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A Comparative Study on GC Analysis of Kernel Fatty Acids of Turkish Walnut (*Juglans regia* L.) Genotypes

FERHAD MURADOGLU* and FIKRI BALTA
Department of Horticulture, Faculty of Agriculture,
Yuzuncu Yil University, Van-65080, Turkey
Tel:/Fax: (90)(432)2251331; E-mail: muradogluf@yyu.edu.tr

This work deals with determining kernel fatty acid composition (FAC) on the basis of kernel ground colour in walnut (*Juglans regia* L.) selections from eastern Turkey. Fruits of 50 promising walnut genotypes were analyzed with respect to their oil and fatty acid composition. Selections with light coloured kernels (LCK) and medium coloured kernels (MCK) were arranged in a row based on their kernel ground colours according to UPOV descriptors (1999). Light coloured kernels and medium coloured kernels selections had mean values of 58.97-58.04 % for kernel oil, 56.79-57.26 % for linoleic acid, 22.56-21.90 % for oleic acid, 12.28-12.46 % for linolenic acid, 4.35-4.34 % for palmitic acid and 2.03-2.05 % for stearic acid. With respect to unsaturated fatty acids and saturated fatty acids, significant differences were not found between light coloured kernels and medium coloured kernels selections.

Key Words: Walnut, Fatty acids, Kernel colour, Turkey.

INTRODUCTION

Today, walnut is one of valuable nut crops with its increasing importance related to nutritional value. Light coloured kernel and thin shell thickness are considered among the desired characteristics for commercial walnut varieties and walnut breeding efforts. In walnut markets, specially fruits with light coloured kernels are preferred by the consumers.

The ω-3-polyunsaturated fatty acids are used against some important diseases[1]. Walnut kernels that have a major role for human nutrition, diet and healthfulness mostly contain unsaturated, and unsaturated fatty acids that are related to beneficial effects on serum lipids. Studies conducted on walnut kernels suggest that their frequent consumption of moderate quantities favourably modify the lipoprotein profile and lowered serum levels of total cholesterol[2]. They contain mostly mono unsaturated fatty acids and are rich in ω-6 and ω-3-polyunsaturated fatty acids.

The nutritional improvement efforts of nut crops maintain their current importance in relation to a healthy human life style[3]. Since walnut genetic resources may have a large variability in their nutritional values[4], they also need nutritional identification in oil and fatty acid contents. The nutritional identification of genetic resources is important[5]. In order to characterize and evaluate promising new selections in walnut

breeding efforts, informations on chemical evaluation of walnut kernel based on genotypic variability are also very limited although chemical component analyses were done for some fruit species. In addition, the use of kernel for industrial purposes depends on its chemical composition, therefore such analyses based on chemical evaluation of the new plant materials would also arouse interest[6].

Focusing on the oil content, fatty acid composition and chemical components of walnuts, many researches have been conducted[7-13], but they do not report compositional data based on kernel colour which is important fruit characteristic affecting the consumer preference. Also, there is no information reporting kernel fatty acid composition (FAC) on the basis of kernel ground colour in walnut fruits. The aim of this work is to determine kernel fatty acid composition (FAC) on the basis of kernel ground colour in walnut fruits. For this aim, fruits of 50 promising walnut selections from Hakkari and Ahlat (eastern Turkey) were analyzed with respect to their oil and fatty acid composition.

EXPERIMENTAL

Fruit materials and sampling: The material of the study consisted of kernels of 50 promising walnut (*Juglans regia* L.) selections from Hakkari and Ahlat situated in the eastern Anatolia region (Turkey) with cold climate conditions in the winter. The walnut fruits were harvested were early-middle October in Hakkari and Ahlat. The harvested fruits were removed from their shells and they were dried in a vacuum oven at 60 °C for 3 days. The dried fruits of 50 walnut selections were arranged in a row based on their kernel ground colours. Their kernel ground colours were classified according to UPOV descriptors[14]. For walnuts, kernel ground colours are described as very light, light, medium and dark according to UPOV descriptors[14]. As a result of kernel colour observations, 25 selections had light coloured kernels and 25 selections had medium coloured kernels. Therefore, fruits of walnut selections were arranged in a row as two groups to compare their oil and fatty acid profiles based on kernel colours. From nut quality characteristics in walnuts (*Juglans regia* L.), kernel weight (g) and shell thickness (mm) were determined for all walnut selections using three replications. Twenty fruits among the harvested almonds were randomly chosen for fruit analyses. The means were expressed as values of 3 harvest years.

Analysis of kernel protein, oil and fatty acid composition: In order to analyze kernel proteins in walnut selections, a Kjeldal digestion method was used[15]. The oil components of kernels were extracted by petroleum ether using a Soxhlet apparatus at 45-50 °C according to standard AOAC[15] procedure in the kernel samples of walnut fruits. The oil content was determined as the difference in weight of dried kernel sample before and after the extraction[16]. Using the usual procedure, the oils were saponified[17]. All analyses of the kernel samples were done in triplicate. Of kernel oil, 0.5 g was dissolved in 4 mL of isooctane and methylated in 0.2 mL 2 M methanolic KOH for preparation the fatty acid methyl esters (FAME). The FAME was analyzed using an Agilent 6890 series gas-chromatography equipped with

flame-ionization detector and a 60 m capillary column (ID = 0.25 mm) coated with 0.25 μm of 50 %-cyanopropyl-methylpolysiloxane (J. and W. Scientific, Folsom, CA, USA). Helium was a carrier gas at a flow rate of 1.5 mL/min and a split ratio of 1:10. The injector temperature was 250 °C and detector temperature was 260 °C. After the oven temperature was programmed at 120 ºC for a hold of 5 min, it was increased to 240 ºC at a rate of 15 ºC/min and hold at the final temparture for 20 min[18]. The fatty acid methyl esters were identified by comparison of their retention times and equivalent chain lengths regarding standard fatty acid methyl esters (Supelco. 47885-U). In the kernel samples, fatty acid methyl esters were quantified based on their percentage areas[15].

Statistical analysis: The statistical package program Minitab release 10.2 for Windows were used for the analysis of variance (ANOVA). A completely randomized design with three replications, was used. Using *t*-test, the means were compared and statistical significant differences were computed at $p < 0.01$.

RESULTS AND DISCUSSION

The shell thickness was recorded between 1.04 mm (HW/119) and 1.66 mm (HW/190) for 25 LCK (light colored kernels) selections and between 1.11 mm (HW/142) and 2.05 mm (AW/030) for 25 MCK (medium colored kernels) selections. The mean values of shell thickness for LCK and MCK selections were 1.36 and 1.41 mm. The kernel weight was from 5.11-6.50 g for LCK selections and from 5.02-6.48 g for MCK selections. The mean values of kernel weight for LCK and MCK selections were 5.61 and 5.59 g. The LCK and MCK selections had mean values of 2.44 and 2.43 % for kernel moisture and 1.81 and 1.72 % for ash content. The protein content ranged from 13.9 % (HW/119) to 22.8 % (AW/022) for LCK selections and from 14.0 % (HW/233) to 23.3 % (AW/014) for MCK selections. In addition, LCK and MCK selections had its mean values of 18.13 and 18.38 %. The 13 selections contained protein more than 20 %. The total fat content of kernel changed between 51.3 % (HW/114) and 67.0 % (HW/172) for LCK selections and between 52.5 % (HW/247) and 64.8 % (HW/118) for MCK selections. The LCK and MCK selections had its mean values of 58.97 and 58.04 %. The 22 selections contained fat more than 60 %. With respect to shell thickness, kernel weight, kernel moisture, kernel ash, kernel protein and kernel oil contents, insignificant statistical differences were found between LCK and MCK selections (Table-1).

Table-2 shows the comperative values of unsaturated fatty acids (UFA %) in LCK and MCK selections. In LCK selections, the range was from 44.34 % (AW/013) to 67.51 % (HW/114) for linoleic acid, from 11.92 % (AW/032) to 36.17 % (AW/013) for oleic acid, from 9.97 % (AW/023) to 15.32 % (AW/032) for linolenic acid, from 0.75-2.66 % for palmitoleic acid, from 0.01-0.13 % for gadoleic acid and from 92.01 % (HW/222) to 95.74 % (HW/114) for UFA. In MCK selections, the range was from 46.02 % (HW/010) to 67.44 % (HW/149) for linoleic acid, from 12.73 % (HW/149) to 34.95 % (AW/014) for oleic acid, from 10.10 % (HW/221) to 15.23 % (AW/010) for linolenic acid, from 0.61-2.65 % for palmitoleic

TABLE-1
A COMPARISON OF SHELL THICKNESS, KERNEL MOISTURE, KERNEL ASH, KERNEL PROTEIN AND KERNEL OIL CONTENTS IN 50 PROMISING WALNUT SELECTIONS WITH LIGHT AND MEDIUM COLOURED KERNELS FROM EASTERN TURKEY

Selections	Kernel colour	Shell thick (mm)	Kernel weight (g)	Kernel moisture (%)	Ash cont. (%)	Protein cont. (%)	Kernel oil (%)
HW/017	Light	1.52	5.70	1.20	1.60	20.0	52.5
HW/043	Light	1.10	5.61	2.80	1.40	21.0	64.6
HW/099	Light	1.26	5.78	2.50	2.20	16.5	60.6
HW/114	Light	1.64	5.22	1.90	2.30	14.7	51.3
HW/119	Light	1.04	5.39	3.30	2.50	13.9	54.2
HW/126	Light	1.23	5.11	1.00	2.10	16.6	56.1
HW/130	Light	1.43	5.76	2.20	2.40	19.4	55.3
HW/147	Light	1.46	5.72	2.40	2.20	19.0	57.9
HW/165	Light	1.27	6.18	2.50	1.80	17.3	58.2
HW/166	Light	1.31	6.29	3.50	2.30	20.8	64.3
HW/168	Light	1.26	6.08	2.10	1.50	16.3	52.7
HW/172	Light	1.33	5.24	2.50	2.10	18.6	67.0
HW/183	Light	1.50	6.50	1.80	1.30	16.9	63.0
HW/184	Light	1.30	5.69	1.60	2.40	17.2	60.9
HW/190	Light	1.66	5.20	2.00	2.00	17.9	54.8
HW/216	Light	1.36	5.27	2.00	1.90	20.3	57.8
HW/222	Light	1.33	5.30	3.30	1.20	15.6	62.6
HW/251	Light	1.17	5.49	1.90	1.30	17.0	63.9
HW/263	Light	1.42	5.11	2.10	1.70	15.1	52.5
AW/013	Light	1.36	5.51	2.20	1.50	17.9	62.4
AW/016	Light	1.53	5.51	3.40	1.90	18.6	60.4
AW/019	Light	1.29	5.49	2.60	1.80	19.1	61.5
AW/022	Light	1.52	5.00	3.80	1.00	22.8	62.0
AW/023	Light	1.60	6.22	3.10	1.70	20.5	61.2
AW/032	Light	1.23	5.91	3.40	1.30	20.3	56.7
HW/010	Medium	1.42	5.02	2.10	2.40	20.4	57.4
HW/035	Medium	1.42	5.04	1.40	1.60	18.5	61.2
HW/078	Medium	1.15	5.02	2.10	1.90	19.5	54.5
HW/083	Medium	1.29	5.62	1.60	2.20	17.1	59.9
HW/118	Medium	1.27	5.20	2.80	1.40	16.7	64.8
HW/142	Medium	1.11	5.14	1.20	2.00	17.7	54.3
HW/149	Medium	1.29	5.11	3.20	1.10	17.6	53.8
HW/171	Medium	1.20	6.20	1.90	2.10	17.2	54.0
HW/185	Medium	1.48	6.44	2.30	1.20	18.8	58.9
HW/199	Medium	1.47	5.54	1.20	2.00	20.4	55.7
HW/221	Medium	1.31	5.43	1.50	1.60	16.4	53.0
HW/233	Medium	1.22	5.16	1.80	1.90	14.0	60.6
HW/243	Medium	1.69	5.62	2.30	1.90	18.3	56.8
HW/247	Medium	1.40	6.48	2.20	2.10	17.1	52.5
HW/248	Medium	1.31	5.29	2.80	1.50	17.5	61.4
HW/254	Medium	1.67	5.80	2.40	2.10	19.8	55.2
AW/005	Medium	1.22	6.04	3.80	1.50	17.7	58.4
AW/006	Medium	1.49	5.76	2.50	1.5	19.3	61.7

AW/007	Medium	1.73	6.24	3.60	1.50	15.5	62.8
AW/010	Medium	1.46	5.06	2.60	1.40	20.3	59.5
AW/014	Medium	1.41	6.17	4.20	2.40	23.3	51.5
AW/018	Medium	1.36	5.31	2.70	1.30	15.8	58.7
AW/021	Medium	1.59	5.97	3.10	1.20	21.1	62.3
AW/030	Medium	2.05	5.52	2.40	1.90	20.9	61.5
AW/040	Medium	1.47	5.53	3.10	1.40	18.7	60.7
Mean of LCK		1.36	5.61	2.44	1.81	18.13	58.97
Mean of MCK		1.41	5.59	2.43	1.72	18.38	58.04
Significance		NS	NS	NS	NS	NS	NS

NS: Non-significant ($p < 0.01$).

TABLE-2
A COMPARISON OF UNSATURATED FATTY ACIDS (UFA %) IN 50 PROMISING WALNUT (*Juglans regia* L.) SELECTIONS WITH LIGHT AND MEDIUM COLOURED KERNELS FROM EASTERN TURKEY

Selections	Kernel colour	Linoleic acid C18:2	Oleic acid C18:1	Linolenic acid C18:3	Palmitoleic acid C16:1	Gadoleic acid C20:1	UFA (%)
HW/017	Light	50.79	30.27	11.16	1.28	0.03	93.53
HW/043	Light	58.56	20.59	12.55	1.67	0.05	93.42
HW/099	Light	62.01	17.89	11.12	2.15	0.07	93.24
HW/114	Light	67.51	15.14	10.36	2.66	0.07	95.74
HW/119	Light	54.30	26.02	11.09	1.16	0.04	92.61
HW/126	Light	58.67	21.05	12.18	2.36	0.08	94.34
HW/130	Light	57.74	19.92	13.84	2.48	0.07	94.05
HW/147	Light	56.49	20.06	14.57	2.08	0.05	93.25
HW/165	Light	55.81	22.18	13.65	1.26	0.04	92.94
HW/166	Light	52.44	26.50	11.70	1.52	0.01	92.17
HW/168	Light	57.04	21.46	13.02	1.35	0.04	92.91
HW/172	Light	54.42	23.85	12.95	1.50	0.05	92.77
HW/183	Light	57.67	19.14	13.44	2.12	0.05	92.42
HW/184	Light	57.30	21.40	12.06	1.43	0.06	92.25
HW/190	Light	57.43	24.31	10.20	0.75	0.03	92.72
HW/216	Light	57.86	20.83	12.26	1.28	0.03	92.26
HW/222	Light	57.65	20.68	12.35	1.29	0.04	92.01
HW/251	Light	54.82	27.73	10.10	1.67	0.05	94.37
HW/263	Light	58.42	21.67	12.55	1.32	0.05	94.01
AW/013	Light	44.34	36.17	11.12	1.20	0.04	92.87
AW/016	Light	51.36	28.41	11.91	1.01	0.03	92.72
AW/019	Light	52.65	24.98	13.96	0.88	0.01	92.48
AW/022	Light	59.90	18.91	13.81	2.54	0.07	95.23
AW/023	Light	59.99	23.03	09.97	2.02	0.08	95.09
AW/032	Light	64.77	11.92	15.32	2.23	0.13	94.37
HW/010	Medium	46.02	31.51	13.62	1.34	0.05	92.54
HW/035	Medium	56.46	21.08	13.62	1.48	0.05	92.69
HW/078	Medium	58.44	20.15	12.43	2.44	0.06	93.52
HW/083	Medium	59.58	17.51	13.70	2.20	0.05	93.04
HW/118	Medium	61.28	17.82	12.66	1.94	0.06	93.76
HW/142	Medium	63.09	16.70	11.90	2.65	0.07	94.41

HW/149	Medium	67.44	12.73	13.53	2.38	0.11	96.19
HW/171	Medium	62.53	16.28	12.71	1.40	0.04	92.96
HW/185	Medium	52.25	26.86	11.90	0.95	0.04	92.00
HW/199	Medium	61.55	18.22	11.28	2.34	0.07	93.46
HW/221	Medium	53.97	27.43	10.10	1.41	0.05	92.96
HW/233	Medium	55.10	25.61	10.76	0.95	0.02	92.44
HW/243	Medium	64.76	15.18	12.30	2.35	0.06	94.65
HW/247	Medium	59.76	19.21	12.79	1.65	0.07	93.48
HW/248	Medium	58.30	18.17	14.40	1.99	0.05	92.91
HW/254	Medium	55.80	22.46	13.25	1.49	0.03	93.03
AW/005	Medium	54.83	22.37	15.17	1.81	0.07	94.25
AW/006	Medium	57.82	22.61	10.75	2.21	0.05	93.44
AW/007	Medium	60.92	17.18	13.59	2.62	0.18	94.49
AW/010	Medium	49.50	26.61	15.23	0.87	0.06	92.27
AW/014	Medium	45.84	34.95	11.21	0.92	0.04	92.96
AW/018	Medium	59.62	19.97	11.63	1.10	0.01	92.33
AW/021	Medium	59.10	22.20	10.80	0.61	0.04	92.75
AW/030	Medium	57.66	22.91	11.73	1.52	0.09	93.91
AW/040	Medium	49.89	31.96	10.54	1.25	0.17	93.81
Mean of LCK		56.79	22.56	12.28	1.64	0.05	93.35
Mean of MCK		57.26	21.90	12.46	1.67	0.06	93.37
Significance		NS	NS	NS	NS	NS	NS

NS: Non-significant ($p < 0.01$).

acid, from 0.03-0.18 % for gadoleic acid and from 92.00 % (HW/185) to 96.19 % (HW/149) for UFA. The means values of LCK and MCK selections were 56.79-57.26 % for linoleic acid, 22.56 -21.90 % for oleic acid, 12.28-12.46 % for linolenic acid, 1.64-1.67 % for palmitoleic acid, 0.05-0.06 % for gadoleic acid, 93.35-93.37 % for UFA and 14.45-14.31 for UFA/SFA ratio. In terms of unsaturated fatty acid contents, statistical differences were not significant between LCK and MCK selections.

The comperative values of saturated fatty acids (SFA %) in LCK and MCK selections were shown in Table-3. In LCK selections, the range was from 2.64 % (HW/114) to 5.55 % (HW/222) for palmitic acid, from 1.22-2.79 % for stearic acid, from 0.01-0.31 % for arachidic acid, from 0.00-0.36 % for myristic acid, from 4.26-7.99 % for SFA and from 11.52 % (HW/222) to 22.47 % (HW/114) for UFA/SFA ratio. In MCK selections, the range was from 3.47 % (AW/007) to 5.45 % (HW/254) for palmitic acid, from 1.14-2.71 % for stearic acid, from 0.01-0.44 % for arachidic acid, from 0.00-0.40 % for myristic acid, from 3.81-8.00 % for SFA and from 11.50 % (HW/185) to 25.25 % (HW/149) for UFA/SFA ratio. The means values of LCK and MCK selections were 4.35-4.34 % for palmitic acid, 2.03-2.05 % for stearic acid, 0.19-0.20 % for arachidic acid, 0.06-0.09 % for myristic acid and 6.65-6.69 % SFA. Regarding saturated fatty acids, significant differences were not found between LCK and MCK selections.

Fruits of the commercial walnut varieties are desired to have light coloured kernel and thin shell thickness. In walnut markets, the consumers prefer specially

TABLE-3
A COMPARISON OF SATURATED FATTY ACIDS (SFA %) IN 50 PROMISING WALNUT (*Juglans regia* L.) SELECTIONS WITH LIGHT AND MEDIUM COLOURED KERNELS FROM EASTERN TURKEY

Selections	Kernel colour	Palmitic acid C16:0	Stearic acid C18:0	Arachidic acid C20:0	Myristic acid C14:0	SFA (%)	UFA/SFA
HW/017	Light	4.41	1.86	0.17	0.02	6.46	14.48
HW/043	Light	4.46	1.92	0.19	0.02	6.59	14.18
HW/099	Light	4.27	2.29	0.19	0.01	6.76	13.79
HW/114	Light	2.64	1.60	0.01	0.01	4.26	22.47
HW/119	Light	4.53	2.67	0.19	0.01	7.40	12.51
HW/126	Light	3.77	1.68	0.20	0.01	5.66	16.67
HW/130	Light	4.08	1.72	0.15	0.00	5.95	15.81
HW/147	Light	4.85	1.73	0.15	0.02	6.75	13.81
HW/165	Light	4.30	2.56	0.19	0.01	7.06	13.16
HW/166	Light	4.99	2.63	0.20	0.01	7.83	11.77
HW/168	Light	4.68	2.22	0.18	0.01	7.09	13.10
HW/172	Light	4.65	2.38	0.18	0.01	7.22	12.85
HW/183	Light	5.23	2.13	0.19	0.02	7.57	12.21
HW/184	Light	5.17	2.34	0.21	0.03	7.75	11.90
HW/190	Light	4.16	2.79	0.31	0.03	7.29	12.72
HW/216	Light	4.99	2.53	0.19	0.02	7.73	11.94
HW/222	Light	5.55	2.23	0.19	0.02	7.99	11.52
HW/251	Light	3.81	1.60	0.20	0.02	5.63	16.76
HW/263	Light	4.20	1.60	0.21	0.02	6.03	15.59
AW/013	Light	4.42	2.23	0.24	0.24	7.13	13.02
AW/016	Light	4.61	2.09	0.23	0.36	7.29	12.71
AW/019	Light	4.90	2.07	0.21	0.34	7.52	12.29
AW/022	Light	3.15	1.22	0.20	0.23	4.80	19.83
AW/023	Light	3.06	1.43	0.21	0.21	4.91	19.36
AW/032	Light	4.05	1.34	0.24	0.01	5.64	16.73
HW/010	Medium	5.33	1.92	0.20	0.01	7.46	12.40
HW/035	Medium	4.74	2.35	0.21	0.01	7.31	12.68
HW/078	Medium	4.57	1.74	0.17	0.01	6.49	14.41
HW/083	Medium	4.60	2.19	0.18	0.00	6.97	13.35
HW/118	Medium	3.99	2.05	0.18	0.01	6.23	15.05
HW/142	Medium	3.63	1.80	0.15	0.01	5.59	16.89
HW/149	Medium	2.54	1.14	0.12	0.01	3.81	25.25
HW/171	Medium	4.83	2.03	0.17	0.02	7.05	13.19
HW/185	Medium	4.95	2.71	0.31	0.03	8.00	11.50
HW/199	Medium	4.24	2.13	0.16	0.02	6.55	14.27
HW/221	Medium	4.34	2.51	0.18	0.02	7.05	13.19
HW/233	Medium	5.04	2.31	0.19	0.02	7.56	12.23
HW/243	Medium	4.20	1.98	0.15	0.01	6.34	14.93
HW/247	Medium	3.95	2.34	0.23	0.01	6.53	14.32
HW/248	Medium	4.59	2.31	0.19	0.01	7.10	13.09
HW/254	Medium	5.45	2.23	0.10	0.03	7.81	11.91
AW/005	Medium	3.63	1.62	0.25	0.24	5.74	16.41
AW/006	Medium	3.65	2.22	0.34	0.33	6.54	14.28

AW/007	Medium	3.47	1.44	0.29	0.23	5.43	17.40
AW/010	Medium	4.88	2.21	0.25	0.40	7.74	11.92
AW/014	Medium	4.52	2.02	0.32	0.17	7.03	13.22
AW/018	Medium	4.95	2.14	0.22	0.36	7.67	12.03
AW/021	Medium	4.76	2.04	0.01	0.18	6.99	13.26
AW/030	Medium	3.74	2.15	0.20	0.01	6.10	15.39
AW/040	Medium	3.91	1.71	0.44	0.13	6.19	15.15
Mean of LCK		4.35	2.03	0.19	0.06	6.65	14.45
Mean of MCK		4.34	2.05	0.20	0.09	6.69	14.31
Significance		NS	NS	NS	NS	NS	NS

NS: Non-significant ($p < 0.01$).

fruits having light coloured kernels. The use of walnut kernel for industrial purposes is dependent on its chemical composition. In addition, these valuable nut characteristics also are important for walnut breeding efforts to develop new varieties. On the other hand, because walnut genetic resources may have a large variability in their nutritional values, they also need nutritional identification in oil and fatty acid contents. In order to characterize and evaluate promising new selections in walnut breeding efforts, informations on chemical evaluation of walnut kernel based on genotypic variability are also very limited although chemical component analyses were done for some fruit species. The chemical description of walnut kernel based on nutritional quality evaluation of different genotypes would contribute to variety characterization as a selection criterion, as reported for almonds[19].

Selections with light coloured kernels (LCK) and medium coloured kernels (MCK) had the mean values of 5.61-5.59 g for kernel weight, 1.36-1.41 mm for shell thickness. Today, many commercial walnut varieties have similar values kernel weights and shell thickness. The protein content ranged from 13.9-22.8 % for LCK selections and from 14.0-23.3 % for MCK selections. While LCK and MCK selections averagely had protein contents of 18.13 and 18.38 %, 13 selections contained protein more than 20 %. Protein content for walnut kernel has been recorded as 13-14 % by Caglarirmak[11], 15-19 % by Ozkan and Koyuncu[12] and 12-15 % by Amaral *et al.*[10]. Some selections had higher kernel protein content than those of related references.

In this work, kernel oil content ranged from 51.3-67.0 % for LCK selections and from 52.5-64.8 % for MCK selections. LCK and MCK selections had averagely kernel oil of 58.97 and 58.04 %, although insignificant statistical differences were found between LCK and MCK selections as regards kernel oil contents. In addition, 22 selections contained oil more than 60 %. The range of kernel oil has been reported as 57-69 % for some USA, European and New Zealand walnut varieties by Zwarts *et al.*[8], 62-70 % for walnut varieties grown in New Zealand walnut varieties by Savage[9], 57-69 % for some Turkish walnut varieties by Caglarirmak[11], 61-70 % for ten Turkish walnut genotypes by Ozkan and Koyuncu[12], 59-61 % for two walnut varieties by Li *et al.*[13] and 62-66 % for six walnut varieties grown in Portugal by Amaral *et al.*[10]. Findings with regard to oil contents agreed with those reported by the related references.

Regarding unsaturated and saturated fatty acid contents, statistical differences were not significant between LCK and MCK selections had a large variability in fatty acid composition. The LCK selections had ranges from 44.34-67.51 % for linoleic acid, from 11.92-36.17 % oleic acid, from 9.97-15.32 % for linolenic acid, from 2.64-5.55 % for palmitic acid and from 1.22-2.79 % for stearic acid. The range in MCK selections was from 46.02-67.44 % for linoleic acid, from 12.73-34.95 % for oleic acid, from 10.10-15.23 % for linolenic acid, from 3.47-5.45 % for palmitic acid and from 1.14-2.71 % for stearic acid. The ranges of fatty acids composition of walnut kernels have been recorded as 14-26 % for oleic acid, 49-62 % for linoleic acid, 8-15 % for linolonic acid, 6-8 % for palmitic acid and 1.4-2.5 % for stearic acid by Zwarts *et al*.[8]; 14-18 % for oleic acid, 57-62 % for linoleic acid, 9-12 % for linolonic acid, 6-7 % for palmitic acid and 2.4-2.7 % for stearic acid by Amaral *et al*.[10] and 15-16 % for oleic acid, 57-60 % for linoleic acid, 12-15 % for linolonic acid, 5.5-5.8 % for palmitic acid and 2.8-3.2 % for stearic acid by Li *et al*.[13]. Findings associated with fatty acid composition indicated that some walnut genotypes had higher contents of oleic and linoleic acid contents but lower contents palmitic and stearic acid than those from related references.

With respect to oil content and fatty acids, many limited studies indicated a large variability for walnut varieties[8,10-12] and for almond genotypes and varieties[5,20]. In addition, it has been stated that presence of selections with higher oil and fatty acid contents than the commercial varieties enables a very promising base to obtain new varieties with oil of higher quality, satisfying the industrial and consumer sectors[20]. Findings suggested that specially walnut selections containing higher oil and major fatty acids than the commercial varieties may contribute to future nutritional breeding efforts as promising genetic resources. Also, although oil composition was not affected by kernel colour, it should be considered as a selection criteria for varietal breeding efforts of walnut.

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