

## Mentha: A review on its bioactive compounds and potential health benefits

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Received: 23 May 2022; Accepted: 4 August 2022; Published: 21 October 2022

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REVIEW ARTICLE

### Abstract

Mint (*Mentha*) is a medicinal herb, which possesses a lot of bioactive components. Globally, it has been used as a flavor enhancer in foods. Due to the presence of phenolic acids and flavonoids, it is considered to have a greater number of antioxidants. Mint has been linked to physiological benefits to humans that include protection against microbes; anticancer and antiallergenic properties; positive effects in reducing blood sugar; analgesic property; cures loose motion, indigestion, gas, and irritation bowel syndrome; gives relief from respiratory problems; has wound healing activity; , and is good for breastfeeding. The present paper reviews the evidence-based research regarding the bioactive components and health benefits of the mint plant.

**Keywords:** bioactive components; food; mint plant; sensory acceptability; therapeutic properties

### Introduction

Plants possess thousands of bioactive compounds, which are nontoxic and largely effective substitutes with an almost negligible negative consequence. A lot of physiological beneficial activity of these bioactive compounds has been observed, for instance, antimicrobial, antineoplastic, antioxidant, hypoglycemic, analgesic, antidiarrheal as well as wound care properties. These plants contain natural products, which are present in pure form and in a combined form that can be obtained by extraction. The chemical diversity of such plants cannot be matched with others so there are boundless opportunities. As a result of greater demand for chemical diversity in the selection process, in search of natural produce, awareness has increased regarding eatable floras globally. Medicinal uses of herbal plants have increased because of various types

of bioactive compounds. These bioactive compounds help in the treatment of various types of diseases (Amiri *et al.*, 2021; Duraipandiyar *et al.*, 2006; Wani and Kumar, 2018).

Due to the development of negative effects and microbial resistance to the drugs which are synthesized chemically, experts turned to ethnopharmacognosy. These phytochemicals are not only safe but also effective replacements with negligible side effects. There are thousands of plants in this world with health benefits. It should be our priority to introduce such plants to all so that the advantages of such plants can be experienced by one and all. In the present review paper, our main aim was to highlight the chemical constituents and main health benefits of the mint plant.

The genus *Mentha* L. (Lamiaceae) can be found globally and also in many environments. *Mentha* commonly

called Mint (Figure 1) is a collection of about 15–25 plant species. Because of its medicinal value, there is a huge demand in both the food and pharmaceutical industries. In our day-to-day life, mint is used for its flavoring and health beneficial properties. Presently, it is one of the most economically significant medicinal and aromatic crops. Mint is the richest source of antioxidants, as quantified by various antioxidant activity tests. Extract of mint possesses good total phenolic and flavonoid contents (Anwar *et al.*, 2019; Kanatt *et al.*, 2007).

### Taxonomy

The Mentheae tribe of Nepetoideae subfamily belongs to the Lamiaceae family. In the 65 genera of tribe Mentheae, more than 3000 names of genus *Mentha* have been published and most of them are illegitimate names. Their taxonomy is challenging because the nature of hybridization of the genus is easy. Hybrid seeds yield variable offspring; they can multiply by vegetative propagation. This variability has come with an outbreak of species and sub-specific taxa. During 1911–1916 in Central Europe, one taxonomist published 434 new mint taxa (Tucker and Naczi, 2007). Fresh sources identify between 18 and 25 species. The following species have been recognized by the Plants of the World Online as of July 2019.

### Chemical Composition

The various chemical constituents of mint have a lot of economic importance. For example, various derivatives and constituents of mint oil have been used as an agent of flavor in the flavoring industry and in many types of foods, herbal products, medicine, and different perfumes. Mint oil is both water and alcohol soluble. The oil contains liquid and solid fractions, as they have hydrocarbon, which stops the crystallization of menthol. Research



Figure 1. Fresh mint leaves.

has investigated the chemical constituents present in mint (Brahmi *et al.*, 2017).

The most important chemical compounds that have been found in various species of mints are menthol and terpenes which exist both in the free state as well as in esters. One of the species, namely, Japanese mint (Table 1) contains over 90% menthol. Menthol of peppermint oil has been recognized for its medicinal properties, whereas esters, for example, menthyl acetate of peppermint is the reason for its minty taste and associated sensory fragrance (Peixoto *et al.*, 2009). Most of the literature on mint constituents emphasize their essential oils. Certainly, they are utilized in various types of food factories. Furthermore, the presence of phenolic compounds has many properties related to living.

The other important constituents of the mint plant are minerals (Potassium, Iron, Sodium, Magnesium,

Table 1. List of 24 species of genus *Mentha* with their common names.

S. No.	Species name	Common name
1.	<i>Mentha alaica</i>	-
2.	<i>Mentha aquatica</i>	water mint, marsh mint
3.	<i>Mentha arvensis</i>	Corn mint, Wild mint, Japanese peppermint, Field mint, Banana mint
4.	<i>Mentha atrolilacina</i>	Slender mint
5.	<i>Mentha australis</i>	Australian mint
6.	<i>Mentha canadensis</i>	Canada mint, American wild mint
7.	<i>Mentha cervina</i>	Hart's pennyroyal
8.	<i>Mentha cunninghamii</i>	New Zealand mint, hihoi, Maori mint
9.	<i>Mentha dahurica</i>	Dahurian thyme
10.	<i>Mentha darvasica</i>	-
11.	<i>Mentha diemenica</i>	Spreng, slender mint
12.	<i>Mentha gattefossei</i>	Maire
13.	<i>Mentha grandiflora</i>	Gray mint
14.	<i>Mentha japonica</i>	(Miq.) Makinom Hime akka
15.	<i>Mentha laxiflora</i>	Forest mint
16.	<i>Mentha longifolia</i>	Horse mint
17.	<i>Mentha micrantha</i>	Heinr.Braun
18.	<i>Mentha pamiroalaica</i>	-
19.	<i>Mentha pulegium</i>	Pennyroyal, Squaw mint
20.	<i>Mentha requienii</i>	Corsican mint
21.	<i>Mentha royleana</i>	Royle's mint
22.	<i>Mentha satuireioides</i>	Creeping mint
23.	<i>Mentha spicata</i>	Spearmint, garden mint
24.	<i>Mentha suaveolens</i>	Apple mint, pineapple mint, round leaved mint
25.	<i>Mentha piperita</i>	Peppermint

Manganese, Zinc, Calcium, Chromium, Copper, Iodine, and Selenium) and vitamins (Vitamin A, C, and carotene activity were found to be higher, while B<sub>12</sub>, thiamine, folic acid, and riboflavin were also reported).

## Essential Oils

Essential oils are complex blends of organic chemicals that are in the liquid state at room temperature and include volatile components (Palma *et al.*, 2020). The essential oils of mint plants with approximate composition are carvone (1%), pulegone (0.5–1.6%),  $\beta$ -myrcene (0.1–1.7%),  $\beta$ -caryophyllene (2–4%), limonene (1–7%), isomenthone (2–8%), menthofuran (1–10%), menthyl acetate (2–11%), 1,8-cineole (eucalyptol) (5–13%), menthone (15–32%), and menthol (33–60%) (Clark and Menary, 1981; Dimandja *et al.*, 2000; Gherman *et al.*, 2000; Pittler and Ernst, 1998; Sang, 1982). Pennyroyal oil is rich in pulegone oil obtained from *Mentha pulegium*. Pennyroyal oil of *Mentha pulegium* of Greece revealed 0.1–90.7% change in pulegone content (Shahrajabian and Wenli, 2022). Yasa *et al.* (2012) revealed the main components of *Mentha pulegium*. These include isomenthone (52.6%), pulegone (29.5%), and menthol (3.6%) in Turkey (Shahrajabian and Wenli, 2022).

These volatile oils are considered secondary metabolites and have a strong odor. They are obtained from the plants by various distillation methods (Bakkali *et al.*, 2008). Mint is being cultivated for the essential oil present in them. Certainly, the essential oil obtained from mint is amongst the most significant oils produced globally with their values touching the sky every year. For example, menthol is found abundantly in the oil produced by *M. canadensis* L. Linalool and linalyl acetate have been reported from *M. citrate*. Peppermint oil obtained from *M. piperita* L. consists of menthone, menthyl acetate, and menthol as major constituents. Carvone is found abundantly in oils from the *M. spicata*, *M. viridis*, and *M. gracilis*, with different compositions. *M. aquatica* oils are a rich source of menthofuran (Sutour *et al.*, 2008).

There are six chemotypes of *M. haplocalyx*, comprising piperitenone oxide, pulegone, menthone, menthol, carvone, and linalool (Zhao *et al.*, 2013). About 1.2–3.9% (v/w) of essential oil has been reported in the leaves of peppermint, with a count of 300 and more identified compounds. One of the most represented classes is the terpenic class, which contains monoterpenes of 52% and sesquiterpenes of 9%; however, other classes which are present in lesser amounts are 9% of aromatic hydrocarbons, 9% of aldehydes, 8% miscellaneous, 7% of lactones, and 6% of alcohols. As far as monoterpenes are concerned, the main components of menthol, menthone,

menthyl acetate, 1,8-cineole (eucalyptol), menthofuran, isomenthone, neomenthol, and limonene are present in the following percentages of 35–60%, 2–44%, 0.7–23%, 1–13%, 0.3–14%, 2–5%, 3–4% and 0.1–6%, respectively; however, the main sesquiterpene is  $\beta$ -caryophyllene (1.6–1.8%) (Riachi and De Maria, 2015). Table 2 provides data reported in various published materials on various types of mint essential oils.

**Table 2. Main components of the essential oils of some mint species as reported in the literature (Brahmi et al., 2017).**

Species	Component	Reference
Pennyroyal	Menthol	(Marzouk <i>et al.</i> , 2008; Petrakis <i>et al.</i> , 2009)
	Piperitenone	(Kokkini <i>et al.</i> , 2002)
	Piperitone	(Mahboubi and Haghi, 2008)
	Menthone	(Teixeira <i>et al.</i> , 2012)
	Pulegone	(Mata <i>et al.</i> , 2007; Boukhebt <i>et al.</i> , 2011; Reis-Vasco <i>et al.</i> , 1999; Ait-Ouazzou <i>et al.</i> , 2012; Brahmi <i>et al.</i> , 2016)
Horse mint	Cis-piperitone epoxide	(Gulluce <i>et al.</i> , 2007)
	Piperitone	(Mimica-Dukic <i>et al.</i> , 2003)
	Pulegone	(Diop <i>et al.</i> , 2016; Hajlaoui <i>et al.</i> , 2009)
<i>M. rotundifolia</i>	Menthol Morocco	(Derwich <i>et al.</i> , 2010)
	Pulegone	(El Arch <i>et al.</i> , 2003; Riahi <i>et al.</i> , 2013)
	Trans-piperitone oxide	(Avato <i>et al.</i> , 1996; Umamoto <i>et al.</i> , 1994)
	Piperitenone	(Brada <i>et al.</i> , 2007)
	Piperitol	(Perez Raya <i>et al.</i> , 1990)
	Trans-piperitone epoxide	(Brahmi <i>et al.</i> , 2016)
	Lippione	(Koyalta <i>et al.</i> , 1993)
	Carvone	(Galambosi <i>et al.</i> , 1998)
	2,4(8),6-p-Menthatrien-2,3-diol	(Pino <i>et al.</i> , 1999)
	Cis-piperitone oxide	(Brada <i>et al.</i> , 2006)
Spearmint	Piperitenone oxide	(Oumzil <i>et al.</i> , 2002; Brada <i>et al.</i> , 2007)
	Pulegone	(Gonçalves <i>et al.</i> , 2009)
	Piperitone	(Telci <i>et al.</i> , 2010)
	Piperitenone oxide	(Koliopoulos <i>et al.</i> , 2010)
	Carvone	(Mkaddem <i>et al.</i> , 2009; Zhao <i>et al.</i> , 2013; Adam <i>et al.</i> , 1998; Mata <i>et al.</i> , 2007; Hussain <i>et al.</i> , 2010; Govindarajan <i>et al.</i> , 2012)

## Phenolic Compounds

These compounds are distributed widely in plants, with more than 8000 molecules. They can be smaller or larger complex molecules with a minimum of one aromatic ring and one or more -OH sets. Naturally, they can be in the form of esters and glycosides (Pereira *et al.*, 2016).

A wide range of constituents in the different species of mint has been found such as aglycon, cinnamic acids, acylated flavonoids, and/or glycoside (Dorman *et al.*, 2003). The abundance of caffeic acid, rosmarinic acid, and chlorogenic acid among the phenolic acids have been observed in mint (Dorman *et al.*, 2003; Kapp *et al.*, 2013; Lv *et al.*, 2013; Pereira *et al.*, 2016; Riachi and Maria, 2015). Triantaphyllou *et al.* (2001) found esters of phenolic carboxylic acids and hydroxylated glycosidic flavonoids and other derivatives of flavonoids from the extracts of mint. Moreover, mint plants possess about seven salvianolic acids, including, salvianolic acid H/I, isosalvianolic acid A, salvianolic acid B, and salvianolic acid E. (Kapp, 2015).

As far as flavonoids are concerned, mint plants have flavanones and flavones in abundance. Among the flavones, mainly luteolin and its derivatives are reported by Kapp (2015). In the aqueous extracts of mint species, constituents found comprise eriodictyol, luteolin-7-*O*-glucoside, eriocitrin, apigenin, naringenin-7-*O*-glucoside, luteolin and isorhoifolin (Dorman *et al.*, 2003). Moreover, glycoside eriocitrin was found as the main constituent in aqueous mint decoction (Areias *et al.*, 2001).

From the extracts of dried water mint, spearmint, peppermint, and Bergamot mint, lipophilic methylated flavonoids have been reported in older literature. Twenty flavonoids have been recognized. In spearmint and peppermint, 5, 6-Dihydroxy-7,8, 3',4'-tetramethoxyflavone has been reported to be the main bioflavonoid. In water mint and Bergamot mint, 5-hydroxy-6, 7, 8, 4'-tetramethoxyflavone (gardenin B) has been considered to be the main constituent (Voinin *et al.*, 1999).

Bahadori *et al.* (2018) investigated a comparative RP-HPLC-DAD analysis amongst ethanolic extract and infusion of *Mentha longifolia*. The results showed the existence of sixteen compounds including ten phenolic acids and six flavonoids in the experimented samples. Relative analysis revealed the presence of compounds in both ethanolic extract and infusion of *Mentha longifolia* but with different quantities. The structures of the identified phenolic compounds are shown in Figure 2. From the results, it was noticed that Sinapic and rosmarinic acid are in abundance, followed by hesperidin and o-coumaric acid. As per literature review, *Mentha* species are abundant in phenolics and particularly phenolic

acids. Furthermore, it appears that rosmarinic acid is the rich phenolic compound in the genus.

## Other Compounds

There are studies that show the presence of other compounds in *Mentha*. Smaller quantities of a number of other compounds have been found in spearmint and peppermint (Choudhury *et al.*, 2006; Kizil *et al.*, 2010). The *M. piperita* leaves possess major compounds like palmitic, linolenic, and linoleic (Pérez *et al.*, 2014). In some species of the mint, presence of free fatty acids, diacylglycerol, and triacylglycerol have been observed. In the leaves of some species such as horsemint, *M. crispata*, and sachalin mint, high levels of C18:3 have been reported (Maffei and Scannerini, 1992ab). Moreover, recently from the methanolic extract of horsemint two new ceramides have been reported, longifoamides A and B (Kunnumakkara *et al.*, 2009). The upper ground parts of the same plant, that is, horsemint, steroids, and triterpenoids were reported. Steroids include  $\beta$ -sitosterol, stigmast-5-en-3-one, and stigmast-5-en-3- $\beta$ -yl formate and triterpenoids, including uvaol and ursolic acid (Ertaş *et al.*, 2015). Alternatively, various types of pigments have been found in different species of mint. For instance, pigments like carotenes and xanthophylls (lutein, neoxanthin, zeaxanthin, and violaxanthin) (Raju *et al.*, 2007) and chlorophyll a and b (Curutchet *et al.*, 2014; Dambrauskienė *et al.*, 2008) were reported in spearmint. From the *M. piperita* tea,  $\beta$ -carotene and lutein isomers were identified; however, lutein was found in mixture (Riachi and De Maria, 2015). Vitamins like vitamin E and vitamin C were found in mint (Dambrauskienė *et al.*, 2008; Riachi and De Maria, 2015). Research has also revealed the presence of anthraquinones, saponins, quinines, and alkaloids (Padmini *et al.*, 2008). However, while investigating using HPTLC, the results obtained were totally surprising and should be verified in detail.

## Effect of Drying on Phytochemicals of *Mentha*

Drying is an ancient method of preserving the essence of fragrant and medicinal herbs. It entails removing moisture from the herbs to the point where microbial spoilage and degradation responses are greatly reduced (Rocha *et al.*, 2011). To preserve medicinal herbs, a number of drying processes are used, including oven, microwave drying, freeze-drying, and so on (Harbourne *et al.*, 2009). The most common drying method is hot air drying; however, it can cause heat destruction and drastically destroy the color and volatiles of plants (Antal *et al.*, 2011). Volatiles are retained at a lower temperature range, below 50°C. But, when related to freeze-drying, hot air drying resulted in a 60% reduction of phenolics as well as

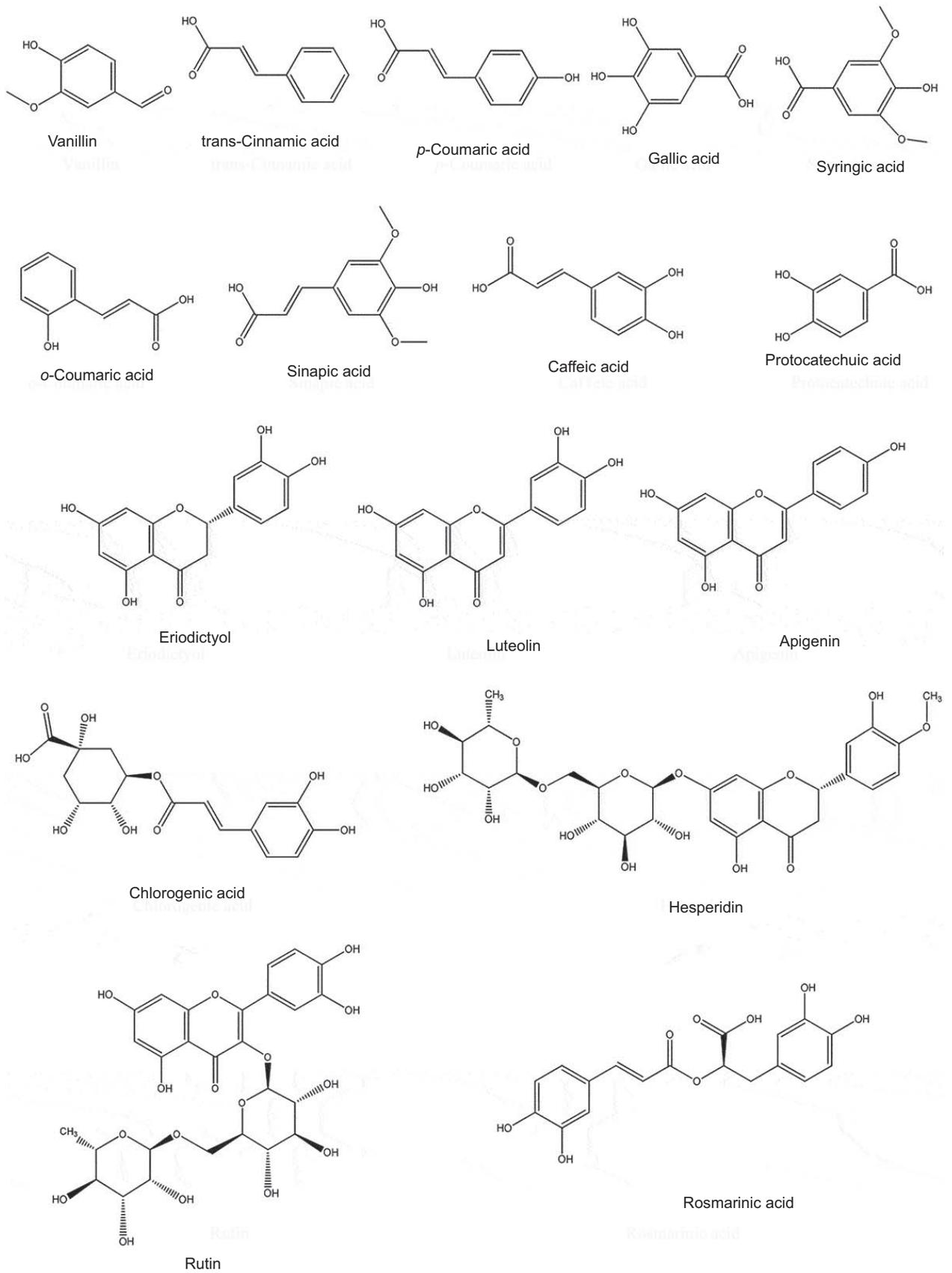


Figure 2. Phenolic compounds identified and quantified in infusion and ethanol extract of *Mentha longifolia* (Bahadori et al., 2018).

antioxidants (Rocha *et al.*, 2011). The drying procedure had a substantial impact on the composition and amount of oil of aromatic herbs. Most essential oil components degrade at temperatures above 30°C, as per literature (Yadegari *et al.*, 2013).

Mint herb, amongst the attractive herbs to study lies amongst therapeutic and aromatic herbs (Mekonnen, 2011). Fresh Lamiaceae plants, such as spearmint, often contain 75–80% water, which must be reduced to less than 15% for effective preservation (Diaz-Maroto *et al.*, 2002). Herb drying limits microbial development and prevents biochemical changes, but it can also result in other changes that impact the herb's quality. The value of spearmint oil might be affected during the drying process. It can cause a loss in essential oil, color and texture changes, and nutritional value reduction (Bartley *et al.*, 2000; Ozcan *et al.*, 2005). The type of drying and how long it takes have a big impact on the oil content and composition. When herbs are dried under normal circumstances rather than accelerated conditions, essential oils are maintained to a larger level (Charles *et al.*, 1993). The temperature, at which plants are dried, had a significant impact on the composition and quality of essential oils. At 60°C, oven drying causes a 75.7% loss of essential oils than at 30°C (Baydar and Erbas, 2009). The content of monoterpenes reduces as the temperature rises, whereas the content of sesquiterpenes rises (Khanqholi and Rezaeinodehi, 2008).

*Mentha piperita* was assessed in its fresh and dried form in order to quantify its composition which can be used as a standard for maximising its possibilities and uses in human nourishment. Volatile oils, glycosides, steroids, tannins, alkaloids, saponins, and flavonoids were all detected in the phytochemical screening. Both samples had 92.31 and 56.31% carbs, 2.19 and 7.69% protein, 0.50 and 5% lipid, 1.5 and 9% fiber, 3.57 and 22% ash, and 89.5 and 9% moisture, respectively. Potassium was the most predominant mineral detected, accounting for 72 and 23% followed by sodium for 13 and 7.75%, phosphorus for 0.341 and 0.325%, magnesium for 0.005 and 0.235% and other minerals for 0.5 and 0.045% (Mainasara *et al.*, 2018).

Effect of drying methods, such as air drying, microwave drying, freeze-drying, and oven drying, on the hydroxycinnamic acid derivatives, total phenolic content, and antioxidant activities of spearmint were examined. Spectrophotometric assessments of phenolic content revealed that spearmint which was freeze-dried possesses the highest total phenolic content (34.61.9 mg/g) as well as the highest antioxidant capability (126.20.4 mg/g for FRAP and 88.15.9 mg/g for DPPH). The least amount of phenolics and antioxidants were observed in the oven and microwave dried spearmint. This might explain as to how

heat degrades the sensitive phenolics. When compared to freeze-drying, phenolic content loss and antioxidant reduction were up to 60% (Orphanides *et al.*, 2013).

In an experiment, the leaves of *Mentha piperita* L. herbs, “Peppermint,” and “Krasnodarskaja” were dehydrated using various ways. Biochemistry and technology methodologies were used to investigate fresh and dried plants. The cv. “Peppermint” had the greatest levels of essential oil (0.77%) and chlorophyll (1.69%). In fresh peppermint leaves, the ratio of chlorophyll a to b was 1.35 in the cv. “Peppermint” and 1.44 in the cv. “Krasnodarskaja.” Sublimation, microwave, vacuum, infrared, convection, and active ventilation technologies were used to dry peppermint leaves. Plant type and drying procedures influenced the quality of dried herbs. The dried peppermint leaves of the cv. “Krasnodarskaja” had the greatest concentration of essential oil (0.64–0.68% of dry mass). Microwave dried herbs had the lowest essential oil concentration (0.08 and 0.065% of dry mass, respectively). The leaves of peppermint which were lyophilized of the cv. “Peppermint” had the maximum chlorophyll (715.0 mg 100 g<sup>-1</sup> dry mass). Significant changes in the chlorophyll a to b ratio were discovered after drying the cv. “Krasnodarskaja” irrespective of the drying technique used. The cv. “Peppermint” fresh and dried peppermint samples showed the value of L\* and b\* as the lowest. Microwave dried peppermint leaves showed the greatest increases in greenness a\* value (Rubinskienė *et al.*, 2015).

The influence of various drying techniques on the chemical content and quality of *Mentha longifolia* essential oil were investigated. Menthone was reportedly observed in higher amounts in leaf oils dried in both air (47.9%) and sun (38.3%), while limonene was the most prominent compound in the oven-dried leaf oil (40.8%), and pulegone was the most prominent compound in the original fresh leaf oil. The oven-dried leaf oil did not contain menthone or pulegone. When the leaves were dried using the three distinct processes, the essential oil experienced substantial chemical transformations in its monoterpenoids, as oven-drying significantly reduces the potentially hazardous pulegone and menthone. Therefore, it is recommended to oven-dry or cook herbs before eating to avoid toxicity (Asekun *et al.*, 2007).

A study uses a nontargeted relative metabolomics method using the HPLC-QTOF-MS technique to investigate the impact of the drying process on the *Mentha spicata*. This study explores the compositional differences between the leaves (Dried and fresh) of *Mentha spicata* identified using a metabolomic technique, and it was revealed that after drying the leaves are greater metabolite sources of bioactives. A kidney-on-a-chip was used to test the kaempferol nephrotoxicity, which is a bioactive metabolite found in spearmint. On the basis of morphology, human

embryonic kidney cells treated with 30 mM kaempferol for 12 h resulted in no evident cell harm or apoptosis, giving proof of concept for kaempferol's nontoxicity (Li and Tian, 2018).

The influence of drying on flavonoid, antioxidant activity, total phenolics concentration, and color qualities was investigated in four different fresh and dried herb species (sage, thyme, mint, and lemonbalm). Undried mint possesses the greatest amounts of phenolic content, while thyme had the lowest value. All of the plants studied had considerably lower phytochemical content after being dried. In comparison to air drying, oven drying appears to reduce flavonoids, antioxidants, and total phenolic concentration in them. Undried mint exhibited the greatest antioxidant capacity (87.46%) and flavonoid concentration, whereas fresh sage, thyme, and lemon balm had 86.81, 86.56, and 85.26% antioxidant activity, respectively (Rababah *et al.*, 2015). Table 3 shows the phytochemical composition of the fresh and dried mint leaves.

## Food Uses

Throughout the world, mint has been used for the preparation of various types of food. Sometimes, it has been used to make candies, tea, jellies, and chewing gum. In

Kashmir and Arabian countries, the leaves of mint were used for salads, which enhance the sensory acceptability of food. In roast lamb and veal, mint sauce is the basic adjunct, and it helps in the digestion of such meat. In Mexico, mint is used for flavoring *albondigas*, which is a type of soup with meatballs. The people of Brazil add mint to omelettes, crackers, sauces, and some meat products. In the United States, the leaves of mint are used for flavor purposes in various eatables such as peppermint cream, mint syrup, dessert foods, and double mint tea. Candies prepared using mint are used to make cookies. In India, chutney is prepared using fresh mint; such types of chutneys are used with other foods such as fried produces, like *pakorras* and *samosas*.

For over 3000 years, the mint plant has been used extensively for its therapeutic characteristics. People have used it to make poultices or balms, or due to its high methanol content, it can be inhaled. Now researchers are working to encapsulate the extract of *Mentha piperata*. Essential oil was encapsulated and incorporated into the ice cream as a model food product. It was observed that Ca-alginate matrix was the most suitable for peppermint essential oil encapsulation. The sensory analysis revealed that ice cream incorporating encapsulates is a promising system for consumption of health beneficial peppermint essential oil (Yilmaztekin *et al.*, 2019).

**Table 3.** Phytochemical composition of the fresh and dried mint leaves (Rababah *et al.*, 2015; Mainasara *et al.*, 2018).

Sample	Fresh (%)	Dried (%)
Moisture	89.50	19.00
Ash	3.50	22.00
Fiber	1.50	9.00
Lipids	0.50	5.00
Proteins	2.19	7.69
Carbohydrates	92.31	56.31
Calcium	0.050	0.045
Magnesium	0.005	0.235
Potassium	23.000	72.000
Sodium	7.750	13.000
Phosphorus	0.341	0.325
Total phenolics/ mg GAE per 100 g FW	335.4	137.9
Antioxidant activity	87.5	84.0
Flavonoids content/ mg CE per 100 g FW	298.5	90.6
<i>L</i>	42.0	33.2
<i>a</i>	-5.3	-1.1
<i>b</i>	23.5	16.2
$\Delta E$	48.4	36.9
chroma	25.6	15.6
Moisture content/%	82.0	6.80

## Traditional Therapeutic Properties and Usage

In addition to its food uses, traditionally mint has been used as a medicine, particularly for the treatment of disorders related to the digestive system; however, its uses as medicine are larger (Saric-Kundalic *et al.*, 2009). In the beginning, mint had been used for relieving pain related to gastrointestinal problems and chest and generally, people used it as tea for problems related to digestion (dyspepsia), for decreasing stomach pain, problems related to gall bladder, inflammation in the small intestine, accumulation of gases, inflammation related to the protective covering inside the stomach, stomach acidities, too much air swallowing, pain in the small and large intestines, as a home remedy (Abbaszadeh *et al.*, 2009; Arumugam *et al.*, 2008; Kunnumakkara *et al.*, 2009). Mint has been found to be helpful in the digestion of fat; in recent times, obese people have been advised to include mint in their diet. Mint tea is included in drinks that have a diuretic property (Abbaszadeh *et al.*, 2009).

Mint essential oil had been exploited for the treatment of stomatitis and as a component in several antimicrobial and pain-relieving creams. Oil from mint has also been utilized for the cure of biliary disorders, muscle pain, irritable bowel syndrome, neuralgia, stomatitis, dysmenorrhea, amenorrhea, infrequent menstrual cycle, and

diverticulitis. It has been also used to reduce inflammation and used to treat cough (Diop *et al.*, 2016; Peixoto *et al.*, 2009). More therapeutic effects in different species of mint have been shown in Table 4.

Mint plant has been used for oral hygiene. Previously, ground leaves of mint were used to whiten the teeth (Abbaszadeh *et al.*, 2009). For gum bleeding, hot water extract of mint has been used as a mouth wash, and

fresh leaves of mint were used to chew for mouth burns (Lamendin *et al.*, 2004). It has been used to ensure fresh breath by maintaining oral hygiene. Research is being conducted as it contributes to inhibiting plaque and caries, and studies have shown that it doesn't provide any favorable atmosphere for germs (Balakrishnan, 2015). Besides, one of the mints, namely, peppermint is useful for relieving pain and makes teeth clear, when applied on teeth (Peixoto *et al.*, 2009).

**Table 4. Traditional therapeutic effects of some of the important Mint species (Brahmi *et al.* 2017).**

Species	Therapeutic effects
Spearmint	<p>Daily intake of spearmint between the meals of about 500 to 900 ml helps in relieving problems related to digestive system. It has been considered as an antidote for poisons (Akdogan <i>et al.</i>, 2007).</p> <p>In children it helps to relieve, fever, spasm of involuntary muscle, flatulence, as a stimulant; extracts of the plant in hot water helps to relax in hiccup, gassiness, light headedness and helps in relieving bronchitis, inflammation, to control nausea in the times of pregnancy (Kumar and Chattopadhyay, 2007).</p> <p>(El-Hilaly <i>et al.</i>, (2003) reported that the extract of the upper ground parts of the plant for headache and fatigue.</p> <p>Di Stasi <i>et al.</i>, (2002) reported eviction of giant roundworm which is a parasitic worm.</p> <p>Spearmint leave extract in the boiled water has been advised for hepatitis caused by virus, as pain reliever. Its leaves has been used as a ointment for mouth ulcer, as an appetite promoter and diuretic, joint or connective tissue pain, toothache, irritation bowl syndrome and mouthwash (Arumugam <i>et al.</i>, 2008).</p> <p>It has strong action on the brain (Bruneton, 2009).</p> <p>Spearmint is generally used as stomachic, to relieve common cold, sinusitis, rise in body temperature and antiemetic (Kunnumakkara <i>et al.</i>, 2009).</p>
Field mint	<p>Field mint has been found to useful against superficial visual obstructions, sores, mouth ulcers, and cutaneous condition; red eyes, fever, cold, and enlargement, dilation or ballooning effect and non-cardiac chest pain and health anxiety (Bensky <i>et al.</i>, 2004; Chinese Pharmacopoeia Commission, 2010).</p>
Horse mint	<p>This type has been found to be useful against microorganisms, flatulence, joint disorders; as a tonic, pain killer, insecticidal, antidiarrhal; helps in healing wound, to get rid of worms and vomiting; helps in relaxing, diuretic, philtre, purifies blood, pain killer, stomachic, biliary disorder, tonsil inflammation, loose motion, gastrointestinal disorders, asthma, jaundice and nephrolithiasis (Mikaili <i>et al.</i>, 2013).</p>
Wild mint	<p>Induces abortion (Kunnumakkara <i>et al.</i>, 2009).</p>
Pennyroyal	<p>Di Stasi <i>et al.</i> (2002) reported eviction of parasitic worms, like giant roundworm, <i>Entamoeba histolytica</i> and <i>Giardia intestinalis</i>, kidney stone, cold, fever, bronchitis, antitussive and stomach pain.</p> <p>Promotes appetite, relieving flatulence and vomiting, relieve spasm, tonic, relieve cough, and is used as insecticidal (Delille, 2007).</p> <p>Used as an antibacterial, for common cold, bronchitis, sinus infection, cholera, food borne illness, and TB (Mahboubi and Haghi, 2008).</p>
<i>M. rotundifolia</i>	<p>Abbaszadeh <i>et al.</i>, (2009) reported that <i>M. rotundifolia</i> can be used to cure flatulent dyspepsia and pain in the small and large intestines.</p> <p>Abnormal low blood pressure (Bello <i>et al.</i>, 2001).</p> <p>Boiled upper ground part of <i>M. rotundifolia</i> was used to relieve chill and act as stomachic (El-Hilaly <i>et al.</i>, 2003).</p> <p>Acts as a pain killer, Abnormal low blood pressure, increases appetite, promotes calm, controlling insects (Sutour <i>et al.</i>, 2008).</p>
Peppermint	<p>The essential oil of peppermint and its leave has been reported to be helpful against gastrointestinal disorders, problems related to respiratory system, and stomatitis. The oil can be used externally against muscle pain and neuralgia. Other problem such as dysmenorrhea, headache, and chicken pox (Balakrishnan, 2015).</p> <p>Like other species this plant has also been used as appetizer, antiemetic; against chill, rise in body temperature, bronchitis, upper abdominal discomfort (Kunnumakkara <i>et al.</i>, 2009).</p> <p>Helpful against bronchitis, gastrointestinal disorder, nausea and antitussive (Kapp <i>et al.</i>, 2013).</p> <p>Peppermint odors are helpful, as a stimulant of central nervous system and reduces tiredness (Lv <i>et al.</i>, 2012).</p>
Australian mint	<p>Hot water extract has been used to relieve common colds; antitussive, however intake of crushed mint helps to relieve pain in the head. Also induce abortion (Tang <i>et al.</i>, 2016).</p>

Essential oil from mint and other components has been used globally to enhance flavor in foods, used in medicines, and in perfumes (Balakrishnan, 2015). There is a long history of usage of essential oils from the mint plant in confectionaries like chewing gum and sweets and various types of drinks. The flavor of mint plants, particularly *Mentha spicata*, *Mentha piperita*, and *Mentha arvensis*, is considered to be among the most liked flavor. That is why it is cultivated throughout the world for the production of leaves (Kapp, 2015; Lawrence, 2007).

### As antitumor

Okadaic acid, non-12-O-tetradecanoylphorbol-13-acetate -type, are the promoters of tumor; they promote this by inhibiting the phosphatase-2A. Mint promotes antitumor activities by inhibiting the above promoters. Ohara and Matsuhisa (2002) found the strong suppressing effect of okadaic acid in mint plants. The line J5 of tumor cell in the human liver depends on dose in a different way; the cytosolic arylamine N-acetyltransferase (NAT) activity was found to be affected by menthol derived from *M. piperita* (Lin et al., 2001).

### As antiallergenic

The presence of rosmarinic acid as an anti-inflammatory and antioxidant has been reported to have antiallergenic properties. Among various flavonoid glycoside compounds tested, Inoue et al. (2002) found only luteolin-7-O-rutinoside of mint as an effective inhibitor of the release of histamine-induced by 48/80 compound and an antigen-antibody response. However, beyond the flavonoids, Juergens et al. (1998) also reported menthol to inhibit release of the compounds such as prostaglandin E2 (56.6%) interleukin - $\beta$ 2 (64.2%) and leukotriene B4 (64.4%), which are inflammatory.

### Good for breastfeeding

Breastfeeding is very much important to babies; however, some mothers can suffer from pain and cracks in the nipples. Studies have reported that peppermint water could be effective against nipple pain and cracks of first-time breastfeeding mothers.

### Relief from respiratory problems

The presence of menthol in mint which is a natural decongestant helps in getting rid of mucus and phlegm by easy expelling. Helps in relieving sore throat, and it becomes more effective when taken in combination with tea.

The unique pharmacological action of menthol obtained from peppermint is not linked to its aroma on the nerves of the nose (Eccles et al. 1988).

A significant decrease in the problems related to the respiratory sensation was noticed, when the flow loading was done in an elastic and resistant way in 11 normal subjects (Nishino et al., 1997). Methanol (lozenges) of about 11 mg taken orally had not reduced stuffy nose in a placebo-controlled, double-blind, randomized experimental study involving 62 subjects suffering from acute coryza (Eccles et al., 1990); however, a noticeable variation in the airflow of the nose was observed with sensation in case of a stuffy nose.

### Indigestion and gas

There is a long history of using mint as a relaxing and soothing aromatic plant as a stomachic. It has been reported that mint helps in the secretion of bile and also boosts its flow, which in turn helps in the digestion of fat. As discussed in Table 3, *M. Peperita* helps to relieve inflammation and other problems related to digestion. To get rid of flatulence, *M. Peperita* tea is very helpful. A lot of research has been done to find out the influence of mint on the muscular actions and secretory processes of the digestive system in various kinds of animals. A significant effect of aqueous extracts of mint was observed on isolated rabbit duodenum (Mahmood et al., 2003). A reduction in spontaneous activity was noticed and also the influence of extract obtained from mint leaves which are dried was more compared to extracts obtained from fresh leaves.

Goerg and Spilker (2003) conducted a study using 12 subjects. They observed that 90 mg of peppermint oil didn't have any influence on the stomach emptying time (evaluated by H2 breath and ultrasonography examinations) in comparison with a placebo; however, it had influenced in the draining of gall and also raised its volume by quick fill up. Peppermint oil ( $85.0 \pm 7.8$  min) delayed the passage time through the small intestines in comparison with placebo ( $65.0 \pm 6.1$  min). It was found that the addition of peppermint oil accelerates gastric emptying rate (Dalvi et al., 1991). Studies about peppermint oil and menthol reported that the doses of 25–50 mg/kg could effectively stimulate bile flow (choleric activity) in rats (Trabace et al., 1992, 1994). Similarly, a high rate of gall-bladder secretion in rats given 830 mL/kg by feeding nevertheless not less than 83 or 8.3 mL/kg (Vo et al., 2003).

### Irritable bowel syndrome

Abdominal pain or discomfort is considered to be Irritable bowel syndrome. A study was conducted to use

peppermint oil as an enteric-coated capsule two times a day for a period of 1 month and had been found to have a decreased effect on the symptoms of Irritable bowel syndrome (Pittler and Ernst, 1998).

### As Analgesic

The peppermint oil has been utilized as an analgesic by application on the forehead. An experiment with 32 healthy persons ( $25 \pm 2.1$  years) revealed a positive effect of peppermint oil as an analgesic (Gobel *et al.*, 1994, 1995). A decrease in pericranial muscle tension was observed by 30.6% with peppermint. Pain to the head due to the stimuli of heat and ischemia was reduced by using peppermint oil. The application of peppermint oil ensured that there was a decrease in the pain intensity of 41 patients of the age group of 18–65 years experiencing headache problems (Gobel *et al.*, 1996).

### Antimicrobial

Mint has natural antibiotic characteristics and gives fresh breath after its intake. Antibiotic properties of mint during storage of purslane and lettuce in the refrigerator on *S. Typhimurium* and *E. coli O157:H7* was observed. Its essential oil has shown a greater microbial reducing effect on disease-causing microorganisms. When it was used at a concentration of about 0.08 ml/L, it was a highly effective antibiotic against disease-causing microorganisms in purslane and lettuce vegetables (Karagozlu *et al.*, 2011).

### Conclusion

Mint is one of the most important herbs used by consumers to enhance the sensory perception. It claims health benefits since time immemorial (over 3000 years). It is a useful plant that can be found everywhere, and such plants should not be ignored when searching for natural remedies. On the basis of the literature studied and discussed in the review, it can be concluded that the presence of bioactive constituents such as phenolics, antioxidants, menthol, rosmarinic acid, alcohols and terpenoids, etc and health beneficial characteristics of the *Mentha*, such as anticancer, antineoplastic, antiviral, anti-histamine, anti-inflammatory, analgesic, against hypertension, and urease inhibitory and other biological activities, such as biopesticidal, antioxidant activity, antimicrobial activity etc can be looked at as a promising applicant for the development of healthy products. Besides, still there is a need to explore the bioactivities of various unexplored species of *Mentha*. Furthermore, applications of extract and essential oil of *Mentha* in a particular field of food science and technology needs to be investigated.

### Conflict of Interest

None.

### Acknowledgements

The first author is thankful to UGC for D.S. Kothari Postdoctoral fellowship.

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