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HERBAGE YIELD, ESSENTIAL OIL CONTENT AND COMPONENTS OF CULTIVATED AND NATURALLY GROWN *Origanum syriacum*

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Abstract

Origanum spp. is one of the most economically important culinary herbs in the World. Essential oil content, essential oil components and dry leaf color are the most important quality criterion in the oregano market. Origanum syriacum var. bevanii is both gathered from the nature and cultivated under the field condition. This study was conducted to determine herbage yield and quality criterion between cultivated and naturally grown oregano. Compared with non-cultivated wild oregano, cultivated oregano at the first and second harvest had the highest plant height, dry herbage yield in 2011 and 2012. The essential oil content of cultivated and naturally grown oregano varied between 2.9-3.5%, and between 2.4-3.5%, respectively. Essential oil component ratios of cultivated and naturally grown oregano were similar. Main essential oil components were carvacrol, β-terpinene, β-Cymene, α-thujene, β-myrcene and caren in both production type. Cultivated oregano had higher plant height, herbage yield and essential oil content than that of the wild grown oregano. Although there was not a visual difference between leaf color of natural grown and cultivated oregano, cultivated oregano was more homogenous and contains higher amount of essential oil than that of naturally grown oregano to meet quality criterion.

Key words: *Origanum syriacum, herbage yield, essential oil content, essential oil components.*

INTRODUCTION

The genus *Origanum* is broadly grown in wild in Turkey and has 22 species (Ietswaart, 1980; Kokkini, 1997). Turkey is one of the leading countries in the world supplying Mediterranean type of oregano (*Origanum* spp.). This type of oregano is considered as one of the most important spices in the Mediterranean countries (Baser et al., 1992; Baser et al., 1993). Beside the usage as a spice, essential oil of oreganos is utilized in pharmaceutical and cosmetic industries. Antibacterial (Biondi et al., 1993) and antifungal (Paster et al., 1993) actions of the oregano essential oils add extra value for the crop. Vegetative parts of oregano and its biochemical extracts are commonly used in food industry. In addition, the dried herb is also used by the food industry in flavoring of processed foods especially in vegetables, meat products, and condiments. Oregano is well known as the ''pizza herb'' and widely used in the Mediterranean kitchen as fresh and dried flavoring additive.

Origanum syriacum, a perennial herbaceous plant native to the Middle East and Eastern Anatolia, grows in mountainous areas with rocky, calcareous soil. It is very popular culinary herb that has been added to soups, casseroles, sauces, stew, stuffing, eggs, olives, teas, tomato-based dishes, chili and pizza.

The general interest of the market towards oregano is increasing not only for their traditional culinary use but also for the novel demands of the phyto-pharmaceutical sector.

The food and pharmaceutical industries have an increasing demand for homogeneous high quality materials for the standardization of their high quality outputs.

The essential oil and the constituents of *Origanum syriacum* has been intensively studied. It was reported that thymol and carvacrol represent the major constituents of the essential oils of *Origanum* species (Sarer et al., 1982).

The purpose of the present study was to determine essential oil content, composition and some plant parameters of naturally grown and cultivated O*riganum syriacum*.

MATERIALS AND METHODS

Origanum syriacum plants were collected from bottom of Amanos mountains (36°.10'.02" N, 35°.59'.70") in the Eastern Mediterranean region of Turkey. The collected plants were grown in a nursery to screen the superior high yielding genotypes. A high yielding selected genotype was vegetatively propagated by stem cuttings. The rooted cuttings were transferred in 4-row plots, 5 m long with 30 cm intra-row spacing at the experimental field of the Mustafa Kemal University. The experimental design was a randomized complete block with three replications. The crop was fertilized with 75 kg/ha of N and 75 kg/ha of P_2O_5. Drip irrigation was applied during the growing period. The soil of experimental plots was a clay silt loam with pH of 7.4, having 1.1% organic matter, 0.11% total nitrogen content, and water holding capacity of 0.36 cm3. The daily climatic data were recorded by using HOBO weather station, (Onset Computer Corporation, USA). The long-term monthly mean temperatures from January to December were 8.2, 9.6, 13.2, 17.2, 21.2, 24.8, 27.2, 27.7, 25.6, 20.9, 14.0 and 9.4°C, respectively. The long-term monthly mean precipitations from January to December were 172.7, 156.8, 141.3, 101.5, 90.4, 21.9, 21.9, 8.0, 39.8, 74.0, 114.2 and 172.1 mm, respectively.

The wild grown oregano in the bottom of Amanos mountains (36°.10'.02" N, 35°.59'.70") was harvested at the flowering stage to determine yield and quality criterion of wild grown oregano. Second harvest was done in late August when the plans were flowering stage.

The above ground parts of the plants were harvested at the onset of the flowering in the first week of the June for first harvest and late August for second harvest in 2011 and 2012. At harvest, a sample of 10 plants was randomly selected from each plot to determine plant height, dry leaf weight/plant and dry stem weight/plant. Essential oil content, herbage and essential oil yield were determined by harvesting the central two rows of the 4-row plots.

Dry leaves of *O. syriacum*, grown cultivated and wild were subjected to steam distillation for 3 h using a Clevenger type apparatus. Leaves and flowers of harvested plants were separated and dried under shadow. Essential oil was distilled from leaves and the volumetric determination of the essential oil content was carried out under following conditions: Neo-Clevenger apparatus with 500 ml flask. 20g drug, 250 ml water, 2 h distillation time by hydro-distillation. The distillation unit consisted of a retort (boiling flask), a condenser and a decanter (receptive flask). Dry plant leaves were immersed in double their volume of distilled water and boiled. The condensate was collected in the receptive flask, and the oil was removed with a pipette and stored in glass vials. The extracted oils were stored at –20 ºC until gas chromatography-mass spectrometry (GC-MS) analysis.

Analysis of the essential oil was carried out by using Thermo Scientific Focus Gas Choromatograph equipped with MS, auto sampler and TR-5MS (5% Phenyl Polysilphenylene-siloxane, 0.25 mm x 60 m i.d, film thickness 0.25). The carrier gas was helium (99.9%) at a flow rate of 1 mL/min; 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 1μL. Oven temperature was programmed to 50 °C to 220 °C at 3 °C/min. The structure of each compound was identified by comparison of their mass spectrum (Wiley) using the Xcalibur software program. The retention indices (RIs) were calculated for all volatile constituents using a homologous series of n-alkane standard solutions C8-C20 (Fluka, product no. 04070) and C21-C40 (Fluka, product no. 04071).

Color Analysis

The color of dried product was quantified by using a Minolta (CR-400) Chroma meter (Osaka, Japan). The color meter was set to CIE Standard Illuminant C. The dried material was ground and then its color was measured using the ground material color measurement apparatus of the instrument. L*, a*, and b* values were measured to describe three-dimensional color space and interpreted as follows: L* is the brightness ranging from no reflection for black (L=0) to perfect diffuse reflection for white (L=100). The value a* is the redness ranging from negative values for green to positive values for red. The value b* is the yellowness ranging from negative values for blue and positive values for yellow. The data was presented as mean of 10 independent measurements for each treatment.

RESULTS AND DISCUSSION

The climatic data indicate that the mean air temperatures January to December 2011 and 2012 were similar to the long-term mean. The long-term monthly mean precipitations from January to December in 2011 and 2012 was similar and being slightly lower than the multi-year average.

Economically important part of oregano is the vegetative parts, mainly the leaves, and essential oil which are sold in the markets. The measured plant parameters between cultivated and wild grown oregano were given in Table 1, 2, 3 and 4. Plant heights at the first harvest varied between 81.5 and 65.1 cm and 74.4 and 42.6 cm in 2011 and 2012, respectively (Table 1). The highest plant heights were obtained from cultivated oregano due to more availability of water and plant nutrition. At the second harvest, similarly the cultivated oregano had the longest plant height with 58.9 and 45.1 cm in 2011 and 2012, respectively. Lower plant height at the second harvest could be attributable to the high air temperature during the period between the first and the second harvest.

Table 1. Plant height of cultivated and wild grown *Origanum syriacum*

Production type	Plant height (cm)					
	2011			2012		
	I. Harvest	II. Harvest	Mean	I. Harvest	II. Harvest	Mean
Cultivated	81.5 a	58.9 a	70.2 a	75.4 a	45.1 a	60.2 a
Wild grown	56.1 b	26.7 b	41.4 b	42.6 b	21.2 b	31.9 b
LSD 0.05	9.4	6.3	6.0	10.1	7.6	5.2

Table 2. Dry herbage yield of cultivated and wild grown *Origanum syriacum*

Production type	Herbage yield (g/plant)					
	2011			2012		
	I. Harvest	II. Harvest	Mean	I. Harvest	II. Harvest	Mean
Cultivated	65.5 a	38.9 a	50.7 a	62.4 a	42.1 a	53.7 a
Wild grown	45.1 b	26.7 b	35.9 b	43.8 b	24.2 b	34.5 b
LSD 0.05	11.5	8.4	7.3	12.4	9.7	5.7

Cultivated oregano at the first harvest always had the highest dry herbage (leaf) yield with 62.5, 65.4 g/plant in 2011 and 2012, respectively (Table 2). The lowest dry herbage yields at the first harvest were obtained from non-cultivated oregano with 45.1 and 43.8 g/plant in 2011 and 2012, respectively. At the second harvest, the lower dry herbage yields were obtained from non-cultivated wild grown oregano with 26.7 24.2 g/plant in 2011 and 2012, respectively. The highest dry herbage yields were obtained from cultivated oregano since water and plant nutrition were more available for plant growth and development under the cultivated field conditions. At the second harvest, the lower dry herbage yield could be attributable to the elevated air temperature between the first and the second harvest.

Table 3. Essential oil content of cultivated and wild grown *Origanum syriacum*

Production type	Essential oil content (%)					
	2011			2012		
	I. Harvest	II. Harvest	Mean	I. Harvest	II. Harvest	Mean
Cultivated	3.5 a	3.0 a	3.2 a	3.5 a	2.9 a	3.2 a
Wild grown	2.8 b	2.4 b	2.6 b	2.9 b	2.6 b	2.7 b
LSD 0.05	0.7	0.5	0.3	0.5	0.6	0.2

Essential oil contend variations between cultivated and non-cultivated oregano were significant at the first and the second harvest (Table 1). At the first harvest the highest essential oil was obtained from cultivated oregano with 3.5% and the lowest was obtained from non-cultivated wild grown oregano with 2.8% in 2011. However, opposite results were obtained by Ibrahim et al. (2012) that wild grown *O. Syriacum* produced more essential oil percentages compared with cultivated accessions. At the second year, the highest essential oil contents were obtained from the first harvest with 3.5 and 2.9% cultivated and non-cultivated oregano, respectively. The essential oil contents of the current study were in the range of reported by Sellami, et al. (2009), Ibrahim et al. (2012), and where they studied the variation in the oil content of *O. syriacum* who found that oil contend varied between 2.3 and 2.9%.

The average brightness, redness and yellowness values for cultivated and non-cultivated oregano were given in Table 4. The dry herbage color of cultivated oregano had lower brightness and yellowness values while having a higher greenness value than that of the non-cultivated oregano. When dried herb color is considered, green is preferred over grey in the oregano market.

Tablo 4. Dry herbage color of cultivated and wild grown *Origanum syriacum* in 2011 and 2012

	Dry herbage color					
	2011			**2012**		
Production type	***L****	***a****	***b****	***L****	***a****	***b****
Cultivated	46.95	-8.94	16.20	41.45	0.28	1.33
Wild grown	47.93	-9.32	18.12	43.14	0.45	0.75

*L** is the brightness ranging from no reflection for black (*L* = 0) to perfect diffuse reflection for white (*L* = 100).
*a** is the redness ranging from negative values for green to positive values for red.
*b** is the yellowness ranging from negative values for blue and positive values for yellow.

Table 5. Essential oil components of cultivated and wild grown *Origanum syriacum* in 2011 and 2012

			Area %			
			2011		**2012**	
No	**Compound name**	**RT**	**First harvest**		**Second harvest**	
1	α-Pinene,	3.92	0.35	0.82	0.68	1.19
2	α-Thujene	3.99	2.54	1.30	1.52	1.92
3	β-Ocimene	4.69	0.19	0.23	0.11	-
4	β-Pinene	5.55	0.21	0.49	0.19	0.39
5	Sabinene	5.87	0.22	-	0.27	-
6	β-Myrcene	6.99	2.22	2.60	1.89	2.85
7	Caren	7.41	2.17	1.25	2.02	3.10
8	L-Limonene	7.96	0.40	0.70	0.43	-
9	1,8-Cineole	8.16	0.28	0.18	0.38	0.49
10	Sabinene	8.24	0.24	-	0.20	-
11	β-cis-Ocimene	9.14	1.05	1.90	0.65	0.97
12	β-Terpinene	9.44	12.32	15.74	11.95	14.15
13	β-Cymene	10.30	6.44	8.63	5.74	9.37
14	1 Octen 3 Ol	16.92	0.39	0.67	0.21	0.41
15	Cis-Sabinenehydrate	17.36	0.47	-	0.37	-
16	trans Sabinene hydrate	20.56	0.87	1.14	0.17	0.28
17	Trans-caryophyllene	22.25	0.66	0.22	0.69	0.82
18	Terpinen-4-ol	22.65	0.31	0.65	0.34	0.39
19	Borneol	26.27	0.24	0.11	0.28	-
20	9-Octadecen-12-ynoic acid, methyl ester	27.25	0.29	0.42	0.21	0.36
21	9,12,15-Octadecatrienoic acid, methyl ester	35.84	0.13	-	0.14	-
22	Carvacrol	43.58	67.82	61.33	68.95	62.38
Total			99.81	98.38	97.39	99.07

The predominant components of the cultivated and wild oregano essential oil were carvacrol, β-terpinene, β-Cymene, α-thujene, β-myrcene and caren in the first and second year of the study

(Table 5). The amounts of above-mentioned compounds varied between cultivated and wild grown oregano and between the first and the second harvest. Carvacrol was the main dominant component both cultivated and wild grown oregano in both years and both harvest time (Table 5). Little variability occurred between the rate of essential oil component of cultivated and non-cultivated oregano. Baser and Kurkcuoglu (2003) reported that thymol (24-29%), cis-sabinene hydrate (18–20%), γ-terpinene (13–15%), p-cymene (5-8%) and terpinen-4-ol (4–8%) were characterized as the main constituents of *O.syriacum*. Similar oil components of *O.syriacum* was reported by Lukas et al., (2009) that carvacrol was dominant while thymol was present only in minor amounts.

CONCLUSION

Plant height, dry herbage yield and essential oil content of cultivated oregano were higher than the wild grown non-cultivated oregano. The color of cultivated oregano had higher greenness value than that of the non-cultivated oregano. Carvacrol and β-terpinene were dominant essential oil components in the cultivated and wild grown plants in both harvest times and both years. Most of the exported *O. syriacum* was gathered from the nature. In order to meet domestic and international marked criteria such as herbage quality, essential oil content and composition, *O. syriacum* must be cultivated.

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