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Physicochemical soil properties of genus *Origanum* (Lamiaceae) L. grown in Turkey

Turan ARABACI [*1], Türker YAZICI [2], Taner ÖZCAN [2], Tuncay DİRMENCİ [2]
ORCID: 0000-0003-3869-4557, 0000-0001-7709-9828, 0000-0003-1683-7297, 0000-0003-3038-6904

[1] Department of Pharmaceutical Botany, Faculty of Pharmacy, İnönü University, 44280, Malatya, Turkey
[2] Department of Biology Education, Necatibey Education Faculty, Balıkesir University, Balıkesir, Turkey

Abstract

This study aimed to determine the physicochemical soil properties of genus *Origanum* L. (in Turkish: Mercanköşk) grown in Turkey. Soils samples were collected from 22 localities where the 24 *Origanum* taxa grown. Soil texture, pH, electrical conductivity, $CaCO_3$, organic matter, P, K, Cu, Fe, Zn, and Mn parameters were evaluated for each sample. According to soil analysis the texture consists from clay, clay-loam or loam, pH value between 6.62 and 7.49, electrical conductivity (E.C.) is saltless or slightly salty, $CaCO_3$ content among 0.08 % to 48.97 % and the amount of organic matter were between 0.01 % and 11.54 %. The availability of P, K, Cu, Fe, Zn and Mn were determined low, medium, adequate or high level in the analyzed soils. The results are discussed with the previous studies.

Key words: ecology, *Lamiaceae*, *Origanum*, soil, Turkey

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Türkiye'de yetişen *Origanum* L. (Lamiaceae) cinsinin toprağının fiziko-kimyasal özellikleri

Özet

Bu çalışmada, Türkiye'de yetişen *Origanum* L. (Mercanköşk) cinsinin fiziko-kimyasal toprak özelliklerinin belirlenmesi amaçlanmıştır. *Origanum* cinsinin 24 taksonunun büyüdüğü 22 bölgeden toprak örnekleri alındı. Her bir örnek için toprak bünyesi, pH, elektriksel iletkenlik, $CaCO_3$, organik madde, P, K, Cu, Fe, Zn ve Mn parametreleri değerlendirildi. Toprak analizine göre bünye killi, killi-tınlı veya tınlı, pH değeri 6.62 ile 7.49 arasında, Elektriksel İletkenlik (E.İ.) tuzsuz veya az tuzlu, $CaCO_3$ içeriği % 0.08 ile % 48.97 arasında ve organik madde miktarı % 0.01 ila % 11.54 arasında bulundu. Analiz edilen topraklarda P, K, Cu, Fe, Zn ve Mn miktarı düşük, orta, yeterli veya yüksek seviyelerde belirlendi. Sonuçlar önceki çalışmalarla tartışıldı.

Anahtar kelimeler: ekoloji, *Lamiaceae, Origanum*, toprak, Türkiye

1. Introduction

The aromatic and medicinal genus *Origanum* L (Lamiaceae). (in Turkish: Mercanköşk) is represented by 43 species (50 taxa) and 19 hybrids in the world. The members of *Origanum* are widespread in Turkey, mainly in the Mediterranean area, with 21 species (24 taxa) and 12 hybrids, 23 of which are endemic [1,2,3]. *O. vulgare* L. *s.l.* is one of the widespread species in Turkey [4,5].

Origanum has antimicrobial, antifungal, antioxidant, antibacterial, antithrombin, antimutagenic, angiogenic, antiparasitic and antihyperglycemic activities that are important medicinally [6]. Many phytochemical studies such as their essential oil and phenolic components have been conducted to investigate the chemical profiles and activities of *Origanum* species [7,8,9]. A broad variability was observed in the essential oil profiles of *O. vulgare* populations, suggesting that the basis of variation in essential oil composition could be the differences in the geographical area of collection site, altitude and soil types [10]. A significant correlation between some edaphic factors (pH, K_2O content, soil texture) and the essential oil yield *O. compactum* Benth. was determined [11].

* *Corresponding author* / Haberleşmeden sorumlu yazar: Tel.: + +904223773090; Fax.: +904223773090; E-mail: turan.arabaci@inonu.edu.tr

This study included the physical and chemical properties of soil in native growing areas of *O. amanum* Post, *O. bilgeri* P.H.Davis, *O. boissieri* Ietsw (2 areas), *O. brevidens* (Bornm.) Dinsm. (2 areas), *O. haussknechtii* Boiss., *O. husnucan-baseri* H.Duman, Aytaç & A.Duran, *O. hypericifolium* O.Schwarz & P.H.Davis, *O. laevigatum* Boiss. (2 areas), *O. leptocladum* Boiss., *O. majorana* L., *O. minutiflorum* O.Schwarz & P.H. Davis, *O. onites* L., *O. rotundifolium* Boiss., *O. saccatum* P.H. Davis, *O. sipyleum* L., *O. solymicum* P.H. Davis, *O. syriacum* L. subsp. *bevanii* (Holmes) Greuter & Burdet, *O. vogelii* Greuter & Burdet, *O. vulgare* L. subsp. *hirtum* (Link) Ietsw. (3 areas), *O. vulgare* L. subsp. *vulgare*, *O.* × *bilgilii* Dirmenci, Yazıcı & Arabacı, *O.* × *haradjanii* Rech.f., *O.* × *intercedens* Rech.f. and *O.* × *sevcaniae* Dirmenci, Arabacı & Yazıcı.

2. Materials and methods

Soils samples were collected from 22 localities where the 24 *Origanum* taxa occurred during the field studies conducted on the flowering time of the taxa, between the years 2013 and 2015 from Turkey (Table 1). The organic matter on the soil surface was removed. The materials were taken from 0-30 cm depth and dried in air circulated oven. The soil samples were grinded by a 2 mm sieve. Soil texture, pH, electrical conductivity (E.C.), $CaCO_3$, organic matter, P, K, Cu, Fe, Zn, and Mn parameters were analyzed for each sample. The crushing, drying and sieving were made according to the TS 10308 ISO 11464 Soil Quality Pretreatment for Samples for Physico-Chemical Analysis. Determination of P, K, trace elements (Cu, Fe, Zn, and Mn), CaCO3, organic matter and water saturation of soil samples were made according to the TS 8340 UDK 631.41, TS 8341 UDK 631.41, TS ISO 14870, TS 8335 ISO 10693, TS 8336 UDK 631.41 and TS 8333 UDK 631.43 respectively. The soil sample, where more than one *Origanum* taxa growth on, was evaluated for all taxa occurs there.

3. Results

The main physicochemical soil properties of *Origanum* taxa in this study are given in Table 2-3. The soil sample of 24 *Origanum* taxa collected from 22 localities are analyzed in term of soil texture, pH, E.C., $CaCO_3$, organic matter, P, K, Cu, Fe, Zn, and Mn parameters.

The texture consist from clay in *O. amanum, O. brevidens* (TD3996), *O. majorana, O. vulgare* subsp. *vulgare, O.* × *haradjanii, O. syriacum* subsp. *bevani* and *O. laevigatum* (TD 4334); clay-loam in *O. bilgeri, O. boissieri* (TD 4319), *O. brevidens* (TD4270), *O. haussknechtii, O. laevigatum* (TD 4000), *O. leptocladum, O. minutiflorum, O.* × *intercedens, O. onites, O. saccatum, O.* × *bilgilii* and *O. vulgare* subsp. *hirtum* (TD 4294 & TD 4309) and loam in *O. boissieri* (TD 4285), *O. husnucan-baseri, O. hypericifolium, O. rotundifolium, O. sipyleum, O. solymicum, O. vogelii, O.* × *sevcaniae* and *O. vulgare* subsp. *hirtum* (TD 4018) (Table 2).

Amount of organic matter is between 0.01 and 11.54 %. The soil, where the endemic species *O. amanum* growth on, is the riches by the organic matter with the 11.54 %. *O. vulgare* subsp. *vulgare, O. solymicum, O. majorana* and *O. bilgeri* has poor soil with the 0.01 % organic matter value (Table 2).

The availability of P, K, Cu, Fe, Zn and Mn were determined low, medium, adequate or high level in the analyzed soils. The lowest P amount is found as <1.0 mg/kg in *O. leptocladum, O. solymicum, O. vogelii* and *O.* × *sevcaniae* while, the highest level is observed in *O.* × *haradjanii, O. syriacum* subsp. *bevanii* and *O. laevigatum* (TD 4334) soil samples. The K was lower in 59%, adequate in 36% and high in 5% of the plant soil samples. Cu, Fe, Zn and Mn levels are mostly adequate with the ratio of 55%, 82%, 59% and 73% of the plant soil samples respectively (Table 3).

4. Conclusions and discussion

The soil samples where the *Origanum* taxa grow naturally in Turkey are consist from clay to loam soil texture and saltless or slightly salty soil with neutral pH values. *Origanum compactum* populations sampled in Morocco were growth on clayey, silty and sandy soils [11]. The soils where the oregano occurs naturally in Greece was found to be alkaline with the pH values between 7.5 and 8.5 in the 65% of the soil samples, the E.C. was calculated 1.15- 0.4 dS/m in the 72% of the soil samples, the organic matter content determined higher than 5% in the 60% soil samples and the $CaCO_3$ content measured among 4 to 7% in the 70 % soil samples [12]. The soils found to be alkaline and relatively acidic with the pH between 6.3 and 7.9 in *Origanum compactum* populations [11].

The organic matter amount mostly has a low concentration in the examined soil samples. The organic matter content was found 2.28%, 6.43%, 10.18% and 6.05% in *Origanum solymicum, O. husnucan-baseri, O. bilgeri* and *O. minutiflorum* soil samples respectively in previous studies [13]. The soil samples are generally determined adequate in term of Cu, Fe, Zn and Mn, low in term of K, both adequate and low in term of P parameters.

Table 1. Localities of *Origanum* taxa

Taxa	**Localities**
O. amanum	C6 Osmaniye: Düziçi, west slopes of Düldül Mountain, Between Başkonuş plateau and Hüseyinoluk fountain, rocky places in the pass, 19.09.2014, Dirmenci 4321 & Arabacı (NEF-TD4321)
O. bilgeri	C3 Antalya: 13 km Gündoğmuş to Hanboğazı, 1460 m, 17.08.2014, Dirmenci 4300, Arabacı & Yazıcı (NEF-TD4300)
O. boissieri	C5 Mersin: 15 km from Çamlıyayla to Saydibi, 1850 m, 18.09.2014, Dirmenci 4319 (NEF-TD4319)
	C5 Mersin: 15 km from Çamlıyayla to Saydibi, 1850 m, 16.08.2014, Dirmenci 4285, Arabacı & Yazıcı (NEF-TD4285)
O. brevidens	C6 Osmaniye: Between Yarpuz and Yağlıpınar, 1350 m, 15.07.2013, Dirmenci 3996 (NEF-TD3996)
	C6 Osmaniye: Between Yarpuz and Yağlıpınar, 1310 m, 15.08.2014, Dirmenci 4270, Arabacı, Yazıcı (NEF-TD4270)
O. haussknechtii	B7 Erzincan: 15-20 km from Kemaliye to Arapkir, 1000-1100 m, calcareous rocks, 22.08.2013, Arabacı 2824, (NEF-TA2824)
O. husnucan-baseri	C4 Antalya: 43 km from Alanya to Gökbel plateau, Kuşyuvası place, around tunnels, 1350 m, 17.08.2014, Dirmenci 4298, Arabacı, Yazıcı (NEF-TD4298)
O. hypericifolium	C2 Denizli: Honaz, Honaz Mountain, Arpacık plateau road, north slopes, *Pinus nigra* openings, 1260 m, , 19.08.2014, Dirmenci 4315 & Yazıcı (NEF-TD4315)
O. laevigatum	C5 Osmaniye: Zorkun plateau, 8 km from Erzin junction, 1250 m, 15.07.2013, Dirmenci, 4000 (NEF-TD4000)
	C6 Hatay: Between Antakya and Samandağ, Around St. Symeon Church, slopes facing the sea, 20.09.2014, Dirmenci 4334, Arabacı & Yazıcı (NEF-TD4334)
O. leptocladum	C4 Karaman: Between Ermenek and Kazancı, 1 km above Görmeli village, 880 m, 17.08.2014, Dirmenci 4290, Arabacı, Yazıcı (NEF-TD4290)
O. majorana	C5 Mersin: Güzeldere, 252 m, 13.07.2013, Dirmenci 3984 (NEF) (TD3984)
O. minutiflorum	C3 Antalya: Kemer, Üçoluk, above Tülek, *Cedrus libani* and *Pinus nigra* openings, 1360 m, 18.08.2014, Dirmenci 4305 & Yazıcı (NEF-TD4305)
O. onites	C2 Denizli: Taşocağı , *Quercus* scrubs, stony places in maquis shrubland, 530 m, 19.08.2014, Dirmenci 4311 & Yazıcı (NEF-TD4311)
O. rotundifolium	A8 Artvin: 10 km from Artvin to Ardanuç, 600-700 m, 27.08.2013, Dirmenci 3943 & B.Yıldız (NEF-TD3943)
O. saccatum	C4 Antalya: Alanya, 8 km from Gökbel to Çökelek, 1370 m, 17.08.2014, Dirmenci 4296, Arabacı & Yazıcı (NEF-TD4296)
O. sipyleum	C3 Konya: 1 km from Akşehir to Yalvaç, Sultan Mountain foothill, 1100 m, 09.07.2013, Dirmenci 3959-a (NEF-TD3959-a)
O. solymicum	C3 Antalya: Kemer, Kesme couloir, *Pinus brutia* opening, calcareous rocks,100 m, 18.08.2014, Dirmenci 4302 & Yazıcı (NEF-TD4302)
O. syriacum subsp. *bevanii*	C6 Hatay: Between Antakya and Samandağ, Around St. Symeon Church, slopes facing the sea, 20.09.2014, Dirmenci 4336, Arabacı & Yazıcı (NEF-4336)
O. vogelii	C5 Mersin: Gülek, around castle, 1500 m, 01.10.2015, Dirmenci 4503 & Yazıcı (NEF-TD4503)
O. vulgare subsp. *hirtum*	C4 Antalya: Alanya, 8 km from Gökbel to Çökelek, 1370 m, 17.08.2014, Dirmenci 4294, Arabacı & Yazıcı (NEF-TD4294)
	C5 Adana: 16 km from Feke to Yahyalı, 940 m, 17.07.2013, Dirmenci 4018 (NEF-TD4018)
	C2 Denizli: Taşocağı, *Quercus* scrubs, stony places in maquis shrubland, 530 m, 19.08.2014, Dirmenci 4309, & Yazıcı (NEF-TD4309)
O. vulgare subsp. *vulgare*	A8 Artvin: 17.5 km from Borçka to Hopa, slopes, 26.08.2013, Dirmenci 3937 & Yıldız **(**NEF-TD3937)
O. × bilgilii	C4 Antalya: Alanya, 8 km from Gökbel to Çökelek, 1370 m, 17.08.2014, Dirmenci 4295, Arabacı & Yazıcı (NEF-TD4295)
O. × haradjanii	C6 Hatay: Between Antakya and Samandağ, Around St. Symeon Church, slopes facing the sea, 20.09.2014, Dirmenci 4335, Arabacı & Yazıcı (NEF-TD4335)
O. × intercedens	C2 Denizli: Taşocağı, *Quercus* scrubs, stony places in maquis shrubland, 530 m, 19.08.2014, Dirmenci 4310-a/b, & Yazıcı (NEF-TD4310-a/ T.D. 4310-b)
O. × sevcaniae	C5 Mersin: Gülek, around castle, 1500 m, 01.10.2015, Dirmenci 4504 & Yazıcı (NEF-TD4504)

Table 2. Soil texture, pH, E.C., $CaCO_3$ and organic matter parameters of examined soil

Taxa	Parameters									
	Soil Texture %		pH		E.C. µS/cm		$CaCO_3$%		Organic matter %	
O. amanum	104	C	6.62	N	211	SS	2.36	limy	11.54	high
O. bilgeri	53	CL	7.42	N	88	S	35.45	high limy	0.01	low
O. boissieri (TD 4285)	40	L	7.09	N	71	S	27.63	high limy	0.43	low
O. boissieri (TD 4319)	51	CL	7.02	N	169	S	32.81	high limy	1.66	low
O. brevidens (TD 3996)	94	C	7.49	N	172	S	6.81	limy	9.28	high
O. brevidens (TD 4270)	58	CL	6.99	N	216	SS	14.75	limy	5.71	high
O. haussknechtii	59	CL	7.25	N	111	S	22.59	high limy	2.99	medium
O. husnucan-baseri	33	L	7.17	N	70	S	27.46	high limy	0.49	low
O. hypericifolium	41	L	7.43	N	92	S	9.64	limy	0.61	low
O. laevigatum (TD 4000)	51	CL	7.25	N	172	S	32.41	high limy	1.62	low
O. leptocladum	66	CL	7.16	N	112	S	38.02	high limy	1.11	low
O. majorana	71	C	7.05	N	184	S	32.22	high limy	0.01	low
O. minutiflorum	54	CL	6.91	N	107	S	32.85	high limy	0.12	low
O. onites, *O. vulgare* subsp. *hirtum* (TD 4309), *O. × intercedens*	51	CL	7.02	N	169	S	32.81	high limy	1.66	low
O. rotundifolium	40	L	6.68	N	79	S	1.11	limy	2.13	medium
O. saccatum, *O. × bilgilii*, *O. vulgare* subsp. *hirtum* (TD 4294)	66	CL	7.03	N	102	S	0.08	low limy	8.29	high
O. sipyleum	40	L	7.20	N	119	S	18.09	high limy	1.22	low
O. solymicum	33	L	7.21	N	68	S	48.97	high limy	0.01	low
O. vogelii, *O. × sevcaniae*	33	L	6.85	N	56	S	3.47	limy	0.18	low
O. vulgare subsp. *hirtum* (TD 4018)	48	L	6.89	N	80	S	0.08	low limy	1.73	low
O. vulgare subsp. *vulgare*	81	C	7.15	N	185	S	23.59	high limy	0.01	low
O. × haradjanii, *O. syriacum* subsp. *bevanii*, *O. laevigatum* (TD 4334)	89	C	6.93	N	266	SS	24.60	high limy	11.18	high

C: clay, CL: clay loam, L: loam, N: neutral, S: saltless, SS: slightly saltyThe pH of soil samples is evaluated as neutral between 6.62 and 7.49. E.C. value is slightly salty in the soil samples of *O. amanum*, *O. brevidens* (TD 4270), *O. × haradjanii, O. syriacum* subsp. *bevanii* and *O. laevigatum* (TD 4334) whereas saltless for the others. $CaCO_3$ content ranging from 0.08 to 48.97 % among the soil samples. The soil of *O. saccatum*, *O. × bilgilii* and *O. vulgare* subsp. *hirtum* (TD 4294 & TD 4018) are poor in terms of $CaCO_3$, while *O. solymicum* has a high $CaCO_3$ percentage (Table 2).

Table 3. P, K, Cu, Fe, Zn, and Mn parameters of examined soil

Taxa	Parameters											
	P mg/kg		K mg/kg		Cu mg/kg		Fe mg/kg		Zn mg/kg		Mn mg/kg	
O. amanum	9.6	M	115	A	1.1	H	10.5	A	1.4	A	13.6	A
O. bilgeri	14.3	M	106	L	0.8	A	9.1	A	0.5	A	14.8	A
O. boissieri (TD 4285)	8.5	M	<60	L	0.5	A	4.1	A	0.9	A	2.3	M
O. boissieri (TD 4319)	4.3	L	152	A	1.2	H	8.7	A	0.9	A	16.1	A
O. brevidens (TD 3996)	1.1	L	97	L	0.1	A	15.9	A	1.4	A	15.9	A
O. brevidens (TD 4270)	7.3	L	<60	L	<1.0	L	13.9	A	0.9	A	6.8	A
O. haussknechtii	4.9	L	194	A	0.4	A	5.7	A	0.5	A	18.7	A
O. husnucan-baseri	10.7	M	<60	L	0.2	A	3.1	M	0.7	A	1.0	M
O. hypericifolium	8.5	M	<60	L	0.7	A	8.7	A	0.3	L	5.6	A
O. laevigatum (TD 4000)	8.4	M	<60	L	0.3	A	1.9	L	0.1	L	4.3	M
O. leptocladum	<1.0	L	126	A	0.1	A	11.0	A	0.3	L	1.9	M
O. majorana	17.7	A	196	A	0.6	A	8.7	A	0.7	A	22.0	A

Table 3. Continued

O. minutiflorum	9.6	M	166	A	1.2	H	8.7	A	0.4	L	2.2	M
O. onites, *O. vulgare* subsp. *hirtum* (TD 4309), *O. × intercedens*	4.3	L	152	A	1.2	H	8.7	A	0.9	A	16.1	A
O. rotundifolium	15.8	A	<60	L	1.4	H	4.8	A	0.6	A	26.3	A
O. saccatum, *O. × bilgilii* *O. vulgare* subsp. *hirtum* (4294)	19.6	A	105	L	0.6	H	27.9	A	1.6	H	5.9	A
O. sipyleum	10.2	M	<60	L	0.2	A	2.9	M	0.2	L	8.7	A
O. solymicum	<1.0	L	<60	L	<1.0	L	2.4	L	0.4	L	1.2	M
O. vogelii *O. × sevcaniae*	<1.0	L	<60	L	<1.0	L	22.7	A	0.5	A	5.2	A
O. vulgare subsp. *hirtum* (TD 4018)	4.4	L	<60	L	0.2	A	10.9	A	0.2	L	35.1	A
O. vulgare subsp. *vulgare*	12.5	M	148	A	1.1	H	7.7	A	0.4	L	21.3	A
O. × haradjanii, *O. syriacum* subsp. *bevanii* *O. laevigatum* (TD 4334)	34.5	H	339	H	0.7	A	7.7	A	1.0	A	13.7	A

A: adequate, H: high, L: low, M: medium

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