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Mineral Content of Berries in Native Grape Cultivars Grown in Mid-Black Sea Zone

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Abstract
Fruits present safe and healthy nutrition in the human diet. They are rich sources of certain macro and micronutrients. Environmental factors such as temperature, rainfall, sunshine, wind, soil and many other growing conditions effects chemical composition of the berries. The present study was conducted to investigate 24 grape cultivars from the Mid-Black Sea zone in terms of berry mineral composition. Analysis was performed according to official methods procedure and the contents of Phosphorus (P), Calcium (Ca), Magnesium (Mg), Manganese (Mn), Iron (Fe), Copper (Cu), Zinc (Zn), Boron (B) and Selenium (Se) were determined by ICP-OES (Inductively Coupled Plasma Optical Emission Spectroscopy) and Potassium (K) was measured by AAS (Atomic absorption spectroscopy). The results indicated that the mineral composition of grapes differ according to genotype.

Keywords: Grape, mineral nutrients, *Vitis vinifera* L., cultivar

Orta Karadeniz Geçit Kuşağında Yetişen Bazı Yerli Üzüm Çeşitlerinin Mineral Madde Kompozisyonu

Öz: Meyveler, besin maddelerince zengin güvenli ve sağlıklı beslenme kaynaklarıdır. Başta, sıcaklık, yağış, güneş, rüzgar, toprak gibi ekolojik faktörler ve diğer birçok yetiştirme koşulları gibi çevresel faktörler, meyvelerin kimyasal bileşimini etkilemektedir. Bu çalışmada Orta Karadeniz Kuşağı'nda yetişen 24 üzüm çeşidinin tane mineral madde kompozisyonu belirlenmiştir. Çalışmada, Fosfor (P), Kalsiyum (Ca), Magnezyum (Mg), Bakır (Cu), Mangan (Mn), Demir (Fe), Çinko (Zn), Bor (B) ve Selenyum (Se) ICP-OES (İndüktif Olarak Eşleşmiş Plazma Optik Emisyon Spektrometresi), Potasyum (K) ise AAS (Atomik Absorpsiyon Spektroskopisi) cihazları ile belirlenmiştir. Sonuçlar, aynı koşullarda yetiştirilen üzüm çeşitlerine ait tane mineral bileşiminin genotiplerde değiştiğini göstermiştir.

Anahtar kelimeler: Üzüm, mineral madde, *Vitis vinifera* L., çeşit

1. Introduction

Balanced nutrition is intake of nutrients adequately and on time for human health. Despite technology and advances in the level of life, nowadays, balanced nutrition has been still popular and one of the most issues that inadequacy in its practice in the world. Therefore, it is very important to determine the basic and trace mineral element contents of food in terms of balanced nutrition.

Fruits are source of minerals that are potentially useful for human health. Grape is one of featured fruit that helps the growth of bones and teeth with having the mineral substances and providing appropriate pH value for blood. Winkler et al. (1974) reported that 100 g fresh grape contains 0-70 ppm B, 40-250 ppm Ca, 0-3

ppm Cu, 0-30 ppm Fe, 100-250 ppm Mg, 0-51 ppm Mn, 1500-2500 ppm K, 200-500 ppm P, and 0-200 ppm Na.

Minerals are taken from the soil by the grapevine and transferred to the leaves and indirectly to the berries. The amounts are within certain limits and depend on grape cultivar, maturity, soil type, fertilization and climatic conditions (Martins et al. 2012). In general, amount of minerals is lower in arid climatic conditions and dry years. The quantities of minerals are influenced by soil conditions; in addition, some pesticides that used against plant diseases and atmospheric conditions also affect mineral content. In this study, mineral content of some native grape varieties grown in the Mid-Black Sea, which is very important region in terms of ecology and grapevine genetic sources in our country, was determined.

2. Materials and Methods

Materials

24 local grape varieties grown in the Mid-Black Sea region were used in this study. 16 of the cultivars have white skin (Beyaz Tilki Kuyruğu, Boduroğlu, Cılk, Çavuş Aktaş, Çavuş Misket, Çavuş, Çıtlık, Hacı Vel', Hırsız Kesmez, Hosan, Kuş Üzümü, Patlak Üzüm, Şiredenlik1, Şiredenlik, Topşire and Turşuluk) and 8 of these (Kömüşciciği, Kargayüreği, Siyah Üzüm, Kırmızı Üzüm, Fenerid, Kara Üzüm, Kızıl Üzüm and Renkli Üzüm) have black skin color. The maturities of the cultivars were between July 20 and September 25. The cultivars were grown on their own roots and trained with traditionally goble-shaped. Irrigation was unavailable in vineyard. Vines were planted at 1.20 m x 1.20 m (vine x row) spacing. Only the spraying with sulfur and copper were used against to powdery mildew and downy mildew diseases.

Method

Taking of grape samples

When total soluble solids (TSS) was 19.0-23.0%, ten vines representing the cultivars were identified and 3 clusters were harvested from each vine. The clusters were carried in ice containers to the laboratory Then they stored at -20 °C until mineral content analyses.

Mineral content analysis

The berries were washed with tap water and wiped. Then they were placed in paper bag and dried at 65 °C in oven and then ground by grinding machine (Ika, Germany) (Kacar and Inal 2008; Çavuşoğlu 2018). 200 mg of the grinded sample was weighed and placed in an incinerator with 100 ml. Then 2 ml of 67% nitric acid and 8 ml of H_2O_2 were added. When clear and colorless solution was obtained; the amounts of Phosphorus (P), Calcium (Ca), Magnesium (Mg), Manganese (Mn), Iron (Fe), Copper (Cu), Zinc (Zn), Boron (B) and Selenium (Se) were determined in the extracts with external standards of ICP–OES (Inductively coupled plasma–optical emission spectrometry) device; while Potassium (K) content was determined with AAS (Atomic absorption spectroscopy).

Statistical Analysis

The data was obtained from Randomized Plot Design with 3 (three) replication. Analysis of means (ANOM) was performed to determine the variability among the cultivars. Decision limits in the figures were calculated according to ANOM test (Nelson et al. 2005). By considering all traits together, hierarchical cluster analysis was carried out to identify the similarities among the cultivars. In the cluster analysis, Single linkage and Euclidean distance methods were used for linkage and distance methods, respectively. The statistical significance level was considered as 5% and MINITAB (ver: 17) statistical package program was used for all statistical computations.

3. Results and Discussion

Mineral content of the grape berries has been evaluated as quality criteria for the final product. In the study, mineral contents of the rootstocks on their roots were examined independently of the selective effect of them.

Within this framework, mineral content of 24 grape cultivars was presented comparatively in Table 1. P content of grape cultivars ranged from 421.82 mg/kg ('Hırsız Kesmez') to 154.85 mg/kg ('Kömüşciciği'). For the P, the overall mean of cultivars was 230 mg/kg and 95% confidence

interval were between 207.1 and 252.8 mg/kg. According to these results, the means of 'Hırsız Kesmez', 'Cılk', 'Kırmızı Üzüm' and 'Çıtlık' cultivars were higher than 252.8 mg/kg, while the means of 'Kömüşciciği', 'Turşuluk', 'Kara Üzüm', 'Çavuş Misket' and 'Karga yüreği' were lower than 207.1 mg/kg. The differences for the cultivars that located in out of lower and upper limits of 95% confidence interval were statistically significant (Fig 1).

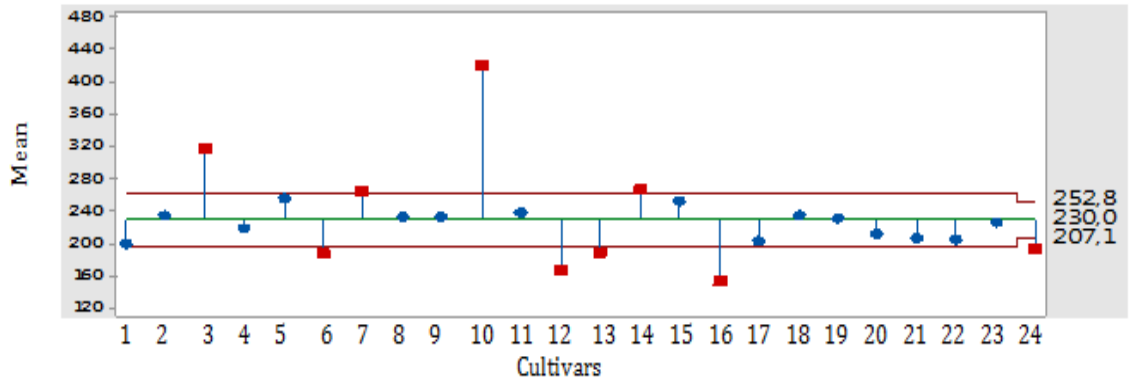

Figure 1. P content of the cultivars (Center line represents overall mean, while upper and bottom lines indicate decision limits for ANOM) [1: Beyaz Tilki Kuyruğu, 2: Boduroğlu, 3: Cılk, 4: Çavuş, 5: Çavuş Aktaş, 6: Çavuş Misket, 7: Çıtlık, 8: Fenerid, 9: Hacı Veli 10: Hırsız Kesmez, 11: Hosan, 12: Kara Üzüm, 13: Kargayüreği, 14: Kırmızı Üzüm, 15: Kızıl Üzüm, 16: Kömüşciciği, 17: Kuş Üzümü, 18: Patlak Üzüm, 19: Renkli Üzüm, 20: Siyah Üzüm, 21: Şiredenlik1, 22: Şiredenlik2, 23: Topşire, 24: Turşuluk]

***Şekil 1**. Çeşitlerin P içeriği (ANOM grafiğinde; merkezdeki çizgi genel ortalamayı, üstteki çizgi Üst karar çizgisini, alttaki çizgi Alt karar çizgisini göstermektedir) [1: Beyaz Tilki Kuyruğu, 2: Boduroğlu, 3: Cılk, 4: Çavuş, 5: Çavuş Aktaş, 6: Çavuş Misket, 7: Çıtlık, 8: Fenerid, 9: Hacı Veli 10: Hırsız Kesmez, 11: Hosan, 12: Kara Üzüm, 13: Kargayüreği, 14: Kırmızı Üzüm, 15: Kızıl Üzüm, 16: Kömüşciciği, 17: Kuş Üzümü, 18: Patlak Üzüm, 19: Renkli Üzüm, 20: Siyah Üzüm, 21: Şiredenlik1, 22: Şiredenlik2, 23: Topşire, 24: Turşuluk]*

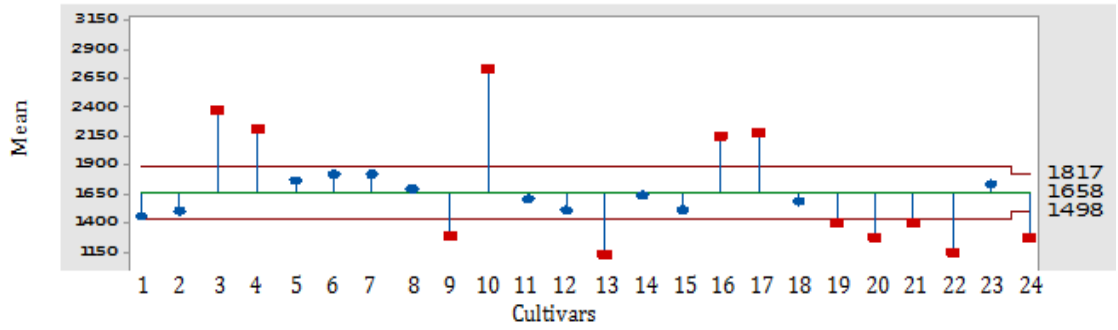

Figure 2. K content of the cultivars (Center line represents overall mean, while upper and bottom lines indicate decision limits for ANOM) [1: Beyaz Tilki Kuyruğu, 2: Boduroğlu, 3: Cılk, 4: Çavuş, 5: Çavuş Aktaş, 6: Çavuş Misket, 7: Çıtlık, 8: Fenerid, 9: Hacı Veli 10: Hırsız Kesmez, 11: Hosan, 12: Kara Üzüm, 13: Kargayüreği, 14: Kırmızı Üzüm, 15: Kızıl Üzüm, 16: Kömüşciciği, 17: Kuş Üzümü, 18: Patlak Üzüm, 19: Renkli Üzüm, 20: Siyah Üzüm, 21: Şiredenlik1, 22: Şiredenlik2, 23: Topşire , 24: Turşuluk]

***Şekil 2.** Çeşitlerin K içeriği (ANOM grafiğinde; merkezdeki çizgi genel ortalamayı, üstteki çizgi Üst karar çizgisini, alttaki çizgi Alt karar çizgisini göstermektedir) [1: Beyaz Tilki Kuyruğu, 2: Boduroğlu, 3: Cılk, 4: Çavuş, 5: Çavuş Aktaş, 6: Çavuş Misket, 7: Çıtlık, 8: Fenerid, 9: Hacı Veli 10: Hırsız Kesmez, 11: Hosan, 12: Kara Üzüm, 13: Kargayüreği, 14: Kırmızı Üzüm, 15: Kızıl Üzüm, 16: Kömüşciciği, 17: Kuş Üzümü, 18: Patlak Üzüm, 19: Renkli Üzüm, 20: Siyah Üzüm, 21: Şiredenlik1, 22: Şiredenlik2, 23: Topşire, 24: Turşuluk]*

Table 1. Mineral contents of the cultivars (mg/kg)
Çizelge 1. *Çeşitlerin mineral içeriği (mg/kg)*

Cultivars	P	K	Ca	Mg	Fe	Mn	Cu	Zn	B	Se
Kargayüreği	189.35	1124.07	379.10	78.83	6.89	0.734	0.234	1.93	0.038	18.73
Siyah Üzüm	212.50	1277.38	359.75	86.79	7.02	0.982	0.267	2.36	0.040	17.34
Kırmızı Üzüm	266.27	1637.05	543.35	102.54	8.00	0.890	0.199	2.20	0.052	19.38
Kuş Üzümü	203.92	2179.00	464.03	70.01	14.94	0.716	0.148	1.80	0.065	14.46
Renkli Üzüm	231.08	1392.60	305.35	63.36	9.14	0.583	0.860	7.33	0.065	15.56
Şiredenlik1	206.68	1396.18	408.78	109.79	14.57	0.834	0.250	8.50	0.048	16.48
Şiredenlik2	205.47	1147.08	362.85	76.04	12.84	0.114	0.112	1.62	0.037	17.40
Beyaz Tilki Kuyruğu	199.30	1456.85	295.95	68.84	11.44	0.976	0.185	1.45	0.030	15.14
Boduroğlu	234.73	1499.83	323.08	86.52	8.47	0.122	0.190	1.53	0.047	18.58
Çavuş Aktaş	255.70	1765.40	408.70	80.31	7.88	0.898	0.102	1.01	0.049	15.85
Çavuş Misket	187.52	1817.15	410.95	82.68	6.62	0.634	0.105	2.58	0.062	11.97
Çıtlık	264.17	1819.95	768.68	112.74	7.60	0.140	0.222	1.58	0.098	17.29
Fenerid	233.42	1691.50	499.30	89.82	22.99	0.109	0.208	3.04	0.087	12.41
Patlak Üzüm	235.20	1583.13	503.73	98.72	6.20	0.106	0.119	1.30	0.085	12.39
Çavuş	219.54	2219.25	528.90	97.25	21.91	0.253	0.289	3.50	0.044	16.53
Hacı Veli	233.10	1284.83	449.73	94.22	8.05	0.127	0.138	2.71	0.029	12.41
Hosan	238.35	1605.18	483.75	88.27	6.77	0.905	0.127	1.76	0.039	14.31
Kara Üzüm	167.78	1512.03	318.88	72.80	5.06	0.770	0.191	2.26	0.026	16.41
Kızıl Üzüm	252.98	1509.70	488.50	110.68	6.95	0.124	0.110	2.31	0.029	17.60
Topşire	226.95	1736.58	433.95	84.96	21.56	0.134	0.160	2.91	0.033	14.70
Turşuluk	230.37	1516.45	506.93	93.71	5.81	0.829	0.868	1.29	0.031	15.45
Cılk	318.55	2377.75	425.25	101.01	8.70	0.841	0.177	1.35	0.039	14.58
Hırsız Kesmez	421.82	2726.00	584.15	138.69	10.42	0.103	0.190	1.21	0.047	16.91
Kömüşciciği	154.85	2147.90	295.88	59.29	15.70	0.124	0.308	3.50	0.026	15.78
Standard Error of Mean	10.8	82.4	22.3	3.77	1.04	0.0708	0.0399	0.357	0.0041	0.406
p	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01

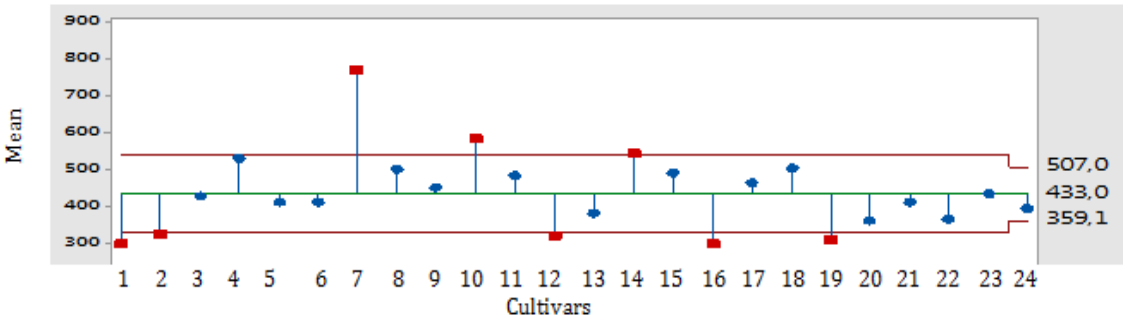

Figure 3. Ca content of the cultivars (Center line represents overall mean, while upper and bottom lines indicate decision limits for ANOM) [1: Beyaz Tilki Kuyruğu, 2: Boduroğlu, 3: Cılk, 4: Çavuş, 5: Çavuş Aktaş, 6: Çavuş Misket, 7: Çıtlık, 8: Fenerid, 9: Hacı Veli 10: Hırsız Kesmez, 11: Hosan, 12: Kara Üzüm, 13: Kargayüreği, 14: Kırmızı Üzüm, 15: Kızıl Üzüm, 16: Kömüşciciği, 17: Kuş Üzümü, 18: Patlak Üzüm, 19: Renkli Üzüm, 20: Siyah Üzüm, 21: Şiredenlik1, 22: Şiredenlik2, 23: Topşire, 24: Turşuluk]
Şekil 3. *Çeşitlerin Ca içeriği (ANOM grafiğinde; merkezdeki çizgi genel ortalamayı, üstteki çizgi Üst karar çizgisini, alttaki çizgi Alt karar çizgisini göstermektedir) [1: Beyaz Tilki Kuyruğu, 2: Boduroğlu, 3: Cılk, 4: Çavuş, 5: Çavuş Aktaş, 6: Çavuş Misket, 7: Çıtlık, 8: Fenerid, 9: Hacı Veli 10: Hırsız Kesmez, 11: Hosan, 12: Kara Üzüm, 13: Kargayüreği, 14: Kırmızı Üzüm, 15: Kızıl Üzüm, 16: Kömüşciciği, 17: Kuş Üzümü, 18: Patlak Üzüm, 19: Renkli Üzüm, 20: Siyah Üzüm, 21: Şiredenlik1, 22: Şiredenlik2, 23: Topşire, 24: Turşuluk]*

The K content of the cultivars varied between 2726 mg/kg (‘Hırsız Kesmez’) and 1018.55 mg/kg (‘Turşuluk’) (Table 1). The overall mean of the cultivars was 1658 mg/kg and 95% confidence interval were between 1817 and 1498 mg/kg for the K (Fig. 2). It was observed that the highest and lowest means of K were 768.68 mg/kg (‘Çıtlık’) and 276.3 mg/kg (‘Turşuluk’), respectively, (Table 1).

For the Ca, the overall mean of the cultivars was 433 mg/kg with 507.0 and 359.1 confidence interval (Fig. 3).

The Mg content of the cultivars ranged between 138.69 mg/kg (‘Hırsız Kesmez’) and 56.07 mg/kg (‘Turşuluk’) (Table 1). The overall mean was 88.16 mg/kg with 100.22 and 76.09 mg/kg confidence interval (Fig. 4).

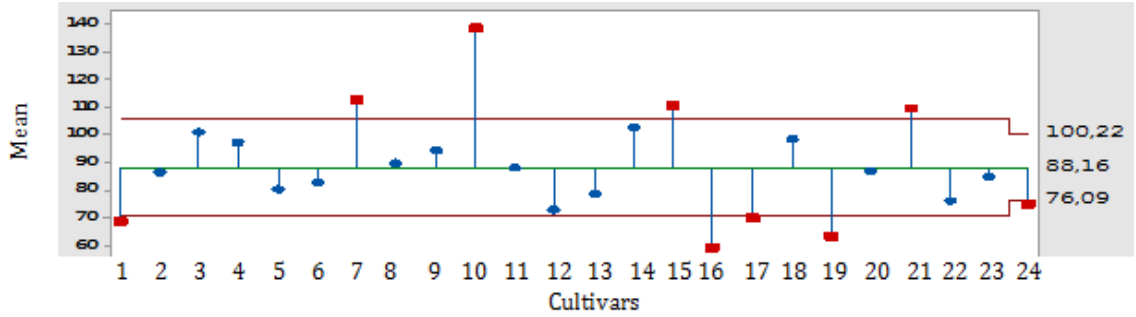

Figure 4. Mg content of the cultivars (Center line represents overall mean, while upper and bottom lines indicate decision limits for ANOM) [1: Beyaz Tilki Kuyruğu, 2: Boduroğlu, 3: Cılk, 4: Çavuş, 5: Çavuş Aktaş, 6: Çavuş Misket, 7: Çıtlık, 8: Fenerid, 9: Hacı Veli 10: Hırsız Kesmez, 11: Hosan, 12: Kara Üzüm, 13: Kargayüreği, 14: Kırmızı Üzüm, 15: Kızıl Üzüm, 16: Kömüşciciği, 17: Kuş Üzümü, 18: Patlak Üzüm, 19: Renkli Üzüm, 20: Siyah Üzüm, 21: Şiredenlik1, 22: Şiredenlik2, 23: Topşire, 24: Turşuluk]

Şekil 4. *Çeşitlerin Mg içeriği (ANOM grafiğinde; merkezdeki çizgi genel ortalamayı, üstteki çizgi Üst karar çizgisini, alttaki çizgi Alt karar çizgisini göstermektedir) [1: Beyaz Tilki Kuyruğu, 2: Boduroğlu, 3: Cılk, 4: Çavuş, 5: Çavuş Aktaş, 6: Çavuş Misket, 7: Çıtlık, 8: Fenerid, 9: Hacı Veli 10: Hırsız Kesmez, 11: Hosan, 12: Kara Üzüm, 13: Kargayüreği, 14: Kırmızı Üzüm, 15: Kızıl Üzüm, 16: Kömüşciciği, 17: Kuş Üzümü, 18: Patlak Üzüm, 19: Renkli Üzüm, 20: Siyah Üzüm, 21: Şiredenlik1, 22: Şiredenlik2, 23: Topşire, 24: Turşuluk]*

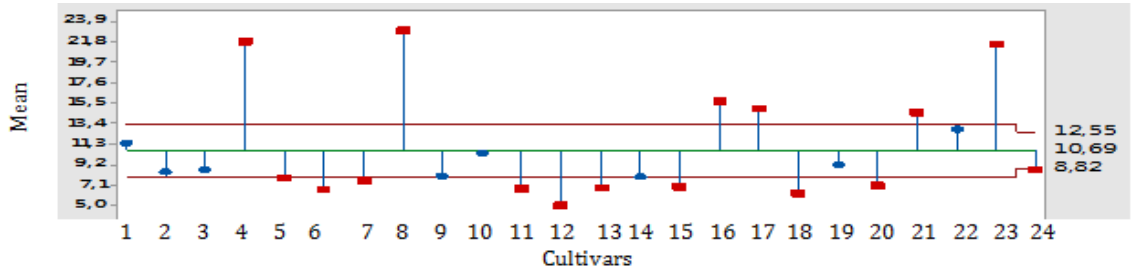

Figure 5. Fe content of the cultivars (Center line represents overall mean, while upper and bottom lines indicate decision limits for ANOM) [1: Beyaz Tilki Kuyruğu, 2: Boduroğlu, 3: Cılk, 4: Çavuş, 5: Çavuş Aktaş, 6: Çavuş Misket, 7: Çıtlık, 8: Fenerid, 9: Hacı Veli 10: Hırsız Kesmez, 11: Hosan, 12: Kara Üzüm, 13: Kargayüreği, 14: Kırmızı Üzüm, 15: Kızıl Üzüm, 16: Kömüşciciği, 17: Kuş Üzümü, 18: Patlak Üzüm, 19: Renkli Üzüm, 20: Siyah Üzüm, 21: Şiredenlik1, 22: Şiredenlik2, 23: Topşire, 24: Turşuluk]

Şekil 5. *Çeşitlerin Fe içeriği (ANOM grafiğinde; merkezdeki çizgi genel ortalamayı, üstteki çizgi Üst karar çizgisini, alttaki çizgi Alt karar çizgisini göstermektedir) [1: Beyaz Tilki Kuyruğu, 2: Boduroğlu, 3: Cılk, 4: Çavuş, 5: Çavuş Aktaş, 6: Çavuş Misket, 7: Çıtlık, 8: Fenerid, 9: Hacı Veli 10: Hırsız Kesmez, 11: Hosan, 12: Kara Üzüm, 13: Kargayüreği, 14: Kırmızı Üzüm, 15: Kızıl Üzüm, 16: Kömüşciciği, 17: Kuş Üzümü, 18: Patlak Üzüm, 19: Renkli Üzüm, 20: Siyah Üzüm, 21: Şiredenlik1, 22: Şiredenlik2, 23: Topşire, 24: Turşuluk]*

The Fe content of the cultivars varied from 22.99 mg/kg (‘Fenerid’) to 5.06 mg/kg (‘Kara Üzüm’). The overall mean was 10.69 mg/kg while the 95% confidence interval was between 12.55 and 8.82 mg/kg (Fig. 5).

Mn content of grape cultivars changed between 0.982 mg/kg (‘Siyah Üzüm’) and 0.103 mg/kg (‘Hırsız Kesmez’) (Table 1). The overall mean was 0.509 mg/kg with 0.556 and 0.463 mg/kg values of 95% confidence interval (Fig. 6).

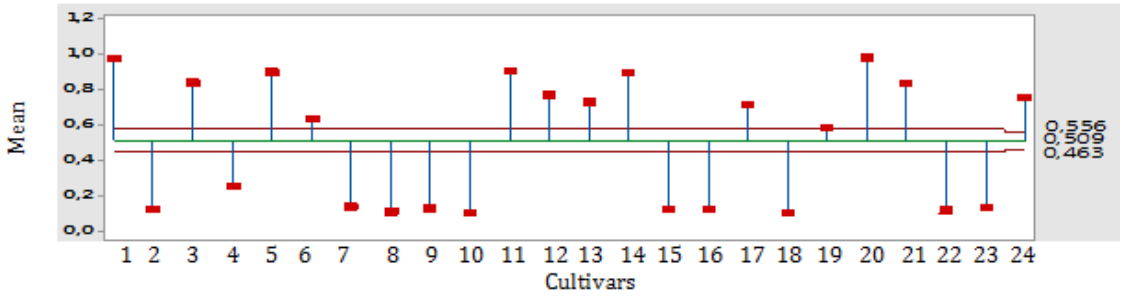

Figure 6. Mn content of the cultivars (Center line represents overall mean, while upper and bottom lines indicate decision limits for ANOM) [1: Beyaz Tilki Kuyruğu, 2: Boduroğlu, 3: Cılk, 4: Çavuş, 5: Çavuş Aktaş, 6: Çavuş Misket, 7: Çıtlık, 8: Fenerid, 9: Hacı Veli 10: Hırsız Kesmez, 11: Hosan, 12: Kara Üzüm, 13: Kargayüreği, 14: Kırmızı Üzüm, 15: Kızıl Üzüm, 16: Kömüşciciği, 17: Kuş Üzümü, 18: Patlak Üzüm, 19: Renkli Üzüm, 20: Siyah Üzüm, 21: Şiredenlik1, 22: Şiredenlik2, 23: Topşire, 24: Turşuluk]
Şekil 6. *Çeşitlerin Mn içeriği (ANOM grafiğinde; merkezdeki çizgi genel ortalamayı, üstteki çizgi Üst karar çizgisini, alttaki çizgi Alt karar çizgisini göstermektedir) [1: Beyaz Tilki Kuyruğu, 2: Boduroğlu, 3: Cılk, 4: Çavuş, 5: Çavuş Aktaş, 6: Çavuş Misket, 7: Çıtlık, 8: Fenerid, 9: Hacı Veli 10: Hırsız Kesmez, 11: Hosan, 12: Kara Üzüm, 13: Kargayüreği, 14: Kırmızı Üzüm, 15: Kızıl Üzüm, 16: Kömüşciciği, 17: Kuş Üzümü, 18: Patlak Üzüm, 19: Renkli Üzüm, 20: Siyah Üzüm, 21: Şiredenlik1, 22: Şiredenlik2, 23: Topşire, 24: Turşuluk]*

Cu content of the cultivars was determined between 0.868 mg/kg (‘Turşuluk’) and 0.102 mg/kg (‘Çavuş Aktaş’) (Table 1). The overall mean was 0.247 mg/kg with 0.392 and 0.102 mg/kg of 95% confidence interval (Fig. 7).

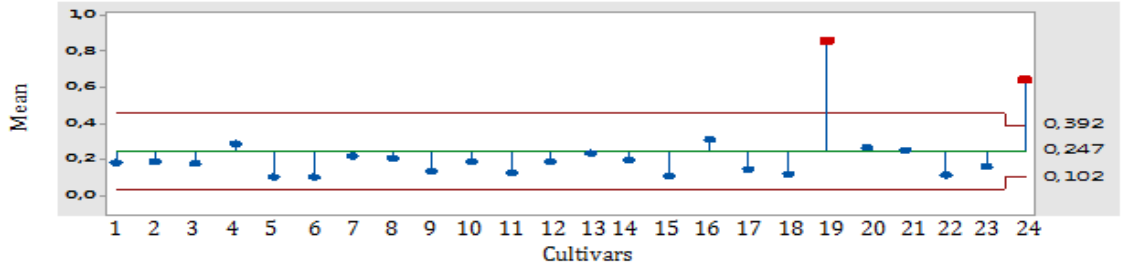

Figure 7. Cu content of the cultivars (Center line represents overall mean, while upper and bottom lines indicate decision limits for ANOM) [1: Beyaz Tilki Kuyruğu, 2: Boduroğlu, 3: Cılk, 4: Çavuş, 5: Çavuş Aktaş, 6: Çavuş Misket, 7: Çıtlık, 8: Fenerid, 9: Hacı Veli 10: Hırsız Kesmez, 11: Hosan, 12: Kara Üzüm, 13: Kargayüreği, 14: Kırmızı Üzüm, 15: Kızıl Üzüm, 16: Kömüşciciği, 17: Kuş Üzümü, 18: Patlak Üzüm, 19: Renkli Üzüm, 20: Siyah Üzüm, 21: Şiredenlik1, 22: Şiredenlik2, 23: Topşire, 24: Turşuluk]
Şekil 7. *Çeşitlerin Cu içeriği (ANOM grafiğinde; merkezdeki çizgi genel ortalamayı, üstteki çizgi Üst karar çizgisini, alttaki çizgi Alt karar çizgisini göstermektedir) [1: Beyaz Tilki Kuyruğu, 2: Boduroğlu, 3: Cılk, 4: Çavuş, 5: Çavuş Aktaş, 6: Çavuş Misket, 7: Çıtlık, 8: Fenerid, 9: Hacı Veli 10: Hırsız Kesmez, 11: Hosan, 12: Kara Üzüm, 13: Kargayüreği, 14: Kırmızı Üzüm, 15: Kızıl Üzüm, 16: Kömüşciciği, 17: Kuş Üzümü, 18: Patlak Üzüm, 19: Renkli Üzüm, 20: Siyah Üzüm, 21: Şiredenlik1, 22: Şiredenlik2, 23: Topşire, 24: Turşuluk]*

The Zn content of the cultivars varied from 8.50 mg/kg (‘Şiredenlik1’) to 1.01 mg/kg (‘Çavuş Aktaş’) (Table 1). The overall mean of the cultivars was 2.50 mg/kg and 95% confidence interval were between 2.55 and 2.45 mg/kg (Fig. 8).

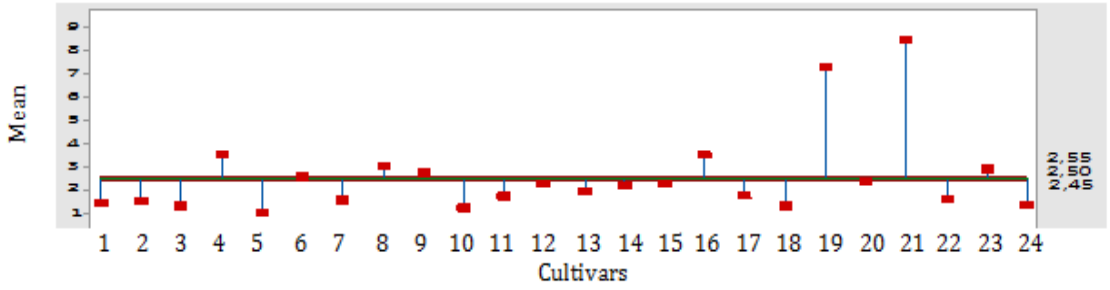

Figure 8. Zn content of the cultivars (Center line represents overall mean, while upper and bottom lines indicate decision limits for ANOM) [1: Beyaz Tilki Kuyruğu, 2: Boduroğlu, 3: Cılk, 4: Çavuş, 5: Çavuş Aktaş, 6: Çavuş Misket, 7: Çıtlık, 8: Fenerid, 9: Hacı Veli 10: Hırsız Kesmez, 11: Hosan, 12: Kara Üzüm, 13: Kargayüreği, 14: Kırmızı Üzüm, 15: Kızıl Üzüm, 16: Kömüşciciği, 17: Kuş Üzümü, 18: Patlak Üzüm, 19: Renkli Üzüm, 20: Siyah Üzüm, 21: Şiredenlik1, 22: Şiredenlik2, 23: Topşire, 24: Turşuluk]

Şekil 8. *Çeşitlerin Zn içeriği (ANOM grafiğinde; merkezdeki çizgi genel ortalamayı, üstteki çizgi Üst karar çizgisini, alttaki çizgi Alt karar çizgisini göstermektedir) [1: Beyaz Tilki Kuyruğu, 2: Boduroğlu, 3: Cılk, 4: Çavuş, 5: Çavuş Aktaş, 6: Çavuş Misket, 7: Çıtlık, 8: Fenerid, 9: Hacı Veli 10: Hırsız Kesmez, 11: Hosan, 12: Kara Üzüm, 13: Kargayüreği, 14: Kırmızı Üzüm, 15: Kızıl Üzüm, 16: Kömüşciciği, 17: Kuş Üzümü, 18: Patlak Üzüm, 19: Renkli Üzüm, 20: Siyah Üzüm, 21: Şiredenlik1, 22: Şiredenlik2, 23: Topşire, 24: Turşuluk]*

For the B mineral, the highest and lowest values were 0.098 mg/kg (‘Çıtlık’) and 0.02 mg/kg (‘Turşuluk’), respectively. 95% confidence interval was between 0.050 and 0.043 mg/kg (Fig.9).

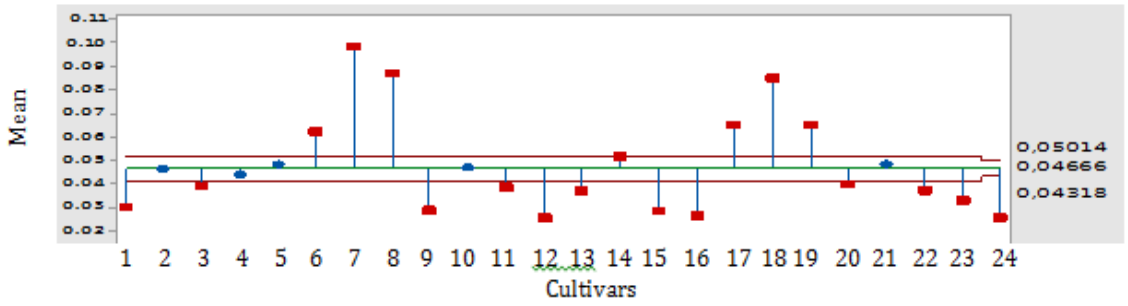

Figure 9. B content of the cultivars (Center line represents overall mean, while upper and bottom lines indicate decision limits for ANOM) [1: Beyaz Tilki Kuyruğu, 2: Boduroğlu, 3: Cılk, 4: Çavuş, 5: Çavuş Aktaş, 6: Çavuş Misket, 7: Çıtlık, 8: Fenerid, 9: Hacı Veli 10: Hırsız Kesmez, 11: Hosan, 12: Kara Üzüm, 13: Kargayüreği, 14: Kırmızı Üzüm, 15: Kızıl Üzüm, 16: Kömüşciciği, 17: Kuş Üzümü, 18: Patlak Üzüm, 19: Renkli Üzüm, 20: Siyah Üzüm, 21: Şiredenlik1, 22: Şiredenlik2, 23: Topşire, 24: Turşuluk]

Şekil 9. *Çeşitlerin B içeriği (ANOM grafiğinde; merkezdeki çizgi genel ortalamayı, üstteki çizgi Üst karar çizgisini, alttaki çizgi Alt karar çizgisini göstermektedir) [1: Beyaz Tilki Kuyruğu, 2: Boduroğlu, 3: Cılk, 4: Çavuş, 5: Çavuş Aktaş, 6: Çavuş Misket, 7: Çıtlık, 8: Fenerid, 9: Hacı Veli 10: Hırsız Kesmez, 11: Hosan, 12: Kara Üzüm, 13: Kargayüreği, 14: Kırmızı Üzüm, 15: Kızıl Üzüm, 16: Kömüşciciği, 17: Kuş Üzümü, 18: Patlak Üzüm, 19: Renkli Üzüm, 20: Siyah Üzüm, 21: Şiredenlik1, 22: Şiredenlik2, 23: Topşire, 24: Turşuluk]*

For Se mineral, the highest mean was determined as 19.38 mg/kg in ‘Kırmızı Üzüm’, while the lowest was 11.97 mg/kg in ‘Çavuş Misket’. The overall mean of the cultivars for Se was 15.62 mg/kg with 15.81 and 15.71 mg/kg confidence limits (95%) (Fig. 10).

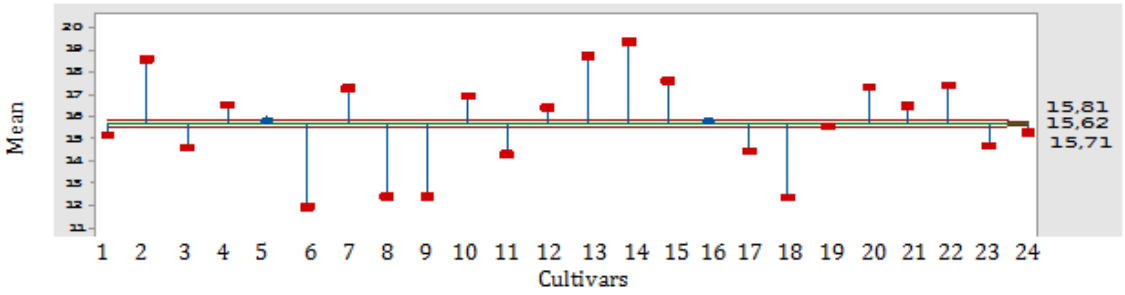

Figure 10. Se content of the cultivars (Center line represents overall mean, while upper and bottom lines indicate decision limits for ANOM) [1: Beyaz Tilki Kuyruğu, 2: Boduroğlu, 3: Cılk, 4: Çavuş, 5: Çavuş Aktaş, 6: Çavuş Misket, 7: Çıtlık, 8: Fenerid, 9: Hacı Veli 10: Hırsız Kesmez, 11: Hosan, 12: Kara Üzüm, 13: Kargayüreği, 14: Kırmızı Üzüm, 15: Kızıl Üzüm, 16: Kömüşciciği, 17: Kuş Üzümü, 18: Patlak Üzüm, 19: Renkli Üzüm, 20: Siyah Üzüm, 21: Şiredenlik1, 22: Şiredenlik2, 23: Topşire, 24: Turşuluk]
Şekil 10. *Çeşitlerin Se içeriği (ANOM grafiğinde; merkezdeki çizgi genel ortalamayı, üstteki çizgi Üst karar çizgisini, alttaki çizgi Alt karar çizgisini göstermektedir) [1: Beyaz Tilki Kuyruğu, 2: Boduroğlu, 3: Cılk, 4: Çavuş, 5: Çavuş Aktaş, 6: Çavuş Misket, 7: Çıtlık, 8: Fenerid, 9: Hacı Veli 10: Hırsız Kesmez, 11: Hosan, 12: Kara Üzüm, 13: Kargayüreği, 14: Kırmızı Üzüm, 15: Kızıl Üzüm, 16: Kömüşciciği, 17: Kuş Üzümü, 18: Patlak Üzüm, 19: Renkli Üzüm, 20: Siyah Üzüm, 21: Şiredenlik1, 22: Şiredenlik2, 23: Topşire, 24: Turşuluk]*

In order to examine the similarities between 24 grape cultivars, results of the cluster analysis are shown in Table 2 and the visual presentation of these results is shown in Fig. 11. As shown in Table 2, the highest similarity was observed between 'Patlak Üzüm' and 'Hosan' cultivars with 98.054% and followed by 'Kargayüreği' and 'Şiredenlik2' cultivars with 97.970%. In terms of mineral content, 'Hırsız Kesmez' cultivar considerably differs from the other 23 cultivars and joined into other clusters with 75.603% similarity level. According to these results, the general similarity level varied between 98% and 76%. Thus, it can be stated that 24 grape cultivars grown in the Black Sea Region have high similarity level in mineral content (Table 2 and Fig. 11).

Potassium is generally existed in high quantities in Grape berries. It is known to play an important role in fruit development and wine quality (Martins et al. 2012). In our results K is the abounded mineral in the berries of the all cultivars. The content found to be between 2726 mg/kg ('Hırsız Kesmez') and 1018.55 mg/kg ('Turşuluk'). Cantürk et al. (2016) determined that potassium content in the seed, flesh and berry skin of 'Gülüzümü' was 205.23, 112.78 and 6.11 mg/100g, respectively. Similarly, Bertoldi et al. (2011) reported that K content of Chardonnay cultivar was 246.9 mg/100g while Pereira et al. (2006) reported as 203.2 mg/100g in Merlot cultivar.

The highest Ca and P in the composition of grape berries were determined as 768.68 mg/kg ('Çıtlık') and 421.82 mg/kg ('Hırsız Kesmez'), respectively while the lowest values were 295 mg/kg ('Kömüşciciği') and 154 mg/kg ('Kömüşciciği'). P value was lower than 120 mg/100 g of 'Sauvignon blanc' (Nakajima et al. 2004) while similar to that of Cantürk et al. (2016) finding.

Mg content in grape berries varied in a wide range 138.69 mg/kg ('Hırsız Kesmez') to 59.2 mg/kg ('Kömüşciciği'). As mentioned by the previous studies (Nakajima et al. 2004, Sousa et al. 2014; Panceri et al. 2013; Cantürk et al. 2016). Nakajima et al. (2004) reported that magnesium content of Sauvignon blanc cultivar was 50 mg/100g. Similarly, Panceri et al. (2013) indicated that Mg content in Cabernet Sauvignon and Merlot cultivars were 3896 and 5079 µg/100g, respectively. However, Cantürk et al. (2016) reported that Mg content of 'Gülüzümü' in seed, flesh and berry skin were 51.29, 6.38 and 2.19 mg/100g, respectively.

Table 2. Results of cluster analysis

Çizelge 2. *Kümeleme analizi sonuçları*

Step	Number of cluster	Similarity level	Distance level	Cluster joined		New cluster	Number of observation in new cluster
1	23	98.054	31.771	14	17	14	2
2	22	97.970	33.149	1	7	1	2
3	21	97.557	39.887	2	21	2	2
4	20	96.932	50.090	10	20	10	2
5	19	96.044	64.595	8	9	8	2
6	18	95.836	67.991	8	18	8	3
7	17	95.542	72.781	5	8	5	4
8	16	95.471	73.942	2	16	2	3
9	15	95.454	74.233	3	14	3	3
10	14	95.212	78.178	3	19	3	4
11	13	95.110	79.847	10	13	10	3
13	12	95.092	80.129	3	10	3	7
12	11	94.924	82.887	4	15	4	2
14	10	94.747	85.770	3	11	3	8
15	9	92.885	116.163	5	6	5	5
16	8	92.472	122.920	2	5	2	8
17	7	92.348	124.935	1	2	1	10
18	6	91.023	146.577	1	3	1	18
19	5	89.083	178.241	4	24	4	3
20	4	86.883	214.163	4	22	4	4
21	3	82.213	290.413	1	12	1	19
22	2	78.403	352.632	1	4	1	23
23	1	75.607	398.272	1	23	1	24

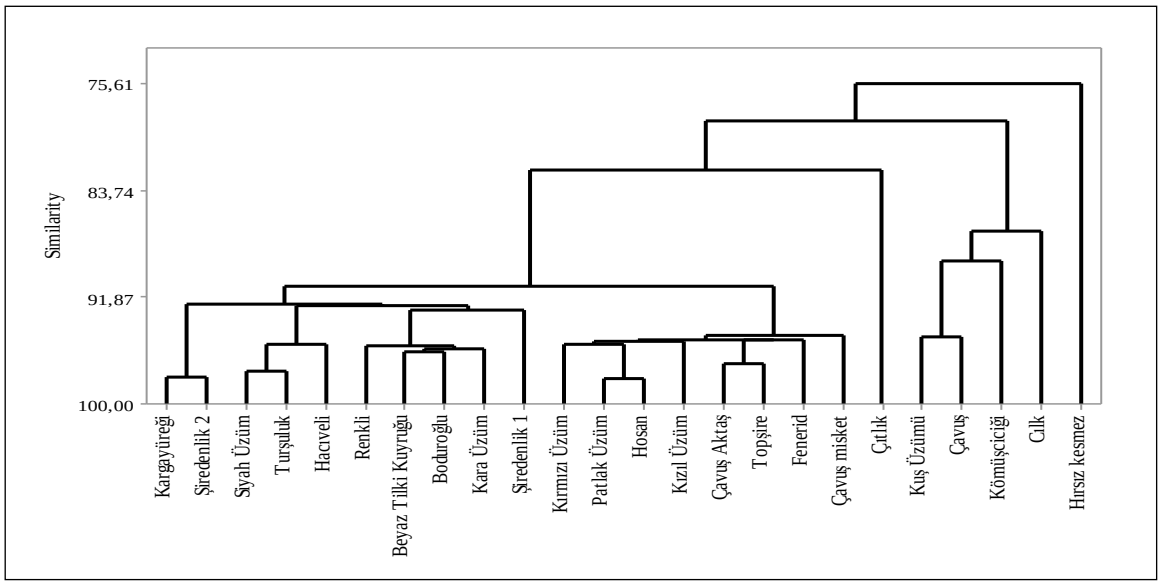

Figure 11. Dendogram
Şekil 11. *Dendogram*

Among the minor elements, it is important that the grape fruit is rich for Fe content.

Fe was also found the highest minor element in our study.

The Fe content of the cultivars varied between 22.99 mg/kg (‘Fenerid’) and 5.06 mg/kg (‘Kara Üzüm’). According to result of previous studies, (Tangolar et al. 2009; Bertoldi et al, 2011; Sousa et al, 2014; Cantürk et al. 2016) Fe content of grapes varies between 0.3 and 18.1 mg/100g. Zn limits of the study (8.50 mg/kg in ‘Şiredenlik1’ - 1.01 mg/kg in ‘Çavuş Aktaş’) are in standard levels proposed by Tangolar et al. (2009); Cantürk et al. (2016); Olalla et al. (2004); Bertoldi et al. (2011).

Cu content of the grape berries in the cultivars changed from 0.868 mg/kg (‘Turşuluk’) to 0.102 mg/kg (‘Çavuş Aktaş’).

Şamil et al. (2005) reported that copper content varied from 0.20 to 0.33 mg/kg while zinc content ranged from 2.40 to 4.30 mg/kg in the grape cultivars grown in Şarkikaraağaç (‘Gatıkara’, ‘Devegözü’, ‘Aküzüm’, ‘Cemre’, ‘Kızılüzüm’, ‘Buzgölü’, ‘Tilkikuyruğu’ and ‘Kadınparmağı’).

In general, Mn has low concentrations in the berries of the grape cultivars. Thus, Mn content ranged from 0.982 mg/kg (‘Siyah Üzüm’) to 0.103 mg/kg (‘Hırsız Kesmez’). Similarly, Boron varied between 0.098 mg/kg (‘Çıtlık’) and 0.02 mg/kg (‘Turşuluk’) and Se changed from19.38 mg/kg (‘Kırmızı Üzüm’) to 11.97 mg/kg (‘Çavuş Misket’).

4. Conclusions

Intake of the nutrients that need for healthy and balanced nutrition adequately and on time from different sources is extremely important. In this framework, fruits are among the most valuable foods. Especially, grapes can be used various forms and consumable in all seasons. In this study, the mineral content of 24 native grape cultivars grown in the Mid-Black Sea Region was determined.

As a result of this study, it can be stated that ‘Hırsız Kesmez’ has rich for P, K, Mg; ‘Çıtlık’ for Ca and B; ‘Fenerid’ for Fe; ‘Siyah Üzüm’ for Mn; ‘Turşuluk’ for Cu; ‘Şiredenlik1’ for Zn; and ‘Kırmızı Üzüm’ for Se.

It can be expected that this study will provide an important contribution to the literature in terms of introduction of native grape cultivars as well as increase of their economic value.

References

Amâl H (1963). Farmasötik Kimya I. Organik Bileşikler ve Organomineraller, İstanbul Üniv. Yayınları No: 1036, Eczacılık Fak. No: 1, İstanbul.

Bertoldi D, Larcher R, Bertamini M, Otto S, Concheri G, Nicolini G (2011). Accumulation and distribution pattern of macro and micro elements and trace elements in *Vitis vinifera* L. cv. Chardonnay berries. J. Agric. Food Chem. 59, 7224-7236. DOI: 10.1021/jf2006003.

Cantürk S, Kunter B, Aykut O, Keskin N (2016). Gülüzümü’nün (*Vitis vinifera* L.) mineral madde kompozisyonu ve tanedeki dağılımı. Bahçe, Özel Sayı: 45:683-687.

Çavuşoğlu Ş (2018). Effects of hot water and UV-C on mineral content changes in two strawberry cultivarsstored at different temperatures. Turk. J. Agric. For., 42: 423-432. DOI:10.3906/tar-1802-123.

Kacar B, İnal A (2008). Bitki Analizleri. Nobel Yayın Dağıtım, Ankara.

Martins V, Cunha A, Gerós H, Hanana M, Blumwald E (2012). Mineral compounds in grape berry in The Biochemistry of the Grape Berry eds Gerós H., Chaves M. M., Delrot S., editors. (Sharjah: Bentham Science), 23–43. DOI: 10.2174/97816080536051120101.

Nakajima H, Behboidian MH, Greven M, Zegbe-Domínguez JA (2004). Short Communication: Mineral contents of grape, olive, apple and tomato under reduced irrigation. J. Plant Nutr. Soil. Sci., 167, 91-92.DOI: 10.1002/jpln.200320354.

Nelson PR., Peter S, Wludyka PS, Copeland KAF (2005). The Analysis of Means: A Graphical Method for Comparing Means, Rates, and Proportions, ASA-SIAM Series on Statistics and Applied Probability, SIAM, Philadelphia, ASA, Alexandria, VA, USA, 260p.

Olalla M, Fernandez J, Cabrera C, Navarro M, Gimenez R, Lopez MC (2004). Nutritional study of copper and zinc in grapes and commercial grape juices from Spain. J. Agric. Food Chem., 52:2715-2720. DOI: 10.1021/jf030796w.

Panceri CP, Gomes TM, De Gois JS, Borges DLG, Bordignon-Luiz T (2013). Effect of dehydration process on mineral content, phenolic compounds and antioxidant activity of Cabernet Sauvignon and Merlotgrapes. Food Research International 54, 1343–1350. DOI: 10.1016/j.foodres.2013.10.016.

Pereira GE, Gaudillere JP, Pieri P, Hilbert G, Maucourt M, Deborde C, Moing A, Rolin D (2006). Micro climate influence on mineral and metabolic profiles of grape berries. Agric. Food Chem., 54, 6765-6775. DOI: 10.1021/jf061013k.

Sousa EC, Uchôa-Thomaz AM, Carioca JO, Morais SM, Lima A, Martins CG., Alexandrino CD (2014). Chemical composition and bioactive compounds of grape pomace (*Vitis vinifera* L.), Benitaka variety, grown in the semiarid region of Northeast Brazil. Food Sci. Technol, Campinas, 34 (1), 135-142. DOI: 10.1590/S0101-20612014000100020.

Şamil A, Tezcan R, Ceylan N, Erçetin M (2005). Şarkikaraağaç yöresinde. yetiştirilen üzüm çeşitlerinde bakır ve çinko tayini. KSÜ Fen ve Mühendislik Dergisi, 8 (1), 31-34.

Tangolar S, Özoğul Y, Tangolar SA (2009). Evaluation of fatty acid profiles and mineral content of grape seed oil of some grape genotypes. Int. J. Food Sci. Nutr., 60 (1), 32-39. DOI. 10.1080/09637480701581551.

Winkler AJ, Cook JA, Kliewer WM, Lider LA (1974). General Viticulture. Univ. of California Press. Berkeley, Los Angeles and London, 710p.