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Antioxidant and Antiseptic Properties of Volatile Oils from Different Medicinal Plants: A Review

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Review Article

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Abstract

The use of preservatives is increasingly common in the food industry. The extension of the term of validity of the food products, as well as the preservation of their appearance for a longer period, is an increasingly common condition among food processors. Unfortunately, most synthetic preservatives are used, omitting the use of natural preservatives. The antiseptic potential of essential oils from different medicinal plants may be a natural alternative to the synthetic preservatives used. The daily stress that surrounds us produces in the human body a significant amount of free radicals that over time affect our health. To eliminate these free radicals we need antioxidants from the outside. A very good variant of consumption of these antioxidants is directly through the food we consume. Medicinal plants have a high content of antioxidants, and their use in our diet as volatile oils can be a solution. This review includes published articles on the antioxidant and antiseptic properties of essential oils from different medicinal plants. We classified the plants according to their properties and highlighted the most important compounds that they have.

Keywords: Antiseptic; Antioxidant; Volatile Oil; Medicinal Plants; Compounds

Abbreviations: FAO: Food and Agriculture Organization; MIC: Minimum Inhibitory Concentration; FRAP: Ferric Reducing Antioxidant Power

Introduction

According to the FAO (Food and Agriculture Organization) of the United States, agri-food production will increase by about 70% in the coming decades. This is necessary to keep up with the increasing number of the population. The intensification of food production leads to numerous changes in the quality, safety and health of people [1]. Food preservatives are considered as a problem in the health of consumers. After numerous researches, it was concluded that their toxicity evolution should be tested and they should be subjected to pharmacological tests [2]. The extension of the term of validity of the food products, as well as the preservation of

their appearance for a longer period, is an increasingly common condition among food processors. Unfortunately, most synthetic preservatives are used, omitting the use of natural preservatives.

According to several types of research, it has been discovered that volatile oils extracted from different plants bring extraordinary benefit to the health of consumers. These oils are extracted either from the aerial part of the plant or from its root. Most essential oils have antiseptic action especially on pathogenic bacteria such as *Listeria monocytogenes, L. innocua, and Salmonella typhimurium* [3]. The mode of action is as follows: irreversible lesions of the bacterial cell membrane are generated, which cause material losses (cytoplasm), ion leakage, loss of energy substrate (glucose, ATP), leading directly to the cytolysis of bacteria and thus to their death [4]. In terms of antiseptic action on viruses, volatile oil interferes with the virus, inhibiting its specific process of propagation. Antioxidant activity is another benefit of volatile oils. Free radicals cause oxidation of biomolecules, including proteins, amino acids, DNA, etc. and eventually cause molecular changes related to ageing, arteriosclerosis and cancer. In the human body, an imbalance between the production of free radicals and their removal by the antioxidant system leads to "oxidative stress". So, the external supply with antioxidants is necessary to reach the balance between free radicals and antioxidants, and the volatile oil is a very good source [3].

Volatile oils are increasingly used in medicine and the food industry due to their antiseptic properties. Increasing interest in natural substances has increased the interest in finding new applications for these substances [5]. The main objective of this study was to examine the studies that investigated the antiseptic and antioxidant properties of volatile oils from different medicinal plants.

Methods

The searches were performed in the Scopus database. The search terms were as follows: “antiseptic” AND “antioxidant” AND “food” AND “preservatives” AND “basil” AND “caraway” AND “thyme” AND “black currant” AND “coriander” AND “fennel” AND “marigold” AND “lavender” AND “marjoram” AND “mint” AND “chamomile”. Initially, the title and abstract were read, and if the articles did not include information regarding the antiseptic and antioxidant properties of these medicinal plants they were excluded. The articles that were selected after sorting were read in full. In total, 54 articles were analyzed on different medicinal plants.

Basil (Ocimum Basilicum L.)

Basil is a very important plant and often used in medicine, aromatherapy and gastronomy. Due to its composition and the presence of volatile oil, this plant has a specific aroma and taste [6]. The quantitative and qualitative profile of the basil differs depending on its geographical origin [7]. *Ocimum basilicum L.* (basil) is a widely used medicinal plant with antiseptic and antioxidant properties due to phenolic acids and aromatic compounds [8,9]. According to the study by Bayala et al. (2014), the antioxidant activity of basil was examined using the methods 1,1-diphenyl-2-picryl-hydrazyl (DPPH) and 2,29-azinobis- (3-ethylbenzothiazoline-6-sulfonic acid (ABTS). Basil has high antioxidant activity in both methods [10]. The main components of basil that confer its antioxidant properties are beta-Myrcene, citral, eugenol, copaene, linalool and nerolidol [9]. Regarding the antimicrobial activity, in 2016 Chenni et.al. conducted a study in which they investigated this activity against five microorganisms: two Gram-positive bacteria, *Staphylococcus aureus* and *Bacillus subtilis*, two Gram-negative bacteria, *Escherichia coli* and *Pseudomonas aeruginosa*, and one yeast, *Candida albicans*. Basil has a very high antiseptic activity against these microorganisms [11]. The most important compounds that confer these antiseptic properties to the basil are linalyl acetate and linalool [12]. Another study was conducted in 2018 by Gucwa et.al., this time investigating the antiseptic activity of basil against a group of 183 strains isolated from *Candida albican* and 76 strains isolated from *Candida glabrata*. The result was similar to the study presented above, basil having a high antiseptic capacity [13]. Following the chemical composition analysis of basil volatile oil by GC-MS analysis method, 32 compounds were identified. The most important ones were estragole, 1,6-Octadien-3-ol, 3,7-dimethyl, trans-alpha-Bergamotene, eucalyptol, citral, N-Cyano-3-methylbut-2-enamine, cis-alpha-Bisabolene, levomenthol, and beta- Myrcene [9]. Following these studies, it has been shown that this type of volatile oil can be used as an alternative to conventional chemical preservatives. Also because of their very high specific activity, basil essential oil can be used for the prevention and treatment of intestinal diseases in animals and humans, caused by *E. coli*, *Salmonella*, *Listeria* and other pathogenic bacterial species [14].

Table 1 presents the main compounds of basil volatile oil, as well as their quantity according to each research study.

Compound	Source 1 [15]	Source 2 [6]	Source 3 [9]	Source 4 [10]	Source 5 [14]	Source 6 [12]	Source 7 [8]
Linalool	31.52 %	45.3 %			69.3 %	46.0 %	55.2 %
Eugenol	14.39 %	42.06 %	0.40 %		1.4 %	11.5 %	3.2 %
Eucalyptol	14.06 %		3.51 %	1.46 %			
Camphor	11.31 %				0.3 %		
β-caryophyllene	2.13 %			10.54 %	0.6 %		0.4 %
α-pinene	0.36 %		0.13 %	0.39 %	0.1 %		0.4 %
β-pinene	0.31 %			1.08 %			1.1 %
β-Myrcene			1.11 %	2.71 %	0.3 %		0.7 %
Estragole			41.40 %			1.1 %	
trans-alpha-Bergamotene			5.32 %		1.1 %	3.6 %	7.0 %
Humulene			0.59 %	3.90 %	0.5 %		
Terpinolene				0.60 %	0.4 %		0.9 %
1,8-Cineole					0.8 %	5.9 %	8.8 %

Table 1: The main compounds of basil volatile oil.
Source 1: The plants were collected in the city of Botucatu, São Paulo, Brazil [15].
Source 2: The plants were collected in the Botanical Garden near the Agricultural University of Tirana, Albania [6].
Source 3: The plants were collected in South Africa (Faithful to Nature) [9].
Source 4: The plants were collected in Gampela, 25 km East from Ouagadougou, Burkina Faso [10].
Source 5: The plants were collected in Pančevo, Serbia [14].
Source 6: The plants were collected in Pisa, Italy (FLORA) [12].
Source 7: The plants were collected in Ponta Grossa, Parana´, Brazil (Quinari) [8].

Caraway (Carum Carvi)

The caraway is one of the oldest known plants, with a pleasant aroma, being native to Asia, Europe and North Africa. Its fruits are used in pharmacy, perfumery and food. Many studies indicate that caraway volatile oil has antimicrobial, antifungal, antioxidant properties and is a cancer prevention agent [16]. The most important compounds of volatile cumin oil are limonene and carvone [17].

Table 2 presents the main compounds of caraway volatile oil, as well as their quantity according to each research study.

Compound	Source 1 [16]
α-Pinene	5.17 %
β-Pinene	0.02 %
β-Myrcene	4.76 %
p-Cymene	0.34 %
D-Limonene	26.55 %
1,8-Cineol	0.45 %
Linalool	0.87 %
cis-Limonene oxide	0.63 %
Menthone	0.59 %
Menthol	0.07 %
4-Terpineol	1.34 %
γ-Terpinene	0.17 %
Eugenol	1.45 %

Table 2: The main compounds of caraway volatile oil.
Source 1: The plants were collected in China [16].

Thyme (Satureja Hortensis L.)

The thyme is an aromatic plant native to southern Europe, and its aerial part is traditionally used for culinary purposes and as a medicinal plant [18]. The aerial parts of this plant are commonly used as a traditional remedy to treat various conditions, including cramps, muscle aches, nausea, indigestion, diarrhoea and infectious diseases, based on the antispastic, antidiarrheal, anti-bacterial and antifungal properties of their constituents. Antioxidant activity has also been reported for the aerial parts of the plant [19]. Regarding the antibacterial activity of thyme volatile oil, in 2007 a study was conducted by Ghalfi et.al. against *L. monocytogenes, E. coli* and *S. Typhi*. This oil has been shown to have high inhibitory activity against all tested bacteria [20]. Another study by Santoro et.al. in 2018 has shown that thyme volatile oil has a high antiseptic antiviral activity against *M. fructicola* and *B. Cinerea* [21]. The most important components of thyme volatile oil are thymol, γ-terpinene, carvacrol, and p-cymene [18].

Compound	Source 1 [19]	Source 2 [18]	Source 3 [18]
α-pinene	0.80 %		2.7 %
β-pinene	0.36 %		4.5 %
myrcene	0.91 %		
α-terpinen	2.86 %	1.29 %	
ρ-cymene	9.18 %	6.73 %	19.6 %
γ-terpinene	50.45 %	15.30 %	16.0 %
thymol	32.67 %		28.2 %
β-caryophyllene	0.34 %	1.90 %	
Carvacrol		67.0 %	11.0 %
Sabinene			4.4 %
4-terpineole			1.6 %

Table 3: The main compounds of thyme volatile oil.
Source 1: The plants were collected in Isfahan, Iran [19].
Source 2: The plants were collected in Serbia [18].
Source 3: The plants were collected in Iran [18].

Table 3 presents the main compounds of thyme volatile oil, as well as their quantity according to each research study.

Black Currant (*Ribes Nigrum* L.)

Black currant is a shrub that grows in Central and Eastern Europe, especially in temperate areas and is most commonly cultivated. The most important compounds of black currant volatile oil are Δ^3-carene, β-caryophyllene, sabinene, cis-β-ocimene and α-terpinolene. In the study conducted by Stevic et.al. in 2010, the antimicrobial activity of black currant volatile oil was tested against the Gram-positive and Gram-negative toplines of *Candida albicans*. This oil has shown a high resistance against this fungus, but against the bacterium *Listeria monocytogenes* has shown a low resistance [22].

Table 4 presents the main compounds of black currant volatile oil, as well as their quantity according to each research study.

Compound	Source 1 [22]
α-Pinene	0.98 %
Camphene	0.12 %
Sabinene	11.63 %
β-Myrcene	1.83 %
Δ^2-Carene	0.21 %
α-Phellandrene	0.24 %
Δ^3-Carene	18.67 %2
α-Terpinene	0.51 %
p-Cymene	0.06 %
cis-β-Ocimene	10.64 %
trans-β-Ocimene	6.94 %
γ-Terpinene	0.34 %
α-Terpinolene	10.58 %
α-Terpineol	0.05 %
β-Caryophyllene	17.67 %
α-Humulene	2.43 %
Germacrene D	4.28 %

Table 4: The main compounds of black currant volatile oil.
Source 1: The plants were collected in Čačanska crna, Serbia [22].

Coriander (Coriandrum Sativum L.)

Coriander is an annual plant, native to the Mediterranean region and cultivated in different parts of the world. All parts of the plant are edible, the plant and its fruits are used as a spice in different countries. In folk medicine, coriander fruits are recommended for the treatment of anxiety, insomnia or for improving nervousness. Studies have reported that coriander volatile oil has sedative-hypnotic, anti-anxiety and antioxidant activities [23]. The composition of coriander volatile oil was determined using gas chromatography-mass spectrometric (GC-MS). The main components were linalool, α-pinene, camphor, γ-terpinene, D-limonene and geranyl acetate [24]. In 2014 Freires et.al. conducted a study that demonstrated the antiseptic activity of volatile coriander oil against the active strains of *Candida sativum*. The result of the study showed that this type of oil showed a high antiseptic activity [25]. Regarding antioxidant activity, in 2012 Shahwar et.al. conducted a study that determined this capacity. Two methods were used: 1,1-Diphenyl-2-Picrylhdrazyl (DPPH) Scavenging Activity, the oil being measured at a spectrophotometer at 517 nm and Ferric Reducing Antioxidant Power (FRAP) Antioxidant, the oil being measured at the spectrophotometer at 700 nm. In both situations, results were obtained that confirm the antioxidant activity of the oil [26]. Another study that demonstrated the antioxidant activity of this volatile oil was carried out in 2014 by Zheljazkov et.al. In this case, was used the method of oxygen radical absorbance capacity (ORAC), and its result looks the same as in the study described above [27].

Table 5 presents the main compounds of coriander volatile oil, as well as their quantity according to each research study.

Compound	Source 1 [24]	Source 2 [27]	Source 3 [26]	Source 4 [23]
α-Pinene	5.03 %	15.5 %	7.14 %	5.0 %
Camphene	0.64 %	2.0 %	1.78 %	1.0 %
β-Pinene	0.48 %	1.2 %	0.71 %	0.8 %
Myrcene	0.47 %	1.8 %	0.98 %	0.1 %
ρ-Cymene	0.54 %	4.4 %	0.90 %	2.8 %
D-Limonene	2.58 %	4.0 %	1.36 %	
γ-Terpinene	3.80 %	11.4 %	7.47 %	2.7 %
Terpinolene	0.63 %			0.5 %
Linalool	78.45 %	50.7 %	55.49 %	67.8 %
Camphor	3.90 %	2.6 %	5.59 %	5.0 %
Geraniol	1.07 %	0.8 %	2.23 %	2.0 %
Geranyl acetate	2.13 %	1.0 %	4.42 %	3.7 %
α-Thujene			0.28 %	0.1 %
Sabinene			0.40 %	0.7 %
1,8 Cineol			0.19 %	0.1 %
Limonene			3.10 %	2.6 %
Borneol			0.41 %	0.3 %
α-Terpineol			0.81 %	0.6 %

Table 5: The main compounds of coriander volatile oil.
Source 1: The plants were collected in Gostyń, Poland (Plant Herb "KAWON-HURT" Nowak sp.j.) [24].
Source 2: The plants were collected in Winslow, ME, USA (Johnny's Selected Seeds) [27].
Source 3: The plants were collected in Ayub Agricultural Research Institute, Faisalabad, Pakistan [26].
Source 4: The pants were collected in the Garden of Medicinal—Aromatic Plants in the Campus of the University of Salerno, Italy [23].

Fennel (Foeniculum Vulgare L.)

Fennel is an aromatic plant being considered one of the oldest cultivated medicinal plants in the world. Fennel seeds are of particular economic importance, as they are widely used in the pharmaceutical, food and cosmetic industries. Fennel seeds are also a rich source of dietary fibre, protein, vitamis, sterols and phenolic compounds [28]. Using the GC-MS method, 29 compounds were identified in fennel volatile oil. Its most important compounds are trans-anethole, pinene and fenchone [29]. Fennel volatile oil has the antioxidant and antimicrobial

capacity [30]. Regarding antiseptic activity, in 2013 Thompson et.al.conducted a study investigating the antimicrobial capacity against the *Escherichia Coli* bacterium. The results show that this type of volatile oil has a high antimicrobial activity [31]. In 2018, Salma et.al. conducted a study that demonstrated the antiseptic capacity of fennel volatile oil. In this study, the disc diffusion method called Kirby-Bauer method was used. This method is based on the inhibition of bacterial growth measured under standard conditions. The result of this method demonstrates high antiseptic activity [32]. In 2011 Shahat et.al. investigated the antioxidant activity of fennel volatile oil through several complementary tests: the DPPH free radical scavenging, the ferric reducing power (FRAP) assay, thiobarbituric acid reactive species assay (TBARS) and the ferrous ion chelating (FIC) assay, using butylated hydroxytoluene (BHT) and ascorbic acid as references or positive controls. The highest antioxidant activity was obtained by the DPPH method, even higher than in the case of ascorbic acid and BHT [33]. In the study carried out by Pande and Preetha in 2017 the antioxidant activity of fennel volatile oil was measured using the DPPH method (2, 2-diphenylpicryl hydrazyl). Following this study, it has been shown that fennel volatile oil has a high antioxidant activity [34].

Table 6 presents the main compounds of fennel volatile oil, as well as their quantity according to each research study.

Compound	**Source 1** [29]	**Source 2** [33]
Phellandrene	0.21 %	0.11 %
Myrcene	0.16 %	0.32 %
Pinene	11.11 %	
Limonene	1.09 %	20.64 %
Fenchone	8.32 %	7.22 %
α-Terpineol	0.31 %	
Camphor	0.34 %	0.29 %
Terpinen-4-ol	0.46 %	
trans-Anethole	63.30 %	4.99 %
α-Pinene		3.61 %
Camphene		0.19 %
Sabinene		0.56 %
β-Pinene		0.21 %
o-Cymene		0.71 %
Eucalyptol		1.93 %
γ-Terpinene		0.38 %
Linalool		0.11 %
Estragole		57.94 %

Table 6: The main compounds of fennel volatile oil.
Source 1: The plants were collected in Tarim University, Xinjiang, China [29].
Source 2: The plants were collected in Cairo, Egypt [33].

Marigold (Calendula Officinalis)

Marigold are annual plants with yellow to orange flowers, originating in the Mediterranean region [35]. In the scientific literature, there are indicated different applications of the marigold extract due to the anti-inflammatory, antimicrobial and healing properties that they possess [36]. The main components of the marigold volatile oil obtained by the SD, HS-SPME, and HS-CF methods are δ-cadinene, γ-cadinene and α-cadinol [35]. In 2012 Vinod et.al. conducted a study that investigated the antiseptic and antioxidant character of volatile oil from marigold. As far as the antiseptic activity is concerned, the volatile oil has been tested against strains of *Candida albicans*, *Candida dubliniensis*, *Candida parapsilosis*, *Candida glabrata*, *Candida tropicalis*, *Candida guilliermondii*, *Candida krusei* and *Rhodotorella spp*., and it showed very good antiseptic activity against all strains. The antioxidant activity of the plant was investigated using the successive extraction method of 70% methanol from the plant with ether, chloroform, ethyl acetate and n-butanol, leaving a residual extract, which was tested for antioxidant activity by Fe^{2+} and ascorbic acid. Extracts of ether, ethanol and water, containing flavonoids, showed good antioxidant activity [37].

Table 7 presents the main compounds of marigold volatile oil, as well as their quantity according to each research study.

Compound	Source 1 [35]
α-humulene	1.2 %
Geranylacetone	1.6 %
γ-muurolene	2.3 %
β-ionone	3.2 %
Ledene	2.3 %
α-muurolene	5.6 %
γ-cadinene	8.9 %
δ-cadinene	22.5 %
α-cadinene	0.9 %
α-calacorene	2.3 %
Caryophyllene oxide	0.5 %
Copaen-4-α-ol	0.6 %
β-oplopenone	1.7 %
viridiflorol	2.2 %
ledol	1.3 %
1-epi-cubenol	1.6 %
epi-α-muurolol	12.9 %
α-cadinol	20.4 %

Table 7: The main compounds of marigold volatile oil.
Source 1: The plants were collected in the medicinal botanical garden of the Universidade Paranaense in Umuarama, Brazil [35].

Lavender (Lavandula Angustifolia)

Lavender is an aromatic plant used in folk medicine to relieve stress and anxiety**.** The genus Lavandula includes more than 30 species and is widely distributed in countries around the Mediterranean and the Atlantic Ocean archipelagos [38]. Lavender volatile oil is a complex mixture of mono- and sesquiterpenoid alcohols, esters, oxides, and ketones. It was obtained by the distillation method with water [14]. The main components of volatile lavender oil obtained by the Gas Chromatography-Mass Spectrometry method are the monoterpenoids linalool, linalyl acetate, 1,8-cineole, β-ocimene, terpinen-4-ol, and camphor [39,40]. Lavender volatile oil is recognized for use in the treatment of anxiety, migraines, stress, irritability, exhaustion, depression, headache, digestion, colds, flatulence, insomnia, appetite loss, stomach disorders, liver disease, nervousness and aromatherapy [41]. More this volatile oil enhances cognitive deficits induced by scopolamine in mice, exerting a neuroprotective effect in Alzheimer's disease[38]. In 2017 Zhao et.al. demonstrated that volatile lavender oil was effective in inhibiting tumour growth of human carcinogenic xenografts in mice. Linalool has mainly contributed to this effect [42]. Regarding antiseptic activity, in 2015 Kunicka-Styczyńska et.al. investigated this in lavender volatile oil against *Staphylococcus aureus*, *Escherichia coli*, *Candida sp*. and *Aspergillus niger.* The result was a positive one, this type of oil having high antiseptic activity [43]. In the study carried out by Andrys et.al. in 2017, the antioxidant activity of volatile lavender oil was investigated. The DPPH (2,2-diphenyl-1-picrylhydrazyl) method was used according to the procedures described by Kumaran and Karunakaran (2007), and Wojdyło et al. (2007). The reduction of the DPPH radical was determined spectrophotometrically by measuring the absorbance at 517 nm. Finally, it was shown that volatile lavender oil has a high antioxidant capacity [44].

Table 8 presents the main compounds of lavender volatile oil, as well as their quantity according to each research study.

Compound	Source 1 [41]	Source 2 [39]	Source 3 [43]	Source 4 [14]	Source 5 [23]
Caryophyllene	24.12 %	0.47 %			
Terpinen-4-ol	9.57 %		5.6 %	2.1 %	
β-phellandrene	16.0 %				
Eucalyptol	15.69 %				
α-Pinene		4.66 %		0.2 %	0.8 %
Camphene		2.9 %			0.6 %
β-Pinene		2.62 %			0.9 %
p-Cymene		2.69 %			0.4 %
Limonene		2.05 %		8.5 %	2.1 %
1,8- Cineole		41.37 %	4.4 %	3.3 %	0.8 %
trans-Pinocarveol		0.97 %		0.2 %	0.1 %
Camphor		15.83 %		1.1 %	11.0 %
Borneol		12.32 %	6.6 %	2.5 %	4.5 %
Cryptone		1.55 %	1.0 %		

Verbenone		1.05 %	0.7 %		
γ-Cadidene		1.07 %			0.2 %
Caryophyllene oxide		0.73 %	0.6 %		0.4 %
Linalool oxide			1.0 %	2.4 %	0.1 %
Linaool			43.6 %	27.2 %	33.1 %
Lavandulol			1.6 %		0.1 %
α-terpineol			7.5 %	4.2 %	1.6 %
Nerol			0.4 %		0.2 %
α-Terpinene				0.3 %	0.2 %
Linalyl acetate				27.5 %	10.4 %

Table 8: The main compounds of lavender volatile oil.
Source 1: The plants were collected in Timişoara, Romania [41].
Source 2: The plants were collected in Yazd, Iran [39].
Source 3: The plants were collected in Wielkopolska, Poland (Herb Factory KAWON-HURT) [43].
Source 4: The plants were collected in Pančevo, Serbia [14].
Source 5: The plants were collected in in the Gardenof Medicinal-Aromatic Plants in the Campus of the University of Salerno, Italy [23].

Marjoram (Origanum Majorana)

Marjoram is an aromatic plant rich in essential oils and grown in southern Europe and the Mediterranean region. The main components of the marjoram volatile oil determined by GC-MS (gas chromatography-mass spectrometry) were γ-terpinene, α-terpinene, terpinen-4-ol and sabinene [45]. In the study conducted by Radaeli et.al. (2016) the antibacterial activity was evaluated from the minimum inhibitory concentration (MIC) and the minimum bactericidal concentration (MBC) using the microdilution method. Marjoram volatile oil has a high antiseptic capacity against C. Perfringens [46].

Table 9 presents the main compounds of marjoram volatile oil, as well as their quantity according to each research study.

Compound	**Source 1** [46]	**Source 2** [45]
Sabinene	3.14 %	10.80 %
β-Pinene	0.23 %	
Myrcene	0.55 %	2.08 %
α-Phellandrene	0.19 %	1.70 %
α-Terpinene	4.84 %	17.35 %
p-Cymene	1.56 %	
β-Phellandrene	1.51 %	7.05 %
1,8-Cineole	0.19 %	
γ-Terpinene	8.27 %	25.73 %
cis-Sabinene	2.62 %	
Terpinolene	1.56 %	3.76 %
Terpinen-4-ol	40.85 %	17.24 %
α-Terpineol	7.25 %	
trans-Sabinene hydrate acetate	0.32 %	0.13 %

Table 9: The main compounds of marjoram volatile oil.
Source 1: The plants were collected in São Paulo, Brazil [46].
Source 2: The plants were collected in Santa Cruz do Sul, RS, Brazil (Luar Sul Company) [45].

Mint (Mentha Piperita L.)

Mint is a perennial plant grown worldwide for the production of volatile oil. According to Capuzzo and Mafei (2016), mint is a hybrid between water mint (*Mentha aquatica* L.) and spearmint (*Mentha spicata* L.) [47]. According to the literature, mint is used in the treatment of intestinal colic, spasms of the biliary tract, dyspepsia,

biliary disorders, gall bladder and gastrointestinal tract, gastritis, flatulence and enteritis [48]. The main components of volatile peppermint oil are menthol, menthone, menthofuran, isomenthone, (E)-caryophyllene, 1,8-cineole, linalool, limonene, carvone, pulegone and α-terpineol [49]. In 2017 Ramos et al conducted a study that demonstrated the antiseptic and antioxidant activity of volatile peppermint oil. The antiseptic activity of this oil was tested against two strains of bacteria, one Gram-positive (*Staphylococcus aureus*) and one Gram-negative (*Escherichia coli*). The test results indicate a high antiseptic activity for these bacteria. For antioxidant activity, the 2,2-diphenyl-1-picrylhydrazyl (DPPH) method was used. The reading was done at the spectrophotometer at an absorbance of 517 nm and it was shown that peppermint oil has a high antioxidant activity [50]. In the study conducted by Singh in 2015, the antioxidant activity of volatile peppermint oil was also studied by the 2,2-diphenyl-1-picrylhydrazyl (DPPH) method. The reading was also performed on the spectrophotometer at an absorbance of 517 nm, and the result was the same as the previous study [51].

Table 10 presents the main compounds of mint volatile oil, as well as their quantity according to each research study.

Compound	Source 1 [50]	Source 2 [52]	Source 3 [48]	Source 4 [14]
β-Pinene	3.8 %	0.23 %	0.7 %	
Linalool	51.8 %			0.2 %
Cadinene	4.0 %			0.8 %
Germacrene	2.3 %			0.5 %
α-Pinene		0.13 %	0.7 %	
Sabinene		0.07 %	0.3 %	2.5 %
Myrcene		0.12 %	0.1 %	0.5 %
Para-cymene		0.29 %		0.1 %
Limonene		0.34 %	1.7 %	6.9 %
1,8-cineole		1.58 %	0.3 %	5.6 %
γ-terpinene		0.40 %		0.3 %
Menthone		15.74 %	14.5 %	12.7 %
isomenthone		7.73 %	1.1 %	
Menthol		39.69 %	56.6 %	37.4 %
pulegone		2.14 %	5.6 %	1.2 %
Piperitone		2.09 %	0.5 %	0.8 %
Menthyl acetate		3.02 %	2.1 %	17.4 %
Eugenol		0.21 %		
beta-bourbonene		0.22 %	0.2 %	0.4 %
Caryophyllene		0.11 %		0.3 %
Menthofuran			7.8 %	6.8 %
t-β-farnesene			0.1 %	0.7 %

Table 10: The main compounds of mint volatile oil.
Source 1: The plants were collected in Macapá, Brasil [50].
Source 2: The plants were collected in Hunedoara County, Romania (Fares BioVital Laboratories Orastie) [52].
Source 3: The plants were collected in Mitcham, Great Britain [48].
Source 4: The plants were collected in Pančevo, Serbia [14].

Chamomile (Matricaria Chamomilla)

The chemical composition of chamomile volatile oil was determined using GC-MS (gas chromatography-mass spectrometry) method, and the main compounds are β-farnesene, bisabolol oxide and α-farnesene [53]. In the study by Sokovicǵ, et al. In 2010, the antiseptic activity was certified using two methods: the disc-diffusion method and the microdilution method (MIC and MBC - μg/mL). In both methods, the antiseptic activity was checked against *M. flavus, B. subtilis*, *S. epidermidis*, *S. aureus*, *S. enteritidis*, *S. typhimurium*, *E. coli*, *E. cloacae*, *P. mirabilis*, *P. aeruginosa*

and *L. monocytogenes*. Chamomile volatile oil has shown good antiseptic activity for all of these bacteria [14].

Table 11 presents the main compounds of chamomile volatile oil, as well as their quantity according to each research study.

Compound	Source 1 [14]	Source 2 [53]
Camphene	0.1 %	
Sabinene	0.4 %	
α-Terpinene	0.1 %	
p-Cymene	0.2%	
Limonene	0.2 %	
1,8 – Cineole	0.4 %	
γ-Terpinene	0.1 %	
trans-Sabinene	0.3 %	
β-Caryophyllene	0.4 %	
trans-β-pharnesene	43.5 %	52.73 %
Germacrene D	0.4 %	3.42 %
Bicyclogermacrene	5.2 %	
trans-γ-Bisabolene	8.5 %	
Bisabolol oxide B	9.0 %	12.09 %
Bisabolone oxide	6.0 %	
Chamazulene	5.6 %	2.30 %
Bisabolol oxide A	8.5 %	
(E,E)-a-farnesene		10.34 %
α-bisabolol		9.83 %

Table 11: The main compounds of chamomile volatile oil.
Source 1: The plants were collected in Pančevo, Serbia [14].
Source 2: The plants were collected in Maringá-PR, Brazil (QUINARI Cosmetic and Fragrances Inc.) [53].

Discussion

Antioxidant and antiseptic properties of herbs are a growing factor among researchers. The use of these plants in the form of volatile oil in our diet is a very good option for our health. The use of synthetic preservatives and the food products we consume is increasing. Unfortunately, most of the preservatives currently used are harmful to our health, and their avoidance has to worry us more and more. Given that the medicinal plants around us have antiseptic capabilities, replacing these preservatives with their volatile oil may be a beneficial alternative for our health. Besides the synthetic preservatives that we ingest daily, the stress that surrounds us produces certain anomalies in our body. The daily stress that surrounds us produces in the human body a significant amount of free radicals that over time affect our health. External intake of antioxidants to eliminate the disturbances caused by oxidative stress is necessary. An extraordinarily good and healthy source are volatile oils from certain medicinal plants.

The studied plants were: basil, thyme, caraway, black currant, coriander, fennel, marigold, lavender, marjoram, mint and chamomile. All the studied plants have antioxidant or antiseptic properties, which means that their use in the food industry can be an excellent alternative.

Conclusion

The main purpose of this review was to present the antioxidant and antiseptic properties of the volatile oil obtained from certain medicinal plants. We studied eleven medicinal plants, and the results of the research indicated us that all the studied plants have antioxidant or antisepctic properties. Their use in the food industry is quite low at present. Food manufacturers should focus more on these plants because they bring many benefits to consumer health.

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