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REVIEW ARTICLE

MENTHA PIPERITA L. - A PROMISING DENTAL CARE HERB MAINLY AGAINST CARIOGENIC BACTERIA

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ABSTRACT
Oral diseases are considered from the major health problems and are not limited to dental caries and periodontal diseases but to various autoimmune conditions. Itsayurvedic therapy includes different plants used in management of toothache, sore throat, mouth sores, abscess, broken tooth and jaw, tooth sensitivity, mouth thrush, dental caries, gingivitis, tooth bleaching, dental anxiety, dental phobia and plants used for dental extraction. Peppermint (*Mentha piperita* L.), a sterile hybrid of the species *M. aquatica* L. and *M. spicata*, L. is considered one of the important aromatic herbs containing high amount of volatile oil used in dental care. The peppermint leaves have a characteristic, aromatic, strong odor and an aromatic, warm, pungent taste followed by a cooling sensation.The medicinal parts are the essential oil extracted from the aerial parts of the flowering plant, the dried leaves, the fresh flowering plant and the whole plant. *M. piperita* L.is a perennial 50–90 cm high, normally quadrangular and a prototypical member of the mint family. The essential oil of *M.piperita* L.leaves is characterized by the presence of high percent of menthol (29-48%) in addition tomenthone (20-31%), and the different isomers of menthol in addition to other constituents.*M. piperita* L. is one of most promising species with antibacterial potential against cariogenic bacteria as *Streptococcus mutans*. Peppermint oil and leaves posses several other biological effects as antiseptic in oral preparations, antibacterial,antiviral, antifungal, antioxidant and antispasmodic effects. It is also used as a flavoringagent in food and pharmaceutical industry and oral preparations.
Keywords: Antibacterial, dental caries, flavoring agent, mentha, menthol.

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INTRODUCTION

Recently there is a great renewed interest for the reuse of different traditional drugs generally in therapy and especially for oral and dental health. Various plants have high potential in the treatment of dental problems. The most commonly used medication for oral and dental health is *Mentha piperita* L. *Mentha piperita* L., a medicinally important plant belongs to the Family Lamiaceae and commonly known as Peppermint is a hybrid *of M. spicata* L. (spearmint) and *Mentha aquatic* L[1]. It was cultivated by the ancient Egyptians and documented in the Icelandic pharmacopoeia of the thirteenth century. It is widely grown in temperate areas of the world, particularly in Europe, North America and North Africa but nowadays cultivated throughout all regions of the world. The medicinal parts are the essential oil extracted from the aerial parts of the flowering plant, the dried leaves, the fresh flowering plant and the whole plant. Peppermint oil has a fresh, sharp, menthol smell, is clear to pale yellow in color and watery in viscosity. India is the world's largest producer and exporter of mint oil[2]. It is used in the form of herbal preparation(s); infusion and tinctures; in addition to its use in different Pharmaceutical forms whether solid or liquid dosage forms**.**

Synonyms
Mentha piperita (L.) Huds., *M. piperita* Stokes, *M. balsamea* Willd.

Taxonomy
Kingdom: Plantae. **Division :** Angiospermae.
Class: Dicotyledoneae. **Sub class**: Sympetalae.
Order: Tubiflorae. **Sub order**: Verbenineae.
Family: Labiatae (Lamiaceae). **Genus:** *Mentha*
Sub family: Stachydoideae **Tribe:** Satureieae.
Species: *Mentha piperita* Linnaeus (Peppermint).
Varieties: *Mentha piperita* var. *officinalis* Sole (White Peppermint)[58].

Mentha piperita var. *Vulgaris*, Sole (Black Peppermint).

Local names around the world

Arabic: Nana; **Bogota:** Yerba Buena; **Brazil:** Nortelapimento; **Chinese:** Po Ho; **Danish:** Pebermynte; **Dutch:** Pepermint; **English:** Brandy Mint, Pepper Mint; **French:** Menthe, Menthe anglaise; **Kashmiri:** Pudyanu **Mexico:** Menta piperita **Hungarian:** Borsus menta; **Italian:** Menta piperita; **NorthAmerica:** Lamb Mint, Brandy Mint, Lam Mint,Peppermint; **Norwegian:** Peppermynte; **Polish:** Pepparmunta; **Portuguese:** Hortelanapimentosa; **Russian:** Myataperechnaya; **Spanish:** Mentainglesa, Menta Piperita; **Swedish:** Pepparmynt; **Turkish:** Nana; **Uruguay:** Menta; **Indian:** Hindi, Bengali, Gujarati, Punjabi, Urdu, Marathi, Tamil and **Telugu:** Pudina;; **Malayalam:** Puthina.

PHARMACOGNOSTICAL CHARACTERS

M. piperita L. is a perennial 50–90 cm high, normally quadrangular and a prototypical member of the mint family[3].The usually branched stems are often purplish or tinged violet but sometimes they are gray-tomentose. The dark or light green leaves are short-petioled, oblong-ovate and serrate with their margins finely toothed. The flowers are purple or pinkish having false spikes with numerous inconspicuous bracts and rarely bear seeds. The plant is generally sterile and spreads by means of runners. The plant grows in a sunny side and prefers acid, neutral and basic, light, medium soils but can also grow in heavy clay soil[4].

Leaf anatomy

Figure 1: Leaves of *Mentha piperita* L.

Leaves being the most important part from which oil is extracted, the anatomical characters are relevant. Upper epidermis composed of large, clear epidermal cells with sinuous, vertical walls and possessing few or no stomata, few glandular trichomes present; palisade parenchyma, comprising a layer of columnar cells rich in chloroplasts; spongy parenchyma, of 4-6layers of irregularly shaped chloroplastid containing cells and intercellular airspaces. Lower epidermis of small epidermal cells with sinuous, vertical walls and numerous diacytic stomata; in the region of veins and midrib, exhibits non-glandular and glandular trichomes as outgrowths; non-glandular trichomes uniseriate, papillose, 1-8 celled; glandulartric homes have 1-2 celled stalk and 1-8celled glandular head containing the essential oil, calcium oxalate crystals absent[5].

Phytochemistry of *Mentha piperita* L.

In *M. piperita* essential oil 26 components were detected and identified (97.7%). Menthol (37.4%), menthyl acetate (17.4%) and menthone (12.7%) were the main components in this oil are Sabinene, β-Myrcene, 3-Octanol, α-Terpinene, *p*-Cymene, Limonene, 1,8-Cineole, *cis*-Ocimene, *trans*-Ocimene, γ-Terpinene, α-Terpinolene, Linalool, Menthone, Menthofuran, Pulegone, Piperitone, β-Bourbonene, β-Caryophyllene, (*Z*)-β-Farnesene, Germacrene D, Bicyclogermacrene, Germacrene A, δ-Cadinene, Viridiflorol[6].

Other constituents include flavonoid glycoside (eg. Narirutin, Luteolin-7-o-rutinoside, Isorhoifolin and Hesperidin etc), polyphenols (e.g Rosmaric acid, Eriocitrin, Cinamic acid, Caffeic acid and Narigenin-7-oglucoside); luteolin-diglucoronide anderiodictyol glucopyranosyl-rhamnopyranoside were also purified from aerial parts of mint[7].

QUALITY CONTROL

General identity tests

Thin-layer and gas chromatography for characteristic monoterpene profiles[8,9].

Purity tests

MICROBIOLOGICAL

Tests for specific microorganisms and microbial contamination limits are as described in the WHO guidelines on quality control methods for medicinal plants[10].

CHEMICAL

Acid value: not more than 1.4[8,9]

Relative density: 0.900–0.916[8]

Refractive index: 1.457–1.467[8]

Optical rotation: -10° to -30°

Solvent solubility: miscible with ethanol (96%), ether and methylene chloride[9]

Pesticide residues

The recommended maximum limit of aldrin and dieldrin is not more than 0.05mg/kg[9] and the WHO guidelines on quality control methods for medicinal plants and pesticide residues[8].

Heavy metals

For maximum limits and analysis of heavy metals, consult the WHO guidelines on quality control methods for medicinal plants[8].

Radioactive residues

Where applicable, consult the WHO guidelines on quality control methods for medicinal plants[10] for the analysis of radioactive isotopes.

Chemical assays

The monoterpene content determined by gas chromatography should be 1,8-cineole (6–14%), limonene (1–5%), menthone (14–32%), menthofuran (1–9%), isomenthone (2–10%), menthyl acetate (3–5%), menthol (30–55%), pulegone (not more than 4.0%) and carvone (not more than 1.0%). The ratio of 1, 8- cineole to limonene should be greater than 2.0[8,9].

***Mentha piperita* L. and dental care:**

M. piperita L. is used in making oral dentifrices as it can provide overall freshness in breath and also keep

away bad breath[2]. Mentha is used in preparations used as mouthwashes to remove dental plaque[11,12].

The aqueous extract of *Mentha piperita* (linn.) has inhibited the initiation and promotion of oral dysplastic lesions[13] and for treatment of inflammation of the oral mucosa[14].

Anti-bacterial effect against cariogenic bacteria:

The oral cavity contains a wide variety of oral bacteria, but only a few specific species of bacteria are believed to cause dental caries namely *Streptococcus mutans*, *Lactobacillus acidophilus*, *Actinomyces viscosus*, *Nocardia* spp. *Streptococcus mutans* are most closely associated with caries[15].The essential oil of *M. piperita* L. has strong antibacterial activity against *S. mutans* and lactobacilli responsible for dental caries[16,17,18,12]. Essential oil and peppermint leaves are used for making mouth rinses and gels that affect the periodontal bacteria[19].

M. piperita has been proved to have antimicrobial activity against oral microorganisms and can be used as an alternative medicine and as an adjunct to the conventional therapy, which would help the countries which are developing and having financial constraints and with limited oral health care facility for the concerned population[20]. Menthol is also used as a mouthwash which is effective as an anti-plaque and anti-gingivitis agent[21].

TRADITIONAL USES

Peppermint has traditionally been used as a rubefacient[22]**.**

The essential oil from *Mentha* is used topically to treat oral mucosal inflammation and also an antimicrobial and an ingredient in many analgesic creams. Approved for internal use, the oil from *Mentha* is also used to treat bile duct discomfort, irritable bowel syndrome, myalgia and neuralgia, inflammation of the oral mucosa, discomfort from menstrual cramps, secondary amenorrhea and oligomenorrhea, and diverticulitis and is used as an anti-inflammatory and expectorant[23].

In India, Peppermint oil (as well as peppermint leaf) has been used internally as an antispasmodic (upper gastrointestinal tract and bile ducts) and to treat irritable bowel syndrome, catarrh of the respiratory tract, and inflammation of the oral mucosa. Externally, peppermint oil has been used for myalgia and neuralgia, to relieve menstrual cramps and used externally for neuralgia, myalgia, headaches, migraines, and chicken pox. In addition, Peppermint plants have been used for many conditions, including loss of appetite, common cold, bronchitis, sinusitis, fever, nausea, vomiting, and indigestion. In Finland, Peppermint uses include irritable bowel syndrome, flatulence, indigestion, nausea, vomiting, cough, and bronchitis. While in USA, the odors of peppermint serve as central nervous system stimulant and are used to decrease fatigue[23].

PHARMACOLOGICAL PROPERTIES

Anti-bacterial activity

Peppermint oil and different extracts of *Mentha piperita* possess potent antibacterial activity against some Gram-positive and Gram-negative bacteria strains[24,25,] and its ability to on the adherence and retention of bacteria in dental biofilm[26].

Anti-microbial activity

Menthol is virucidal against Influenza, Herpes and other viruses *in vitro*[27]. Aqueous extracts of *M. Piperita* L., *M. Piperita* L. oil and menthol have mild antibacterial effects against both Gram-positive and Gram-negative bacteria[28,29,30,31]. *M. Piperita* L. extracts are bacteriostatic against *Streptococcus thermophilus* and *Lactobacillus bulgaricus*[32]. Menthol is bactericidal against strains like *Staphylococcus pyogenes*, *S. aureus*, *Streptococcus pyogenes*, *Serratia marcescens*, *Escherichia coli*, and *Mycobacterium avium*[28,32]. Menthol and peppermint oil are fungicidal against *Candida albicans*[34], *Aspergillus albus* and dermatophytic fungi[28].

Anti-oxidant activity

The oil and different extracts of *M. piperita* exhibit significant antioxidant activity[31].

Cardiovascular activity

*M. piperita*is said to have vasodilating properties on some animals. It has a lowering effect on the heart rate and the systolic pressure. Relaxation of bronchial smooth muscles, increase in the ventilation are also other cardiovascular effects of peppermint oil[35].

Gastrointestinal Benefits

M. piperita L. is used for treatment of non-obstructive dyspepsia without any known side effects. It improves the gastric emptying rate. There is a significant antiemetic effect of peppermint in reducing postoperative nausea for patients with very sensitive gag reflexes[2].

Neuropsychiatric effects

Some studies have suggested that peppermint is a central nervous system stimulant. Studies have been conducted on the effectiveness of aromas on cognitive performance, perceived physical workload, and pain responses were conducted based on possible changes in the brain activity[2].

Endocrine effects

Certain researches have proved that there was a statistically significant increase in the secretion of endocrine hormones[35]. In one study there was a noted segmental maturation arrest in the somniferous tubules however, the effects of *M. spicata* L. extended from maturation arrest to diffuse germ cell aplasia in relation to the dose. Other than this there are not many significantly known effects on the human endocrine system.

Effect on skin and mucous membrane

M. piperita L. is said to be a good analgesic to be applied topically and also a coolant for the skin. *M. piperita* L. oil stimulates cold receptors on the skin and dilates blood vessels, causing a sensation of coldness and an analgesic effect[35]. Menthol is a topical vasodilator that enhances the absorption of other topical skin medications. It is said that menthol enhances the absorption of cortisone, mannitol, indomethacin, morphine hydrochloride, and propranolol[28,29]. Menthol moderates oral sensations of warmth and coldness[30,36]. In low concentrations, topical application of menthol causes a cooling sensation, while in high concentrations it causes irritation and

local anesthesia[37]. It also increases cutaneous blood flow, muscle temperature, and skin temperature after topical application of the oil. Some studies have claimed that menthol has reduced histamine induced irritation and itching.

Immune modulation

Menthol has anti-inflammatory effects when applied topically. In one study it was claimed that it could suppress antigen induced allergies. Menthol also has a property of inhibiting cutaneous anaphylaxis that's mediated by IgE antibody[2].

Anti-spasmodic activity

Previous studies have shown that various kinds of mint were effective in reducing muscle pain[57] muscle relaxation, and reduce fatigue. Until now, many researchers have been done on the effectiveness of various kinds of natural products in the improvement of sport performances. Mint is a herb which is well known for its antispasmodic, painkilling[27,38], anti-inflammatory, antispasmodic, decongestant, and antioxidant effects. Peppermint is one of the mentha species (i.e., *M. piperita*, peppermint oil, *M. arvensis*, cornmint oil[40]. Menthol and menthone are the major components of the peppermint essential oil. External application of peppermint extract raised the pain threshold in human[41]. Peppermint aroma was also effective on perceived physical workload, temporal workload, effort, and anxiety[42]. According to certain *in vitro* studies conducted on the antispasmodic effect of peppermint oil, peppermint relaxes gastrointestinal smooth muscle spasm by reducing calcium influx in both guinea pig large intestine and rabbit jejunum.

Anti-headache activity

Since ancient times, herbal therapy has been used as treatment for headache disorders. Consumption of peppermint and derivatives is the best target for headache therapy in combination in relieving patients' headache pain[7].

Effect on hepatic enzymes

The aqueous extract of peppermint (at concentration 2% v/v) can modulate of phase I and phase II drug metabolizing enzymes. In phase I, a variety of enzymes act to introduce reactive and polar groups into their substrates. Phase II biotransformation reactions generally serve as a detoxifying step in drug metabolism. The peppermint alcoholic extract ameliorated the adverse effects of CCl_4 on growth performance and liver function, therefore it was indicated that it might be useful for the prevention of oxidative stress-induced hepatotoxicity[7].

Radio protective Effects

The effectiveness of peppermint alcoholic extract against radiation induced morbidity and mortality using the optimum dose of 100 mg/kg for 3 consecutive days. The antioxidant and free radical scavenging activities of leaf extract of peppermint are directly related to its mechanism of radiation protection. Several mechanisms such as antioxidant activity, immune response, and enhanced recovery of bone marrow have been suggested for chemo prevention and radioprotection of peppermint extracts[7].

Adult Dosing (Age>18)

Oral dosage:

- **Colonic spasm:** 8mL of peppermint oil solution has been used.
- **Cough:** 75% menthol in eucalyptus oil has been used to suppress cough induced by 33µM citric acid[43].
- **Digestive disorders:** 0.2-0.4mL of peppermint oil has been used three times daily in dilute preparations or suspension[44].
- **Esophageal spasm:** Five drops of peppermint oil in 10mL of water has been used[45].
- **Gastric spasm:** 16mL of peppermint oil dissolved in hot water and infused intra-luminally has been used during upper endoscopy[46].
- **Irritable bowel syndrome (IBS):** 0.2- 0.4mL of peppermint oil or 187-374mg of peppermint oil in a thixotropic gel) has been used three times daily15-30 minutes before meals for up to one month[2], 180-200mgenteric-coated peppermint oil has also been used[47].
- **Sore throat:** Lozenges that contain 2-10mg of peppermint oil have been used, according to secondary sources.
- **Vomiting:** 3-6g of leaf and 5-15g of tincture have been used as an antiemetic, according to secondary sources.

Other traditional dosing:

The following doses of peppermint have been used traditionally for various indications of gastrointestinal tract, gall bladder, and bile duct, and there is no proven dosing regimen[48].

- **Dried extract:** 2-4g of dried herb extract three times daily.
- **Infusion:** 1.5-3g of peppermint oil in 150mL of water three times daily.
- **Spirits:** (10% oil and 1% leaf extract) 1mL (20 drops) with water.
- **Tea:** 3g of dried peppermint leaves in 250mL of boiling water, approximately 3-4 cups daily between meals for gastrointestinal symptoms.
- **Tincture:** (1:5 preparation 45% ethanol) 2-3mL three times daily.

Topical dosage:

- **Tension headache:** A combination of eucalyptus and peppermint oil (19% in ethanol solution) has been applied to the temples at the onset of the symptoms and applied hourly across the forehead and temples, and repeated every 15-30 minutes[49].
- **Post-herpetic neuralgia:** 2-4 drops of peppermint oil (standardized to 10% menthol) massaged in skin 3-4 times per day has beenused[50].

Inhalation dosage

Congestion: Traditionally, 3-4 drops of oil added to hot water and inhaled has been used to relieve congestion. Alternatively, 62.5mgmenthol in 1mL petrolatum has been applied and inhaled in treating nasal congestion[27].

Parenteral dosage

Caution: From one case study, peppermint oil should not be injected, as it may cause pulmonary edema by direct toxicity and an increase in pulmonary vascular permeability[51].

Caution: Avoid topical use of peppermint oil around the facial or chest areas of infants and young children, especially around the nose, because the menthol constituent can induce apnea, laryngeal and bronchial spasm, acute respiratory distress with cyanosis, or respiratory arrest if applied directly to the nasal and the chest areas[52].

Toxicological investigations

The oral LD_{50} in Wistar male rats was found to be 4.4g/kg after 24hours and 2.4g/kg after 48 hours[53.]

The intraperitoneal LD_{50} of peppermint oil U.S.P. was determined to be 819mg/kg after 24hours[52]. Rats administered peppermint oil and pulegone (a constituent of peppermint oil) up to 100-160mg/kg body weight per day developed brain lesions and encephalopathy after 28 days[54]. Pulegone, at doses of 80-160mg for 28 days, induced atonia, weight loss, decreased blood creatinine, and histopathological changes in the liver in an animal study[54]. Ataxia and convulsions have occurred in single doses of 3, 4, and 5g/kg of peppermint oil in an animal study[55]. Cyst-like spaces in the white matter of the cerebellum were observed after 90 days of peppermint oil administration at doses of 10, 40, 100mg/kg body weight per day in an animal study[54]. In rats given menthone orally, there was a decrease in creatinine, and increases in alkaline phosphatase, bilirubin, and liver and spleen size[56,58]. The no-effect level was < 200 mg menthone per kilogram of body weight per day. In one case study, injection of peppermint oil resulted in pulmonary edema and acute lung injury, presumably due to direct toxicity and a resultant increase in pulmonary vascular permeability[50.]

CONCLUSION

Concerning the importance of Peppermint in the remedy of dental caries, it can be considered as one of the potent and highly safe drugs used for their treatment due to its effective antibacterial activity against cariogenic bacteria. It has a bright future in this field for its great benefits and its safety for use in humans without any considerable side effects or contraindications.

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