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ARAŞTIRMA MAKALESİ **RESEARCH ARTICLE**

Some Yield and Quality Properties of Endemic *Origanum husnucan-baserii* Grown in Different Ecological Conditions

Farklı Ekolojik Koşullarda Yetiştirilen Endemik *Origanum husnucan-baserii* Bitkisinin Bazı Verim ve Kalite Özellikleri

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Abstract

Origanum husnucan-baserii is an endemic species naturally found in Ermenek district of Karaman and Antalya. This study was carried out to determine the agronomic and chemical components of the *O. husnucan-baserii*, which grows naturally in Ermenek (South of Turkey). The experiment was carried out in the garden of Ermenek Vocational School for 3 years in 2014, 2015 and 2016, and in the research areas of Field Crops Department of Cukurova University for 2 years in 2015 and 2016 (*O. husnucan-baserii* plant grown in Adana vegetation could not be harvested in the first trial year (2014), since flowering did not occur). *O. husnucan-baseri* grown in Ermenek, 3-year plant height is between 79.00-74.61 cm, average 74.61 cm, the number of branches between 29.07-27.14 units/plant, average 28.29 units/plant, fresh herbage weight between 731.5-233.7 g/plant, average 463.40 g/plant, dry herbage weight between 344.3-84.14 g/plant, average 193.31 g/plant, dry leaf weight between 163.60-34.30 g/plant, average 83.70 g/plant, essential oil ratio between 0.92-0.16 %, the average was determined as 0.63%. The main component of the essential oil, p-cymene, was obtained as 81.29% in the first year, 81.39% in the second year and 66.62% in the third year. The plant height of the plants grown in Adana is between 84.67-61.57 cm, the average is 73.12 cm, the number of branches is between 37.00-25.71 units/plant, the average is 31.36 units/plant, the fresh herbage weight is between 304.33-190.90 g/plant, the average is 247.62 g/plant, dry herbage weight between 113.66-80.43 g/plant, average 97.05 g/plant, dry leaf weight between 72.00-31.40 g/plant, average 51.70 g/plant and essential oil ratio between 1.26-0.98%, the average was determined as 1.12%. The rate of p-cimen, the main component of the essential oil, was determined as 69.52% in the first year and 76.38% in the second year. Some characteristics such as plant height, fresh and dry grass weights were higher in Ermenek than Adana results. In terms of essential oil content, plants cultivated in Adana had higher values. In this case, it would be more appropriate to choose a region according to the purpose of cultivation.

Keywords: *Lamiaceae, Origanum husnucan-baserii*, Endemic, Essential oil, GC/MS.

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Öz

Origanum husnucan-baserii, Antalya ve Karaman 'ın Ermenek ilçesinde doğal olarak bulunan endemik bir türdür. Bu çalışma ise Ermenek'te doğal olarak yetişen *O. husnucan-baserii* bitkisinin agronomik özellikleri ve kimyasal bileşenlerinin belirlenmesi amacıyla yapılmıştır. Deneme 2014, 2015 ve 2016 yıllarında 3 yıl süreyle Ermenek Meslek Yüksekokulu bahçesinde, 2015 ve 2016 yıllarında 2 yıl süreyle Çukurova Üniversitesi Tarla Bitkileri Bölümü araştırma alanında yürütülmüştür (Adana vejetasyonunda yetiştirilen *O. husnucan-baserii* bitkisinde birinci deneme yılında (2014), çiçeklenme meydana gelmediğinden hasat yapılamamıştır). Ermenek'te yetişen *O. husnucan-baseri*, 3 yıllık bitki boyu 79.00-74.61 cm arasında, ortalama 74.61 cm, dal sayısı 29.70-27.14 adet/bitki, ortalama 28.29 adet/bitki, taze herba ağırlığı 731.50-233.70 g/bitki arasında, ortalama 463.40 g/bitki, kuru herba ağırlığı 344.30-84.14 g/bitki, ortalama 193.31 g/bitki, kuru yaprak ağırlığı 163.60-34.30 g/bitki, ortalama 83.7 g/bitki, uçucu yağ oranı 0.92- %0.16, ortalama %0.63 olarak belirlendi. Uçucu yağın ana bileşeni, p-simen ilk yıl % 81.29, ikinci yıl % 81.39 ve üçüncü yıl %62.52 olarak elde edilmiştir. Adana'da yetiştirilen bitkilerin bitki boyu 84.67-61.57 cm arasında, ortalama 73.12 cm, dal sayısı 37.00-25.71 adet/bitki arasında, ortalama 31.36 adet/bitki, taze ot ağırlığı 304.33-190.90 g/bitki arasında, ortalama 247.62 g/bitki, kuru ot ağırlığı, 113.66-80.43 g/bitki arasında, ortalama 97.05 g/bitki, kuru yaprak ağırlığı 72.00-31.40 g/bitki arasında, ortalama 51.70 g/bitki ve uçucu yağ oranı 1.26-0.98 arasında ortalama % 1.12 olarak belirlenmiştir. Uçucu yağın ana bileşeni p-simen'in ilk yıl oranı % 69.52, ikinci yıl % 76.38 olarak tespit edilmiştir. Bitki boyu, yaş ve kuru herba ağırlıkları gibi bazı özellikler Ermenek'te daha yüksek çıkarken uçucu yağ içeriği bakımından Adana'da yetiştirilen bitkiler daha yüksek değerlere ulaşmıştır. Bu durumda yetiştirme amacına göre bölge seçimi yapılması daha uygun olacaktır.

Anahtar Kelimeler: *Lamiaceae*, *Origanum husnucan-baserii,* Endemik, Uçucu yağ, GC/MS.

1. Introduction

Lamiaceae is called the mint family which is regarded as an important medicinal family. It contains about 236 genera and more than 6000 species. It has great diversity and variety with a cosmopolitan distribution (Salama and El-Shabasy, 2019). Turkey, an important gene center of the L*amiaceae* family, is represented by 782 species and taxa, 346 of which are endemic (44.2% endemism ratio). According to the latest data, 287 taxa (36.7%) are in the Irano-Turonian, 293 taxa (37.4%) in the Mediterranean and 90 (11.5%) in the Euro-Siberian phytogeographic regions and 112 taxa (14.3%) are unknown. or the multi-regional element is located in Turkey (Celep and Dirmenci, 2017). Many *Lamiaceae* species produce essential oils secreted by granular hairs on aerial vegetative organs and some reproductive organs. Many species of *Lamiaceae* with their pleasant scents have been used as herbal teas in Turkey, and most of them are used as raw materials in the cosmetics industry. Some species are used as traditional medicinal plants (Dinç and Doğu, 2013).

There are many genera known as 'thyme' due to similar smells in Turkey. These are *Thymus* (58 taxa), *Origanum* (26) *Satureja* (13 taxa), *Tymbra* (4 taxa) and *Coridothymus* (1 species) (URL 1, 2020). The common features of these genera are that they have carvacrol or thymol or both as the main component in their essential oils. Studies by various researchers show that *Origanum* is a powerful source for the isolation of various bioactive molecules such as terpenes, phenols, flavonoids, etc., thus this genus has important biological activities and is effective against different types of diseases (Chishti et al, 2013). *Oregano* is used as a spice by humans all around the world for ancient times and it is a good raw material for the production of tincture to use against some diseases like cold, for digestive and respiratory problems (Kaplan et al., 2019; Ivanova et. al., 2005). There are 22 species and 32 taxa of *Origanum* in Turkey, 21 of which are endemic. The rate of endemism among the Turkish *Origanum* species is 63%. Out of 52 known taxa of *Origanum*, 32 are distributed in Anatolia, meaning 60% fall *Origanum* taxa are recorded to grow in Turkey. This high rate is suggestive that the gene center of *Origanum* is Turkey (Baser, 2004; Duman et al. 1995; Davis, 1982; Ietswaart, 1980; Federov, 1974). After *Origanum* was revised by Ietswaart for Flora of Turkey, *O. husnucan-baserii* has been described as a new science species from Turkey (Dinç and Doğu, 2013).

One of the endemic species is *O. husnucan-baserii* belongs to Section *Brevifilamentum* Ietswaart (Baser 2004), which is found naturally in Karaman's Ermenek province and Antalya. The plant is sub-shrub to 30 cm, calcareous rocks with *Pinus nigra* and 1200-1350 m sea level (Taş, 2010). Karaman Ermenek District, both geographical and floristic in terms of climate, Central Anatolia - is presented in the passage between the Mediterranean Regions, Davis (1965 - 1988) enters the C4 frame according to his grid system for Turkey. As a result of the studies conducted in this area, it is reported that many different species are known as "thyme" are distributed in this region (Davis, 1965-1988). The village of Ermenek in Karaman contains many habitats with different characteristics ranging from bare rocks and rubble to abundant humus forests. The diversity of regional vegetation can be better understood if these habitats are also compared with those of Central Anatolia and Mediterranean climates. When we look at the analysis of the region's flora, it can be thought that the ratio of Iran-Turan (21.20%) and Mediterranean (20.45%) elements is very close to each other. *Thymus* ssp. (Thyme), *Salvia* ssp. (Sage), *Rhus coriaria* (Sumac) is collected and evaluated by local people (Davis, 1965-1988; Tanker et al., 1985; Maral et al., 2018; Maral and Kırıcı, 2022). The richness of Turkey in terms of natural plant species is a fact known by everyone. Medicinal and aromatic plants have an important place among these plants. Especially the Mediterranean region has a special importance for essential oils. However, these plants have not been produced sufficiently yet and their conservation in nature has not been achieved as desired (Ayanoğlu and Kaya, 1999).

Essential oils can vary in quality and quantity depending on several factors, including climate (precipitation, temperature), seasonal variations (day length, light exposure, harvest period), soil composition (available micro-nutrients, application of fertilizers), vegetative cycle stage, genetic variation (plant ecotype or variety), geographic location (altitude), stress during growth or maturity, and the post-harvest drying and storage (Zgheib et al., 2019).

The aim of this study is to determine the yield and essential oil potential of endemic *O. husnucan-baserii* in both Ermenek and Adana conditions.

2. Materials and Methods

The material of the research consisted of plants that were determined at an altitude of 864 m in Ermenek district of Karaman on 28 July 2012. In March and April 2014, cuttings were taken from the plants whose locations

were determined before and planted in vials for rooting. In March and April 2014, cuttings were taken from the plants whose locations were determined before and planted in vials for rooting. Rooting was done in the garden of Karamanoglu Mehmetbey University, Ermenek Vocational School. The rooted cuttings in the vials were transferred at the trial site in Ermenek on 14.04.2014 and the test site in Adana on 23.06.2014. The experiment was set up in rows at a distance of 40 x 60, with 15 plants. The experimental area was irrigated regularly with drip irrigation method. During the yield period, 6 kg nitrogen (N) and 4 kg phosphorus (P) were given per decare per year. During the research, weed control was provided by mechanical methods in the experiment. Plants in the Ermenek trial area were harvested during the flowering period in 2014, 2015 and 2016. The plants in the Adana trial area were harvested during the flowering period in 2015 and 2016, in the first year did not harvest due to the lack of flowering due to late planting in 2014. The harvest of the experiment was done by hand during the flowering period of the plants. In the Ermenek trial area, 7 plants were harvested in the first year and 14 plants in the other years. In Adana experiment area, 8 plants were harvested in both years and observations were taken. Planting and harvesting dates of the plants are given in *Table 1*.

Table 1. Planting and harvesting dates of the plants

	Ermenek			**Adana**	
	I. Year	II. Year	III. Year	I. Year	II. Year
Seedling date	March- April 2014				
Planted date	14.4.2014			23.06.2014	
Harvest Date	06.07.14	27.07.15	22.07.16	06.07.15	01.07.16

In all harvested plants, plant height (cm), number of branches (number/plant), fresh and dry herbage weight (g/plant), dry leaf weight (g/plant) and essential oil content and components were determined.

2.1. Climatic Properties of Ermenek Trial Area

In *Table 2*, the climate data of the experiment for the years 2014, 2015 and 2016 are given. In general, the Ermenek climate belongs to the subtype of Mediterranean-influenced climates (Mediterranean transitional climate). Taurus Mountain system followed by the hot character, dry summers in the arid winters is a type of climate. The average annual temperature is between 0.5-24.6°C. The hottest month is August. The coldest month is January. In these high mountains and highlands, summers pass through the wetlands in the valleys of Göksu although they are short and cool. The average annual rainfall is 564 mm.

2.2. Climate Characteristics of the Trial Area in Adana

Table 2. Some Important Climate Data for 2014, 2015, 2016 and Long Years.

Ermenek		**Months**												
Climate Factors	Years	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	**Av.**
Average Temp. °C	2014	4.8	5.4	7.5	11.6	14.6	19.0	23.8	24.6	18.6	13.1	7.2	6.0	**13.0**
	2015	1.8	2.0	6.0	8.7	15.7	17.9	23.0	23.4	22.3	15.1	9.7	4.1	**12.5**
	2016	0.5	6.5	7.2	14.0	14.5	21.2	24.5	24.6	19.9	13.4	9.0	4.0	**13.3**
														Total
Precipitation mm	2014	71.8	9.7	15.9	15.6	82.8	35.5	14.6	5.0	9.6	48.7	55.2	66.7	**431**
	2015	25.6	108	77.6	2.9	17.4	38.5	2.2	29.6	4.2	48.1	11.8	9.6	**376**
	2016	78.3	22.9	53.5	20.6	63.3	5.5	0.0	2.1	7.4	7.2	37.5	172	**470**
Adana														**Av.**
Average Temp. °C	2015	9.4	11.1	14.5	16.9	22.5	25.0	28.5	30.0	28.4	23.4	17.5	11.8	**19.91**
	2016	8.7	13.9	15.7	20.5	21.6	27.1	29.6	29.9	26.3	23.1	15.6	9.0	**20.08**
	Long Years	9.6	10.5	13.5	17.5	21.7	25.6	28.1	28.4	25.9	21.3	15.4	11.2	**19.05**
														Total
Precipitation mm	2015	108	122	135.1	21.5	65.7	4.8	0.40	10.9	130.0	32.1	10.5	0.6	**641.1**
	2016	138	83.1	67.1	36.6	87.9	45.6	0.20	4.4	39.8	0.0	11.9	216.3	**731.3**
	Long Years	110	84.2	66.8	55.2	47.3	20.0	7.1	5.2	15.8	40.7	73.7	128.7	**654.6**

Source: Regional Directorate of State Meteorology

In the Adana province where the trial was conducted, the winters are warm and rainy, and the hot and arid Mediterranean climate prevails in summer. Climate data for 2015, 2016 and long years average of the experiment are given in *Table 2*. In 2015 and 2016, the temperature values were consistent with the averages for many years but were generally above the averages. The highest precipitation was in December 2016 with 216.3 mm.

2.3. Soil Properties of the Experimental Area in Ermenek

In *Table 3*, some physical and chemical properties of the soils in the area where the experiment was conducted are given. The soil pH (7.56) in the area where the experiment was established generally shows neutral characteristics. The salt content is 0.17%, available P_2O_5 is 5.9 ppm.

Table 3. Some Physical and Chemical Properties of Ermenek Site

Depth (cm)	Sand (%)	texture Plate (%)	Clay (%)	pH	Salt %	Lime	P_2O_5 kg/da	K_2O	Fe	Zn	Mn mg/kg	Cu
0-30	46.0	25.5	28.5	7.56	0.17	63.1	5.9	-	3.3	0.6	2.2	0.8

2.4. Soil Properties of the Trial Area in Adana

Experimental field soil was young alluvial originated from Seyhan River containing gravels and pebbles deposits with various sizes and in different depths. The lime amount in the whole profiles is very high but, the organic matter is so low (Çalışkan et al., 2019). Some physical and chemical properties of soils in the area where the experiment is carried out are given in *Table 4*.

The soil pH in the area where the experiment was established varies between 7.28-7.29. The soil of the trial area is generally neutral. The salt content is between 0.052-0.060%. The available P_2O_5 top layers have a level of 14.17 ppm, which decreases as they fall to the lower layers. The nitrogen content of the soil was 0.112% in the upper layers and 0.056% in the lower layers. The lime content is 33.02% in the upper layers and increases as the lower layers are reached (*Table 4*).

Table 4. Some Physical and Chemical Properties of Experimental Ground Soils

depth (cm)	pH	Salt (%)	P_2O_5	KDK	K_2O	NO_3	lime (%)
0-20	7.29	0.055	14.17	30.40	900	0.112	33.02
20-40	7.28	0.060	3.42	29.30	800	0.056	35.28
40-60	7.29	0.052	2.43	34.78	850	0.056	40.52

1-) Extension of $NaHCO_3$
2-) Extension of HNO_3
3-) Total nitrogen determined by Kjeldahl method

2.5. Isolation of Essential Oils

To isolate the essential oil, 40 g of dried herbage was extracted with 500 ml of distilled water with a neo Clevenger type apparatus. Hydro-distillation was carried out for 2 hours. The essential oils obtained were dried over anhydrous sodium sulfate in amber colored bottles (Turkmen et al., 2022). The extracted essential oils were stored at -18°C until gas chromatography-mass spectrometry (GC-MS) analysis.

2.6. GC-MS Analyses

Essential oils were analyzed using a Thermo Scientific Focal Gas Chromatograph equipped with MS, autosampler and TR-5MS (5% Phenyl Polysylphenylene-siloxane, 0.25 mm x 30 ml i.d, film thickness 0.25). The carrier gas was helium (99.9%) at a flow rate of 1 mL min-1; ionization energy was 70 eV. Mass range m/z 50-650 amu. Data acquisition was scan mode. MS transfer line temperature was 250 °C, MS Ionization source temperature was 220°C, and the injection port temperature was 220 °C (Kara et al., 2020). The samples were injected with 250 split ratios. The injection volume was 1 µl. The oven temperature was programmed in the range of 50 to 220°C at 3°C min-1. Identification was confirmed by comparison of their mass spectral fragmentation patterns with those stored in the MS database (National Institute of Standards and Technology and Wiley 9 Registry of Mass Spectral Data) and with published mass spectra literature data (Adams, 2007; Maral, 2023).

2.7. Statistical Analysis

The data obtained from single plant measurements were determined by using the SAS package program, with the mean, minimum, maximum and standard deviation values for each trait separately. LSD multiple comparison test was used to compare the means.

3. Results and Discussion

The measured plant parameters such as plant height (cm), number of branches per plant (unit/plant), fresh herbage weight (g/plant), dry herbage weight (g/plant), dry leaf weight (g/plant) and essential oil contents (%) which cultivated in Ermenek (Karaman) District and Adana, were given in *Table 5*.

Plant heights at the Ermenek varied between 71.71, 73.13 and 79.00 cm in 2014, 2015 and 2016, respectively. Plant heights at the Adana varied between 61.57 and 84.67 cm in 2015 and 2016, respectively. The mean plant heights in the experiment areas were 74.61 cm for Ermenek and 73.12 cm for Adana. The highest plant height was obtained at the Adana location with 84.67 cm in 2016 due to more availability of water and soil nutrition and it was followed by the Ermenek location with 79.00 cm in 2016. The lowest plant height was obtained from the Adana location in 2015 with 61.57 cm. When the plants grown in Ermenek and Adana were compared in terms of plant height, the values of the plants grown in Adana were shorter than the ones grown in Ermenek in the first year and longer in the second year.

Duman et al. (1995) define the plant as a sub-shrub, stem ascending or erect, 10-30 cm long, purplish or dark brown, glabrous, unbranched. Our results of plant heights in both experiment areas were higher than 10-30 cm because cultivated O *husnucan-baserii* had more e availability of water and plant nutrition.

The number of branches of cultivated *O.husnucan-baserii* at the Ermenek varied between 27.14, 28.67 and 29.07 numbers per plant in 2014, 2015 and 2016, respectively. At Adana, it was varied between 25.71 and 37.00 numbers per plant in 2015 and 2016, respectively. The average number of branches per plant in the experiment was determined as 28.29 for Ermenek and 31.36 for Adana. The highest number of branches was obtained in the Adana location with 37.0 in 2016, followed by Ermenek with 29.07 numbers per plant in 2016. The lowest number of branches was obtained from the Adana location in 2015 with 25.71. The plant number values of the plants grown in Adana were lower than those of Ermenek in the first year and higher in the 2nd year.

The fresh herbage weights at the Ermenek varied between 233.7-396.7 and 731.5 g in 2014, 2015 and 2016, respectively. Fresh herbage weights at the Adana varied between 190.90 and 304.33 g in 2015 and 2016, respectively (*Table 5*). The average fresh herb weight was obtained as 463.40 g/plant for Ermenek and 247.62 g/plant for Adana. The highest weight of herbs was obtained from the Ermenek in 2016 with 731.5 g, followed by the same place at 396.7 g in 2015. The lowest value (190.90 g) was taken from the Adana location in the 1st year. In the Ermenek, the values of fresh herb weight of the cultivated plants reached especially high values in the 3rdyear because it was the perennial plant and weight was increasing by year and year. Fresh herbage weight results have reached especially high values in the 3rd year. This can be explained as a natural result of the perennial plant root structure and the fact that the plant grows much earlier. Similarly, the highest dry herb weight was obtained with 344.3 g in the 3rd year of Ermenek and the lowest value was obtained from Adana location with 80.43 g.

The dry herbage weights at the Ermenek varied between 84.14-151.5 and 344.3 g in 2014, 2015 and 2016, respectively. Dry herbage weights at the Adana varied between 80.43 and 113.66 g in 2015 and 2016, respectively (*Table 5*). The average dry herb yields of the plants were 193.31 g and 97.05 g, Ermenek and Adana, respectively. The highest weight of herbs was obtained from Ermenek in 2016 with 344.3 g. The lowest value (80.43 g) was taken from Adana location in the 1st year. Since the dry biomass is directly related to the fresh biomass; so, the results have the same variation pattern. The dry biomass is also affected by the ecologic condition, agro techniques (Alkire and Simon, 1996) and the genetic nature of plants (Tugay et al., 2000). Adana trial area soil is a young alluvium originating from the Seyhan River, containing gravel and gravel deposits of various sizes and depths, and is quite fertile according to Ermenek. However, in this study, the plant's gene center being close to Ermenek caused it to perform better than Adana in terms of yield and yield elements.

The average of years of dry leaf weights of the plants was 83.70 g in Ermenek and 51.70 g in Adana was the highest dry leaf weight was obtained at the Ermenek location in 2016 with 163.60 g. The lowest value was obtained in Adana in 2015 with 31.40 g. O. *husnucan-baserii* is an endemic species for turkey. Although studies have been

conducted on the essential oil content and components of this species, there are limited studies on yield and quality parameters.

Bayram et al. (1998), in their study with *O. onites* populations collected from different locations, reported that plant heights of plants varied between 40.50 and 55.50 cm. Mancak (2002), in the study conducted *with O. micrantum*, determined the average plant height as 13.72 and 15.13 cm, and the number of branches as 6.34 and 9.10 unit plants^{-1} in the first cuttings and in the second cuttings respectively. Türkmenoğlu and Fakir (2016), determined the plant height of *O. sipyleum* as 72.24 cm. Bayram et al. (1998), in a study conducted on populations of the *O. onites* species, reported that the dry herb yield ranged between 53.20-169.30 g plant^{-1}. Mancak (2002) determined the yield of fresh herb in the first and second cuttings as 11.41 and 13.39 g plant^{-1}, and dry herb yield as 4.40 and 6.59 g plant^{-1}, respectively. In a study conducted with *O. husnucan-baserii* in field conditions in 2017 and 2018, Uysal Bayar and Çınar (2020) determined that the plant height changed between 39.00 and 84.34 cm, the number of branches between 30.00 and 43.67 unit plants^{-1}, the weight of fresh herbage between 118.80 and 211.83 g plant^{-1}, and the weight of dry herbage between 47.06 and 57.40 g plant^{-1}. When our findings regarding all features in both experimental areas are compared with both other *Origanum* species and *O. husnucan-baserii*, it is seen that the values we obtained are higher. Telci (2015) reported that in excessively short cuttings, the newly formed buds will be damaged and this will negatively affect the post- cuttings development. High yield values can be achieved by determining the cultivation techniques specific to each plant. Especially in perennial crops that are harvested more than once in one vegetation period, the height of the cuttings is one of the most important factors affecting the yield (Erken et al., 2007). The fact that the plant height and number of branches are higher than other studies may be due to the differences in agricultural processes, planting time, ecology, climate and geographical factors.

Table 5. Plant Height, Number of Branches, Fresh Herbage Weight, Dry Herbage Weight, Dry Leaf Weight and Essential Oil Rate Values of Origanum husnucan-baserii plant samples grown in Karaman, Ermenek District and Adana

Years			Plant Height (cm)	Number of Branches (unit/plant)	Fresh Herbage Weight (g/plant)	Dry Herbage Weight (g/plant)	Dry Leaf Weight (g/plant)	Essential Oil Content (%)
			ns	ns	**	**	**	
		Min.	43	21	56	16	9	
	2014	Max.	91	41	600	212	86	0.80
	n= 7	Ave.	71.71a	27.14a	233.7b	84.14b	34.30b	
		SD	19.29	8.47	206.59	72.31	28.48	
		Min.	63	15	257	92	37	
	2015	Max.	88	46	570	217	85	0.16
	n= 14	Ave.	73.13a	28.67a	396.7b	151.5b	53.20b	
Ermenek		SD	6.41	9.05	98.63	41.10	13.86	
		Min.	72	21	460	212	102	
	2016	Max.	88	47	1370	642	301	0.92
	n= 14	Ave.	79.00a	29.07a	731.5a	344.3a	163.6a	
		SD	4.93	8.61	276.32	128.91	61.41	
		Mean	74.61	28.29	463.40	193.31	83.70	0.63
		LSD	10.39	9.19	186.83	78.71	35.99	
			*	ns	**	**	**	
		Min.	33	18	56	21	10	
	2015	Max.	81	31	500	212	76	0.98
	n= 8	Ave.	61.57a	25.71a	190.90b	80.43	31.40b	
		SD	19.15	6.31	148.35	64.07b	22.07	
		Min.	72	32	45	18	12	
Adana	2016	Max.	94	44	663	236	153	1.26
	n= 8	Ave.	84.67a	37.00a	304.33a	113.66	72.00a	
		SD	11.37	6.24	120.75	111.41a	72.80	
		Mean	73.12	31.36	247.62	97.05	51.70	1.12
		LSD	8.96	6.72	142.77	57.85	28.50	

* significant at %5, ** significant at %1, ns: not significant, SD: Standard Deviation, n: Number of Plants, LSD: Least Significant Difference

3.1. Essential Oil Contents

The *O. husnucan-baserii* has great variability in the essential oil content and components, quality and contents of essential oil were developed for introduction into cultivation and experiment areas. The essential oil content of the plants in Ermenek was 0.80% in the 1st year, 0.16% in the 2nd year and 0.92% in the 3rd year. Cultures in Adana were 0.98% in the 1st year and 1.26% in the 2nd year. The contents of the essential oils obtained were higher in cultivated plants in Adana than in plants grown in Ermenek. Baser et al. (1998) reported that the essential oil content of *O.husnucan-baserii* was 0.13% collection in Alanya (Turkey) at an altitude of 1350 m in wild flora. Additionally, according to Uysal Bayar and Cınar (2020), *O. husnucan-baserii* essential oil contents were 1.44 % in the 1st year and 2.75 % in the 2nd year under cultivation conditions at Antalya in Turkey. Ermenek's results of essential oils were similar to Baser et al. (1998) because they grow the same location as high altitudes and Adana's ones were similar Uysal Bayar and Cınar (2020) as lower altitude. The essential oil contents varied in quality and quantity depending on several factors (Zgheib et al., 2019), especially geographic location as altitude. In addition, essential oil biosynthesis increases during long days and high light intensity (Fernandes et al., 2013). Due to this situation, the essential oil ratios of the plants grown in Adana were higher.

3.2. Essential Oil Components

The values of the essential oil components of *O. husnucan-baserii* taken from natural flora and cultured in Karaman's Ermenek and Adana Districts are given in Table 6. When the essential oil components of *O. husnucan-baserii* were examined, the 1st year was p-cymene with 81.29% as the main component followed by γ-terpinene with 4.37% and carvacrol with 3.90%. The 2nd year's highest rate was p-cymene with 81.39% followed by γ-terpinene with 8.24% and carvacrol with 2.88%. In the 3rd year, the highest value was p-cymene with 66.62%, followed by γ-terpinene with 22.72% and thymol with 2.38%.

In the study, values related to essential oil components (%) of *O. husnucan-baserii* samples cultured in Adana were given in *Table 6*. The highest rate as the main ingredient in the 1st year was p-cymene with 69.52% followed by carvacrol with 21.67%, thymol with 2.10% and γ-terpinene with 1.27%. The 2nd year highest rate was p-cymene with 76.38% followed by γ-terpinene with 7.86%, thymol with 4.66% and carvacrol with 2.86%. The importance of p-cymene is due to its utilization as an intermediate in industrial fine chemicals syntheses for fragrances, flavorings, herbicides, pharmaceuticals-cresol production, syntheses of not nitrated musk's, the industrial production of p-cymene is carried out by Friedel-Craftsalkylation's form benzene or toluene (Martin-Luengo et al., 2008). *O. husnucan-baserii* can be used as a source of p-cymene.

Baser et al. (1998) recorded that 20.23% borneol, 10.97% trans-sabinene hydrate, 8.36% terpinene and 6.06% β-caryophyllene were found in *O. husnucan-baserii* volatile oil. Uysal et al. (2010) reported that 12.8-15.2% borneol, 10.8-12.3% α-terpineol and 9.92% -11.8% trans-sabinene hydrate were found in *O. husnucan-baserii* essential oil. Uysal Bayar and Cınar (2020) searched the yield and quality parameters of some cultivated *Origanum* spp. Species for two years and the main component of essential oil *O. husnucan-baserii* was cymene with 40.27-62.80% (mean 51.54%), and gamma-terpinene was another with 26.97-22.50% (mean 24.73%). The components carvacrol ranged from 10.05-2.97% (mean 6.51%) and thymol from10.14-2.26% (mean 6.20%). Consistent with the findings of Uysal Bayar and Cınar (2020) in the present study the main component of *O. husnucan-baserii* essential oil was p-cymene both experiment areas, gamma-terpinene was the second component in Ermenek, but it's varied according to years in Adana and also carvacrol was a very changeable component in Adana, it was high with 21.67% in the first year, was lower with 2.86% in the second year. A similar situation was determined by Uysal Bayar and Cınar (2020). Unlike both studies, Baser et al. (1998) and Uysal et al. (2010) determined borneol as the main component in *O. husnucan-baserii.* There are differences in the main components of the researches mentioned in our study. It is known that environmental factors (such as temperature, precipitation, duration and intensity of light, altitude, viewing, drought, salinity, soil nutrients and soil structure) have a great influence on the synthesis and accumulation of active substances (Zgheib et al., 2019; Baydar, 2007). Altitude seemed to be the most important environmental factor influencing the essential oil content (Chishtii et al., 2013). In addition, day length (presence of light) and solar intensity cause the plant's photochemical reaction and change in the accumulation of secondary metabolites and their constituents (Soltanbeigi and Samadpourrigani, 2021). We can say that the work done differs from the other works due to the influence of environmental factors. This suggests that ecological differences may be different components of the same species.

Table 6. Essential Oil Components (%) of Origanum husnucan-baserii cultivated in Karaman's Ermenek and Adana province

RT	Components	Ermenek			Adana	
		2014	2015	2016	2015	2016
3.39	α-pinene	0.85	0.48	0.54	-	0.81
3.46	α-phellandrene	0.69	0.60	0.72	0.37	0.81
4.02	Camphene	0.83	0.39	0.35	0.34	0.62
4.73	β-pinene	0.66	0.62	0.10	-	0.14
5.01	Sabinene	0.27	-	0.20	-	-
6.00	Myrcene	-	0.53	0.90	0.14	0.39
6.34	α-terpinene	0.66	0.82	1.53	0.28	0.73
6.82	D-limonene	0.34	-	0.25	0.18	0.29
8.15	γ-terpinene	4.37	8.24	22.72	1.27	7.86
8.94	P-cymene	81.29	81.39	66.62	69.52	76.38
9.56	α-methylcyclopentanone	0.12	0.55	0.23	-	-
15.35	1-Octen-3-ol	-	-	-	0.39	0.47
20.28	caryophyllene	2.35	0.63	0.26	0.12	-
20.80	4-terpeneol	0.23	-	0.12	0.31	0.28
24.39	Borneol	0.86	0.18	0.50	0.64	1.30
25.28	β-bisabolene	0.65	-	0.41	0.27	0.23
25.61	Geranial	0.15	-	-	-	-
27.17	Cuminaldehyde	0.10	-	0.12	0.15	0.11
33.64	Caryophyllene oxide	0.37	-	0.13	0.19	0.22
38.44	Spathulenol	0.36	-	0.10	-	-
40.79	Thymol	-	-	2.38	2.10	4.66
40.35	Carvacrol	3.90	2.88	0.98	21.67	2.86
	Total (%)	99.05	97.31	99.16	97.94	98.16
	Number of Compounds	99.05	97.31	99.16	97.94	98.16

4. Conclusion

The wild *O. husnucan-baserii* have been cultivated at two locations and evaluated in terms of morphological and chemical properties. Some properties as the height of the plant, fresh and dry herbage weights at Ermenek were higher than Adana's results however, Ermenek's plants were three years old. The quantitative and qualitative of essential oil is influenced by environmental factors, growing conditions and geographical locations. In terms of essential oil content, plants cultivated in Adana had higher values. The composition of essential oil in both locations was similar; p-cymene was the main component. Further, it could use as a source of p- cymene, especially in Adana conditions. As a result, Ermenek conditions were more appropriate in terms of agricultural properties in the *O. husnucan-baserii* samples, whereas Adana conditions were more appropriate in terms of essential oil content. Although the yield values of *O. husnucan-baserii* are quite high, it is thought to be more suitable to use as an ornamental plant because of the low essential oil content.

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