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Mineral Contents of Several Grape Seeds

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The mineral contents (Al, B, Ca, Co, Mo, Cr, Fe, K, Mg, Mn, Na, P, S, Se and Zn) of some grape seeds collected from different locations of Turkey were established by inductively coupled plasma atomic emission spectrometry (ICP-AES). Ca, K, Mg, Na and P were established as the major minerals in Dimrit (Doganhisar-Konya), Iri ak Uzum (Doganhisar-Konya), topacik (Konya), Koz (Kargicak-Silifke-Mersin) and Honusu (Gulnar-Mersin) grape seeds, respectively. While Al, B, Fe, Mn and Zn mineral contents of seeds were found partly similar in all the seeds, the Co, Mo, Cr and Se contents were found very low. As a result, grape seeds were thought to be important sources of nutrients and essential elements.

Key Words: Grape seeds, Minerals, Ca, Mg, K, P, ICP-AES.

INTRODUCTION

There are many identified cultivars of grape grown in Turkey. Turkey has a very rich genetic potential in grapes due to varying climatic conditions and is one of the world's leading grape producers. Turkey has had a grape industry since 3000-4000 years BC according to archaeological findings[1-4]. About 40 % of total grape production in Turkey is used in wine making and the production of traditional foods such as molasses, vinegar, grape juice and "pekmez" (boiled grape juice)[4-6]. The large amount of grape seeds were obtained from processing of wine, vinegar and the other grape products. About the total production amounts of grape seeds is average 2-3 % of the grape production capacity (about 40 % grape production[2,5,7].

The medicinal and nutritional value of grapes has been known for thousands of years[8]. Grape seed is a natural plant substance which is a source of oligomeric proanthocyanidins. Grape seed extract may be helpful in asthma and allergies. Several studies support the use of proanthocyanidins, such as those found in grape seed, as a supplement for allergic conditions (including airborne and food allergies)[9-12]. In addition of oil content of grape seeds, they contain mineral contents, polyphenols[13,14]. In the earlier part of this century, scientists could qualitatively detect small amounts of several mineral elements in living organisms. The trace elements found in living organisms may be essential[15,16]. Human, as well as animal, studies originally showed that optimal intakes of elements such as sodium, potassium, magnesium, calcium, manganese, copper, zinc and iodine could reduce individual risk factors, including

those related to cardiovascular disease[17-19]. The increase in the consumption of refined foods and the lack of vitamins and minerals in the diet can cause health problems. Dietary supplements are widely utilised as a way to include essential vitamins and minerals in the diet[20].

Due to the importance of grape seeds as sources of bioactive constituents on functional nutrients, the aim of the present study was by-products of agro industries. So, the use of these waste materials can contribute on human health.

EXPERIMENTAL

Grape fruits were collected from different locations of Turkey and were separately crushed by hand and their pulps were removed from seeds. The seeds were washed with distilled water three times. Then, the seeds were dried in atmospheric conditions. The dried materials were finely ground in a mortar and kept in sealed bottles until analysis. The common and location names of grape seeds are given in Table-1.

TABLE-1
COMMON AND LOCATION NAMES USED IN EXPERIMENT

No.	Common name	Locations	No.	Common name	Locations
1	Büzgülü	Gülnar-Mersin	26	Hönüsü	Gülnar-Mersin
2	Çavus-beyaz	Konya	27	Sergi	Hadim-Konya
3	Ziraat-Beyaz	Beybes-Konya	28	Güzgülü	Gülnar-Mersin
4	Deve gözü- siyah	Doganhisa-Konya	29	Eksi kara	Hadim-Konya
5	Marcas-beyaz	Gülnar-Mersin	30	Müsgüle	Gaziantep
6	Hesapali	Hadim-Konya	31	Hönüsü	Gaziantep
7	Miski	Gülnar-Mersin	32	Topacik	Beysehir-Konya
8	Dimrit-Siyah	Doganhisar-Konya	33	Pekmezlik	Alakovan-Konya
9	Recep-yesil	Gülnar-Mersin	34	Adana beyazi	Büyükeceli-Gülnar
10	Keçimen siyah	Beybes-Konya	35	Tarsus Beyazi	Mersin
11	Aküzüm-Beyaz	Konya	36	Koz	Silifke-Mersin
12	Kardinal	Gülnar-Mersin	37	Razaki	Gaziantep
13	Dökülgen	Konya	38	Topacik	Konya
14	Büzgülü	Isparta	39	Antep karasi	Gaziantep
15	Pekmezlik-siyah	Bozkir-Konya	40	Kadin parmagi	Silifke-Mersin
16	Iri aküzüm	Doganhisar-Konya	41	Büzgülü	Konya
17	Küçük aküzüm	Doganhisar-Konya	42	Nazli	Konya
18	Barinak	Silifke-Mersin	43	Karadimrit	Hadim-Konya
19	Ince Kabuk	Hadim-Konya	44	Misket	Hadim-Konya
20	Torosbeyazi-sari	Doganhisar-Konya	45	Ispitiren	Hadim-Konya
21	Kizil üzüm (sik dimrit)	Konya	46	Göküzüm	Taskent-Konya
22	Kara üzüm (sik dimrit)	Doganhisar-Konya	47	Irikara	Taskent-Konya
23	Gök üzüm	Konya	48	Isbitiren	Taskent-Konya
24	Kizil üzüm	Bozkir-Konya	49	Dimrit	Taskent-Konya
25	Siyah erkek üzüm	Bozkir-Konya	50	Muftalma	Taskent-Konya

Methods

Determination of mineral contents: About 0.5 g of finely ground grape seed samples was put into burnig cup with 15 mL of pure NHO_3. The sample was incinerated in a MARS 5 microwave oven at 200 °C. Distilled deionized water and ultra high-purity commercial acids were used to prepare all reagents, standards and grape seed samples. After digestion the samples were filtrated through Whatman No. 42. The filtrates were collected in 50 mL Erlenmayer flasks and analyzed by ICP-AES. The mineral contents of the samples were quantified against standard solutions of known concentrations which were analyzed concurrently[21].

Working conditions of ICP-AES: Instrument: ICP-AES (Varian-Vista, RF power: 0.7-1.5 kw (1, 2-1, 3 kw for Axial), plasma gas flow rate (Ar): 10.5-15.0 L/min (radial) 15" (axial), auxilary gas flow rate (Ar): 1.5", viewing height: 5-12 mm, copy and reading time: 1-5 s (max. 60 s), copy time: 3 s (max. 100 s).

RESULTS AND DISCUSSION

The mineral contents of grape seeds were determined by ICP-AES. The mineral compositions of seeds are summarized in Table-2. Mineral elements were found to vary widely depending on different grape seeds.

According to results, Ca, K, Mg, Na, P and S contents of all the grape seed samples were generally found very high. In addition, Al, B, Fe, Mn and Zn minerals were established in a similar range for all the seeds. Also, Co, Mo, Cr and Se contents of seeds were established very low.

While calcium content was high (10108.4 mg/Kg) in Dimrit (Doganhisar-Konya), it was low (2722.6 mg/Kg) in Razaki seed (Gaziantep). The level of potassium of Iri ak üzüm (Doganhisar-Konya), in this work, was found to be higher (9342.6 mg/Kg) than other samples. This element was high in most cases and ranged from 3488.6 mg/Kg (Aküzüm-Konya) to 9342.6 mg/Kg (Iri ak uzum-Doganhisar-Konya). Magnesium content ranged from 1011.7 mg/Kg (Pekmezlik-Bozkir-Konya) to 1796.6 mg/Kg (Topacik-Konya). Sodium contents of the seeds were found in similarly small percentages in all the seeds analyzed. The level of sodium ranged from 424.3 mg/Kg (Karadimrit-Hadim-Konya) to 601.7 mg/Kg (Koz-Kargicak-Silifke), whereas phosporus contents varied from 2600.2 mg/Kg (Pekmezlik-Bozkir-Konya) to 4633.2 mg/Kg (Honusu-Gülnar-Mersin). On the other hand, among these seeds, S was found in large amounts between 665.7 mg/Kg (Kardinal-Buyukeceli-Mersin) and 1298.4 mg/Kg (Miski-Gülnar-Mersin). Of the high mineral contents, the levels of Ca, K, Mg and P were shown in Figs. 1-4.

Goktangolar *et al.*[4] established 12.29 mg/Kg zinc, 17.30 mg/Kg iron, 11.33 mg/Kg manganese and 9.29 mg/Kg copper in razaki seed. Fe, Mn and Cu contents of grape seeds determined in this study are high with respect to result of Goktangolar *et al.*[4]. Kamel *et al.*[22] reported that grape seeds were found to contain significant levels of Ca, Mg, P and K.

TABLE-2
MINERAL CONTENTS OF SEVERAL GRAPE SEEDS (mg/Kg)*

Samples	Minerals															
	Al	Co	Mo	Ca	B	Cr	Cu	Fe	K	Mg	Mn	Na	P	S	Se	Zn
Büzgülü	9.42	0.09	0.04	5922.5	20.5	0.49	5.47	10.7	5252.8	1104.4	14.9	505.5	3984.2	1035.1	0.00	10.1
Çavus-beyaz	24.17	0.16	0.12	5497.4	13.1	0.52	3.46	18.9	4546.5	1488.9	17.6	502.7	3805.9	911.5	0.11	11.3
Ziraat-Beyaz	7.11	0.23	0.34	9377.3	16.7	0.46	6.83	10.3	4920.3	1152.7	22.7	440.4	3859.6	881.5	0.16	12.2
Deve gözü-siyah	14.57	0.24	0.01	4545.1	20.8	0.45	1.007	5.4	6829.8	1232.5	6.4	473.1	3241.3	837.5	0.09	8.1
Marcas	6.20	0.11	0.16	4305.4	13.6	0.51	6.06	11.9	5830.4	1394.8	3.4	474.9	3429.1	862.8	0.08	13.8
Hesapali	11.98	0.15	0.12	7350.7	8.767	0.53	3.25	15.9	3955.6	1524.3	49.5	443.8	4062.8	1030.4	0.04	12.8
Miski	11.35	0.16	0.44	5134.4	14.6	0.63	6.94	10.7	3966.6	1210.9	34.6	596.7	3915.1	1298.4	0.32	11.8
Dimrit-Siyah	35.16	0.06	0.05	10108.4	15.6	0.47	3.73	15.3	4921.6	1224.1	16.8	453.8	3831.9	879.1	0.08	11.0
Recep-yesil	22.07	0.13	0.12	7723.7	10.5	0.46	5.31	12.1	4044.7	1216.1	76.7	427.9	3308.6	991.4	0.09	16.9
Keçimen siyah	7.41	0.00	0.00	4716.2	12.6	0.57	7.25	11.4	6229.1	1188.3	22.6	621.1	4070.2	1022.2	0.18	7.5
Aküzüm-Beyaz	11.56	0.22	0.00	3368.9	12.5	0.57	1.24	9.3	3488.6	1239.2	17.4	488.2	2874.2	792.0	0.12	8.0
Kardinal	7.99	0.15	0.00	6221.5	8.8	0.55	0.99	11.9	5732.6	1137.6	105.1	533.8	2928.7	665.7	0.18	9.1
Dökülgen	19.91	0.20	0.00	4946.8	13.2	0.66	6.37	11.6	6530.0	1548.7	21.9	601.3	4163.0	1165.9	0.00	11.5
Büzgülü	12.90	0.06	0.69	5794.9	8.5	0.47	17.80	21.6	7115.0	1252.4	16.8	480.1	3825.4	1026.2	0.00	13.8
Pekmezlik-siyah	25.43	0.08	0.13	3513.2	12.9	0.50	3.54	13.1	6262.7	1011.7	24.6	504.9	2600.3	717.9	0.02	25.6
Iri aküzüm	45.06	0.26	0.32	8590.9	21.4	0.58	4.04	13.7	9342.6	1414.9	14.9	584.5	3864.7	906.1	0.10	12.8
Küçük aküzüm	120.04	0.20	0.07	6691.9	11.1	0.57	7.11	22.2	5080.4	1230.0	10.9	461.2	3601.9	1096.2	0.07	13.7
Barinak	13.98	0.13	0.00	3957.9	5.9	0.43	7.45	26.5	5475.0	1517.9	38.5	441.3	3117.3	929.9	0.00	12.2
Ince Kabuk	14.69	0.11	0.11	4312.7	17.9	0.53	2.09	10.7	5183.4	1257.9	82.7	510.9	2857.4	909.2	0.157	11.5
Toros beyazi	13.61	0.24	0.28	6905.2	8.6	0.46	2.43	12.2	5578.9	1699.9	30.8	449.9	4364.3	1041.4	0.15	13.0
Kizil üzüm (sik dimrit)	57.5	0.26	0.14	4025.4	11.7	0.60	3.80	22.4	5241.2	1271.2	10.4	508.2	4144.1	1051.6	0.16	13.7
Kara üzüm (sik dimrit)	15.7	0.14	0.07	7186.4	15.0	0.44	0.87	12.9	4553.9	1221.4	20.3	447.8	3667.9	961.4	0.09	12.4

Gök üzüm	13.1	0.11	0.00	4052.4	13.1	0.47	4.43	6.35	4952.5	1289.2	10.2	464.3	3594.9	1106.5	0.12	9.8
Kizil üzüm	14.7	0.16	0.00	6103.6	9.2	0.58	3.88	18.7	4933.2	1128.6	18.7	461.9	3228.1	832.0	0.11	12.6
Siyah erkek üzüm	10.2	0.11	0.04	5185.6	17.9	0.57	6.42	9.5	7820.9	1307.2	23.7	511.7	3651.97	1011.8	0.01	9.5
Hönüsü	13.2	0.19	0.00	3611.8	10.6	0.53	6.61	15.4	6512.8	1560.9	17.5	505.8	4633.2	988.5	0.20	11.5
Sergi	4.6	0.17	0.00	5195.3	6.3	0.58	3.59	8.7	4077.5	1383.7	11.0	546.9	3254.3	820.5	0.06	10.9
Güzgülü	18.5	0.13	0.00	4332.4	9.7	0.47	7.41	17.0	6518.1	1494.5	20.9	433.9	4502.9	1017.0	0.01	10.6
Eksi kara	6.7	0.00	0.12	5300.7	16.8	0.45	3.59	15.1	6416.8	1145.8	19.5	464.5	3310.7	944.0	0.05	11.7
Müsgüle	11.5	0.16	0.00	6718.5	19.0	0.53	4.19	9.4	4402.9	1130.3	27.5	532.3	3379.9	841.3	0.07	9.2
Hönüsü	24.8	0.17	0.00	6523.5	9.9	0.67	4.05	15.9	4584.7	1284.3	9.0	603.2	3805.4	943.2	0.08	11.6
Topac?k	8.4	0.19	0.08	3884.3	10.2	0.47	8.41	14.9	4794.1	1366.2	12.0	430.8	3982.9	1064.5	0.00	9.7
Pekmezlik	21.2	0.13	0.00	3439.6	15.0	0.48	3.05	14.2	5888.9	1046.9	11.3	458.3	3486.9	819.5	0.15	7.11
Adana beyazi	17.5	0.03	0.00	6097.8	4.1	0.49	4.41	15.8	4779.7	1162.0	17.3	473.81	3344.1	829.3	0.08	7.9
Tarsus Beyazi	14.0	0.01	0.00	5713.6	6.6	0.51	3.93	11.1	6672.9	1374.6	13.7	631.7	3308.9	720.6	0.20	11.2
Koz	16.5	0.12	0.00	3258.1	9.8	0.56	4.42	12.1	5894.9	1550.6	9.5	534.4	3508.2	853.7	0.06	6.7
Razaki	14.7	0.11	0.00	2722.6	6.4	0.49	5.99	19.1	4545.7	1738.5	19.0	446.9	3857.0	1013.4	0.06	10.3
Topacik	19.9	0.12	0.00	5196.5	16.3	0.61	11.19	33.7	4898.5	1796.6	18.2	546.8	4271.1	1122.9	0.06	14.7
Antep karasi	8.32	0.00	0.00	3023.6	11.8	0.62	6.79	20.9	7142.9	1505.6	13.4	541.5	2754.6	753.6	0.21	9.3
Kadin parmagi	16.26	0.00	0.00	4883.7	10.6	0.54	4.60	12.4	5406.7	1206.6	11.9	565.1	2953.8	796.7	0.18	9.6
Büzgülü	15.3	0.00	0.05	5604.5	11.2	0.56	1.56	18.5	5982.1	1110.6	17.1	591.3	3376.4	1075.1	0.17	10.1
Nazli	20.1	0.11	0.18	3679.9	6.1	0.54	1.57	14.6	5722.0	1273.9	13.7	506.4	3944.1	1044.2	0.09	9.2
Karadimrit	7.1	0.15	0.16	3085.5	5.1	0.45	1.35	11.9	4791.9	1069.4	11.5	424.3	3323.2	881.0	0.09	7.791
Misket	10.3	0.16	0.15	3390.2	16.5	0.49	2.51	16.9	8448.7	1269.6	14.9	457.6	3127.2	838.3	0.04	6.5
Ispitiren	9.3	0.00	0.00	6682.6	11.0	0.50	3.21	43.9	5982.8	1317.0	15.2	502.7	3457.9	912.0	0.17	11.7
Göküzüm	14.1	0.10	0.18	4628.4	7.6	0.49	6.06	14.9	5443.2	1046.4	18.2	448.3	3315.5	701.4	0.09	16.9
Irikara	17.5	0.14	0.00	3653.3	19.9	0.52	7.92	11.3	7124.3	1374.8	9.2	536.3	3349.0	931.9	0.07	8.3
Isbitiren	21.1	0.10	0.09	3599.1	19.9	0.54	7.93	11.1	7045.8	1355.4	9.1	533.4	3308.7	919.3	0.06	8.1
Dimrit	9.9	0.07	0.44	5106.7	12.8	0.54	1.46	17.4	5580.6	1149.7	16.0	557.6	3730.1	1131.7	0.08	10.1
Muftalma	15.3	0.12	0.17	4968.1	11.1	0.50	6.92	13.1	6297.5	1065.6	11.5	511.5	36705.2	865.1	0.00	10.9

*Dry weight basis.

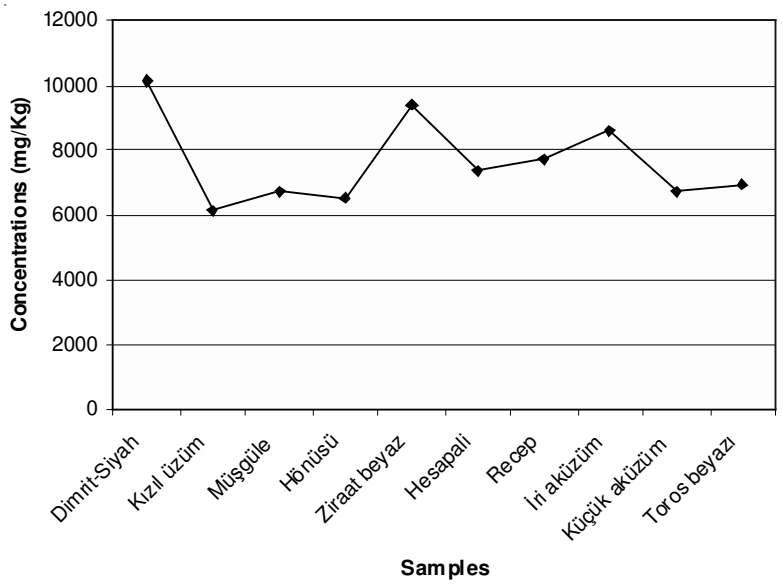

Fig. 1. Calcium contents of some selected grape seeds

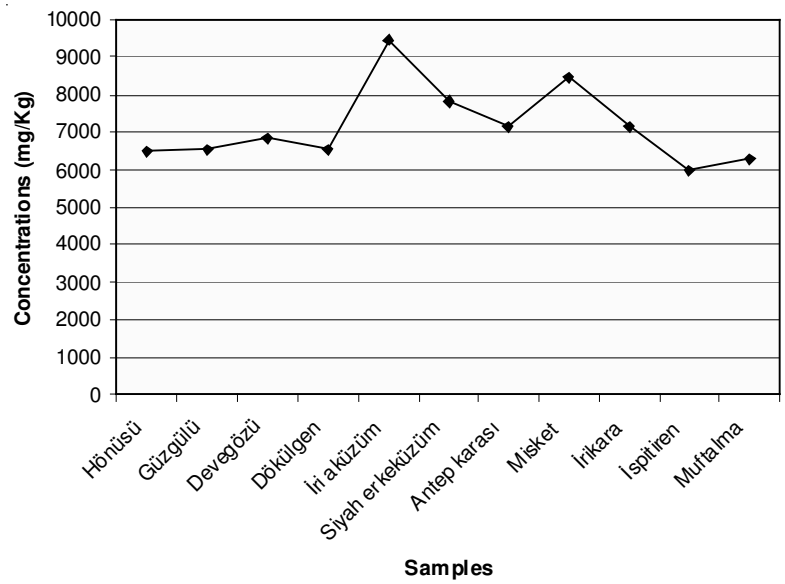

Fig. 2. Potassium contents of some selected grape seeds

These differences of the mineral contents of grape seeds may be due to growth conditions, varieties, genetic factors, harvesting times, soil properties, geographical variations and analytical procedures[23,24]. Calcium is the major component of bone and assists in teeth development[25]. The importance of these elements can not be over emphasized because many enzymes require them as cofactors[26]. The essential

role of selenium for human health has been well established in recent years[27]. Selenium has an active role as a modulator in inflammatory and immune responses[28]. Other elements which may contribute to biological processes, but which have not been established as essential, are barium, bromine, cadmium, lead and lithium[23].

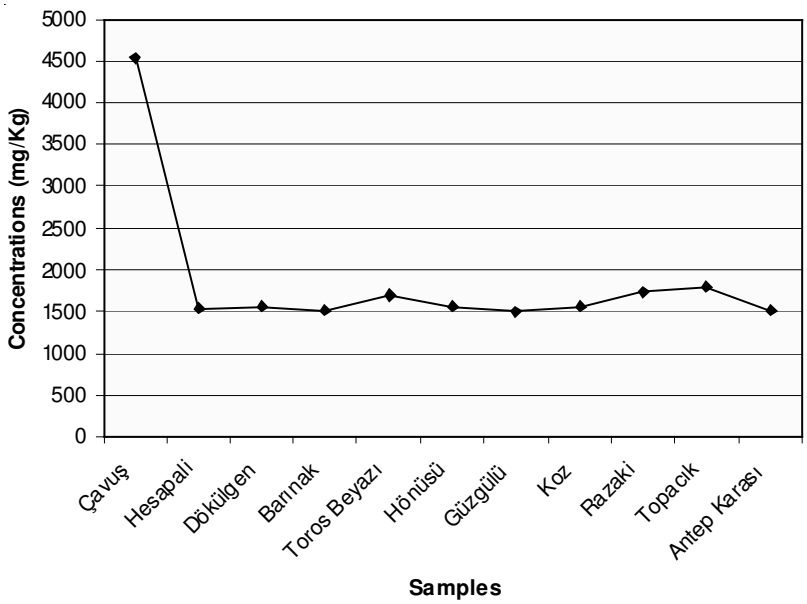

Fig. 3. Magnesium contents of some selected grape seeds

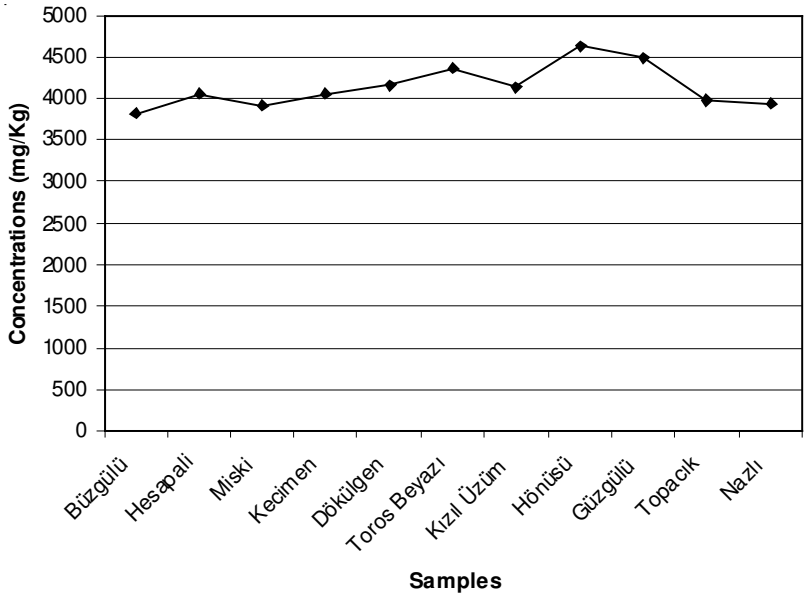

Fig. 4. Phosphorus contents of some selected grape seeds

Conclusion

The mineral contents (Al, B, Ca, Co, Mo, Cr, Fe, K, Mg, Mn, Na, P, S, Se and Zn) of grape seeds collected from different locations of Turkey were established by ICP-AES. The contents of Ca, Fe, K, Mg, P and Zn of samples are adequate levels. Mineral elements were found to vary widely depending on different grape seeds. Grape seeds were found to be important sources of nutrients and essential elements. In addition, it is apparent that grape seeds are good sources of the micro and macro minerals and consumed as a food ingredient to provide the human nutrition.

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REFERENCES

1. T. Onul, Agriculture in Turkey, Ankara: Barok Press (1999) (in Turkish).
2. S. Celik, Bagcilik (Ampeloloji) Cilt 1. Sti: Anadolu Matbaa Ambalaj San. ve Tic. Ltd.. p. 426s (1998).
3. Tuik, Turkiye Istatistik Kurumu. Available online at: http://www.tuik.gov.tr/PrelstatistikTablo.doristab_id:70.Accessed 3/8/07 (2006).
4. S. Göktangolar, Y. Özogul, S. Tangolar and A. Torun, *Int. J. Food Sci. Nutr.*, **60**, 32 (2009).
5. H. Çelik, S. Çelik, B. Kunter, B.M. Kunter, G. Söylemezoglu, Y. Boz, C. Özer and A. Atak, Bagcilikta gelisme ve üretim hedefleri, VI Türkiye Ziraat Mühendisligi Teknik Kongresi, Ankara (2005).
6. Anonymous, 2006/2007 Ege Bölgesi Sumalik Üzüm Pazarlama Dönemi Degerlendirmes, Available online at: http://www.tzob.org.tr./tzob_web/tbmm_iletilenler/Uzum-2006.doc.accessed 8/9/2007 (2007).
7. H. Çelik, Y.S. Agaoglu, Y. Fidan, B. Marasali Kunter and G. Söylemezoglu, Genel Bagcilik, Sunfidan A.S. Mesleki Kitaplar Serisi, Vol. 1, 253 (1998).
8. Anonymous, Available in: http://www.umm.edu/altmed/articles/grape-seed-000254.htm (2008).
9. L. Bielory, *Ann. Allergy Asthma Immunol*., **93**, 45 (2004).
10. J. Busserolles, E. Gueux and B. Balasinska, *Int. J. Vit. Nutr. Res.*, **76**, 22 (2006).
11. Anonymous, Available in:http://www.bodybuildingforyou.com/health-supplements/grape-seed-extract.htm, Accessed December (2008).
12. Y. Nakamura, S. Tsuji and Y. Tonogai, *J. Health Sci.*, **49**, 45 (2003).
13. J.E. Kinsella, *Food Tech*., **28**, 58 (1974).
14. S.S. Joshi, C.A. Kuszynski and D. Bagchi, *Curr. Pharm. Biotechnol.*, **2**, 187 (2001).
15. A. Koedam, *J. Sci. Food Agric.*, **36**, 681 (1986).
16. E. Yesilada and N. Ezer, *Int. J. Crude Drug Res.*, **27**, 38 (1989).
17. M. Anke, B. Groppel and H. Kronemann, Significance of Newer Essential Trace Elements (Like Si, Ni, As, Li, Vi, …) for the Nutrition of Man and Animals, In eds.: P. Bratter and P. Schramel, In: Trace Element-Analytical Chemistry in Medicine and Biology, Vol. 3, pp. 421-464, Berlin (1984).
18. W. Mertz, *Food Protect,* **41**, 2807 (1982).
19. C.P. Sanchez-Castillo, P.J.S. Dewey, A. Aguirre, J.J. Lara, R. Vaca, P. Leon de la Bara, M. Ortiz, I. Escamilla and W.P.T. James, *J. Food Comp. Anal*., **11**, 340 (1998).
20. M. Ivey and G. Elmen, Nutritional Supplement, Mineral and Vitamin Production in: Handbook of Non-prescription Drugs, edn. 8, American Pharmaceutical Association, The National Professional Society of Pharmacists, 2215 Constitution Avenue, N.W. Washington, DC 20037, USA, p. 215 (1986).

21. S. Skujins, Handbook for ICP-AES (Vartian-Vista) A short guide to Vista series (CP) AES operation, Variant Int. Ag. Zug, Version 1.0, Switzerland (1998).
22. B.S. Kamal, H. Dawson and Y. Kakuda, *J. Am. Oil Chem. Soc.*, **62**, 881 (1985).
23. R. Macrae, R.K. Robinson and M.J. Sadler, Encyclopaedia of Food Science, Food Technology and Nutrition, Vol. 5, pp. 3126-3131, Academic Press Inc., San Diego, CA (1993).
24. M.M. Özcan, A. Ünver, T. Uçar and D. Arslan, *Food Chem.*, **106**, 1120 (2008).
25. T. Brody, Nutritional Biochemistry, San Diego, CA: Academic Press (1994).
26. M.I. Akpanabiatu, N.B. Bassey, E.O. Udosen and E.U. Eyong, *J. Food Comp. Anal.*, **11**, 292 (1998).
27. L.H. Foster, M.F. Chaplin and S. Sumar, *Food Chem.*, **62**, 21 (1998).
28. J. Neve, *Experimentia*, **47**, 187 (1991).

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