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Chemical Properties of Selected Walnut (*Juglans regia* L.) Genotypes From The Hekimhan Region

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Abstract: This research was conducted between 2015-2016 in Hekimhan / Malatya region. 11 walnut genotypes with superior properties were selected from 297 walnut genotypes. In the study, chemical properties of genotypes were determined. The amount of water content of the genotypes was 2.49-5.17%; protein content 11.47-14.43%; ash was found to be 1.52-1.97% and the oil content was 59.21-71.73%. The ratios of palmitic, stearic, oleic, linoleic and linolenic acids among fatty acids were determined between 4.62-6.76%, 2.41-3.65%, 24.79-43.48%, 41.75-57.17% and 6.56-13.94%, respectively. Macro and micro element contents of genotypes were also analyzed in mg / 100 g. Results were determined as 50.76 mg Na, 172.67 mg Mg, 374.64 mg N, 145.49 mg Ca, 4.77 Mn, 4.10 mg Fe, 1.98 mg Cu and 2.38 mg Zn.

Key words: Chemical properties, Hekimhan/Malatya, Selection, Walnut,

Hekimhan Yöresinden Seçilmiş Ceviz (*Juglans regia* L.) Genotiplerinin Kimyasal Özellikleri

Öz: Bu Araştırma, Hekimhan/Malatya yöresinde 2015-2016 yılları arasında yapılmıştır. Seleksiyon sonunda 297 ceviz genotipi içerisinden, üstün özelliklere sahip 11 ceviz genotipi seçilmiştir. Araştırmada, genotiplerin kimyasal özellikleri belirlenmiştir. Genotiplerin su içeriği %2.49-5.17; protein miktarı %11.47-14.43; kül %1.52-1.97 ve yağ oranı % 59.21-71.73 olarak bulunmuştur. Yağ asitlerinden palmitik, stearik, oleik, linoleik ve linolenikasit oranları da sırasıyla % 4.62-6.76, % 2.41-3.65, % 24.79-43.48, % 41.75-57.17 ve % 6.56-13.94 arasında belirlenmiştir. Genotiplerin makro ve mikro element içerikleri de, mg/100 g olarak analiz edilmiştir. Sonuçlar 50.76 mg Na, 172.67 mg Mg, 374.64 mg K, 145.49 mg Ca, 4.77 Mn, 4.10 mg Fe, 1.98 mg Cu ve 2.38 mg Zn olarak belirlenmiştir.

Anahtar kelimeler: Ceviz, Hekimhan/Malatya, Kimyasal özellikler, Seleksiyon

1.Introduction

Walnuts spread over a wide area in the world. 18 Designated properties in the walnut species, *Juglans regia* is separated from the rest with the quality of the fruit (Şen, 1986). This kind of, for many years, were only grown from seed, and many different types (Ünver, 2005).

Anatolia is the gene center of the species *Juglans reg*ia L., and their homeland. Due to different climatic and geographical features of Anatolia, there are walnuts in almost every region (Muradoğlu and Balta 2010).

Selection is the final stage of the method applied in plant breeding. Planned the selection, in which genetic resource is collected on the presence of the desired characteristics is quite important (Şen, 1986).

Walnut is one of the most important fruits in Turkey and will exist in the future. The walnuts are found in almost every region of the country. A valuable fruit in human nutrition. Also, its a valuable timber for furniture products (Kaşka, 2001). Although have an important place in terms of production and number of the walnut tree,

walnut to our production standard is quite low (Çelik et al., 2011).

The fruit of the walnut contains substances that are very important in humannutrition. These chemical substances differ according to genotype. Therefore, these genetic resources (genotypes) requires the determination of the chemical and mineral content (Muradoğlu et al., 2011).

Important walnut producing countries in the world are China, the United States, Iran and Turkey. Production in China, approximately 1 600 000 tons. Grown from seed from the type of production usually is obtained. On the other hand, the U.S. production of walnuts from the garden off of walnut established with all the standard varieties is provided (Yılmaz, 2007). In our country, in recent years, especially with the characteristics of outstanding domestic and foreign varieties gardens began to be established.

However, production was also relatively low. Walnut production in 2018, 215 thousand tons (Anonymous, 2018). Which are of great importance as a source of local genetic varieties/genotypes is very important for breeding studies. Quality varieties selected in these populations. Due to various reasons in these genotypes are destroyed. Therefore, selective breeding studies in our country, according to other breeding studies are of more importance (Acar and Bostan 2009).

2.Material And Methods

2.1.Material

The material of the study consisted of 11 walnut genotypes with good properties which were selected from Hekimhan / Malatya.

2.2. Methods

This research was conducted in 2015 and 2016 years. The analysis was performed on 11 genotypes of walnut. These genotypes Hekimhan/Malatya from the region of 297 walnut genotypes were selected. Hekimhan is located in the northern section of the city and 1040-1700 m altitude. The district is mountainous and rugged structure. It has a typical continental climate. The average annual temperature is 11.6 degrees; average rainfall is 425 mm (Anonim, 2016). In this study, 20 fruit samples were taken from each walnut genotype. The samples were separated from their green shells and dried in the shade for two weeks (Yarılgaç, 1997; Bayazit, 2000). Type numbers were given to the trees where fruit samples were taken. The following analyzes were performed on dried fruit samples.

Chemical Analysis

In the dried fruit samples, the walnut kernels were first crushed in the blender and packed separately. Fruit chemical analyzes were also performed as follows;

Determination of water content (%): Internal walnuts taken from the fruits of the selected types were shredded in the blender and taken to 10 g in 0.01 g sensitive balance and dried at 105 °C for 4 to 6 hours (Cemeroğlu 1992).

Determination of ash content (%): Ash analysis was carried out by leaving 1 g of sample in porcelain crucibles and drying at 105 ^{o}C for 24 hours, then incubating in ash furnace at 560 ^{o}C for 5 hours until gray-white color was obtained (Gönül et al., 1988).

Protein determination (%): Nitrogen was determined according to Kjeldahl Method in walnut genotypes and the amount of nitrogen obtained was multiplied by 6.25% and protein ratio was calculated. 0.25 g of walnut samples were used for each genotype. After the samples were burned in the oven, distillation was performed by adding pure water and boric acid in the following apparatus. At the end of distillation and titration, % nitrogen ratio was read from the digital indicator of the device and multiplied by 6.25% and protein ratio was calculated (Bayraklı, 1987; Muradoğlu, 2005).

Analysis of total fat (%): The AOAC method was used in this study. Fat (AOAC 22.034) were determined using standard methods. The total fat was found by the total dry matter (AOAC 1990; Muradoğlu 2005).

Analysis of fatty acids (%): Fatty acid composition for the walnut samples was determined using the modified fatty acid methyl ester method as described by Baydar et al. (1999). The oil was extracted three times from 2 g air-dried seed sample by homogenization with petroleum ether. For fatty acid methyl esters (FAME), 1 ml of methylation reagent (80 ml methanol + 0.5 g sodium methylate + 20 ml isooctane) was added to 50 mg of oil. The mixture was vortexed and allowed to react for 24 hours at room temperature; then 0.25 ml of isooctane was added. The sample was then centrifuged for 5 min at 2400 x g at 5°C and the liquid portion was transferred to labeled Wheaton vials and stored at 20° C. The methyl esters of the fatty acids (0.5 ml) were analyzed in a gas chromatograph (Perkin Elmer Auto System XL, USA) equipped with a flame ionizing detector (FID), a fused silica capillary column (MN FFAP (50 m x 0.32 mm i.d.; film thickness 0.25 mm). It was operated under the following conditions: oven temperature program, 120° C for 1 min. raised to 240° C at a rate of 6° C/min and then kept at 240°C for 15 min); injector and detector temperatures,250 and 260°C; respectively, carrier gas, helium at a flow rate of 14 psi; split ratio, 1/20 ml/min. The contents of palmitic (C16:0), stearic (C18:0), oleic (C18:1), linoleic (C18:2) and linolenic (C18:3) acids were determined by a computing integrator.

Determination of mineral matter content (mg/100g): Samples were burned at 500 degrees, and 5 ml of 3N HCL was added. After 5 minutes, 10 ml of distilled water was added. The samples were filtered with distilled water to 100 ml was completed. The obtained filtrate was analyzed in the ICP-MS (Kaçar, 1972).

3. Results and Discussion

In the research, 56 walnut genotypes from 297 walnut populations were determined by preselection. 11 walnut genotypes were selected according to the weighted scale. Some fruit characteristics of these genotypes in which chemical analyzes are performed are given in Table 3.1.

Table 3.1. Fruit characteristics and roundness index of selected walnut genotypes
Çizelge 3.1. *Seçilen ceviz genotiplerinin meyve özellikleri ve yuvarlaklık indeksi*

Genotype	Nut weight (g)	Kernel weight (g)	Kernel ratio (%)	Nut lenght (mm)	Nut width (mm)	Nut height (mm)	Shell thickness (mm)	Nut roundness Index
44HEK11	10.43±0.56	5.88±0.46	56.40	37.94±1.96	30.18±1.37	31.42±1.19	0.97±0.03	123
44HEK20	13.60±1.10	7.90±0.79	58.09	37.91±1.41	35.58±0.84	37.42±1.54	1.02±0.02	104
44HEK27	14.48±0.40	8.30±0.81	57.34	40.31±2.05	35.03±1.25	37.78±2.16	1.05±0.03	111
44HEK28	15.08±0.51	7.42±0.37	49.20	44.95±0.95	34.54±0.62	36.85±0.98	1.13±0.09	126
44HEK31	14.04±0.60	8.10±0.63	57.69	44.77±1.17	35.30±0.72	36.71±0.69	0.97±0.03	124
44HEK33	13.03±0.58	7.03±0.69	53.95	38.11±0.38	34.31±0.62	35.28±0.42	1.06±0.03	110
44HEK35	14.10±0.74	7.78±0.38	55.18	44.30±1.23	32.62±0.86	32.15±0.71	1.07±0.06	137
44HEK40	17.03±0.96	8.58±0.67	50.37	45.95±1.28	42.14±1.42	38.90±0.92	1.13±0.09	113
44HEK42	16.02±0.52	7.78±0.23	48.56	42.87±0.73	36.97±0.47	37.16±1.02	1.08±0.04	116
44HEK43	17.46±1.12	8.42±0.79	48.22	42.96±1.32	35.28±0.79	38.00±0.97	1.47±0.06	117
44HEK50	15.73±1.23	7.68±0.76	48.82	38.56±0.98	35.22±0.73	35.49±0.76	1.10±0.06	109

Some fruit characteristics of the genotypes we selected were higher than both the standard varieties and the values obtained from previous studies. Fruit size is an important feature in both domestic and foreign markets. Since this feature of genotypes selected as variety candidate is quite good, we believe that they will make a significant contribution to the economy if they are brought

into production. In walnut genotypes selected as variety candidate; 7 genotypes were identified as light yellow and 4 genotypes as dark yellow.

In these genotypes; fruit water content, protein content, ash content, fat content and fatty acids composition and mineral matter content were also determined (Table 3.2.; Table 3.3. and Table 3.4).

Table 3.2. Some chemical properties of selected walnut genotypes
Tablo 3.2. *Seçilen ceviz genotiplerinin bazı kimyasal özellikleri*

Genotype	Moisture (%)	Protein (%)	Ash (%)	Fat (%)
44HEK11	3.79	14.11	1.69	69.22
44HEK20	4.86	13.38	1.86	71.73
44HEK27	3.17	13.34	1.75	70.32
44HEK28	2.58	11.47	1.85	64.92
44HEK31	5.17	11.99	1.61	65.58
44HEK33	4.88	13.94	1.52	66.30
44HEK35	3.19	14.43	1.72	61.97
44HEK40	5.12	13.75	1.97	62.86
44HEK42	4.27	13.19	1.96	65.37
44HEK43	3.68	13.83	1.86	65.47
44HEK50	2.49	14.02	1.88	59.21
Average	**3.93**	**13.40**	**1.79**	**65.72**
Minimum	**2.49**	**11.47**	**1.52**	**59.21**
Maximum	**5.17**	**14.43**	**1.97**	**71.73**

As can be seen in Table 3.3; the average moisture content of the genotypes was 2.49% (44HEK50) - 5.17% (44HEK31), protein amounts were between 11.47% (44HEK28) - 14.43% (44HEK35), ash contents were between 1.52% (44HEK33) - 1.97% (44HEK40) and fat amounts were 59.21 (44HEK50) - 71.73% (44HEK20).

Many researchers working on walnut; Gün (1998) in his study, protein rates between 17.00-29.95% and fat rates between 54.09-68.77%; In the study of Yıldırım et al. (2005) protein content of 12.47-21.88%, fat content 63.09-70.01%, moisture content 3.04-5.37% and ash content between 1.11-2.73%; In the study of Koyuncu et al. (2005) found that moisture content was 3.03-5.42%, ash content was between 1.63-2.31% and oil content was between 60.41-67.25%.

In addition, Beyhan (2005) 's study in the district of Darende 50.00-73.61% fat content, protein content 11.14-23.72% and ash content between 2.10-2.95%; Ünver and Çelik (2005) 'protein ratios between 16.06-25.50% and fat rates between 47.84-66.74%; Şimşek (2010) reported that ash content was between 1.88-2.89% and water content was between 1.63-4.73%. Aslansoy (2012) found that water content of walnut fruits in their selection study was 2.38-5.77%, ash content was 0.91-2.01% and protein ratios were found between 11.86-16.22%.

Some of the characteristics of the genotypes in the selection study conducted by Keleş (2012) in Gümüşhacıköy region were also found as follows. Protein content was 12.55-21.34%, total fat content was 63.99-69.34%, moisture content was 2.09-3.87% and ash content was between 1.33-2.50%.

Also, the ratios of fatty acids of walnut genotypes were given in Table 3.3. Unsaturated fatty acids are very important for healthy living. Walnut selection in studies of types of fat and fatty acids analysis determination of the composition, to be produced will increase the value of the nuts (Arda, 2006).

As can be seen in Table 3.3. The results of the analysis of fatty acid components were found as follows. Palmitic acid (C 16:0) ratio 4.62% (44HEK40) to 6.76% (44HEK50); stearic acid (C

18:0) ratio 2.41% (44HEK28) to % 3.65% (44HEK43); oleic acid (C 18:1) ratio 24.79% (44HEK35) to 43.48% (44HEK43); linoleic acid (C 18:2) ratio 37.60%(44HEK43) to 57.17% (44HEK35); linolenic acid (C 18:3) ratio 6.56% (44HEK50) to 13.94% (44HEK20).

Table 3.3. Fatty acid compositions of selected walnut genotypes
Tablo 3.3. *Seçilen ceviz genotiplerinin yağ asit kompozisyonları*

Genotype	Palmitic Acid (%)	Stearic Acid (%)	Oleic Acid (%)	Linoleic Acid (%)	Linolenic Acid (%)
44HEK11	5.13	2.52	27.62	50.61	13.59
44HEK20	5.40	2.45	28.13	49.53	13.94
44HEK27	5.29	2.97	39.35	41.75	10.09
44HEK28	5.42	2.41	31.00	48.53	12.09
44HEK31	5.50	2.85	37.87	43.24	9.99
44HEK33	5.66	2.65	26.54	52.90	11.71
44HEK35	5.31	3.04	24.79	57.17	9.14
44HEK40	4.62	2.82	41.27	42.98	7.68
44HEK42	5.62	2.75	32.31	49.42	9.35
44HEK43	6.56	3.65	43.48	37.60	7.77
44HEK50	6.76	3.45	37.61	44.62	6.56
Ortalama	**5.57**	**2.87**	**33.63**	**47.12**	**10.17**
Minumum	**4.62**	**2.41**	**24.79**	**41.75**	**6.56**
Maksimum	**6.76**	**3.65**	**43.48**	**57.17**	**13.94**

Garcia et al. (1994) in their study have found the following fatty acid ratios: Palmitic acid 6.40 to 7.80%, stearic acid 1.70 to 2.20%, oleic acid 16.10 to 27.00%, linoleic acid 51.80 to 61.50% and linolenic acid 10.00 to 18.50%. Koyuncu and Aşkın (1996) in their study have found the following fatty acid ratios: Palmitic acid 7.22%, stearic acid1.07%, oleic acid 28.51%, linoleic acid 52.46% and linolenic acid 10.50%. Some other research results on this subject are as follows. Ağar et al. (1995) have found their selection in studies of fatty acid ratios in the following way. Palmitic acid 5.77 to 7.86%, stearic acid 2.72 to 3.29%, oleic acid 19.02 to 30.14%, linoleic acid 53.08 to 59.61% and linolenic acid 7.77 to 13.82%.

Many researchers also fatty acid ratios are found at approximately the same levels. For example; it was noted that there were differences in findings among genotypes and cultivars (Özkan, 2002; Ünver and Çelik 2005; Yarılgaç et al., 2005). The studies compared with our findings; it is observed that the rate of palmitic and linolenic acid is lower. A bit high rate of stearic and oleic acid, linoleic acid ratios were closer to observed values.

Studies on mineral content of walnut fruits are less. In a selection study, macro and micro element contents of 100 g of internal fruit were analyzed in walnut genotypes. Genotypes were found to contain 2.44% N, 297.5 mg P, 442.6 mg N, 331.9 mg Mg, 186.8 mg Ca, 169.1 mg S, 1.88 mg Na, 2.58 mg Fe, 2.86 mg Mn, 2.29 mg Zn and 1.34 mg Cu in the fruits (Başer et al., 2016). Our findings are very similar to the above-mentioned findings.

Table 3.4' shows the mineral content of the genotypes. As will be seen in the table 3.4.; K was the highest mineral with an average of 374.64 mg / 100 g. Others include Mg 137.00 mg / 100 g (44HEK50) -24.90mg / 100 g (44HEK43); Ca 99.00 mg / 100 g (44HEK20) -189,60mg / 100 g (44HEK33); Mn is between 2.00 mg / 100 g (44HEK33) -6.80 mg / 100 g (44HEK43); Fe between 3.20 mg / 100 g (44HEK40) -6.10 mg / 100 g (44HEK43), Zn between 0.80 mg / 100 g (44HEK11) -4.70 (44HEK43); Cu 0.80 mg / 100 g (44HEK11) -3.50 mg / 100 g (44HEK43); Na

was determined between 27.60 mg / 100 g (44HEK11) -100.50 mg / 100 g (44HEK43). In general, when we look at the elements from very low to K> Mg> Ca> Na> Mn> Fe> Zn> Cu are listed as.

Yarılgaç et al. (2005), in their study, the mineral contents N 0.208%, P 0.019%, K 0.041%, Ca 90.3 mg, Mg 124.8 mg, Cu 1.20 mg, Mn 1.76 mg and Zn as 2.69 mg; Muradoglu et al. (2011), 2.96% N, 484.64 mg / 100g K, 148.76 mg / 100g Ca; 166.75 mg / 100g Mg; 3.41 mg / 100 g Fe, 1.93 mg / 100 g Mn, 1.27 mg / 100 g Cu and 2.01 mg / 100 g Zn.

Aslansoy (2012) in the research findings, K (467.692 ppm), Mg (66.767 ppm), Ca (23.848 ppm), Na (0.049 ppm), Zn (0.812 ppm), Cu (0.573 ppm), Fe (1.140 ppm), Mn (0.996 ppm), Ni (0.060 ppm) and Ba (0.044 ppm); Gülsoy et al. (2016), 1.83%N, 335.76 mg/100 g P, 493.49 mg/100 g N, 260.79 mg/100 g Ca, 234.40 mg/100 g Mg, 12.71 mg/100 g Na, 12.47 mg/100 g Fe, 2.88 mg/100 g Cu, 2.58 mg/100g Zn and 3.35 mg/100 g were found to be the Mn.

When the findings obtained in our study were compared with previous studies; Na, Ca, Mn and Cu contents are high; It is seen that K and Fe ratios are lower and Mg and Zn ratios are close. Mineral content of walnut fruit; In addition to genetic and ecological characteristics, factors such as harvest dates, cultural processes, soil pH, different soil structure may be influenced.

Table 3.4. Mineral content of selected walnut genotypes

Tablo 3.4. *Seçilen ceviz genotiplerinin mineral madde içerikleri*

Genotype	Na (mg/100 g)	Mg (mg/100 g)	K (mg/100 g)	Ca (mg/100 g)	Mn (mg/100 g)	Fe (mg/100 g)	Cu (mg/100 g)	Zn (mg/100g)
44HEK11	27.60	148.90	283.90	114.10	3.60	3.90	0.80	0.80
44HEK20	31.20	159.60	304.70	99.00	3.70	4.50	2.10	2.00
44HEK27	31.70	155.70	343.20	112.50	5.70	3.80	1.80	2.40
44HEK28	51.80	200.50	474.30	171.30	5.10	4.40	2.20	2.20
44HEK31	72.90	178.80	398.60	152.00	5.60	3.80	2.00	2.60
44HEK33	65.60	171.80	352.10	189.60	2.00	4.40	1.70	2.90
44HEK35	51.50	160.70	347.00	166.30	4.50	3.40	3.20	1.90
44HEK40	43.30	166.00	387.90	145.10	4.80	3.20	1.30	1.80
44HEK42	53.80	177.50	351.60	130.00	4.80	4.00	2.20	2.90
44HEK43	100.50	242.90	556.20	189.10	6.80	6.10	3.50	4.70
44HEK50	28.50	137.00	321.50	131.40	5.90	3.60	1.00	2.00
Ortalama	**50.76**	**172.67**	**374.64**	**145.49**	**4.77**	**4.10**	**1.98**	**2.38**
Minumum	**27.60**	**137.00**	**283.90**	**99.00**	**2.00**	**3.20**	**0.80**	**0.80**
Maksimum	**100.50**	**242.90**	**556.20**	**189.60**	**6.80**	**6.10**	**3.50**	**4.70**

4. Conclusions

As a result; In the selection study conducted between 2015-2016, 11 genotypes which were over 740 points were selected as a result of weighed scale. In this study, chemical analyzes of genotypes (44HEK11, 44HEK20, 44HEK27, 44HEK28, 44HEK31, 44HEK33, 44HEK33, 44HEK35, 44HEK40, 44HEK42, 44HEK43, 44HEK50) were also performed.

These genotypes are distinguished by their important features such as fruit weight, side branch yield, internal rate and crust thickness; The good chemical content, which is very important for health, will increase the value of variety candidates further. As a candidate for varieties, studies for obtaining multi-year data are continuing.

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