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Oil Content, Major Fatty Acids Composition, α tocopherol, β tocopherol and Nut Characteristics of Almond at Time of Harvest

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ABSTRACT

Oil content, 7 major fatty acids composition, α, β tocopherol and nut characteristics in 5 almond cultivars: Ferragnes, Saba, Fragiulio, Shokoofe and Mamaee in time of harvest were investigated. Results showed oil content varied from 59.16% to 48.47% of the total kernel dries weight for Shokoofe and Ferragnes cultivars respectively. Also the results of analysis of seven different fatty acids; Methyl palmitate, Methyl palmitoleate, Methyl stearate, Methyl oleate, Methyl linnoleate, Methyl arachidat, Methyl eicosenoate, tocopherols (α, β) and physical nut characteristics 5 cultivars of almond at harvest showed that the highest amount of Methyl palmitoleate is Mamaee (0.7100%) and the lowest one is in Ferragnes (0.48). In the other hand, the highest amount of Methyl stearate is for Ferragnes (1.70%) and the lowest one for Fragiulio(1.20%) and amount of Methyl oblate in Mamaee is the least (69.8%)) and in Ferragnes is the most (76.1%), but amount of Methyl linnoleate in Mamaee is the most (19.39%) and in Shokoofe is the least (13.14%). Furthermore, the most amount of Methyl arachidat is for Mamaee(0.08%) and the least one is for Saba(0.056). Also in this study, it was determined that the highest index of diversity (47%) and lowest index variation (45/3%) in the order corresponding to the weight of the fruit and methyl arashidat. Results indicated that β and α tocopherols were different levels, in way that Ferragnes had the most amount β tocopherol (0.0160mlg/g oil) in harvest, and Fragiulio had the least one(). Finally, the most α-tocopherol in Mamaee (0.153mlg/g oil) and the least it in Fragiulio (0.1500mlg/g oil) were observed. Ordinarily, some cultivars in same contention were found with higher oil contents, high ratios of oleic/linoleic acids, tocopherols (α and β) and physical nut characteristics than other.

KEYWORDS*:* almond; oil content; tocophyrol; fatty acids; nut

INTRODUCTION

Almond is an important food product which in addition the local use as a dry nut; it's as important component of food and industrial products in normal condition [3]. On other words, quality keeping of nut is very important from different aspects in nut harvesting. In this case, various factors, particularly physical characteristics of nut and chemical composites are effective attributes for determining quality [8, 7, 9, 20]. One of the most important biochemical characteristics can be vitamins, oil and fatty acids [16]. Vitamins solved in the oil such as vitamins E (tocopherol) are present by adequate amount in almond oil. The main type of tocopherol in almond is type of α which has more antioxidant activity than other types of tocopherols such as β, δ and γ and its effective on quality keeping in almond kernel. Almond kernels are good source for α- tocopherol and has so low amount of other isomers of tocopherol such as philoguanin [14]. Tocopherols are monopherols which present anti oxidant activity and depend on position and amount of methyl groups have different isomer [21]. It is believed that their important biochemical performance is supporting the unsaturated fatty acids against peroxdation [13]. In almond concentration of tocopherol plays important role in supporting lipids against oxidation and in time of storage [8, 9]. Total concentration of tocopherol at storage is reduced [28,29, 8] which cause of anti-oxidant activity of lipids [8]. In almond, concentration of α-tocopherol is 187 to 490 g/kg of oil and after that are γ and δ isomers [14]. In the other hand, content and components of lipid in confectionary industry are so important, because high content of the oil leads to reduce the water absorption by almond paste [5]. In the other hand, amount of fat in sweet almond is 43-56% and in bitter almond is 36-50%. Amount of oil of 12 kinds of almond in Portugal country were reported 30.01 to 51% [17]. In other studies, amount of oil in almond was determined 45.9 to 61.7% [18]. Salvo et al (1986)[23] studied on amount of peoxidation and changing in compounds of almond oil in longer than 3 years in 4˚c and temperature of environment and a similar but faster manner in stored almond oils in temperature of environment was observed. Thus, they concluded that oxidative stability of almond oil depends on tocopherpl presence and probably other materials which help to oil stability. A report of Agar et al (1998)[2] is represented in which amount of fatty acids and oil of different kinds of almond are different. 5 fatty acids; oleicacid (18.1), linnolei cacid (18.2), palmetic acid (16.0), palmitoleic acid (16.1), and stearic acid (18.0) form more than 95% of total fat which report 8 additional compounds of fatty acids depend on their kind [1]. Furthermore, analyzing the compound of fatty acid of almond oil[27] indicated

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that oleic acid (68%) is important fatty acid in present, then linoleic acid (25%), palmetic acid (4.7%) and a litter amount (2.3%) of palmitoleic, stearic and Archidic acid are present. Based on a report Soler *et al*.(1988)[25] kind of acids in pons almond are 6.5% of palmitic acid, 0.5% of palmitoleic acid, 1.5% of stearic acid, 62.5% oleic acid and 29% of linnoleic acid. In several varieties of almond, 15.18-5.465% of palmitic, 2.52-0.36% of palmitoleic, 3.83-0.8% of stearic, 81.20-50.41% of oleic and 31.13-6.21% of linnoleic acids were determined (6). Linnoleic and oleic acids are as important fatty acids. When amount of oleic acid in samples are 72.5% (Nonpareil) and 9.19% (Cristomorto), amount of linoleic acid will be 13.52% (Cristomorto) and 19.77% (Nonpareil) [18]. Amount of oleic acid (67.6-80.8%) is different of linoleic acid (11.9-24.4%). Furthermore amounts of palmitic acids of the oils were determined between 5.87 %(Tuono) and 67.73% (Nonpareil) [19]. Iranian almond oil indicated the highest amount of myristic and stearic acid (0.4-4.4%) and lowest amount of palmitic acid (6-8.1). In this way, present study was done for investigating oil content, major fatty acids composition, α tocopherol, β tocopherol and nut characteristics of selective almonds at time of harvest.

MATERIAL AND METHOD

In this study oil content, major fatty acids composition, α tocopherol, β tocopherol and nut characteristics of selective almonds at time of harvest was investigated.For oil analyses of fruits of 5 cultivars of almond (Ferragnes, Saba, Fragiulio, Shokoofe and Mamaee) in harvest after homogenized and subjected to extraction for 6 h with petroleum ether (boiling range 30–60 ◦C) in a Soxhlet apparatus. The extracted oil was dried over anhydrous sodium sulphate and the solvent was removed under reduced pressure in a rotary film evaporator. Oil percentages were determined by method of Zacheo et al (2000)[8]. The HPLC system used for determination of tocopherols content was determined using the method of Kodad et al.(2011)[16].Fatty acid composition for kernel oils was determined using a fatty acid methyl ester method as described by Ozcan et al (2011)[19]. The oil was extracted three times for 2 g air-dried seed sample by homogenization with petroleum ether. The oil samples (5–100 mg) were converted to its fatty acid methyl esters (FAME).The methyl esters of the fatty acids (1µl) were analyzed in a gas chromatography (Shimadzu GC-2010) equipped with a flame ionizing detector (FID), a fused silica capillary column (60m×0.25mm i.d.; film thickness 0.20µm). It was operated under the following conditions: oven temperature program, 90 ◦C for 7min (raised to 240 ◦C at a rate 5 ◦C/min and then kept at 240 ◦C for 15 min); injector and detector temperatures, 260 and 260 ◦C, respectively; carrier gas, nitrogen at flow rate of 1.51 ml/min; split ratio, 1/50µl/min. A Standard fatty acid methyl ester mixture (Sigma Chemical Co.) was used to identify sample peaks. Commercial mixtures of fatty acid methyl esters were used as reference data for the relative retention times [5]. also Data from an experiment as randomized complete block design(RCBD) in triplicate and using SAS software for statistical analysis and means comparison by Duncan Multiple Range Test, and drawing diagrams using Mini-Tab software version 16 2.2 version was done.

RESULTS AND DISCUSSION

Obtained results of variance analyze of oil, 7 fatty acids; Methyl palmitate, Methyl palmitoleate, Methyl stearate, Methyl oleate, Methyl linnoleate, Methyl arachidat, Methyl eicosenoate, tocopherols(α, β) and physical nut characteristics of 5 cultivars of almond at harvest are presented in Table 1.

Table 1 Analyze Variance of oil 7 of fatty acids, α- tocopherol, β- tocopherol and physical nut characteristics of 5 cultivars of almond at harvest

S.V.	DF	MS																
		Weight kernel	kernel thickness	kernel width	kernel length	Weight nut	nut thickness	nut width	nut length	α-tocophero	β-tocophero	%Methyl eicosenoat	%Methyl arachidat	%Methyl linnoleate	%Methyl oleate	%Methyl stearate	%Methyl palmitolea	%Methyl palmitate	%oil
Cultivar	4	0.476**	9.991**	10.979**	65.735**	8.876**	17.988**	35.140**	134.755**	0.001**	0.00008**	0.00002**	0.0003**	18.995**	17.459**	0.153**	0.02780*	0.0221ns	52.007**
Replication	2	0.044ns	1.016ns	1.601ns	1.512ns	0.363ns	0.072ns	3.317ns	3.559ns	0.00006ns	0.00002ns	0.00002ns	0.0002ns	9.316 ns	10.843ns	0.0135ns	0.01922 0ns	2.9954ns	22.955ns
Error	8	0.014	0.131	4.477	1.98	0.122	1.371	3.35	2.749	8E-08	9E-08	0.0000002	0.0003	0.304	0.494	0.001	0.00597	0.5509	0.362
C.V.		22.21	20.12	18.21	17.44	47.66	16.9	16.36	18.36	15.99	15.15	16.68	15.21	16.44	3.46	14.42	20.76	13.41	7.73

**: in 1% significant;*: in 5% significant; ns: no significant

In the other hand, obtained results of comparing the average of effect of cultivar on amount of of oil, 7 fatty acids; Methyl palmitate, Methyl palmitoleate, Methyl stearate, Methyl oleate, Methyl linnoleate, Methyl arachidat , Methyl eicosenoate and tocopherols(α and β) and physical nut characteristics 5 cultivars of almond at harvest are presented in Table 2.

Table 2 Oil, 7 of fatty acids, α- tocopherol , β- tocopherol and physical nut characteristics of 5 cultivars of almond at harvest

Cultivar	Mean																	
	%oil	%Methyl palmitate	%Methyl palmitoleate	%Methyl stearate	%Methyl oleate	%Methyl linnoleate	%Methyl arachidat	%Methyl eicosenoate	β- tocopherol	α- tocopherol	nut length	nut width	nut thickness	Weight nut	kernel length	kernel width	kernel thickness	Weight kernel
Fragness	59.166a	6.490a	0.460b	1.700a	76.857a	14.137c	0.0750a	0.023a	0.016a	0.016a	38.670a	22.567a	14.827b	3.917b	25.607b	13.617a	8.467b	1.237b
Mamaee	57.485ab	6.4633a	0.7100a	1.6500ab	71.2700b	19.8567a	0.0800a	0.0220a	0.0167a	0.0167a	36.7067s	24.9467a	18.1533a	5.1900a	30.1700a	14.8167a	11.2933b	1.7233a
Saba	57.0263b	6.4867a	0.5000ab	1.3000c	75.6000a	16.4867b	0.0567b	0.0180b	0.0133b	0.0133b	36.9167a	21.7667a	13.2767bc	2.3400c	27.4567ab	12.90000a	7.3267c	1.1233b
Fragiulio	54.9113c	6.3033a	0.5400ab	1.2000d	75.7233a	16.1933b	0.0660ab	0.0160c	0.0130b	0.0130b	38.6700a	22.6333a	14.3100bc	4.6433ab	27.5067ab	13.7900a	6.7167c	1.2500b
Shokoofe	48.4770d	6.5200a	0.6300ab	1.6100b	77.3900a	13.4100c	0.0750a	0.0190b	0.0150ab	0.0150ab	23.1333b	15.80000b	11.4900c	1.0133d	17.8700c	9.7867a	7.3500c	0.6067c

Mean with the same letter are not significantly different at p=0.05using Duncan's multiple range test

Also in Table 3 parameters for describe examined characteristics of selected almond cultivars including the minimum, maximum, standard deviation, average and index of diversity has been showed

Table 3 Description examined characteristics of selected almond cultivars at harvest using different parameters

Variable	Minimum	Maximum	Mean	St.Dev.	Diversity Index (%)
Oil%	46.16	61.02	55.41	4.28	7.72
Methyl palmitate	4.770	7.870	6.453	0.865	13.40
Methyl palmitoleate	0.3000	0.7400	0.5720	0.1188	20,76
Methyl stearate	1.1600	1.7200	1.4920	0.2151	14.41
Methyl oleate	69.400	1.7200	75.368	2.611	3.46
Methyl linoleate	12.450	21.420	16.017	2.633	16.30
Methyl arachidate	0.04000	0.08300	0.07053	0.01073	3.45
Methyl eicosenoate	0.014000	0.025000	0.019600	0.003269	16.84
Beta tocopherol	0.012000	0.019000	0.014800	0.002242	15.14
Alpha tocopherol	0.10100	0.15800	0.12720	0.02034	15.99
Nut length	22.06	42.13	34.70	6.37	18.33
Nut width	14.180	26.310	21.543	3.525	36.16
Nut thickness	10.810	20.230	14.413	2.436	16.90
Nut Weight	1.000	5.290	3.421	1.630	47.64
Kernel length	16.79	31.98	25.72	4.49	17.45

In respect to Table 1, it can be said that, there are no significant difference between cultivar effect on amount of Methyl palmitate and kernel width but in others (oil, Methyl stearate, Methyl oleate, Methyl linnoleate, Methyl arachidat, α and β tocopherol and physical nut characteristics including nut length, nut width, nut thickness, nut weight, kernel length, kernel width, kernel thickness and kernel Weight) there are significant difference. Thus, the most amount of these for nut length, nut width, nut thickness , nut weight, kernel length, kernel width, kernel thickness and kernel Weight are respectively, 39.70mm, 24.94 cm, 18.15 mm, 5.19g, 30.17mm, 14.81mm and 1.22g in Shokoofe and the least one in Mamaee are respectively 24.13mm, 15.80 cm, 11.49 mm, 1.03g, 17.87mm, 9.78mm and 0.60g (Table 3).Also, the most amount of kernel thickness in Mamaee(11.29mm) and the least one in Fragiulio (6.17mm) was observed(Table 2). Similar reports are showed that effect of kernel on oil content, major fatty acid composition and tocopherols in seeds of almond cultivars was various due to variety type and climate conditions in way that in some of years, Linoleic acid was increased, while, Oleic acid was decreased in samples [6].

In the other hand, obtained results of oil in 5 cultivars in Table 1 have showed significant difference, while Methyl palmitate doesn't have significant difference at all. The highest amount of oil in Ferragnes (59.16%) and the lowest in Shokoofe (48.47%) are indicated corresponded to above Table 2, the highest amount of Methyl palmitate is in Shokoofe (6.52%) and the lowest in Fragiulio (6.3%).but base on statically their between don't have significant difference.

Furthermore, the highest amount of Methyl palmitoleate is Mamaee(0.7100%) and the lowest one is in Ferragnes (0.48). In the other hand, the highest amount of Methyl stearate is for Ferragnes (1.70%) and the lowest one for Fragiulio(1.20%) and amount of Methyl oblate in Mamaee is the least (69.8%) (Table 2) and in Ferragnes

is the most (76.1%), but amount of Methyl linnoleate in Mamaee is the most (19.39%) and in Shokoofe is the least (13.14%). Furthermore, the most amount of Methyl arachidat is for Mamaee(0.08%) and the least one is for Saba(0.056).

Results in Table 2 indicated that β and α tocopherols were different levels, in way that Mamaee had the most amount β tocopherol (0.0167 mlg/g oil) in harvest, and Fragiulio had the least one(0.130). Finally, the most α-tocopherol in Mamaee (0.153mlg/g oil) and the least it in Fragiulio (0.1500mlg/g oil) were observed. Results of this experiment the same with George et al (2002) and Salvo et al (1997)[24] reports that they indicated oil content affected by different factors specially genotype in almond and other oily seed crops. In way that, in 64 genotypes of cabbage, oil content was reported between 39.9% to 44.6% (Ahuja et al., 1989) and in 36 genotype of blackcurrant between 11% to 19% [22]. Also obtained results of this study are in line to results which obtained by other researchers about fatty acids, such as Abdallah et al. (1998)[1] and Martin carratula et al. (1998)[17] on Oleic, Linnoleic, Palmetic, Palmitoleic, and Stearic acids by more than 95% of total fat on the other hand [26] et al. (1988) reported that pons almond includes 6.5% of Palmitic acid, 0.5% Palmitoleic acid, 1.5% Stearic acid, 62.5% Oleic acid and 29% Linoleic acid. Shi et al. (1999) by fatty acids analising on almond oil concluded that Oleic acid (68%) is on important fatty acid and then Linoleic acid (25%), Palmitic acid (4.7%) and afew amount of (2.3%) Palmitoleic, stearic and archidic acid. Askin et al (2007)[6] proved that Oleic acid is important fatty acid. Because in a research they found that 15.78-5.46% Palmitic, 2.52-0.36% Palmitoleic, 3.83-0.8% Stearic, 81.20-50.41% Oleic and 37.13-6.21% Linoleic acid. While, Oleic acid in samples are 72.5% (non-paryle) and (79.9%) (cristomorto) and Linnoleic acid is 13.52% (cristomorto) and (19.77%) (non-paryle). Nour bakhshiyan and Mardani (2011) reported that main fatty acids in almond are: Oleic (18:1), Linoleic (18:2), Palmitic (16:1), Stearic (18:0) and Palmitoleic (16:1). Mehran And and Filsoof (1974) [18] observed that Oleic (67.6-80/8%) and Linoleic acid (11.9-24/4%) based on different condition and cultivars are different, which was seen in our experiment. Su et al. (2001) and Zacheo et al (2000)[8] indicated that total concentration of tocopherol at storage is decreased for antioxidants activity in kernels that corresponded with our results. Kodad et al (2006)[14] indicated that in almond, concentration of α-tocopherol is 187 to 490 mg /kg of oil and them are for δ, γ for its confidence, similar founding's by Rape seed and by Goffman and Becker (2001)[11] were obtained our results are also same.

In respect to Table 3, it was found that the highest and the lowest standard deviation are related to the amount of oil (47.64%) and tocopherol-beta (0.0022 mg/g oil). On the other hand, diversity index is the most important among the indexes, which is important in helping to breeder for select in breeding programs. Hence the highest index of diversity (47.64%) and lowest index variation (3.45%) in the order corresponding to the weight of the fruit and methyl arashidat was obtained. These results of the experiment presented have shown that some almond cultivars in same growth conditions were found with higher Oil content, major fatty acids composition, α tocopherol, β tocopherol in the company of suitable nut characteristics that could be used as index in almond breeding program to improvement almond quality [Socias i Company et al., 2008; Socias i Company et al.,2010]. Also, the fatty acid composition of kernel oils not only gives good information about the further use of the kernels or the oil but also is decisive for the nutritional or technical application [11].

CONCLUSION

At present study, oil and 7 fatty acids, α tocopherol, β tocopherol and physical nut characteristics including nut length, nut width, nut thickness , nut weight, kernel length, kernel width, kernel thickness and kernel Weight in 5 cultivars of almond were different; depend on type of variety. Totally, it can be said that all cultivars of almond have many oil but for 7 fatty acids, it was concluded that 3 fatty acids means Methyl oleate, Methyl linnoleate and Methyl palpitate were more. According to the results, some cultivars in same contention were found with higher oil contents, high ratios of oleic/linoleum acids, alpha tocophyrol, beta tocophyrol content and different physical nut characteristics than others.

Therefore, obtainable to genotypes and cultivars with high fat content can be used in almond breeding program to obtain new cultivars with high oil content, satisfying the industrial and consuming sectors.

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