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The Comparison of Elemental Composition of Deveci and Santa Maria Pear Varieties

[a]Serhat GÜREL* and [a]Haluk BAŞAR
[a,b]Department of Soil Science and Plant Nutrition, Faculty of Agriculture, University of Uludağ, Bursa, Turkey
*Corresponding author: sgurel@uludag.edu.tr

Abstract

This study was implemented to compare the nutrient elements contents of two different pear cultivars in order to determine the sufficiency ranges might be used for different cultivars. For this purpose, concentrations of N, P, K, Ca, Mg, B, Fe, Zn, Cu, Mn, Cr, Ni, Cd, Pb and Co elements were determined in the leaf and fruit parts of pear cultivars, Deveci and Santa Maria. The mean values of N, Ca, Mg, B, Mn and Cd concentrations were found to be statistically different in the leaf samples. Concentrations of the elements in the fruit flesh were different at N, P, K, Ca, Mg, B, Fe, Zn and Cu. Concentrations of the elements in fruit peel were similar in both two cultivars, except N and B. Despite the differences found among the same elements, in the leaves of two different cultivars, the concentration of these elements were near to each other. So that, it could ve suggested that interpretation of the leaf and fruit analysis results from the different pear cultivars can be made by comparing to a single set of critical values or sufficiency ranges.

Key words: pear, cultivar, elemental content; sufficiency range

Deveci Ve Santa Maria Armut Çeşitlerinin Elementel Kompozisyonlarının Karşılaştırılması

Özet

Bu çalışma farklı armut çeşitleri için kullanılan yeterlilik aralıklarını belirlemek için yapılmıştır. Araştırmada iki farklı armut çeşidinin besin elementi içeriği karşılaştırılmıştır. Bu amaçla Deveci ve Santa Maria çeşitlerinde yaprak, meyve eti ve meyve kabuğu örneklerinin N, P, K, Ca, Mg, B, Fe, Zn, Cu, Mn, Cr, Ni, Cd Pb ve Co elementlerinin konsantrasyonları belirlenmiştir. N, Ca, Mg, B, Mn ve Cd konsantrasyonları ortalama değerleri yaprak örnekleri arasında istatistiksel olarak farklı olduğu bulunmuştur. Meyve eti örneklerinin N, P, K, Ca, Mg, B, Fe, Zn ve Cu elementleri arasında istatistiksel olarak önemli farkların olduğu bulunmuştur. Meyve kabuğu örneklerinde ise N ve B dışındaki diğer elementlerin çeşitler arasında istatistiksel olarak bir farklılık göstermediği belirlenmiştir. Her iki armut çeşidinde yapraklarda elementler arasında bulunan farklılıklara rağmen bitki besin elementlerinin konsantrasyonları birbirine yakın değerlerdedir. Bu yüzden kritik değerler veya yeterlilik aralıkları tek bir dizi karşılaştırma yerine farklı armut çeşitlerinden gelen yaprak ve meyve analiz sonuçlarının birlikte yorumlanması önerilmektedir.

Anahtar Sözcükler: armut, çeşit, element içeriği, noksanlık sınırı

Introduction

Pear (*Pyrus communis* L.) fruit is one of the most widely consumed fruits through the whole world, and it is commonly found in processed products such as drink, candy, preserved fruit and jams (Li et al., 2014). Pear fruits are popular among consumers due to their sweetness, crispness, characteristic fragrance and slight aroma (Chen et al., 2007). The interest to pear in Turkey has been increasing year by year (Öztürk et al., 2009). Turkey is 7th biggest country for pear production in the world. Bursa region is dominate the pear crop production of Turkey. Above the 70 % of Turkey's pear crop production is carried out in Bursa region (Anonymous, 2011).

During recent years, some researchers have been focused on analysis and comparison of the physicomechanical and chemical properties of edible part of pear fruit such as total sugars, vitamins, organic and fatty acids, amino acids, volatiles, polyphenols, minerals and so on (Kahle et al., 2005; Tanrıöven and Eksi, 2005; Barroca et al., 2006; Öztürk et al., 2009; Guopeng et al., 2012).

Spanos and Wrolstad (1990) claim that the phenolic content of pear depends on primarily on variety and the level of maturity. Varietal differences in leaf nutrient content have also been reported (Kenworthy, 1961).

Fruit aroma is an important sensory attributes that it is particularly sensitive to changes in the chemical composition (Guopeng et al., 2012). The variation in the element content and the associations that may exist with harvest quality characteristics in flesh tissue and fruit peel from two pear cultivars were studied. Total nutrient elements and some total metals content parameters were measured in leaf, flesh and peel fruit tissues from pear cultvars Deveci and Santa Maria. Therefore, this research focused on analysis and comparison of the mineral compositions of two different pear cultivars dominates the pear production of Turkey. A more detailed knowledge of the variability of these composition contents of the cultivars will be of benefit in the future selection of pear genotypes with improved nutritional quality of pear.

Materials And Methods

The study was conducted in towns of Gürsu, Kestel, Osmangazi, Nilüfer ve Karacabey districts of Bursa province in southeastern of Marmara region (40˚ 2' - 40˚ 35' N latitudes and 28˚ 35' - 32˚ 2' E longitudes) (Figure 1). The southeastern of Marmara region is situated in the northwestern of Turkey. The experimental orchards were chosen from 76 different pear cultivars of “Santa Maria” (37 orchards) and “Deveci” (39 orchards) grown orchards. The rootstocks of the cultivars in each orchard were wild type with the same origin. All orchards had alluvial great soil group. Healty, uniform and regular bearing trees in the each grove were chosen. The trees were applied almost the same fertilizer program and irrigation scheduling with adjustment tree size.

The leaf samples that were expanded to full size and have petiole were taken from the mid part of annual shoots located on different sides of middle section of canopy in each orchard, in January, as stable period for nutrients (Kacar and İnal, 2008). The fruit samples were collected at maturity in september-october. After collection, leaf and fruit samples were immediately transported to laboratory in closed polyethylene bags and washed thoroughly with tap water, acidified (0.1 *M* HCl) water and then distilled water. The fruit peels were removed by a knife before they were oven dried. Analysis were conducted on the flesh and peel. The samples were oven-dried at 65 ^{o}C for 72 hr and finely ground in stainless steel mill to pass through a 0.5 mm sieve. Care was taken to prevent contamination at all steeps in progress.

To dissolve both the plant and soil samples for total elemental analysis, microwave – assisted acid decomposition was performed at high pressure and temperature (Model Start D, Milestone S.r.l, Sorisole, Italy). The extracts were analyzed for Ca, Mg and K by flame photometer. Total P concentration was measured colorimetrically after developing the yellow color with ascorbic acid as described by Kacar and Kovancı (1982). Total B was analysed according to Wolf (1971) and measured colorimetrically. Available Fe, Mn, Zn, Cu, Co, Ni, Cr, Pb, and Cd contents of the soils were extracted by 0.005 *M* DTPA – extractant (Lindsay and Norvell, 1978). Heavy metal concentration was analyzed with an atomic absorption spectrometer (Model A Analist 400, Perkin Elmer, Waltham, Massachusetts, USA).

All the analysis were carried out in duplicate and the results were subjected to statistical analysis. Simple correlations were examined among the data, which were obtained from the soil, leaf and fruit (flesh and peel) samples (Jump 6).

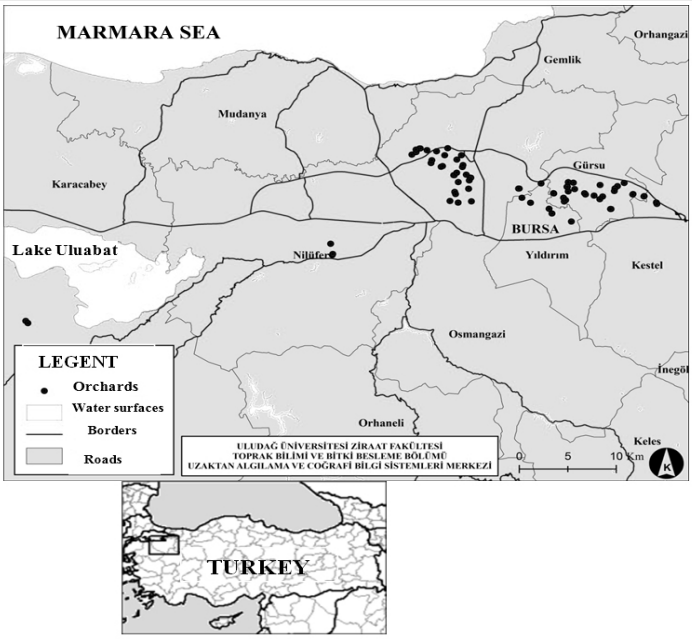

Figure 1. The locations of pear gardens.

Results And Dıscussıon

Leaf analysis

The mineral contents of pear cultivars are given in Table 1. Results were compared to literature values. Some mineral contents of pear leaf samples were determined and compared to values of Jones et al. (1991). Tolerable and excessive concentrations of the metals were assessed based on the information of Kabata-Pendias and Pendias (1992). According to the results; both of the Deveci and Santa Maria pear varieties showed deficiency for N, P, K, Ca, Mg, B, Fe and Zn contents. Toxic leaf heavy metal concentrations were not found in all of the cultivars in the leaf samples (Figure 2). Santa Maria showed much defficient for their N, Ca and Mg contents than Deveci orchards (Figure 2). Similar results were reported by Günen et al. (2003).

Table 1. Leaf mineral composition of pear cultivars.

			%					mg kg^{-1}										
			N	P	K	Ca	Mg	B	Active Fe	Fe	Zn	Cu	Mn	Ni	Co	Cr	Pb	Cd
LEAF	Deveci	Min.	1.98	0.09	0.65	0.86	0.14	13.01	12.75	22.10	11.54	9.86	34.77	1.09	0.48	0.00	0.00	0.00
		Max.	2.73	0.19	1.29	1.35	0.42	36.10	42.72	91.46	57.62	26.30	357.02	11.49	3.08	0.00	4.89	1.78
		MEAN	**2.39**	**0.13**	**1.00**	**1.06**	**0.27**	**22.69**	**21.98**	**53.41**	**33.20**	**16.39**	**166.95**	**4.47**	**1.81**	**0.00**	**1.33**	**0.60**
	Santa Maria	Min.	1.73	0.09	0.56	0.43	0.17	14.31	16.68	24.56	22.12	9.71	42.04	0.79	0.68	0.00	0.00	0.00
		Max.	2.52	0.20	1.42	1.24	0.31	79.35	49.44	105.26	52.02	25.91	298.02	7.89	3.38	0.00	5.59	1.28
		MEAN	**2.19**	**0.03**	**1.03**	**0.96**	**0.23**	**27.96**	**25.64**	**55.81**	**32.35**	**16.76**	**135.85**	**4.23**	**1.76**	**0.00**	**1.23**	**0.41**

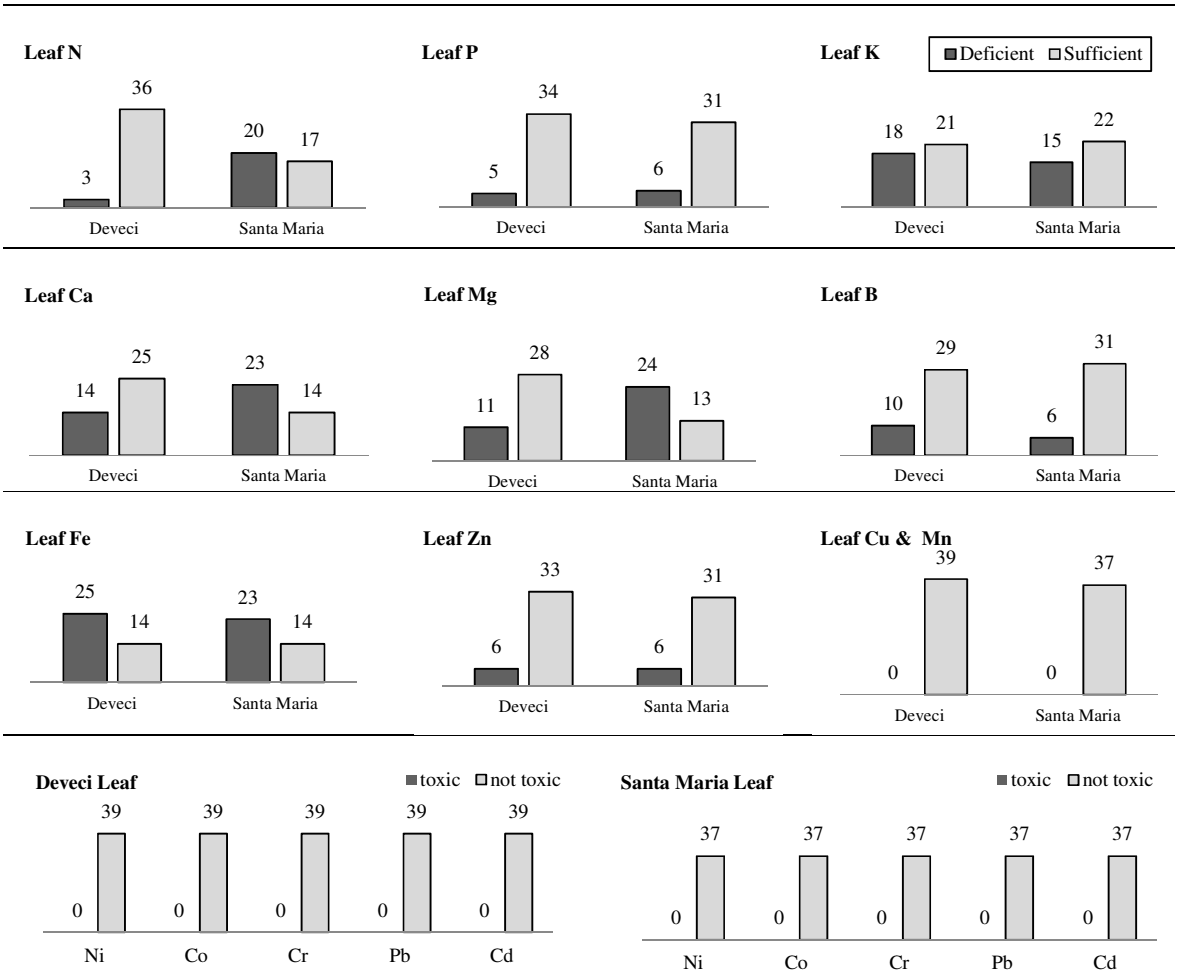

Figure. 2. Comparison of Santa Maria and Deveci orchards for their leaf nutrient and metal composition.

According to the variance analysis on the mean concentrations of N, Mg, ($p < 0.01$) and Ca, B, Active Fe, Mn and Cd ($p < 0.05$) were found to be statistically different in the leaves depending on the cultivars (Table 2). The N, Ca, Mg, Mn and Cd concentrations were found high levels in Deveci but B and Active Fe contents were found in high levels in Santa Maria leaf tissue samples.

Table 2. The comparison of mean values and results of the t-test at leaf samples.

		%					mg kg^{-1}										
		N	P	K	Ca	Mg	B	Act. Fe	Fe	Zn	Cu	Mn	Ni	Co	Cr	Pb	Cd
LEAF	Deveci	2.39 a	0.13	1.00	1.06 a	0.27 a	22.69 b	21.98 b	53.41	33.20	16.39	166.95 a	4.47	1.81	0.00	1.33	0.60 a
	Santa Maria	2.19 b	0.13	1.03	0.96 b	0.23 b	27.96 a	25.64 a	55.81	32.35	16.76	135.85 b	4.23	1.76	0.00	1.23	0.41 b
	t ratio	-4.95	0.25	0.63	-3.28	-4.28	2.67	2.17	0.61	-0.40	0.38	-1.77	-0.45	-0.31	-	-0.25	-1.98
	Significance	**	n.s	n.s	*	**	*	*	n.s	n.s	n.s	*	n.s	n.s	-	n.s	*

*P<0.05 and **P<0.01: *; ns: not significant

Fruit analysis

The contents of some nutrients in pear fruit were evaluated considering critical values reported for pear by Soylu (2006) (N ≤ 0.05 %, P ≤ 0.01%, K ≤ 0.14%, Ca ≤ 0.01%, Mg ≤ 0.01%, B≤ 8.3 mg kg^{-1}). Metal concentrations in the fruit were evaluated considering critical values reported for fruit by Anonymous (2008) (Fe ≤ 15 mg kg^{-1}), Herrick (1990) (Mn≤ 20 mg kg^{-1}), and WHO/FAO (WHO/FAO, 1984) (Zn ≤ 10 mg kg^{-1}, Cu ≤ 10 mg kg^{-1}, Ni ≤ 0.6 mg kg^{-1}, Cr ≤ 0.5 mg kg^{-1}, Co ≤ 0.4 mg kg^{-1}, Pb ≤ 0.2 mg kg^{-1}, Cd ≤ 0.03 mg kg^{-1}) According to the results; both of the Deveci and Santa Maria orchards showed not deficiency for nutrient contents. Contents of the nutrients were found to be in the tolerable levels in the pear samples. The heavy metal concentrations were not found in toxic level in all of the orchards in the fruit samples (Table 3). Similar findings were reported by Chen et al. (2007) and Öztürk et al. (2009).

Table 3. Fruit materials mineral composition of pear cultivars.

			%					mg kg^{-1}									
			N	P	K	Ca	Mg	B	Fe	Zn	Cu	Mn	Ni	Co	Cr	Pb	Cd
FRUIT FLESH	Deveci	Min.	0.13	0.01	0.26	0.001	0.02	0.61	3.27	0.04	0.08	0.02	0.00	0.00	0.00	0.00	0.00
		Max.	0.59	0.10	0.76	0.04	0.05	43.53	12.33	5.99	5.65	5.75	0.16	0.06	0.00	0.07	0.00
		MEAN	**0.26**	**0.04**	**0.52**	**0.01**	**0.03**	**9.81**	**7.11**	**2.15**	**1.96**	**1.91**	**0.03**	**0.01**	**0.00**	**0.01**	**0.00**
	Santa Maria	Min.	0.16	0.02	0.21	0.01	0.01	3.04	4.02	0.04	0.04	0.01	0.00	0.00	0.00	0.00	0.00
		Max.	1.10	0.10	1.18	0.19	0.07	71.87	39.02	9.99	4.43	5.44	0.55	0.05	0.00	0.05	0.00
		MEAN	**0.49**	**0.06**	**0.69**	**0.07**	**0.04**	**17.71**	**11.69**	**3.76**	**1.49**	**1.90**	**0.06**	**0.01**	**0.00**	**0.01**	**0.00**
FRUIT PEEL	Deveci	Min.	0.11	0.01	0.26	0.01	0.03	1.01	2.05	0.91	0.02	0.01	0.00	0.00	0.00	0.00	0.00
		Max.	0.97	0.16	0.80	0.12	0.07	60.32	15.44	30.69	6.69	8.70	0.27	0.16	0.00	0.08	0.00
		MEAN	**0.45**	**0.04**	**0.42**	**0.05**	**0.04**	**15.16**	**7.04**	**7.43**	**2.35**	**3.21**	**0.02**	**0.07**	**0.00**	**0.01**	**0.00**
	Santa Maria	Min.	0.28	0.01	0.26	0.02	0.02	3.04	0.31	0.5	0.03	0.001	0.00	0.00	0.00	0.00	0.00
		Max.	1.04	0.11	0.89	0.14	0.10	33.02	18.94	18.41	5.83	11.07	0.48	0.16	0.00	0.04	0.00
		MEAN	**0.51**	**0.05**	**0.44**	**0.06**	**0.04**	**12.64**	**6.44**	**6.31**	**2.11**	**3.15**	**0.04**	**0.06**	**0.00**	**0.01**	**0.00**

Fruit flesh analysis showed significantly important differences among the pear cultivars on N, K, Ca, Mg, Zn ($p < 0.01$) and P, B, Fe ($p < 0.05$). On the other hand fruit peel analysis did not significantly important for nutrient elements except Ca. Öztürk et al. (2009), were studied also Deveci and Santa Maria pear cultivars. They reported that P, K, Mg and Na content were determined significantly important differences among this pear cultivars (Table 4).

Table 4. The comparison of mean values and results of the t-test at fruit parts.

		%					mg kg^{-1}									
		N	P	K	Ca	Mg	B	Fe	Zn	Cu	Mn	Ni	Co	Cr	Pb	Cd
FRUIT FLESH	Deveci	0.26 b	0.04 b	0.52 b	0.01 b	0.03 b	9.81 b	7.11 b	2.15 b	1.96	1.91	0.03	0.01	0.00	0.01	0.00
	Santa Maria	0.49 a	0.06 a	0.69 a	0.07 a	0.04 a	17.71 a	11.69 a	3.76 a	1.49	1.90	0.06	0.01	0.00	0.01	0.00
	t ratio	6.51	3.39	4.47	8.34	5.56	3.12	3.57	4.20	-1.56	-0.02	1.56	0.06	-	0.64	-
	Significance	**	*	**	**	**	*	*	**	n.s	n.s	n.s	n.s	-	n.s	-
FRUIT PEEL	Deveci	0.45	0.04	0.42	0.05 ab	0.04	15.16	7.04	7.43	2.35	3.21	0.02	0.07	0.00	0.01	0.00
	Santa Maria	0.51	0.05	0.44	0.06 a	0.04	12.64	6.44	6.31	2.11	3.15	0.04	0.06	0.00	0.01	0.00
	t ratio	1.63	1.45	0.68	1.84	0.78	-1.19	-0.69	-0.79	-0.58	-0.09	-1.34	-0.70	-	-0.77	-
	Significance	n.s	n.s	n.s	*	n.s	n.s	n.s	n.s	n.s	n.s	n.s	n.s	-	n.s	-

**P <0.05 and **P <0.01: *; ns: not significant

Conclusion

The results showed that concentrations of the elements in the leaves and fruit parts of two different pear cultivar were closely similar but on the other hand statistical important differences among the pear cultivars on N, Ca, Mg, B and Zn contents were observed.

The pear aroma, flavor and quality is affected by some factors as climatic factors, variety, geographical conditions, agricultural managing, rootstock, soil conditions. This research can not make a decision about which kind of pear variety have the best quality. But we can evaluade the chemical composition of two important pear varieties. Therefore, interpretations of the leaf and fruit analysis data from the different pear cultivars can made by comparing to a single set of critical concentrations or sufficiency ranges. Further researchs on the chemical status of pear varieties should be conducted to improve nutritional quality and to develop more processed pear products.

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