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REVIEW ON THE CHEMICAL COMPOSITION OF ESSENTIAL OIL FROM *LAVANDULA* SPP. AND ITS APPLICATIONS

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Abstract

Lavandula spp., known as lavender, belongs to the Lamiaceae family and is an aromatic plant with various uses, the most important of which are pharmaceutical (medicinal plant), food, cosmetics, detergents, industrial, perfumery, etc. The Lamiaceae family includes 47 species of flowering plants, and among Lavandula spp. we can mention: Lavandula angustifolia, Lavandula dentata, Lavandula lanata, Lavandula latifolia, Lavandula multifida, Lavandula pedunculata, Lavandula stoechas, Lavandula viridis, etc. This paper reviews studies and research conducted in the specialized literature over the last 10 years (2014-2024) on the characteristics and properties of Lavandula spp., thus providing a comprehensive overview of the use of essential oils and extracts in various fields. The variability of essential oil is discussed according to the species of lavender, geographical area (where it is cultivated), plant material (flowers, leaves, whole plant), and extraction methods.

Key words: *chemical compounds,essential oil, Lavandula, multiple applications.*

INTRODUCTION

Lavender *(Lavandula angustifolia* Mill.), also known as English lavender (syn. *Lavandula officinalis* L. Chaix et Vill., *Lavandula vera* DC), belongs to the *Lamiaceae* family.

The *Lamiaceae* family includes 47 species of plants (with flowers), and the genus *Lavandula* spp. comprises 39 species and numerous hybrids and varieties, which grow on all continents (North Africa, Southwest Asia, North and South America, Europe, India, and the Arabian Peninsula (Lis-Balchin, 2012; Messaoud, 2012).

The genus *Lavandula* spp. includes the following species: *Lavandula angustifolia* (English lavender), *Lavandula x allardii*, *Lavandula coronopifolia*, *Lavandula dentata* (toothed lavender/fringed lavender), *Lavandula x intermedia* (lavandin), *Lavandula lanata* (woolly lavender), *Lavandula latifolia* (Portuguese lavender), *Lavandula luisieri*, *Lavandula multifida* (Egyptian lavender), *Lavandula officinalis* (medicinal lavender), *Lavandula stoechas* (Spanish lavender), *Lavandula viridis* (Green Lavender) (https://mymediterraneangarden.com/types-of-lavender/,https://www.pinterest.com/pin/140806232692625/).

Lavandula spp. is a medicinal plant with a specific aroma, used in traditional medicine for many years, but also in other industries (*detergents, perfumery, pharmaceuticals*), and in landscaping as an ornamental plant in parks and gardens, as it is a plant that improves the soil in which it is grown (Chrysargyris et al., 2016; Giuliani et al., 2023; Laza and Rácz, 1975; Muntean et al., 2007; Patil et al., 2022*)*.

The main objective of this study is to provide a systematic overview of the essential oil derived from species of the genus *Lavandula*, to highlight the chemical composition of the volatile oil, as well as the diversity of its applications.

According to Giuliani (2023), *Lavandula angustifolia* Mill. has high commercial value due to its trichomes (secretory hairs), which are responsible for producing volatile substances.

Essential oils derived from *Lavandula angustifolia* Mill. are rich in linalyl acetate, which gives them their characteristic scent, coumarin, tannin, a bitter principle, and the essential oil obtained by distilling the inflorescences (flowers) can be used in human medicine (effective in treating early and moderate depression) (Shafiee-Kandjani et al., 2023), in the pharmaceutical industry (obtaining pharmaceutical products based on essential oil), cosmetics (creams, soaps), and in the perfume industry (cologne, perfumes) (Constantinescu et al., 2004).

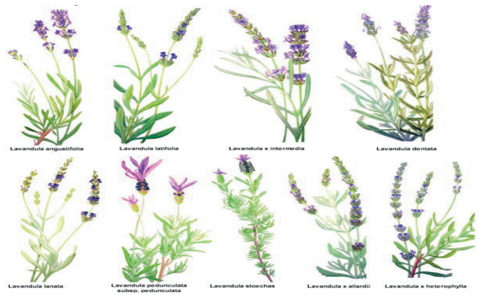

Figure 1. Various cultivars of the genus *Lavandula* spp.
Source: https://in.pinterest.com/pin/12596073951347604/

Lavandula angustifolia Mill. is a highly prized species worldwide, which means that lavender is cultivated (on all continents) and researched (all over the world), due to the species' multiple uses in various industries such as: the food industry, the paint industry, the detergent industry, the pharmaceutical industry, in medicine, but also as an ornamental (decorative) plant.

It is very important to note that if we want to cultivate lavender (especially when cultivating a specific variety), it is essential to know how to differentiate between: the use of the species for the production of essential oil, the use of the species for the production of cut flowers, or the use of the species strictly for ornamental purposes. At the same time, lavender has multiple uses, including: antibacterial, antiseptic, antispasmodic, aromatic, carminative, cosmetic, culinary, decorative, expectorant, medicinal, and stimulant.

Worldwide, research conducted on the *Lavandula* spp. species has extensively described both the chemical composition of the essential oil obtained by various methods and its main components (essential oil).

The chemical composition of the essential oil differs depending on the area of cultivation (continent, country), the species cultivated, and the variety, so that significant differences in chemical compounds have been reported. Linalool (the most important chemical compound) has shown different concentration values depending on the results obtained by different researchers (Table 1).

Table 1. Linalool concentration in different countries where research on lavender essential oil has been conducted

Country	Linalool (%)	Sources/Year
Lavandula angustifolia Mill.		
Algeria	22,30	Djenane și colab., 2012
Bulgaria	30.10-33.70	Ognianov, 1994
Bulgaria	23.13-35.52	Todorova și colab., 2023
China	24.30	Xiaotiana și colab., 2020
Croaia	3.97	Blazekovic și colab., 2018
Cyprus	0.17-0.24	Chrysargyris și colab., 2016
France	9.30-68.80	Beale și colab., 2017
France	9.30-68.80	Lawerence, 1993
Greece	20.18	Adam și colab., 1998
Hungary	5.1-62.70	Detar și colab, 2021
India	23.60	Raina și Negi, 2012
India	35.30	Fakhari și colab., 2006
Italy	32.70	Evandri și colab., 2005
Italy	39.31	Alteriis și colab., 2022
Poland	15.10-21.77	Walasek-Janusz, 2022
Romania	18.46-39.50	Oroian și colab., 2019
Romania	24.15-50.84	Gonceariuc și colab., 2018
Serbia	28.0-37.0	Lakusik și kolab., 2014
Syria	27.30-34.70	Al-Wassouf și colab., 2018
U.S.A.	29.00-33.00	Wang și colab., 2021
Lavandula intermedia		
Croatia	57.10	Blazekovic și colab., 2018
Italy	41.60	Garzoli și colab., 2019
Poland	25.53-29.56	Walaseck-Janusz, 2022
Romania	21.90	Marincaș și Feher, 2018
Lavandula latifolia		
India	9.1	Al-Ansari și colab., 2021
Spain	30.34	Mendez-Tovar și col., 2016
Lavandula officinalis		
Argentine	53.50	Martuccci și colab., 2015
Spain	34.34	Marin și colab., 2016
Lavandula viridis		
Porugal	0.93	
Lavandula stoechas		
Marocco	0.7	En-Zoubi și colab., 2022

Thus, among the main components present in lavender essential oil, we can mention monoterpenoids (most importantly linalool, linalyl acetate, 1,8-cineole, beta-ocimene, terpine-4-ol, and camphor, another important product).

Lavender essential oil also contains sesquiterpenoids (beta-caryophyllene) and other terpenoid compounds (Bikmoradi et al., 2017).

The importance of essential oil (volatile)

Research has shown that essential oil obtained from species of the genus *Lavandula* spp. (Table 2) has a very high content and many beneficial effects on the human body, and is also used in various fields (Plotto and Roberts, 2001; Cavanach et al., 2002, Hyldgaard et al., 2012; Gutierez, 2008; Adaszynska et al., 2013; Nieto, 2017; Sarkik and Stappen, 2018), including:

Cosmetics and pharmaceuticals - the perfume industry (cologne) and cosmetics (body care, detergents, face creams, hand creams, skin care, shampoos, shower gels, soaps,), in pharmaceuticals (flavoring ointments, infusions, tinctures - *Lavandula angustifolia* being preferred due to its strong scent), industrial preparations with sedative and cholagogue effects and for internal use, pharmaceutical preparations such as *Acetum Aromaticum* (aromatic vinegar), Spiritus Lavandulae (lavender-flavored alcohol), and Tinctura vulneraria (wound tincture). (Luchian et al., 2017, Păun et al., 1988, Pârvu et al., 2006, Prisăcaru et al., 2009)

Dendrological and ornamental - real interest from an ornamental point of view (flower color - from red to dark blue, fragrance, foliage persistence), dwarf species suitable for parks and gardens (simple borders or in combination with other species, in rockeries alongside other perennial species), cultivated alone or in various floral compositions. (Iliescu, 2005, Pârvu, 2006)

Food **-** preparation of cakes, dishes, juices, honey (very good nectar-producing capacity - nectar- and pollen-producing species), yielding about 50-100 kg of high-quality honey/ha, with a pleasant taste and specific aroma, medium economic and beekeeping value (Pârvu, 2006).

Industry **-** in the porcelain industry (Yegorova, 2011), in ceramics (good solvent and paint fixative), insect repellent (for combating moths), tobacco (anti-asthmatic cigarettes). (Constantinescu et al., 2004, Munteanu, 1988 cited by Roman, 2008, Muntean, 1990, Stănescu et al., 2014, Pârvu, 2016).

Medical and therapeutic in both human and folk medicine (internal use - antiseptic, antispasmodic, healing, and soothing action, and external use - when we are tired, for rheumatism, whooping cough, flu, bronchitis, digestive disorders, and headaches). It increases bile secretion, helping to relieve stomach pain, as well as in traditional veterinary medicine (internal use - to treat lack of thirst, a few drops of essential oil are added to water, encouraging animals to drink (Bakkali et al., 2008; Hassiotis et al., 2010; Ion et al., 2008, Păun et al., 1988, Pârvu, 2006, Pârvu et al., 2016).

Lavender essential oil, obtained from plants of the *Lavandula* genus, has various beneficial effects on the body due to the active compounds in its composition.

Other therapeutic uses of the essential (volatile) oil

Antifungal action: Lavender essential oil has antifungal properties and can be used to treat fungal infections, such as athlete's foot, or to inhibit the fungus Ustilaginoidea virens (inhibition of hyphal growth, dry weight of mycelium, conidia germination, and conidia production) that attacks rice crops (Fu et al., 2024).

Antibacterial action: Lavender essential oil has antibacterial properties and can be used to treat bacterial infections such as acne, as well as promising antibacterial activity against some strains of *S. aureus* and *E. coli* (Soulaimani et al., 2025).

Anti-inflammatory action: Lavender essential oil has anti-inflammatory properties and can be used to relieve inflammation and reduce (skin) inflammation in atopic dermatitis (Duan et al., 2024).

Sedative action: Lavender essential oil has sedative properties and can be used to help reduce stress and anxiety, especially in children who need to undergo endoscopy (Aydin et al., 2025).

Analgesic action: Lavender essential oil has analgesic properties and can be used to help relieve headaches and other pains, as well as to treat chronic prostatitis with the help of creams based on lavender essential oil (Wang et al., 2025).

Antispasmodic action: Lavender essential oil has antispasmodic properties and can be used to help relieve muscle spasms or prevent pain in pediatric patients (children) undergoing surgery (tonsillectomy), reducing postoperative pain (Ahmadi et al., 2023).

Antidepressant action*:* Lavender essential oil can be used to help alleviate symptoms of depression and other mental health issues through the effects of aromatherapy. Inhaling the essential oil has a calming effect, reducing depression and leading to more restful sleep in patients who have suffered strokes (Yin et al., 2024).

Due to these properties, lavender essential oil is frequently used as an ingredient in medicinal and cosmetic products.

Table 2. The use of essential oil derived from lavender species of the genus *Lavandula* spp.

Species	Use
1. Lavandula x allardii	cosmetics, food industry, perfume industry, pharmaceutical industry
2. Lavandula angustifolia Mill.	acaricidal effect, allelopathy, aromatherapy, cosmetics, food industry (food products), insecticidal effect, soil modification, repellent, therapeutic potential, veterinary products
3. Lavandula coronopifolia	food industry (food products), therapeutic potential, *soil* phytoremediation, veterinary use (veterinary products)
4. Lavandula dentata	therapeutic potential
5. Lavandula x intermedia	Food industry (in nutrition), in medicine (anesthetic)
6. Lavandula latifolia	food industry, medicine (medicinal purpose), use as insecticide
7. Lavandula luisieri	in medicine (antifugal drugs) veterinary medicine (for appetite and thirst in animals), use as insecticide
8. Lavandula multifida	therapeutic potential
9. Lavandula officinalis	medicine (medicinal purpose)
10. Lavandula stoechas L.	cosmetics, perfume industry, pharmaceutical industry, therapeutic potential,

The species of lavender and the uses of the essential oil extracted from each species will be listed below as follows:

1. ***Lavandula x allardii*** - *cosmetics, food industry, perfume industry, pharmaceutical industry* (Chasiotis et al., 2001);

2. ***Lavandula angustifolia* Mill.** - *acaricidal effect* (Perrucci et al., 1996; Kaya, 2010), *allelopathy* (Sidorenko et al., 1995), *aromatherapy* (Lis-Balchin & Hart, 1999; Evandri et al., 2005; Donatello et al., 2020), *cosmetics* (Koniger, 1997; Fakhari et al., 2005; Kunicka-Styczynska, 2009; Adaszynska et al., 2013; Kunicka-Styczynska et al., 2015; Saeed et al., 2023), *food industry* (*food products*) (Fenaroli, 1998; Fakhari et al., 2005; Adaszynska et al., 2013; Fascella et al., 2020), *insecticidal effect* (Carson & Riley, 1995; Sertkaya et al., 2010; Khosravi et al., 2013; Yazdani et al., 2013; Julio et al., 2014; El Abdali et al., 2022; Ez-zoubi et al., 2022), *soil modification* (Yohalem et Passey, 2011), *repellent* (Warren et al., 1997) *therapeutic potential* (Bertram, 1995; Buyukokuroglu et al., 2003; Hajhashemi et al., 2003; Woronuk et al., 2011; Raut & Karuppayil, 2014; Koziol et al., 2015; Kivrak, 2018; Malcolm & Tallian, 2018; Bialon et al., 2019; Donatello et al., 2020; Zeinab et al., 2020; Detar et al., 2021; Doha et al., 2021; Firoozeei et al., 2021; Villalpando et al., 2022; Saeed et al., 2023), *veterinary products* (Wren, 1988; Ercan & Esma, 2019);

3. ***Lavandula coronopifolia*** - *food industry* (*food products*) (Preedy, 2016), *therapeutic potential* (Said et al., 2015; Hasanin et al., 2020; Naseef et al., 2022.), *soil phytoremediation* (Shafagha et al., 2012), *veterinary use* (*veterinary products*) (Ferguson,et al, 2013.);

4. ***Lavandula dentata*** - *therapeutic potential* (El Abdali,2022; Bouyahya et al., 2023);

5. ***Lavandula x intermedia*** - *food industry* (*in nutrition*) (Fenaroli, 1998), *in medicine* (*anesthetic*) (Krasteva et al., 2021, Yigit et al., 2022);

6. ***Lavandula latifolia*** - *food industry* (Fenaroli, 1998; Mendez-Tovar et al., 2016), *medicine* (*medicinal purpose*) (Rodrigues et al., 2012; Herraiz-Peñalver et al., 2013; Gayoso et al., 2018; Al-Ansari et al., 2021), *use as insecticide* (Al-Ansari et al., 2021);

7. ***Lavandula luisieri*** - *in medicine* (*antifugal drugs*) (Zuzarte, et al., 2012), *disinfectant solution* (*antiseptic*) (Gonzalez-Coloma et al., 2011);

8. ***Lavandula multifida*** - *therapeutic potential* (Benbelaid, 2012);

9. ***Lavandula officinalis*** - *medicine* (*medicinal purpose*) (Meftahizade et al., 2011; Imene, 2012; Et-Touys et al., 2016; Kivrak, 2018).

10. ***Lavandula stoechas*** **L.** - *cosmetics* (Bouyahya et al., 2017), *perfume industry* (Repici, 2019), *pharmaceutical industry* (Repici, 2019), *therapeutic potential* (Bouyahya et al., 2017; Chograni et al., 2021; Rasheed et al., 2023).

Harvesting

Species of the genus *Lavandula* spp. shall be harvested at the optimum time, which shall be determined with precision. Thus, the flowering period of the species *Lavandula angustifolia* Mill. (Lavender) comprises four distinct stages (phases): *budding* (inflorescences are budding); *the beginning of flowering* (25% of the flowers are in bloom); *full flowering* (50% of the flowers are in bloom); *the end of flowering* (85% of the flowers are past their prime), where harvesting must be carried out before 12 noon (because the oil content increases continuously), and after 4 p.m. (it decreases significantly), noting that the most recommended hours for harvesting are 10 a.m. to 12 p.m. (on small areas) and 9 a.m. to 2 p.m. (on large areas), harvesting not being recommended in cloudy or cool weather, this being done manually with a sickle or mechanically with the help of machines specially mounted on tractors.

Chemical composition of essential oil

Currently, in the specialized literature, as well as in research conducted on the genus Lavandula spp., there is a wealth of data on the composition of essential oil (Cavanagah and Wiolkinson, 2005; Bombarda et al., 2008; Gyrai et al., 2008; Baydar and Kineci, 2009, Danh et al., 2013; Binello et al., 2014; Aprotosoaie et al., 2017; Dris et al., 2017; Tardugno et al., 2019; Detar et al., 2020; Giuliani et al., 2023)

All results obtained regarding the composition of essential oil mention that it (the oil) is greatly influenced by the origin of the species, the cultivated genotype (Munoz-Bertomeu et al., 2007; Stanev, 2010),

the stage of development of the species (Lacusik et al., 2014), agronomic factors (plant growth and development) as well as pedoclimatic factors (climate and soil), agrotechnical factors (cultivation technology applied, soil tillage, sowing, crop care, harvesting) (Renaud et al., 2001; Angioni et al., 2006; Pinto et al., 2007; Erbaş & Baydar, 2008, Kara & Baydar, 2013; Camen et al., 2016; Garcia-Caparros et al., 2019; Lyczko et al., 2019; Fascella et al., 2020; Pecanha et al., 2021), plant parts (Geisel et al., 2004; Lakusic et al., 2014) extraction method, storage and processing of biological material (Chemat et al., 2006; Karapandzova et al., 2014; Babu et al., 2016; Duskova et al., 2016; Salata et al., 2020;).

Numerous authors who have studied the chemical composition of essential oil have demonstrated, through their research findings, the presence of significant differences in its composition. These variations are primarily attributed to the extraction method used, such as hydrodistillation or microwave-assisted extraction.

Thus, microwave-assisted extraction significantly accelerates the process of obtaining essential oil, without causing notable changes in its chemical composition.

According to the scientific literature, essential oil contains over one hundred chemical constituents, the main compounds being linalool (with a concentration ranging from 9–69%) and linalyl acetate (1.2–59%) (Beale et al., 2017)

The quality of essential oil derived from *Lavandula* spp. is determined by its high content of linalool and linalyl acetate (Figure 2 and Figure 3), as well as by the ratio in which these two components are present in its chemical composition (Beale et al., 2017).

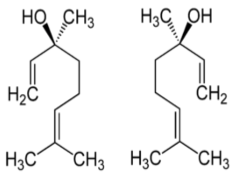

Figure 2. Linalool
Source: https://sk.wikipedia.org/wiki/Linalool

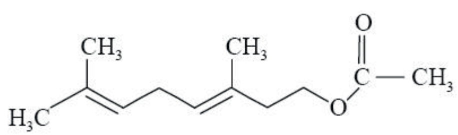

Figure 3. Linalyl acetate
Source: https://alchetron.com/Linalyl-acetate

According to Noyraska (2023), essential oil is actually the product generated from an aromatic plant through the process of distillation (hydrodistillation), which is then followed by the process of separation from the aqueous phase, bearing the generic name of essential oil (EO). Dias (2021) mentions that essential oil represents a complex liquid mixture of various secondary metabolites (different concentrations), which are classified into two main groups as follows: ***hydrocarbons*** (*diterpenes, monoterpenes, sesquiterpenes*) and ***oxygenated compounds*** (hydrocarbon derivatives), including a*lcohols, aldehydes*, *ketones*, *esters*, *oxides*, etc.

Both the quantity and quality of essential oil obtained from Lavandula spp. are influenced by several factors, including: plant material, age of the plant (bush), the health of the plant (bush), the soil and climate conditions during the harvesting of the plant material, the conditions for the growth and development of the plants (bushes), the method of drying the plant material, and the method used to extract the essential oil, all play a very important role.

Essential oils extracted from medicinal plants, particularly from species belonging to the *Lavandula* spp. genus, have been known and used since ancient times. These oils exhibit a wide range of biologically active properties, including antimicrobial, antioxidant, antitumoral, antiseptic, digestive, antispasmodic, and neuro-sedative effects. Moreover, essential oils have been studied as alternative sources to commercial pesticides for ecological preservation, with their active compounds forming the basis of effective defense strategies against herbivorous pests

Significant differences are observed among the cultivated genotypes. Research indicates that, in some cases, the highest concentration of linalool (%) was recorded in the middle of the flowering period, while the highest concentration of linalyl acetate (%) was observed at the end of flowering. In other cases, research shows that large amounts of linalool were recorded (from flowering to the end of the flowering phenophase), and the concentration of linalyl acetate decreased considerably (Baydar and Kineci, 2009) Cantor et al., 2018; Detar et al., 2011).

In other cases, various researchers mention that the three chemical compounds (linalool, terpinen-4-ol, and 1,8-cineole) were found in very high concentrations when the inflorescences (flowers) were in the bud stage.

It is recommended that inflorescences be harvested in the early part of the day because that is when they contain the highest amount of oil and active ingredients. They are detached from the inflorescence axis, or the entire inflorescence is harvested (Constantinescu, 2004).

The raw material is provided by the inflorescences (Lavandulae flos, Lavanduale angustifoliae flos) (Muntean, 1996).

Lavender flowers (*Lavandula angustifolia* Mill.) contain essential oil (0.7-1.4%) which is composed of linalyl acetate (30-40%), linalool acetate, geraniol, nerol, lavandulol, borneol, (+) citronellol, (+)-terpinen-1-01, (+)-epoxy-dihydro-linalool, isogeraniol, cumin alcohol, traces of α-bisabolol, amyl and isoamyl alcohol, n-hexyl alcohol, valeric, isovaleric, propionic, caproic acids, terpenic hydrocarbons, coumarin, herniarin, furfural, etc., tannin, a bitter principle, mineral substances. The flowers are characterized by a pleasant, strongly aromatic scent and a slightly bitter taste. (Pârvu et al., 2016).

Lavender contains volatile oils (approximately 1.5% dry matter), which contain at least 34% esters, tannins (5-10%), coumarins and furanocoumarins (herniarin), flavonoids (luteolin), phytosterols, sterolic saponosides (rosmarinic, ursolic, and oleanolic acids). (Burzo et al., 2005, Burzo, 2013)

We also find: coumarins (herniarin), anthocyanins (delphinidin, malvidin), flavones (luteolin), phenolic acids (rosmarinic acid, chlorogenic acid), triterpenes (ursolic acid, oleanolic acid, betulinic acid, pomilic acid-3,19-dihydroxy-12-ursen-28-oic acid), betulin (Lis-Balchin, 2002 cited by Burzo I, 2015).

Monoterpenes are found in concentrations of 50-90% in lavender flowers, sesquiterpenes in concentrations of 7.5-15.0%, and triterpenoids have the lowest concentration (Bakkali et al., 2008; Lesage-Meessen et al., 2015; Chrysargyris et al., 2016).

The chemical compounds are many and varied, but they vary depending on the species cultivated. The content of oxygenated monoterpenes differs from species to species (cultivated species), and in the case of *Lavandula angustifolia* Mill. (36-93%), *Lavandula x intermedia* (68-93%), *Lavandula stoechas* (46-93%), and *Lavandula latifolia* (85-94%).

Additionally, oxygenated monoterpenes have been found in high concentrations in the species *Lavandula lusieri*, *Lavandula* *pedunculata*, and *Lavandula viridis.* The species *Lavandula angustifolia*, *Lavandula luisieri*, and *Lavandula stoechas* have a high content (more than 20%) of sesquiterpenes in their essential oil (Aprotosoaie et al., 2017).

Among the monoterpenoids of fatty acids found in lavender inflorescences, the most important are: linalool, terpinen-4-ol, α-terpineol, borneol, lavandulol, linalyl acetate, lavandulyl acetate, geranyl acetate, geranyl propionate, camphor, fenchone, thujone, and 1,8-cineole, while the most frequently reported monoterpenes found in lavender fatty acids are: limonene, cis-β-ocimene, and trans-β-ocimene. From the sesquiterpenes group, we can mention: β-caryophyllene, β-farnesene, caryophyllene oxide, and viridiflorol (Chrysargyris et al., 2016).

The volatile oil contains a mixture of mono- and sesquiterpenes, of which borneol (40.73%) and tau-cadinol (27.02%) account for the largest proportion. Other substances identified in lavender essential oil had the following proportions: linalool (4.51%), r-cadinene (3.44%), ß-phellandrene (2.97%), camphor (2.79%), α-pinene (1.96%), α-santalene (1.13%), caryophyllene oxide (1.17%), cubenol (0.94%), neryl acetate (0.81%), p-cymene-8-ol (0.69%), bornyl acetate (0.66%), geranyl acetate (0.56%) and α-terpineol (0.41%). (Burzo and Toma, 2013 cited by Burzo, 2015)

By analyzing the volatile oil extracted by Boelens (1986), 44 components were identified, including linalool (41.70%), 1,8-cineol (26.30%), and camphor (12.80%). Concentrations higher than 1% were found for ß-pinene (2.10%), α-bisabolene (1.90%), α-pinene (1.80%), ß-caryophyllene (1.40%), limonene (1.10%), linalyl acetate (1.10%), and α-terpineol (1.00%). Concentrations lower than 1% were determined for borneol, camphene, lavandulol, sabinene, terpinen-4-ol, δ-cadiene, α-humulene, bornyl acetate, trans-linalool oxide, α-p-dimethylstyrene, isoborneol, cis-linalool oxide, myrcene, (E)-β-ocimene, 3-octanone, 1-octenol-3, α-terpinene, γ-terpinene, terpinolene, coumarin, geraniol, (Z)-beta-ocimene, 1-octanol, α-phellandrene, butyl acetate, caryophyllene oxide, dihydrocoumarin, eugenol, 1-hexanol, hexyl acetate, isoamyl acetate, nerol, and α-thujen. (Burzo et al., 2005; Prisăcaru et al., 2009).

The leaves and stems contain small amounts of essential oil. The organic substances highlighted contain N, P, K, Ca, Mg, B, Fe, Mn, and Cu.

Essential oil production varies with the age of the plant: it reaches its maximum after approximately 5-7 years and becomes very low after 10-12 years. The maximum oil content is found at the beginning of flowering between 9 a.m. and 2 p.m. (Pârvu et al., 2016).

The flowers of *Lavandula angustifolia* Mill. contain essential oil (volatile) in quantities that depend on the variety, species, and time of harvest, as well as linalool acetate, lavandulol, terpenic hydrocarbons, tannins, minerals, etc. Dried lavender flowers contain 1.5-3% essential oil, and fresh flowers contain 0.55-1.5% - linalool (up to 30%), linalyl acetate (up to 40%), geraniol, linalool valerate, borneol, linalyl butyrate. The flowers also contain triterpenic acids, flavonoids, resins, coumarins, bitter principles, cineol, tannins, and minerals (Luchian et al., 2017).

Lavender also has active ingredients such as coumarins and caffeic acid derivatives (Rîșca, 2016).

CONCLUSIONS

The volatile oil of *Lavandula* is highly valued for its complex chemical composition, especially its high content of linalool and linalyl acetate, which confer multiple therapeutic and cosmetic properties. The variability of its active compounds depends on the species, cultivation conditions, and extraction methods, influencing its efficacy across various applications. Due to its antimicrobial, antioxidant, and sedative effects, *Lavandula* oil holds significant potential in pharmaceutical, food, and cosmetic industries. Furthermore, its use as an ecological alternative to synthetic pesticides underscores its importance in sustainable agriculture. Continuous standardization and research are essential to fully harness its properties and ensure the quality of lavender-based products.

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