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THE PHYSICO-CHEMICAL PROPERTIES AND FATTY ACID COMPOSITION OF THREE DIFFERENT HAZELNUT VARIETIES COLLECTED AT THE DIFFERENT HARVEST PERIODS

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Abstract

The objective of current study was to determine the chemical properties of hazelnuts collected at the different harvest periods from Giresun province in Turkey. The oil contents of the first harvest period ranged from 12.3% to 6.51%. The moisture contents of nuts were found low in the same period. The oil contents of hazelnuts harvested at the last harvest period were ranged between 53.40% (sharp) to 66.11 (black). In general, palmitic, stearic, oleic, linoleic acid were identified as dominant fatty acids. Depending on the cultivar and harvest, the oleic acid have been identified at the highest rate and have been partial differences among the varieties. The oleic acid contents of varieties were determined between 74.79% to 85.58% depending on harvest period. Linoleic acid content was ranged from 5.70 to 15.64 %, palmitic acid content ranged from 4.92% to 7.31%. As other fatty acids was found at the minor level. The highest palmitic, oleic and linoleic acid contents have been identified respectively in Tonbul (II.harvest), Black (II.harvest) and Tonbul (I.harvest) varieties. The optimum harvesting time as depending on the physico-chemical properties of the all hazelnut varieties is understood to be August and September month.

Key words: hazelnut, varieties, harvest periods, proximate, fatty aci,d composition

Introduction

Hazelnut tree, *Corylus avellana* L., is distributed widely in North of Turkey. It is a shrub or tree from Betulaceac family, Corylaceae family and Corylus genus (Bonvehi and Coll, 1993; Parcerisa *et al.,* 1995; Özdemir *et al.,* 2001; Alasalvar *et al.,* 2003). Hazelnut is among the first species which migrated to northern Europe in the ice age in 17 to 18 thousand BC In seven thousand and five hundred years to eight thousand BC hazelnut had a wide habitat in Europe. However, its habitat has been decreased since 5500 BC due to human activities. The oldest existing knowledge on hazelnuts dates back to the year 2838 BC (Darabzand, 2000). There are several cultivars with various botanical features and different economical values. It is, therefore, important to determine their nutritional properties, and to establish their lipids to find out if the results agree with those reported in literature for hazelnut of other origins (Diaz et al.,1980; Bonvehi and Coll,1993; Parcerisa *et al.,* 1995; Özdemir *et al.,* 2001; Alasalvar *et al.,* 2003). Turkey is the main hazelnut producer in the world. Turkey's total export revenue from hazelnut and hazelnut products is approximately 1 billion U.S. dollars annually (Turkish Hazelnut Union; Alasalvar *et al.,* 2003). Among the nuts, hazelnut has an important role in human nutrition and health, because of its special fatty acid composition, which includes oleic and linoleic acids as well as the presence of tocopherols and sterols. Also, it provides an excellent source of energy due to its high oil content of approximately 60% (Parcerisa *et al.,* 1995; Amaral *et al.,* 2003; Alasalvar *et al.,* 2003). It is rich in protein and oil (Baş *et al.,*

1986). Recently, a great deal of attention has been given to the hazelnut and their oil, and their consumption has thus increased, especially in Europe countries. In this study, hazelnuts growing in middle Anatolia were used firstly. The aim of this study was to investigate the chemical properties of hazelnuts collected at the different harvest periods from Giresun province in Turkey.

Material and methods

Hazelnut varieties (Kara, Tonbul and Sivri) were collected by hand in different harvet periods in Giresun, Turkey in 2012. Fruits were cleaned in an air condition, and then stored in polypropylene bags at room temperature. Each sample was analysed as the whole nut, without the shell.Physical and chemical properties of hazelnut fruits were analysed according to Matthaus and Özcan (2012). The oil content was determined according to the method ISO 659:1998 (ISO,1998). About 2 g of the kernels were ground in a ball mill and extracted with petroleum ether in a Twisselmann apparatus for 6 h. The solvent was removed by a rotary evaporator at 40 °C and 25 Torr. The oil was dried by a stream of nitrogen and stored at -20 °C until used. Fatty acid compositions for hazelnut seed oil were determined using a modified fatty acid methyl ester method as described by Hışıl (1998). The oil was extracted three times for 2 g air-dried seed sample by homogenization with petroleum ether. The oil samples (50-100 mg) was converted to its fatty acid methyl esters (FAME). The methyl esters of the fatty acids (1 µl) were analysed in a gas chromotography (HP 6890) equipped with a flame ionising detector (FID), a fused silica capillary column (60 m x 0.25 mm i.d.; film thickness 0.20 mikrometere). It was operated under the following conditions: oven temperature program. 175 ^{o}C for 7 min. Raised to 250 ^{o}C at a rate 5 ^{o}C/min and than kept at 250 ^{o}C for 15 min); injector and detector temperatures, 250 and 250 ^{o}C; respectively, carrier gas. nitrogen at flow rate of 1.51 ml/min; split ratio. 1/50 µl/min. Results of the research were analysed for statistical significance by analysis of variance (Püskülcü and İkiz, 1989).

Results and Discussion

Some physical and chemical properties of hazelnut (Sivri, Tonbul and Kara) varieties collected at different maturation stages were given in Table 1.

Tab. 1. Some physico-chemical properties of three hazelnut cultivars

Harvest periods		Dry matter (%)	Crude ash (%)	Crude oil (%)	Crude protein (%)**
July I	Tombul	59.85±2.17*	1.72	6.51±0ç34	10.81±0.78
	Sivri	46.91±1.78	1.65	6.52±0ç78	11.48±1.17
	Kara	56.22±2.24	1.65	12.3±1.05	7.60±0.64
July II	Tombul	90.33±3.62	1.38	56.88±2.45	13.33±1.32
	Sivri	90.27±2.89	1.96	54.09±3.41	15.67±1.45
	Kara	94.51±3.56	1.68	52.03±3.09	12.38±1.67
August	Tombul	88.02±1.97	1.74	55.14±1.67	12.46±1.43
	Sivri	81.60±1.67	1.59	58.92±3.78	13.59±1.29
	Kara	78.09±2.71	1.53	51.48±2.34	10.03±0.98
September	Tombul	84.92±2.78	1.69	61.49±2.89	12.15±1.56
	Sivri	94.58±2.54	1.76	53.40±1.78	15.29±1.29
	Kara	94.85±3.42	1.66	66.11±2.86	11.58±1.73

*mean±standard deviation; **Nx6.25

The ash and protein contents of hazelnuts had not been a significant change depending on harvest. The oil contents of hazelnuts were found very low at the first harvest period. The oil contents in this harvest period ranged from 12.3% to 6.51%. The moisture contents of hazelnuts were found low in the same period, too. The protein contents of sharp kind hazelnuts were found higher than the others all the harvest period. The oil contents of hazelnuts were found between 53.40% (sivri) to 66.11 (black) in the last harvest period. Consequently, while protein and ash contents are not change depending on the maturation of hazelnuts, oil content increased. The optimum harvesting time as depending on the physico-chemical properties of the all hazelnut varieties was August and September months. Fatty acid composition of oil of several hazelnut varieties harvested at different periods are presented in Table 2.

Tab. 2. Fatty acid composition of oil of several hazelnut varieties harvested at different periods

Fatty Acidsb (%)	11TMS	11TMT	11TMK	20AS1	09ET2	31TMK2	31TMT1	31TMS2	20AT1	20AK1	20AT2	9ES2	9ES1	9EK2	31TMK1	31TMT2	9ET1	20AK2	31TMS1	20AS2	9EK1
C8:0	-*	-	-	-	-	0.05	0.11	0.09	-	-	-	-	-	-	0.06	-	-	-	-	0.06	-
C10:0	-	-	-	-	-	-	0.05	0.47	-	-	-	-	-	-	-	-	-	-	-	-	-
C12:0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.04	0.03	-
C14:0	0.02	0.16	-	-	0.03	-	0.04	-	0.11	0.03	-	-	-	-	0.03	0.09	-	-	0.08	0.06	0.03
C16:0	4.95	5.29	4.92	4.93	5.76	5.56	7.31	6.35	5.66	5.36	5.42	5.04	5.01	5.03	5.53	5.69	4.93	5.81	5.93	6.17	5.43
C16:1	0.12	0.12	0.11	0.10	0.11	0.11	0.15	-	0.20	0.12	0.12	0.10	0.10	0.09	0.12	0.15	0.11	0.12	0.13	0.12	0.12
C17:1	-	-	-	-	-	-	0.08	-	-	-	-	-	-	-	-	-	-	-	-	0.05	-
C18:0	2.56	2.64	2.36	2.57	2.79	2.86	3.87	2.81	2.31	2.50	2.21	2.40	2.36	2.36	2.84	2.18	2.34	2.86	3.04	2.96	2.18
C18:1CIS	82.79	74.79	85.39	83.68	85.16	85.58	83.95	82.11	76.05	83.89	84.37	85.21	85.23	85.23	85.45	78.76	85.39	85.10	83.91	82.28	84.15
C18:2CIS	8.64	15.64	7.09	8.48	5.90	5.70	4.29	8.17	15.09	7.88	7.76	7.12	7.15	7.19	5.70	12.69	7.10	5.88	6.87	7.99	7.78
C18:3CIS	0.82	1.19	0.12	0.14	0.13	0.14	-	-	0.37	0.13	0.12	0.13	0.15	0.10	0.14	0.29	0.12	0.12	-	0.16	0.21
C20:0	0.10	0.16	-	0.09	0.12	-	0.15	-	0.20	0.09	-	-	-	-	0.12	0.14	-	0.11	-	0.12	0.10
TOPLAM	100.0	99.9	99.9	99..9	100.0	100.00	100.00	100.00	99.99	100.0	100.0	100.0	100.0	100,0	99.99	99.99	99.99	100.00	100.00	100.00	100.00
SAFA	7.63	8.25	7.28	7.59	8.70	8.47	11.53	9.72	8.28	7.98	7.63	7.44	7.37	7.39	8.58	8.10	7.27	8.78	9.09	9.40	7.74
MUFA	82.91	74.91	85.50	83.78	85.27	85.69	84.18	82.11	76.25	84.01	84.49	85.31	85.33	85.32	85.57	78.91	85.50	85.22	84.04	82.45	84.27
PUFA	9.46	16.83	7.21	8.62	6.03	5.84	4.29	8.17	15.46	8.01	7.88	7.25	7.30	7.29	5.84	12.98	7.22	6.00	6.87	8.15	7.99
TRANS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ω 3	0.82	1.19	0.12	0.14	0.13	0.14	0.00	0.00	0.37	0.13	0.12	0.13	0.15	0.10	0.14	0.29	0.12	0.12	0.00	0.16	0.21
Ω 6	8.64	15.64	7.09	8.48	5.90	5.70	4.29	8.17	15.09	7.88	7.76	7.12	7.15	7.19	5.70	12.69	7.10	5.88	6.87	7.99	7.78
MUFA+PUFA	92.37	91.74	92.71	92.40	91.30	91.53	88.47	90.28	91.71	92.02	92.37	92.56	92.63	92.61	91.41	91.89	92.72	91.22	90.91	90.60	92.26

*nonidentified:

TMS: July Sivri, TMT: July Tombul, TMK: July black; AS1: August Sivri 1, ET2: October Tombul 2; TMK2: July Black 2; TMT1: July Tombul 1; TMS2: July Sivri 2; AT1: August Tombul 2; ES2: October Sivri 2; ES1: October Sivri 1; EK2: October Black 2; TMK1: July Black 1; TMT2: July Tombul 2; ET1: October Tombul 1; AK2: August Black 2; TMS1: July Sivri 1; AS2: August Sivri 2; EK1: October Black 1

In general, palmitic, stearic, oleic, linoleic acids were identified as the dominant fatty acids. The oleic acid contents of hazelnuts changed between 74.79% and 85.58% depending on harvest period. Linoleic acid content ranged from 5.70 to 15.64 %, palmitic acid content was ranged from 4.92% to 7.31%. As other fatty acids was found to be minor level. The highest palmitic, oleic and linoleic acid contents were identified respectively in Tonbul (II.harvest), Kara (II.harvest) and Tonbul (I.harvest) varieties. As stearic acid content of hazelnut oils changed between 2.18% (Tonbul, II.harvest) to 3.87% (Tonbul, II.harvest). Content of saturated fatty acids in nuts (SAFA) changed between 7.27% to 9.40%, as monounsaturated fatty acids (MUFA) content changed between 74.91% to 85.69%. There wasn't found trans fatty acid content any harvest period and in variety. The omega-6 fatty acid content of varieties were determined at high rate rather according to omega-3 fatty acid content. The omega-6 fatty acids content of varieties changed between 4.29% to 15.64%. As a result, the progress of ripening has been a minor level reduction oleic acid in varieties. Therefore, fatty acids were shown variability depending on the varieties and harvest time. In the three studied cultivars (Daivana), Total ash contents of hazelnuts were found between 1.87-2.72 % (Köksal *et al.,* 2006). Fat was the major compound, ranging from 56.3% in cv.Daviana to 61.6% in cv. M.Bollwiller. Moisture prosented the lower values, between 3.0% in cv. Daviana and 5.6% in cv. F. Coutard (Oliveira *et al.,* 2008).

Oleic acid is the predominant are, ranging from 80.67% in cv. F. Coutard ad 82.63 % in cv. Daviana. Linoleic acid was the second most abundant fatty acid, followed by palmitic and stearic acids (Oliveira *et al.,* 2008). Hazelnut kernels are a good souree of fat (50-73%) and contain unsaturated fatty acids (linoleic, linolenic, oleic, palmitic and stearic acids), essential for human health (Garcia *et al.,* 1994). The mosture content of hazelnut cultivars changed between 2.49 % (Black hazelnut) to 5.25% (Cavcava) (Köksal *et al.,* 2006). The fatty acid profiles of all investigated cultivars were cansistent with data on Turkish hazelnut varieties (Baş *et al.* 1986; Özdemir *et al.* 2001). Crude protein contents of hazelnut kernels ranged from 11,7% to 20,8% (Köksal *et al.* 2006). Most predominate in the oil of hazelnuts is oleic acid, with amounts between 76.3 % (Doğanhisar-Tekke) and 82.6 % (Deutsche), with a mean value of 79.6 % fort he five different samples. In nut oils collected in Konya (Beybes-Konya) and Konya (Doğanhisar) was more than 76 % of oleic acid found in the oil. As another quantitatively interesting unsaturated fatty acid, the oil contained linoleic acid in a range from 6.5 to 14.0 %, with a mean value of 10.02 %. In the case of linoleic acid, the variation was smaller. In all the other hazelnut oils, the amount of linoleic acid was significantly lower. Nutritionally unfavorable is the high content of saturated fatty acids, consisting of palmitic acid, which amounted to between 5.7 % (Doğanhisar-Tekke) and 6.5 % (Beybes-Konya), with a mean value of 6.08 % and stearic acid, which was found in a very small range between 2.1% (Giresun) and 3.8 % (Beybes-Konya), with a mean value of 2.8 % (Matthaus and Özcan, 2012). The main fatty acids of different hazelnut oils in Turkey were 6.38% palmitic, 1.68% stearic, 76.78% oleic and 14.75% linoleic acids (Baş et al., 1986). Allam (2001) reported that hazelnut oil contained 6.91% palmitic, 79.85% oleic, 10.56% linoleic and 2.60% stearic acid. Sixteen fatty acids were identified in Turkish Tombul hazelnut oil, amoung which oleic acid contributed 82.7% to total, followed by linoleic (8.89%), palmitic (4.85%) and stearic acids (2.73%). Parcerisa *et al.,* (1997) reported that oleic acid was dominant in hazelnut oil. These are comparable to data previously reported in the literature within the limits of the slightly different analytical methods used around the world, the composition of hazelnut oil is uniform. Köksal *et al.,* (2006) established 4.72% to 5.87% palmitic, 0.86% to 2.49% stearic, 74.2% to 82.8% oleic and 9.82% to 18.7% linoleic acids in several hazelnut (*Corylus avellana* L.) varieties. The fatty acid composition of hazelnut oil was similar to that reported previously (Baş *et al.,* 1986; Alasalvar *et al.,* 2003; Özdemir *et al.,* 2001).

Conclusion

As a result, hazelnut is a good herticulture product, depending on human nutrition and beneficial nutrient composition. Depending on the cultivar and harvest, the oleic acid have been identified the highest rate and have been partial differences among the varieties. The first harvest period is July month that has been harvested two times in this period, one times as in August and September months. In general, the dominant fatty acids have been identified palmitic, stearic, oleic, linoleic acid So, growing conditions, harvest time, storge and processing can affect the nutritional volue of hazelnut varieties.

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