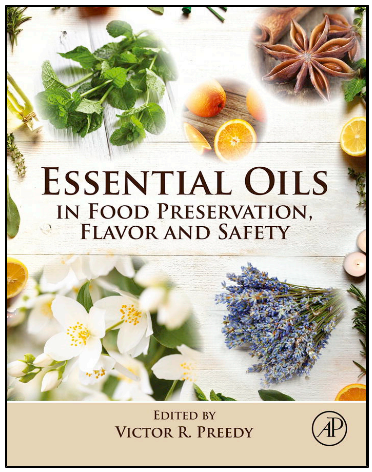

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Chapter 65

Mugwort (*Artemisia vulgaris*) Oils

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INTRODUCTION

Mugwort (*Artemisia vulgaris* L.), belonging to the genus *Artemisia,* is very much popular due to its characteristic odor and unique medicinal and food flavoring applications. There are around 500 species of *Artemisia* distributed across Asia, Europe, and North America that are frequently employed in folk medicine and food preparations (Willcox, 2009). Chemical studies on these plants indicate that several classes of bioactive compounds, in particular, terpenoids and flavonoids are present in this genus. The presence of a significant amount of essential oils and other terpenoids in the plants of this species can be linked with their potential uses as flavoring agents in foods and as ingredients of pharmaceutical products (Wright, 2002).

Mugwort, due to its aromatic nature and distinctive scent, has considerable essential oil potential which can be explored as ingredient of several functional foods, cosmeceuticals, and pharmaceutics. Indeed, research on essential oils has been revived due to their potential antioxidant and antimicrobial activities against aging, inflammation, and infectious diseases as well as their applications in food science (Hussain et al., 2008). This chapter focuses on the botanical and functional food aspects, medicinal uses, and applications of mugwort essential oil in food science.

BOTANICAL ASPECTS

Artemisia vulgaris L., commonly known as mugwort, belongs to family Compositae, and is native to Europe, Asia, and northern Africa. It is grown wildly in semiarid or arid areas throughout the Mediterranean basin and extending into the north-west Himalayas (Asta and Juste, 2006). Mugwort has a pleasant tangy taste. The root is sweet and pungent and the herb is aromatic and bitter in nature. The branched tips are gathered during the flowering season and carefully dried. Other fresh above and under ground parts of the plant are harvested at the beginning of winter, primarily from the wild (Gruenwald et al., 2008).

The plant is a long-stemmed, 70–150 cm high shrub with a branched, many headed and creeping rhizome without runners or rosette, and the medicinal parts are roots and aerial parts, particularly dried branched tips (Gruenwald et al., 2008). A typical photograph of mugwort plant is shown in Figure 1.

Flower and Fruit: Flower heads are ovoid, 3–4 mm long by 2 mm wide. The numerous flowers are short and stemmed erect or slightly drooping. They are dense, heavily branched panicles with numerous lanceolate bracts. The flowers are yellowish or red brown and almost glabrous. The fruit has an indistinct margin (Gruenwald et al., 2008).

Leaves and Stems: The leaves are 5–10 cm long, coriaceous, and the margins are often rolled back. The upper surface is usually dark green and glabrous, occasionally pubescent, and the lower surface is tomentose. The basal leaves are short petioled and lobbed with an end section and one to two pairs of small side leaflets. The rest of the leaves are sessile or almost sessile with a slit base. The shoots are slightly pubescent, often red-tinged, and have week unpleasant smell. The erect or ascending edged, and coriaceous long stems die off each year. They are in branched panicles and downy (Gruenwald et al., 2008).

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FIGURE 1 Mugwort (*Artemisia vulgaris*) (Tobyn et al., 2011).

USES AND APPLICATIONS

The plant is known to possess multiple medicinal uses and application in folk medicine, which include, gastrointestinal tract such as stomach ulcers, and indigestion and liver disorders (Gilani et al., 2005; Gruenwald et al., 2008). The plant is also used for worm infestations, epilepsy, vomiting, to promote circulation, as a sedative, and for delayed or irregular menstruation. The root is used for asthenic states as a tonic and in combination with other remedies also for psychoneuroses, neurasthenia, depression and hypochondria, autonomic neuroses, general irritability and restlessness, insomnia, and anxiety states. Mugwort is not used in pregnancy (Gruenwald et al., 2008).

Essential oils are known to make a major contribution to the plant's biological activity and generally have a broad spectrum of bioactivity, owing to the presence of several active ingredients or secondary metabolites, which work through various modes of action. The essential oil exhibits many other biological activities useful in food science such as antiseptic, antioxidant, larvicidal, nematicide, pesticide, antibacterial, antifungal, and antiviral, and is also used in the flavor and perfumery industry (Silva, 2004).

Mugwort essential oil has been employed for the treatment of diabetes and epilepsy, and in combination for psychoneurosis, depression, irritability, insomnia, and anxiety stress (Walter and Memory, 2003). The essential oil has a warming effect on the body which can be used to counter the effects of cold and moisture in the air; it also acts as a tonic for the nerves.

Mugwort is used to flavor tea and rice dishes in Asia and as a culinary herb for poultry and meat in Western cultures. It has also been utilized as an analgesic agent and in conjunction with acupuncture therapy (Yoshikawa et al., 1996). The leaves and buds are used as a bitter flavoring agent to season fat, meat, and fish. In China, it is used mostly for moxibustion (Tang and Eisenbrand, 2011). A paste or powder of its leaves is applied over skin diseases. It is used as an inferior substitute for cinchona for treating fever (Silva, 2004; Judzentiene and Buzelyte, 2006; Haider et al., 2003).

USES AND APPLICATIONS IN FOOD SCIENCES

There has been a growing interest in research concerning the possible use of plants in their natural form for pest and disease control in agriculture, that are less damaging to the human health and environment (Wang et al., 2005; Hussain et al., 2008). The essential oil exhibits many other biological activities useful in food science such as antiseptic, antioxidant, larvicidal, nematicide, pesticide, antibacterial, antifungal, and antiviral as well as being used in the flavor and perfumery industry (Silva, 2004). Mugwort plant is valued for its medicinal food value. The essential oil of mugwort has been reported to slow down or inhibit the growth of different kinds of insects, microbes, and parasites and can be employed to protect foods from related deteriorations as a part of natural management practise. Repellent and fumigant activity of mugwort essential oil against *Musca domestica* L. and the stored-product insect pest *Tribolium castaneum* (Herbst) have also been reported (Judzentiene and Buzelyte, 2006). Erel et al. (2012) investigated in vitro antimicrobial activity of mugwort's essential oil against different microbial strains including *Staphylococcus aureus*, *Staphylococcus epidermidis*, *Enterococcus faecalis*, *Enterobacter cloacae*, *Escherichia coli*, *Salmonella typhimurium*, and *Candida albicans* using the disk diffusion method compared with positive control (ceftazidime and ketoconazole). The essential oil produced inhibition zones greater than or equal to that of the standard antibiotic suggesting its uses as a natural antimicrobial agent. The strong antimicrobial activity of mugwort essential oil is attributed to the presence of 1,8-cineole, α-thujone, and camphene (Silva, 2004; Blagojevica et al., 2006). The antitumoral activity has also been linked to artemisic acid and artemisinin B extracted from mugwort (Sun et al., 1992).

Interestingly, mugwort's essential oil has 2,2-diphenyl-1-picrylhydrazyl radical scavenging activity similar to that of the standard antioxidant (butylated hydroxyl toluene, BHT) indicating its appreciable potential toward preservation of foods using natural additives (Erel et al., 2012). In another investigation, the essential oils of *A. vulgaris* also showed antioxidant activity in terms of free radical scavenging activity similar to those of the synthetic antioxidant BHT (Erel et al., 2012). It is well known that there is a relationship between antioxidant activity and the phenolic content of the plant extracts (Albayrak et al., 2010). Therefore, antioxidant properties of this potential oil can be attributed to the phenolic and flavonoid contents of the *A. vulgaris* (Wright, 2002).

The essential oil extracted from mugwort stem is a potential larvicide against *Aedes aegypti* in low concentrations of the oil solution and thus could be explored as a natural larvicidal agent against certain vector borne diseases and pest control in food science (Govindaraj and Kumari, 2013). Sharifian et al. (2013) evaluated insecticidal activity of mugwort essential oil against *Tribolium castaneum* (Herbst), *Callosobruchus maculatus* (F.), and *Rhyzopertha dominica* (F.). The results revealed that mortality of the insects increased as the doses of essential oil and exposure time increased thus prompting the need to explore this oil as natural insecticidal agent for insect control in food crops. The insecticidal and larvicidal properties of mugwort essential oil can be attributed to camphene and its chloro derivative and α-Thujone (Silva, 2004). Camphor, an active component of mugwort essential oil, has moth repellent properties and is used as preservatives in pharmaceuticals and cosmetics. Extracts of *A. vulgaris* L. appear to possess blood pressure lowering actions which can be linked with the presence of yomogin (Tigno et al., 2000). The prescribed health food functions coupled with bioactive profile support the potential uses of mugwort essential oil as a medicinal food.

ESSENTIAL OIL PRODUCTION

The extraction of essential oils from plant material can be achieved by various methods such as supercritical fluid extraction, solvent extraction, hydrodistillation, steam distillation, cold or hot pressing, effleurage, and phytonic process (Surburg and Panten, 2006). Various reports have shown that the essential oil yield from mugwort may vary from 0.1 to 1.4% depending on the plant part used and the origin of harvest (Table 1). Mugwort essential oil is clear to pale yellow in color with characteristic fragrance (slightly licorice-like), and can be blended with several other essential oils (Thao et al., 2004; Alizadeh et al., 2012).

CHEMICAL COMPOSITION OF MUGWORT ESSENTIAL OIL

The strong and aromatic smell of *A. vulgaris* is mainly due to high concentrations of volatile terpenes, constituents of their essential oil (Abad et al., 2012). The active components of *A. vulgaris* identified include flavonoids, coumarins, sesquiterpene lactones, volatile oils, inulin, and traces of alkaloids. The chief compounds of volatile oils include camphor, camphene, α-thujone, germacrene D, 1,8-cineole, and β-caryophyllene (Silva, 2004; Judzentiene and Buzelyte, 2006; Haider et al., 2003). The contents and composition of Mugwort (*A. vulgaris*) essential oil appear to be dependent on biochemical and geographical variability as well as on the method of extraction as shown in Table 2. It has been demonstrated that mugwort grown in different countries possessed different composition of essential oils. The oils from mugwort plants harvested in Turkey were found to be rich in α-thujone (56.13%), β-thujone (12.02%), caryophyllene oxide

TABLE 1 Extraction of Essential Oil From Different Parts of Mugwort (*Artemisia vulgaris*)

Origin/Parts	Technique	Apparatus	Yield (%)	References
China/leaves and stems	Hydrodistillation	Clevenger	-	Wang et al. (2005)
Serbia/aerial parts	Hydrodistillation	Clevenger	-	Blagojevic et al. (2006)
Turkey/aerial parts	Hydrodistillation	Clevenger	0.40	Erel et al. (2012)
North Lithuania/aerial parts	Hydrodistillation using hexane and diethyl ether mixture	---------	0.2–0.4	Judzentiene and Buzelyte (2006)
Iran/aerial parts	Steam distillation	Clevenger	1.4	Alizedah et al. (2012)
Vietnam/aerial parts	Hydrodistillation	Clevenger	0.32–1.14	Thao et al. (2004)
Italy/aerial parts	Hydrodistillation	Likens-Nickerson apparatus	-	Mucciarelli et al. (1995)
Cuba/aerial parts	Hydrodistillation	Clevenger	0.1	Pino et al. (1999)
India/aerial parts	Hydrodistillation	Clevenger	0.16–0.5	Haider et al. (2003)
Nepal/leaves	Steam distillation	Clevenger	-	Bhatt et al. (2007)
Iran/aerial parts	Hydrodistillation	Clevenger	0.25	Bamoniri et al. (2010)
India/stem	Hydrodistillation	Clevenger	-	Govindaraj and kumari (2013)

TABLE 2 Chemical Composition of Mugwort (*Artemisia vulgaris*) Essential Oil

Origin/Parts	Major Components	Yield (%)	References
Turkey (aerial parts)	α-Thujone	56.13	Erel et al. (2012)
	β-Thujone	12.02	
	Caryophyllene oxide	10.19	
	1,8-Cineole	8.47	
North Lithuania (aerial parts)	Germacrene D	5.3–15.1	Judzentiene and Buzelyt (2006)
	1,8-Cineole	2.6–17.6	
	β-Pinene	0.1–12.9	
	cis-Thujone	0–12.9	
	trans-Thujone	0–20.2	
	Chrysanthenyl acetate	0–23.6	
	Caryophyllene	2.5–12.2	
Iran (aerial parts)	α-Pinene	23.56	Alizadeh et al. (2012)
	Menthol	9.71	
	β-Eudesmol	8.297	
	Spathulenol	4.582	
	Trans-Caryophyllene	24.76	Bamoniri et al. (2010)
	1, 8-Cineol	18.64	
	Trans-Salvene	14.87	
	β-Cubebene	11.82	

TABLE 2 **Chemical Composition of Mugwort (*Artemisia vulgaris*) Essential Oil—cont'd**

Origin/Parts	Major Components	Yield (%)	References
Cuba (aerial parts)	caryophyllene oxide	31.1	Pino et al. (1999)
	Hexadecanoic acid	6.3	
	Isobornyl 2-methylbutyrate	5.3	
	2-Heptadecanone	5.1	
Vietnam (aerial Part)	β-Anole	21.7	Thao et al. (2004)
	Camphor	10.9	
	β-Pinene	10.2	
	α-Pinene	9.1	
India (seeds)	Camphor	17.3	Govindaraj and Kumari (2013)
	α-Thujone	10.7	
	γ-Muurolene	9.0	
	Camphene	6.0	

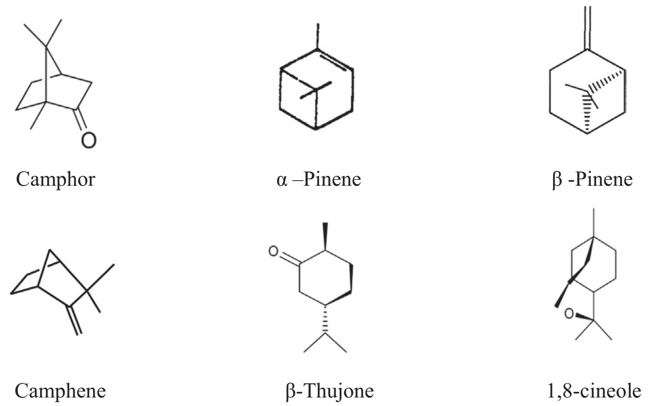

FIGURE 2 Chemical structures of important constituents of mugwort essential oil (Barney et al., 2005; Abad et al., 2012).

(10.19), and 1,8-cineole (8.47%) (Erel et al., 2012). Furthermore, 1,8-cineole (28.9%), sabinene (13.7%), β-thujone (13.5%), and caryophyllene oxide (6.5%) were reported as the principal components in leaf essential oils of Egyptian mugwort plants (Blagojevic et al., 2006), whereas in Croatia, the chief components reported were β-thujone (20.8%), α-pinene (15.1%), and 1,8-cineole (11.7%) (Jerkovic et al., 2003). The oils isolated from North Lithuanian Mugwort (*A. vulgaris*) plants were high in sabinene, β-pinene, 1,8-cineole, artemisia ketone, *cis*- and *trans*-thujone, chrysanthenyl acetate, germacrene D, and β-caryophyllene (Judzentiene and Buzelyt, 2006). The oils extracted from the plants from Iran were mainly composed of *trans*-caryophyllene (24.76%), 1,8-cineol (18.64%), *trans*-salvene (14.87%), and β–cubebene (11.82%) (Bamoniri et al., 2010). Whereas the oils isolated from Indian grown plants were characterized by large amounts of camphor (38.7%), isoborneol (8.2%), and artemisia alcohol (4.5%) (Haider et al., 2003). The components of mugwort essential oil vary depending on where they are cultivated, for example, USA (10 compounds), Serbia (94 compounds), Pakistan (24 compounds), and Turkey (14 compounds). Table 2 describes the content and chemical composition of essential oil from different parts of mugwort. The chemical structures of some important constituents of mugwort essential oil are given in Figure 2.

TABLE 3 Antimicrobial Activity of Mugwort (*Artemisia vulgaris*)

Microorganisms	Bacteria/Fungus		Inhibition Zone (mm)	References
Eschericia coli	Gram-negative bacterium	Plant extract	8–20	Harimath et al. (2011)
Staphylococcus aureus	Gram-positive bacterium	Plant extract	4–20	
Pseudomonas aeruginosa	Gram-negative bacterium	Plant extract	23	Erel et al. (2012)
Staphylococcus aureus	Gram-positive bacterium	Essential oil	23	
Staphylococcus epidermidis	Gram-positive bacterium	Essential oil	13	
Salmonella typhimurium	Gram-negative bacterium	Essential oil	10	
Enterococcus faecalis	Gram-positive bacterium	Essential oil	14	
Enterobacter cloacae	Gram-negative bacterium	Essential oil	8	
Escherichia coli	Gram-negative bacterium	Essential oil	11	
Candida albicans	Fungus	Essential oil	20	
Salmonella Enteritidis	Gram-negative bacterium	Essential oil	25–37	Blagojevic et al. (2006)
Pseudomonas aeruginosa	Gram-negative bacterium	Essential oil	13.5–31	
Klebsiella pneumonia	Gram-negative bacterium	Essential oil	13.5–34	
Aspergillus niger	Fungus	Essential oil	24–31	
Staphylococcus aureus	Gram-positive bacterium	Essential oil	13.5–29	

SUMMARY POINTS

- Mugwort (*Artemisia vulgaris* L.) is an aromatic plant from the family Compositae.
- Mugwort has a pleasant tangy taste with a characteristic scent.
- Mugwort plant is known to possess multiple medicinal uses and applications, which include stomach ulcers, indigestion, liver disorders, emmenagogue, nervine, digestive, diuretic, and diaphoretic, as well as having food flavoring properties.
- Mugwort has also antitumoral activity which is mainly linked to artemisic acid and artemisinin B.
- The active components of mugwort include flavonoids, coumarins, sesquiterpene lactones, volatile oils, inulin, and traces of alkaloids.
- The essential oil yield from mugwort may vary from 0.1% to 1.4% depending on the plant part used and the origin of harvest.
- Mugwort essential oil is mainly composed of β-pinene, α-pinene, camphor, and 1,8-cineole.
- The essential oil exhibits many biological activities useful in food science such as antiseptic, antioxidant, larvicidal, nematicide, pesticide, antibacterial, antifungal, and antiviral properties, as well as being used in the flavor and perfumery industry.
- Mugwort essential oil has high potential as a natural antiinflammatory agent to impart functional food and physiological benefits if incorporated into some food or cosmetic products.
- Mugwort (*Artemisia vulgaris*) plant essential oil and extract have appreciable antimicrobial potential (Table 3).

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