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The Elemental Characterization of Coriander Populations (*Coriandrum Sativum* L.) Cultivated in Turkey

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Abstract: Mineral compositions (macro elements, Na, K, Ca, Mg and P; micro elements, Fe, Zn, Cu and Mn; heavy metals, Al, Ba, Co, Ni, Cr and Pb) of different Coriandrum sativum L. populations were determined which were cultivated in Turkey, Umbelliferae family, were determined by ICP-OES. There were significant ($p<0.01$) differences between the coriander populations in view of their mineral compositons. In the population, the highest amount of phosphorus (P) was obtained from Muğla population with 7878.00 ppm and the lowest from Tokat population with 2969.91 ppm. The iron (Fe) content of micro elements was highest in the Kırşehir population with 435.00 ppm and the lowest in Bursa population with 42.04 ppm. The highest Al content (850.91 ppm) was obtained from the Hatay population in terms of heavy metal content. The aim of this research attempts to contribute to knowledge of the mineral contents of different C. sativum populations.

Key words: Coriander, macro elements, micro elements, heavy metals

Türkiye'de Kültürü Yapılan Kişniş Populasyonlarının (*Coriandrum sativum* L.) Elementel Karakterizasyonu

Özet: Türkiye'de kültürü yapılan Şemsiyeçiçekliler (Umbelliferae) familyasına ait farklı kişniş populayonlarının mineral içerikleri (makro elementler: Na, K, Ca, Mg ve P; mikro elementler : Fe, Zn, Cu ve Mn; ağır metaller: Al, Ba, Co, Ni, Cr ve Pb) İndüktif Olarak Eşleşmiş Plazma-Optik Emüsyon Spektroskopisi (ICP-OES) ile belirlenmiştir. Kişniş populasyonlarının mineral içeriklerinin arasındaki farklılıklar istatistiki olarak önemli ($p<0.01$) bulunmuştur. Populasyonlar içerisinde en yüksek fosfor (P) miktarı 7878.00 ppm ile Muğla populasyonundan elde edilirken en düşük 2969.91 ppm ile Tokat populasyonundan elde edilmiştir. Mikro elementlerden demir (Fe) içeriği en yüksek 435.00 ppm ile Kırşehir populasyonu iken en düşük 42.04 ppm ile Bursa yöresine ait populasyondan elde edilmiştir. Ağır metal içerikleri bakımından da populasyonlara göre en yüksek Alüminyum (Al) içeriği (850.91 ppm) Hatay populasyonundan elde edilmiştir. Bu çalışma ile, farklı kişniş populasyonlarının mineral içerikleri yeni çalışmalara katkı sunması amaçlanmıştır.

Anahtar kelimeler*:* Kişniş, makro element, mikro element, ağır metal

Introduction

It is estimated that there are about 300 thousand plants species which have seeds. WHO reported that 20 thousand of these are used for medical purposes. About five hundred of medicinal plant species are collected, cultivated and traded in Turkey. Coriander (*Coriandrum sativum* L.), family Apiaceae (Umbelliferae) is annual plant 20–50 cm height with strong smell. The parts of the coriander plant that are used are the seeds. Seeds are also regarded as fruit. Coriander seeds are 3-6 mm in diameter and spherical shape (Kan, 2007). Coriander is also known as "Aş otu", "Kizni", "Arap saçı" and "Kuzbere" in Turkish (Baytop, 1994). Seed of coriander is a culinary and medicinal plant originating from the Mediterranean region (native), and is grown widely all over the world (Chen et al, 2009, Katar et al., 2016). It is commonly

cultivated in Southwestern Europe, Middle Eastern, Mediterranean, Indian, Latin American, African and Southeast Asian country in the world (Aissaoui et al, 2008).

It is widespread throughout the world as a result of cultivation for its aromatic and medicinal seeds. Coriander is cultivated at altitude of 0–1500 m above sea level in most parts of Turkey. Production of Coriander is produced in very small quantities in Gaziantep, Bursa, Hatay, Tokat, Aydın, Muğla, Van, Diyarbakır, Burdur, Denizli, Kırşehir, İzmir, Isparta, Kütahya, Uşak and Eskişehir province,

Coriander is generally used in three forms: (i) fresh leaves; (ii) dried ripe seeds (fruits), and (iii) extract. The fresh leaves and riped seeds are used as a spice in additive flavor to food. The seed of coriander contain an essential oil about 1 %. The major content of essential oil coriander are monoterpenoid and linalool (Msaada et al, 2009).

The use of medicinal herbs in Phytotherapy to relieve and treat many human diseases is increasing around the world due to their organic features and low side effects. In addition, the interest in chemical composition of medicinal herb products is growing because of ongoing developments in nutrition and in biochemical surveying and mineral contents (Başgel and Erdemoğlu, 2006). Extracts from seeds of *Coriandrum sativum* have several pharmacological effects such as anti-fertility, anti-diabetic, antihyperlipidemic, antioxidant, and hypotensive activities (Eguale et al, 2007). The products are valuable as dietetics due to the high level of polyunsaturated fatty acids, minerals and elements. Several nutritionally important macro and micro trace elements (N, P, K, Mg, Ca, Na, Mn, Zn, Fe and Cu) constitute an important part of the composition (Kan, 2012). Trace elements, especially heavy metals, are important not only because of their harmful effects, but also because at least some of them may be essential micronutrients to living beings in general and humans in particular. For example, zinc is important during puberty, pregnancy, and menopause, Cd is related to hypertension, silicon is necessary for healthy bone and connective tissue, Cr is responsible for glucose tolerance factor and Cu deficiency may be attributed to a wide range of cardiovascular and blood disorders. However, the benefits of micronutrients may be completely reversed if present at high levels. Trace heavy metal contents in plants are also widely accepted as toxicity indicators (Gupta et al, 2003).

Mineral compositions in a particular plant vary greatly depending upon a number of factors, namely, soil parameters, fertilization, management, climate, etc. Also, mineral element compositions vary from section to section within the same plant (Gupta et al, 2003).

The aim objective of the work presented was to determine the effects cultivation region soil, climate and other factor on mineral yield and composition. Samples of *coriander* populations obtain from sixteen provinces in Turkey were subjected to chemical analyses.

Materials and Methods

Seed materials

The population samples of Coriandrum sativa were kindly provided in 2010 from the wheat milling companies (Demirpolat Company) in Konya, Turkey. The plant samples were subjected to Soxhlet solvent extraction for isolation of the oil and mineralized for elemental analyses without prolonged deposition or storage. During the short storage time, the plant samples were kept at -20°C until use.

The analyses of mineral compositions in coriander populations

The analyses of mineral compositions in coriander populations were determined using NMKL 161 method. A Perkin-Elmer Optima 2000 inductively coupled plasma–optical emission spectrophotometer (ICP–OES) was used to analyze the elements in sixteen coriander samples.

Statistical analysis

Each parameter was tested in triplicate samples with three replications. Conventional statistical methods were used to calculate means. Collected data were

subjected to statistical analyses using JMP statistical package software (Version 5.0.1.a, SAS Institute. Inc.Cary, NC). One way ANOVA was used to evaluate the effect of plant part (branch, leaf and herba) on the parameters studied. When significant ($P < 0.01$) main effect was found, the mean values were further analyzed using Student's t test.

Results and Discussion

Macro elementel composition of coriander populations seed

Table 1 indicates that there were significant ($p<0.01$) differences between the sixteen populations of *Coriandrum sativum* with respect to their mineral compositions (macro elements, Na, K, Ca, Mg and P; micro elements, Fe, Zn, Cu and Mn; heavy metals, Al, Ba, Co, Ni, Cr and Pb).

Table 1 revealed that the potassium (K) and calcium (Ca) contents were the highest macro elements (MAE). The highest K content was observed in Uşak (19502.77 ppm), followed by Muğla (17320.02 ppm) and Van (15480.43 ppm). Moreover, Kırşehir was the highest Ca content with 11861.40 ppm, followed by Uşak (8775.80 ppm) and Hatay (7362.06 ppm). The highest magnesiun (Mg) content was observed to be in Uşak (5710.90 ppm), whereas the lowest content was investigated in Van (2817.08 ppm). In addition, the highest phosphorus (P) determined to be Muğla population (7878.00 ppm). According to the populations, the amount of sodium varied between 414.27 ppm (Eskişehir) and 57.33 ppm (Tokat). In the other study, K, Ca, Mg and P contents of coriander were determined 12.525, 10.360, 4415.00 and 2282.00 ppm respectively (Özcan, 2004). The differences in research results were due to ecological conditions.

Trace (Micro) elementel composition of coriander seed

Furthermore, it was indicated that the highest micro element (MIE) was Fe content and determined in Kırşehir (435.00 ppm), followed by Hatay (348.80 ppm) and Burdur (317.00 ppm). The lowest Fe content was determited in İzmir (38.34 ppm). The highest Zn content was found in Hatay (61.64 ppm), Antep (51.12 ppm) and Diyarbakır (43.64 ppm), respectively. The highest Cu amount was obtained from Hatay (17.74 ppm) and the lowest amount was from the Isparta population (9.65 ppm). The amount of manganese (Mn) was 8.07 ppm in Denizli and 56.12 ppm in Gaziantep populations.

According to the other study, Fe and Zn contents were observed 163.49 and 28.2 mg/kg (Özcan, 2004). In another study, the Cu content of coriander were found to be (6 ppm), Mn content (12 ppm) (Özkutlu et al, 2007).

On the other hand, Al content was the highest heavy metal (HM) and determined in Hatay (850.91 ppm), Kırşehir (607.70 ppm) and Uşak (329.42 ppm), respectively. The highest barium (Ba) and chromium (Cr) content were determined 5.48 ppm (Bursa) 0.92 ppm (Gaziantep) respectively. It was found in the other study that Al content were 442 ppm, Ba (56.70), Cr (9.10) **(**Özcan, 2004; Özkutlu et al, 2007). The amounts of lead, nickel and cobalt were determined at very low levels. Especially industrial activities, several factors may affect the elemental contents of plants such as the variety, harvesting time, soil type, soil conditions, fertilization, irrigation and weather etc (Kan, 2012; Kan et al., 2005).

Conclusion

The samples of seed coriander population contain a relatively high amount of the elemental of mineral. Furthermore, the composition of mineral showed an excellent balance as good nutritional quality. However, further detailed studies on the functional properties of nutritional quality of coriander populations are required. In conclusion, the seed of coriander population contains many valuable minerals that are of importance to humans.

Table 1. The mineral composition of cultivated *Coriandrum sativum* populations
Çizelge 1. Kültürü yapılan kişniş populasyonlarının mineral kompozisyonu

Populations	**Macro Elements (ppm)** *Makro Elementler* **(ppm)**						**Micro Elements (ppm)** *Mikro Elementler (ppm)*					**Heavy Metals (ppm)** *Ağır Metaller (ppm)*						
Populasyonlar	**Na**	**K**	**Ca**	**Mg**	**P**	**ΣMAE**	**Fe**	**Zn**	**Cu**	**Mn**	**ΣMIE**	**Al**	**Ba**	**Co**	**Ni**	**Cr**	**Pb**	**ΣHM**
Antep	102.56^{l}	8668.70^{o}	5858.42^{g}	4264.32^{e}	6843.86^{b}	25737.87^{j}	60.13^{l}	51.12^{b}	15.54^{d}	56.12^{a}	182.92^{g}	12.76^{o}	0.92^{n}	0.01^{a}	2.89^{i}	0.92^{a}	0.89^{a}	18.39^{o}
Bursa	201.12^{f}	14389.73^{e}	5844.42^{h}	3498.51^{j}	4908.45^{e}	28842.25^{f}	42.04^{o}	28.13^{k}	11.42^{m}	27.81^{f}	109.40^{n}	16.24^{m}	5.48^{a}	0.00^{a}	1.24^{o}	0.47^{a}	0.19^{d}	23.63^{l}
Hatay	212.44^{e}	11938.55^{k}	7362.06^{c}	4504.66^{d}	4673.05^{f}	28690.76^{g}	348.80^{b}	61.64^{a}	17.74^{a}	53.41^{b}	481.59^{b}	850.91^{a}	1.76^{k}	0.85^{a}	10.50^{c}	6.13^{a}	0.00^{g}	870.15^{a}
Tokat	57.33^{p}	13256.32^{h}	5976.81^{f}	2784.05^{l}	2969.91^{p}	25044.43^{k}	124.21^{g}	22.87^{n}	11.93^{l}	16.65^{k}	175.65^{i}	70.08^{i}	2.42^{j}	0.19^{a}	1.47^{n}	1.82^{a}	0.17^{e}	76.14^{i}
Van	70.26^{n}	15480.43^{c}	6084.56^{e}	2817.08^{kl}	5839.14^{c}	30291.47^{d}	83.33^{j}	21.51^{o}	14.85^{e}	23.31^{h}	143.00^{j}	49.43^{j}	1.26^{l}	0.00^{a}	0.78^{p}	0.81^{a}	0.17^{e}	52.47^{j}
Aydın	183.72^{g}	9110.15^{n}	5200.62^{l}	3739.34^{h}	4399.14^{k}	22632.98^{n}	202.52^{f}	30.77^{h}	12.13^{i}	19.06^{i}	264.48^{f}	157.61^{f}	3.26^{e}	0.31^{a}	5.74^{f}	2.84^{a}	0.00^{g}	169.76^{f}
Burdur	222.94^{d}	15244.81^{d}	4844.93^{n}	4473.08^{d}	4666.30^{g}	29452.07^{e}	317.00^{c}	34.44^{f}	12.85^{g}	24.98^{g}	389.27^{c}	194.11^{e}	2.46^{i}	0.30^{a}	7.89^{e}	4.00^{a}	0.00^{g}	208.76^{e}
Diyarbakır	63.07^{o}	13362.81^{g}	4301.63^{o}	2843.14^{k}	4402.61^{j}	24973.26^{l}	102.82^{h}	43.64^{c}	15.91^{c}	17.57^{j}	179.94^{h}	81.93^{h}	1.22^{m}	0.07^{a}	1.82^{l}	1.85^{a}	0.00^{g}	86.89^{h}
Denizli	100.42^{m}	14300.01^{f}	3835.68^{p}	3944.00^{g}	3739.00^{o}	25919.11^{i}	60.28^{k}	37.71^{e}	12.55^{h}	8.07^{p}	118.62^{l}	21.72^{k}	2.95^{f}	0.00^{a}	10.32^{d}	1.43^{a}	0.28^{c}	36.70^{k}
Eskişehir	414.27^{a}	8618.63^{p}	5800.40^{i}	3495.60^{j}	4298.27^{l}	22627.16^{n}	50.99^{m}	18.05^{p}	12.02^{k}	14.53^{n}	95.59^{o}	13.93^{n}	2.82^{g}	0.10^{a}	2.16^{k}	0.70^{a}	0.00^{g}	19.71^{n}
Isparta	263.65^{c}	12833.84^{j}	5312.95^{k}	3543.73^{ij}	3775.65^{n}	25729.83^{j}	97.07^{i}	25.06^{m}	9.65^{n}	9.14^{o}	140.92^{k}	83.39^{g}	1.27^{l}	0.14^{a}	3.33^{h}	1.29^{a}	0.00^{g}	89.42^{g}
İzmir	105.85^{k}	10855.04^{m}	5144.14^{m}	3586.84^{i}	4516.53^{i}	24208.40^{m}	38.34^{p}	27.47^{l}	11.94^{l}	15.69^{m}	93.45^{p}	17.29^{l}	2.53^{h}	0.04^{a}	2.21^{j}	0.26^{a}	0.00^{g}	22.33^{m}
Kırşehir	160.86^{h}	11598.85^{l}	11861.40^{a}	4152.68^{f}	4520.03^{h}	32293.82^{c}	435.00^{a}	31.15^{g}	17.08^{b}	28.59^{c}	511.82^{a}	607.70^{b}	4.84^{b}	0.57^{a}	4.41^{g}	4.24^{a}	0.02^{f}	621.78^{b}
Kütahya	144.31^{j}	12927.92^{i}	5441.73^{j}	4662.64^{c}	3808.47^{m}	26985.06^{h}	276.80^{d}	28.37^{j}	12.08^{j}	28.51^{d}	345.76^{d}	312.50^{d}	4.84^{b}	0.86^{a}	15.16^{a}	6.10^{a}	0.00^{g}	339.46^{d}
Muğla	401.02^{b}	17320.02^{b}	6420.01^{d}	5360.00^{b}	7878.00^{a}	37379.05^{b}	46.39^{n}	41.04^{d}	12.12^{i}	15.84^{l}	115.39^{m}	7.94^{p}	4.13^{d}	0.18^{a}	1.78^{m}	0.51^{a}	0.60^{b}	15.14^{p}
Uşak	160.56^{i}	19502.77^{a}	8775.80^{b}	5710.90^{a}	5479.54^{d}	39629.57^{a}	266.80^{e}	28.44^{i}	13.60^{f}	28.29^{e}	337.13^{e}	329.42^{c}	4.77^{c}	0.61^{a}	11.81^{b}	4.76^{a}	0.00^{g}	351.36^{c}

£ ΣMAE, total macro element content
£ ΣMAE, toplam makro element içeriği
§ ΣMIE, total micro element content
§ ΣMIE, *toplam mikro element içeriği*
† ΣHM, total heavy metal content
† ΣHM, *toplam ağır metal içeriği*
a-c The values in the same row with different letters are statistically different (P<0.01).
a-c *Aynı satırda farklı harflerle gösterilen degerler arasındaki farklar istatistiksel olarak önemlidir* (P<0,01).

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