

Review on pharmacological characteristics of *Mentha piperita*

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This review's primary focus is on the pharmacological and medicinal properties of *Mentha piperita*, which may also lessen the symptoms of irritable bowel syndrome and digestive symptoms like nausea and dyspepsia, but more research is required. It is applied topically as an analgesic and to relieve pain and headaches. The most popular oil is peppermint oil, and formulations that use leaf extract are believed to benefit from the usage of this oil. This herbal preparation is used in foods, pharmaceuticals, cosmetics, and personal hygiene products for its flavoring and aroma qualities. A sensation of cooling follows the taste of peppermint oil and the aroma of fresh, strong menthol. Additionally, mouthwashes, toothpastes, aromatherapy, and bath products use it.

Keywords: *Mentha piperita*, peppermint, menthol, medicinal benefits, pharmacological actions, phytoconstituents

Introduction

Many the weeds that grow around us are actually very powerful medicinal plants that can treat a wide range of serious health conditions. Nowadays, herbal remedies constitute an essential component of conventional medical care and are a topic of current research. Since herbal medicinal compounds are the primary source of phytochemicals, they are abundant in bioactive substances. Among ancient cultures, India has long been recognized as a vast repository of natural treatments. And is used as a significant medicinal herb. It is among the most ancient species used for therapeutic purposes that are known to exist in both eastern and Western nations. On the international market, India is the world's leading producer of menthol and mint oil. *Mentha piperita* or peppermint is a member of the Lamiaceae family of plants Growing widely across Europe and North America. Since ancient times, peppermint oil has been used for a variety of ailments, including headaches, neuralgia, and colds. This study focuses on the antispasmodic properties of peppermints oils. Peppermint oil is clear to pale yellow in color, has a watery consistency, and smells sharp and

fresh like menthol. The largest producer and exporter of mint oil worldwide is India. The food, pharmacy, fragrance, and flavoring industries use mint oil and its components and derivatives. Menthol is utilized as the primary ingredient in the production of Dabur Pudina Hara, Lozenges, toothpaste, pain and cold balms, and other products. The main ingredient in mint oil is the leaves of *Mentha* plant (1). Historically, the Latin name of peppermint, *Mentha piperita*, originates from the Greek word *mintha*, the name of a legendary nymph said to have transformed into peppermint. The herbs and latin word *piper*, which means pepper. It is among the oldest therapeutic herbs in the world, and is utilized in both Western and Eastern customs, Greek, Roman, and other ancient ones. The herb was utilized in Egyptian cookery and medicinal. A hybrid plant, peppermint is now widely accepted to have been identified since its first description in 1753 by Carl Linnaeus, who used specimens that had been obtained in England. Many nations throughout the world use *Mentha* species for their flavoring and therapeutic qualities... (2).



Plant *Mentha piperita*.

Taxonomical classification- (2–5)

- Kingdom- Plantae
- Clade-Tracheophytes
- Clade-Angiosperms
- Clade-Fudicots
- Order-Lamiales
- Family-Lamiaceae
- Genus-Mentha
- Species-M.piperita

Vernacular names

- Iran: Nana Felfeli
- Brazil: Hortela pimenta
- USA: Lab Mint, mint
- Norway: Peppermynthe
- Poland: Pepparmunta
- Spain: Mentainglesa
- Turkey: Nana
- Germany: Peppermint
- England: Brandy Mint

Common name

- (1) Marathi-Pudina
- (2) Hindi-Vilaytipudina
- (3) Kannada-Merugu
- (4) Telugu-Miriyaladravakamu
- (5) English-Peppermint
- (6) Malayalam-Karppooru Tulsi
- (7) Tamil-Pudina

Description (6)

Stem- Generally ascending or square-erect, slightly branching, with a consistently quadrangular top portion (**Figure 2**).



Stem.

Rhizome- They have fibrous roots in the herb and are fresh, spreading widely (**Figure 3**).



Rhizome.

Flower- The Flower of *Mentha piperita* is purple in color. They are borne in whorls around the stem, forming thick, blunt spikes (**Figure 4**).



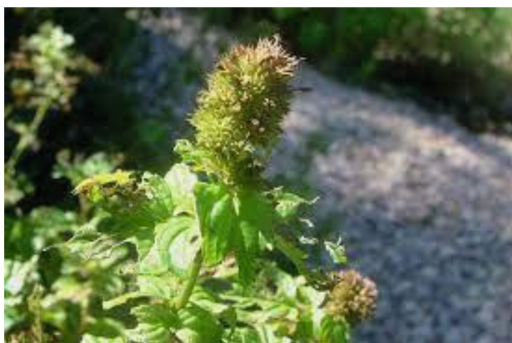
Flower.

Leaves-On the upper surface of the herb, they are opposite, petiolate, pointy and dark green, measuring 4–9 cm in length and 1.5–4 cm in width (**Figure 5**).



Leaves.

Fruit-Four ellipsoidal nutlets with a pale purplish or pinkish hue are present in the fruit (**Figure 6**).



Fruit.

Chemical composition of major parts of the *Mentha piperita*

Parts	Chemical constituents
Leaves	Alkaloids, Flavonoids, Tannins, Phenols, Saponins, Terpenoids, proteins, carbohydrate, Ethanol, Methanol, Ethyl acetate.
Root	Chloroform, hexane, petroleum ether
Stem	Ethanol, Methanol, Ethyl acetate, chloroform, Hexane, Petroleum, ethane

Materials and methods

We gathered information on peppermint from secondary sources. Forty-five publications were gathered and examined from internet resources such as Research Gate and Google Scholar, providing information on chemical composition and medicinal benefits.

Articles are searched using descriptions such as chemical composition and therapeutic usefulness of essential oils. The content analysis of the articles included a descriptive representation of their chemical makeup, therapeutic value, medicinal importance, phytochemical ingredients, and conventional usage.

Cultivation and collection-(7-9)



Cultivation and collection.

ARGRO climatic conditions

With irrigation, mints can be cultivated in any tropical or subtropical climate. They cannot, however, withstand wet winters, which result in root. Vegetative growth is encouraged by temperatures between 20 and 25°C, while higher temperatures are said to boost the levels of menthol and essential oil. It has been found that peppermint and spearmint are not profitable in tropical and sun-tropical regions, particularly in locations with extremely high summer temperatures (40°C). Humid and moderate climates, such as those found in Kashmir and the hills of Uttar Pradesh and Himachal Pradesh, yield the best results. Open, sunny conditions that are free of heavy rains during the growing seasons are ideal for the healthy growth and development of oil. It is possible to grow bergamot mint in both temperate and subtropical climates. However, in temperate climates, the yield is larger.

Soil

Rich in humus and medium to fertile, deep soils are perfect for growing mint. Although there should not be any water-logging, the soil should be able to hold onto water well. The ideal pH range is 6–7.5.

Propagation

Even runners are planted for peppermint and bergamot mint. The months of December and January are the greatest times to get stolons. One hectare of planting requires about 400 kg of stolons. Generally, one hectare of well-established mint yields enough seeds for 10 hectares. Plants from the previous year are the source of stolen goods.

Nursing raising

Seeds are used to propagate eucalyptus. Since the root structure is delicate, the seeds are grown directly in 22cm by 16cm polythene bags. The pulverized shola soils are placed inside the container. Each bag contains two seeds, and for South Indian conditions, January or February is the ideal time to sow. In the nurseries, the polybags are anchored and there is some shade available. After sowing, the seeds typically take 10 to 15 days to germinate and after the plants have formed five to six true leaves, they reach a size that can be planted in two to three quarters of a month.

Land preparation

Mints need well-plowed, fine-textured soil that has been harrowed. Prior to planting the crop, all weed stubble should be eliminated. In order to manure the land, add 25 to 30 t/ha of FYM at the time of soil preparation. You can also perform green manuring prior to planting the mint. An excellent crop for green manure is sun hemp (*Crotalaria juncea* L.). On hillsides or level ground, mints are planted. So, in accordance with the suggested spacing, flat beds of practice proportions or ridges are created.

Planting

After clearing the area of any vegetation, 30*30*45 cm pits are dug with a 2°m*2°m space between them. After this, the pits are left to wither before being planted. After adding 30°g of rock phosphate to each pit, topsoil is poured into the holes. The South-West monsoon's arrival marks the proper planting seasons. When planting, polythene bags are fully removed and the soil is seeded without suffering any damage to root system. It is preferable to stake the plants so that wind damage can occur. To guarantee a suitable population on the field, gap filling is carried out over a period of 2°years.

Irrigation

Mint has an extremely high water need. Before the first monsoon, the crop is irrigated six to nine times, depending on the soil and weather. Three irrigations are needed for the crop in September, October, and November following the monsoon. If the plant is dormant and there are no winter showers, it may occasionally be necessary to irrigate again in the winter to promote healthy growth of the underground stems. Research carried out in Pantnagar has demonstrated that fifteen irrigations are necessary to achieve the highest production of oil and herbs in Japanese mint. In temperate areas, mints require only three to four irrigations between July and October.

Nutrition-fertilizer

A good crop of mint typically requires nitrogenous fertilizers at 80–120 kg P and K at 50 kg P2O5 and 40 kg K2O/ha. Nitrogenous fertilizers applied in large quantities yield excellent results from mint. When phosphorus is applied, the amount of herbage increases, although not as much as when nitrogen is applied. Boron deficiency reduces both the yield of green herb and the essential oil in peppermint.

Harvesting and yield

The crop that is seeded in January and February through stolons is harvested twice a year, in June and October. After growing for 100–120 days, the first crop is harvested 80–90 days after the first. After wilting for 6 to 10 h, the fresh herbage at the harvesting stage, which has an oil content of 0.5 to 0.68%, is prepared for distillation. Harvesting on overcast or wet days reduces the amount of menthol in the oil; therefore, on bright, sunny days, the wilted crop is cut 10 cm above the ground with a sickle. Twenty tons of fresh herbage per hectare on average is produced in two harvests, translating into about 250 kg of oil annually.

Storage of herbage

Before being distilled, mint foliage needs to be shade-dried for about a day. During the drying process, care should be taken to prevent the herbage from beginning to decompose. If wilted herbage produce is kept for a longer time—two to three days—there will be a slight decrease in oil output. For this reason, it is not advisable to store herbage for an extended period of time.

Distillation

Steam distillation is the method used to extract oil. The oil has a golden yellow hue and at least 75% menthol in it. Steam distillation takes 2–3°h to recover all of the oil. Steam is passed through the fresh or semi-dried herbage while it is under pressure in a tank. A condenser is subsequently used to filter the steam that emerges from the tank. Cold water is continuously circulated over and around the condenser that receives the steam and contains the oil that was extracted from the herbage in the tank. A receiver is used to gather the condensed oil and water mixture. Oil floats on the water surface in the receiver because the densities of the two materials are different. The oil is collected after being skimmed off.

Purification of oil

It is necessary to remove any possible water residues from the oil that is skimmed off. An apparatus called a separator funnel is used for this. Any remaining moisture in the oil is eliminated by decanting and treating with anhydrous sodium sulphate. The entire procedure is quite important. If rusting causes the oil's color to change, the steam rectification method may be used.

Storage and packaging oil

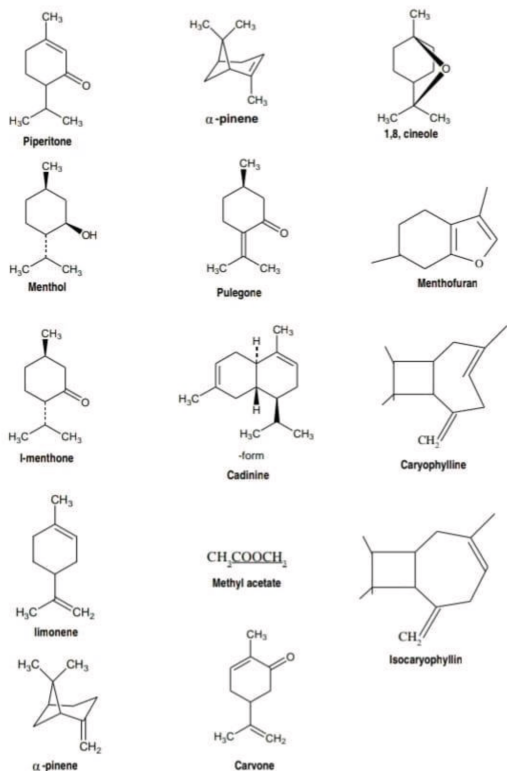
The containers need to be stored in a dark, cool area. Good-quality PVC barrels with a capacity of 20 to 200 liters and aluminum or galvanized iron (GI) drums are appropriate for both short- and long-term storage (**Figure 8**).



Storage and packaging of oil.

Chemical constituents

Primarily composed of menthol, peppermint essential oil is primarily known for its antispasmodic properties. Peppermint oil contains menthone (14.0–32.0%), menthofuran (1.0–9.0%), methyl acetate (2.8–10.0%), isomenthone (1.5–10.0%), carvone (max.1.0%), pulegone (4.0%), cineole (3.5–14.0%), and limonene (1.0–5.0%) (10).



Various chemical constituents of peppermint oil.

Phytochemical

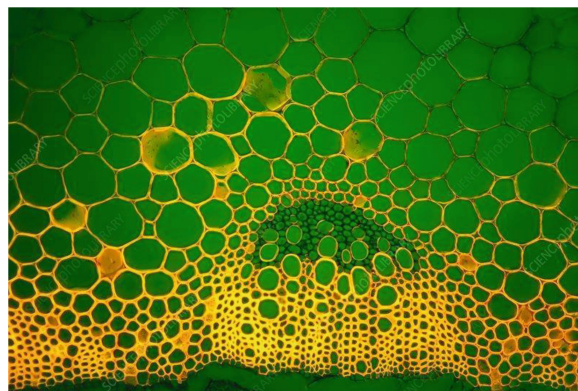
- (1) Alkaloids
- (2) Flavonoids
- (3) Tannins
- (4) Glycosides
- (5) Phenol

Macroscopy- (11)

Color	Colorless or Yellow
Odor	Characteristics
Taste	Pungent Colored by Cooling Sensation
Size	9.8–14.1 cm in length

Microscopy

1. Epidermal cell-Upper cells are polygonal and lower cells are rectangular.
2. Stomata-anomocytic, tetracytic, and anisocytic.
3. Stomatal index-29.03–40.0.
4. Trichomes-glandular and covering trichomes are present.



Microscopic structure of *Mentha piperita*.

Methods of extraction

1. Microwave Extraction:
2. Steam Distillation:

1. Microwave Extraction

The efficiency of the process, which relies on heat produced by ionic conduction and/or dipole rotation, is contingent upon the material's dielectric characteristics. The process of extraction happens when the plant's water absorbs microwave energy, raising the material's internal pressure and causing the cell structure to rupture, allowing the solvent to enter the matrix [(7, 12–14); Routray].

2. Steam Distillation

Plant material is subjected to “dry steam” distillation using this glass-only vertical steam distillation unit, which has a hot plate, boiling flask, biomass flask, still head, condenser, and receiver (see equipment diagram below). By heating distilled water on a hot plate, steam is created during the boiling process. The water-soluble plant compounds and essential oils are extracted into the stream as this steam rises into the biomass flask. The water-cooled condenser is where the stream condenses after passing through the still head. The receiver is where the essential oil layer phase separates. The receiver is specifically made to hold both oils that are heavier than water and oils that are lighter than water, allowing any extra water—which contains the compounds that dissolve in water—to drain out and be collected separately (8).

The essential oils are condensed in this way. Dry steam distillation differs from “wet” steam distillation in that any water that condenses on the biomass can return to the boiling flask thanks to the vertical design, which also prevents the biomass from coming into direct contact with the water. An aqueous condensate known as a hydrosol and an essential oil with a relatively high purity are the two main products obtained from steam distillation of biomass. The hydrophobic, frequently aromatic compounds that make up the oil are produced in very small amounts by the peppermint plants as secondary metabolites. Secondary metabolites are also present in the hydrosol, but they are more hydrophilic in nature (9).

Pharmacological properties

- (1) Spasmolytic properties
- (2) Antiviral activity
- (3) Cytotoxic properties
- (4) Antibacterial properties
- (5) Antipyretic and antiulcer properties of Azulene
- (6) Cosmetic properties
- (7) Anticarcinogenic
- (8) Antioxidant effects
- (9) Antiallergic effects
- (10) Antinociceptive effects
- (11) Anti-inflammatory effects
- (12) Antitumorigenic effects
- (13) Antidiabetic effects
- (14) Antiedema activity
- (15) Analgesic and coolant properties
- (16) Cardiovascular activity
- (17) Radio protective activity
- (18) AntiTB effects
- (19) Antimicrobial effects
- (20) Hepatoprotective effects
- (21) Genetic toxicity Effects
- (22) Larvicidal activity

(1) Spasmolytic properties

Peppermint has been shown to have spasmolytic properties against a variety of convulsant medications, such as acetylcholine, histamine, serotonin, and anaphylatoxin. Isolated sections of guinea pig and rabbit gut, isolated guinea pig lungs, cat lungs “*In situ*,” and entire animals in anaphylactic shock are among the preparations utilized. Papaverine-like smooth muscle spasmolytic action is myotropic. It has been discovered that peppermint extract helps the lower esophageal sphincter relax and let more air escape (12).

(2) Antiviral activity

Many of the components of lemon balm, which has been demonstrated to have significant antiviral action, are also present in peppermint. Based on this, peppermint was studied and it was discovered that, in egg and cell-culture systems, peppermint inhibited various viruses, including West Nile, herpes simplex, Newcastle disease, vaccinia and Semliki forest viruses. The herb has a tannin that binds to the mumps and Newcastle viruses and it also has a non-tannin fraction that has antiviral properties against the herpes simplex virus.

It was determined whether peppermint oil has any virucidal effects on the herpes simplex virus. In viral suspension assays, peppermint oil showed strong virucidal action against HSV-1 and HSV-2. Plaque formation for HSV-1 and HSV-2 was dramatically decreased by 82 and 92%, respectively, at non-cytotoxic concentrations of the oil. Higher peppermint oil concentrations more than 90% lowered the viral titers of both herpesviruses. An investigation on the antiviral, anti-inflammatory, and antioxidant properties of *Mentha piperita* L. leaf ethanol extract (MPE) was conducted. MPE exhibited strong antiviral activity against RSV with a high selectivity index, high amounts of phenolic acid and flavonoids, and a marked reduction in NO, TNF- α , and IL-6 production (13).

(3) Cytotoxic properties

Although peppermint and cornmint oils have some cytotoxic qualities, it is doubtful that the plant as a whole would show these effects (12).

(4) Antibacterial properties

The potential antibacterial effects of peppermint oil and other leaf extract have been observed to prevent the growth of both gramme positive and gramme negative bacteria.

Natural substances or the active ingredients in medications have a major function as antimicrobial agents that stop the growth of microorganisms. The ability of various *Mentha piperita* extracts and peppermint oil to inhibit both Gram-positive and Gram-negative bacteria. Bacterial strains were looked into. Microorganism growth was found to be suppressed by distilled quantities of essential oil and the outcomes were similar to those of the gentamycin antibiotic.

Moreover, the bacterial species' minimal inhibitory concentrations varied between 0.4 and 0.7% v/v (13).

(5) Antipyretic and antiulcer properties of Azulene

The by-products of peppermint oil distillation contain an isolate called Azulene, which exhibits a strong antipyretic effect. A rabbit's ear burns from hot water have been shown to be successfully treated with an intramuscular injection of 0.1°gm/kg. In tests conducted on rats with stomach ulcers caused by butadione, the product, when given at a dose of 0.05°gm/kg, effectively reduces pathological alteration of the mucosa. The lethal dose of azulene when administered intraperitoneally is 1.5°gm/kg mice and 1.165°gm/kg in rats (14).

(6) Cosmetic properties

Peppermint essential oil is an ingredient in a lot of over-the-counter balms and liniments. These are applied topically to treat fungal infections, rheumatism, muscle soreness and itching (14).

(7) Anticarcinogenic properties

Impact by stopping G1 cell cycle arrest and mitochondrial-mediated apoptosis, as well as by improving the treated animal's oxidative balance dose and time-dependently, *Mentha piperita* leaf extract demonstrated a strong anticarcinogenic effect (13).

(8) Antioxidant properties

These plant's methanolic extracts demonstrated neurochemical characteristics, antioxidant activity, and defense against hydrogen peroxide induced toxicity in PC12 cells. Significant protection against oxidative stress was produced by *Mentha piperita* for PC12 cells.

According to a study's findings, peppermint essential oil can effectively treat irritable bowel syndrome in people. This effect can be quantified by looking at the oil's antioxidant and

anti-inflammatory properties. Both the oil and the *Mentha piperita* extracts exhibited significant antioxidant activity, with the oil's efficacy being about half that of the conventional BHT. These results demonstrated peppermint oil's potent antibacterial and antioxidant properties. Measurements were made of *Mentha spicata* extracts' antioxidant and antibacterial properties as well as their composition. While just the essential oil demonstrated antibacterial action, the methanolic extract showed a larger amount of total phenolic components and superior antioxidant activity (15).

(9) Antiallergic properties

Animals have demonstrated dose-dependent antiallergic efficacy of *Mentha piperita* aqueous extract by preventing compound 48/80-induced histamine release from rat peritoneal mast cells (15).

(10) Antinociceptive effects

Mice exposed to heat plate stimulation and acetic acid-induced writhing demonstrated antinociceptive effects from plant extract of *Mentha piperita* (16).

(11) Anti-inflammatory effects

These plant's extract has shown anti-inflammatory properties against cotton pellet-induced granuloma test in rats and xylene-induced ear edema in mice. An investigation was conducted to assess the efficacy of menthol on rats suffering from acute colitis caused by acetic acid. The outcome showed that menthol decreased notably the interleukin levels in the colon TNF- α (tumor necrosis factor- α), 1 β (IL-1 β), interleukin 6 (IL-6), and myeloperoxidase (MPO) activity in colons that are inflammatory. Consequently, the results of the research indicate that menthol may have certain advantages in individuals with acute ulcerative colitis. The use of mint oil and L-menthol as an anti-inflammatory medication, preliminary *in vitro* studies were carried out. Lmenthol considerably reduced the generation of every mediator of inflammation via *in vitro* monocytes. Here is how the production of PGE subset 2 was impacted by mint oil: reduced levels of 10 superseset-10 compared to 10 superseset-8 g/ml enhanced PGE subset2 by up to six times at baseline, although PGE subset2 synthesis was inhibited by around 50% at doses of 10 superseset-7 g/ml. These findings using human monocytes imply that L-menthol has more potent anti-inflammatory properties than mint oil at therapeutically relevant dosages when given in enteric-coated capsules (17).

(12) Antitumorigenic effects

Mice treated with *Mentha piperita* leaves had antitumor effects. In the treatment of cancer, medicinal plants or active ingredients are crucial. The cytotoxic activity and mode of action of methanol extracts derived from ten different types of herbs, including *M. piperita*, were investigated against L1210 cancer cells. All of the cases showed notable cytotoxic effects, with lemon verbena extract exhibiting the most notable effect. It was discovered that the cytotoxic effect depended on the dose and culture duration. Regarding the cytotoxic mechanism, the increased production of O₂-ions and the sharply increased activities of antioxidant enzymes (17).

(13) Antidiabetic effects

According to reports, when given to animals, peppermint juice can lower blood levels of triglycerides, cholesterol, glucose and low-density lipoprotein cholesterol (LDL-c). In the experimental diabetic state, the *Mentha spicata* plant's antidiabetic properties were assessed. Neither a single treatment of the extract nor many administrations had demonstrated a statistically significant decrease in blood glucose levels in normal rats. On the other hand, STZ diabetic rats demonstrated a noteworthy reduction in blood glucose during repeated oral treatment of *M. spicata* aqueous extract. At the dose employed, A.P.A.E.'s ability to decrease blood glucose was equivalent to that of glibenclamide treatment (18).

(14) Antiedema activity

The ear edema caused by 12-O-tetradecanoylphorbol13-acetate was prevented in mice when a topical application of *Mentha piperita* methanol leaf extract (2.0 mg/ear) was administered (19).

(15) Analgesic and coolant properties

Peppermint oil stimulates the skin's cold receptor, which causes blood vessels to dilate and produce cooling and analgesic effects (20).

(16) Cardiovascular activity

Mentha piperita has been shown to have vasodilatory effects on certain animals as well as heart rate and systolic pressure reducing effects. An additional benefit of peppermint oil is the relaxation of smooth muscles in the bronchi (17).

(17) Radio protective activity

In mice with bone marrow exposed to radiation-induced chromosomal damage, the leaf extract of these plants demonstrated radioprotective qualities (18).

(18) AntiTB effects

A patient who inhaled peppermint essential oil showed antituberculosis efficacy (21).

(19) Antimicrobial effects

The antibacterial qualities of peppermint essential oils (*Mentha piperita* L., Lamiaceae), which are utilized in pastes, perfumes, and medications, were studied against 21 plant- and human-pathogenic microbes. Agar diffusion, microdilution, and bioautography were among the *in vitro* methods used to compare the bioactivity of the oils menthone and menthol. It was demonstrated that whereas human infections were only mildly inhibited, all of the peppermint oils screened strongly against plant pathogenic bacteria. The oils' chemical constituents were examined using GC and GC/MS. The antibacterial action of these oils was determined to be attributed to menthol by the use of the bioautography assay (13, 20).

(20) Hepatoprotective effects

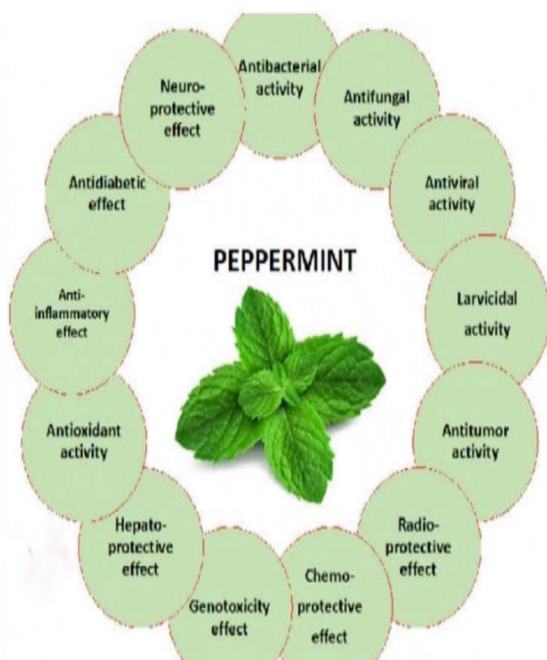
In experimental rats, the preventive effect of parsley (*Petroselinum crispum*) and peppermint (*Mentha piperita*) leaf oils against hepatotoxicity caused by carbon tetrachloride (CCl₄) was assessed. Due to CCl₄'s hepatotoxicity, serum triglycerides, total cholesterol, low-density lipoprotein (LDL-C), and very low-density lipoprotein (VLDL-C) were all significantly elevated while serum high-density lipoprotein (HDL-C) was significantly decreased. The harmful effects and biochemical changes brought on by CCl₄ were lessened by the administration of 0.5 ml of each peppermint, parsley, and their mixture oils, particularly the peppermint oil. Strong antioxidant and radical scavenging properties are present in peppermint, parsley, and their blend oils. In particular, 0.5 ml of peppermint oil significantly increased the activity of SOD and GSH while reducing inside MDA. Ultimately, research indicated that the antioxidant content and free radical scavenger properties of peppermint and parsley oil may be responsible for their hepatoprotective effects (21).

(21) Genetic toxicity effects

The genotoxic properties of essential oils extracted from peppermint (*Mentha piperita* L.), pine (*Pinus sylvestris* L.) needles, and dill (*Anethum graveolens* L.) herb and seeds were tested in human cells. To evaluate the effects of the oils *in vivo*, the *Drosophila melanogaster* somatic mutation and recombination test (SMART) was employed. In the CA test, dill seeds produced the most active essential oil, followed by those from the dill plant, peppermint herb, and pine needles. After dill seeds and herb, the essential oils from peppermint plant and pine needles were found to be the most active in the SCE test. The essential oils from dill herb, seeds, and pine needles clearly induced CA and SCE, whereas peppermint essential oil produced SCE in a dose-independent manner (19).

(22) Larvicidal activity

The larvicidal effectiveness of *Mentha piperita* oil was studied against three different mosquito species: *Culex quinquefasciatus*, *Anopheles stephensi*, and *Aedes aegypti*. *Ae. aegypti*, *An. stephensi*, and *Cx. quinquefasciatus* were the three species studied that were most susceptible. When oil was applied at a rate of 3 milliliters per square meter of water surface area, *Cx. quinquefasciatus* died 100% within 24 h, *Ae. aegypti* 90%, and *An. stephensi* 85%. A total of 100% mortality for *Ae. aegypti* was reached at 3 ml/m² in 48 h or 4 ml/m² in 24 h. At 4 ml/m² in 72 h, 100% mortality for *An. stephensi* was noted (20).



The pharmacological effects of the *Mentha piperita*.

Pharmacological effects of *Mentha* species

<i>Mentha</i> plants	Pharmacological effect	Extraction
<i>Mentha Spicata</i>	Anti-inflammatory, Antipyretic, Analgesic, Antioxidant	Essential oil, Methanol, Diethyl ether, Ethanol, Hexane.
<i>M. spicata</i> var. <i>crispa</i>	Antibacterial, Antiallergic, Antioxidant	Essential oils, Methanol, Water soluble.
<i>Mentha X Piperita</i>	Analgesic, Antimicrobial, Antioxidant, Anti-inflammatory, Antiallergic.	Essential oils, Aqueous extracts, Ethanol, Benzene.
<i>M. arvensis</i>	Cytotoxic, Anti-inflammatory, Analgesic, Antiallergic.	Ethanol, Essential oil, Methanol, Aqueous, Chloroform
<i>M. arvensis</i> var <i>japanensis</i>	Antioxidant	Water soluble
<i>M. cordifolia</i>	Analgesic, Antioxidant	Ethanol, Aqueous
<i>M. aquatica</i>	Antimicrobial, Antioxidant Anti-inflammatory	Essential oils, Methanol, Aqueous, Ethanol.
<i>M. longifolia</i>	Antimicrobial, Antioxidant, Acute toxicity effects	Essential oils, Methanol, Aqueous, Ethanol.
<i>M. longifolia</i> subsp. <i>longifoila</i>	Antimutagenic, Antioxidant	Ethanol, Methanol
<i>M. mozaffarianii</i>	Analgesic, Antimicrobial	Essential oils
<i>M. pulegium</i>	Antiparasitic, Antimicrobial	Hot water, cold Water, Ethanol
<i>M. viridis</i>	Analgesic, Antiparasitic, Antioxidant	Methanol, Aqueous
<i>M. suaveolens</i>	Cardiovascular Effects, Antiviral	Methanol, Hexane
<i>M. australis</i>	Antioxidant	Methanol
<i>M. rotundifolia</i>	Antioxidant & Antibacterial	Essential oils
<i>M. haplocalyx</i>	Antiallergic	Water soluble, Ethanol
<i>Mentha X dalmatica</i>	Antioxidant	Water soluble
<i>Mentha X verticillata</i>	Antioxidant	Water soluble
<i>Mentha X villosa</i>	Cytotoxic	Essential oil
<i>M. canadensis</i>	Antioxidant	Methanol

Medicinal uses- (16)

1. Teeth-

It is used to make dental dentifrices, which are used to clean, brighten, and polish natural teeth. Baby's gums benefit

from it as well because it lessens discomfort and provides teeth clean of germs.

2. Skin-

Mentha piperita oil for skin conditions like rashes, itching, and irritations.

3. Headaches-

Head pain can be reduced by applying *Mentha* oil to the forehead.

4. Colds and Flu-

Menthol is mostly found in *Mentha* peppermint, which is also used as an expectorant and in cold weather conditions.

5. Indigestion-Peppermint oil can help to relieve indigestion by calming the stomach muscles and facilitating better bile flow.

6. Irritable Bowel Syndrome-

Mentha piperita oil is also helpful for IBS symptoms like bloating, pain, diarrhea, and gas.

7. Miscellaneous:

Every part of the herb has therapeutic potential. Dried peppermint leaves are used to make tea that helps relieve throat and mouth mucosal inflammation, cough, and bronchitis. The plant has historically been used to treat issues like morning sickness, anorexia, vomiting, diarrhea, nausea, and flatulence. The medication also reduces gas and cramps in the abdomen by acting as a spasmolytic agent. Menthol oil is used to make toothpaste and helps ladies who are experiencing period cramps. These days, species like *M. piperita* are utilized to treat biliary tract disorders, gall bladder problems, Crohn's disease, and irritable bowel syndrome.

Medical application

1. Masks Bad breath: Smelling peppermint oil before or during driving might improve alertness and reduce feelings of weariness, annoyance, and anxiety. It can improve mental health and increase attentiveness, which can help alleviate the symptoms of Alzheimer's.

2. Treats Asthma: Chest congestion can be eased by peppermint. Mint's methanol functions as a decongestant helps to shrink inflamed nasal membranes and release mucus that has accumulated in the lungs to facilitate breathing. Because of its antioxidant, antibacterial, and antidiabetic properties, mint helps treat a variety of illnesses by inhibiting oxidation *in vitro*.

3. Cures Headache: Menthol, which is found in peppermint, aids in muscular relaxation and pain relief. Mint contains methyl esters, dimethyl sulfide, sabinene, and ocimene. It can be used as a medicinal agent to induce inflammation and relieve headaches and indigestion.

4. Decrease breast feeding pain: Applying peppermint water after nursing was more successful in preventing areola and nipple cracks, which decreased the pain in the nipples.

5. Treatment of Irritable Bowel syndrome:

Menthol, which is present in peppermint oil, relieves the symptoms of IBS by relaxing the muscles in the digestive system. Because peppermint oil relaxes smooth muscle, it is used to treat IBS. The oil is collected from the leaves, stems, and flowers.

6. Rich in Nutrients: A balanced intake of vital nutrients can be obtained from peppermint. Mint leaves are a leafy vegetable that can be consumed to provide nutrients to the body.

7. Digestive Health: It soothes indigestion, supports the digestive system, and prevents stomach infections through its antiseptic and antibacterial qualities. By consuming peppermint oil, which relieves acidity and soothes the stomach, irritable bowel syndrome (IBS) can be treated.

8. Brain Health: Smelling peppermint oil before or during driving might improve alertness and reduce feelings of weariness, annoyance, and anxiety. It can improve mental health and increase attentiveness, which can help alleviate the symptoms of Alzheimer's.

9. Relieves indigestion: It happens when food remains in the stomach for an extended period of time before entering the digestive system. Because peppermint oil is a carminative herb, it helps ease indigestion and minimizes intestinal spasms.

10. Makes Healthy Skin: Due to its anti-inflammatory and antibacterial qualities, peppermint leaves the skin clear of pimples and acne. Mint has numerous anti-inflammatory and antioxidant properties. It also contains vitamins and minerals that can help treat skin conditions. The juice derived from mint leaves the skin feeling hydrated and can be applied to the face.

11. Oral Care: Chewing pudina leaves enhances dental and oral hygiene. The pudina's essential oil aids in improving breath. The leaves of mint are rich in calcium, phosphorus, iron, vitamin D, and E, and they can treat bad breath. Mint also inhibits the formation of bacteria and fungi.

12. Boosts Immunity: Rich in vitamins and antioxidants, mint helps strengthen immunity. These vitamins derived from plants aid in shielding cells from harm. Mint leaves also have antitumor properties. Dietary peppermint enhances immunity by promoting the generation of antibodies and utilizing its antioxidant qualities to shield cells from oxidative harm.

13. Healthy Hair: Antioxidants and mint leaf extract both inhibit and stimulate hair growth and fall prevention. With its antidandruff and insecticidal qualities, peppermint oil promotes hair growth and deepens hair follicles, both of which lessen tension and headaches.

14. Eases Allergies: Mint has antiallergic qualities and can be used to treat a variety of allergies. The anti-inflammatory qualities of mint and the antiallergy effects of rosmarinic acid.

15. Improves Memory: Mint has the ability to enhance memory and restore brain function related to cognition. Drinking pudina can boost cognitive function by enhancing alertness and monthly memory. The scent of peppermint

improves memory and alertness, which supports improved attention, memory, and concentration.

Possible interaction:

The following medications may not be properly absorbed if peppermint is used regularly: warfarin, phenothiazines, digoxin, isoniazid, phenytoin, tetracycline derivatives, and oral anticholinergics. Quinidine and other alkaline medications, such as amphetamines, may be excreted in the urine. Impeded by peppermint's antacid properties. The analgesic properties of peppermint may enhance those of other analgesics and anesthetics. Despite any CNS-depressant effects, barbiturates may decrease these effects. Which could happen. This herb's analgesic effects can be counteracted or even P-chlorophenylalanine, cyproheptadine hydrochloride, and phenobarbital were eliminated.

On the other hand, this analgesic's propensity for CNS depression could be enhanced by tranquilizers, haloperidol, and chlorprothixene HCl (15).

Limits of administration:

Children under 5 years old should be given this medication with extreme caution since menthol can trigger choking reactions in little children. Little children or newborns shouldn't have their faces touched with peppermint oil. It is not advisable to consume peppermint essential oil unless directed by a physician. It is not recommended to consume pure peppermint or pure menthol. Peppermint oil alone could induce a tachycardia. Even at little dosages, pure menthol is toxic and deadly as one teaspoon.

Use peppermint with caution if you are a pregnant woman with a history of miscarriages. Excessive consumption of peppermint leaves may cause miscarriage. Extra care ought to be taken by mothers who are nursing their babies. It is not advisable to combine peppermint with homeopathic remedies (15).

Assessment/safety factors

The plant may cause allergic contact dermatitis in certain people, and peppermint fields have been linked to cases of hay fever in some people. If administered to the nose, menthol and menthol-containing medications can be fatal to babies. As when a baby is sick with a cold. It is best to avoid using this.

When essential oils are not used correctly, dermatitis and other allergic reactions may result in responses. Enteric-coated capsules may cause rare responses. Among these responses include skin muscular spasms, heartburn, rash, and slowed heart rate.

Kidney damage can occur from large internal dosages of peppermint essential oil.

A German Commission E approval status exists for mint oil.

The German Commission E has granted peppermint leaf approval (15).

Toxicity and contraindication

There is a chance that any herbal product could be contaminated by pesticides, herbicides, heavy metals, medicines, or other herbal products. This is especially relevant to imports from poorer nations. Furthermore, sensitive individuals may experience allergic responses to any natural product. There have been reports of peppermint allergies. Pulegone and menthol are two substances in peppermint that may be harmful. Much lesser amounts of the poisonous chemical pulegone, which is present in pennyroyal, are also present in peppermint. In rats, menthol alters the hepatocellular structure. Although they are uncommon, adverse reactions to enteric coated peppermint oil capsules can include contact dermatitis, hypersensitivity reaction, bradycardia, perianal burning, heartburn, and stomach-ache and trembling in the muscles. Menthol inhalation may result in laryngoconstriction and apnea. In one instance, patients' menthol and peppermint sensitivity was noticed upon contact. Having burning mouth syndrome among other oral symptoms, lichenoid reaction, or recurring oral ulcers. The overexposure to mentholated preparations in the air has resulted in reversible nausea, ataxia, anorexia, cardiac issues, and further CNS issues, which are believed to be brought on by the volatile oils present¹⁰². There is a case report describing a 13-year-old kid who, after breathing in five milliliters of Olbas oil (with 200 mg of menthol) as opposed to the suggested a few drops, felt euphoric, confused, and ataxic nystagmus as well as diplopia. Chronic high-concentration menthol vapor exposure in rats has not been found to have any deleterious toxic consequences. When there is significant liver disease, gallbladder inflammation, or bile duct obstruction, peppermint oil should not be used. (15)

Precaution

In low dilutions, peppermint oil is safe and non-irritating, but because it contains menthol, it may cause sensitization. It should be kept far away from the eyes because it can irritate the mucous membranes and skin. It should not be used on children younger than 7°years old and should not be used during pregnancy.

Any form of peppermint oil is not advised for people who have gallbladder illness, hiatal hernias, are pregnant, or are nursing a baby.

Peppermint oil overdose symptoms include vomiting, diarrhea, abdominal discomfort, convulsions, nausea, vomiting, blood in the urine, secretion of pee, dizziness, twitching, unconsciousness, uncoordinated movement, and flushing (15).

Conclusion

It is clear from this that *M. piperita* is a widely recognized plant due to its wide range of potential pharmacological effects. In the global oil extraction business, it has a bright future. Because of its therapeutic benefit, this herb is now highly popular on the Indian subcontinent as well and as a result it is grown for its volatile oil exports.

The therapeutic applications and pharmacological significance of *Mentha piperita*, which may have antibacterial, anti-inflammatory, analgesic, cardiac, antioxidant, anticancer, antispasmodic, and radioprotective effects are covered in this review.

The outcome demonstrated that the peppermint plant, which has beneficial therapeutic qualities, contains constituents of medicinal importance. Because it has antioxidant, antiviral, and antimicrobial qualities and is used to treat fever, dysentery, gastritis, and IBS, most people utilize it as a diet supplement and a medicine precursor. Plant materials cannot be made into effective medicine without the help of modern technology. We may identify a variety of chemicals, including flavonoids, tannins, and carbohydrates, in peppermint leaf extract. *Mentha piperita* is sometimes a foundation stone for upcoming medications. Therefore, further research is necessary regarding its safe consumption by humans.

We can infer that because of its various and extensive pharmacological benefits or potential, *M. piperita* is a well-known herb around the world. In the global oil extraction business, it has a bright future. Due to its many medical applications, this herb is now highly popular in the Indian subcontinent as well and cultivated for exporting volatile oil.

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