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Comparison of Chemical Constituents of Some Plant Species of Lamiaceae Family Grown Conventionally and Organically

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A R T I C L E I N F O

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A B S T R A C T

In this study, the chemical constituents of *Origanum onites, Salvia officinalis* and *Lavandula officinalis* plants belonging to Lamiaceae family grown by conventional and organic methods were determined by soxhlet extraction. Gas Chromatography-Mass Spectrometry (GC-MS) method was used to determine the chemical constituents of conventionally and organically grown plant samples. When the results of the analyses were examined, out of 97 chemical components of *Salvia officinalis* plant, 50 components were determined from plants grown with conventional farming methods and 78 components were determined from plants grown with organic farming methods. Of the 38 components detected in *Origanum onites*, 36 components were determined from plants grown with conventional farming methods and 38 components were determined from plants grown with organic farming methods. Out of 60 components of *Lavandula officinalis*, 40 components were determined from plants grown with conventional farming methods and 60 components were determined from plants grown with organic farming methods. In terms of chemical structure, the components are divided into different classes as hydrocarbons, monoterpenes, monoterpenoids, sesquiterpenes, sesquiterpenoids, diterpenes, diterpenoids, fatty acids and derivatives, and phenolic compounds.

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Introduction

According to the State of Food Security and Nutrition in the World report published by the United Nations in 2023, it is estimated that approximately 750 million people face hunger. (UN, 2021). For this reason, in order to ensure the balance between population and nutrition, it should be aimed to increase the product yield obtained from the existing cultivated areas instead of increasing the production areas (Çetiner and Tuzla 2005). There is an intensive use of chemical fertilisers all over the world in order to increase the yield per unit area and to stimulate the growth and development of plants. In modern agriculture, unfortunately, chemical fertilisers used excessively in order to increase yield and quality cause deterioration in soil structure, decrease in the activities of microorganisms in the soil and disruption of biological balance (Topbaş et al., 1998; Vessey, 2003; Sönmez et al., 2008).

In order to restore the balance in the ecological system that has been disrupted as a result of chemical applications, there is a need to use methods that minimise the use of synthetic chemicals and fertilisers in agricultural production, which include human and nature-friendly production techniques. For this reason, many countries have started to switch from conventional agriculture to environmentally friendly production methods (Zengin, 2007). Organic agriculture, which is preferred as an alternative to conventional agricultural methods today, according to the definition of the International Federation of Organic Agriculture Movements (IFOAM); instead of agricultural production processes using inputs that have negative effects on soil, ecosystem and human health, it envisages agricultural production processes adapted to ecology, biodiversity and local conditions. Organic agriculture is a form of agriculture that combines tradition, innovation and science to benefit from the common environment that belongs to all, to establish fair relationships between all stakeholders and to ensure a good quality of life for all (Anonymous, 2021).

Lamiaceae Family

Plants belonging to the Lamiaceae family exhibit a wide distribution in the world (Yılmaz et al. 2007). The Lamiaceae family has approximately 236 genera and 7200 species in the world. It is the third largest family in Türkiye with 45 genus and 574 species and 256 species are endemic in Türkiye (Büyükkartal et al. 2011). The head is shaped like an eight-celled scale, and the glandular hairs are characteristic for the family (Baytop 1996). The stem is quadrangular and the leaves are decusate. Flowers vertisillastrum corollas are usually bilabiate. Stamens consist of four and/or two (Davis 1982).

Salvia spp.

Salvia species are widely grown in temperate and tropical regions all over the world. *Salvia* species are herbaceous plants, typically 30-150 cm tall, usually perennial, with flowers of various colours (Topçu 2006). *Salvia* species have square stems and pairs of simple, velvety or hairy leaves. Leaf (pennatisect, simple or trisect), calyx (membranous or thick textured, whether the upper lip has 2 grooves, whether it is concave or not); corolla (upper lip with oraxial, tubular scales, ring-shaped or not) and stamen characteristics are the most important ways to distinguish Salvia genus (Özler et al. 2011). Essential oil yield of *Salvia* species varies between 0.07% and 6%; genetic and environmental factors are highly effective in essential oil yield (Sharifi-Rad 2018).

Secondary metabolites of *Salvia* species mainly consist of terpenoids, steroids, flavonoids and other phenolic compounds. In addition to anti-inflammatory, antiviral, hepatotoxic, cytotoxic/antitumour activities especially due to the di- and triterpenes they contain, the flavones they carry are known to have many activities such as antioxidant, antimicrobial, cytotoxic etc. (Topçu 2006).

Lavandula spp.

Lavandula spp. is an essential oil plant of economic value as a medicinal aromatic and ornamental plant from the family Lamiaceae (Guenther, 1952). There are about 39 *Lavandula spp*., most of which are of Mediterranean origin. There are three important *Lavandula spp*. species with high commercial value in the world.

Lavandula is a perennial herb with a semi-shrub form and a height of 50-100 cm. Leaves opposite and 2-6 cm long, short-petioled, greyish-green. The flowers are light purple to blue-dark purple in colour. The sepals surround the petals and are veined, hairy or glabrous, with 5 short teeth. Petals are 2-lipped and the upper lip has two lobes and the lower lip has three lobes (Urwin, 2009; Kara, 2011)

The oil composition and yield of Lavandula characterise each other. Camphor, linalool and linalyl acetate, terpinen-4-ol essential oil ratios are the common criteria for determining oil quality (Bardar and Kineci, 2009). In addition, Gonçalves et al. (2008) reported that the main essential oil components of Lavandula viridis are monoterpenes and taht 1.8-cineole, camphor and α pinene are the major components. The most important monoterpenes in lavender are borneol, linalool, linalyl acetate, 1.8 cineole, camphor and from these components, linalyl acetate, linalool, and camphor determine the quality of lavender essential oil (Sarker et al., 2012).

Origanum onites

One of the most important plants of the Lamiaceae family. It is a perennial herb in shrub form, 10-40 cm tall. The leaves are arranged in a cross-shaped arrangement, the margins are straight. Thyme flowers are plants with irregular calyx, upper lip with three lobes and yellow, white or purple colour.

In Türkiye, there are five genera named Origanum, Satureja, Tymbra and Coridothymus (Başer et al., 1994; Davis, 1982). Main components of essential oils belonging to these genera are usually carvacrol and thymol. Thymol, carvacrol, linalool, p-cymene, geraniol, borneol were found to be the most important terpenes in the essential oil components of *Origanum onites*. The most important source of monoterpenoid phenols in the plant kingdom is *Origanum onites* species (Stahl-Biskup E., 2002).

Material and Method

Material: The conventionally grown *Origanum onites, Salvia officinalis* and *Lavandula officinalis* plants (Figure 1) were obtained from a local herbalist. Organically grown *Origanum onites, Salvia officinalis* and *Lavandula officinalis* plants (Figure 2) were obtained from the harvest of 2022 from an organisation with Organic Agriculture Certificate in Niğde region.

Conventionally and organically grown *Origanum onites*, *Salvia officinalis* and *Lavandula officinalis* plants were dried at room temperature for two weeks. The dried samples were ground to powder in a mechanical plant grinding mill before analysis.

(a) (b) (c)

Figure 1. Conventional agricultural plants (a) *Origanum onites*, (b) *Lavandula officinalis*, (c) *Salvia officinalis*

(a) (b) (c)

Figure 2. Organic agricultural plants (a) *Origanum onites*, (b) *Lavandula officinalis*, (c) *Salvia officinalis*

Method: Origanum onites, Salvia officinalis and *Lavandula officinalis* plant species belonging to Lamiaceae family grown by conventional and organic methods were used. The extracts of the dried and ground plants were prepared using a Soxhlet extraction device (Anonymous 1993). The extracts of the dried and ground plants were prepared using a Soxhlet extraction device. Oil extraction procedures were carried out with 5 g of sample and four different solvents. These solvents were determined as methanol, ethanol, chloroform, and acetone. In the extraction process, 50 mL of each solvent was used and the extraction process was completed in approximately 10-15 minutes. The extracts obtained after solvent evaporation in a rotary evaporator were converted to methyl esters by the method proposed by Marquard (1987) and injected into GC-MS under the following conditions. GC-MS device

Shimadzu QP2010 Ultra brand, Column; Restek brand, Rxi-5ms 30m×0,25 mm ID×0,25 micrometre df. Detector: FID was applied for chromatographic separation of analytes using Helium as carrier gas at a constant flow rate of 2 ml\min. The column temperature programme was started at 40°C (1 minute held), increased to 240°C at 25°C min^{-1} and then to 280°C at 10°C min^{-1} and analytes were completely separated within 18 min.

Results and Discussion

The findings obtained as a result of the experimental studies are given below. The results of the analyses of the extracts obtained by conventional Soxhlet extraction method using four different solvents (acetone, methanol, ethanol, chloroform) and three different plants grown by conventional and organic methods are given in Tables 1, 2 and 3.

Table 1. Chemical constituents of *Salvia officinalis* grown by conventional and organic methods (%)

Salvia Officinalis	Asetone		Ethanol		Methanol		Chloroform	
Compounds	Con.	Org.	Con.	Org.	Con.	Org.	Con.	Org.
Hydrocarbons and derivatives								
Heptadecane	-	0.33	-	-	-	-	-	-
Pentacosane	-	0.81	-	-	-	-	-	-
Tetrapentacontane	2.39	-	-	-	0.64	19.4	-	-
Nonadecene	-	-	0.91	1.51	-	0.54	-	-
13-Docosenamide	-	1.56	-	-	-	-	-	-
Monoterpenes and Monoterpenoids								
Limonene	-	0.36	-	-	-	-	0.46	-
1,8-Cineole	3.56	3.43	14.17	8.65	1.65	-	13.67	12.7
Linalool	2.1	0.79	1.37	0.93	7.05	1.08	1.63	-
Thujone	13.14	8.71	22.99	16.36	2.11	9.86	19.52	29.16
Terpinen-4-ol	-	-	0.49	-	-	0.54	-	0.46
Camphor	0.55	8.37	1.27	14.99	1.96	15.19	0.88	16.43
Trans Pinocarveol	-	-	-	-	-	-	-	1.13
Endo-Borneol	0.58	0.86	-	1.16	1.14	1.13	-	1.05
Bornyl acetate	-	0.78	-	1.72	-	1.15	-	1.52
Sabinol	-	-	-	0.37	-	-	-	-
Myrtenyl acetate	-	-	-	-	-	0.38	-	-
α Pinene	-	-	-	-	-	-	1.33	-
β-Pinene	-	-	-	-	-	-	0.54	-
Trans Sabinene hydrate	-	-	-	-	0.54	-	-	-
Sesquiterpenes and Sesquiterpenoids								
Caryophyllene Oxide	-	1.42	4.63	7.54	0.66	2.25	0.69	0.7
Caryophyllene	6.08	6.29	5.24	3.75	1.14	2.86	7.48	1.02
Humulane-1,6-dien-3-ol	-	-	1.29	-	-	1.38	-	-
Spathulenol	-	-	-	-	-	-	-	1.14
β-Selinene	-	-	-	-	-	-	1.45	-
β-Bisabolene	-	-	-	-	1.45	-	-	-
Veridiflorol	7.25	6.36	8.00	7.87	-	7.7	6.72	5.5
Diterpenes and diterpenoids								
Phytol	0.61	0.81	0.92	-	-	-	0.75	0.66
Neophytadiene	0.52	0.27	-	-	-	-	-	-
Biformen	-	0.38	-	-	-	-	-	-
Manool	12.55	7.71	17.33	13.15	-	12.22	14.22	9.72
Larixol	3.86	2.9	3.72	3.04	-	4.14	4.31	3.72
Ferruginol	0.46	0.48	-	1.21	-	0.98	0.36	-
Totarol	0.66	0.96	-	-	-	-	-	-
Geranyl-α-terpinene	-	-	0.86	1.1	-	-	0.51	-
Fatty acids and derivatives								
Palmitic Acid	-	0.75	-	-	-	-	-	-
Methyl Stearate	2.3	2.84	0.57	-	1.03	-	4.04	4.65
Cis-11,14,17-Eicosatrie noicacid methyl ester	-	-	1.23	0.39	-	-	-	-
Heptadecanoic acid, ethyl ester	-	-	1.25	0.48	-	-	-	-
Hexadecanoic acid, methyl ester	3.74	3.64	0.46	1.25	0.75	3.15	6.29	5.61
Octadecanoic acid ethyl ester	-	-	-	0.53	-	-	-	-
Linoleik Asit methyl ester	3.00	3.64	-	-	5.53	1.02	2.83	2.8
Cycloeucalenyl Acetate	1.69	2.45	-	-	-	-	-	-
Diisooctylphthalate	-	0.48	-	-	-	-	-	-
1-tetradecanol	-	-	-	1.86	-	0.33	-	-
1-Eicosanol	-	-	-	0.98	-	-	-	-
Ethyl Linoleolate	-	-	0.79	-	-	-	-	0.94
Phenolic compounds								
Carvacrol	5.2	0.6	2.68	0.5	68.88	1.65	2.78	1.21

Con.: conventionally grown, Org.: organically grown

Table 2. Chemical constituents (%) of *Origanum onites* grown by conventional and organic methods

Origanum Onites	Asetone		Ethanol		Methanol		Chloroform	
Compounds	Con.	Org.	Con.	Org.	Con.	Org.	Con.	Org.
Hydrocarbons and derivatives								
Hexacontane	-	-	2.89	-	-	-	-	-
Nonadecene	4.29	-	-	-	-	-	-	-
Monoterpenes and Monoterpenoids								
Trans Sabinene Hydrate	0.44	0.3	-	-	0.54	-	-	-
1,8 Cineole	-	-	2.62	5.8	1.65	1.57	0.8	2.83
Linalool	4.23	5.46	7.61	7.26	7.05	5.27	4.00	3.84
Thujone	-	-	1.36	7.14	2.11	3.93	-	2.53
(+)-2-Bornanone	-	0.21	0.96	4.71	1.96	4.3	-	1.85
Terpinen 4-ol	0.32	-	-	-	0.55	-	0.41	-
Camphor	-	0.21	-	-	-	-	-	-
Endo-Borneol	0.78	0.47	1.03	1.08	1.14	0.75	0.93	0.52
para-Cymene	-	-	0.84	-	-	-	-	0.33
γ- Terpinene	-	-	1.11	-	-	-	1.24	0.28
Borneol	-	-	1.03	0.67	-	0.75	-	0.52
Carvotanacetone	66.28	44.08	59.81	-	-	65.94	-	52.54
Camphene	-	-	-	-	-	-	0.29	-
Sesquiterpenes and Sesquiterpenoids								
Caryophyllene	0.66	0.36	1.51	0.45	1.14	0.95	0.69	0.29
Caryophyllene oxide	0.38	0.22	-	-	0.66	0.5	-	-
β-Bisabolene	2.01	1.16	2.99	1.74	1.45	0.42	2.03	0.9
Cedrelanol	-	0.49	-	-	0.54	0.71	-	0.52
epi-α-Muurolol	-	-	-	1.11	0.62	-	-	-
Diterpenes and diterpenoids								
Phytol	0.46	-	0.76	-	-	-	0.5	-
Abietiniacid	-	-	-	-	-	0.79	-	0.5
Fatty acids and derivatives								
Palmitic acid, methyl ester	2.34	3.01	1.87	-	3.15	2.71	4.54	6.06
Hexadecanoic acid, ethyl ester	-	-	3.38	-	-	-	-	-
Linoleic acid methyl ester	3.67	14.18	2.27	-	4.87	2.46	3.34	4.19
Methyl stearate	1.33	1.69	0.95	-	1.03	1.01	3.05	3.77
Ethyl linoleate	-	-	4.74	-	-	-	-	-
Stearik asit ethyl ester	-	-	1.35	-	-	-	-	-
Miristil acid	-	-	-	2.44	-	-	-	-
Tetradecanol	-	-	-	2.44	-	-	-	-
Linalyl Acetate	0.33	0.48	-	0.8	-	-	-	0.43
Thymoquinone	-	-	-	-	1.33	0.73	-	-
Phenolic compounds								
Thymol	-	-	-	5.85	-	-	-	-
Carvacrol	2.91	4.76	1.94	53.33	68.88	-	74.34	4.92

Con.: conventionally grown, Org.: organically grown

In the chemical components detected in plants grown with conventional and organic methods; 50 components were detected in plants grown with conventional farming methods and 78 components were detected in plants grown with organic farming methods out of 97 components of *Salvia officinalis* plant. In the same study, out of 38 components of *Origanum onites*, 36 components were determined from plants grown with conventional farming methods and 38 components were determined from plants grown with organic farming methods. Of the 60 components of *Lavandula officinalis*, 40 components of plants grown with conventional farming methods and 60 components of plants grown with organic farming methods were determined.

According to the results of the analyses of the chemical components of the samples taken from all the plants grown with conventional and organic methods; 2 hydrocarbon compounds were detected in *Origanum onites*, 5 in Salvia officinalis, 6 in *Lavandula spp.* among the hydrocarbon compounds, nonadecene was detected in *Origanum Onites* and *Salvia Officinalis* plants, but not in *Lavandula spp.* Tetrapentacontane was detected in *Lavandula spp.* and *Salvia Officinalis* plants, but not in *Origanum Onites.* hydrocarbon compounds were not detected in *Origanum onites* plants grown under organic farming. In *Salvia officinalis* plant, hydrocarbon derivative compounds were found more in organically grown plants. In *Lavandula spp.* only tetrapentacontane hydrocarbon component was determined in the plant grown by conventional methods.

According to the results of the analyses, 13 compounds belonging to the group of monoterpenes and monoterpenoids were detected in *Origanum Onites*, 15 compounds in *Salvia officinalis*, 20 compounds in *Lavandula spp.*

Table 3. Chemical constituents (%) of *Lavandula spp.* grown by conventional and organic methods

Lavandula spp.	Asetone		Ethanol		Methanol		Chloroform	
Compounds	Con.	Org.	Con.	Org.	Con.	Org.	Con.	Org.
Hydrocarbons and derivatives								
Tetrapentacontane	2.01	-	-	-	2.78	-	-	-
Tetratetracontane	-	0.19	-	7.74	-	-	-	4.2
Hexatriacontane	-	52.6	-	38.65	-	43.74	-	-
Heptacosane	-	11.73	-	2.08	-	-	-	-
Tetracosane	-	-	-	-	-	-	-	20.61
Tetracontane	-	4.65	-	-	-	-	-	-
Monoterpenes and Monoterpenoids								
Eucalyptol	-	0.56	-	1.47	-	-	-	-
Linalool oxide	-	0.25	-	-	-	1.34	-	5.25
Linalool	11.85	0.33	12.58	11.18	12.61	12.24	6.88	-
(+)-2-Bornanone	-	0.57	7.69	0.76	6.81	1.89	7.01	-
Endo-Borneol	12.31	0.5	6.27	-	5.97	1.68	5.81	1.56
Lavandulyl acetate	-	0.66	-	1.22	1.59	1.73	-	-
(.+/-.)-Lavandulol	-	-	-	1.28	-	-	-	-
1,8-Cineole	3.86	-	7.18	-	4.1	1.68	6.25	-
Thujone	5.1	-	4.8	0.44	6.73	2.02	3.3	-
Terpinen -4-ol	-	0.23	-	0.8	-	0.87	-	-
Ethyl 2-(5-methyl-5-vinyltetrahydro furan-2-yl)propan-2-yl carbonate	2.92	-	5.09	-	5.19	-	7.31	-
2,6-Dimethyl-3,7-octadiene-2,6-diol	4.71	-	5.57	0.33	7.14	-	4.76	-
3Nonanol,1,2:6,7diepoxy -3,7-dimethyl-, acetate	3.99	-	3.65	-	4.98	-	5.59	4.7
3,7-Octadiene-2,6-diol, 2,6-dimethyl-	-	-	-	-	1.12	-	1.46	-
3,7-Nonadien-2-ol, 4,8-dimethyl-	-	-	-	-	1.04	0.31	-	-
2H-Pyran-3-ol,6-ethenyl tetrahydro-,2,6trimethyl	-	-	-	-	-	-	1.35	2.3
Cryptone	-	-	-	-	-	-	0.97	-
2-Heptanone,7,7-dimethoxy-5-(1-methylethyl)	-	-	-	-	-	-	0.91	-
Lilac alcohol B	-	-	-	-	-	-	-	2.97
Lilac aldehyde B	-	-	-	-	-	-	-	3.96
Sesquiterpenes and Sesquiterpenoids								
Caryophyllene	1.85	0.62	2.11	1.89	1.93	0.62	-	-
Caryophyllene oxide	1.35	0.23	1.77	0.4	2.02	1.14	-	-
β Farnesene	-	1.07	-	3.09	-	0.86	-	-
α-Bisabolene	1.92	-	2.56	-	3.73	-	-	-
Formic acid, 3,7,11-trimethyl-1,6,10-dodecatrien-3-yl ester	-	-	-	-	1.09	-	-	-
Diterpenes and diterpenoids								
Phytol	-	0.22	1.58	0.4	-	-	-	-
Fatty acids and derivatives								
Methyl stearate	1.58	0.21	-	0.53	0.89	0.52	5.36	18.37
Hexadecanoic acid, methyl ester	3.94	-	2.05	-	4.1	-	9.87	25.24
Linolenic asit methyl ester	1.4	0.87	2.75	2.00	2.8	2.3	4.28	-
Hexadecanoic acid, ethyl ester	-	-	4.86	-	-	-	-	-
Linalyl acetate	24.85	6.37	27.1	19.43	21.68	17.49	21.23	-
Phenolic compounds								
Carvacrol	-	0.39	-	0.34	1.69	0.94	-	-
Tyhmol	-	0.31	-	-	-	-	-	-

Con.: conventionally grown, Org.: organically grown

The most important of these are 1,8 cineole, linalool, thujone, terpinen 4-ol, endo-borneol were found in all plants. Terpinene 4-ol in *Origanum onites* only in conventionally farmed plants, the monoterpene carvotanacetone was found to be 66.28 % in the plant grown with conventional agriculture in acetone solvent, in methanol solvent, 65.94 % was detected in the plant grown with organic farming. In *Salvia officinalis*, thujone and camphor were detected in all solvents and plants. Trans pinocarveol, bornyl acetate, myrtenyl acetate were detected only in plants grown with organic farming and pinene was detected in plants grown with conventional farming. In *Lavandula spp*. eucalyptol, lilac alcohol, lilac aldehyde were found in plants grown with organic farming, ethyl 2-(5-methyl-5-vinyltetrahydro furan-2-yl)propan-2-yl carbonate, 3,7-Octadiene-2,6-diol, 2,6-dimethyl, 3,7-Nonadiene-2-ol, 4,8-dimethyl, cryptone were found in plants grown with conventional farming.

Sesquiterpene and Sesquiterpenoids group components; 5 components were detected in *Origanum Onites*, 7 components in *Salvia officinalis*, 5 components in *Lavandula spp.* Caryophyllene, caryophyllene oxide, β bisabolene were detected in all plants.

The diterpene alcohol phytol was found in all plants, manool and ferriginol, and the diterpenoids larixol only in *Salvia officinalis*. Phytol in *Origanum onites* was detected in plants grown with conventional agriculture.

In the class of fatty acids and derivatives, the components obtained from all three plants are methyl stearate, hexadecanoic acid and linolenic acid. The least number of fatty acid components is in *Lavandula spp.* In *Origanum Onites* plant, hexadecanoic acid, stearic acid components were detected in conventional agricultural products, myristyl acid and tetradecanol components were detected in organic agricultural products. In Salvia officinalis, all components were found in plants grown with conventional and organic farming, while only palmitic acid and octadecanoic acid were found in plants grown with organic farming.

Phenolic compounds tyhmol and carvacrol were detected in samples taken from plants grown with conventional and organic methods in all three plants. Carvacrol was detected at the highest rate of 74,34 % in *Origanum Onites* plants grown with conventional agriculture in chloroform solvent.

This study is a basic study on *Origanum onites, Salvia officinalis* and *Lavandula officinalis* plants belonging to Lamiaceae Family grown by conventional and organic methods. It will contribute to analyse the chemical constituents of plants grown with conventional and organic agriculture in more detail and with different extraction

In a study of Tohidi et al. on Thymus species, the essential oil composition of T. migricus, T. fallax, T. serpyllum, T. trautvetteri, T. transcaspicus, T. carmanicus, T. fedtschenkoi, T. vulgaris, T. daenensis, and T. pubescence species were determined by GC-MS. Thirty-eight compounds containing between 81.24% and 99.75% of the total oils were identified. The main compounds detected in essential oils are thymol (12.4-79.74%), carvacrol (4.37-42.14%), geraniol (0.3-22.44%) and p-cymene (0.8-12.86%). Although thymol is generally detected as the major component of Thymus species in the literature, Carvotanacetone, carvacrol, linalool were detected in the species we examined.

Rai et al. (2020) reported that linalyl acetate, 20.0% in the essential oil of Lavandula angustifolia Mill, Moussii et al. (2020) determined linalyl acetate as 9.78% in Lavandula angustifolia Mill. essential oil. In our study, linalool ratio varied between 23.52-25.36%. The linalyl acetate ratios we obtained in our study were 27.1% in the conventionally grown product, while this value was 21.23% in the organic farming product.

Mot vet al. (2022) conducted GC-MS analysis of three Salvia officinalis L. essential oil samples and found the presence of terpenes such as 1,8-cineole, thujones, borneol, camphor, sabinene, camphene and caryophyllene as main components. In the results obtained in our study, thujone, 1,8-Cineole, camphor, manool, carvacrol, Caryophyllene were detected.

Conflicts Of Interest

The authors declare no conflict of interest. This research received no external funding.

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