POMOLOGICAL AND CHEMICAL PROPERTIES OF SOME WALNUT GENOTYPES IN CENTRAL ANATOLIA

Safder Bayazit, Oguzhan Caliskan

Mustafa Kemal University, Faculty of Agriculture, Hatay, Turkey

Corresponding author: sbayazit@mku.edu.tr

Abstract

This study was conducted to determine some pomological and chemical characteristics of Bilecik, Yavuz, Şebin walnut cultivars and Yerli genotype grown in Kırşehir, Turkey. Characteristics of walnut such as nut weight, kernel weight, nut width, nut hight and nut diameter and some kernel features were investigated. The results indicated that the average fruit weight ranged from 17.33 g (Yavuz) to 12.83 g (Şebin), the nut width alternated from 37.63 mm (Yavuz) to 31.33 mm (Yerli), the nut height ranged from 52.25 mm (Yavuz) to 41.07 mm (Yerli), and the kernel percentage ranged from 46.07% (Bilecik) to 49.43% (Yavuz). The highest oil content was detected in Yavuz cultivar (63.20%), while the lowest value was obtained from the Bilecik cultivar with 53.90%. Contrary to fat content, the highest protein content was detected in the Bilecik cultivar. Consequently, our data showed that the fruit properties of Yavuz and Şebin cultivars were superior than the others in Central Anatolian ecological conditions.

Keywords: Walnut, cultivars, nut, kernel characteristics, Central Anatolia.

Introduction

Walnut (*Juglans regia* L.), an important fruit crop for Turkey, is the oldest cultivated fruit in the world and grown naturally almost all over Turkey (Sen, 1986; Asma, 2012).

World walnut production has been estimated as 3.462.731 tons of shelled product. The main producing country is the China, which accounts for 1.602.373 tons 46.3% of the world production. The other producing countries are USA (518.002 tons; 15%), Iran (445.829 tons; 12.88%), Turkey (212.807 tons; 6.20%) Mexico (125.758; 3.8%), Ukraine (102.740 tons; 3%), followed by others countries with a lower production (Anonymous, 2017).

Turkey has notably good walnut cultivars. Breeding programs have been launched over the last 40 years to develop new cultivars with uniform fruit quality and high yield quantity (Bayazit et al. 2016).

Turkey has a remarkable walnut population of walnut varieties when compared to other parts of the world. The walnut new cultivars have been improved by breeding programs in Atatürk Central Research Institute, Yalova, Turkey in 1971 (Şen, 1980). Several selection studies have been carried out especially dealing with the quality and fruit properties of walnuts grown in Turkey to improve walnut cultivars (Olez, 1971; Sen, 1983; Celebioglu et al., 1988; Sen and Beyhan, 1993; Ferhatoglu, 1993; Akca and Sen, 1995; Askin and Gun, 1995; Koyuncu and Askin, 1995; Koyuncu and Askin, 1999; Bayazıt, 2000; Sutyemez, 2000; Keles et al. 2014; Akça et al. 2015). A number of walnut cultivars have been developed as a result of these breeding programs. The most important walnut cultivars of are Sebin, Bilecik, Yalova 1, Yalova 3, Yalova 4, Sen1, Sen 2, Kaman 1, Kaman 5 and Yavuz in Turkey. In recent years, Maraş18, Sütyemez 1, Akça 1, Akça 2 varieties have been improved and the production is getting widespread day by day. Today, Walnut breeding studies are carried on in different Universities and Research Institutes. However, some foreign walnuts varieties such as Fernor, Chandler, Franquette are also cultivated.

The high quality varieties, determined as a result of these breeding trials in Turkey, do not show desired characteristics except for the regions where they are selected. Sometimes there are some serious problems such as poor fruit quality, inefficiency, frost damage etc. Thus; Çelebioğlu et al. (1988), Tosun and Akçay (2005) reported that some walnut varieties perform better in selected

places, whereas some walnut varieties perform better than selected ones. Similarly, it is not possible to know in advance the performance of the walnut varieties brought from other countries. For this reason, it is necessary to determine suitable walnut varieties for those ecological conditions before planting a walnut orchard, which requires significant labour and money. There are many ways to determine the appropriate variety for an ecological condition. Yield and fruit quality are the most important characteristics.

The Turkish Standards Institution established physical nut and kernel properties of walnut as a quality criteria (Anonymous, 1990; 1991). These properties are nut weight, kernel weight, kernel ratio, shell shape, nut dimensions, and other shell properties.

Some walnut genotypes which are very promising for cultivation have not been examined so far in terms of fruit quality and chemical composition in the Central Anatolian Region. The objective of this study was to determine the fruit quality parameters and chemical composition of some important Turkish walnut genotypes.

Material and methods

Total of four genotypes, 3 out of 4 were standard cultivars, 'Şebin', 'Bilecik', 'Yavuz', and the rest were promising genotypes, 'Yerli' were included in the study. These genotypes were grown onto seedling rootstocks, and planted at 7 x 7 m in 2008. Fruits of these genotypes were collected from Mucur district of Kırsehir province, which is situated in the Central Anatolia, altitude 1050 meters, in October 2016. The examinations were carried out for one year and trees were eight years old. The location of walnut trees, the sampling days and storage conditions and time until analyses were similar for all genotypes. Physical analyses were quickly determined and kernel samples were kept at –18 ^{o}C before chemical analyses. This study was set up with three repetitions in chemical analyses and twenty repetitions in physical analyses.

Pomological analyses: Fruits were harvested at their fully mature period in three replicates of 20 fruit in per replicate. Fruit weight (g), fruit width (mm), fruit length (mm), shell thickness (mm), kernel weight (g), kernel percentage (%) were measured. Fruit shape index, fruit shape, shell roughness, shell breaking and size were determined according to Turkish Standard Institution (TSI) 1275/T1 (Anonymous, 2010).

Shape index: nut length / (nut diameter + nut thickness) / 2. This index was evaluated as follows: shape index < 1.25: sample is sphere; shape index 1.25: sample is oval. Kernel ratio (%): (kernel weight / nut weight) x100. Extra: Nut diameter ≥ 27 mm for sphere, nut diameter 26 mm for oval. Class I: nut diameter 24-27 mm for sphere, nut diameter 24-26 mm for oval, class II: diameter 20-24 mm for sphere and oval. Kernel crinkling was determined as fine, medium, bad and empty.

Also, fruit shell and kernel colours were determined using a Color Meter CR-300. The L* value represents lightness (L* 0 for black, L* 100 for white), while a* scale represents the red/green dimension, with positive values for red and negative ones for green. The color values were measured on three different spots in each of two samples for fruit shell and two different spots each of three samples for kernel. The results were recorded as the mean of these measurements. Chroma [(a*2 + b*2)1/2] and hue angle (tan)-1 b*/a*) were also calculated.

Total fat content: Total fat analyses were extracted with Hexane in Soxhlet set. Total fat contents of samples were calculated according to the formula given by Akyuz and Kaya (1992):

Total fat (%) = (fat weight (g)/fruit weight (g) in cartridge) x 100.

Crude protein content (N×6.25) was determined by using kjeldahl method (Jung et al. 2003).

Data analysis: The analysis of variance was constructed according to Steel and Torrie (1980) using SAS (2005). The percentage values were transformed (arcsin) to increase normality. The mean separations were analysed by Tukey test at $p<0.05$.

Results and discussion

Good kernel quality is desirable and important properties for walnut cultivars and walnut production. Nut characteristics of 4 walnut genotypes are presented in Table 1. Analyses of variance showed that there were statistically significant differences among the genotypes for all traits.

Table1. Pomological traits of some important Turkish walnut genotypes in the Central Anatolia Region of Turkey in 2016

Genotypes	Nut weight (g)	Kernel weight (g)	Kernel ratio (%)
Yavuz	17.33 a	8.56 a	49.43 a
Şebin	12.83 b	6.28 b-c	48.93 a
Bilecik	16.66 a	7.67 a-b	46.07 a
Yerli	15.54 b	5.69 c	36.69 b
HSD	2.21	1.58	7.65

The average nut weight changed between 17.33 and 12.83 g. The highest value showed 'Yavuz' (17.33 g) followed by 'Bilecik' (16.66 g) and 'Yerli' genotypes (15.54 g). Kernel weight varied from 8.56 g (Yavuz) to 5.69 g (Yerli). It has been noted that the kernel weight of the Yerli walnut genotypes is low.

Kernel ratio varied according to varieties. Kernel/nut ratio ranged from 49.43% (Yavuz) to 36.69% (Yerli), and were lower than 50% in all genotypes. In walnut genotypes, nut weight and kernel weight were found higher than results from other region by other researchers in Turkey (Tosun and Akçay, 2005; Bayazıt and Sumbul, 2012). In contrast, the kernel percentage of the walnut genotypes was low.

Akça and Aydın (2005) determined the nut weight (10.16 and 15.92 g), kernel weight (6.56 and 5.92 g) and kernel ratio (64.80 and 48.56 %) for the Şebin and Bilecik cultivars grown in Tokat province. Our results are better than that shown by Baymış (2008) who studied the Sebin and Bilecik cultivars grown in Kahramanmaras and found nut weight (11.22 g-13.13g), kernel weight (6.33 g-6.11g), kernel ratio (56.41%-46.53%). This could be due to differences in the ecological, cultural practices, tree age and genetic properties of walnut genotypes grown in different areas. As a matter of fact, the kernel ratio of Şebin walnut cultivars in Ankara ecological conditions is reported as 33.98% by Akkuzu (2001).

Promising walnut genotypes should have a shell thickness of between 0.7 and 1.5 mm (Zhadan and Strukov, 1977). In this research shell thickness of the walnut genotypes determined varied between 1.42 (Bilecik) and 1.83 mm (Şebin) (Table 2). In the previous adaptation researches, shell thickness was 1.06 mm for the Sebin cultivars and 0.93 mm for the Bilecik variety (Baymış, 2008). Similarly, shell thicknesses of the Şebin walnut variety was reported to be 1.85 mm in the Hatay ecologic conditions (Bayazıt and Sumbul, 2012). As a result of this research, the shell thickness values obtained from the walnut varieties were higher than the values obtained from other researches.

Table 2. Nut characteristics of walnut genotypes

Genotypes	Nut width (mm)	Nut length (mm)	Nut thickness (mm)	Shell thickness (mm)
Yavuz	37.63 a	52.25 a	39.23 a	1.54 b
Şebin	34.11 b	44.44 b	35.31 b	1.83 a
Bilecik	35.40 b	45.42 b	35.85 b	1.42 b
Yerli	31.33 c	41.07 c	33.27 c	1.53 b
HSD	1.41	2.26	1.92	0.19

Shell thickness is essential for saving kernels from the external effects. In addition, average nut length ranged from 41.07 (Yerli) to 52.25 mm (Yavuz), nut width varied from 31.33 (Yerli) to 37.63

mm (Yavuz), nut cheek varied from 33.27 (Yerli) to 39.23 mm (Yavuz) in the walnut genotypes (Table 2). The pomological characteristics of walnut genotypes were similar to results of other researcher (Baymış, 2008; Akça and Aydın, 2005; Bayazıt and Sumbul, 2012).
Fruit shape was determined as oval, kernel colour was light yellow and yellow. Kernel removal was easy in the majority of the walnut genotypes.
The ideal nut should have a clean, strong, thin shell, a tight seal and weight between 12 and 18 g. The kernel should be easily removable from the shell, uniformly light in colour, clean, and weight 6–10 g or at least 50% of entire nut weight. Nut and kernel quality is strongly affected by genotypes, environment and their interaction (McGranahan and Leslie 1991; Akça and Ozongun 2004).
The fruit shape index (fruit length/width) of the genotypes between 1.28-1.38, and the fruit shapes were oval in walnut genotypes (Table 3). Shell roughness was smooth for 'Şebin' and 'Bilecik', and medium for 'Yerli', and was rough for 'Yavuz'. 'Şebin', and 'Bilecik' were on ease of shell breaking, but other genotypes were intermediate. The fruits of all walnut varieties in the experiment were included in the extra class.

Table 3: Fruit quality traits of some important Turkish walnut genotypes in in the Central Anatolia Region of Turkey in 2016

Genotypes	Fruit Shape Index	Nut shape	Shell roughness	Shell breaking	Size
Yavuz	1.38	Oval	Rough	Intermediate	Extra
Şebin	1.30	Oval	Smooth	Ease	Extra
Bilecik	1.28	Oval	Smooth	Ease	Extra
Yerli	1.31	Oval	Medium	Intermediate	Extra

The percentage of clean yellow kernel should be at least 50% in walnut genotypes according to previous findings. In our study, walnut genotypes had light coloured kernels.
The shell and kernel of all the walnut varieties in the experiment were light coloured. The biggest reason for this is that the temperate climatic conditions prevail in the experiment area, and there is no high summer temperatures.

Table 4. Fruit shell colour traits of some important Turkish walnut genotypes in the Central Anatolian Region of Turkey in 2016 year

Genotypes	L	a	b	C	H
Yavuz	50.30 c	11.09 a	18.09 a-b	21.23 a-b	58.39 a-b
Şebin	59.71 a	10.25 a	16.35 b	19.31 b	57.78 b
Bilecik	56.05 b	10.57 a	17.36 a-b	20.34 a-b	58.56 a-b
Yerli	52.24 c	11.35 a	19.20 a	22.31 a	59.29 a
HSD	2.74	1.25	2.10	2.40	1.29

Table 5. Fruit kernel colour traits of some important Turkish walnut genotypes in the Central Anatolian Region of Turkey in 2016 year

Genotypes	L*	a*	b*	C	H
Yavuz	40.62 a	10.99 c	21.86 b	24.53 b	62.99 a
Şebin	39.33 a	13.93 a	24.53 a-b	28.35 a	59.88 a
Bilecik	45.23 a	12.06 b	25.95 a	28.68 a	64.61 a
Yerli	44.14 a	11.19 b-c	25.23 a-b	27.71 a	64.33 a
HSD	7.80	0.99	3.49	2.75	6.35

Fruit skin L* value had the lightness value of 59.71 for 'Şebin' (Table 4). Fruit skin a* values indicating red color, was the highest for 'Yerli' (11.35), while it was the lowest for 'Şebin' (10.25). The maximum hue angle value (*ho*, the higher values are the clearer) was found from 'Yerli' (59.29). Chroma values (C, the lower values are more density) were found highest for 'Yerli' (22.31) genotype.

The kernel L* value was the lightest for 'Bilecik' (45.23). The kernel a* values indicating red colour, had the highest for 'Şebin 86' (13.93). C and *ho* values had the highest for 'Bilecik' (28.68 & 64.61, respectively) (Table 5).

In this study, chemical properties of walnuts were also determined. For chemical composition (Fat and protein content), Statistical differences among the genotypes were significant. Table 6 shows the highest protein quantity (20.08%) in Bilecik, the lowest value was found in Yavuz (17.11%). The protein values were in good agreement with the literature (Koyuncu and Askin, 1995; Bayazit and Sumbul, 2012).

Table 6. Fat and protein ratios of walnut genotypes

Genotypes	Fat (%)	Protein (%)
Yavuz	63.20 a	17.11 b
Şebin	60.40 a	18.45 a-b
Bilecik	53.90 b	20.08 a
HSD	5.46	2.48

Fat contents of the sample (%) were in the range of 53.90–63.20. Yavuz had the highest fat contents. Kahraman (2006) reported oil content in walnut genotypes as 51.70–72.80% and protein content was 15.61–27.50%, respectively.

Conclusions

In Kırsehir province with climate characteristics, fruit quality features of four walnut genotypes were found high. Especially compared to other research results, the shell and kernel weight of 'Şebin' walnut cultivar was relatively high. In addition, per tree yield was higher in 'Şebin' walnut compared to other varieties. Kernel percentage is very important for quality parameters. The 'Yerli' walnut genotype, grown for many years in the region, is found to be large in fruits. But, the low kernel percentage is the disadvantage of this genotype.

In Turkey, especially, late spring frosts in central and eastern Anatolia regions can damage walnut plants. It was seen that late spring frosts were not effective in walnut varieties in this study.

In conclusion, 'Bilecik' and 'Şebin' genotypes would be choice for fruit quality traits in the Kırsehir province in Central Anatolia Region of Turkey.

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