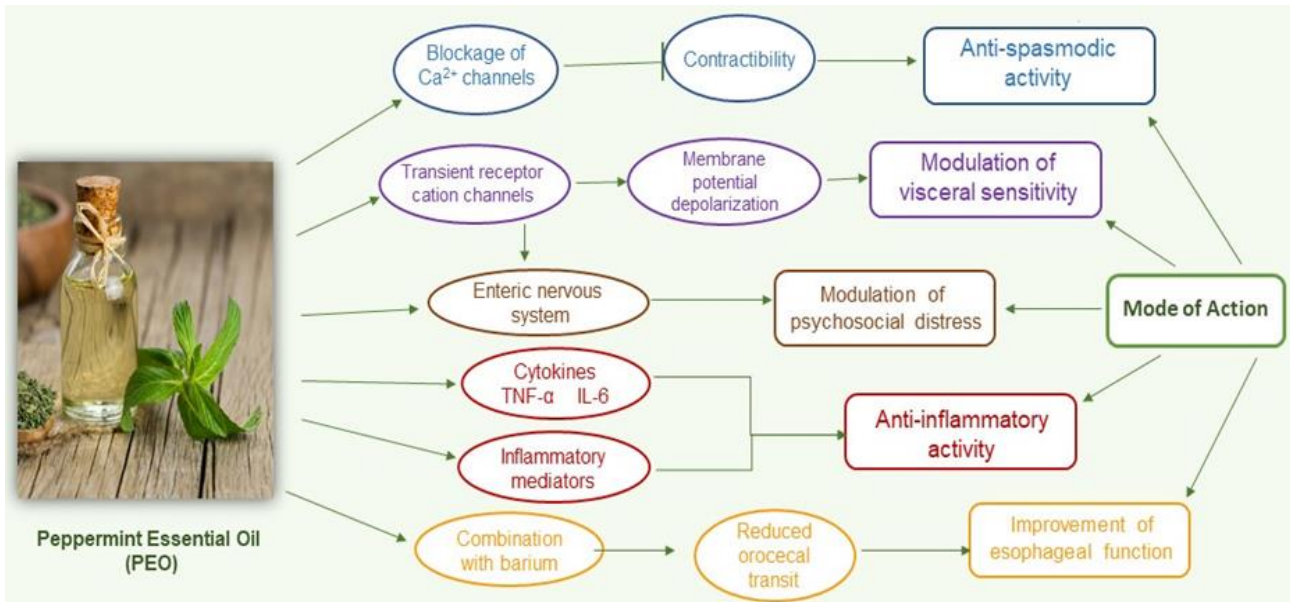


Fig. 3: Mode of action of PEO in various ailments

Combination with other Oils

A combination of peppermint oil and caraway oil is of special interest in FD and IBS since the documented mechanistic investigations reveal a synergistic and additive impact of the combination against the sensation of abdominal discomfort and bloating by a multitarget approach (Alliger et al., 2020; Krueger et al., 2020; Zhang et al., 2021). Both caraway and peppermint oil have been examined alone and in combination using a post-inflammatory visceral hyperalgesia paradigm. When used in combination, the sensitivity to pain was significantly reduced (Adam et al., 2006). Using the disk diffusion method, the antibacterial activity of peppermint, lavender, and their blend have also been evaluated (Park and Yoon, 2018). Because of the antibacterial and antiviral properties, peppermint, eucalyptus, and rosemary oils have also been believed to work in concert to treat certain infectious disorders of both the upper and lower respiratory tracts (Köteles et al., 2018).

Various Ways to use Peppermint Oil

There are various ways to use peppermint essential oils which are described as:

Applied Topically on Skin

One way to use PEO is by its direct application on the skin. Menthol, a component of peppermint plant and known to be effective in external use, is the main ingredient in many ointments and provides a little analgesic and cooling effect (Kligler and Chaudhary, 2007). It has been observed that menthol alters the Ca²⁺ currents in neuronal membranes, hence increasing the susceptibility of cutaneous cold receptors and can be considered as the most efficient penetration enhancer (Aqil et al., 2007). About 3% peppermint oil allows hair growth by promoting the conservation of vascularization of hair dermal papilla, thus contributing to the improvement of hair growth (Oh et al., 2014).

Applied Intranasally

PEO is also effective when it is applied intranasally. The therapeutic agents administered this way are regarded to reach the brain through the olfactory pathway. However, this pathway is associated with a primary restricting element, the olfactory epithelial barrier. A natural barrier modulating agent, peppermint oil, has been found to enhance the delivery of

therapeutic agents via secure and transient permeabilization of the olfactory epithelium. It is most likely that peppermint oil opens the tight junction to enhance the delivery of therapeutic factors (Vaka and Murthy, 2010).

Oral Ingestion (Capsule or tablet form)

It is very well known that the use of peppermint oil is a common method to treat IBS (Nee et al., 2021). ZO-Y60 is an enteric-coated pill, the core factor of which is peppermint oil extracted from the peppermint plant (Asgarshirazi et al., 2015). Peppermint oil ZO-Y60 exerts notable impacts on IBS, regardless of its subtypes (Matsueda et al., 2024). Colpermin is also an enteric coated peppermint oil formulation designed to delay peppermint oil release, which seems beneficial in the treatment of irritable bowel/spastic colon syndrome (Khanna et al., 2014). Oral administration of PEO can also prevent xylene caused intestinal infection (From the American Association of Neurological Surgeons (AANS), American Society of Neuroradiology (ASNR), Cardiovascular and Interventional Radiology Society of Europe (CIRSE), Canadian Interventional Radiology Association (CIRA), Congress of Neurological Surgeons (CNS), European Society of Minimally Invasive Neurological Therapy (ESMINT), European Society of Neuroradiology (ESNR), European Stroke Organization (ESO), Society for Cardiovascular Angiography and Interventions (SCAI), Society of Interventional Radiology (SIR), Society of NeuroInterventional Surgery (SNIS), and World Stroke Organization (WSO) et al., 2018). While injected directly into the large intestine during colonoscopy, peppermint oil reduces colonic spasm caused by the process and decreases colonic motility.

Diffused in the form of Essential Oils

Peppermint diffused in the form of essential oil, consisting mainly of menthol, menthone, neomenthol and isomenthone, is a combination of biologically active secondary metabolites with numerous properties (Zhao et al., 2022). This is the most crucial and potent method to acquire benefits of peppermint plant. It can pharmacologically defend gastrointestinal, liver, kidney, skin, breathing, brain and nervous structures, and also reduces viral infectivity (Civitelli et al., 2014). Colorectal cancer cells proliferation is notably inhibited by PEO, by inducing apoptosis and thus arresting cell cycle at different phases (G1/G0 and G2/M) (Yi and Wetzstein, 2011). Urolithiasis can also be treated by crystal-inhibiting, antioxidant, anti-inflammatory and diuretic effects by PEO (Ullah et al., 2014). Mental fatigue is also known to be eliminated by the continuous administration of PEO.

Repercussions of Peppermint Oil

The common repercussions of peppermint oil are given as:

- i. There is a long history of using peppermint oil and also leaves to treat stomach issues.
- ii. The impact of this oil on chemotherapy-induced nausea, vomiting, retching, and frequency has also been assessed in some cancer patients (Efe Ertürk and Taşçı, 2021).
- iii. The effects of targeted ileocolonic release of PEO and the safety and effectiveness of small-intestinal release of peppermint oil in IBS patients has been confirmed (Matsueda et al., 2024).
- iv. Additionally, it is thought to be helpful in the treatment of nerve illnesses and mental exhaustion.
- v. The psychological effects of peppermint oil (EO) on animals have also been observed.
- vi. The invigorating effects of peppermint have been studied as an objective measure to treat daytime drowsiness (Norrish and Dwyer, 2005).
- vii. In spite of a broad range of health benefits of peppermint oil, few side effects are also taken under consideration such as possibility of nausea, heartburn, and dry mouth if PEO is taken orally.
- viii. In rare cases, PEO has a slight possibility to cause some allergic reactions as well. However, a broad range of therapeutic efficiencies of this oil is responsible for its escalating popularity.

Conclusion

This chapter provides a comprehensive analysis of the biological activities of peppermint plant, specifically peppermint essential oil. It is a well-known oil regarding its curing activities in IBS, gastric irritation and digestive problems. However, it has been illustrated that therapeutic efficacy and pharmacological potential of PEO is not just limited to gastrointestinal issues, but also addresses several other ailments including cancer. A number of ways by which this oil can be used is just remarkable, as each type of the practice highlights its curing efficiency in a whole different way. This is one of the reasons due to which pharmacodynamics of peppermint oil is attaining a great deal of attention in medical practices. This escalating popularity is also because it gives multiple advantages with comparatively less side effects. Therefore, if the benefits of PEO, either alone or in synergistic way, are utilized to an advanced extent, it would be a positive step toward modern therapeutics and natural drug discovery practices.

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