INFLUENCE OF VARIETY AND GEOGRAPHICAL REGION ON MINERAL CONTENTS OF HAZELNUT (*CORYLUS AVELLANA L.*) VARIETIES

Mustafa S. Dundar,* Emel Bahçıvancı, Canan Muslu
Sakarya University, Fen-Edebiyat Fak. Kimya Bölümü, 54100 Adapazarı, TURKEY.
(Email : dundar@sakarya.edu.tr)

Received 01-02-2002

Abstract

The mineral contents of three different varieties of hazelnut, namely Karafındık, Tombul, and Delisava, which are cultivated in Sakarya-Turkey, were studied for variety and geographical region and analysed by using flame atomic absorption spectrometry. A total of four elements, iron, copper, manganese, zinc, were determined in hazelnut kernels in hulled and dehulled forms. The mean levels of iron, copper, manganese, and zinc are 3.45±1.3, 1.61±1.1, 12.72±0.6, 2.63±0.6 in hulled kernels, 3.24±1.9, 1.72±0.9, 11.54±0.9, 2.76±0.4 in dehulled kernels, respectively. Mineral compositions of varieties showed significant differences from each other by means of geographical region and hulled or dehulled state of hazelnut kernels. It was found that the highest mineral levels were measured in Hendek district whereas in Akyazı district lowest mineral contents were obtained.

Introduction

Wild species of hazelnut, *genus Corylus*, are distributed in nearly all parts of temperate zones of the northern hemisphere while the major producers are Italy, Spain, USA, and Turkey which produces about 80% of the total hazelnut production of the world exports.[1,2] Tombul is among the top, Kara Fındık is among the very high quality hazelnut cultivars of the world. The Turkish variety of hazelnut, Delisava, is mainly consumed in-shell in the domestic market due to their moderate texture, taste, and other quality factors. Essential minerals improve the nutritional quality of Turkish hazelnut cultivars. They are not inferior cultivars but the demand for it is less due to overproduction of the better varieties.[1,2,3] Parcerisa[4] stated that the hazelnuts from Spain are influenced strongly by environmental and growing conditions. Studies indicate that mineral compositions of hazelnuts are affected by variety, geographical origin, harvest year, climate and the methods of cultivation.[4,5] There is no researches on mineral composition of hazelnut varieties cultivated in Sakarya-Turkey based on hulled or dehulled forms of hazelnut kernels. Mineral compositions are of interest due to their

prooxidant activity and health benefits.[4,5,6] Therefore, this study was planned and carried out to determine the effects of geographical region, variety and kernel hull on mineral composition of Turkish hazelnut varieties.

Experimental

Reagents and Standards

All chemicals used were of analytical-reagent grade (Merck, Darmstadt, Germany) and ultra high purity water (18 MΩ cm^{-1}) was used throughout the experiments. Working standard solutions for calibration purposes containing 0.05-0.80 μg ml^{-1} of iron and zinc, 0.01-0.64 μg ml^{-1} of copper, and 0.10-0.80 μg ml^{-1} of manganese were prepared from spectroscopic grade stock standard solutions (1000 mg L^{-1}) by serial dilution with 0.2% (v/v) HNO_3 prior to use. Peak height was used in all measurements because better precision was obtained. The reproducibilites of the method expressed as coefficients of variation for Fe, Cu, Zn and Mn contents were: 1.10%, 0.60%, 0.20% and 0.10%, respectively. The sensitivities of the method for Fe, Cu, Zn, and Mn contents were; 0.48 mg/kg, 0.32 mg/kg, 0.21 mg/kg, 0.26 mg/kg, respectively.

Cleaning and Storage Material

All glassware and polyethylene bottles were kept overnight and cleaned by soaking in 10% HNO_3, rinsing five times with ultra high purity water prior to use.

Sampling

Three samples corresponding to three commonly grown varieties of hazelnut (*Corylus avellana* L.) were collected from trees cultivated in five geographical districts of Sakarya province of Turkey (The varieties are Kara Fındık, Tombul and Delisava from Kocaali, Karasu, Akyazı, Hendek, Ferizli districts). Samples in hulled and dehulled states were stored after wait at 100 °C for twelve hours. The hazelnut kernels were separated from hulls and stored in polyethylene bags as hulled and dehulled forms until analysis were performed. All analyses were conducted in duplicate and each value measured is a mean of three replicate determinations.

Chemical analysis

Mineral contents (iron, copper, zinc and manganese) of hazelnut varieties were determined according to standard method described in AOAC Official Methods of Analysis (AOAC Official Method 975.03[7]) by wet ashing of hazelnut kernels and Shimadzu (Tokyo, Japan) AA6701F model flame atomic absorption spectrometer equipped with an autosampler was used in all measurements. Background absorption was corrected by using a deuterium lamp and Koto brand hollow-cathode lamps were used in all measurements.

Statistical analysis

One way analysis of variance (ANOVA), multiple range least significant difference (LSD) test and correlation analyses were carried out by using a statistical package program (AXUM ver. 4.1) for $p<0.05$ significance level. Means, standard error of mean and significance level for every parameter are shown in table 1. Further, percentage of recoveries of each element were determined in hazelnut kernels both hulled and dehulled forms using dry and wet ashing digestion methods (table 2). In these digestion methods, spiked samples were used to calculate percentage of recoveries to evaluate the reliability of the method used.

Table 1. Statistical data:mean ($\bar{\times}$), standart error of mean (SE) and significance level for mineral composition.

		Kocaali	Karasu	Akyazı	Hendek	Ferizli	*SE*	*P*
		$\bar{\times}$	$\bar{\times}$	$\bar{\times}$	$\bar{\times}$	$\bar{\times}$		
HULLED	Iron	3.49	2.66	3.35	3.89	3.88	0.0067	NS
	Copper	1.60	1.49	1.51	1.81	1.64	0.0026	NS
	Manganese	15.21	13.36	6.40	16.07	12.54	0.0114	NS
	Zinc	2.68	2.59	2.53	2.79	2.57	0.0024	NS
DEHULLED	Iron	3.17	2.31	2.82	3.60	4.30	0.0092	NS
	Copper	1.72	1.70	1.60	1.93	1.67	0.0023	NS
	Manganese	13.37	17.54	3.62	14.33	8.83	0.0155	NS
	Zinc	2.82	2.97	2.62	2.77	2.64	0.0016	NS

Table 2. Recovery test for Fe, Cu, Mn, and Zn in hulled and dehulled Kara Fındık variety of Turkish hazelnut kernels from Kocaali district. Results are averages of three replicates. (mg/100 g).

		Percentages of Recoveries ±RSD%			
		Iron	*Copper*	*Manganese*	*Zinc*
DRY ASHING	Hulled Kara Fındık	83±3.2	76±1.0	74±0.9	83±0.2
	Dehulled Kara Fındık	86±7.6	85±1.7	98±0.7	84±0.2
WET ASHING	Hulled Kara Fındık	102±1.0	108±0.7	97±0.2	102±0.6
	Dehulled Kara Fındık	99±0.7	105±1.1	100±0.2	98±0.5

Results and Discussion

Three different hazelnut varieties (Kara Fındık, Tombul, and Delisava) collected from Kocaali, Karasu, Akyazı, Hendek, and Ferizli districts were divided into two different categories as hulled and dehulled forms and analysed for iron, copper, zinc, and manganese. The results in general showed that iron and manganese levels determined were higher in hulled kernels than dehulled kernels while in dehulled kernels higher amounts of copper and zinc were measured.

The results obtained can be seen in tables 3 and 4 as hulled and dehulled kernels, respectively. The range of iron in all districts studied are between 1.61-5.64 mg/100 g. The highest level were obtained in dehulled Delisava kernels of Ferizli district at the amount of 5.64 mg/100g and the lowest level were dehulled Kara Fındık kernels of Karasu at the amount of 1.61 mg/100 g. Copper concentrations were determined in the range of 1.38-1.97 mg/100g. The highest levels were found in dehulled Delisava kernels of Kocaali and Hendek districts at 1.97 mg/100 g. The lowest levels were obtained in hulled Delisava kernels of Akyazı and Karasu districts at the amount of 1.38 mg/100g. The range of manganese changes between 2.41-21.77 mg/100 g. The highest amounts were obtained from dehulled Kara Fındık of Karasu district at the level of 21.77 mg/100 g while the lowest level was observed in dehulled Delisava kernels of Akyazı district at the rate of 2.41 mg/100 g. Zinc levels were determined between 2.15-3.77 mg/100g based on sample types and districts. In Karasu district, dehulled Delisava hazelnut

showed the highest level at 3.77 mg/100 g. However, the hulled Tombul kernels of Akyazı district showed the lowest level at 2.15 mg/100 g.

In general, hazelnut samples picked up from Hendek district indicated the highest mineral compositions whereas Akyazı district showed lowest levels. Delisava variety showed the richest mineral composition among the three hazelnut varieties analysed. The lowest mineral contents were obtained in Tombul variety of all regions except for Hendek. On the other hand, Delisava variety showed highest mineral contents in all regions except for Ferizli and Akyazı districts (tables 3 and 4). Besides the varieties, geographical region differences affect the mineral compositions of varieties. These differences observed could be due to the geological formation of soil, the fertilisers and pesticides used, climate conditions, etc. Mineral composition of hazelnuts shown in tables 3 and 4, with respect to variety and geographical region, the mean values of iron, copper, manganese and zinc content of the samples were 3.45, 1.61, 12.72, 2.63 mg/100 g

Table 3: Mineral contents of hulled Turkish hazelnut kernels in mg/100 g (n=3)*

DISTRICT	Hazelnut Variety	*Iron*		*Copper*		*Manganese*		*Zinc*	
		Mean ±RSD%	Range (Min-Max)	Mean ±RSD%	Range (Min-Max)	Mean ±RSD%	Range (Min-Max)	Mean ±RSD%	Range (Min-Max)
KOCAALİ	Kara Fındık	3.29 ± 1.0	3.15 – 3.41	1.42 ± 0.7	1.39 – 1.44	16.48 ± 0.2	16.45 – 16.51	2.63 ± 0.6	2.50 – 2.73
	Tombul	2.82 ± 0.6	2.79 – 2.84	1.58 ± 0.8	1.56 – 1.59	12.18 ± 0.6	12.06 – 12.29	2.17 ± 0.7	2.15 – 2.18
	Delisava	4.37 ± 0.3	4.30 – 4.42	1.80 ± 1.3	1.78 – 1.82	16.98 ± 0.8	16.95 – 17.00	3.25 ± 0.1	3.24 – 3.26
KARASU	Kara Fındık	2.74 ± 1.5	2.69 – 2.76	1.70 ± 1.8	1.67 – 1.72	11.35 ± 0.3	11.34 – 11.36	2.53 ± 0.4	2.49 – 2.57
	Tombul	2.45 ± 1.7	2.43 – 2.46	1.40 ± 1.3	1.39 – 1.41	8.70 ± 0.4	8.67 – 8.72	2.29 ± 0.2	2.19 – 2.37
	Delisava	2.78 ± 0.3	2.77 – 2.79	1.38 ± 0.8	1.35 – 1.40	20.03 ± 0.3	19.91 – 20.13	2.94 ± 0.4	2.82 – 3.04
AKYAZI	Kara Fındık	3.69 ± 1.3	3.18 – 4.19	1.61 ± 1.0	1.56 – 1.65	3.87 ± 0.8	3.86 – 3.88	2.58 ± 0.7	2.52 – 2.63
	Tombul	2.77 ± 0.7	2.75 – 2.78	1.55 ± 1.7	1.52 – 1.57	4.23 ± 1.7	3.98 – 4.47	2.15 ± 0.3	2.10 – 2.19
	Delisava	3.59 ± 0.5	3.48 – 3.69	1.38 ± 1.2	1.35 – 1.39	11.09 ± 0.4	11.00 – 11.17	2.86 ± 0.7	2.51 – 3.21
HENDEK	Kara Fındık	4.65 ± 1.5	2.46 – 4.83	1.77 ± 1.9	1.76 – 1.78	11.58 ± 0.5	11.23 – 11.93	2.67 ± 1.2	2.57 – 2.76
	Tombul	2.45 ± 2.9	2.36 – 2.51	1.84 ± 0.7	1.68 – 1.97	16.68 ± 0.4	16.63 – 16.72	2.27 ± 0.6	2.26 – 2.29
	Delisava	4.58 ± 0.3	4.57 – 4.59	1.82 ± 0.4	1.80 – 1.83	19.96 ± 0.5	19.84 – 20.06	3.44 ± 0.4	2.94 – 3.92
FERİZLİ	Kara Fındık	4.20 ± 1.8	4.01 – 4.40	1.66 ± 1.4	1.64 – 1.67	14.54 ± 0.3	14.43 – 14.65	2.41 ± 1.3	2.30 – 2.51
	Tombul	3.20 ± 2.6	3.13 – 3.23	1.79 ± 1.3	1.65 – 1.92	14.34 ± 0.2	13.72 – 14.96	2.45 ± 0.6	2.25 – 2.65
	Delisava	4.24 ± 2.1	4.10 – 4.39	1.46 ± 0.9	1.45 – 1.47	8.75 ± 1.1	8.69 – 8.82	2.85 ± 0.6	2.84 – 2.86
	Mean	**3.45 ± 1.3**	**3.21-3.56**	**1.61 ± 1.1**	**1.57-1.64**	**12.72 ± 0.6**	**12.58-12.84**	**2.63 ± 0.6**	**2.51-2.74**

* Each value is a mean ± relative standard deviation of three determinations.

Table 4: Mineral contents of dehulled Turkish hazelnut kernels in mg/100 g (n=3)*

DISTRICT	Hazelnut Variety	*Iron*		*Copper*		*Manganese*		*Zinc*	
		Mean ±RSD%	Range (Min-Max)	Mean ±RSD%	Range (Min-Max)	Mean ±RSD%	Range (Min-Max)	Mean ±RSD%	Range (Min-Max)
KOCAALİ	Kara Fındık	2.78 ±0.7	2.62-2.92	1.48±1.1	1.43-1.50	16.18±0.2	15.93-16.53	2.48±0.5	2.44-2.50
	Tombul	2.76 ±4.2	2.58-2.93	1.70±0.5	1.69-1.70	9.85±0.7	9.79-9.89	2.36±0.3	2.31-2.40
	Delisava	3.96 ±0.9	3.87-4.04	1.97±0.2	1.95-1.96	14.07±0.3	13.98-14.15	3.61±0.1	3.60-3.62
KARASU	Kara Fındık	1.61 ±3.2	1.55-1.66	1.85±1.4	1.68-2.00	21.77±0.5	21.63-21.88	2.96±0.5	2.88-3.03
	Tombul	2.14 ±3.7	2.06-2.21	1.55±0.7	1.83-1.55	9.14±0.9	9.09-9.18	2.18±0.1	2.13-2.23
	Delisava	3.18 ±2.0	2.75-3.60	1.69±0.8	1.64-1.73	21.70±0.8	21.59-21.80	3.77±0.8	3.14-4.38
AKYAZI	Kara Fındık	2.37 ±3.1	2.23-2.49	1.67±0.4	1.66-1.68	3.58±2.1	3.56-3.60	2.73±0.6	2.62-2.82
	Tombul	1.83 ±0.2	1.82-1.84	1.65±1.3	1.63-1.66	4.88±0.7	4.76-4.98	2.32±1.0	2.30-2.34
	Delisava	4.26 ±2.7	2.03-6.48	1.48±2.7	1.44-1.50	2.41±2.3	2.39-2.42	2.82±0.3	2.81-2.83
HENDEK	Kara Fındık	2.37 ±0.7	2.22-2.49	1.94±0.5	1.93-1.95	10.24±0.5	10.14-10.33	2.73±0.4	2.60-2.85
	Tombul	3.91 ±1.9	3.19-4.61	1.88±1.4	1.86-1.89	14.02±1.3	13.69-14.34	2.60±0.2	2.15-3.04
	Delisava	4.53 ±1.8	4.38-4.67	1.97±0.9	1.96-1.98	18.72±0.8	18.61-18.83	2.98±0.3	2.92-3.02
FERİZLİ	Kara Fındık	3.60 ±0.3	3.49-3.71	1.85±0.3	1.82-1.88	13.24±0.4	13.14-13.34	2.47±0.9	2.40-2.54
	Tombul	3.67 ±1.9	3.62-3.72	1.56±1.2	1.45-1.68	5.15±1.0	5.01-5.28	2.40±0.7	2.38-2.43
	Delisava	5.64 ±0.7	5.50-5.78	1.60±0.6	1.56-1.64	8.10±1.2	7.74-8.46	3.04±0.1	2.98-3.09
	Mean	**3.24 ±1.9**	**2.93-3.54**	**1.72±0.9**	**1.68-1.76**	**11.54±0.9**	**11.40-11.67**	**2.76±0.4**	**2.64-2.87**

* Each value is a mean ± relative standard deviation of three determinations.

in hulled kernels and 3.24, 1.72, 11.54, 2.76 mg/100 g in dehulled kernels, respectively. Significant differences between mineral contents of varieties were observed (table 3 and 4) based upon hulled and dehulled forms of hazelnut kernels. The highest levels of manganese were determined in the samples of Delisava and Kara Fındık. The results are comparable with those given by Açkurt *et al.*[8] Ayfer *et al.*[2] Baş *et al*.[9], Mehlenbacher[10] and by Pala *et al*.[11] for Turkish hazelnut varieties. It can be seen from tables 2 and 3 that copper and zinc levels of hazelnut varieties were not affected by geographical region. However, there were significant differences observed in the levels of iron between the geographical regions. Mineral compositions of our results were also in agreement by previous studies carried out by Açkurt *et al.*[8], Ayfer *et al*.[2], Baş *et al*.[9], Pala *et al*.[11] and Özdemir[1] for Turkish hazelnut varieties. The results reported by Parcerisa *et al*.[4] for Spanish hazelnuts that significant changes were observed for manganese and copper according to geographical regions.

In addition, a correlation study was applied to mineral compositions included in this work. Strong correlations observed in table 5 suggest that soil composition and uses of fertilizers influence mineral composition, which consequently contributes stability and quality of hazelnuts. Parcerisa *et al.*[4] stated that composition of soil, uses of fertilizers and irrigation affect the mineral compositions of hazelnuts and consequently influence the stability and quality of the product. On the other hand, variety has a minor affect on the mineral composition of hazelnuts. A correlation study was performed between iron, copper, manganese and zinc contents. Results for the correlation coefficient (*r*) and significance level (*p*) are shown in table 5.

Table 5. Correlation between mineral compositions and kernel forms.

			Iron	Copper	Manganese		Iron	Copper	Manganese
HULLED	Copper	r[1]	0.0283			DEHULLED	0.3180		
		p[2]	NS[3]				NS		
	Manganese	r	-0.0557	0.4850			0.1426	0.2732	
		p	NS	NS			NS	NS	
	Zinc	r	0.3500	0.3584	0.4965		0.6649	0.1324	0.5144
		p	NS	NS	NS		NS	NS	NS

[1] r, correlation coefficient.
[2] p, probability of significance.
[3] NS, not significant.

Significant differences were found for mineral contents between hulled and dehulled hazelnut kernels. In relation to the metal contents determined, it can be concluded that only iron and manganese contents in hulled kernels showed a negative correlation. So, other mineral contents are positively correlated. Among these four elements, copper content is the only one that shows significant differences between the varieties. The accuracy of the method for hazelnut samples was estimated with the analysis of spiked samples. In spiked samples examined, the recovery tests showed good agreement of the results with the calculated values (table 2) which indicating that present procedure can reliably be used for analysis of minerals in hazelnut samples.

References

1. Ozdemir, M. *Z. Lebensmittel Untersuchung und Forschung,* **1985**, *180*, 289-292.
2. Ayfer, M., Uzun, A., Baş, F. *Türk fındık çeşitleri*. Ankara: Black Sea Hazelnut Exporters Union, 1986.
3. Diaz, A., Torija, M.E., Valls, C. *Anal. Bromatol,* 1980, *32*, 41-48.
4. Parcerisa, J., Rafeces, M., Castellote, A.I., Codony, R., Farran, A., Garcia, J., Lopez, A., Romero, A., Boatella, J. *Food Chemistry*, **1985**, *53,* 71-74.
5. Pershem, A.S., Breene, W.M., Lulai, E.C. *Journal of Food Processing and Preservation,***1995**, *19*, 9-25.
6. Alphan, E., Pala, M., Açkurt, F., Yılmaz, T. *Acta Horticulturae,* 1996, *445*, 305-310.
7. AOAC, Official Methods of Analysis. 16th edn. Association of Official Analytical Chemists, Washington DC, 1996, pp.3-4.
8. Açkurt, F., Ozdemir, M., Biringen, G., Löker, M. *Food Chemistry,***1999**, *65*, 309-313.
9. Baş, F., Ömeroglu, S., Türdü, Aktaş, S. *Gıda,* **1986**, *11*, 195-203.
10. Mehlenbacher, S.A. *Acta Horticulture,***1991**, *290*, 791-836.
11. Pala, M., Açkurt, F., Löker, M., Yıldız, M., Ömeroglu, S. *Turkish Journal of Agriculture & Forestry,***1996,** *20*, 43-48.

Povzetek

Proučevana je bila vsebnost mineralov v treh vrstah lešnikov, Karafindik, Tombul in Delisava, ki jih gojijo v Turški pokrajini Sakarya. Študiran je bil vpliv geografskega področja. Vzorci so bili analizirani s plamensko atomsko absorpcijsko spektrometrijo.