Araştırma Makalesi

www.ziraat.selcuk.edu.tr/ojs
Selçuk Üniversitesi
Selçuk Tarım ve Gıda Bilimleri Dergisi
24 (4): (2010) 33-37
ISSN:1309-0550

Mineral Composition and Physical Characteristics of Walnut (Juglans regia L.) Cultivars Originating in Romania

Sina COSMULESCU[1], Mihai BOTU[1,3], Ion TRANDAFIR[2]

[1]University of Craiova, Horticulture Faculty, A.I.Cuza, 13, 200585, Craiova/Romania
[2]University of Craiova, Chemistry Faculty, Calea Bucuresti 107, Craiova/Romania
[3]University of Craiova, SCDP Vâlcea, Calea lui Traian, 464, 240273 Rm. Vâlcea/Romania

(Geliş Tarihi: 15.09.2010, Kabul Tarihi:13.10.2010)

Abstract

Romania has very good walnut (Juglans regia L.) cultivars. In this study nuts of different walnut cultivars ('Valcor', 'Valmit' and 'Valrex') grown in Romania were evaluated for their physical characteristics and mineral composition. Walnut samples were collected during the years 2008 and 2009. Microelements Na, Ca, Mg, Fe, Mn, Cu, Se, Al, Cr, Zn, Sr and Rb were determined by using ICP-MS as measurement tool, while K content was determined with an atomic absorption spectrometer in flame, by using as excitation source the cavitar cathode lamp for potassium. Mineral contents (mg/100 g) were: K, 387.25-444.35; Mg, 264.7-272.3; Ca, 62.78-72.91; Mn,10.45-18.06; Fe, 5.44-5.90; Zn, 3.19-4.10; Cu, 2.93-3.47. Physical characteristics of fruits represent a quality feature of nuts; they varied within small limits (56.54-59.64% kernel percentage, 14.0-16.65 g fruit weight, 7.80 – 9.92 g kernel weight, 33.3 - 38.15 mm fruit diameter, 38.2 – 42.2 mm fruit height). Fruit properties indicate that 'Valcor', 'Valmit' and 'Valrex' are superior walnut cultivars in terms of physical properties and mineral composition.

***Key Words**: Fruit properties, Juglans regia L., nutritional composition*

Romanya'da Yetiştirilen Ceviz (Juglans regia L.) Kültürlerinin Mineral Kompozisyonu ve Fiziksel Karakteristikleri

Özet

Romanya çok iyi bir ceviz (Juglans regia L.) kültürüne sahiptir. Bu çalışmada, Romanya'da yetiştirilen farklı ceviz kültür ('Valcor', 'Valmit' ve 'Valrex') kabuklu meyvelerinin fiziksel karakteristikleri ve mineral kompozisyonları değerlendirildi. Ceviz örnekleri 2008 ve 2009 yıllarında toplandı. Na, Ca, Mg, Fe, Cu, Se, Al, Cr, Zn, Sr ve Rb mikro elementleri bir ölçüm cihazı olarak ICP-MS kullanılarak belirlendi. K içeriği ise kavitar katot lambası uyarı kaynağı olarak kullanılarak bir alev atomik absorpsiyon spektrometre ile belirlendi. Mineral içerikleri (mg/100g): K, 387.25-444.35; Mg, 264.7-272.3; Ca, 62.78-72.91; Mn,10.45-18.06; Fe, 5.44-5.90; Zn, 3.19-4.10; Cu, 2.93-3.47'dir. Meyvelerin fiziksel karakteristikleri, kabuklu yemişlerin kalite özelliğini yansıtır. Bu karakteristikler küçük sınırlar içinde değişir: (%56.54-59.64 iç yüzdesi, 14.0-16.65 g meyve ağırlığı, 7.80 – 9.92 g iç ağırlığı, 33.3 - 38.15 mm meyve çapı, 38.2 – 42.2 mm meyve yüksekliği). Meyve özellikleri, 'Valcor', 'Valmit' ve 'Valrex'in fiziksel özellikleri ve mineral kompozisyonu bakımından üstün ceviz kültürleri olduğunu göstermektedir.

***Anahtar Kelimeler**: Besinsel bileşimi, Juglans regia L., meyve özellikleri.*

Introduction

Walnut (*Juglans regia* L.) demonstrates high genetic variability. Walnut fruits are different as regards morphologic characteristics and mineral composition. Regarding physical characteristics of fruits, there is an extremely high variability among genotypes of different origins (Zeneli et al., 2005; Dogan et al., 2005ş Asadian and Pieber, 2005; Beyhan and Taki, 2006; Balta et al., 2007; Arzani et al., 2008; Ebrahimi et al., 2009; Verma et al., 2009; Cerović et al., 2010). Ali et al. (2010) considered that fruits nut cultivars vary greatly in term of nut weight, kernel weight, kernel ratio, shell thickness, moisture content, protein content, carbohydrates content, energy content, and mineral content.

Walnuts are thought to be a good source of dietary minerals. The kernels contain oil, mucilage, albumin, mineral matter, cellulose, and water. Nuts are also a rich source of main nutritive matter that seem to have positive effect on human health (Ozkan and Koyuncu, 2005; Özcan, 2009; Colaric et al., 2006; Çağlarırmak, 2003). Potassium, phosphorus, magnesium, calcium, manganese, and iron are found in significant amounts in English walnut kernel in Romanian cultivars (Cosmulescu et al., 2009). Mineral composition of walnut fruits is being influenced by certain factors. Bujdosó et al. (2010) considered that different crop years have

[2]Sorumlu Yazar: sinacosmulescu@hotmail.com

a stronger influence on composition of cultivars, and the main influential factor was probably the temperature.

In Romania, walnut (*Juglans regia* L.) is an important fruit crop. Romania has very good walnut cultivars. Walnut assortment in Romania is generally local. Breeding programs have been launched over the last 30 years to develop new cultivars with uniform fruit quality. Three cultivars were selected from local populations of Vâlcea area and they were named 'Valcor', 'Valmit' and 'Valrex' (Botu, et al., 2007).

The paper aims at determining mineral composition and physical characteristics of fruits in three walnut cultivars ('Valcor', 'Valmit' and 'Valrex'), which are cultivated under the same climate, experimental and technological conditions, over two years. Previous researches showed that Romanian walnut cultivars proved to be important sources of phenols (Cosmulescu et al., 2010).

Materials and Methods

Materials

The study was conducted by using local walnut cultivars (Valcor**'**, Valmit**'**, **'**Valrex**'**) for determinations. The material of study comes from collection orchard of Vâlcea Research Station (SCDP Vâlcea), located in Sub-Carpathian area in Oltenia (45° 6′ 17″ N, 24° 22′ 32″ E), with temperate climate, an area which is known as favorable to walnut culture.

Mineral analysis

Instrumentation. A commercial ICP-MS system (Perkin-Elmer Elan 9000), the atomic absorption spectrometer in flame (Avanta PM) and Milestone digestion microwave system were used. The experimental operating parameters are summarized in Table 1.

Table 1. ICP-MS and the atomic absorption spectrometer in flame operating conditions

ICP-MS, model Elann9000	
Rf power(W)	1000
ICP torch	fassele type
Torch injector	ceramic alumina
Nebulizer	Type cross flow
Nebulizer gas flow (l/min)	0.93
Spray chamber	
Sweeps/reading	20
Reading/replicate	2
Number of replicates	5
Atomic absorption spectrometer in flame Model Avanta PM	
Optics	Double fascicle
Flame	Air –Acetylene
Flame Control	Programmed

Reagent and chemicals. Etalon standards were obtained from multi-element stock solutions ICP–MS calibration STD 3, etalon solutions mono-element 1000 ppm K, nitric acid 65% puriss p.a (Fluka), oxygenated water 33% reactive p.a and ultrapure water, 1st degree according to ISO 3696:1987.

Method

For solid sample mineralization, a Milestone digestion microwave system was used. Quantities of approximately 0.5 g sample, weighed with 0.0001g precision, 6 ml nitric acid 65 % and 2 ml oxygenated water 33% were introduced in Teflon recipients and were under thermic treatment programme under pressure: heating up to 180^0C by a rate of 4.5^0C/min and keeping them for 20 minutes at 180^0C. After cooling down, liquid samples were transferred into marked glass balloons; they were brought to 50 mL volume, by using ultrapure water, and were analyzed according to specific procedures in the two spectrometer instruments. Control sample (blank) was made of 6 ml nitric acid 65 % and 2 ml oxygenated water 33 % and it was processed under the same conditions as the analyzed sample. Microelements: Na, Ca, Mg, Fe, Mn, Cu, Se, Al, Cr, Zn, Sr, V, Rb – were determined by using the ICP-MS as measurement tool, while K content was determined with the atomic absorption spectrometer in flame, excitation source the cavitar cathode lamp for potassium.

Physical analysis

The following physical walnut analyses were performed: nut dimensions and shape properties (diameter, length and size of nut), fruit properties (weight of nut, weight and ratio of kernel) and kernel properties (color and fullness of kernel). These analyses were determined in at least 100 samples of the same genotypes.

Statistical analysis

For statistical analysis (Microsoft Excel) was used. All data were expressed as means ± standard deviations of triplicate measurements.

Results and Discussions

The composition of mineral elements and physical characteristics in three walnut cultivars were analyzed over two years (2008 and 2009). For comparison the average value was used for the two years, both for physical characteristics, and chemical ones.

Results on mineral composition of fruits are presented in Table 2. Statistical differences between genotypes were significant ($p<0.05$). Among identified elements, the highest amount was obtained in potassium, between 387.25 mg/100g ('Valcor') and 444.35 mg/100g ('Valrex'). Over two years, higher variability was obtained in 'Valmit' cultivar (SD=61.58).

Values for potassium were in accordance with literature. The potassium content was found as 4627.6 mg/kg in cultivars grown in Turkey (Özcan, 2009). In 'Franquette' cultivar and 'Hartley' cultivar, the potassium contents were 487 mg/100g, and 466 mg /100g, respectively. Both cultivars were cultivated in France (Lavedrine et al., 2000). Fruits analyzed had higher content of magnesium; values were 264.7 mg/100g in 'Valcor' cultivar and 272.3 mg/100g in 'Valrex' cultivar; higher variability over two years was obtained in 'Valmit' cultivar (SD=95.74).

Table 2. Mineral composition* of walnut kernels varieties

No.	Mineral composition (mg/100g)		Cultivar		
			Valcor	Valmit	Valrex
1	Na	Mean	0.25	1.38	0.55
		SD	0.02	0.42	0.25
2	K	Mean	387.25	400.65	444.35
		SD	36.73	61.58	49.85
3	Ca	Mean	72.91	89.52	62.785
		SD	4.74	1.86	1.93
4	Mg	Mean	264.7	267.5	272.3
		SD	84.56	95.74	67.03
5	Fe	Mean	5.88	5.44	5.90
		SD	1.10	1.06	0.04
6	Mn	Mean	10.45	18.06	16.01
		SD	5.12	0.66	1.14
7	Cu	Mean	3.12	2.93	3.47
		SD	1.48	0.77	0.35
8	Al	Mean	0.33	0.17	0.21
		SD	0.08	0.05	0.16
9	Cr	Mean	0.85	0.84	0.59
		SD	0.44	0.60	0.48
10	Zn	Mean	3.19	4.10	4.04
		SD	0.85	0.70	0.72
11	Sr	Mean	0.39	0.55	0.45
		SD	0.05	0.19	0.04
12	Rb	Mean	2.21	2.02	1.86
		SD	0.56	0.19	0.13

** mean over two years. SD = standard deviation.*

Magnesium content was higher than in 'Franquette' cultivar (191-202 mg 100 g^{-1}) and 'Hartley' (129-134 mg 100 g^{-1}) (Lavedrine et al., 2000); or in cultivars grown in Turkey (1089.9 mg/kg) (Özcan, 2009); or in walnut cultivars grown in Pakistan (1059-1765 ppm) (Ali et al., 2010). As regards content, the third element is calcium. It varied between 62.78 mg/100g ('Valrex') and 89.52 mg/100g ('Valmit'); lower than the one found in Pakistan nuts (925-1250 ppm) (Ali, et al., 2010); or the one found in Turkey nuts (1108.6 mg/kg) (Özcan, 2009). Calcium content is similar to the one found in Hungarian walnut cultivars (62.9 - 89.5 mg/100g) (Bujdosó, et al., 2010).

Manganese content varied between 10.45 mg/100g ('Valcor') and 18.06 mg/100g ('Valmit'); higher than the one obtained in Turkey nuts (46.3 mg/kg) (Özcan, 2009). Iron content was higher than the one found in Turkey (Özcan, 2009) or Pakistan cultivars (Ali, et al., 2010); with variation within quite small limits in the three cultivars (5.44 mg/100g in 'Valmit' and 5.90 mg/100g in 'Valrex'). Copper, zinc and rubidium have recorded lower values, over one gram (between 2–4 mg/100g) in all three cultivars studied; the rest of elements (Na, Al, Cr, Sr) were found in lower amounts, under 1 mg/100g.

The results regarding the fruit properties of walnut cultivars are shown in Table 3. Fruit weight varied between 14 g ('Valmit') and 16.65 g ('Valrex'), while kernel weight varied between 7.8 g ('Valmit') and 9.92 ('Valrex').

Higher variability of fruit weight was recorded in 'Valmit' cultivar (SD=3.11), over the two years of observation. Vales recorded on fruit weight are thought to be higher in Romanian walnut cultivars. Higher values were found out in Turkish walnut cultivars (24.34 g in 'Kaplan 86' and 18.94 g in 'Yalova 2') (Dogan, et al., 2005).

By calculating the ratio between kernel weight and fruit weight, higher percentage content of kernel was obtained (more than 50%); variation limits were between 56.54% ('Valmit') and 59.61% ('Valrex'), (Table 3). Previous research (Botu, et al., 2010) made on assessment of some Romanian walnut cultivars showed that average kernel percentage has varied between 48.0% and 53.0%, which indicates that new cultivars are of higher quality. Highest variability in

kernel percentage over the two years was obtained in 'Valmit' cultivar, a fact that was confirmed by standard deviation recorded (SD = 7.51).

Regarding physical characteristics of walnut fruits, studies carried out in different culture zones have shown high variability. Thus, in genotypes from central Iran it was found that the average fruit characteristics - nut weight, kernel weight, and kernel ratio - were in the range of 6.0-15.2g, 2.6-9.1g, and 38.4-79.6%, respectively (Arzani et al., 2008). Variations of physical characteristics were found also for nut weight (10.3-18.22g), kernel weight (5.81-9.24g) and kernel ratio (43.19-65.14%) for six walnut cultivars grown in Pakistan (Ali, et al., 2010). Variations in weight of nut shell (9.07-16.01 g) and weight of kernel (5.00-7.37g) were found also in genotypes in Turkey (Aslantaş, 2006). Higher values for kernel percentage were found in China's cultivars (51-70% kernel ratio) (Baojun, et al., 2010) and in Turkey's cultivars (45.66-67.14% kernel ratio) (Aslantaş, 2006).

Table 3. Physical characteristics* of fruits in three cultivars analyzed

No.	Characteristic		Cultivar		
			Valcor	Valmit	Valrex
1	Fruit weight (g)	Mean	14.60	14.00	16.65
		SD	0.56	3.11	0.49
2	Kernel weight (g)	Mean	8.25	7.80	9.92
		SD	0.21	0.70	0.10
3	Kernel percentage (%)	Mean	56.57	56.54	59.61
		SD	3.64	7.51	1.14
4	Diameter 1 (D1, mm)	Mean	36.75	33.3	38.15
		SD	2.19	0.14	3.04
5	Diameter 2 (D2, mm)	Mean	33.4	32.0	35.05
		SD	1.97	0.56	5.16
6	Fruit height (H, mm)	Mean	40.95	38.2	42.2
		SD	3.04	0.01	3.25
7	Size Index (D1+D2+H/3)	Mean	37.01	34.46	38.43
		SD	2.42	0.19	3.86

** mean over two years. SD = standard deviation.*

By comparing results obtained, it was found out that Romanian cultivars have higher characteristics of fruit weight and kernel percentage. Differences obtained are due to genetic characteristics and environmental factors.

As regards nut dimensions, nut length varied between 38.2mm ('Valmit') and 42.2mm ('Valrex'), and diameter between 33.3mm ('Valmit') and 38.15mm ('Valrex'). In conformity with standards in force, fruits of the three cultivars are of higher quality; size index has values over 35, which indicates that fruits of cultivars analyzed comply with the larger size class. Highest variability for these characteristics, over two years, was obtained in cultivar 'Valrex' (SD = 3.04 for fruit diameter, SD=3.86 for size index), (Table 3). Fruit shape is broad ovate for 'Valcor', round for Valmit and ovate for 'Valrex'.

In conclusion, differences on physical characteristics of fruits, over the two years of observation, were caused probably by agro-climatic conditions. As regards physical characteristics, the three cultivars analyzed comply with the class of higher quality fruits. As regards mineral composition of fruits in three cultivars analysed, one might say that nut kernel has complex composition; it is a source of nutritive elements. Mineral composition varies by cultivar; values are higher than (for Mg, Mn, Fe) or close to (K, Ca) the ones found by other authors (Arzani et al., 2008; Bujdosó, et al., 2010; Lavedrine et al., 200; Özcan, 2009).

Acknowledgements

This work was supported by CNCSIS –UEFISCSU, project number PNII – IDEI code 430 /2008.

References

Ali, M., Ullah, A., Ullah, H., Khan, F., Ibrahim, S. M., Ali, L. and Ahmad, S., 2010. Fruit properties and nutritional composition of some walnut cultivars grown in Pakistan. Pak. J Nutrition. 9 (3): 240-244.

Arzani, K., Mansouri-Ardakan, H., Vezvaei, A. and Roozban, M.R., 2008. Morphological variation among Persian walnut (*Juglans regia*) genotypes from central Iran. New Zealand J Crop Hort. Sci. 36 (3):159 – 168.

Asadian, G. and Pieber, K., 2005. Morphological variations in walnut varieties of the Mediterranean Regions**.** Int. J Agric. Biol. 7(1): 71-73.

Aslantaş, R., 2006. Identification of superior walnut (*Juglans regia*) genotypes in north-eastern Anato-

lia, Turkey. New Zealand J Crop Hort. Sci. 34(3): 231-237.

Balta, F., M., Dogan, A., Kazankaya, A., Ozrenk, K. and Celik, F., 2007. Pomological definition of native walnuts (*Juglans regia* L.) grown in Central Bitlis. J Biol. Sci. 7(2): 442-444.

Baojun, Z., Yonghong, G. and Liqun, H., 2010. Overview of walnut culture in China. Acta Hort. (ISHS) 861: 39-44.

Beyhan, N. and Taki, D., 2006. Selection of promising walnut genotypes in Samsun province in Turkey. J Agronomy 5: 435-439.

Bujdosó, G., Tóth-Markus, M., Daood, H.G., Adányi, N. and Szentiványi, P., 2010. Fruit quality and composition of Hungarian bred walnut cultivars. Acta Aliment. 39 (1): 35–47.

Botu, M., Botu, I., Achim, G. and Tudor, M., 2007. Walnut cultivars in Romanian conditions. Acta Hort. (ISHS). 760: 555-561.

Botu, M., Tudor, M. and Papachatzis, A., 2010. Evaluation of some walnut cultivars with different bearing habits in the ecological conditions of Oltenia - Romania. Acta Hort. (ISHS). 861: 119-126.

Çağlarırmak, N. 2003. Biochemical and physical properties of some walnut genotypes (*Juglans regia*, L.). Nahrung / Food. 47(1): 28 - 32.

Cerović, S., Gološin, B., Ninić Todorović, J., Bijelić, S. and Ognjanov, V., 2010. Walnut (*Juglans regia* L.) selection in Serbia. Hort. Sci. (Prague). 37(1): 1-5.

Colaric, M., Stampar, F., Hudina, M. and Solar, A., 2006. Sensory evaluation of different walnut cultivars (*Juglans regia* L.). Acta Agric. Slovenica. 87: 403-413.

Cosmulescu, S., Baciu, A., Achim, G., Botu, M. and Trandafir, I., 2009. Mineral composition of fruits in different walnut (*Juglans regia* L.) cultivars. Not. Bot. Hort. Agrobot. Cluj. 37 (2):156-160.

Cosmulescu, S., Trandafir, I., Achim, G., Botu, M., Baciu, A. and Gruia, M., 2010. Phenolics of Green Husk in Mature Walnut Fruits. Not. Bot. Hort. Agrobot. Cluj. 38 (1): 53-56.

Dogan, A., Kazankaya, A., Gün, A., Askin, M.A,, Oğuz, H.İ. and Celik, F., 2005. Fruit characteristics of some Turkish walnut. Asian J Plant Sci. 4(5): 486-488.

Ebrahimi, A., Zarei, A., Fatahi, R. and Ghasemi Varnamkhasti, M., 2009. Study on some morphological and physical attributes of walnut used in mass models. Sci. Hort. 121(4): 490-494.

Lavedrine, F., Ravel, A., Villet, A., Ducros, V. and Alary, J., 2000. Mineral composition of two walnut cultivars originating in France and California. Food Chem. 68(3): 347-351.

Özcan, M. M., 2009. Some nutritional characteristics of fruit and oil of walnut (*Juglans regia* L.) growing in Turkey. Iran. J. Chem. Chem. Eng. 28(1): 57-63.

Ozkan, G. and Koyuncu, M. A., 2005. Physical and chemical composition of some walnut (*Juglans regia* L) genotypes grown in Turkey. Grasas y Aceites. 56(2): 141-146.

Verma, V.D., Pradheep, K. and Rana, J.C., 2009. Evaluation studies on some walnut genetic resources in Himachal Pradesh. Ind. J Plant Genetic Resources. 22(2): 129-133.

Zeneli, G., Kola, H. and Dida, M., 2005. Phenotypic variation in native walnut populations of Northern Albania. Sci. Hort. 105(1): 91-100.