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Research Article

Determination of Phenological, Pomological and Biochemical Characteristics of Some Walnut (*Junglas regia* L.) Genotypes Growing in Demirci (Manisa) District

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Abstract

Anatolia has long traditional walnut cultivation and rich for seed propagated walnut genetic variation. Selection studies on these rich variable walnut genetic resources are important in terms of determining and preserving genotypes with desired fruit and tree characteristics. This study carried out on seed propagated walnut genotypes in the Demirci District of Manisa Province between 2018 and 2019 to determine superior walnut genotypes from natural seed propagated walnut populations. In the field study a total of 130 walnut genotypes were selected the first year and after reevaluation in the second year 20 promising walnut genotypes were selected among them as cultivar candidate and their phenological, pomological and biochemical characteristics were determined. The kernel weight, nut weight and kernel ratio of 20 promising genotypes were in the range of 5.03-9.27 g, 11.27-24.00 g, and 26.54-61.18%, respectively indicating great variability among genotypes. Nut length, width and shell thickness were between 31.8-44.9 mm, 29.0-35.8 mm, 1.3-2.4 mm, respectively. Average protein, oil, and ash ratio in fruits of 20 genotypes was determined as 24.48%, 65.08% and 1.90%. Considering all parameters Dem.45.karY, Dem.45.KoAlt, Dem.45.Koüst and Dem.45.Mah genotypes are found to be the most promising to register them as cultivar candidate.

Keywords: Walnut, selection, genetic resources, pomology

Demirci (Manisa) İlçesinde Yetişen Bazı Ceviz (*Junglas regia* L.) Genotiplerinin Fenolojik, Pomolojik ve Biyokimyasal Özelliklerinin Belirlenmesi

Öz

Anadolu, uzun yıllardır geleneksel ceviz yetiştiriciliğine sahip olup, tohumdan üretilen ceviz genetik çeşitliliği açısından zengindir. Bu zengin ve değişken ceviz genetik kaynaklarında yapılacak seleksiyon çalışmaları, istenilen meyve ve ağaç özelliklerine sahip genotiplerin belirlenmesi ve korunması açısından önemlidir. Bu çalışma, 2018-2019 yılları arasında Manisa Demirci ilçesinde tohumdan üretilen ceviz genotipleri üzerinde yürütülmüş olup, doğal olarak tohumdan üretilen ceviz popülasyonlarından üstün ceviz genotiplerini belirlemek amacıyla yapılmıştır. Arazi çalışmasında ilk yıl toplam 130 ceviz genotipi seçilmiş olup, ikinci yıl yapılan yeniden değerlendirme sonrasında bunlar arasından 20 ümitvar ceviz genotipi çeşit adayı olarak seçilmiş ve fenolojik, pomolojik ve biyokimyasal özellikleri belirlenmiştir. 20 ümitvar genotipin iç meyve ağırlığı, kabuklu meyve ağırlığı ve iç oranı sırasıyla 5,03-9,27 g, 11,27-24,00 g ve %26,54-61,18 aralığında bulunmuş olup, genotipler arasında büyük değişkenlik göstermektedir. Meyve uzunluğu, meyve genişliği ve meyve kabuk kalınlığı sırasıyla 31.8-44.9 mm, 29.0-35.8 mm, 1.3-2.4 mm arasında bulunmuştur. 20 genotipin meyvelerindeki ortalama protein, yağ ve kül oranı %24.48, %65.08 ve %1,90 olarak belirlenmiştir. Tüm parametreler göz önüne alındığında Dem.45.karY, Dem.45.KoAlt, Dem.45.Koüst ve Dem.45.Mah genotiplerinin çeşit adayı olarak tescil edilmek için en umut verici olduğu belirlenmiştir.

Anahtar Kelimeler: Ceviz, seleksiyon, genetik kaynak, pomoloji

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1. Introduction

Türkiye is among the countries with rich biodiversity and is considered one of the gene centers for many plant species. Additionally, due to its geographical location, Türkiye is suitable for the cultivating horticultural plants, with many of them being native to the region [1, 2, 3]. One of these species, walnut (*Juglans regia* L.), holds a special place among fruit species due to its high nutritional value and its valuable timber used in the furniture industry [4]. Walnut leaves, fruits and the other plant organs are also used in various industries. The food and pharmaceutical industries utilize green fruits of walnut before the shell hardens and leaves, barks, and roots are employed in the tannin and dye industries. Walnut oil, on the other hand, is a precious oil used food science and fine arts. Additionally, walnut trees serve as important sources of raw material in woodworking due to their longevity and durability characteristics [5].

The increasing demand for healthy nutrition in society in recent years and in addition the increase in demand for fast-consumed foods due to fast working hours and lack of time, and changes in consumption habits (e.g. products such as breakfast muesli, energy-giving chocolate and bars) have increased the tendency towards hard-shelled fruits and therefore walnuts gained more importance at this point [6, 7]. Walnuts are useful for brain health with their high content of omega-3 fatty acids and prevent heart disease and cancer [8, 9]. In addition to the fatty acids it contains, walnuts contain fat-soluble vitamins A and E, water-soluble vitamins B1, B2, C, folic acid, pantothenic acid and niacin, and minerals; It also contains iron, magnesium, copper, zinc and phosphorus [4, 10]. It has been stated that walnut consumption increases the level of melatonin in the blood and contributes to eliminating disorders such as sleep disorders [11]. In addition to its healing effect on cholesterol, walnuts, a type of hard-shelled fruit, have also been stated to reduce the risk of vascular heart diseases [12]. The researcher found that the diet containing walnut oil also reduced the LDL cholesterol level and carbon reactive protein level [13]. Decreasing the amount of carbon-reactive protein causes a decrease in vascular occlusions and heart diseases [14].

Türkiye is an important walnut producer and ranks 4th globally in walnut production [15]. However, Türkiye is also an important walnut importing country because this production does not even meet domestic consumption. Since walnuts are traditionally propagated by seeds in Türkiye, there are a great variability in tree and fruit characteristics of walnuts. While this situation prevents the cultivation of standard varieties, it has enabled the creation of valuable genetic material to obtain new varieties through selection breeding studies. The increasing interest in walnut fruit in recent years and the satisfaction of its price to growers have increased the interest in walnut farming. This interest has also increased the number of research and studies conducted on walnuts. In these studies, in addition to revealing varieties with commercial values, emphasis was also placed on finding types with promising tree and fruit traits among the walnuts growing naturally in Anatolia [16].

By revealing the genotypes found as natural population resources through selection studies, existing resources are prevented from disappearing for various reasons. These obtained seed

propagated genotypes will be evaluated as candidate varieties and will provide the basis for future cross breeding and other breeding studies. No walnut selection studies have been carried out before in Manisa province and its districts. This point of selection study aims to identify genotypes with superior tree and fruit characteristics in the region and to obtain registered variety (s) after various stages. Such studies will bring Turkey's walnut cultivation to the deserved levels and make great contributions to the country's economy.

2. Material and Methods

2.1. Plant Material

This research was conducted in 2018-2019 in Demirci district and neighborhoods of Manisa Province, located in the western Anatolia of the Aegean region. Demirci center has an altitude of 900 m. The average temperature during the year is around 12-13 ºC, nearly 50-55% of annual precipitation occurs in the winter months. It is under the influence of the Mediterranean and continental transition zone. All walnut genotypes used in the study consisted of ungrafted material grown from seeds. While selecting the region and determining the locations, decisions were made in line with the selection criteria and the information provided by the breeders. In the research, first year observations were made on 130 walnut genotypes and 20 promising genotypes were selected from them in second year.

Figure 1. Map of Demirci District of Manisa Province

2.2. Method

The preliminary information provided by the producer was taken as a criterion to determine whether the genotypes were not damaged by late frosts that occurred in the spring in the region and had lateral fruitfulness. Collection of data such as collecting samples from trees, altitude and geographical location of the region was carried out under field conditions. Evaluations were made based on the selection screenings and the phenological and pomological characteristics of the promising types obtained in the screenings. The walnut genotypes examined under field conditions were evaluated and the promising genotypes were determined by the modified weighted grading method (Table 1) [17]. After removing the green shells of 25 walnut fruits collected from each tree, these samples were stored in specially prepared numbered cloth bags and left to dry in the shade at room temperature. Fruit quality characteristics and biochemical analyzes were carried out on the determined genotypes in the side branches in 2018 and 2019, as well as on the fruits to be taken during the harvest season. Phenological observations (In addition to the first leafing dates and fruit set rate on side branches, characteristics such as male and female flowering dates and flowering type were also emphasized) were done in the spring of 2018 and 2019. The following characteristics were examined in the trees and fruits of the genotypes.

Table 1. Fruit and tree characteristics used in the weighted grading method

Character Impact Rate	**(%)**		
	A*	**B****	**C*****
First leaf date	30	5	20
Fruiting on side branches	5	25	30
Nut Weight	20	20	15
Internal ratio	15	15	10
Inner color	10	10	10
Shell roughness	10	5	5
Interior wolf	5	10	5
Anthracnose	5	10	5
TOTAL	100	100	100

*A: Importance levels of characters used in the selection of late leafing, good fruit quality, disease and pest resistant types **B: The importance of the characters used in selecting types with high side branch yield, good fruit quality, and resistance to diseases and pests ***C: Importance levels of characters used in selecting late leafing, high fruit yield on side branches, good fruit quality, and resistant to diseases and pests

2.2.1. Morphological characteristics

Fruit retention rate on lateral fruitfulness, dichogamy and leafing time was determined according to [17].

2.2.2. Pomological characteristics

Nut length (length), nut width (width-suture diameter) and nut height (thickness-cheek diameter) and shell thickness were measured with a digital caliper sensitive to 0.01 mm (VWR6, Milan, Italy). Nut weight with skin (g) and kernel weight (g) were determined by weighing each fruit sample on a precision scale sensitive to 0.1 mg. Fruit shape was determined according to Ercisli et al. [4]. shell surface roughness and kernel colour was determined according to Keles et al. [17]. The kernel ratio (%) was calculated as the kernel ratio as a result of the measurements of the shelled fruit weights and kernel weight of 25 fruit samples taken from the selected genotypes.

2.2.3. Biochemical characteristics

Walnut samples belonging to the genotypes that were determined to be superior were separated from their shells, ground thoroughly with the help of a shredder, and then stored in protective bags with reduced air permeability to zero to prevent deterioration. Protein (Nitrogen amounts of fruits were calculated by multiplying by the constant 6.25 using the Khejdal (Nx6.25) method), fat (Total oil contents of walnut fruits of selected genotypes were determined by Soxhlet apparatus) and ash content (%) (Walnut kernels from the fruits of the selections were dried at 105˚C for 1 day, 0.5 g of the sample was burned in a 550 °C oven for 6 hours to determine the ash content, and the ash content was expressed as %) was determined according to Beyhan et al. [18] and Muradoğlu [48].

3. Results and Disscussion

Morphological traits are important for germplasm characterization and therefore must be evaluated and recorded in the early steps of selection [19]. Characterization of plant phenology can be as vital tool for ecosystem simulation models and for predicting the response of ecosystems to climate change [20]. Main nut and kernel characteristics of 20 promising walnut selections are given in Table 1. Nut length, width and nutshell thickness of 20 walnut genotypes were between 30.5 mm (Dem.45.KüpŞır) - 44.9 mm (Dem.45.karY); 29.0 mm (Dem.45.İrY1) - 35.8 mm (Dem.45.karY), and 1.3 mm (Dem.45.Çay1) - 2.4 mm (Dem.45.karY and Dem.45KüpŞır), mostly found in the Dem.45.karY genotype (Table 2).

Table 2. Nut and kernel characteristics of promising walnut genotypes examined in 2018-2019 average values.

Genotypes	Nut length (mm)	Nut width (mm)	Shell thickness (mm)	Nut weight (g)	Kernel weight (g)	Kernel ratio (%)
Dem.45.CY	33.9±1.6	30.8±1.5	1.5±0.14	11.27±0.74	7.07±0.30	49.72±3.1
Dem.45.KüpŞır	30.5±1.4	33.1±1.7	2.4±0.17	18.70±0.83	7.37±0.36	29.82±2.7
Dem.45.KüpY	37.8±2.2	33.0±1.4	2.0±0.20	18.77±0.80	5.07±0.26	27.00±2.5
Dem.45.Çay1	37.9±2.4	34.0±1.6	1.3±0.11	18.30±0.69	6.27±0.38	34.24±2.5
Dem.45.Çay2	38.0±2.2	33.7±1.6	2.1±0.21	16.97±0.55	7.13±0.43	47.94±2.7
Dem.45.Y1	36.3±1.8	34.8±1.5	2.1±0.18	15.83±0.70	5.93±0.30	37.47±2.3
Dem.45.Y2	32.0±1.4	30.5±1.2	2.0±0.19	11.70±0.74	5.37±0.27	45.87±2.9
Dem.45.Mah	39.4±1.7	33.9±1.7	2.1±0.20	22.33±0.61	8.10±0.56	49.46±2.7
Dem.45.Ören	34.5±1.5	30.5±1.9	2.1±0.24	15.20±0.67	6.90±0.40	45.39±2.8
Dem.45.İrY1	33.6±1.3	29.0±2.0	1.9±0.19	14.30±0.72	5.70±0.32	39.86±3.0
Dem.45.İrY2	31.8±1.4	31.6±1.8	2.1±0.22	13.23±0.70	5.43±0.30	41.06±2.6
Dem.45.Koüst	40.4±2.6	33.0±1.9	2.0±0.15	19.93±0.87	9.00±0.86	60.56±3.7
Dem.45.KoAlt	41.6±2.8	32.8±1.4	1.9±0.14	19.33±0.91	8.43±0.91	60.41±3.5
Dem.45.Ko	39.6±2.3	34.9±1.5	2.0±0.17	16.27±0.73	7.70±0.52	47.34±2.9
Dem.45.Hoş	42.5±2.7	32.9±1.7	2.1±0.19	15.80±0.67	7.00±0.35	43.27±2.8
Dem.45.EsY	34.2±1.9	32.4±1.6	2.0±0.11	13.70±0.70	6.67±0.46	48.66±3.0
Dem.45.Çanmez1	32.1±1.5	31.1±1.6	2.0±0.18	12.80±0.47	6.53±0.36	51.04±3.5
Dem.45.Çanmez2	33.4±1.6	34.2±1.8	2.0±0.14	18.97±0.74	5.03±0.28	26.54±2.2
Dem.45.ÇanKM	38.5±1.6	30.0±1.4	1.9±0.11	11.60±0.71	6.43±0.39	55.46±3.5
Dem.45.karY	44.9±2.9	35.8±1.9	2.4±0.16	24.00±0.97	9.27±0.95	61.18±3.9

The nut and kernel weight of the genotypes were quite variable with a range of 11.27-24.00 g and 5.03-9.27 g, respectively. The kernel ratio of genotypes was found between 26.54% and 61.18%. Among all genotypes, the maximum nut weight was determined in Dem.45.karY with 24.00 g (Table 2). Previously Cerovic et al. [21] determined the nut weight between 3.30-29.00 g and the kernel ratio 26.2-64.3% in several walnut selections in Serbia. In Türkiye Orman 2018, [22] reported nut weight between 7.48-26.17 g among seed propagated walnuts. Cosmulescu et al. [23] determined the average nut weight of 7.62–20.90 g on 64 seed propagated walnut genotypes in the Oltenia region of Romania. Cosmulescu and Botu [24] in another study on walnut biodiversity in the Oltenia region of southwestern Romania, found nut weights between 6.8-18.4 g, kernel weights between 1.70-8.79 g, kernel ratio 23.6-71.7%, respectively. Poggetti et al. [25] used elite walnut genotypes selected in the North-Eastern Italian Alps, reported the nut weight with rind was determined to be 2.2-17.3 g and the kernel ratio was within the range of 25-58%, and 9 genotypes out of 184 genotypes were determined to have a fruit weight of 12 g or more. Rezai et al. [26] in a study conducted in 5 different parts of the Malay region of Iran, calculated the nut weight as 5.35-21.31 g, the kernel weight as 2.49-11.15 g, and kernel ratio as 37.27-66.29%. Simsek et al. [27] measured nut weights of the walnut genotypes they selected in the Mardin region as 9.67-15.68 g, kernel weight as 5.35-

8.54 g and kernel ratio as 48.35-67.27%. Tsampas and Botu [28] studied the pomology of walnuts in the regions of Oltenia (Romania) and Epirus (Greece). Epirus 12 coded genotype in Greece and Cernişoara P7 coded genotype in Romania determined the highest rate with nut weight (18.5 g) and kernel ratio (50%). In different parts of walnut growing region in Türkiye several selection studies were conducted on seed propagated walnuts. In these studies, Tasci [29]. Ates [30] Basak [31] and Senar-Saka [32] reported the kernel weight of seed propagated walnuts as 6.85-9.22 g; 8.02-10.17 g; 4.15-7.55 g and 5.45-8.60 g, respectively. Muradoglu and Balta [33] carried out a survey in Ahlat region in eastern Anatolia and reported 9.91-15.22g nut weight, 5.00-6.24 g kernel weight, 40.9-52.3 % kernel ratio for 15 promising seed propagated walnut genotypes. In Anatolia quite variable kernel ratio of seed propagated walnuts was determined. Goksuncukgil [34] reported these values between 44.57% and 56.01% in southern Anatolia, Erdonmez [35] reported between 47.17% and 55.03% in western Anatolia, Orbay [36] reported between 37.1% and 50.36% in inner Anatolia. Cosmulescu et al. [23] in their study on the seed propagated walnut population in Romania, they found that the fruit length of the 64 genotypes they selected varied between 31.17- 53.60 mm. Simsek et al. [27] in their research in the Mardin region in Türkiye, determined nut sizes of seed propagated walnuts in the ranges of 33.53-45.78 mm, 28.42-37 mm, 28.30-36.32 mm. Unver [37] found that the shell thicknesses of the selected seed propagated walnuts varied between 1.04 mm (06.ANK.348) and 2.03 mm (06.ANK.357). Poggetti et al. [25]. determined the shell thickness as 0.35- 2.30 mm in their study on the Northeast Italian Alps walnut population. Oruc [38] found the shell thickness between 0.99-2.78 mm on seed propagated walnuts in Türkiye.

Nut shape, kernel color and shell surface roughness of 20 walnut genotypes are shown in Table 3. According to results, most genotypes had round nut shape (15 genotypes), 4 genotypes had oval nut shape and only 1 genotype had long nut shape. For kernel color, 11 genotypes had light kernel color and 9 genotypes of dark kernel colors. In terms of shell surface roughness, 14 genotypes had media shell surface roughness, 4 genotypes smooth and 2 rough types were determined.

Table 3. Nut shape, kernel color and shell surface roughness of 20 promising walnut genotypes examined in 2018-2019 average values.

Genotypes	Nut shape	Kernel color	Shell surface roughness
Dem.45.CY	Round	Dark	Smooth
Dem.45.KüpŞır	Round	Light	Middle
Dem.45.KüpY	Round	Dark	Middle
Dem.45.Çay1	Round	Light	Middle
Dem.45.Çay2	Oval	Dark	Middle
Dem.45.Y1	Round	Light	Middle
Dem.45.Y2	Round	Dark	Smooth
Dem.45.Mah	Round	Light	Smooth
Dem.45.Ören	Round	Dark	Middle
Dem.45.İrY1	Round	Light	Middle
Dem.45.İrY2	Round	Light	Middle

Dem.45.Koüst	Long	Light	Middle
Dem.45.KoAlt	Round	Light	Middle
Dem.45.Ko	Round	Dark	Rough
Dem.45.Hoş	Oval	Dark	Rough
Dem.45.EsY	Round	Light	Middle
Dem.45.Çanmez1	Round	Light	Middle
Dem.45.Çanmez2	Round	Dark	Middle
Dem.45.ÇanKM	Oval	Dark	Middle
Dem.45.karY	Oval	Light	Smooth

Khub et al. [39] determined that in kernel color evaluation of seed propagated walnuts, 10 genotypes were very light, 134 genotypes were light, 87 genotypes were light yellow, and 1 genotype was dark shell. Poggetti et al. [25] in their study, in the color classification of 184 seed propagated walnut genotypes, they classified 73 of the genotypes as very light, 66 as light, 27 as dark yellow, and 18 as yellow. Boruzan-Ucar [40] studied on seed propagated walnuts and found that the kernel colour to be 20% light, 40% yellow, and 40% dark.

Altitude, leafing time, dichogamy and lateral fruitfulness characteristics of 20 promising walnut genotypes examined in 2018-2019 were presented in Table 4.

Table 4. Altitude, leafing time, dichogamy and lateral fruitfulness characteristics of 20 promising walnut genotypes examined in 2018-2019 average values.

Genotypes	Altitude (m)	Leafing time	Dichogamy	Lateral fruitfulness %
Dem.45.CY	900	7 April	protandry	55
Dem.45.KüpŞır	820	23 April	protandry	45
Dem.45.KüpY	810	19 April	protandry	58
Dem.45.Çay1	810	30 April	protandry	55
Dem.45.Çay2	810	26 April	protandry	50
Dem.45.Y1	810	25 April	protandry	50
Dem.45.Y2	810	26 April	protandry	45
Dem.45.Mah	1150	27 April	protandry	63
Dem.45.Ören	960	20 April	protandry	45
Dem.45.İrY1	1050	28 April	protandry	45
Dem.45.İrY2	1100	27 April	homogamy	30
Dem.45.Koüst	900	28 April	protandry	64
Dem.45.KoAlt	870	25 April	protandry	63
Dem.45.Ko	890	18 April	protandry	50
Dem.45.Hoş	895	18 April	protandry	55
Dem.45.EsY	850	26 April	protandry	60
Dem.45.Çanmez1	1100	28 April	homogamy	35
Dem.45.Çanmez2	1103	27 April	protandry	60
Dem.45.ÇanKM	1000	29 April	protandry	55
Dem.45.karY	1000	2 May	protandry	64

When evaluated regarding leafing date, it was seen between the first week of April and the first week of May. The latest leafing date was found to be in the Dem.45.karY genotype. Considering the damages caused by late spring frosts, late leafing is advantageous in walnut cultivation.

Late leafing genotypes were detected in present study. It can be said that these differences vary depending on the local ecology and genetic structure. Lateral fruitfulness efficiency varies between 35% and 64%. Yaviç [41] reported lateral fruitfulness efficiency as between 30-100% on seed propagated walnuts in eastern Anatolia; In other studies, conducted in Türkiye, Yılmaz and Akca [42] reported between 20-85%; Akca and Ozongun [43] found between 10-70%, Simsek et al. [27] found between40-90%, Acar, [44] revealed between 40-90%, Ates [30] reported 50-60%, Basak [31] determined between 40-78%. Ramos [45] reported fruiting rates on lateral fruitfulness of USA standard walnut varieties as 63% in Pedro, 55% in Serr, 90% in Payne, 95% in Chandler and 70-75% in Amigo. When we compare our results with above studies, the fruiting rates on the lateral fruitfulness are sufficient. Beyhan [46] determined that 68.66% of the selected seed propagated walnut genotypes were protandrous, 25.37% were protogynous, and 5.87% were homogamous.

Protein, oil, and ash ratio in kernel of 20 walnut genotypes are shown in table 5.

Table 5. Protein, fat and ash ratio in kernel of 20 walnut genotypes examined in 2018-2019 average values.

Genotypes	Protein ratio (%)	Oil ratio (%)	Ash ratio (%)
Dem.45.CY	16.92±0.9	54.84±2.9	1.13±0.2
Dem.45.KüpŞır	16.10±0.8	55.01±3.1	1.28±0.1
Dem.45.KüpY	12.87±0.6	48.72±3.1	1.44±0.2
Dem.45.Çay1	20.74±1.1	45.70±2.8	1.76±0.3
Dem.45.Çay2	14.70±0.7	55.24±2.9	1.59±0.2
Dem.45.Y1	19.95±0.9	45.99±2.6	1.21±0.1
Dem.45.Y2	15.58±0.9	52.30±2.8	1.68±0.3
Dem.45.Mah	25.55±1.4	65.00±3.8	1.92±0.5
Dem.45.Ören	12.50±0.5	59.32±2.8	1.75±0.4
Dem.45.İrY1	12.95±0.5	58.69±2.6	1.15±0.2
Dem.45.İrY2	22.00±0.9	56.55±2.5	1.41±0.3
Dem.45.Koüst	23.05±1.3	65.00±2.9	1.85±0.5
Dem.45.KoAlt	23.88±1.1	64.58±3.4	1.88±0.5
Dem.45.Ko	12.50±0.4	57.01±2.5	1.39±0.2
Dem.45.Hoş	20.45±0.9	49.90±2.3	1.28±0.2
Dem.45.EsY	19.65±0.7	51.28±2.8	1.33±0.3
Dem.45.Çanmez1	16.71±0.5	53.60±2.9	1.70±0.5
Dem.45.Çanmez2	15.85±0.4	58.13±3.4	1.27±0.2
Dem.45.ÇanKM	16.60±0.4	59.48±3.3	1.34±0.2

Dem.45.karY	24.48±1.5	65.08±3.7	1.90±0.6

The highest protein content was obtained from Dem.55.Mah genotype as 25.55% and followed by Dem.45.KarY (24.48%), Dem.45.KoAlt (23.88%) while the lowest protein content was seen in genotypes Dem.45.KüpY and Dem.45.Önem as 12.87% and 12.50%, respectively indicating that 2 times differences on protein content among the highest and the lowest genotypes (Table 5).

Oil content of walnut genotypes was quite variable, and the highest oil value was observed in genotype Dem.45.KarY as 65.08% and followed by Dem.45.Mah (65.00%) and Dem.45.KoÜst (65.00%). The lowest oil content was seen in genotypes Dem.45.Y1 and Dem.45.Çay1 as 45.99% and 45.70%, respectively (Table 5).

The ash content of genotypes varied from 1.13% (Dem.45.CY) to 1.92% (Dem.45.Mah).

These features are considered in walnut quality. Simsek [47] determined average protein content between 13.70–20.18%, average oil content 58.88–65.64%, and average ash content between 1.88–2.89%. Regarding these features, the values we obtained from the study are compatible with the literature [40, 29, 30, 31]. Depending on genetic structure and environment factors, walnut kernels generally contain 12-19% protein, 60% oil, and 2-4% ash. 65% of this oil composed of polyunsaturated fatty acid. Yilmaz and Akca [42] studied walnut populations in Niksar, Türkiye and reported protein, oil and ash content of seed propagated 14 promising walnut selection as 7.09-23.89 %, 62.80-73.05 %, and 1.36-2.20 %, respectively, which indicate similarities with our results.

4. Conclusion

As a result of the study conducted between 2018-2019 in Demirci District of Manisa Province, 20 promising genotypes selected from 130 walnut types were determined. It is thought that the differences that occur may be affected by the genetic structure, environment, soil, climate conditions and maturity status of the fruits. These genotypes were examined in terms of foliation, disease and pest incidence, resistance to frost and cold, fruit yield and quality, and their superior characteristics were determined. Accordingly, Dem.45.karY and Dem.45.KoAlt, Dem.45.Koüst and Dem.45.Mah genotypes were found to be promising in selection studies in terms of many breeding criteria such as nut weight, kernel weight, lateral fruitfulness yield. It is envisaged that these types will be evaluated as a variety of candidates. Considering the data we obtained in the research, considering that they are types that grow from seeds under natural conditions, when examined in terms of their physical properties, it has been observed that they have superior properties than some standard varieties and selected types. It can be said that these selected types will have superior properties under better conditions by multiplying them. This study, which once again shows that we have a rich genetic variation, has contributed to the district and our country. The importance of such selection studies for the future of agriculture in our country is obvious.

Ethics in Publishing

There are no ethical issues regarding the publication of this study.

Author Contributions

All authors contributed equally to all stages of the study, including its conceptualization, methodology, data collection, analysis, and writing.

Conflict of Interest

The authors declare no competing interests.

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This article is summarized from the master thesis of Selahattin ÖZCAN. On behalf of all authors, I declare that it is not a work of interest.

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