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Review article

Physiological and pharmaceutical properties of peppermint as a multipurpose and valuable medicinal plant

M. Akbari^a, P. Ezati^b, M. Nazari^c, N. Moradi kor^{c,*}

^aDepartment of Animal Sciences, College of Agriculture and Natural Resources, Razi University, Kermanshah, Iran.

^bDepartment of Food Hygiene and Safety, Faculty of Health, Shahid Sadoughi University of Medical Sciences, Yazd, Iran.

^cResearch Center of Physiology, Faculty of Medicine, Semnan University of Medical Sciences, Semnan, Iran.

*Corresponding author; Research Center of Physiology, Faculty of Medicine, Semnan University of Medical Sciences, Semnan, Iran.

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ABSTRACT

Peppermint is one of the oldest and most highly regarded herbs for appeasing digestion and may also restore digestive efficiency. In addition, peppermint has been known as disorders improving including: analgesic, ulcer, anti-spasmodic, anti-bloat, irritable bowel syndrome or gastrointestinal motility, and immune system stimulant and etc. Peppermint essential oil has biological activities, such as antibacterial, antifungal and antioxidant properties. In animal studies peppermint essential oil along chromium picolinate improved blood parameters in broiler chicks reared under heat stress condition. Peppermint essential oil stimulated immune system in broiler chicks. Furthermore peppermint not only improved disorder's digestive system, also peppermint had antimicrobial and antioxidant effects. Moreover peppermint was efficient in blood parameters improvement and immune system stimulation in birds. To achieve these goals with regard to sustainable medical uses, we reviewed a summary of introduction, history, active constituents physiological and pharmacology uses of peppermint with concerning on essential oil in this paper.

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1. Introduction

The most of the world population currently depended on medicinal herbs for their primary health needs, and most of this therapy involves the use of plant extracts, often in aqueous solutions (Zhang 2002). The essential oils or (volatile or ethereal oils) are aromatic oily liquids produced from plant material. Volatile oils specially consist of two classes of compounds, the terpenes and phenylpropenes relies on the number of 5-carbon building blocks. Peppermint (*Mentha piperita*) is a medicinal plant of the *Labiatae* family and possibly originated in Eastern Asia. Peppermint powder or essential oil used in many foods, cosmetic and pharmaceutical products. There were differences in active constituents between peppermint leaves and oil that may be explained by variety, geographical region and processing conditions (Ruizdel et al., 2003; Pino et al., 2002). Peppermint commonly used as medicinal herb because was benefit in building the immune system and fighting secondary infections. Peppermint essential oil has antibacterial activities because it was contained menthol (Schuhmacher et al., 2003). Menthol is mostly responsible for digestive system disorders including: stimulation of bile flow, reduces the tone in the esophageal sphincter, facilitates belching, and has antibacterial properties (Fleming 1998; Tyler 1992). Furthermore peppermint commonly used as a local anesthetic agent in cold and cough preparations and in liniments for insect bites, eczema, poison ivy, hemorrhoids, toothaches, and musculoskeletal pain (Murray, 1995; Peirce, 1999). It is thought to provide a local anesthetic action on the lungs and throat, repressing the cough reflex (Robbers and Tyler 1999). Also, peppermint essential oil was contained a rich source of polyphenolic compounds and hence could possess power antioxidant properties (Dorman et al. 2003). This benefit of medicinal plant is due the presence of phytochemicals active components including vitamins, flavonoids, terpenoids, carotenoids, coumarins, curcumins, lignin, saponin, plant sterol and etc (Bukhari et al., 2008).

2. History of peppermint

Peppermint (*Mentha piperita* L.) is a sterile hybrid of spearmint (*Mentha spicata*) and water mint (*Mentha aquatica*), which was first recorded as budding in a field of spearmint growing in England in 1696. Since then, it has been intensively extended for its fragrant oil. It is a perennial herb, growing to the size of 1m together with stream banks and wastelands during much of Europe and North America. Essential oil of peppermint is acquired by steam distillation from the fresh aboveground parts of the flowering plant of *Mentha piperita* L.

3. Active constituents

The table 1 shows the various constituents of peppermint oil as per monographs of International Pharmacopoeia (Alankar, 2009).

Table 1
The various constituents of peppermint oil.

Constituents	Amount (%)
Menthol	30.0-55.0
Menthone	14.0-32.0
Cineole	3.5-14.0
Isomenthone	1.5-10.0
Menthyl acetate	2.8-10.0
Menthofuran	1.0-9.0
Limonene	1.0-5.0
Pulegone	Max. 4.0
Carvone	Max. 1.0
Isopulegol	Max. 0.2

4. Medicinal uses

4.1. Peppermint essential oil benefits in digestive system

4.1.1. Ulcer

From old times, herbs have been proved to be powerful therapeutic responsible for ulcer. Because searches has been focused on natural products with antiulcer properties. Therapy by medicinal plant compared as commercial drugs is better because gastric ulcer therapy faces a major drawback in modern days due to the unpredictable side effects of the long-term uses of commercially available drugs. On other hand, ulcer consequent factors such as activity *H. Pylori* in stomach. There is only one study showing dietary peppermint essential oil resulted in preventing of activity *H. Pylori* and *S. aurous* (Lis-Balchin, 2006).

4.1.2. Anti-spasmodic effect

Peppermint is well known as anti-spasmodic. Although the mechanism the association are not understood; but it's believed peppermint relaxes gastrointestinal smooth muscle by reducing calcium influx in both large intestine and jejunum (Pizzorno, 1999; Cappello et al., 2007). There is a study showing similar mechanism in animals. Hawthorn et al. (1988) reported an action of peppermint essential oil or menthol on calcium channel blocking activity in atrial and papillary muscle or brain synaptosomes (rat) or atrial and papillary muscle (guinea pig) and retinal neurons (chick).

4.1.3. Anti-bloat effect of peppermint

The peppermint essential oil pharmacological action (Anti-bloat) in humans are well cleared but although the mechanism of this association is not understood. The mechanism may be results of gas pressure reduce in stomach (Pizzorno, 1999) and or to equal stomach gas pressure with esophagus (Mills and Bone, 2000). There is evidence showing effectiveness peppermint in decrease intestine gas (Mills and Bone 2000). They showed the pills produced of peppermint decreased intestine gas pressure.

4.1.4. Gastrointestinal motility

In vitro and *in vivo* studies showed suppressivity impacts of peppermint oil on gastrointestinal motility (Leicester and Hunt, 1982; Taddei, 1988). The idea confirmed by Beesley et al. (1996) who reported a mechanism of peppermint essential oil on gastrointestinal motility. The spasmolytic action of peppermint oil was demonstrated on isolated rabbit and rat intestine in 1921 (Gunn, 1921). Studies showed peppermint essential oil benefit on gastrointestinal motility, although the mechanism of this association is not understood. A calcium antagonistic effect of menthol was found (Hawthorn et al., 1988). Both gastric motility and secretion are affected by substance (Smith et al., 2000) and many lines of evidence suggest that material plays an important action in nociception at the spinal level (Hokfelt et al., 2001). Recent studies have shown a non-competitive prevent of the contraction response induced by 5-hydroxytryptamine and substance on isolated smooth muscles (Hills and Aaronson, 1991). Therefore; a neuronal site of action of peppermint oil could also be possible. Moreover, a direct epithelial site of action was observed on small intestinal enterocytes.

4.1.5. Irritable Bowel Syndrome (IBS)

Small intestine bacterial overgrowth and lactose intolerance are related with increased gas production, which may sometimes trigger abdominal discomfort and bloating which are also considered also the cardinal symptoms in IBS (Pimentel et al., 2003; Vernia et al., 2001). Furthermore, a high prevalence of celiac disease has been observed in patients with bloating and diarrhea and positive H₂-lactose breath test. Marzio (2007) showed improvements in patients with irritable bowel syndrome were treated with peppermint oil for 4 weeks oil. In other study Beesley et al. (1996) showed peppermint oil at rates 0.5 and 1 mg/ml inhibited enterocyte glucose uptake through a direct role in the brush border membrane.

4.2. Peppermint essential oil benefits in other systems

4.2.1. Skin and mucus membranes

Peppermint oil motivates cold receptors on the skin and dilates blood vessels, furthermore caused a sensation of coldness and an analgesic impact (Anonymous, 1999).

4.2.2. Growth stimulant

Animal studies showed positive effects of peppermint on growth stimulant. Al-Ankari et al. (2004) observed the beneficial influence of wild mint on broilers productive performance but later in another study Ocak et al. (2008) failed to monitor any significant effect of dry peppermint on broiler performance. Seem active principles of essential oils (menthol in peppermint) act as a digestibility enhancer, balancing the gut microbial ecosystem and stimulating the secretion of endogenous digestive enzymes and thus improve growth (Cross et al., 2007). There is evidence showing application mint as indigestion disorders and colonic spasms by reducing the gastrocholic reflux (Spirling and Daniels, 2001).

4.2.3. Immunomodulation

Nickels (1996) mentioned that peppermint oil protect the structural integrity of immune cells due to its strong antioxidant action which protects cell membrane from free radical oxidants, thereby resulted as an improving immune response. According to Mekay and Blumberg (2006), peppermint oil has a significant antimicrobial, antitumor, antiviral, immunomodulating and chemo preventive potential. Iscan et al. (2002) and Schuhmacher et al. (2003) reported that peppermint oil had also antimicrobial effect against wide range of bacteria which decreased the general healthy conditions of animal that may be reflected in increased immune response. Awwad et al. (2010) reported eucalyptus and peppermint oils demonstrate to be able to perform innate-cell mediated, humoral immune response and have a potent immunomodulatory impact in broiler chicks.

4.2.4. Ascites syndrome

Oxygen default resulting several factors such as low temperature, presence of cartilaginous and bony nodules in lungs and pulmonary disease such as bronchitis, mycoplasmosis, colibacillosis and aspergillosis, fast growth, height, poisoning, inappropriate ventilation (Decuyper et al., 2000). However, the syndrome can be appear after disease such as chronic respiratory disease complex and infective bronchitis as a result of complication (Calnek et al., 1991). It's well known that peppermint extraction has anti-cough and nasal decongestant effects which are causes to reduce in surface tension of synthetic surfactant that can reduce pulmonary surface tension. Peppermint essential oil application resulted in destruction of airways discharges. On other hand utilization of peppermint essential oils resulted in decreasing of mucosal hypertrophy, losses of goblet cell and mucosal accumulations in trachea and minimizing the neutrophils infiltration. All above mentioned remarks causes increase in animal productivity against secondary respiratory infections (Elie et al., 2006). Menthol stimulates the same reflex inhibition of respiration in humans (De Cort, 1993).

4.2.5. Blood parameters

Unfortunately, we could find no human study in the literature showing the effect of peppermint essential oil on blood parameters but Akbari and Toriki (2014) in an animal study showed peppermint essential oil along chromium picolinate decreased the serum concentration of glucose and triglycerides in broiler chicks reared under heat stress condition. Akbari and Toriki (2014) believed the mechanism may be explained by antioxidant properties of chromium picolinate and peppermint essential oil because antioxidants decrease, lipid peroxidation increases in the plasma and tissues. Of course, Teissedre and Waterhouse (2000) showed a mutual relation among the total phenol content of essential oils and human low-density lipoprotein oxidation in vitro.

5. Other benefits

5.1. Antioxidant properties

Antioxidants have been greatly used as food additives to supply protection against oxidative degradation of foods by free radicals. Since ancient times, herbs applied in different types of food to improve flavours are known

to have antioxidant capacities. Antioxidants serve to maintain these highly reactive free radicals, thereby maintaining the structural and functional integrity of cells. Herbs of the *Labiatae* family have been extensively studied for their antioxidant activity. *Labiatae* family is well known for its antioxidant activity and demonstrated a considerable effect on inhibition or delaying the process of lard oxidation (Economou et al., 1991). The phenolic compounds may contribute directly to the antioxidant action; therefore, it is necessary to investigate total phenolic content. The amounts of total phenolic compounds were higher in ethanol extract while lowest for essential oil. Antioxidants are important for the immune defense and health of humans and animals. According report Kamkar et al. (2009) who indicated that *in vitro* condition, ethanolic extract of *Mentha* genera has noticeable antioxidant ability against various oxidative systems; moreover, this extract can be used as an accessible source of natural antioxidants in possible food supplement or in pharmaceutical industry. On other hand, peppermint is also a rich source of polyphenolic compounds and hence could possess strong antioxidant activities (Dorman et al., 2003).

5.2. Antimicrobial and anti-fungal activities

Mentha piperita L. (Peppermint oil), widely was applied for microbial activity against different microbial species; in low concentrations (*S.aureus*, *E.coli*). In *in vitro* study peppermint oil and menthol have demonstrate antibacterial effects against both gram-positive and gram-negative bacteria (El-Kady et al., 1993; Moleyar and Narasimham, 1992). Tassou et al. (2000) demonstrated that peppermint contained antibacterial agents such as; menthol, pulegone, isomenthone, piperitone, carvone and dehydrocarvone. The efficiency of material was depended on the concentration (Beuchat and Golden, 1998). Gram-positive bacteria were more sensitive compared as gram-negative bacteria, probability the mechanism related to outer membrane in gram-negative bacteria. Antibacterial action has been attributed to complex of cell membrane. Peppermint extracts are bacteriostatic against *Streptococcus thermophilus* and *Lactobacillus bulgaricus* (Bayoumi, 1992). Menthol is bactericidal against *Staphylococcus pyogenes*, *Staphylococcus aureus*, *Streptococcus pyogenes*, *Serratia marcescens*, *Escherichia coli*, and *Mycobacterium avium*. In one experiment, peppermint extraction has antibacterial effects against *E.coli*, *Clostridium perfringens*, *Lactobacillus bulgaricus*, and *Streptococcus thermophilus* (Lelander et al., 1998). In an animal study Barbour et al. (2010) reported essential oil of peppermint was effective against on *Influenza*, *Herpes* and other viruses. Aqueous extracts of peppermint leaves were antiviral against *Influenza A*, *Newcastle disease virus*, *Herpes simplex virus*, and *Vaccinia virus* in egg and cell-culture systems (Herrmann and Kucera, 1967). Peppermint oil is also active against an acyclovir resistant strain of HSV-1 (HSV-1-ACVres) plaque formation was significantly reduced by 99%. Considering the lipophilic nature of the oil which makes capable it to permeate the skin, peppermint oil might be profit for topical therapeutic use as virucidal agent in recurrent herpes infection (Schuhmacher et al. 2003). Dilution (5.0%) of concentrated peppermint water has now been shown to exhibit considerable fungi static but was not efficient against strains of *Aspergik niger* and *Penicillium ckysogenum* (Hugbo, 1982). In *in vitro* condition menthol and peppermint oil are fungicidal against *Candida albicans*, *Aspergillus albus* and *dermatophytic* fungi (El-Kady et al., 1993; Pattnaik et al., 1996).

6. Toxicity and side effects

Herbal medicines are used greatly in the world, and according to a recent survey, the majority of people who employ herbal medicines do not inform their physicians about their use. Herbal medicines can cause undesirable results and confusion in proper diagnosis. Herbal medicines can change test results by direct interference with certain immunoassays. Drug herb interactions can result in unexpected concentrations of therapeutic drugs. Peppermint is considered on the FDA's list of herbs generally recognized as safe (GRAS) only times used as food or as a beverage. Contrary reactions to enteric coated peppermint oil capsules are rare but can include hypersensitivity reaction, contact dermatitis, abdominal pain, heartburn, perianal burning, bradycardia and muscle tremor. Inhalation of menthol can cause apnea and largoconstriction in newborn infants and susceptible individuals. In rats, doses of 80 and 160 mg of pulgeone for 28 days caused atonia, weight loss, reduced blood creatinine content, and histopathological alters in the liver and the white matter of the cerebellum. Menthol causes hepatocellular changes in rats (Thorup et al., 1983).

7. Conclusion

It can be concluded that peppermint alleviate disorders in body systems. Peppermint essential oil improved digestive system disorders in terms anti-spasmodic, anti-bloat, ulcer, IBS and etc. Moreover peppermint improved syndrome ascites and stimulated growth and immune system. Peppermint had antimicrobial and antioxidant properties that can effectively be used as natural antimicrobial and antioxidant in foods. Also peppermint essential oil decreased the serum content of glucose and triglycerides in birds. It was concluded peppermint is a suitable medicinal plant and needs much more attention.

The authors declare that they have no conflict of interest.

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