

## Effects of Almond Genotype and Growing Location on Oil Percentage and Fatty Acid Composition of its Seeds

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### Abstract

Almond oil is used in many cosmetic products as a snack, in confectionery (marzipan, "turrón", nougat), food products (almond milk, ice cream, chocolate), culinary recipes and also cosmetic base. For surveying the effects of almond genotype and growing location on oil percentage of oil seed content and fatty acid of almond, seeds of 6 almond cultivars: Ferragnes, Tuono, Azar, Sahand, Nonpareil and Ne Plus Ultra were collected from tree growing in Tabriz (Sahand Station) and Kesht Sanat Jovin regions in Iran and analyzed for oil content and fatty acid in 2011. In this experiment, at least 2g almond kernels from each cultivar of almond with 3 replications were examined individually. Oil extraction methyl esters were done in one step and according to the GC/MS, analysis of fatty acid methyl esters tacked place and according to the HPLC, alpha and beta tocopheryl were determined. Our results showed significant variation between cultivars and some degree of different growing location. Oil content varied from 47.36% to 60.54% of the total kernel dry weight in Tuono and Azar respectively. 8 fatty acids of seeds of 6 almond cultivars were determined, with the percentages varying from 0.01% eicosenoic acid to 78.7% linoleic acid. The results of analysis of eight different fatty acid methyl esters according to the GC/MS method showed that Oleic acid, Linoleic acid and Palmitic acid contents were deferent as major fatty acids among cultivars in a way that oleic acid contents of samples range between 72.44% (Tuono) and 79.14% (Azar). linoleic acid values were varied between 12.05% (Tuono) and 18.47% (nonpareil). Palmitic acid contents were obtained between 5.71% (Ferragnes) and 6.97% (Ne plus ultra). According to the results, almond genotype and growing location on oil percentage and fatty acid composition of its seeds were found affect that could be considered in almond agro-breeding program.

**Keywords:** Almond, Cultivar, Fatty acids, Genotype, Oil.

### Introduction

The almond has been used as food for the mankind, the animals and the birds, and due to the high oil content has a good calorie. On the other hand, by having effective materials such as fiber, vitamin, mineral elements, as well as antioxidant properties and etc., it always has been paid attention to. The several studies in recent years has shown that herbal oils especially the oil of almond seeds, not only is used as a food in the diet but it can also be used in making the cosmetic detergent creams, soap and perfumery industries, and preventing the itching of the skin and the acnes (Agunbiade et al. 2006; Salvo et al. 1997). Also in reducing heart disease by conserving the useful cholesterols (HDL) and by reducing the total harmful cholesterol content (Triglyceride and LDL) it has been reported to be effective. Nowadays vast researches in identifying and accessing cultivars with high oil seeds are done (George et al. 2002). The study of almond seeds oil and cultured genotypes done by Kodad and Socias I Company (2008) showed that there are considerable differences among the cultivars and genotypes. Oil content of 5 commercial cultivars of US-grown almonds such as Carmel, Mission, Neplus, Nonpareil, and Peerless was reported from 53.59% to 56.05% (Kodad and Socias I Company 2008). Also recently, On the basis of the report of Sathe et al. (2008), fatty composition of California grown

almonds was significant difference depending on the cultivar, location, and crop year. Oil content of twenty-six almond (*Prunus dulcis* (Miller) D.A. Webb.) genotypes were selected from Elazig province located on eastern Anatolia region of Turkey in 1999 and 2001 by Askin et al. (2007) was reported 25.19-60.77%. The aim of this study was to determine the oil content and fatty acid composition of kernels from different varieties of almond to evaluate the effect of growing location on their oil seed content and fatty acid.

### Materials and methods

Fruits of six cultivars of almond (Ferragnes, Tuono, Azar, Sahand, Nonpareil and Ne Plus Ultra) were collected by hand in August 2011 from 7 old year's trees growing in Tabriz (Sahand Station) and Kesht Sanat Jovin regions in Iran and analyzed for oil content and fatty acid in 2011. Dried fruits were transferred to laboratory in polypropylene bags under cool conditions. Kernels were obtained from hulls by hand processing and stored in glass jars at 6 °C until analysis. In this experiment, at least 2 g almond kernels of each cultivar with 3 replications were done. To do this, first the cut filter paper was put for an hour in the oven; then after 20 minutes it was maintained in the desiccators for the absorption of moisture, and then the dry paper weight was determined with the digital scale.

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The ground almond kernels were poured into the filter paper and then the samples were put in the oven for 90 minutes. After that they were put in the desiccators for 30 minutes and were weighted with the digital scale (paper and sample weight before the Soxhelt device), then they were placed for a day in the Soxhelt device which was based on the use of Trent Solvent system (Foma and Abdola 1985); therefore, the samples were placed in the vicinity of the air so that their ether is vapoured. Finally, they were put in the oven for 1:30 hours, and then in the desiccators for 45 minutes. At the end, they were weighted (the weight of the paper and samples after Soxhelt) and their oil percentage was determined according to the method of Foma and Abdola (1985).

Fatty acid composition for kernel oils was determined using a fatty acid methyl ester method as described by Ozcan et al. (2011). 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 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 0.20\_μm). 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, 1/50\_1/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 (AOAC 1990). Quantitative analyses of the fatty acids were performed using the heptadecanoic acid methyl ester as internal standard. The results are mean values of three replicates.

**Results**

Results of extracted oil content and analysis of fatty acids of almond cultivars in 2011 under effect of growing location have been summarized in Fig 1 to 9.

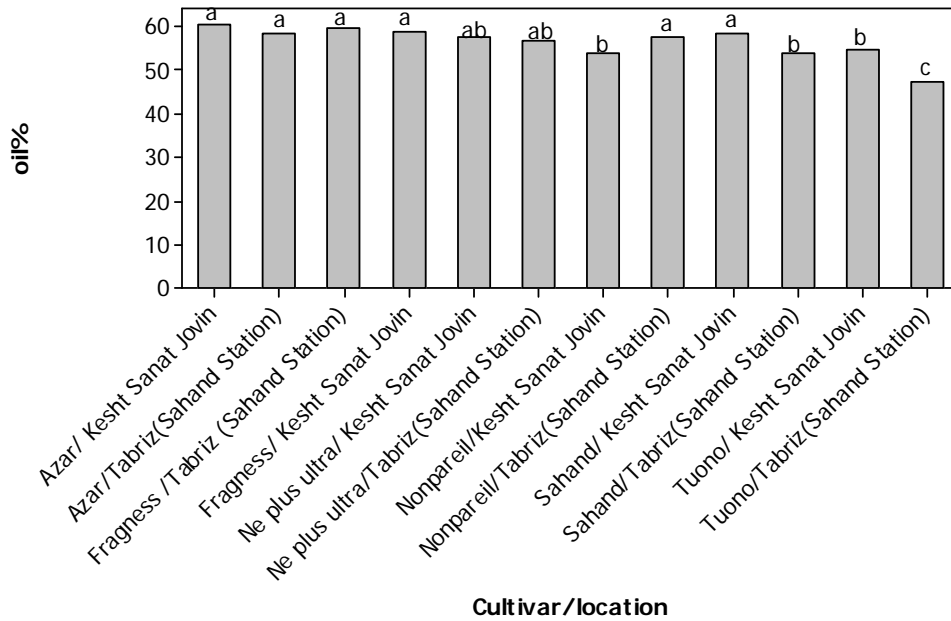


Fig 1. The effect of genotype and location on the average percentage of oil seed content of almond. Mean with the same letter are not significantly different at p=0.05 using Duncan’s multiple range test

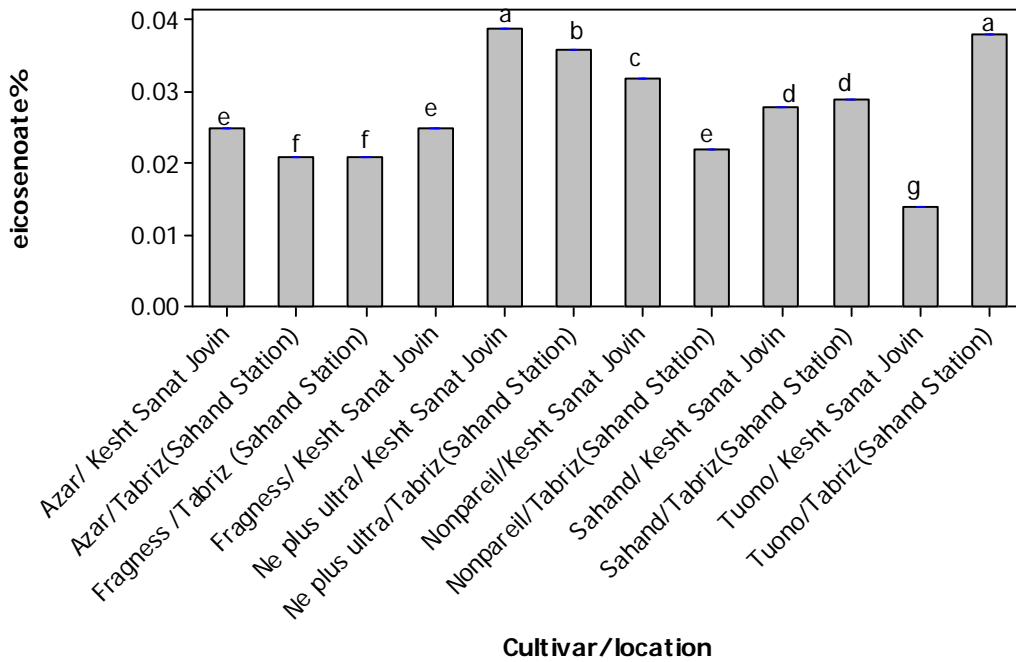


Fig 2. The effect of genotype and location on the average percentage of eicosenoate of almond. Mean with the same letter are not significantly different at  $p=0.05$  using Duncan's multiple range test

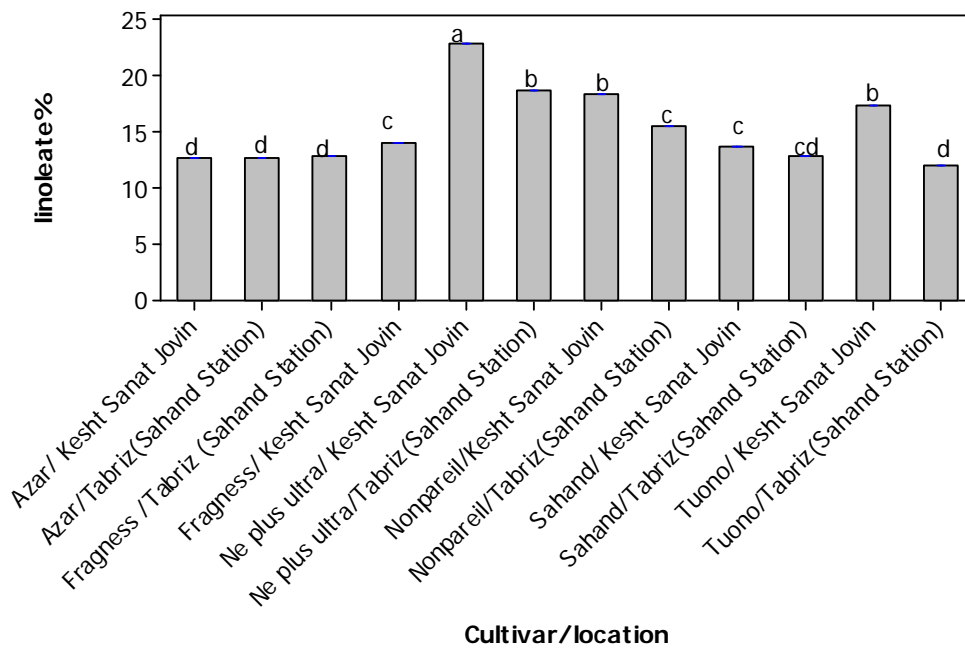


Fig 3. The effect of genotype and location on the average percentage of linoleate of almond. Mean with the same letter are not significantly different at  $p=0.05$  using Duncan's multiple range test

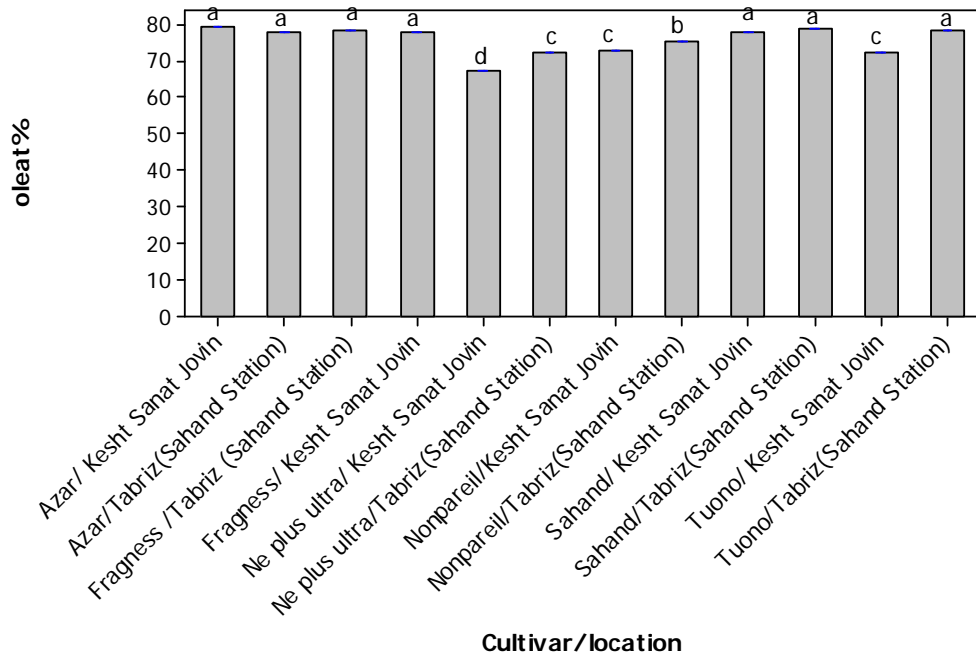


Fig 4. The effect of genotype and location on the average percentage of oleate of almond. Mean with the same letter are not significantly different at  $p=0.05$  using Duncan's multiple range test

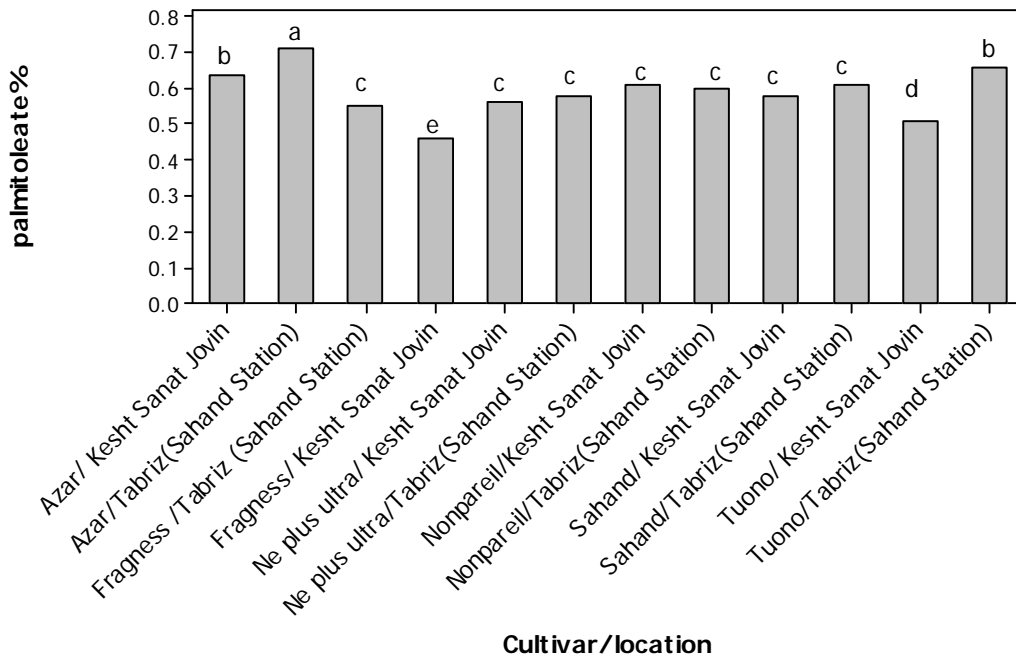


Fig 5. The effect of genotype and location on the average percentage of palmitoleate of almond. Mean with the same letter are not significantly different at  $p=0.05$  using Duncan's multiple range test

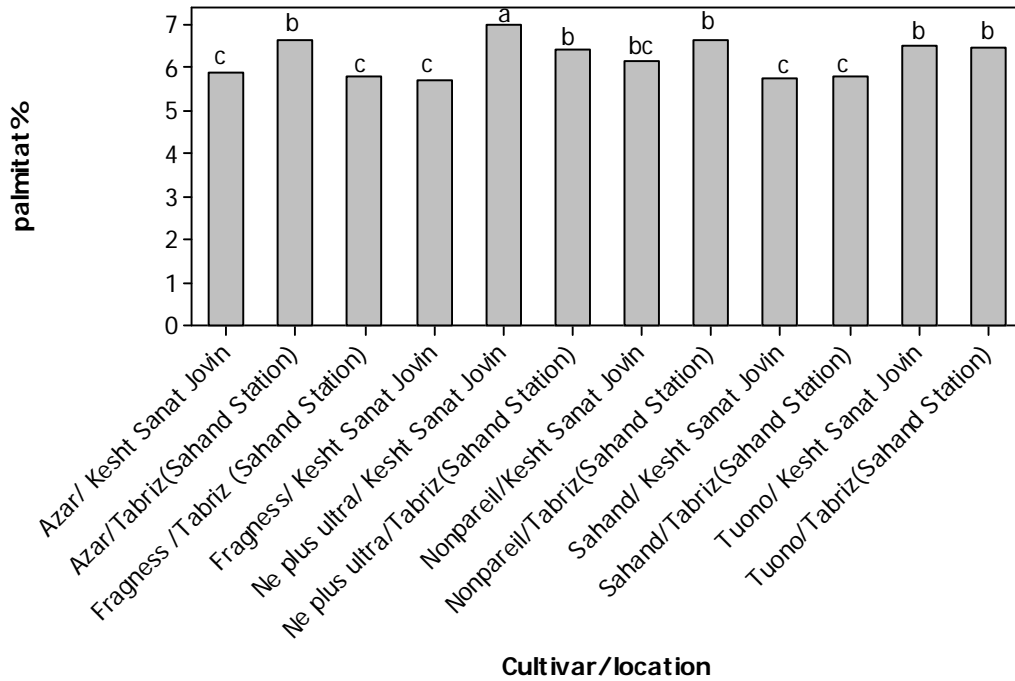


Fig 6. The effect of genotype and location on the average percentage of palmitate of almond. Mean with the same letter are not significantly different at  $p=0.05$  using Duncan's multiple range test

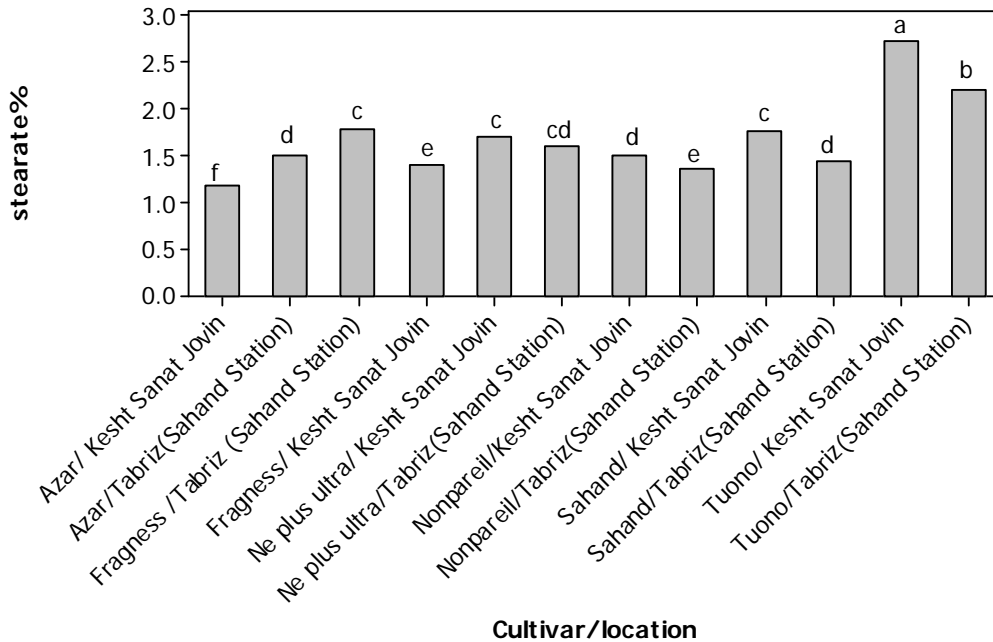


Fig 7. The effect of genotype and location on the average percentage of stearate of almond. Mean with the same letter are not significantly different at  $p=0.05$  using Duncan's multiple range test

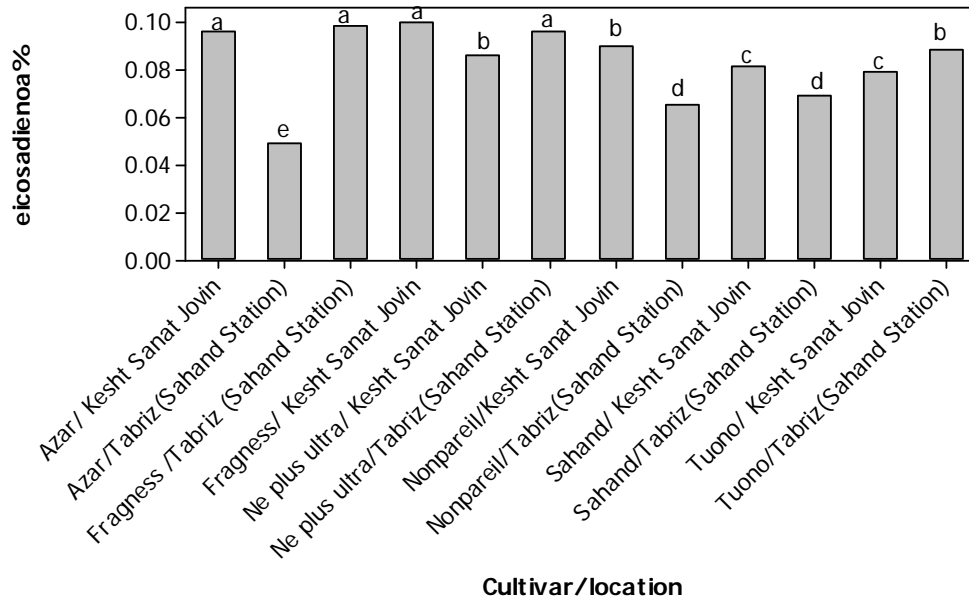


Fig 8. The effect of genotype and location on the average percentage of eicosadienoic acid of almond. Mean with the same letter are not significantly different at  $p=0.05$  using Duncan's multiple range test

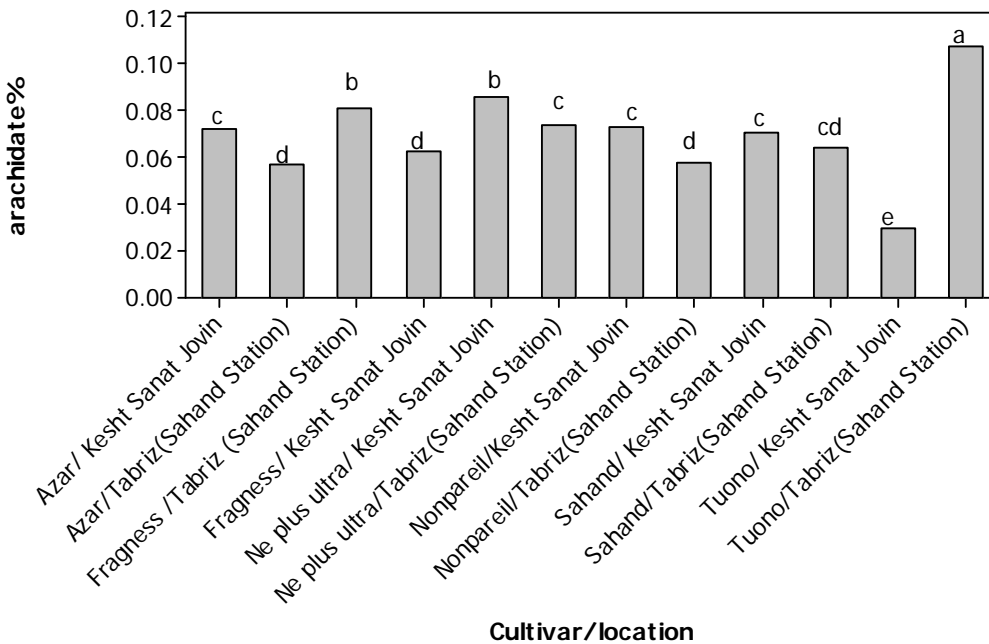


Fig 9. The effect of genotype and location on the average percentage of arachidic acid of almond. Mean with the same letter are not significantly different at  $p=0.05$  using Duncan's multiple range test

**Discussion**

The gained results of the experiment of determining the oil percentage and fatty acids of almond fruits of 6 cultivars in different locations showed that there are a little difference of the oil content and fatty acids among

the cultivars in a way that the oil content ranged from 47.36% to 60.54% of the total kernel dry weight in Tuono and Azar cultivars respectively (Fig 1). These results agree with the reports of the experiments of examining the almond oil done by Özcan et al. (2011)

that has been showed only a relatively small variation of the oil content in the range from 48.8% (Cristomorto) and 55.7% (Ferragnes) on dry weight basis (d.w.%). Also according to reports, oil content in the Iranian cultivars between 30.1% and 51.0%. (Mehran and Filsoof, , 1974), in the Californian cultivars from 45.9% to 61.7% , 36 to 53% (Abdallah et al. 1998) , in Australian cultivars from 35 to 61% (Vezvaei and Jackson , 1996) and in European cultivars from 40 to 68% has been (Souty et al. 1973; Romojaró et al. 1977; Saura Calixto et al. 1981, 1988; Barbera et al. 1994; Schirra et al. 1994; Kafkas et al. 1995; Aslantas et al. 2001; Cordeiro et al. 2001; Kodad and Socias i Company, 2008). Thus, oil content on dry weight basis was found to differences among cultivars. Some studies have found the year effect to be not significant (Saura Calixto et al. 1981; Romojaró et al., 1988a; Kodad and Socias i Company, 2008) whereas others (Barbera et al. 1994; Kafkas et al. 1995; Abdallah et al. 1998) found significant differences, possibly due to the specific climatic conditions of years tested.

In general, in this study, the oil contents of cultivars were established higher in Tabriz region in comparison to the kernels of the same almond varieties in Kesht Sanat Jovin region. The reports of Kodad and Socias I Company (2008) and Sathe et al. (2008) has been showed that oil content of different locals grown almonds had significant variation depending on the cultivar, location, and crop year. The oil content is a relatively stable feature independent on the different variety. This kind of differences is more due to the types of almond genotypes than other factor typically (Socias i Company et al. 2010).

The results of the fatty acids composition in Fig 2 to 8 is shown that Oleic and linoleic acids contents were deferent as major fatty acids among cultivars in a way that oleic acid contents of samples range between 72.44% (Touno) and 79.14% (Azar). linoleic acid values were varied between 12.05% (Touno) and 18.47% (nonpareil). Palmitic acid contents were obtained between 5.71% (Ferragnes) and 6.97% (Ne

plus ultra). The levels of major fatty acids obtained in this study are in accordance with the results of the previous studies by Mehran and Filsoof (1974) that showed the Iranian almond oils lower content of myristic and stearic (0.4–1.4%) acids and higher content of palmitic acid (6.0–8.1%). They are different in their content of oleic (67.6–80.8%) and linoleic (11.9–24.4%) acids. Also, base on report of Soler et al. (1988) in Pons almond variety level of palmitic, palmitoleic, stearic, oleic and linoleic acids was 6.5%, 0.5%, 1.5%, 62.5% and 29.0% respectively. Askin et al. (2007) reported that 5.46–15.78% palmitic, 0.36–2.52% palmitoleic, 0.80–3.83% stearic, 50.41–81.20% oleic and 6.21–37.13% linoleic acids in several almond oils. In conclusion, can be Saied that almond seed contains high fat content and is known as a high energy food (Salvo et al. 1997), and also because of its oily character, it sometimes gives immediate relief in heart burn; the fatty acid composition is a successful factor that lowers LDL cholesterol and preserves HDL cholesterol. Thus, almond oil is a more potent cholesterol reducing agent than olive oil because it contains mom or polyunsaturated fatty acids rather than saturated fatty acids. 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 (Socias i Company, 2008). In this study, the variability was observed for oil content between all cultivars of almond but variability for oil content between same cultivar in different location was diminutive. These results of the experiment presented have shown that some cultivars in different growth conditions were found with higher oil contents, however with lower value of oleic acids (Tuono cultivar) that could be used as index in almond breeding program to improvement almond quality (Socias i Company et al. 2008, 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 (Özcan et al. 2011).

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