The Effect of Harvest Times on Mineral Contents of Almond and Walnut Kernels

Mehmet Musa Özcan & Viktar Lemiasheuski

ONLINE FIRST

Erwerbs-Obstbau

ISSN 0014-0309

Erwerbs-Obstbau
DOI 10.1007/s10341-020-00523-9

Springer

Erwerbs-Obstbau
https://doi.org/10.1007/s10341-020-00523-9

ORIGINAL ARTICLE / ORIGINALBEITRAG

The Effect of Harvest Times on Mineral Contents of Almond and Walnut Kernels

Mehmet Musa Özcan[1] · **Viktar Lemiasheuski**[2]

Received: 28 January 2020 / Accepted: 7 August 2020

Abstract

Ca contents of almond and walnut kernels changed between 924.51 (4. Harvest (H)) and 1970.86 (1. H), and 13.43 (1. H) and 26.51 (4. H) mg/kg, respectively. While K contents of almond kernels range from 4817.31 (2. H) to 7218.58 (1. H), K contents of walnut kernels varied between 2707.33 (3. H) and 11,091.16 (1. H) mg/kg ($p<0.05$). P contents of almond kernels were found between 3774.42 (2. H) and 5488.25 (1. H) mg/kg. In addition, P contents of walnut kernels ranged from 2329.10 (3. H) to 2977.60 (1. H) mg/kg ($p<0.05$). While Zn contents of almond kernel change between 29.29 (2. H) and 42.15 (3. H) mg/kg, Zn contents of walnut kernels varied between 16.82 (4. H) and 21.25 (1. H) mg/kg. Generally, Ca, Cu, K, Mg, Mn, Na, P and S contents of almond kernels at the first harvest time were found at the high level. The Cu, K, Mg, Na, P, S and Zn contents of walnut kernels were also highest at the first harvest date.

Keywords Almond · Walnut · Kernels · Harvest time · Minerals · ICP-AES

Einfluss des Erntetermins auf Mineralstoffgehalte von Mandel- und Walnusskernen

Schlüsselwörter Mandel · Walnuss · Kerne · Erntetermin · Mineralstoffgehalte · ICP-AES

Introduction

Almond (*Prunus amygdalus* L.) and Walnut (*Juglans regia* L) belong to the Rosaceae and Juglandaceae family, respectively and *Prunus* genus grows in temperate zones in most countries of the world (Çağlarırmak 2003; Moayedi et al. 2011; Izaddost et al. 2013). The nutritional values as well as the components of almonds and walnuts such as oil, protein, fiber, minerals and bioactive compounds make these plants of great industrial and medicinal importance (Ahrens et al. 2005). The consumption and demand for nuts are high due to their impact on human health (Sánchez-Bel et al. 2008; Tiwari et al. 2010). The almond is considered a pleasant nut throughout the world with applications in food, pharmaceutical and cosmetic industries. Also, nuts such as almond and walnut kernels are used as an ingredient in many snacks and other processed foods (Eganathan et al. 2006). The kernels may be ground and made into a paste which is used in making various bakery products (Kester and Asay 1979). Almond and walnuts are important food crop as a major ingredient in manufactured food products. Nuts are source of energy, fats, protein and minerals (Kester et al. 1990). Nuts are rich in proteins, carbohydrates, unsaturated fatty acid (linoleic acid and γ-linoleic acids), vitamins and essential minerals (Welna et al. 2008). Although walnuts are rich in fat, a diet supplemented with walnuts had a beneficial effect on blood lipids, lowering blood cholesterol and lowering the ratio of serum concentrations of low deroity lipoprotein:high density lipoprotein by 12% (Sabate et al. 1993; Savage 2001). The aim of this study was to determine the effect of harvest times on mineral contents of almond and walnut types naturally grown in Gülnar district of Mersin in Turkey.

✉ Mehmet Musa Özcan
mozcan@selcuk.edu.tr

[1] Department of Food Engineering, Faculty of Agriculture, University of Selcuk, 42031 Konya, Turkey

[2] Department of Environmental Medicine and Radiobiology, Faculty of Environmental Medicine, International Sakharov Environmental Institute of Belarusian State University, 220070 Minsk, Belarus

Published online: 21 September 2020

Material and Methods

Material

Almond and walnut kernel samples were collected in a field of the South of Turkey (Antalya) at intervals of about 10 days during five harvest periods (Harvest 1 to Harvest 5 = H 1 to H 5). They were kept in refrigerator by using. For almond and walnut kernel, three trees were determined as replicates. 25 kg were collected from each tree. The fruits were placed on steel trays for drying, and they were dried until reaching determined dry weight. Drying was carried out 70 °C in oven. Then each kernels were ground to form a homogeneous, and collected in color bottle. Samples are kept at refrigerator until analysis.

Method

Determination of Mineral

Nut samples were dried at 70 °C in a drying cabinet with air-circulation until they reached constant weight. Later, about 0.5 g dried and ground samples were digested by using 5 ml of 65% HNO_3 and 2 ml of 35% H_2O_2 in a closed microwave system (Cem-MARS Xpress). The volumes of the digested plant samples were completed to 20 ml with ultra-deionized water, and mineral contents were determined by ICP AES (Varian-Vista, Australia) (Table 1). Measurements of mineral concentrations were checked using the certified values of related minerals in the reference samples received from the National Institute of Standards and Technology (NIST; Gaithersburg, MD, USA) (Skujins 1998).

Statistical Analysis

A complete randomized split plot block design was used analysis of variance (ANOVA) was performed by using JMP version 9.0 (SAS Inst. Inc., Cary, N.C.U.S.A). Results of the research were analysed for mean ± standard deviation (MSTAT C) (Püskülcü and Ikiz 1989).

Table 1 Working conditions of ICP-AES

Instrument	ICP-AES (Varian-Vista)
RF Power	0.7–1.5 kw (1.2–1.3 kw for Axial)
Plasma gas flow rate (Ar)	10.5–15 L/min. (radial) 15″ (Axial)
Auxilary gas flow rate (Ar)	1.5″
Viewing height	5–12 mm
Copy and reading time	1–5 s (max. 60 s)
Copy time	3 s (max. 100 s)

Results and Discussion

In this study, the effects of harvest time on mineral contents of almond and walnut kernels were investigated. Mineral contents of both almond and walnut kernels are given in Table 2. At all harvest times Ca, Fe, K, Mg, P and Zn contents of almond kernels were found higher compared with results of walnut kernels. While Ca contents of almond change between 924.51 (4. H) and 1970.86 (1. H), Ca contents of walnut kernels varied between 13.43 (1. H) and 26.51 (4. H) mg/kg. While K contents of almond kernels range from 4817.31 (2. H) to 7218.58 (1. H), K contents of walnut kernels varied between 2707.33 (3. H) and 11,091.16 (1. H) mg/kg ($p < 0.05$) (Fig. 1). In addition, Mg values of both nut kernels were partly similar, but when compared these values, Mg contents of almond were found partly higher than that of Mg results of walnut kernels. While Mn contents of almond change between 3.96 (1. H) and 6.69 (1. H), Mn values of walnut kernels ranged from 14.01 (3. H) to 27.69 (5. H) mg/kg. P contents of almond kernels were found between 3774.42 (2. H) and 5488.25 (1. H) mg/kg ($p < 0.05$). In addition, P contents of walnut kernels ranged from 2329.10 (3. H) to 2977.60 (1. H) mg/kg. The highest S content was determined in walnut kernel at the first (1. H) harvest time (2068.51 mg/kg). While Zn contents of almond kernel change between 29.29 (2. H) and 42.15 (3. H) mg/kg, Zn contents of walnut kernels varied between 16.82 (4. H) and 21.25 (1. H) mg/kg ($p < 0.05$). Generally, Ca, Cu, K, Mg, Mn, Na, P and S contents of almond kernels at the first harvest time were found at the high level. The Cu, K, Mg, Na, P, S and Zn contents of walnut kernels were also highest at the first harvest date. Significant differences were found between Ca values of almond and walnut specimens. Generally, mineral contents of both almond and walnut kernels progressively decreased depending on harvest time. This reduction may be due to the increase in

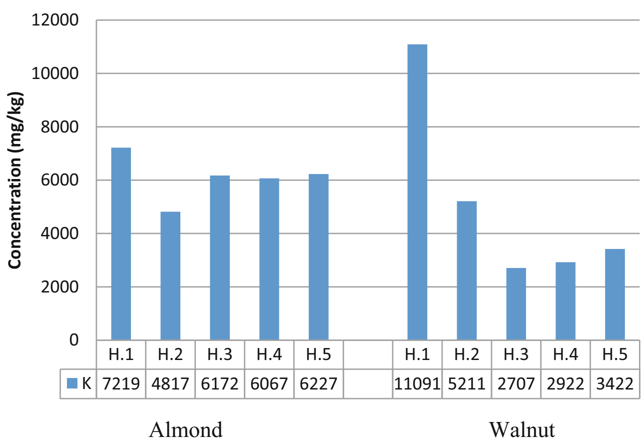

Fig. 1 The effects of harvest time on K contents of almond and walnut kernels

Table 2 Mineral contents of almond and walnut harvested at the different harvest (H) periods (mg/kg)

Almond	Ni	Cd	Mo	Ca	B	Cu	Fe	K	Mg	Mn	Na	P	S	Zn
1. H	1.03 ±0.11[a]b	0.06 ±0.91	0.26 ±0.03c	1970.86 ±11.38a	9.85 ±0.38d	10.42 ±0.48a	38.71 ±0.81b	7218.58 ±19.46a	2808.57 ±16.27a	6.69 ±0.56a	20.60 ±0.25a	5488.25 ±13.28a	1628.80 ±3.25a	38.76 ±0.98b
2. H	0.90 ±0.13*c	0.08 ±0.01	0.31 ±0.07a	1026.81 ±21.46b	9.48 ±0.67d	7.44 ±0.57c	23.62 ±1.23e	4817.31 ±12.39c	2001.70 ±11.64d	3.96 ±0.13d	9.38 ±0.13c	3774.42 ±17.42c	1020.24 ±1.98e	29.29 ±0.57e
3. H	1.16 ±0.21b	0.05 ±0.01	0.27 ±0.01c	1089.55 ±19.59b	10.87 ±0.89c	9.99 ±0.81b	29.76 ±0.76d	6172.18 ±15.63b	2784.90 ±12.59b	5.28 ±0.49b	14.44 ±0.83b	5298.22 ±18.32b	1511.85 ±4.38b	42.15 ±0.61a
4. H	1.01 ±0.09b	0.02 ±0.00	0.29 ±0.03b	924.51 ±13.78c	12.78 ±0.61b	9.81 ±0.93b	41.48 ±1.17a	6067.40 ±16.39b	2631.28 ±13.98c	4.38 ±0.52c	19.59 ±0.24a	5024.04 ±27.12bc	1322.80 ±7.26d	34.46 ±0.33d
5. H	1.29 ±0.17a	0.08 ±0.01	0.27 ±0.03c	928.47 ±15.27c	14.53 ±0.59a	9.67 ±0.37b	36.14 ±1.29c	6226.81 ±23.71b	2618.40 ±21.44c	5.48 ±0.67b	14.30 ±0.31b	5131.83b ±14.71	1430.37 ±1.78c	35.15 ±0.49c
Walnut	**Ni**	**Cd**	**Mo**	**Ca**	**B**	**Cu**	**Fe**	**K**	**Mg**	**Mn**	**Na**	**P**	**S**	**Zn**
1. H	8.22 ±0.33b	–[b]	0.09 ±0.01a	13.43 ±1.17d	16.50 ±0.67c	11.20 ±0.88a	6.04 ±0.74d	11091.16 ±23.54a	2646.59 ±19.47a	15.31 ±0.98d	29.17 ±1.28a	2977.60 ±4.57a	2068.51 ±9.46a	21.25 ±0.75a
2. H	7.18 ±0.21c	–	–	24.49 ±2.24b	18.43 ±0.78a	11.02 ±0.49a	8.79 ±0.58b	5210.59 ±12.47b	2208.30 ±17.72b	17.54 ±0.77c	16.91 ±1.32c	2800.57 ±9.14b	1839.92 ±3.48b	17.02 ±0.64c
3. H	10.12 ±0.17a	0.02 ±0.01	–	18.17 ±1.13c	18.71 ±0.49b	11.55 ±0.98a	7.80 ±0.79c	2707.33 ±27.13d	1662.98 ±14.89e	14.01 ±0.38e	12.93 ±0.74d	2329.10 ±11.43d	1656.33 ±1.64d	17.75 ±0.59c
4. H	4.32 ±0.19d	–	0.04 ±0.01c	26.51 ±3.29a	16.67 ±0.27c	8.86 ±0.71c	9.20 ±0.38a	2922.44 ±18.49d	1761.99 ±18.63d	18.43 ±0.21b	12.48 ±0.63d	2761.58 ±7.43c	1615.75 ±2.54d	16.82 ±0.84d
5. H	4.27 ±0.37d	0.01 ±0.0	0.07 ±0.01b	17.46 ±1.26c	14.33 ±0.56d	10.30 ±0.27b	8.90 ±0.79b	3421.62 ±37.85c	1879.61± 21.38c	27.69 ±0.53a	18.82 ±0.81b	2841.72 ±11.84b	1770.27 ±4.39c	20.12 ±0.96b

H Harvest
[a]Mean ± standard deviation
[b]Nondetected
*Values within each row followed by different letters are significantly different ($p < 0.05$)

the amount of other nutrients during the development of the fruit. Differences in mineral values at some harvesting times may be due to the fact that the fruits do not get sufficient nutrients from the soil. This is related to the moisture content of the soil. It is thought that plants do not take plant nutrients in dry time. The mineral difference between the fruits may be due to the kind and genetic structure of the fruit. Cultivar, species, genetic factors, ecological conditions and different ripening, harvest time generally effect the chemical contents of almond kernel (Soler et al. 1988). Özcan et al. (2011) reported that some almond kernels contained 2.98–4.04 mg/g Mg, 0.29–0.38 mg/g Na, 7.93–9.38 mg/g P, 13.14–15.10 mg/g K, 1.83–2.94 mg/g Ca, 0.20–0.27 mg/g Fe and 0.04–0.06 mg/g Zn. In previous study, almond kernels contained 1546–1685 mg/100 g K, 253–259 mg/100 g P, 640–678 mg/100 g Ca, 447–496 mg/100 g Mg, 24.30–25.80 mg/100 g Cu, 76.33–80.50 mg/100 g Zn, 54.83–65.33 mg/100 g Fe and 37.67–37.83 mg/100 g Mn (Barbara et al. 1994). Aslantaş et al. (2001) determined 98.5–187.00 mg/100 g Ca, 360.8–513.4 mg/100 g Mg, 403.9–800 mg/100 g P, 1677.3–2051.1 mg/100 g K, 39.77–146.35 mg/100 g Fe, 77.86–88.44 mg/100 g Zn, 29.0–33.95 mg/100 g Mn, 16.0–23.0 mg/100 g Cu and 56.66–103.88 mg/100 g Na in selected almond types naturally grown in Kemaliye district of Erzincan in Turkey. Schirra et al. (1994) determined 1050 mg/100 g K, 300 mg/100 g P, 467 mg/100 g Ca, 30 mg/100 g Mg, 5 ppm Cu, 34 ppm Zn and 70 ppm Fe in Texas almonds during fruith growth and ripening. Significant differences were observed by several researchers (Özcan et al. 2011; Barbara et al. 1994; Saura Calixto et al. 1981). The study showed that the almond and walnut kernels were well supplied with essential elements. The mineral elements contained in nuts are very important in human nutrition. The high levels of these elements (K, P, Mg) show that nut kernels could provide alternative source of potassium and magnesium in diet. Generally, the most of elements almond and walnut kernels were found at the first harvest time.

Conflict of interest M.M. Özcan and V. Lemiasheuski declare that they have no competing interests.

References

Ahrens S, Venkatachalam M, Mıstry AM, Lapsley K, Sahte SK (2005) Almond (Prunus dulcis L.) protein quality. Plant Foods Hum Nutr 60:123–128

Aslantaş R, Güleryüz M, Turan M (2001) Some chemical contents of selected almond (Prunus amygdalus Batsch) types. In: Ak BE (ed) XI GREMPA Seminar on Pistachios and Almonds CIHEAM, Zaragoza, pp 347–350 (Cahiers Options Méditerranéennes; n . 56)

Barbara G, Martını L, Monastra F (1994) Response of Ferragnes and Tuono almond cultivars to different environmental conditions in southern Italy. Acta Hortic 373:99–103

Çağlarırmak N (2003) Biochemicaland physical properties of some walnut genotypes (Juglans regia L.). Nahrung/Food 47(1):28–32

Eganathan P, Subramanian HMSR, Latha R, Srinivasa Rao C (2006) Oil analysis in seeds of Salicornia brachiata. Ind Crops Prod 23:177–179

Izaddost M, Imani A, Piri S, Bagiri AM (2013) Oil content, major fatty acids composition, α-tocopherol and nut characteristics of almond at time of harvest. J Basically Appl Sci Res 3:201–205

Kester DE, Asay R (1979) Almonds. In: Janick J, Moore JN (eds) Advances in fruit breeding. Purdue Univ. Press, Westlafayette, pp 387–418

Kester DE, Gradziel TM, Grasselly C (1990) Almonds (Prunus). In: Moore JN, Ballington JR (eds) Genetic resources of temperate fruit and nut crops II. ISHS, Wageningen, pp 699–758

Moayedi A, Rezaei K, Moini S, Keshavarz B (2011) Chemical composition of oils from several wild almond species. J Am Oil Chem Soc 88:503–508

Özcan MM, Ünver A, Erkan E, Arslan D (2011) Characteristics of some almond kernel and oils. Sci Hortic 127:330–333

Püskülcü H, Ikiz F (1989) Introdiction to statistic. p 333. Bilgehan Press, Bornova (in Turkish)

Sabate J, Fraser GE, Burke K, Knutsen SF, Benett H, Linstead KD (1993) Effects of walnuts on serum lipid levels and blood pressure in normal men. N Engl J Med 329:603–607

Saura Calixto F, Bauza M, Martinez de Toda F, Argamenteria A (1981) Amino acids, sugars and inorganic elements in the sweet almond (Prunus amygdalus). J Agric Food Chem 29:509–511

Savage GP (2001) Chemical composition of walnuts (Juglans regia L.) grown in New Zealand. Plant Foods Hum Nutr 56:75–82

Schirra M, Mulas M, Nieddu G, Virdis F (1994) Mineral content in Texas almonds during fruit growth and ripening. Acta Hortic 373:207–214

Skujins S (1998) Handbook for ICP-AES (Varıan-Vista). A short guide to vista series ICP-AES operation. Varian Int, Australia

Soler L, Canellas J, Saura Calixto F (1988) Oil content and fatty acid composition of developing almond seeds. J Agric Food Chem 36:695–697

Sánchez-Bel P, Egea I, Martínez-Madrid MC, Flores B, Romojaro F (2008) Influence of irrigation and organic/inorganic fertilization on chemical quality of almond (Prunus amygdalus cv. Guara). J Agric Food Chem 56(21):10056–10062

Tiwari RS, Venkatachalam M, Sharma GM, Su M, Roux KH, Sathe SK (2010) Effect of food matrix on amandin, almond (Prunus dulcis L.) major protein, immunorecognition and recovery. LWT Food Sci Technol 43(4):675–683

Welna M, Klimpel M, Zyrnicki W (2008) Investigation of major and trace elements and their distributions between lipid and non-lipid fractions in Brazil nuts by inductively coupled plasma atomic optical spectrometry. Food Chem 111:1012–1015