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Determination of Some Yield and Quality Properties of *Origanum dubium* Boiss Grown in Different Ecological Conditions

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ABSTRACT

In this study, it was aimed to determine the agronomic and chemical components of the *Origanum dubium*, which grows naturally in the Ermenek region. The plants used in the experiment were collected at 5 different altitudes (467, 1096, 1331, 1332 and 1478 m) in the Ermenek district of Karaman. The experiment was carried out in the garden of Ermenek Vocational School for 3 years in 2014, 2015 and 2016, and in the field of Field Crops Department of Çukurova Univ. for 2 years in 2015 and 2016. For *O. dubium* cultivated in Ermenek for 3 years, the plant height average was 40.36 cm, the average of plant number was 18.94 units/plant, of green herb weight was 99.85 g/plant, of dry herb weight was 43.53 g/plant and of dry leaf weight was 25.12 g/plant. The average essential oil ratio, on the other hand, was determined as 5.09%, whose main components were carvacrol, linalool and p-cymene. For the plants cultivated in Adana 2 years, the average of plant height was 44.41 cm, of plant number was 17.6 units/plant, of green herb weight was 101.15 g/plant, of dry herb weight was 48.0 g/plant and of dry leaf weight 24.48 was g/plant. Their average essential oil ratio was calculated as 4.90% and it was observed to contain mainly carvacrol with the highest 88.40%.

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ÖZET

Çalışmada Ermenek yöresinde doğal olarak yetişen *Origanum dubium*'un agronomik ve kimyasal bileşenlerinin belirlenmesi amaçlanmıştır. Denemede kullanılan bitkiler Karaman'ın Ermenek ilçesinde 5 farklı yükseltide (467, 1096, 1331, 1332 and 1478) toplanmıştır. Deneme 2014, 2015 ve 2016 yıllarında 3 yıl Ermenek Meslek Yüksekokulu bahçesinde, 2015 ve 2016 yıllarında 2 yıl süreyle Çukurova Üniversitesi Tarla Bitkileri Bölümü deneme alanında yürütülmüştür. Ermenek'te yetiştirilen *O. dubium*'un 3 yıllık bitki boyu ortalama 40.36 cm, bitkideki dal sayısı 18.94 adet/bitki, taze herba ağırlığı 99.85 g/bitki, kuru herba ağırlığı 43.53 g/bitki kuru yaprak ağırlığı 25.12 g/bitki, uçucu yağ oranı % 5.09 olarak belirlenmiştir. Uçucu yağın ana bileşenleri karvakrol, linalool ve p-cimen olduğu tespit edilmiştir. Adana'da yetiştirilen bitkilerin bitki boyu ortalama 44.41 cm, bitkideki dal sayısı sayısı 17.6 adet/bitki, yeşil herba ağırlığı 101.15 g/bitki, kuru herba ağırlığı, 48.0 g/bitki, kuru yaprak ağırlığı 24.48 g/bitki, uçucu yağ oranı % 4.90 olarak belirlenmiştir. Uçucu yağın ana bileşeni, en yüksek% 88.40 ile karvakrol olduğu tespit edilmiştir.

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INTRODUCTION

Türkiye is one of the richest countries in terms of natural plant species. Among these plant species, medicinal and aromatic plants have an important place. Especially the Mediterranean region has a special importance for essential oils. However, besides the fact that these plants have not yet been put into production, the desired goal has not been achieved in terms of their preservation in nature. (Ayanoğlu et al., 1999; Maral et al., 2018).

The *Lamiaceae* family is widely distributed in the world with 236 genera and 7133 species (Harley et al., 2004). The plants of the *Lamiaceae* family are distributed in tropical and temperate regions with high elevation levels in the Mediterranean Region (Cantino et al., 1992; Yılar et al., 2017). Turkey is one of the important gene centers with 45 genera, 558 species and 742 taxa. The rate of endemism was 44.2% (Koyuncu et al., 2010; Belen, 2012). Many of the plants included in this family are very important in many areas such as medicine because they are rich in essential oils and secondary compounds (Kahraman et al., 2009; Yılar et al., 2017).

Due to similar smells in Turkey, there are a large number of species and species known as 'thyme'. These are *Thymus* (57 taxa), *Origanum* (23) *Satureja* (14 taxa), *Thymbra* (4 taxa) and *Coridothymus* (1 species) (Başer et al., 1994). Common characteristics of these genera are that the main components of essential oils are carvacrol or thymol or both. (Federov, 1974; Ietswaart, 1980; Duman et al., 1996).

Oregano is classified as an essential oil plant in terms of the active substance it contains and as a spice plant according to consumption and use (Ceylan, 1995). According to the organs used, herbs (Herba Origani) and leaves (Folia Origani) belong to the group of plants used. It is also widely used as oregano oil (*Oleum Origani*) (Baytop, 1999). Oregano largest exporter in Turkey, according to data from 2017, 121 472 hectares were planted, 14,477 tons were produced (TÜİK, 2017). As of the year 2016, the export amount of oregano was 17050 tons and the export value was 60 million 380 thousand USD (Bayraktar et al., 2017).

Origanum dubium Boiss, (syn: O. *majorana* L.) flowers and leaves are used as tea or condiment. This strain is known in western countries as “sweet marjoram (sweet thyme)” and contains small amounts of carvacrol. In the Antalya region, it draws attention with its richness in terms of carvacrol and its highly productive essential oil. In this region known as white oregano, it has been determined that carvacrol has a rate of 32-84% in the volatile oil obtained from 5-8% of the above-ground parts (Başer, 2001).

It is emphasized that the cultivation of medicinal plants is necessary for the sustainable use of plants in the long term and that plants will exhibit qualitative and quantitative changes in morphological and biochemical properties under ex-situ conditions. It has been stated that the changes in the phenological characteristics of plants such as morphological, flowering and maturation are caused by changes in environmental conditions (temperature, humidity, precipitation, light) and temperature is the main factor in these plants (Butola and Malik, 2012).

Karaman Ermenek District is the gateway between Central Anatolia and Mediterranean Regions in terms of both geography and climate; According to Davis's (1965 - 1988) grid system for Turkey, it enters the C4 square. 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; TUBİVES, 2011; Maral and Kırıcı, 2018).

In this study, it was aimed to determine the yield potential, essential oil content and essential oil components of *O. dubium* samples collected at different altitudes in the conditions of Ermenek district of Karaman and Adana.

MATERIALS and METHODS

Plant material and experimental location

Plant materials from *O. dubium* were collected from five different altitudes (467, 1096, 1331, 1332 and 1478 m, plant IDs 23, 11, 29, 30 and 26 respectively) during its flowering stage in July 2012 from Ermenek (Southern part of Turkey). Plants were described by Prof. Dr. Necattin Türkmen, Prof. Dr. Rüştü Hatipoğlu and Prof. Dr. Saliha Kırıcı. In March and April 2014, samples were taken from the previously identified plants. The ones rooted in the violins were planted on the trial site in Ermenek on 14.04.2014 and on the test site in Adana on 23.06.2014.

Climatic Properties of Ermenek Trial Area

Climate data for 2014, 2015 and 2016 years of the trial are given in Table 2. In general, the Ermenek climate belongs to the subtype of Mediterranean-influenced climates (Mediterranean transitional climate). The average annual temperature is between 0.5-24.6 °C. The coldest month is January. The average annual rainfall is 564 mm.

Climate Characteristics of the Trial Area in Adana

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. The Climate data of the experiment are given in Table 1.

Soil Properties of the Experimental Area in Ermenek

Some physical and chemical properties of soils in the area where the experiment is carried out are given in Table 2. 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 1 Some Important Climate Data for 2014, 2015, 2016 and Long Years
Çizelge 1. 2014, 2015, 2016 ve Uzun Yıllara Ait Bazı Önemli İklim Verileri

Ermenek		Months												
Climate Factor	Year	1	2	3	4	5	6	7	8	9	10	11	12	Av.
Av. 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
	Av. (2012-2016)	2.3	4.7	6.9	11.4	15.4	19.7	23.5	24.0	19.6	14.0	8.9	4.2	12.9
													Total	
Precip. 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
	Av. (2012-2016)	60.0	44.4	41.9	22.7	47.9	19.9	4.35	9.2	5.6	36.6	27.0	74.1	394
Adana														Av.
Av. 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	19.9
	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	20.0
	Long Year	9.6	10.5	13.5	17.5	21.7	25.6	28.1	28.4	25.9	21.3	15.4	11.2	19.0
													Total	
Precip. mm	2015	108	122	135.1	21.5	65.7	4.8	0.40	10.9	130	32.1	10.5	0.6	641.
	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
	Long Year	110	84.2	66.8	55.2	47.3	20.0	7.1	5.2	15.8	40.7	73.7	128.7	654

Source: Regional Directorate of State Meteorology

Table 2. Some Physical and Chemical Properties of Ermenek Site
Çizelge 2. Ermenek Deneme Alanının Bazı Fiziksel ve Kimyasal Özellikleri

Depth (cm)	texture			pH	Salt	Lime	P_2O_5	K_2O	Fe	Zn	Mn	Cu
	Sand (%)	Plate (%)	Clay (%)			%	kg/da		mg/kg			
0-30	46.0	25.5	28.5	7.56	0,17	63.1	5.9		3.3	0.6	2.2	0.8

Soil Properties of the Trial Area in Adana

The area of the trial area is the enticolites formed by very young alluvial deposits brought by the Seyhan River Side Rivers. Her breathing is moderate to profound. There are only A and C horizons. The territory where the experiment is established is usually loamy. Some physical and chemical properties of soils in the area where the experiment is carried out are given in Table 3.

Table 3. Some Physical and Chemical Properties of Experimental Ground Soils
Çizelge 3. Adana Deneme Alanının Bazı Fiziksel ve Kimyasal Özellikleri

depth (cm)	pH	Salt (%)	P_2O_5	KDK	K_2 -)	N 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

Treatments, harvesting and records

The places where *O. dubium* plants can be found in the Ermenek flora were determined according to Flora of Turkey (Davis, 1982). In March and April 2014, 10 cm long steels were taken from the previously determined altitudes. Plants rooted in viols were spoiled in the

trial field in Adana and Ermenek. Planting and harvest dates of plants are given in Table 4. The experiment was set up in rows at a distance of 40 x 60, with 15 plants from each sample. The trial area was taken 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 due to the lack of flowering due to late planting in 2014. The plants were cuttings from 8-10 cm surface and weighed for yield calculation. After harvesting, the essential oils were extracted using a neo-Clevenger type apparatus after the plants were dried in the shade.

At the harvest, all plants were determined plant height (cm), number of branches (number/plant), fresh and dry herbage weight (g/plant), dry leaf weight (g/plant), essential oil content and component.

Table 4. Planting and Harvesting Dates of Plants in Adana and Ermenek.
Çizelge 4. Adana ve Ermenek'teki Bitkilerin Dikim ve Hasat Tarihleri

Type Id (Altitude)	Ermenek				Adana		
	Date of Planting	Harvest Date			Date of Planting	Harvest Date	
		2014	2015	2016		2015	2016
11 (1096 m)	14.04.2014	13.06	28.06	14.06	23.06.2014	28.05	16.05
23 (467 m)		17.06	21.07	10.06		17.06	16.05
26 (1478 m)		28.05	15.06	08.06		28.05	12.05
29 (1331 m)		21.06	27.06	18.06		10.06	18.05
30 (1332 m)		15.06	28.06	10.06		02.06	16.05

Isolation of essential oils

To isolate the essential oil, 40 g of dried herb was extracted with 500 ml of distilled water with a neo-Clevenger type apparatus. Hydro-distillation was carried out for 3 hours. The essential oils obtained were dried over anhydrous sodium sulfate and stored at +4 ºC in amber colored bottles (Turkmen and Mert 2020).

GC-MS Analyses

Analysis of the essential oils carried out by using Thermo Scientific Focus Gas Chromatograph equipped with MS, auto sampler and TR-5MS (5% Phenyl Polysilphenylene-siloxane, 0.25 mm x 30 m 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, the injection port temperature was 220 °C. The samples were injected with 250 split ratio. The injection volume was 1 µl. Oven temperature was programmed in the range of 50 to 220 °C at 3 °C min^{-1}. The structure of each compound was identified by comparison with their mass spectrum (Wiley9). The data were handled using Xcalibur software program (Maral et al. 2017).

Statistical analysis

The mean, minimum, maximum and standard deviation values for individual characteristics were determined using the SPSS package program.

RESULTS and DISCUSSION

Plant Height

The first-year average plant height of the plants grown in Ermenek varied between 22.13 - 42.08 cm, the average was 34.53 cm, and the highest plant height was taken as 42.08 cm in sample number 30. The second-year averages varied between 22.50-52.25 cm, the average was 38.85 cm and the highest plant height reached 52.25 with the sample 23. In the third year, average plant height varied between 24.22-60.27 cm, with an average of 47.71 cm, and the highest plant height was obtained in sample 26 with 60.27 cm (Table 5). For the Ermenek location, samples 23, 26 and 30 showed superior characteristics in terms of plant height compared to the others.

The average plant height of the plants growing in Adana varied between 35.66 -45.22 cm in the first year, with an average of 41.62 cm. The highest plant height was taken from sample 11 with 45.22 cm. In the second year, the highest plant height was taken from sample 30 with 55.4 cm. The lowest plant height was 36.33 cm from sample 23 (Table 5). For the Adana location, samples 11 and 30 showed superior characteristics compared to the others.

In terms of plant height, sample number 23 shows superior characteristics in the Ermenek location, samples numbered 11, 26 and 29 show superior characteristics in the Adana location. The sample number 30 was similar in both locations.

Turgut et al. (2017) reported that the plant height of *O. dubium* varied between 37.18 cm and 72.60 cm, while the average plant height was determined as 51.27 cm. As a result of our research, average plant

height average values obtained in Adana were longer than in the first year in the second year. This situation is in parallel with the above study. The mean plant height values obtained in Ermenek were lower than Turgut et al. (2017). It is thought that this situation is related to the height of the places where plants grow at sea level. Turgut et al. (2017) conducted their study at an altitude of 33 m above sea level, while this study was conducted at an altitude of 1250 m above sea level. It is thought that above sea level shortening of the plant height because of the increasing sunshine intensity.

Table 5. Plant Height of O. dubium Grown in Ermenek and Adana
Çizelge 5. Ermenek ve Adana'da Yetiştirilen O. dubium Örneklerinin Bitki Boyu

Plant ID Altitude		Ermenek				Adana		
		2014	2015	2016	Average	2015	2016	Average
11 (1096 m)	Min.	14	14	18		35	40	
	Max.	45	30	31		58	62	
	Av.	22.13	22.50	24.22	22.95	45.22	48.36	46.79
		n=8	n=8	n=8		n=4	n=4	
	SD	±9.20	±6.0	±5.86		±9.53	±9.03	
23 (467 m)	Min.	25	38	38		25	29	
	Max.	72	72	74		51	46	
	Av.	38.2	52.25	52.60	47.68	35.66	36.33	35.99
		n=8	n=8	n=8		n=13	n=13	
	SD	±6.0	±12.78	±14.51		±13.61	±8.73	
26 (1478 m)	Min.	16	18	44		42	47	
	Max.	49	52	71		47	55	
	Av.	36.56	38.60	60.27	45.14	44.50	51.0	47.75
		n=9	n=10	n=10		n=8	n=8	
	SD	±9.97	±11.29	±7.74		±10.40	±11.88	
29 (1331 m)	Min.	28	26	39		36	40	
	Max.	36	44	56		44	53	
	Av.	32.67	34.60	46.50	37.92	40.67	45.0	42.83
		n=10	n=10	n=8		n=8	n=8	
	SD	±4.16	±5.77	±6.41		±4.16	±7.0	
30 (1332 m)	Min.	33	42	50		33	35	
	Max.	41	53	62		58	68	
	Av.	42.08	46.33	55.00	47.80	42.08	55.4	48.74
		n=13	n=13	n=13		n=13	n=10	
	SD	±6.58	±5.85	±5.03		±6.58	±12.06	
	Average	34.53	38.86	47.72	40.37	41.63	47.22	44.42

n: Number of plants, SD: Standard Deviation

Number of Branches

While the average number of branches of plants grown in Ermenek varies between 9.13 and 17.15 number per plant in the first year, the average is 12.54 numbers per plant. The highest number of branches was obtained from sample 30 with 17.15 numbers per plant. In the second year, the average number of branches varied between 9.75-30.13 numbers per plant and the average was 18.43 numbers per plant. The highest number of branches was taken from sample 23 with 30.13 numbers per plant. In the third year, the average number of branches varied between 18.56-31.80 numbers per plant and the average was 25.85 numbers per plant. The highest number of branches was obtained from sample 23 with 31.80 numbers per plant (Table 6). In terms of the number of branches per plant, samples numbered 30 in the first year and 23 in the second and third years reached higher values.

The average number of branches per plant of the plants growing in Adana varied between 9.66-19.38 numbers per plant in the first year and the average was 14.62 numbers per plant. The highest number of branches was taken from sample 30 with 19.38. In the second year, the number of branches varied between 11.0 and 31.0 numbers per plant, with an average of 20.58 numbers per plant. The highest number of branches was taken from sample 30 with 31.0 numbers per plant (Table 6). In terms of the number of branches per plant, the sample number 30 reached the highest values.

Samples 23 and 29 in Ermenek and Samples 11 and 26 reached the higher number of branches in Adana. Sample 30 had similar values at both locations.

Turgut et al. (2017) reported that the number of branches of *O. dubium* in the plant ranged from 12.9

to 54.67, with an average of 31.73. The results of the 1st and 2th year results obtained by Turgut et al. (2017), the results of the third year showed similarity.

Table 6. Number of Branches of O. dubium Grown in Ermenek and Adana
Çizelge 6. Ermenek ve Adana'da Yetiştirilen O. dubium Örneklerinin Bitkideki Dal Sayısı

Plant ID Altitude		Ermenek				Adana		
		2014	2015	2016	Average	2015	2016	Average
11 (1096 m)	Min.	4	4	8		9	11	
	Max.	14	15	30		16	17	
	Av.	9.13	9.75	18.56	12.48	12.25	13.75	13.0
		n=8	n=8	n=8		n=4	n=4	
	SD	±3.13	±3.69	±7.66		±2.98	±2.50	
23 (467 m)	Min.	4	5	12		4	8	
	Max.	28	56	66		18	14	
	Av.	13.8	30.13	31.80	25.24	9.66	11.0	10.33
		n=8	n=8	n=8		n=13	n=13	
	SD	±12.13	±9.34	±8.91		±7.37	±3.0	
26 (1478 m)	Min.	6	6	12		17	21	
	Max.	16	18	38		18	34	
	Av.	10	11.30	26.91	16.07	17.50	27.50	22.5
		n=9	n=10	n=10		n=8	n=8	
	SD	±3.20	±4.24	±8.92		±8.58	±10.47	
29 (1331 m)	Min.	9	15	21		11	18	
	Max.	18	31	43		18	22	
	Av.	12.67	22.30	29.25	21.40	14.33	19.67	17.0
		n=10	n=10	n=8		n=8	n=8	
	SD	±4.72	±5.20	±6.40		±3.51	±2.08	
30 (1332 m)	Min.	6	16	14		6	12	
	Max.	37	23	27		37	46	
	Av.	17.15	18.67	22.75	19.52	19.38	31.0	25.19
		n=13	n=13	n=13		n=13	n=10	
	SD	±9.50	±3.78	±5.96		±8.91	±10.80	
	Average	12.55	18.43	25.85	18.94	14.62	20.58	17.60

n: Number of plants, SD: Standard Deviation

Fresh Herb Weight

The fresh herb weights of plants growing in Ermenek in the first year varied between 18.0-118.9 g and the average was 60.37 g. The highest weight of 118.9 g was obtained from sample 30. Fresh herb weights of other samples were measured as 84.40, 48.56, 32.0 and 18 g, sample 23, 26, 29 and 11 respectively. In the second year, fresh herb weights varied between 19.75-160.5 g and the average was 95.23 g. The highest weight was taken from sample 23 with 160.5 g. The weights of the other samples were determined as Sample 30 (145.7 g), Sample 29 (99.9 g), Sample 26 (50.30 g), and Sample 11 (19.75 g). In the third year, the average fresh herb weights varied between 24.22-185.7 g and the average was 143.96 g. While the highest fresh herb weight was obtained from sample 30 with 185.7 g, sample 23 with 178.1 g, sample 26 with 168.8 g, sample 29 with 163.0 g and sample 11 with 24.22 g followed (Table 7). In terms of fresh herb weight, samples 30 and 23 reached the highest values.

Fresh herb weights of the plants grown in Adana in the first year varied between 35.50 - 118.9 g, and the average was 72.64 g. While the highest plant weight was obtained from sample 30 with 118.9 g, sample 26 with 109.5 g, sample 29 with 66.67 g, sample 11 with 35.50 g and sample 23 with 32.67 g followed it. In the second year, the average plant weight varied between 36.75-242.1 g and its average was 129.67 g. Sample 30 reached the highest plant weight with 242.1 g, followed by sample 26 with 195.5 g and sample 29 with 131.7 g. The lowest fresh herb weight was obtained from sample 11 with 36.75 g (Table 7). In terms of fresh herb weight, sample 30 reached the highest value.

In terms of fresh herb weight, sample number 23 and 30 reached higher fresh herb weight in Ermenek and sample number 30 in Adana. Sample 29 had similar values.

Turgut et al. (2017), *O. dubium* biomass yield, volatile oil content and carvacrol in their study to determine the ratio of fresh herb per plant yield between 41.93 and 185.44 g reported that the average is 94.05 g. When the results of the study were compared with the previous studies, the average values obtained in Ermenek for the first year were lower, the values for

the second year were similar and the values for the third year were higher. According to the values obtained in Adana, the lower value (32.67 g) obtained in this study was lower and the upper value (242.10 g) was higher.

Table 7. Fresh Herbage Weight of O. dubium Grown in Ermenek and Adana
Çizelge 7. Ermenek ve Adana'da Yetiştirilen O. dubium Örneklerinin Taze Herba Ağırlığı

Plant ID Altitude		Ermenek				Adana		
		2014	2015	2016	Average	2015	2016	Average
11 (1096 m)	Min.	10	10	11		23	30	
	Max.	32	41	44		45	47	
	Av.	18	19.75	24.22	20.65	35.50	36.75	36.12
		n=8	n=8	n=8		n=4	n=4	
	SD	±2.82	±10.95	±10.77		±10.01	±7.41	
23 (467 m)	Min.	36	30	58		21	34	
	Max.	240	368	375		44	52	
	Av.	84.40	160.5	178.1	141.0	32.67	42.33	37.5
		n=8	n=8	n=8		n=13	n=13	
	SD	±8.30	±5.39	±12.79		±11.50	±9.07	
26 (1478 m)	Min.	8	8	58		102	126	
	Max.	102	111	317		117	265	
	Av.	48.56	50.30	168.8	89.22	109.5	195.5	152.5
		n=9	n=10	n=10		n=8	n=8	
	SD	±4.96	±8.32	±9.37		±10.40	±7.70	
29 (1331 m)	Min.	19	61	41		47	97	
	Max.	47	139	296		82	178	
	Av.	32	99.9	163	98.30	66.67	131.7	99.18
		n=10	n=10	n=8		n=8	n=8	
	SD	±14.10	±5.21	±7.0		±7.89	±4.74	
30 (1332 m)	Min.	40	103	111		40	41	
	Max.	216	220	286		234	401	
	Av.	118.9	145.7	185.7	150.1	118.9	242.1	180.5
		n=13	n=13	n=13		n=13	n=10	
	SD	±7.84	±6.60	±7.23		±7.84	±12.64	
	Average	60.37	95.23	143.96	99.85	72.65	129.68	101.16

n: Number of plants, SD: Standard Deviation

Dry Herb Weight

The average dry herb weights of the plants grown in Ermenek in the first year varied between 9.88-52.08 g and the average was 25.5 g. Sample 30 reached the highest dry herb weight with 52.08 g, followed by sample 23 with 30.4 g, sample 26 with 19.56 g, sample 29 with 13.33 g and sample 11 with 9.88 g. Second-year averages varied between 11.50 and 71.33 g, with an average of 35.84 g. While the highest plant weight was taken from sample 30 with 71.33 g, the lowest weight was taken from sample 11 with 11.50 g. In the third year, dry herb weights varied between 15.33-115.5 g and the average was 69.72 g. The highest dry herb weight was obtained from sample 23 with 115.5 g, followed by sample 30 with 78.0 g, sample 29 with 74.13 g, sample 26 with 65.64 g and sample 11 with 15.33 g (Table 8). In terms of dry herb weight, samples 23 and 30 reached the highest value similar to fresh herb weight.

The average dry herb weights of the plants grown in Adana varied between 19.33 - 54.85 g in the first year and the average was 34.37 g. The highest dry herb weight was obtained from sample 30 (54.85 g), followed by sample 26 (44.0 g), sample 29 (32.67 g), sample 11 (21.0 g) and sample 23 (19.33 g). In the second year, the average dry herb weight varied between 20.0-105.7 g and the average was 61.63 g. The highest dry herb weight was obtained from sample 30 with 105.7 g, followed by sample 26 with 89.50 g, sample 29 with 67.33 g, sample 23 with 25.66 g and sample 11 with 20.0 g (Table 8). In terms of dry herb weight, sample number 30 reached the highest value as in fresh herb weight.

In terms of dry herb weight, sample number 23 was superior in Ermenek and samples number 11, 26, 29 and 30 were superior in Adana.

Butola and Malik (2012), emphasize that the cultivation of medicinal plants is necessary for the sustainable use of plants in the long term and that they will exhibit qualitative and quantitative changes in the morphological and biochemical properties of plants during ex-situ conditions. They stated that the changes

in the phenological characteristics of the plants such as morphological, flowering and maturation were caused by the change of environmental conditions (temperature, humidity, rainfall, light) and that temperature was the main factor in these plants.

Turgut et al. (2017) reported that the yield of dry herb per plant of *O. dubium* ranged from 21.64 to 95.52 g, with an average of 50.39 g. While the results obtained in Adana were similar to the above study, the dry herb yield values obtained in the 1st and 2nd years of the experiment in Ermenek were lower compared to the above study and 3rd year results were higher.

Table 8. Dry Herbage Weight of O. dubium Grown in Ermenek and Adana
Çizelge 8. Ermenek ve Adana'da Yetiştirilen O. dubium Örneklerinin Kuru Herba Ağırlığı

Plant ID Altitude		Ermenek				Adana		
		2014	2015	2016	Average	2015	2016	Average
11 (1096 m)	Min.	6	6	4		12	16	
	Max.	16	22	33		31	28	
	Av.	9.88	11.50	15.33	12.23	21.0	20.0	20.5
		n=8	n=8	n=8		n=4	n=4	
	SD	±3.72	±5.50	±10.22		±9.41	±5.47	
23 (467 m)	Min.	11	11	20		16	18	
	Max.	85	83	363		25	33	
	Av.	30.4	34.88	115.5	60.26	19.33	25.66	22.49
		n=8	n=8	n=8		n=13	n=13	
	SD	±31.14	±25.99	±15.67		±4.93	±7.50	
26 (1478 m)	Min.	4	4	27		40	58	
	Max.	40	48	124		48	121	
	Av.	19.56	22.20	65.64	35.80	44.0	89.50	66.75
		n=9	n=10	n=10		n=8	n=8	
	SD	±13.15	±13.14	±33.59		±5.88	±31.13	
29 (1331 m)	Min.	8	24	40		19	54	
	Max.	19	52	102		41	81	
	Av.	13.33	39.30	74.13	42.25	32.67	67.33	50.0
		n=10	n=10	n=8		n=8	n=8	
	SD	±5.50	±8.19	±20.97		±11.93	±13.50	
30 (1332 m)	Min.	18	49	49		19	16	
	Max.	104	108	108		115	176	
	Av.	52.08	71.33	78	67.13	54.85	105.7	80.27
		n=13	n=13	n=13		n=13	n=10	
	SD	±9.47	±32.0	±24.50		±30.55	±54.18	
	Average	25.05	35.84	69.72	43.54	34.37	61.64	48.0

n: Number of plants, SD: Standard Deviation

Dry Leaf Weight

The average dry leaf weight of the plants grown in Ermenek in the first year varied between 6.75-25.85 g, and the average was 14.38 g. The highest dry weight was obtained from sample 30 with 25.85 g, followed by sample 23 with 18.4 g and sample 29 with 10.67 g. The lowest leaf weight was taken from example 11 with 6.75 g. In the second year, the average leaf weight varied between 7.75 - 35.33 g and the average was 20.57 g. The highest dry leaf weight was obtained from sample 30 with 35.33 g. The lowest weight was taken from example 11 with 7.75 g. In the third year, the average dry leaf weight varied between 9.11-62.20 g and the average was 40.44 g. While the highest weight was obtained from sample 23 with 62.20 g, sample 29 with 47.63 g, sample 30 with 42.0 g, and sample 26 with 41.27 g followed it. The lowest dry leaf weight was obtained from example 11 with 9.11 g (Table 9). In terms of dry leaf weight, samples number 30 and 23 performed better.

The average dry leaf weight of the plants grown in Adana in the first year varied between 12.70 - 40.69 g, and the average was 24.76 g sample 30 reached the highest dry leaf weight with 40.69 g, followed by 32.50 g sample 26, 23.67 g sample 29, 14.25 g sample 11 and 12.70 g sample 23, respectively. In the second year, dry leaves averages ranged from 14.80 to 70.50 g, while the average was 36.89 g. Sample 30 reached the highest leaf weight with 70.50 g, followed by sample 26 with 47.50 g, sample 29 with 36.33 g, sample 23 with 15.33 g and sample 11 with 14.80 g (Table 9). In terms of dry leaf weight, sample number 30 performed better.

Table 9. Dry Leaf Weight of O. dubium Grown in Ermenek and Adana
Çizelge 9. Ermenek ve Adana'da Yetiştirilen O. dubium Örneklerinin Kuru Yaprak Ağırlığı

Plant ID Altitude		Ermenek				Adana		
		2014	2015	2016	Average	2015	2016	Average
11 (1096 m)	Min.	4	4	2		8	11	
	Max.	11	17	18		21	21	
	Av.	6.75	7.75	9.11	7.87	14.25	14.80	14.52
		n=8	n=8	n=8		n=4	n=4	
	SD	±2.65	±4.30	±6.50		±6.23	±4.57	
23 (467 m)	Min.	7	8	13		10	10	
	Max.	47	45	191		17	21	
	Av.	18.4	21.50	62.20	34.03	12.70	15.33	14.01
		n=8	n=8	n=8		n=13	n=13	
	SD	±16.96	±13.77	±9.72		±3.78	±5.50	
26 (1478 m)	Min.	3	3	18		29	33	
	Max.	21	21	77		36	62	
	Av.	10.22	11.50	41.27	17.16	32.50	47.50	40.0
		n=9	n=10	n=10		n=8	n=8	
	SD	±5.69	±5.29	±19.08		±6.02	±12.39	
29 (1331 m)	Min.	6	17	28		15	31	
	Max.	11	36	62		30	43	
	Av.	10.67	26.80	47.63	28.36	23.67	36.33	30.0
		n=10	n=10	n=8		n=8	n=8	
	SD	±4.50	±5.92	±10.80		±7.67	±6.11	
30 (1332 m)	Min.	9	25	28		14	12	
	Max.	52	62	57		82	117	
	Av.	25.85	35.33	42	34.39	40.69	70.50	55.59
		n=13	n=13	n=13		n=13	n=110	
	SD	±12.87	±14.97	±11.91		±21.86	±13.58	
	Average	14.38	20.58	40.44	25.13	24.76	36.89	30.82

n: Number of plants, SD: Standard Deviation

In terms of dry leaf weight, sample number 23 was superior in Ermenek and samples number 11, 26, 29 and 30 were superior in Adana.

Turgut et al. (2017) reported that dry leaf yield per plant of *Origanum dubium* ranged from 14.80 to 48.77 g, with an average of 26.99 g. When we look at the dry leaf weights obtained in Ermenek, the dry leaf yield values of only sample 11 were lower and the other samples 23, 26, 29 and 30 were higher. When we look at the values obtained in Adana, the dry leaf yield values of only sample 23 were lower and the other samples 11, 26, 29 and 30 had higher values.

Essential Oil Content

The essential oil content of the plants cultivated in Ermenek varied between 2.06-5.58% in the first year and the average was 4.52%. Sample 30 had the highest essential oil content with 5.58%. In the second year, essential oil contents varied between 1.20% and 8.20% and its average was 4.71%. While the highest essential oil content was taken from sample 11 with 8.20%. In the third year, the average of essential oil contents varied between 4.32-8.0% and the average was 6.06%. Sample 30 reached the highest essential oil content with 8.0% (Table 10). In terms of essential oil content, samples 30 and 11 performed better.

The essential oil contents of the plants cultivated in Adana varied between 2.26-6.54% in the first year and the average was 3.83%. In the Adana location, the highest essential oil content was obtained from sample 30 with 6.54%. In the second-year the averages changed between 4.26% and 7.84% and the average was 5.98%. The highest essential oil content was obtained from sample 11 with 7.84% (Table 11). In terms of essential oil content, samples 30 and 11 performed better.

When Ermenek and Adana locations are compared in terms of average values of essential oil content; Samples 23 and 26 in Ermenek and Samples 11, 29 and 30 in Adana reached higher essential oil content.

However, samples 11 and 30 performed better at both locations.

Turgut et al. (2017) According to the *O. dubium* essential oil content ranged between 6-9%, the average was 7.36%. The results of the essential oil in Ermenek compared to the study of the aforementioned researchers in the second year of sample 11 (8.20%), in

Table 10 Essential Oil Components of O. dubium Plants Cultured in Ermenek for 2014, 2015 and 2016 (%)
Çizelge 10. Ermenek'te Kültürlenen O. dubium Bitkilerinin Uçucu Yağ Bileşenleri (%)

		2014					2015					2016				
Essential Oil Content		5.00	5.16	4.80	2.06	5.58	8.20	4.60	6.80	2.75	1.20	4.76	7.94	5.28	4.32	8.0
RT	Components	11 1096 m	23 467 m	26 1478 m	29 1331 m	30 1332 m	11 1096 m	23 467 m	26 1478 m	29 1331 m	30 1332 m	11 1096 m	11 1096 m	23 467 m	26 1478 m	29 1331 m
3.41	α-Pinene	0.29	0.54	0.34	1.07	0.77	0.22	0.44	0.39	0.34	0.68	nd	0.47	0.27	0.54	0.47
3.46	α-phellandrene	0.11	1.13	0.81	1.44	1.58	nd	0.94	0.94	0.56	1.52	nd	0.96	0.58	0.96	1.14
4.04	Camphene	0.12	0.12	nd	0.40	0.16	nd	nd	nd	nd	0.16	nd	0.11	nd	0.16	nd
5.98	Myrcene	nd	1.43	0.77	0.99	1.58	nd	1.18	0.90	0.61	1.06	nd	1.15	0.56	1.00	1.05
6.01	ß-Pinene	0.34	0.10	nd	0.18	0.16	0.27	0.27	0.13	nd	0.14	nd	nd	nd	nd	0.16
6.36	α-Terpinene	0.28	1.62	0.74	2.18	1.53	0.18	1.22	0.84	0.57	1.20	nd	1.28	0.60	1.11	1.02
6.81	D-Limonene	nd	0.16	nd	0.34	0.19	nd	0.19	nd	nd	0.14	nd	0.15	nd	0.14	0.11
7.04	Eucalyptol	0.22	0.23	nd	0.26	0.30	0.11	0.31	0.11	nd	0.33	0.13	0.13	nd	0.13	0.13
8.18	γ-terpinene	0.39	8.90	3.04	7.55	5.86	0.28	7.64	3.72	4.88	5.02	0.16	7.27	2.92	8.40	4.12
8.96	P-cymene	2.25	6.02	2.61	44.8	7.41	1.21	5.64	3.11	5.28	5.21	0.33	4.72	1.90	6.62	3.66
14.86	Linalooloxide	nd	nd	0.34	nd	nd	nd	nd	nd	nd	nd	0.32	nd	nd	0.14	nd
15.76	Sabinenehydrate	0.15	0.59	0.12	0.13	0.96	0.21	0.48	0.40	nd	0.41	0.30	0.37	nd	nd	0.67
18.83	4-Thujanol	nd	nd	0.12	nd	0.30	nd	0.16	0.11	0.13	0.12	nd	0.13	0.28	0.60	0.14
19.07	Linalool	50.9	0.15	21.5	0.26	0.38	62.0	0.24	27.7	0.14	0.15	66.1	0.16	27.8	1.12	0.14
20.31	Caryophyllene	0.12	0.27	0.20	0.60	0.12	0.17	0.25	0.31	0.79	0.22	0.12	0.22	0.28	0.82	0.13
20.83	4-Terpeneol	0.29	0.44	0.30	1.19	0.64	0.19	0.41	0.30	nd	0.66	nd	0.37	0.13	0.27	0.27
20.98	Thymolmethylether	nd	0.24	nd	0.19	nd	nd	0.27	nd	nd	nd	nd	0.17	nd	0.17	nd
24.38	Isoborneol	0.47	0.38	0.27	0.59	0.41	0.23	nd	nd	0.27	nd	0.21	0.43	nd	0.32	nd
40.80	Thymol	nd	nd	2.25	1.17	1.57	nd	nd	2.25	nd	nd	nd	nd	0.23	nd	0.30
40.79	Carvacrol	43.1	76.7	65.6	34.7	75.1	33.3	79.1	58.4	84.4	81.5	30.7	80.9	63.0	76.6	85.3
	Total (%)	99.0	99.0	99.0	97.9	99.0	98.4	98.7	99.6	97.9	98.5	98.3	99.0	98.6	99.1	98.8
	Number of Compounds	14	17	15	18	18	12	16	15	11	16	9	17	12	17	16

Table 11. Essential Oil Components of O. dubium Plants Cultured in Adana for 2015 and 2016
Çizelge 11. Adana'da Kültürü Yapılan O. dubium Bitkilerinin Uçucu Yağ Bileşenleri

		2015					2016				
Essential Oil Content		4.40	3.35	2.26	2.60	6.54	7.84	6.08	4.26	4.92	6.83
RT	Components	11 1096 m	23 467 m	26 1478 m	29 1331 m	30 1332 m	11 1096 m	23 467 m	26 1478 m	29 1331 m	30 1332 m
3.41	α-Pinene	0.42	0.55	0.72	0.56	0.70	0.47	0.52	0.41	0.53	0.53
3.47	α-phellandrene	0.80	0.92	1.32	0.55	1.37	0.82	0.91	0.70	0.89	0.93
4.04	Camphene	0.12	0.14	0.12	0.25	0.12	0.13	0.11	nd	0.15	0.13
4.76	ß-pinene	nd	0.11	0.15	0.11	0.13	nd	0.11	nd	nd	0.10
6.01	Myrcene	0.86	1.05	1.23	0.60	1.31	0.95	1.02	0.84	0.91	1.07
6.36	α-Terpinene	1.17	1.34	0.90	0.81	1.25	1.13	1.34	0.73	0.91	1.31
6.85	D- Limonene	nd	0.20	0.16	0.16	0.18	0.13	0.16	nd	0.13	0.15
7.04	Eucalyptol	0.15	0.42	0.49	nd	nd	0.12	0.17	0.37	nd	0.16
7.09	Sabinene	nd	nd	nd	0.12	0.25	0.11	0.22	nd	0.11	0.13
8.18	γ-terpinene	2.26	6.91	2.59	3.38	4.83	5.52	6.69	2.37	6.94	6.65
8.96	P-cymene	1.14	4.25	5.20	17.2	6.18	4.83	4.44	3.19	6.42	5.09
15.76	cis-Sabinene hydrate	0.66	0.83	1.04	nd	0.17	0.71	nd	0.62	0.40	0.69
18.82	4-Thujanol	nd	nd	nd	nd	nd	nd	0.80	nd	0.11	nd
19.07	Linolool	10.3	0.23	nd	0.18	0.10	13.9	nd	nd	nd	nd
20.31	Caryophyllene	0.18	nd	nd	0.27	0.11	nd	nd	nd	0.75	nd
20.84	4-Terpineol	0.41	0.34	1.00	0.79	0.43	0.33	0.32	0.31	0.23	0.37
24.41	Isoborneol	0.12	0.71	nd	0.49	0.31	0.42	nd	nd	0.29	0.37
40.83	Thymol	nd	nd	0.41	nd	nd	nd	nd	0.60	nd	nd
41.62	Carvacrol	80.3	80.9	83.6	72.8	80.9	69.3	81.7	88.4	79.8	81.0
	Total (%)	99.0	98.9	99.0	98.4	98.4	98.9	98.5	98.6	98.5	98.7
	Number of Compounds	14	15	14	15	16	15	14	11	15	15

the third year of sample 23 (7.94%), in the second year of sample 26 (6.80%) and in sample 30 of sample 3. Similar results were obtained in (8.0%) and lower values were obtained in other samples. Results of the study in Adana have lower values. Tınmaz et al. (2002), although it seems that the percentage of essential oil decreased by the cultivation of plants, the amount of essential oil increased in most of the plants transferred from the natural environment to the culture medium, but that the decrease in the essential oil of some populations was due to the differences in the vegetation period of the samples taken from the natural environment.

Essential Oil Components

In the study, the values of the essential oil components (%) of *O.dubium* samples taken from the natural flora collected in the Ermenek district of Karaman are given in Table 10.

When the essential oil components of Sample 11 were examined, linalool was the highest in the first year with 50.9%, followed by carvacrol with 43.1% and p-cymene with 2.25%. In the second year, the highest rate was linalool with 62.0%, carvacrol with 33.3% and p-cymene with 1.21%. In the third year, the highest value was linalool with 66.1%, followed by carvacrol with 30.7% and p-cymene with 0.33%. Compared to its natural form, an increase in linalool ratio and a decrease in carvacrol ratio were observed.

Sample 23, the highest percentage of essential oil components in the first year was carvacrol, γ-terpinene and p-cymene (76.7%, 8.90% and 6.02% respectively). The second-year carvacrol ratio was 79.1%, the γ-terpinene ratio was 7.64% and the p-cymene ratio was 5.64%. 3. year carvacrol 80.9%, γ-terpinene 7.27% and p-cymene was determined as 4.72% compared with the natural form of carvacrol ratio increased, linalool, γ-terpinene and p-cymene ratio decreased.

In the essential oil of sample 26, the main component was carvacrol with 65.6%, linalool with 21.5%, γ-terpinene with 3.04% and p-cymene with 2.61%. In the second year, carvacrol ratio was 58.4%, linalool ratio was 27.7%, γ-terpinene ratio was 3.72 and p-cymene ratio was 3.11%. In the third year, the main components were carvacrol, linalool, γ-terpinene and p-cymene (63.0%, 27.8%, 2.92% and 1.90% respectively). When compared with its natural form, it is seen that the ratio of carvacrol increases.

Sample 29, the essential oil components in the first year were p-cymene 44.8%, carvacrol 34.7% and, γ-terpinene 7.55%. In the second year, carvacrol ratio was 84.4%, p-cymene ratio was 5.28% and γ-terpinene was 4.88%. The third year carvacrol ratio was 76.6%, the γ-terpinene was 8.40% and the p-cymene ratio was

6.62%. Compared to the natural form, the rate of carvacrol in the first year was lower than in the natural form and higher in the 2nd and 3rd years.

Sample 30, the essential oil components were carvacrol, p-cymene and γ-terpinene (75.1%, 7.41% and 5.86% respectively) in the first year, while carvacrol, p-cymene and γ-terpinene (81.5%, 5.21 and 5.02% respectively) in the second year, and carvacrol, γ-terpinene and p-cymene (85.3%, 4.12% and 3.66% respectively). Compared with the natural form of carvacrol ratio increased linalool, p-cymene and γ-terpinene ratio is seen to decrease (Table 7). As a result; essential oil components of *O. dubium* plants collected from nature and cultivated in Ermenek district of Karaman; Carvacrol, linalool, P-cymene and γ-Terpinene has been (Table 7).

In the study, the values of essential oil components (%) of *O. dubium* samples collected from natural flora collected in Adana are given in Table 11.

When the essential oil components of sample 11 were examined, carvacrol was the highest with 80.34% carvacrol, followed by linalool with 10.37%, γ-terpinene with 2.26% and p-cymene with 1.14%. In the second year, the highest rate was carvacrol with 69.31%, linalool with 13.95%, γ-terpinene with 5.52% and p-cymene with 4.83%. Compared to its natural form carvacrol ratio increased, linalool rate decreased.

Sample number 23, the highest rate of essential oil components in the first year was carvacrol, γ-terpinene and p-cymene (80.96%, 6.91% and 4.25% respectively), while in the second year carvacrol ratio was 81.75% and γ-terpinene ratio was 6.69%. The p-cymene ratio was 4.44%. When compared with its natural form, it is seen that the ratio of carvacrol increases and the ratio of linalool, γ-terpinene and p-cymene decreases.

In the essential oil of sample 26, the main components were carvacrol with 83.64%, p-cymene with 5.20% and γ-terpinene with 2.59%. The second-year carvacrol ratio was 88.47%, the p-cymene ratio was 3.19% and the γ-terpinene ratio was 2.37%. When compared with its natural form, it is seen that the ratio of carvacrol increases and other main components decrease.

Sample 29, the essential oil components for the first year were carvacrol 72.85%, p-cymene 17.28% and γ-terpinene 3.38%. In the second-year, carvacrol ratio was 79.81%, γ-terpinene ratio was 6.94% and p-cymene ratio was 6.42%. The carvacrol ratio was increased and γ-terpinene and p-cymene ratio decreased compared to its natural form.

Sample number 30, the essential oil components were carvacrol, p-cymene and γ-terpinene (80.98%, 6.18% and 4.83 % respectively) in the first year, while the second year was carvacrol, γ-terpinene and p-cymene (81.06, 6.65 and 5.09% respectively). Compared with the natural form of carvacrol ratio increased linalool, p-cymene and γ-terpinene ratio are seen to decrease (Table 8).

As a result, the major components of *O. dubium* essential oil cultured in Adana were Carvacrol, P-cymene, γ-terpinene and linalool (Table 11). Again, as a result of this study, it was determined that the plants grown in Adana had a higher carvacrol ratio than the plants grown in Ermenek. Butola and Malik (2012), stated that the changes in the phenological characteristics of the plants such as morphological, flowering and maturation were caused by the change of environmental conditions (temperature, humidity, rainfall, light) and that temperature was the main factor in these plants. The chemical components of essential oils are affected by many endogenous and exogenous factors. Production of secondary metabolites and their qualities in medicinal and aromatic plants are directly related to various factors such as genetic characteristics, climatic conditions (light, temperature, rainfall, irrigation, soil, height, location, etc.), environment organisms, applied agro-techniques and post-production processing (Soltanbeigi and Sakartepe, 2020). Güneş (2005), in his study, reported that the rate of carvacrol decreased at low temperatures. It can be said that the high carvacrol ratio in plants grown in Adana is related to temperature.

Baser (1994), *Origanum* in a study on the essential components of essential oils vary according to the species, carvacrol, caryophyllene, p-cymene, γ-terpinene, linalool and terpinen-4-ol said that the main component. Mastro (1996) stated that although carvacrol and tymol are the main constituents of the genus essential oil of *Origanum*, some germplases have linalool, terpinen-4-ol and caryophyllene and with these results, there is a wide variability in terms of essential oil composition. Turgut et al. (2017) In their study on *O. dubium* in Antalya, reported that γ-terpinene, p-cymene, myrcene, and thujene were the highest components of carvacrol, respectively. Maral et al. 2017, in their study to determine the chemical composition and antioxidant properties of *O. dubium*, reported that 63.09% of the main component is carvacrol. In this study, the main components of carvacrol, linalool, p-cymene and γ-terpinene were determined in parallel with the above studies.

CONCLUSIONS

This study was conducted to determine the essential oil content and yield potential of *O. dubium* collected at different altitudes from nature in different locations.

In terms of average plant height, samples 23, 26 and 30 stood out in Ermenek, while samples 11 and 30 reached higher plant height in Adana. In particular, sample number 30 showed similar performance in both locations.

For Ermenek, sample 23 stood out in the average number of branches per plant, while the sample number 30 stood out in Adana. As with plant height, sample number 30 reached good values in both locations.

The highest fresh herb weight was obtained in sample 30 for both Ermenek and Adana. Dry leaf weight the average for Ermenek sample 30 had the highest value. For Adana the highest value was obtained in sample number 30.

While the highest dry herb weight was obtained from the sample number 23 in Ermenek, it was obtained in the sample number 30 in Adana.

The average essential oil content for Ermenek the highest rate was taken from sample number 30. For Adana the highest rate was again obtained in sample number 30.

It was determined that the main components of the essential oils of the plants grown in Ermenek were carvacrol; linalool and p-cymene, while for the ones grown in Adana, it was carvacrol.

As a result of the study, samples 23 and 30 for Ermenek conditions stood out among all other *O. dubium* samples examined in terms of agricultural characteristics, while only sample 30 for Adana conditions stood out. In terms of essential oil content, sample number 30 stood out in both locations. *O. dubium* samples showed very good performance in terms of both yield values and essential oil content.

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The authors contributed equally to the article.

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