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Distribution of Fatty Acids in A Seedling Almond Population and Their Mutual Relationships

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This paper deals with determining kernel fatty acid contents based on oil distribution in a seedling almond population consist of 90 seedling trees from Turkey and mutual relationships among fatty acids. Almond population was divided into three groups based on the range of fat contents. Genotypes averagely contained 6.70 % palmitic acid, 0.57 % palmitoleic acid, 1.78 % stearic acid, 72.83 % oleic acid, 18.03 % linoleic acid, 0.15 % linolenic acid and 0.39 % myristic acid. In addition, they had 91.58 % unsaturated fatty acid content, 8.87 % saturated fatty acid content and 10.32 unsaturated/saturated ratio. Findings of this study indicate that contents of oleic and linoleic acids were influenced by the range of oil in the seedling population.

Key Words: Seedling almond population, Relationship, Oil, Fatty acids.

INTRODUCTION

Recently, almonds gain importance because of their nutritional value. The remarkable increases of almond production in the world are related to consumer awareness about its human healthfulness[1]. Playing a major role for human nutrition, diet and health, omega-3 polyunsaturated fatty acids of almond kernels[2-4] are used against important diseases such as heart disease, rheumatoid arthritis, autoimmune disease and cancer[5]. On the other hand, although composition of kernel fatty acids in almonds can be affected by varieties, genotypes, ecologies, technical and cultural practices, some almonds can genotypically contain higher levels of omega-3 polyunsaturated fatty acids. They can be valuable for human nutrition, diet and health. Therefore, seedling almond populations should be investigated in nutritional values. The aim of this paper is to determine kernel fatty acid contents based on oil distribution in almond population consist of 90 seedling trees from Turkey and to report mutual relationships among fatty acids.

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EXPERIMENTAL

Sampling of kernels: The material of this research constituted kernels of 90 almond [*Prunus dulcis* (Miller) D.A. Webb.] genotypes from eastern Turkey. After fruits of almond were harvested, they were removed from their shells and dried in a vacuum oven at 60 °C for 3 d.

Classification of genotypes: In the study, almond population consist of 90 seedling trees from Turkey was divided into three groups based on the range of fat contents.

Oil analysis: Oil contents (ether-extractable) of samples were determined according to standard AOAC[6] procedure.

Analysis of fatty acid composition: After 0.4 g oil were dissolved in 4 mL of isooctane and methylated in 0.2 mL 2 M methanolic KOH for the preparation of the fatty acid methyl esters (FAME). The analysis of FAME was performed on 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&W Scientific, Folsom, CA, USA). Helium was used as a carrier gas at a flow rate of 1.5 mL/min and a split ratio of 1:10. Injector temperature was 250 °C, detector temperature was 260 °C and the oven temperature was programmed at 120 ºC for a hold of 5 min and increased to 240 ºC at a rate of 15 ºC/min and hold at the final temparture for 20 min[7]. Fatty acid methyl esters were identified by comparison of their retention time and equivalent chain length regarding standard FAMEs (Supelco. 47885-U). Fatty acid methyl esters of kernel samples were quantified based on their percentage area[7]. Analyses of all the samples were performed in triplicate.

Statistical analysis: A completely randomized design with three replications was used for statistical analysis. Statistical program Minitab release 10.2 for Windows and Excel package program were used for the analysis of variance (ANOVA). Significant differences were found at $p < 0.05$ and the means were compared using Duncan's Multiple Range Test. On the other hand, correlation and regression analyses were performed to study the relationships among fatty acid contents using Minitab release 10.2 for Windows and Excel package program.

RESULTS AND DISCUSSION

Eleven almond genotypes with over 60 % kernel oil content contained 6.17 % palmitic acid, 0.54 % palmitoleic acid, 1.79 % stearic acid, 75.08 % oleic acid and 16.24 linoleic acid, respectively. Fifty nine almond genotypes having oil content between 50 and 60 % had 6.17 % palmitic acid content, 0.54 % palmitoleic acid content, 1.79 % stearic acid content, 75.08 % oleic acid content and 16.24 linoleic acid content, respectively. Twenty genotypes had lower oil content than 50 % and they contained 7.39 % palmitic acid, 0.59 % palmitoleic acid, 1.88 % stearic acid, 70.57 % oleic acid and 19.54 linoleic acid, respectively. Based on the range of fat contents, significant differences ($p < 0.05$) were found among groups for contents of fat, palmitic acid, oleic acid and linoleic acid (Table-1).

TABLE-1
MEAN VALUES OF FATTY ACIDS BASED ON THE RANGE OF FAT CONTENT IN 90 ALMOND GENOTYPES FROM TURKEY

Fat content (range %)	Number of genotype	Distribution (%)	Mean values of fat and fatty acid contents (%)					
			Fat	Palmitic acid C16:0	Palmitoleic acid C16:1	Stearic acid C18:0	Oleic acid C18:1	Linoleic acid C18:2
> 60	11	12.2	62.6 a*	6.17 b*	0.54^{NS}	1.79^{NS}	75.08 a*	16.24 b*
60-50	59	65.6	54.0 b	6.55 b	0.58	1.67	72.85 ab	18.31 ab
< 50	20	22.2	45.8 c	7.39 a	0.59	1.88	70.57 b	19.54 a

*Significant at 0.05 level, NS = Non-significant.

In addition, 90 almond genotypes in average contained 6.70 % palmitic acid, 0.57 % palmitoleic acid, 1.78 % stearic acid, 72.83 % oleic acid, 18.03 % linoleic acid, 0.15 % linolenic acid and 0.39 % myristic acid. In addition, they had 91.58 % unsaturated fatty acid content, 8.87 % saturated fatty acid content and 10.32 unsaturated/saturated ratio, 1.10 g kernel size and 3.38 mm shell thickness (Tables 2-4).

TABLE-2
FAT AND UNSATURATED FATTY ACIDS IN 90 ALMOND GENOTYPES FROM TURKEY

	Fat content (%)	Oleic acid C18:1	Linoleic acid C18:2	Linolenic acid C18:3	Palmitoleic acid C16:1
Mean	54.10±0.591	72.83±0.612	18.03±0.520	0.15±0.03	0.57±0.03

TABLE-3
SATURATED FATTY ACIDS IN 90 ALMOND GENOTYPES FROM TURKEY

	Palmitic acid C16:0	Stearic acid C18:0	Myristic acid C14:0
Mean	6.70±0.135	1.78±0.05	0.39±0.04

TABLE-4
UNSATURATED AND SATURATED FATTY ACIDS, KERNEL SIZE AND SHELL THICKNESS IN 90 ALMOND GENOTYPES FROM TURKEY

	Unsaturated fatty acids (%)	Saturated fatty acids (%)	Unsaturated/ saturated	Kernel Size (g)	Shell thickness (mm)
Mean	91.58	8.87	10.32	1.10	3.38

It has been reported for almond kernels 5.0-6.4 % palmitic acid, 64.7-76.0 % oleic acid and 16.3-26.9 % linoleic acid contents by Gradziel *et al.*[8] and 2.15-3.13 % stearic acid, 5.94-7.31 % palmitic acid, 17.52-29.89 % linoleic acid and 58.96-69.68 % oleic acid contents by Martins *et al.*[9]. Sathe *et al.*[10] reported that fatty acid composition in almonds was significantly infuenced by cultivar statistically. The mean fatty acid values of seedling population were similar to those of related references.

On the other hand, mutual relationships among fatty acid contents using correlation and regression analyses were computed based on all seedling population. As seen in Table-3, oil content negatively correlated with palmitic acid content (r= -0.35) and positively correlated with oleic acid content (r = 0.22) significantly. Correlation coefficients with palmitoleic acid (r = 0.40), stearic acid (r = 0.46) and linoleic acid (r = 0.26) of palmitic acid were significantly correlated positively, whereas its relationship with oleic acid (Fig. 1) was negative (r = -0.47). While the relationship computed with oleic acid (Fig. 2) of stearic acid was negative (r = -0.48) and its relationship (Fig. 3) with linoleic acid was significantly positive (r= 0.31), Also, oleic acid was negatively correlated (Fig. 4) with linoleic acid (r = - 0.86). Positive relationships have been established in case of palmitic-palmitoleic acids, palmitic-linoleic acids and fat content-oleic acid. On the contrary negative relationships of palmitic-oleic acids, fat content-palmitic acid and oleic-linoleic acids were reported by Kodad and Company[11].

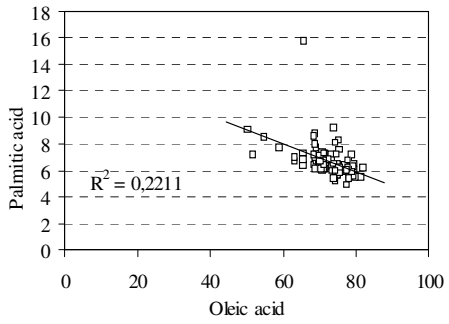

Fig. 1. Relationship of palmitic and oleic acid

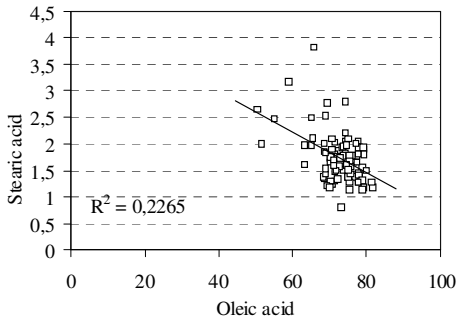

Fig. 2. Relationship of stearic and oleic acid

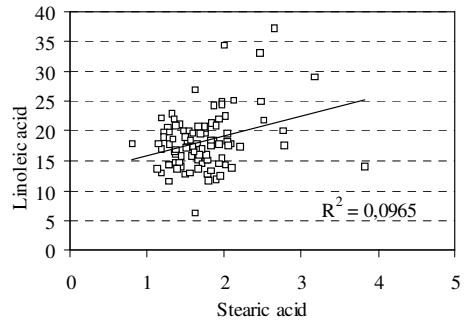

Fig. 2. Relationship of stearic and linoleic acid

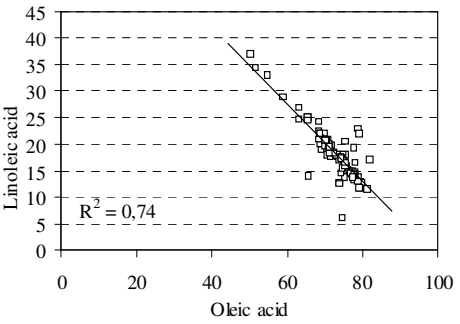

Fig. 4. Relationship of oleic and linoleic acid

A large amount of seedling population contained oil between 50 and 60 %. Related references reported oil contents for almond kernels from 30 to 57 %[9,12,13]. Therefore, it was remarkable that some genotypes in the seedling almond population had higher oil contents than those reported by references.

TABLE-5
MUTUAL RELATIONSHIPS AMONG FATTY ACID CONTENTS IN 90 ALMOND GENOTYPES FROM TURKEY

Correlation coefficients (r)	Palmitic acid	Palmitoleic acid	Stearic acid	Oleic acid	Linoleic acid
Fat content	-0.35**	-0.08NS	- 0.11NS	0.22*	-0.19NS
Palmitic acid		0.40***	0.46***	-0.47***	0.26*
Palmitoleic acid			0.01NS	-0.08NS	-0.05NS
Stearic acid				-0.48***	0.31**
Oleic acid					-0.86***

NS = Non-significant

Based on the range of oil in the population, contents of palmitic acid, palmitoleic acid and stearic acid had not statistical differences. Whereas, statistical differences were computed for oleic acid and linoleic acid. The almond genotypes with kernel oil content over 60 % averagely had the highest level of oleic acid and the lowest level of linoleic acid. Findings indicate that contents of oleic acid and linoleic acid were influenced by the range of oil in the seedling population and changes of fatty acids correlated with one another.

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