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Chemical Composition, Antibacterial and Antioxidant Activities of Some Lamiaceae Essential Oils

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Abstract. Medicinal and aromatic plants contain a variety of pharmacological bioactive compounds that provide enormous beneficial effects. Essential oils are natural substances formed by aromatic plants as secondary metabolites. They are the main reason for the aroma of aromatic plants. Aromatic plants produce essential oils to help them survive and protect them from environmental stressors such as pathogens. Essential oils have received increasing attention in recent years due to its relatively high safety, wide acceptance by consumers, and great potential for multiple commercial use. They are used to treat a wide variety of medical conditions. Essential oils exhibit various biological properties, such as sedative, digestive, anti-inflammatory, antiviral, antimicrobial, and antioxidant activities. Lamiaceae species rich in essential oils are of great value in natural medicine, pharmacology, aromatherapy and cosmetology. The present study gives an insight into some of common essential oils extracted from Lamiaceae species, regarding their chemical composition, antimicrobial and antioxidant activities.

Keywords: Antibacterial, Antioxidant, Essential oils, Lamiaceae.

1. Introduction

Medicinal and aromatic plants contain a variety of pharmacological bioactive compounds that provide enormous beneficial effects and support ecological and economic benefits. As their name suggests, aromatic plants contain aromatic compounds, more precisely, these comprise essential oils[1].

Essential oils, also called volatile oils[2], are volatile, natural, complex compounds formed by aromatic plants as secondary metabolites. They have strong odors[3]. They are soluble in alcohol, ether, and fixed oils, but insoluble in water. These compounds are usually liquid and have a density less than unity, except in a few cases (vetiver, sassafras, and cinnamon)[4].

The term ‘essential oil’ is believed to derive from the name coined in the 16th century by the Swiss reformer of medicine, Paracelsus von Hohenheim; who named the effective constituent of a drug Quinta essential[5]. Aromatic plants produce essential oils to help them survive and protect them from environmental stressors such as pathogens[6].

Plants usually store essential oils in various organs such as (root, bark, wood, leaf, fruit, seed, flower and bud), but in different quantities. Essential oils are secreted either directly from the protoplasm by the degradation of cell membrane and resin materials or by the hydrolysis of some glycosides[7].

Essential oils have received great attention recently, due to their relatively high safety, wide acceptance by consumers and great potential for various commercial use (pesticides, perfumes, and foods)[8]. The term "aromatherapy" was suggested in 1937, by the French chemist, Rene Gattefosse, who began the research in essential oils that showed their therapeutic properties. Today, essential oils can be used to treat a variety of medical conditions[6]. These components have been shown to exhibit diverse biological properties, such as sedative, digestive, anti-inflammatory, antiviral, antimicrobial, and antioxidant activities[2]. However, the use of essential oils in aromatherapy constitutes little more than 2% of the total market[5].

Plants usually contain about 1% essential oil, rarely more than 15%. Some of the families containing essential oil plants are Lamiaceae, Asteraceae, Apiaceae, Myrtaceae, Rutaceae, Lauraceae, Cupressaceae, and Zingiberaceae[9].

Lamiaceae plants rich in essential oils are of great value in natural medicine, aromatherapy, pharmacology, and cosmetology[10]. This study covers literature data summarizing, the chemistry of Lamiaceae essential oils and their antibacterial and antioxidant activities.

2. Lamiaceae Family

Lamiaceae plants is one of the large plant families[11], and one of the most important families containing volatile oil. It also called the mint family[12]. It is one of the most diverse families in term of ethnomedicine. The medicinal value of this family is mainly based on the essential oils composition[13]. It contains 236 genera and about 7,173 species [10]. It comprises herbs, bushes[14] consisting of annual or perennial plants[15], and occasionally trees[14]. It is spread all over the world, mostly in the Mediterranean region and North-Western Asia[15].

Commercially, Lamiaceae plants are very important [16]. The most known species are aromatic spices like mint, basil, sage, savory, oregano, hyssop, lemon, thyme, balm, rosemary, and some others[17].

Lamiaceae plants exhibit many biological activities such as cytotoxic, analgesic, anti-angiogenic, antiepileptic, antiviral, anti-inflammatory, antifungal, antibacterial, antioxidant, anti-anxiety, antispasmodic, cardiovascular, hypoglycemic and hypolipidemic[12]. Rosemary (*Rosmarinus officinalis*) has been used in traditional medicine as a stimulant and mild analgesic, and for treating headaches, inflammatory diseases, physical and mental fatigue and poor circulation[18]. The essential oil of *thymus vulgaris* can be used as natural antioxidant and antimicrobial agent[19]. In folk medicine, *Marrubium vulgare* is employed as antispasmodic and antinociceptive. It exhibits diaphoretic, diuretic, expectorant, aromatic, tonic, and stimulant properties[20]. The essential oil of *Satureja hortensis* has been used in food industry and aromatherapy[21]. *Ocimum* species are among the best-known medicinal plants, with reports of their chemo-protective, cardio-protective, hepatoprotective, immunomodulatory, anti-cataract, antioxidant, anti-inflammatory, anti-microbial, anthelmintic, anti-diabetic, anti-nociceptive, antiulcer, anti-stress, antifertility, antitussive, memory enhancing, anti-arthritic, anti-hypertensive, anticoagulant, anti-hyperlipidemic and radioprotective activity[17].

3. Chemical Composition of Lamiaceae Essential Oils

Essential oils are complex mixtures of low molecular weight compounds[22]. They might contain about 20–60 constituents at different concentrations[23]. Major constituents can constitute up to 85% of the essential oil, whereas other constituents are present only as a trace[5]. The volatile compounds belong to several chemical groups such as phenols, esters, ethers, heterocycles, aldehydes, ketones, alcohols, amides, amines and mainly the terpenes[4]. The chemical composition of the essential oils is different from plant taxonomic group to another[24]. It is affected by endogenous and exogenous factors, such as plant species, harvesting time, geographical position, and climate conditions[25]. Also, the extraction method affects the chemical composition of the essential oil. There are many methods of extraction, including distillation methods, microwave-assisted extraction, expression, enfleurage, and solvent extraction[24]. In general, there are high amount of terpenes in the essential oils of the Lamiaceae species[25].

On the basis of the total percentage, the main components of some Lamiaceae essential oils are displayed in (Table 1). Some of these components such as p-cymene was identified in more than one species (in many species of the family Lamiaceae) such as *Thymus vulgaris, Thymus capitatus, Thymus decussatus, Satureja hortensis, Origanum majorana, Origanum vulgare,* and *Nepeta granatensis.* 1,8-cineole was also introduced as one of the main compounds of *Salvia officinalis, Ziziphora clinopodioides, Thymus capitatus, Mentha piperita* essential oils. γ-terpinene was also identified in the essential oils of *Origanum majorana, Origanum vulgare, Satureja hortensis, Thymus vulgaris, Thymus capitatus, Thymus decussatus.*

Carvacrol was identified in the essential oils of *Lavandula multifida, Origanum vulgare, Satureja hortensis, Thymus vulgaris, Thymus capitatus, Thymus decussatus.*

Caryophyllene oxide was identified in the essential oils of *Ballota nigra subsp. kurdica, Lavandula multifida, Melissa officinalis.* In contrast, some compounds were found as main components in the unique species. Limonene, for instance, was reported as a major component only in the *Rosmarinus officinalis* (rosemary) essential oil.

Table 1. Chemical composition of some Lamiaceae essential oils.

Species	Plant part	Main compounds	Ref.
Thymus vulgaris	Aerial parts	Thymol, p-cymene, carvacrol, γ-terpinene, ß-caryophyllene, carvone	[26]
Thymus capitatus	Aerial parts	Carvacrol, γ-terpinene, p-cymene, (E)-Caryophyllene, 1.8-cineole, α-Terpinene	[13]
Thymus decussatus	Aerial parts	Carvacrol, *p*- cymene, γ- terpinene, cloven	[27]
Mentha piperita	Aerial parts	Menthol, menthofuran, methyl acetate, menthone, 1.8-cineole, neomenthol	[28]
Rosmarinus officinalis (rosemary)	Leaves	Limonene, camphor, α-pinene, Z-linalool oxide, borneol	[29]
Hyssopus officinalis	Aerial parts	Isopinocamphone, elemol, α-eudesmol, γ-eudesmol, myrtenol, (-)-spathulenol	[30]
Ziziphora clinopodioides subsp. *bungeana*	Aerial parts	pulegone, *iso*-menthone, 1,8-cineole, piperitenone	[31]
Satureja hortensis	Aerial parts	thymol, γ-terpinene, carvacrol, *p*-cymene	[32]
Origanum majorana	Aerial parts	α-Terpineol, γ-terpinene, p-cymene, α-terpinene, verbenone, sabinene hydrate	[13]

Origanum vulgare	Aerial parts	Carvacrol, thymol, p-cymene, γ-terpinene, Camphène, α- terpinene	[33]
Salvia officinalis	Leaves	α-thujone, camphor, viridiflorol, borneol, 1,8-cineole, bornyl acetate	[29]
Marrubium incanum	Aerial parts	(*E*)-caryophyllene, germacrene D, bicyclogermacrene, δ-Cadinene, α-humulene, α-copaene	[34]
Nepeta atlantica	Whole plant	4a-a, 7-a, 7a-b-nepetalactone, methylisoeugenol, dihydronepetalactone, farnesol, α– curcumene	[35]
Nepeta tuberosa subsp reticulata	Whole plant	4a-a, 7-a, 7a-b-nepetalactone, dihydronepetalactone, menthol, α – pinene, eucalyptol	
Nepeta cataria	Whole plant	4a-a, 7-a, 7a-b-nepetalactone, dihydronepetalactone, terpinene, limonene, thymol	
Nepeta granatensis	Whole plant	4a-a, 7-a, 7a-b-nepetalactone, eucalyptol, α – pinene, α—phellandrene, p-cymene	
Ocimum basilicum	Leaves	Methyl chavicol, trimethoquinol, gitoxigenin , (Z)-5,7-octadine-4-one-2,6-dimethyl, β-guaiene, aciphyllene	[36]
Melissa officinalis	Leaves	Geranial, Neral, Citronellal, Isomenthol, α-Copaene, Cis-Chresontynol, ß-Caryophyllene, Caryophyllene oxide	[37]
Lavandula multifida	Leaves and stems	carvacrol, β-bisabolene, careophylene oxide, Fenchol, terpinolene, caryophyllene	[38]
Ballota nigra subsp. kurdica	Flowers	Caryophyllene oxide, trans-caryophyllene, germacrene-D, 1-Undecene, Isoaromadendrene epoxide, Tridecane-1	[39]
Teucrium polium	Aerial parts	6-Epi-shyobunol, t-muurolol, cadinene, α-pinene, germacrene-D-4ol	[27]

4. Antimicrobial Activity of Lamiaceae Essential Oils

Conventional antimicrobials have been shown to have potential eco-toxicological risks, and may also affect many non-target organisms[40]. Therefore, it is necessary to identify natural molecules that act as antimicrobials, while ensuring safety and non-toxicity[2]. It has been shown that essential oils extracted from aromatic plants can act as antimicrobials, with reduced side effects[7]. Health and Human Services Public Health Services have recognized essential oil as safe substance[41].

Although the antimicrobial effects of essential oils have been studied in the past, the mechanism of action has not been studied in detail. They showed activities against gram-negative and gram-positive bacteria.

It has been reported that essential oils containing mainly aldehydes or phenols, such as eugenol, thymol, citral, carvacrol, or cinnamaldehyde, were characterized by the highest antibacterial activity, followed by essential oils containing terpene alcohols[4]. The phenolic components are mainly responsible for the antibacterial effects of essential oils[5]. However, the relative position of the phenolic hydroxyl group on the ring did not seem to affect the intensity of the antibacterial activity[4]. The main mechanism of antibacterial effect is the denaturation of proteins. The type of alkyl substituent incorporated in a non-phenolic cycle influences the antibacterial activity of terpenoids. The presence of a carbonyl function in the chemical structure of terpenoids increases the antibacterial properties[42]. Moreover, essential oils are hydrophobic, and this property helps to partition into lipids present in the cell membrane of bacteria, disrupting the structure and making it more permeable. As a result, the bacterial cell dies due to leakage of critical molecules and ions from the bacterial cell to a great extent[41].

Antibacterial activity of essential oils extracted from different Lamiaceae genera, such as *Thymus*, *Mentha*, *Rosmarinus*, *Hyssopus*, *Ziziphora*, *Satureja*, *Origanum*, *Salvia*, *Marrubium*, *Nepeta*, *Ocimum*, *Melissa*, *Lavandula*, *Ballota*, *Teucrium* have been documented (Table 2).

Table 2. Antibacterial activity of some Lamiaceae essential oils against various bacterial strains.

Species	Micro-organisms	MIC values	Ref.
Thymus vulgaris	*Staphylococcus aureus* ATCC 29213	512 µg/ml	[26]
	Streptococcus pyogenes ATCC 19615	512 µg/ml	
	Haemophilus influenzae ATCC 49247	512 µg/ml	
Mentha piperita	*Listeria monocytogenes* PTCC 1163	1250 µg/ml	[43]
	Salmonella typhimurium ATCC 13311	2500 µg/ml	
Rosmarinus officinalis (rosemary)	*Streptococcus Mutans* ATCC 25275	>2000 µg/ml	[44]
	Streptococcus mitis ATCC 49456	>2000 µg/ml	
	Streptococcus sanguinis ATCC 10556	>2000 µg/ml	
	Streptococcus salivarius ATCC 25975	600 µg/ml	
	Streptococcus sobrinus ATCC 33478	500 µg/ml	
	Enterococcus faecalis ATCC 4082	>2000 µg/ml	
Hyssopus officinalis	*E. coli* 25922 ATCC	156.25 mg/ml	[45]
	Listeria monocytogenes 19117 ATCC	312.5 mg/ml	
Ziziphora clinopodioides subsp. *bungeana*	*Staphylococcus epidermidis* ATCC 12228	3.75 mg/ml	[31]
	Staphylococcus aureus ATCC 25923	3.75 mg/ml	
	Escherichia coli ATCC 25922	3.75 mg/ml	
	Bacillus subtilis ATCC 9372	3.75 mg/ml	
	Enterococcus faecalis ATCC 15753	>15 mg/ml	
	Klebsiella pneumoniae ATCC 3583	>15 mg/ml	
Satureja hortensis	*Acinetobacter baumanii* A8	15.62 µg/ml	[32]
	Bacillus macerans A199	62.50 µg/ml	
	Bacillus megaterium A59	62.50 µg/ml	
	Klebsiella pneumonia F3	62.50 µg/ml	
	Pseudomonas aeruginosa ATCC-27859	31.25 µg/ml	
	Salmonella enteritidis ATCC-13076	31.25 µg/ml	
	Staphylococcus aureus A215	15.62 µg/ml	
	Staphylococcus hominis F10	62.50 µg/ml	
	Streptococcus pyogenes KUKEM-676	62.50 µg/ml	
Rosmarinus officinalis	*Pseudomonas aeruginosa* CIP 82118	22.75 mg/ml	[13]
	Escherichia coli CIP 53.126	11.38 mg/ml	
	Salmonella enterica CIP 80.39	22.75 mg/ml	
	Bacillus subtilis CIP 52.62	22.75 mg/ml	
	Staphylococcus aureus CIP 4.83	22.75 mg/ml	
Thymus capitatus	*Pseudomonas aeruginosa* CIP 82118	1.47 mg/ml	
	Escherichia coli CIP 53.126	0.73 mg/ml	
	Salmonella enterica CIP 80.39	0.73 mg/ml	
	Bacillus subtilis CIP 52.62	2.94 mg/ml	
	Staphylococcus aureus CIP 4.83	0.73 mg/ml	
Origanum majorana	*Pseudomonas aeruginosa* CIP 82118	45.00 mg/ml	
	Escherichia coli CIP 53.126	45.00 mg/ml	
	Salmonella enterica CIP 80.39	22.50 mg/ml	
	Bacillus subtilis CIP 52.62	22.50 mg/ml	
	Staphylococcus aureus CIP 4.83	22.50 mg/ml	
Origanum majorana	*Staphylococcus aureus*	6.25 µl/ml	[46]
Origanum vulgare	*Staphylococcus aureus*	12.5 µl/ml	

Salvia officinalis	*Pseudomonas aeruginosa* CIP 82118	22.78 mg/ml	[13]
	Escherichia coli CIP 53.126	22.78 mg/ml	
	Salmonella enterica CIP 80.39	22.78 mg/ml	
	Bacillus subtilis CIP 52.62	22.78 mg/ml	
	Staphylococcus aureus CIP 4.83	22.78 mg/ml	
Marrubium incanum	*Staphylococcus aureus* ATCC 25923	50 µg/ml	[34]
	Staphylococcus epidermidis ATCC 12228	100 µg/ml	
	Micrococcus flavus ATCC 10240	6.25 µg/ml	
	Enterococcus faecalis ATCC 29212	25 µg/ml	
	Escherichia coli ATCC 25922	12.5 µg/ml	
	Klebsiella pneumoniae NCIMB 9111	12.5 µg/ml	
	Pseudomonas aeruginosa ATCC 27853	50 µg/ml	
Nepeta atlantica	*Escherichia coli* ATCC 25922	13.13 µl/ml	[35]
	Pseudomonas aeruginosa ATCC 27853	22.50 µl/ml	
	Staphylococcus aureus ATCC 25923	7.50 µl/ml	
Nepeta tuberosa subsp reticulata	*Escherichia coli* ATCC 25922	6.25 µl/ml	
	Pseudomonas aeruginosa ATCC 27853	40.0 µl/ml	
	Staphylococcus aureus ATCC 25923	4.37 µl/ml	
Nepeta cataria	*Escherichia coli* ATCC 25922	16.25 µl/ml	
	Pseudomonas aeruginosa ATCC 27853	37.50 µl/ml	
	Staphylococcus aureus ATCC 25923	5.00 µl/ml	
Nepeta granatensis	*Escherichia coli* ATCC 25922	35.00 µl/ml	
	Pseudomonas aeruginosa ATCC 27853	40.00 µl/ml	
	Staphylococcus aureus ATCC 25923	22.50 µl/ml	
Ocimum basilicum	*Bacillius cereus*	62.5 µg/ml	[36]
	Bacillius subtilis	125 µg/ml	
	Bacillius megaterium	125 µg/ml	
	Staphylococcus aureus	125 µg/ml	
	Listeria monocytogenes	125 µg/ml	
	Escherichia coli	500 µg/ml	
	Shigella boydii	250 µg/ml	
	Salmonella typhi	250 µg/ml	
Melissa officinalis	*Pseudomonas aeruginosa ATCC 27853*	4 mg/ml	[47]
	Escherichia coli ATCC 25922	4 mg/ml	
	Staphylococcus epidermidis ATCC 12228	1 mg/ml	
	Streptococcus pyogenes ATCC 19615	0.5 mg/ml	
Melissa officinalis	*Bacillus subtilis ATCC 6633*	2 µl/ml	[37]
	Staphylococcus aureus CIP 7625	3 µl/ml	
	Listeria monocytogenes CIP82110	2 µl/ml	
	Pseudomonas aeruginosa CIP A22	2 µl/ml	
	Escherichia coli ATCC 10536	2 µl/ml	
	Klebsiella pneumoniae CIP 8291	3 µl/ml	
	Salmonella enterica CIP 81.3	5 µl/ml	
Lavandula multifida	*Enterococcus faecalis* ATCC 29212	0.2500 µl/ml	[48]
	Escherichia coli ATCC 25922	0.5000 µl/ml	
	Pseudomonas aeruginosa ATCC 27853	10.00 µl/ml	
	Klebsiella pneumoniae ATCC 70603	0.5000 µl/ml	
	Staphylococcus aureus ATCC 25923	0.2500 µl/ml	
	Canidida albicans ATCC 10231	0.0625 µl/ml	
	Listeria monocytogens ATCC 19115	0.2500 µl/ml	
	Bacillus cereus ATCC 11778	0.0312 µl/ml	
	Bacillus subtilis ATCC 6633	0.0312 µl/ml	
Ballota nigra subsp. kurdica	*Staphylococcus aureus* ATCC 25923	3.75 mg/ml	[39]
	Enterococcus faecalis ATCC 15753	3.75 mg/ml	
	Bacillus subtilis ATCC 9372	15 mg/ml	

	Klebsiella pneumonia ATCC 3583	> 10 mg/ml	
	Pseudomonas aeruginosa ATCC 27852	15 mg/ml	
	Escherichia coli ATCC 9763	7.5 mg/ml	
Teucrium polium	*Bacillus subtilis* ATCC6633	62.50 µg/ml	[27]
	Staphylococcus aureus ATCC29213	125.00 µg/ml	
	Escherichia coli ATCC25922	250.00 µg/ml	
Thymus decussatus	*Bacillus subtilis* ATCC6633	3.91 µg/ml	
	Staphylococcus aureus ATCC29213	1.95 µg/ml	
	Escherichia coli ATCC25922	0.98 µg/ml	

MIC=Minimal inhibitory concentrations.

Adiguzel et al., [32] indicated that the essential oil of *Satureja hortensis* plant has an antimicrobial activity against many bacterial strains including *Acinetobacter baumanii* A8, *Bacillus macerans* A199, *Bacillus megaterium* A59, *Klebsiella pneumonia* F3, *Pseudomonas aeruginosa* ATCC-27859, *Salmonella enteritidis* ATCC-13076, *Staphylococcus aureus* A215, exerting the Minimum Inhibitory Concentration values (MIC) ranging from 15.62 to 62.50 µg/ml.

Petrović et al., [34] evaluated the antibacterial activity of *Marrubium incanum* essential oil on laboratory control strains from the *American Type Culture Collection* (ATCC). The best inhibitory effect was detected against *M. flavus* (MIC 6.25 µg/ml), followed by *E. coli* (MIC 12.5 µg/ml) and *K. pneumoniae* (MIC 12.5 µg/ml), while *S. epidermidis* appeared to be the most resistant (MIC 100 µg/ml).

The essential oils of *O. basilicum* displayed a great potential of antibacterial activity against *Bacillius cereus*, *B. subtilis*, *B. megaterium*, *Staphylococcus aureus*, *Listeria monocytogenes*, *Escherichia coli*, *Shigella boydii*, *S. dysenteriae*, *Vibrio parahaemolyticus*, *V. mimicus*, and *Salmonella typhi* with MIC values of 62.5–500 µg/ml[36].

The extracted essential oils of *Teucrium polium* and *Thymus decussatus* were tested against a panel of pathogenic bacterial. *T. decussatus* showed the best results, and exhibited potent inhibitory effect against all tested bacteria, and the lowest minimum inhibitory concentration (MIC) was of 0.98, and 1.95 µg/ml against *Escherichia coli*, and *Staphylococcus aureus*, respectively. However, the essential oil of *T. polium* showed weak antibacterial activity[27].

5. Antioxidant Activity of Lamiaceae Essential oils

It is known that reactive oxygen species (ROS) produced from normal and/or abnormal metabolic reactions are pathogenetic factors involved in many diseases[8].

When reactive oxygen species increase in the body, "oxidative stress" occurs as a result of an oxidative imbalance[49]. Although the body has its own antioxidant defense mechanisms, but the cellular damage caused by oxygen free radicals is omnipresent[50]. Antioxidants are molecules that can decrease or eliminate the effect of reactive oxygen species[49].

The mechanism of action of the antioxidant in inhibiting the DPPH radical depends on the ability to release a hydrogen atom, or to eliminate free radical. As for the antioxidant property of essential oil, it is mostly attributed to the phenolic composition, especially camphor and ß-pinene[45].

Lamiaceae plants are one of the most important sources of compounds with antioxidant effect[16]. The antioxidant activity of essential oils derived from Lamiaceae species have been investigated in several studies (Table 3).

Table 3. Antioxidant activity of some Lamiaceae essential oils.

Species	Technique	Concentration	Results	Ref.
Thymus vulgaris	DPPH	1000 (µg/ml)	Radical scavenging activity=88.5%	[19]
Mentha piperita	DPPH	25000 ppm	Radical scavenging activity=60.70±1.08	[22]
	ABTS	25000 ppm	Radical scavenging activity=49.07±1.47	
Rosmarinus officinalis (rosemary)	DPPH	-	IC50 = 77.6 µl/ml	[18]
Hyssopus officinalis	DPPH	-	IC50 =16.37±0.001 µg/ml	[54]
Ziziphora clinopodioides	DPPH	-	IC50 =3.75±0.3 mg/ml	[55]
Satureja hortensis	DPPH	-	IC50 =0.71 ± 0.01 mg/ml	[56]
Thymus capitatus	DPPH	-	IC50 = 0.619 ± 0.11 µg/ml	[52]
Origanum majorana	DPPH	400 µg/mL	Radical scavenging activity = 83.6%	[57]
	β-carotene		β-Carotene Inhibition= 76.2	
Origanum vulgare	DPPH	-	$IC_{50=}$ 0.357 µg/ml	[53]
Salvia officinalis	DPPH	-	IC50=62.3 ± 1.8 µg/ml	[58]
Marrubium vulgare	DPPH	300 µg/ml	Radical scavenging activity = 79.00 ± 3.00	[20]
Nepeta foliosa	DPPH	-	IC50= 20.10±1.85 mg/ml	[59]
	Lipid peroxidation	-	IC50= 2.13±1.27 µg/ml	
Ocimum basilicum	DPPH	-	IC50= 5.92 ± 0.15 µg/ml	[51]
	H2O2		Inhibition%=72.3 ± 0.10	
Melissa officinalis	DPPH	-	IC50= 69.9 ± 1.9 µg/ml	[58]
Lavandula angustifolia	DPPH	-	IC50= 289.0 ± 8.5 µg/ml	
Teucrium polium	DPPH	-	IC50 = 9200 µg/ml	[60]

Nadeem et al., [51] *O. basilicum* essential oil exhibited excellent antioxidant activity, with IC50 of 5.92 ±0.15 µg/ml as assayed by the DPPH assay, and 14.6 ± 0.59% inhibition by H2O2.

Goudjil et al., [52] evaluated The antioxidant activity of *Thymus Capitatus* EO by three methods: the DPPH test (2,2-diphenyl-1-1-picrirylhydrazil), the FRAP (Ferric reducing antioxidant power) and TAC (Total Antioxidant Capacity) test. The results indicated that *Thymus Capitatus* oil showed higher antioxidant power in comparison with the standards (ascorbic acid, BHA (Butylated hydroxy anisole) and commercial thymol) with values of (0.61, 2.13 and 0.78) µg/mL for the DPPH, FRAP and TAC tests respectively.

Quiroga et al., [53] showed that the essential oil of *Origanum vulgare* had antioxidant activity, with IC_{50} value of 0.400 µg/ml.

The antioxidant activity of the essential oil of *Hyssopus officinalis* was determined by using the DPPH radical-scavenging method. These results demonstrated that hyssop essential oil (IC50 = 16.37±0.001 µg/ml) presented lower antioxidant activity than ascorbic acid (IC50 = 10.94±0.94 µg/ml)[54].

According to[19], the essential oil of *Thymus vulgaris* can be a good source of natural preservatives as an antioxidant. It exhibited the highest DPPH-scavenging activity (88.5%) at the concentration (1000 µg/ml).

In view of the previous data on the antioxidant activity of essential oils derived from different species, it is important to mention that the effective inhibitory concentrations of essential oils can be affected by the agronomic practices, the processing and the variety of the plants can affect the effective inhibitory concentrations of essential oils.

6. Conclusion

This study provided valuable information on the chemical composition of Lamiaceae essential oils, and some of their biological activities in terms of their antibacterial and antioxidant properties. According to this study, Lamiaceae essential oils can be used as alternatives to synthetic additives in the food, cosmetic and pharmaceutical industries. However, other studies are required to investigate the exact mechanisms of these biological activities, which may contribute to the discovery of natural products that ensure safety and non-toxicity, and thus avoid potential health risks of synthetic products.

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التركيب الكيميائي، الفعالية المضادة للجراثيم والفعالية المضادة للأكسدة لبعض الزيوت العطرية من العائلة الشفوية

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المستخلص. تحتوي النباتات الطبية والعطرية على مجموعة متنوعة من المركبات الدوائية الفعالة حيوياً، والتي تبدي تأثيرات مفيدة هائلة. الزيوت الأساسية هي مواد طبيعية تنتج من النباتات العطرية كمستقلبات ثانوية، وتعد المسؤولة عن رائحة النباتات العطرية. تنتج النباتات العطرية الزيوت الأساسية لمساعدتها على البقاء، وحمايتها من المخاطر البيئية مثل العوامل الممرضة. حظيت الزيوت العطرية باهتمام متزايد في السنوات الأخيرة بسبب سلامتها العالية نسبياً، وقبولها الواسع من قبل المستهلكين، والإمكانية الكبيرة لاستخدامها تجارياً في مجالات متعددة. تستخدم الزيوت العطرية لعلاج مجموعة متنوعة من الحالات المرضية. تتميز الزيوت الأساسية بخصائص بيولوجية مختلفة، كمهدئات، ومواد مساعدة على الهضم، ومضادات التهاب ومضادات فيروسية، ومضادات جرثومية، ومضادات أكسدة. تعد أنواع العائلة الشفوية الغنية بالزيوت الأساسية ذات قيمة كبيرة في العلاجات الطبيعية وعلم الأدوية، والعلاج العطري، والصناعات التجميلية. تركز هذه الدراسة على بعض الزيوت الأساسية الشائعة لأنواع العائلة الشفوية، فيما يتعلق بتركيبها الكيميائي، وفعاليتها المضادة للجراثيم والمضادة للأكسدة.

الكلمات المفتاحية: مضاد جرثومي، مضاد أكسدة، الزيوت الأساسية، العائلة الشفوية.