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Proximate Compositions and Fatty Acid Profiles of Promising Almond (*Prunus amygdalus* L.) Genotypes Selected from Yesilyurt (Malatya) Region

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ABSTRACT: This research was carried out to determine various proximate chemical properties and fatty acid profiles of ten promising almond genotypes selected from the Yeşilyurt district of Malatya province. The ratio of crude oil was minimum in YSY-14 (53.10%) and maximum in YSY-22 (66.42%) genotypes, however, the ratio of protein was minimum in YSY-54 (63.1%) and maximum in YSY-68 (26.79%) genotypes. In the study oleic acid, linoleic acid, palmitic acid, palmitoleic acid, and stearic acid, the content of the selected genotypes were ranged from 71.09% (YSY-15) to 79.49% (YSY-61), 11.04% (YSY-61) to 18.75% (YSY-59), 5.47% (YSY-68) to 6.65% (YSY-62), 0.56% (YSY-22) to 0.72% (YSY-14), 1.07% (YSY-50) to 1.64% (YSY-54), respectively. Besides, they had 86.85% - 91.39% unsaturated fatty acid content, 6.65% - 7.95% saturated fatty acid content, and 11.05-13.26% unsaturated fatty acid/saturated fatty acid ratio.

Keywords: Almond, *Prunus amygdalus*, oil content, fatty acids.

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INTRODUCTION

Turkey, as in many fruit species almond is also among their homeland (Özbek, 1971). Almond cultivation can be done in almost every region of our country, except at very high altitudes (Gülsoy ve Şimşek, 2020). Turkey ranks fifth after the United States, Spain, Iran, and Morocco in almond production (FAO, 2020). Almond contains valuable nutrients that have positive effects on human health in the composition of its and therefore it is one of the fruit species whose importance is increasing today (Gülsoy ve Balta, 2014). Almond, which high nutritional value, is rich in fat, protein, monounsaturated fatty acids (MUFA's), polyunsaturated fatty acids (PUFAs), minerals, and vitamins. Almonds, which contain high amounts of monounsaturated fat are among the foods similar to olive oil, recommended to reduce bad cholesterol and protect against heart disease (Davis and Iwahashi, 2001). In recent years, many studies are showing that almond has positive effects in preventing or treating many diseases such as cardiovascular, diabetes, obesity, inflammation, and oxidative stress, lung, and colon cancer Lovejoy et al., 2002; Wien et al., 2010; Dhillon et al., 2016; Topçuoğlu ve Ersan, 2020). Studies have shown that almond reduces the risk of heart attack by 50%, strengthens bones, prevents the development of tumor cells, protects against prostate cancer, reduces kidney and liver pain, and is good for joints, rheumatism, and skin diseases (McManus et al., 2001; Jenkins et al., 2002; Chen et al., 2005; Jia et al., 2006; Mandalari et al., 2010).

The chemical composition and oil profile of almond kernel fruit are influenced by genotype variations and ambient circumstances (Abdallah et al, 1998). Even though numerous researches have been conducted upon the fatty acid composition of almond fruit, (Yıldırım et al, 2008; Celik et al., 2010; Özcan et al., 2011; Beyhan et al, 2011; Balta, 2013; Karatay et al., 2014) there are few studies investigating the fatty acid compositions on the ecological condition it was cultivated.

In this study, it was aimed to determine some proximate properties and fatty acid profiles of 10 almond genotypes selected as promising as a result of selection study carried out in Yesilyurt district center and villages in Malatya province.

MATERIALS AND METHOD

Plant Materials and Sampling

The material of the study was composed of the fruits of 10 almond genotypes (YSY-14, YSY-15, YSY-22, YSY-47, YSY-50, YSY-54, YSY-59, YSY-61, YSY-62, YSY-68) selected from Yeşilyurt district of Malatya province between 2016 and 2018. The study area is located at an altitude range of 980 to 1015 meters. In the research area, average annual temperature and precipitation are 13-14°C, and 470 mm, respectively (Anonymous, 2021). All almond genotypes were harvested between 19 and 30 September. After harvest, fruit samples were as immediate as possible dried and stored at room temperature as shelled. In this study, the proximate chemical and fatty acid compositions of kernels of promising almond genotypes were analyzed in 2018.

Chemical Analysis

Crude Protein (%)

The total raw protein ingredient was reckoned by multiplying the percentage nitrogen (N%) by a constant factor of 6.26 (AOAC, 1990).

$$Crude\ protein\% = N\% \times 6.26 \quad (1)$$

Total oil (%)

The total oil contents of almond kernels were obtained by introducing 60-80 ml of hexane to 5 g of ground dry almond kernels, extracting the mix in Soxhlet extraction device for 6-8 hours, and finally scaling their weight before and after the extraction (James, 1995).

Moisture (%)

After weighing 3 g of sample in nickel dry matter containers (tared), it was obtained as oven dried at 105°C when its weight was constant. The results were calculated as percent moisture (Cemeroglu, 1992)

Ash (%)

1g of kernel almond was weighed into porcelain crucible and kept at 105 °C for 24 hours. Later, the samples were removed into the muffle oven at 560 °C and held for about ten hours. At the end of this process it returned to white ash. The crucible and its content were cooled to about 100 °C in the air then waited for room temperature in a desiccator and weighed. Ash content was reckoned as % (Gönül et al., 1988).

Fatty Acids Analysis (%)

In gas chromatography (GC) analysis, in order to prepare fatty acid methyl esters (FAME), 0.1 g of fat exemplary was melted in 2 ml of heptane, and 0.2 ml of 2M methanolic KOH solution was introduced to it. The solution was shaken strongly for 30 seconds and was let idle until the supernatant liquid became clear. Then, the heptane solution was injected into GC. FAME analysis was performed on a 60 m capillary column (ID = 0.25 mm) covered with an Agilent 6890 series gas chromatography, adorned with a flame ionization detector, and 0.25 um and 50% cyanopropyl methylpolysiloxane (J & W Scientific, Folsom, CA, the US). Helium gas was used as carrier gas with a flow rate of 30 ml/m and 1:50 ratio, and the temperature degrees of the injector and the detector were arranged to be 260 °C and 280 °C respectively. The oven temperature was scheduled in accordance with a retention time of 1 minute in 120 °C, and the temperature was raised to 170 °C with 6.5 °C/m rate, and finally to 215 °C with 2.15 °C/m rate. Fatty acid methyl esters were defined by using standard FAMEs (Supelco – 47885 - U) and calculated in accordance with their percentage values (Dieffenbacher and Pocklington, 1992; Batun et al., 2017).

Statistical Assessment

The statistical package program SPSS 22.0 (SPSS Inc., College Station, TX) was used to determined significance of difference among almond genotypes with Duncan multiple comparison test. The P values of less than 0.05 were considered to be statistically significant.

RESULTS AND DISCUSSION

Proximate composition (total oil, crude protein, ash, moisture, saturated and unsaturated fatty acid compositions) of selected almond genotypes in Yesilyurt were given in Table 1. There were statistically significant differences among genotypes with regard to proximate compositions at 0.05 statistical levels. Variations in the contents of total oil, crude protein, ash, and moisture among the different genotypes were in the range of 53.10% to 66.42%, 15.78% to 26.79%, 4.00% to 7.00 %, and 3.28% to 4.36% respectively.

Simsek and Demirkiran (2010) found that crude oil 43.50% - 54.81%, crude protein 21.18% - 32.90%, moisture 3.08% - 4.43% and total ash 2.54% - 4.42% in 10 almond genotypes selected from the Diyarbakır region. Balta (2013), reported 52.8% - 54.0% fat content and 1.28% - 1.45% kernel moisture for the bitter and sweet kernelled almond genotypes from Tunceli. In other study conducted in Hilvan (Şanlıurfa) region, the protein contents were determined as 20.41% to 25.82%, oil ratio 48.69% to 55.80%, moisture ratio 2.52% - 3.75%, ash 3.29% - 4.66% (Simsek et al., 2018). When the results obtained in this study were compared with previous studies, the total fat percentage was found to be higher and the protein percentage lower than the previous studies. The crude oil and protein contents of almond genotypes and varieties can vary depending on genetic differences, ecological conditions, cultural and maintenance.

The selected genotypes had 86.85% - 91.36% UFA (unsaturated fatty acids), 6.65% - 7.95% SFA (saturated fatty acids), and 11.05 - 13.26 UFA/SFA ratio, respectively (Table 1). Most studies support that uptake of unsaturated fatty acids (UFA) may reduce the risk of cardiovascular diseases and lower cholesterol levels (Jia et al., 2006; Mandalari et al., 2010; Yang et al., 2019). Therefore, it is important for them to consume a healthy diet. In previous studies, in twenty-five genotypes selected from Tunceli and Balikesir it was found that the average fatty acid profiles UFA, SFA and UFA/SFU were in the range of 87.85% - 91.97%, 7.99% - 11.59% and 7.60% - 11.50% respectively (Balta, 2013). Simsek et al., (2018) reported that fatty acid contents of ten almond genotypes ranged from 90.27% to 92.09% UFA, from 7.62% to 9.73% SFA and from 9.29% to 12.12% UFA/SFA, respectively. SFA and UFA compositions and UFA/SFA were found similar to previous studies.

Table 1. Values of crude oil, protein, ash, moisture, saturated and unsaturated fatty acids of selected genotypes.

	Genotype									
	YSY-14	**YSY-15**	**YSY-22**	**YSY-47**	**YSY-50**	**YSY-54**	**YSY-59**	**YSY-61**	**YSY-62**	**YSY-68**
Crude oil (%)	53.10g	54.40f	66.42a	58.65d	57.03e	61.02c	56.80e	62.13b	53.10g	60.59c
Protein (%)	17.12fg	16.24h	21.04d	22.19c	24.37b	15.78h	17.78f	19.32e	16.36gh	26.79a
Ash (%)	5.20bc	4.50fg	4.90c-e	4.00h	4.70d-f	7.00a	5.50b	5.00cd	4.20gh	4.60ef
Moisture (%)	3.28d	3.83bc	3.59cd	4.08ab	4.08ab	4.26a	4.05ab	4.17ab	4.36a	4.24ab
UFA (%)	86.85f	88.78d	87.91e	90.62b	91.39a	90.53b	91.04ab	91.21ab	88.20de	89.77c
SFA (%)	7.65a	7.68a	7.95a	7.86a	7.07bc	7.79a	7.51ab	7.03bc	6.65c	7.04bc
UFA/SFA	11.35c	11.56bc	11.05c	11.53bc	12.93a	11.62bc	12.12b	12.98a	13.26a	12.75a

UFA = Unsaturated fatty acids, SFA = Saturated fatty acids, YSY=Yesilyurt.
Significantly different means (at the 5% level), determined using SPSS 22.0 to run Duncan test, are shown with different letters

The fatty acid profiles of almond genotypes are presented in Table 2. Statistical differences between genotypes were significant ($P < 0.05$). The most abundant fatty acid in almond samples was oleic acid, followed by linolenic, and palmitic acids. The minimum amount of oleic acid, an important unsaturated fatty acid, was found in genotype YSY-15 at 71.09% and the maximum amount in genotype YSY-61 at 79.49%. After oleic acid, was determined 11.04% - 18.75% linolenic acid, 5.47% - 6.65% palmitic acid, 1.07% - 1.64% stearic acid, 0.08% - 1.14% heptadecanoic acid, 0.56% - 0.72% palmitoleic acid, 0.07% - 0.11%, and linolenic acid in the kernels of almond genotypes. Arachidic acid was found only in two genotypes (YSY-15 and YSY-59). Eicosenoic acid was found in genotype YSY-15 at 0.08% rate and in genotype YSY-22 at 0.09%, while decosahegzanoic acid (DHA) was found in genotype YSY-14 at 0.17% and in genotype YSY-22 at 0.24%. When compared to other genotypes, the YSY-14 contained higher amounts of heptadecanoic acid and the YSY-22 higher amounts of DHA (decosahegzanoic acid).

In previous studies, Çelik and Balta (2011), recorded that the almond genotypes from Western and Eastern contained, 6.29% - 6.48% of palmitic acid, 0.41% - 0.64% of palmitoleic acid, 1.60% - 1.76%

of stearic acid, 72.02% - 76.41% of oleic acid, and 14.71% - 18.92% of linoleic acid. Özcan et al. (2011), reported contents of oleic acid from 72.51% to 79.97%, linoleic acid from 13.52% to 19.77%, palmitic acid from 5.87% to 6.73%, palmitoleic acid from 0.18% to 0.82% for five almond cultivars (Ferragnes,Tuono, Guara, Cristomorto and Nonpareil). In this study, some genotypes were found to have higher values in terms of major fatty acids than commercial varieties. Colic et al. (2017), found that the contents of the main fatty acids of almond genotypes were 63.14% - 77.37% oleic, 15.57% - 28.69% linoleic, 4.68% - 6.48% palmitic, and 1.45% - 2.56% stearic acid. Özcan et al. (2020) declared that almond genotypes and varieties had 62.43% (T7) - 76.34% (T4) of oleic acid, 13.97% (T4) - 29.55% (T3) of linoleic acid, and 4.97% (T2) - 7.51% (T3) of palmitic acid. These results were in accordance with previous results of Özcan et al. (2011), Çelik and Balta (2011), and Colic et al. (2017). In this study, some of genotypes (YSY-61, YSY-50) studied had higher amounts of oleic acid, especially (except of Özcan et al., 2011) compared to previous literature.

Table 2. Fatty acid composition of promising almond genotypes

Fatty acid	Genotype									
	YSY-14	**YSY-15**	**YSY-22**	**YSY-47**	**YSY-50**	**YSY-54**	**YSY-59**	**YSY-61**	**YSY-62**	**YSY-68**
Palmitic acid (C16.0)	5.79bc	6.21ab	5.96bc	6.16ab	5.89bc	6.05a-c	6.14ab	5.51c	6.65a	5.47c
Palmitoleic acid (C16:1)	0.72a	0.68ab	0.56c	0.68ab	0.62a-c	0.63a-c	0.58a-c	0.57bc	-	0.62a-c
Heptadecanoic acid (C17:1)	1.14a	0.10b	0.10b	0.10b	0.11b	0.10b	0.10b	0.08b	0.10b	0.23b
Stearic acid (C18.0)	-	1.28bc	1.33bc	1.35bc	1.07d	1.64a	1.27c	1.44b	-	1.34bc
Oleic acid (C18:1n9c)	71.36d	71.09d	74.22bc	74.87b	78.85a	74.89b	71.53d	79.49a	73.58c	74.43bc
Elaidic acid (C18:1n9t)	-	1.45ab	1.44ab	1.43ab	1.54a	1.41ab	1.35ab	1.29b	-	-
Linoleic acid (C18:2n6c)	15.49c	16.85b	13.04e	15.00cd	11.82f	15.01d	18.75a	11.04g	14.62d	14.63d
Linoelaidic acid (C18:2n6t)	1.68a	-	-	-	-	0.27b	-	-	-	-
Linolenic acid (C18.3n3)	-	0.07ab	0.09ab	0.07ab	0.10a	-	0.08ab	0.11a	-	0.09ab
Arachidic acid (C20:0)	-	0.08a	-	-	-	-	0.11a	-	-	-
Eicosenoic acid (C20:1)	-	0.09a	0.08a	-	-	-	-	-	-	-
DHA (C22:6n3)	0.17b	-	0.24a	-	-	-	-	-	-	-

Significantly different means (at the 5% level), determined using SPSS 22.0 to run Duncan test, are shown with different letters

CONCLUSION

Almonds are a good source of nutrients that are important for human health, including vitamin E, dietary fibers, proteins and unsaturated fatty acids. According to the results, the proximate compositions, and fatty acids composition of the evaluated promising almond genotypes were found different. In study, the oleic, palmitic, linoleic, and heptadecanoic acids were detected in all almond genotypes with different amounts, while palmitoleic, stearic, linolenic, arachidic, elaidic, eicosenoic and decosahegzanoic (DHA) acids were not determined in some genotypes. These results suggest that chemical compositions such as fatty acids composition of almond kernels depend on the genotype, ecological conditions, and soil structure. The findings of this study highlight the potential of all of almond genotypes, as a valuable source of nutrients such as proximate compositions and fatty acids. Also, it is thought that the findings from this study made several contributions to the current literature.

Conflict of Interest

I declare that there is no conflict of interest during the planning, execution and writing of the article.

Author's Contributions

I hereby declare that the planning, execution and writing of the article was done by me as the sole author of the article.

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