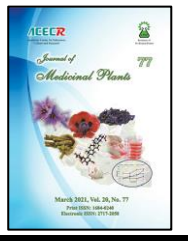
J. Med. Plants 2021; 20(77): 26-36

Institute of Medicinal Plants

Journal of Medicinal Plants

Journal homepage: www.jmp.ir



Research Article

Fatty acids composition of seed oils obtained from eight Iranian pomegranate cultivars

Nafiseh Momeni, Hossein Ali Asadi-Gharneh*

Department of Horticulture, Faculty of Agriculture, Isfahan (Khorasgan) Branch, Islamic Azad University, Isfahan, Iran

ARTICLE INFO

Keywords:
Essential fatty acids
Fatty acid profile
Linolenic acid
Oil content
Unsaturated fatty acids

ABSTRACT

Background: The pomegranate (*Punica granatum* L.) is one of the oldest edible fruits that belongs to the Punicaceae family and different parts of it have been used as medicinal plant. The pomegranate seeds are the sources of lipid, sugars, protein and essential minerals. **Objective:** This study was planned to investigate the composition of fatty acids in seed oil of eight Iranian pomegranate cultivars. **Methods:** Mature ripe fruits of eight pomegranate cultivars were harvested from a commercial pomegranate orchard. Arils were dried via an air oven and oil extraction process was performed using Soxhlet apparatus with petroleum ether as solvent. Finally, identification of fatty acids in pomegranate seed oil was done by gas chromatography (GC). **Results:** A considerable variation was observed in the composition of fatty acids and oil content of pomegranate cultivars. The total oil content of the Iranian pomegranate cultivars was ranged from 10.81 g/100 g DW to 15.03 g/100 g DW palmitic acid (C16:0), stearic acid (C18:0), oleic acid (C18:1), linoleic acid (C18:2) and linolenic acid (C18:3) were major fatty acids in the Iranian pomegranate cultivars. Linolenic acid being considered and identified as the main fatty acid, ranged from 71.35 % for Poost-Ghermez to 74.58 % for Gar cultivars ($P < 0.05$). In saturated fatty acids, palmitic acid (C16:0) with a mean of 0.414 (g/100 g DW) and in unsaturated fatty acids, linolenic acid (C18:3) with a mean of 7.3 (g/100 g DW) were the dominant fatty acids found in studied pomegranates. Also, our results showed that Sorahi cultivar had the highest oil content (15.03 %), C18:1 (8.92 %) and C20:1 (1.12 %) among selected pomegranate cultivars. In pomegranate seed oil, 7.84 % of the fatty acid was saturated and 91.08 % was unsaturated. In addition, the ratio of polyunsaturated fatty acids to saturated ones were found 9.83 to 11.54. **Conclusion:** Eight cultivars of the Iranian pomegranate seed oils in this study contained very high levels of unsaturated fatty acids especially in linolenic acid. The quality obtained due to fatty acid composition can in turn enhance the general condition of the heath.

Abbreviations: SFA, Saturated Fatty Acids; UFA, Unsaturated Fatty Acids; MUFA, Mono Unsaturated Fatty Acids; PUFA, Poly Unsaturated Fatty Acids

* Corresponding author: h.asadi@khuisf.ac.ir

doi: 10.29252/jmp.20.77.26
Received 13 January 2020; Received in revised form 8 November 2020; Accepted 9 November 2020

1. Introduction

The pomegranate (*Punica granatum* L.) is one of the oldest known edible fruits that belongs to the Punicaceae family [1, 2]. It is said that the origin of this fruit Iran and different parts of it (fruit, juice, leaves and bark) have been used in the Iranian herbal medicine [3]. Pomegranate has been grown in Iran since the ancient time. Given that, a diverse germplasm has evolved in the area over the past centuries [4]. The cultivation of the pomegranate is mainly confined to semi-and mild-temperature to subtropical climates and adapted to regions with hot summer and cold winters such as Mediterranean countries [5]. The edible parts of pomegranate fruits are mainly consumed fresh; however, it has also been used in the preparation of fresh juices, canned beverages, jelly, jams, etc. [6]. According to the reports, arils, juicer part of fruit, contain 50 to 70 % of its mass and the seeds represent from 5 to 15 % of the pomegranate mass [7]. The seeds of pomegranate, inner woody part, depending on its cultivar vary between 40 to 100 g/kg [8], but in many pomegranate processing industries the seeds remain as waste product [9], whereas they are the sources of lipid, polyunsaturated fatty acids, sugars, protein and other bioactive compounds [10, 11]. The lipid of seeds varies between 140-270 g/kg dry matter, so they are rich in lipid [12].

Because of the antioxidant activity of some of the pomegranate seed oils, particularly their important role in the prevention of lipid oxidation processes, the studies on the lipid compositions of pomegranate in Iran, Turkey, Spain and China have been considered in horticultural and medical science [13]. Essential fatty acids including saturated and unsaturated fatty acids range based on pomegranate varieties. In pomegranate seed oil, 83.6 % of the fatty acids were saturated and 16.3 % were unsaturated [10]. In another study in Spain, it was shown that 30-33.8 % of the fatty acids were saturated and 66.2-69.0 % of them were unsaturated [14].

Unsaturated fatty acids like oleic acid, linoleic acid, linolenic acid and eicosenoic acid are the components of the pomegranate seed. The linoleic acid and α-linolenic acid (ALA, 18:3n-3) are known as a protector of cardiovascular diseases [15, 16]. Linoleic acid is one of the most important fatty acids that regulates the low-density lipoprotein (LDL) and enhances its clearance [15]. On the other hand, one of the rare conjugate linolenic acid isomer and an ideal highly unsaturated fatty acid is punicic acid. The amount of rare trans-18-carbon fatty acid (punicic acid) ranges from 45 to 70 percent [17, 18].

The dominant unsaturated fatty acid compositions of 15 commercial cultivars grown in Turkey vary between 13.95 to 24.13 % and punicic acid varies between 70.42 to 76.17 % [19]. Punicic acid may inhibit invasion of human prostate cancer cells [20], may prevent cancer and arthrosclerosis [21] and its activities against metabolic syndrome and inflammation have been confirmed by various in vivo experiments [17, 22].

The objective of this study was to investigate the lipid content and fatty acid compositions of oil seeds of eight Iranian pomegranate cultivars.

2. Materials and Methods

2.1. Fruit sample collection

Fully matured fruits of eight pomegranate cultivars namely; "Golabi", "Yazdani", "Sorahi", "Poost-Ghermez", "Mirzaei", "Lop Sorkhi", "Gar" and "Ali-Akbari" were harvested (in September and November 2015) from a commercial pomegranate orchard in Najaf-Abad city in central of Iran situated at the 51º 18' E, 32º 36' N and 1655 m above the sea level. The

[DOR: 20.1001.1.2717204.2021.20.77.2.3]
[DOI: 10.52547/jmp.20.77.26]

average annual rainfall in the studied region was 157.38 mm and the absolute maximum, minimum and the average annual temperature were 35.6 ºC, -5.1 ºC and 18.15 ºC, respectively. The texture of soil was sandy loam with pH = 7.52 and EC = 8.08 (dS/m). The trees were planted 5 and 4 m between and along the rows, respectively.

Fruits of eight cultivars were harvested from 9 year-old trees. For each cultivar, three trees were selected and 15 fruits (5 fruits /tree) were randomly picked from external and internal parts of each pomegranate cultivar. The same routine cultural practice was performed for pomegranate fruit production. Samples of pomegranate fruits were transported to the laboratory of the Islamic Azad University, Isfahan (Khorasgan) Branch for further preparations and analysis.

2.2. Oil extraction and Analysis of Fatty Acid Composition

The selected pomegranates fruits were transported to the laboratory with defects (sunburns, cracks, cuts and bruises in husk) being discarded. Following peeling out the skin, covering seeds were removed. Arils of fruits were hand-separated and 3 samples were taken from each cultivar. All the arils were dried for 2 days in an air oven at 60 ºC to constant weight. Fifteen grams of each cultivar seeds were crushed in a mortar and then the process was further developed by deploying petroleum ether as solvent by Soxhlet extractor device, and lipids extraction procedure was performed for 6 hours [23]. The samples were then dried in desiccators for 1 hour, and finally were weighed to obtain the grams of oil extracted [12].

Fatty acids were converted to their methyl esters by fast cold transmethylation with methanolic potassium hydroxide 2M, according to the method 5509 of the ISO [24, 25]. Briefly, a mass of 4.0 g of oil was weighted and added with 40 ml methanol and 0.5 ml of KOH and the mixture was heated in a bath at 100 ºC and then it was cooled in running water at room temperature. In the next step, the mixture was transferred to a separation funnel along with 20.0 ml heptane and 50.0 ml of deionized water. After agitation and phase separation, the aqueous phase was discarded. After phase separation, the supernatant containing fatty acid methyl esters was collected for gas chromatography analysis.

The compositions of fatty acids were determined by gas chromatography (Agilent 6890) equipped with a flame ionization detector (GC-FID) and an Hp-88 capillary column (100 m, 250-µm i.d., 0.2 µm film thickness). First, the oven temperature was set at 198˚C and was held for 6 minutes. In the next phase, an increasing process including 180 ºC at 20 ºC/ minutes (for 10 minutes) followed by 210˚C at 20 ºC/minutes was done. The temperatures of injector and detector were fixed at 250 and 280 ºC, respectively. Nitrogen with 99.9 % purity was used as carrier. A certified fatty acids methyl ester reference standard mixture (37 fatty acids from C4 to C24) from Supelco, TraceSelec (Bellefonte, PA, USA) was used. Fatty acid methyl esters were identified by comparing the retention time of the sample with a certified fatty acid methyl esters mix and diverse individual fatty acid methyl esters with literature data on pomegranate seed oils. Finally, the contents of fatty acids were expressed as percent [26].

2.3. Chemical and reagents

The solvent and chemical reagents used in the current study had analytical grade and were obtained from Merck Chemical Company and Sigma-Aldrich.

[DOR: 20.1001.1.2717204.2021.20.77.2.3]
[DOI: 10.52547/jmp.20.77.26]

2.4. Statistical Analysis

The experimental design was a completely randomized block design with eight treatments and 3 replications. The results of all studied variables were presented as mean ± SE. The mean values were separated according to Duncan's multiple range test at the 95 % confidence level using MSTAT-C software.

3. Results

According to analysis of variance, a considerable variation was observed the composition of fatty acids and the oil percent of pomegranate cultivars (Table 1, 2 and 3).

The total amounts of lipid content of different Iranian pomegranate cultivars are presented in Fig. 1. According to obtained results, the total oil content was ranged from 10.81 g/100 g (in Lop-Sorkhi) to 15.03 g/100 g (in Sorahi). The highest oil content was obtained for Sorahi, followed by Poost Ghermez, Mirzaei and Aliakbari cultivars.

The contents of saturated and unsaturated fatty of seed oils extracted of the Iranian pomegranate cultivars were given in Table 4 and 5. The main saturated fatty acid among the eight cultivars was palmitic acid (C16:0) that was ranging from 3.53 % (in Yazdani cultivar) to 4.85 % (in Golabi cultivar). The other saturated fatty acids in the samples were heptadecanoic (C17:0), stearic (C18:0), arachidic (C20:0) and behenic acid (C22:0) that were ranged between 0.04-0.07, 1.95-2.87, 0.52-1.36 and 0.35-0.48 %, respectively (Table 3).

Table 1. Analysis of variance for oil percent and the composition of saturated fatty acids of pomegranate cultivars

S.O.V	df	Oil percent	Palmitic acid	Stearic acid	Arachidic acid	Behenic acid
Repeat	2	8.74 ^{ns}	0.476 **	0.380 **	0.292 **	0.001 ^{ns}
Cultivar	7	39.78 **	0.711 **	1.265 **	0.337 **	0.008 ^{ns}
Error	14	20.04	0.056	0.042	0.025	0.007
CV (%)	-	8.97	5.70	8.77	17.13	20.59

S.O.V: Source of variation, df: degree of freedom, C.V: coefficient of variation; ^{ns} and **: non-significant and significant at 1 % probability levels, respectively.

Table 2. Analysis of variance for the composition of unsaturated fatty acids of pomegranate cultivars

S.O.V	df	Oleic acid	Linoleic acid	Linolenic acid	Eicosenoic acid
Repeat	2	4.555 **	3.681 **	115.379 **	0.331 **
Cultivar	7	1.927 **	0.782 ^{ns}	3.234 ^{ns}	0.072 **
Error	14	0.202	0.401	10.452	0.016
CV (%)	-	5.80	6.75	4.43	13.11

S.O.V: Source of variation, df: degree of freedom, C.V: coefficient of variation; ^{ns} and **: non-significant and significant at 1 % probability levels, respectively.

Table 3. Analysis of variance for the content of fatty acids and their ratios of pomegranate cultivars

S.O.V	df	SFA[a]	UFA[b]	MUFA[c]	PUFA[d]	UFA/SFA
Repeat	2	3.109 **	233.932 **	7.317 **	159.760 **	0.503 ^{ns}
Cultivar	7	0.642 *	2.216 ^{ns}	2.021 **	1.755 ^{ns}	1.563 ^{ns}
Error	14	0.201	11.825	0.180	10.124	0.716
CV (%)	-	5.72	3.78	4.88	3.86	7.24

S.O.V: Source of variation, df: degree of freedom, C.V: coefficient of variation; ^{ns,*} and **: non-significant and significant at 5 and 1 % probability levels, respectively.

[a] Saturated fatty acids, [b] unsaturated fatty acids, [c] Monounsaturated fatty acids and [d] Polyunsaturated fatty acids.

[DOR: 20.1001.1.2717204.2021.20.77.2.3]
[DOI: 10.52547/jmp.20.77.26]

The relative percentage of unsaturated fatty acids is shown in Table 5. Linolenic acid (C18:3) was the dominant fatty acid in the studied pomegranate. The amount of this fatty acid ranged between 71.35 for Poost-Ghermez and 74.58 % for Gar cultivars.

High amount of total unsaturated fatty acids was seen in all oil samples. Major mono-unsaturated fatty acid among all studied cultivars was oleic acid (C18:1), ranging from 6.51 % (for Lop-Sorkhi) to 8.92 % (for Sorahi). Eicosenoic acid (C20:1) as a major mono-unsaturated fatty acid ranged between 0.62 (for Poost-Ghermez) to 1.12 % (for Sorahi). In this research, Linoleic acid (C18:2) was the second most unsaturated fatty acid and its percentage was between 8.52 and 10.12 % in Sorahi and Poost-Ghermez cultivars, respectively. Oleic acid (C18:1) content in the samples was 6.51 % for Lop Sorkhi to 8.92 % for Sorahi cultivars. In terms of eicosenoic acid content (C20:1), Poost-Ghermez and Sorahi had the lowest (0.62 %) and highest (1.12 %) percentages.

The relative order of unsaturated fatty acids in studied pomegranates cultivars was linolenic acid (71.35-74.58 %), followed by linoleic acid (9.05-10.12 %) and oleic acid (6.51-8.92 %). The amount of saturated fatty acids, mono-unsaturated fatty acid, poly-unsaturated fatty acid and ratio of poly-unsaturated to saturated fatty acids of different Iranian pomegranate cultivars are shown in Table 6.

As shown in Table 6, it has been confirmed that the unsaturated fatty acids (USFA) were dominant fatty acids in all Iranian pomegranate cultivars. The unsaturated fatty acids (MUFA+PUFA) were 89.85 % (Lop-Sorkhi) to 92.42 % (Gar) of the total fatty acids. The ranges of SFA, MUFA and PUFA between studied pomegranates cultivars were 7.09-8.33, 7.38-10.04 and 81.47-83.97 %, respectively. The highest values of PUFA were observed in Gar cultivar (83.97 %) and the (MUFA) and (SFA) ranged between 7.38-10.04 % and 7.09-8.33 %, respectively. Pomegranate seed oil samples in this study had high concentration of PUFA with a mean of 82.38 %. The ratio of PUFA/SFA varied between 9.83 (Ali-Akbari) and 11.54 (Mirzaei). Based on the obtained results, pomegranate seed oils had the following sequence: PUFA > MUFA > SFA.

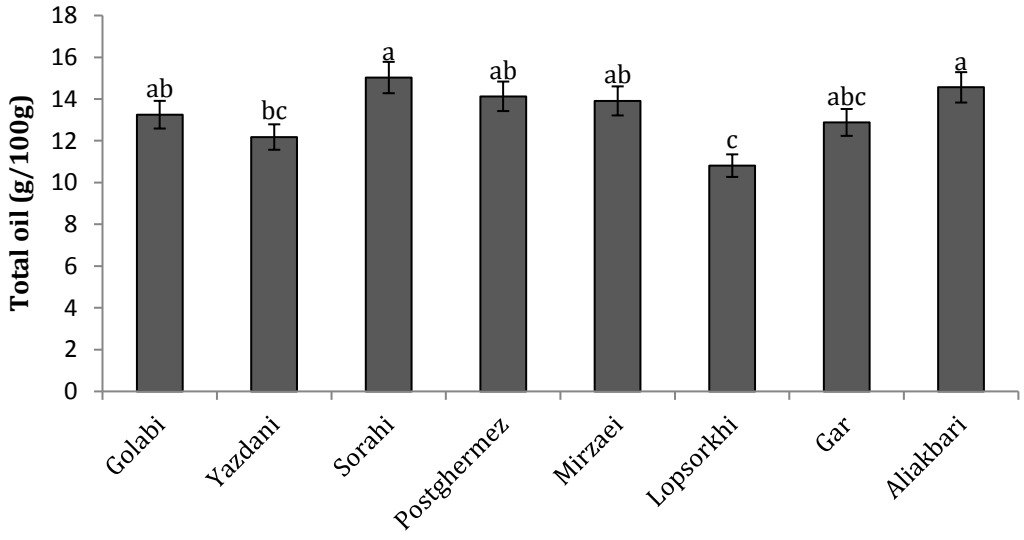


Fig. 1. Total lipid content of studied Iranian pomegranate cultivars

Table 4. The content of saturated fatty acids (relative percentage %) from seeds of eight Iranian pomegranate cultivars

Cultivars	Palmitic acid (C16:0)	Heptadecanoic acid (C17:0)	Stearic acid (C18:0)	Arachidic acid (C20:0)	Behenic acid (C22:0)
Golabi	4.85 ± 0.27^{a}	0.06 ± 0.01^{ab}	2.48 ± 0.52^{b}	0.54 ± 0.07^{d}	0.38 ± 0.09^{a}
Yazdani	3.53 ± 0.21^{c}	0.06 ± 0.02^{ab}	2.03 ± 0.07^{cd}	1.36 ± 0.18^{a}	0.48 ± 0.12^{a}
Sorahi	3.58 ± 0.11^{c}	0.06 ± 0.01^{ab}	2.41 ± 0.16^{bc}	1.25 ± 0.23^{a}	0.45 ± 0.08^{a}
Poost Ghermez	4.52 ± 0.63^{a}	0.05 ± 0.01^{ab}	2.45 ± 0.47^{b}	0.61 ± 0.20^{cd}	0.37 ± 0.05^{a}
Mirzaei	3.89 ± 0.21^{bc}	0.04 ± 0.02^{b}	2.29 ± 0.21^{bcd}	0.52 ± 0.23^{d}	0.35 ± 0.5^{a}
Lop Sorkhi	4.64 ± 0.31^{a}	0.05 ± 0.03^{ab}	2.11 ± 0.15^{bcd}	1.13 ± 0.34^{ab}	0.35 ± 0.07^{a}
Gar	4.05 ± 0.39^{b}	0.05 ± 0.01^{ab}	1.95 ± 0.19^{d}	1.11 ± 0.36^{ab}	0.36 ± 0.09^{a}
Ali-Akbari	4.08 ± 0.24^{b}	0.07 ± 0.02^{a}	2.87 ± 0.22^{a}	0.87 ± 0.22^{bc}	0.44 ± 0.07^{a}
Mean	4.14	0.05	3.32	0.92	0.39

Mean in each column followed by different letters are significantly different ($P \leq 0.05$)

Table 5. The content of unsaturated fatty acids (relative percentage %) from seeds of eight Iranian pomegranate cultivars

Cultivars	Oleic acid (C18:1)	Linoleic acid (C18:2)	Linolenic acid (C18:3)	Eicosenoic acid (C20:1)
Golabi	7.45 ± 0.71^{de}	9.05 ± 1.15^{ab}	73.64 ± 3.56^{a}	1.06 ± 0.12^{ab}
Yazdani	6.93 ± 0.34^{ef}	9.52 ± 0.79^{ab}	73.11 ± 3.10^{a}	1.03 ± 0.22^{ab}
Sorahi	8.92 ± 1.40^{a}	8.52 ± 0.34^{a}	73.58 ± 1.22^{a}	1.12 ± 0.28^{a}
Poost Ghermez	8.40 ± 0.77^{ab}	10.12 ± 0.56^{a}	71.35 ± 1.20^{a}	0.62 ± 0.24^{c}
Mirzaei	7.93 ± 1.05^{bcd}	9.96 ± 0.41^{a}	71.88 ± 1.53^{a}	1.01 ± 0.37^{ab}
Lop Sorkhi	6.51 ± 0.63^{f}	9.11 ± 0.26^{ab}	73.36 ± 3.52^{a}	0.87 ± 0.20^{b}
Gar	7.53 ± 0.81^{cde}	9.39 ± 1.28^{ab}	74.58 ± 3.73^{a}	0.92 ± 0.12^{ab}
Ali-Akbari	8.32 ± 0.80^{abc}	9.36 ± 1.50^{ab}	72.57 ± 3.09^{a}	0.99 ± 0.22^{ab}
Mean	7.74	9.37	73.00	0.95

Mean in each column followed by different letters are significantly different ($P \leq 0.05$)

Table 6. Content of fatty acids and their ratios in the seeds of Iranian pomegranate cultivars

Cultivars	SFA (%)	UFA (%)	MUFA (%)	PUFA (%)	Ratio UFA/SFA
Golabi	8.31 ± 0.74^{a}	91.2 ± 5.08^{a}	8.51 ± 0.79^{bcd}	82.69 ± 4.38^{a}	10.99 ± 0.36^{b}
Yazdani	7.46 ± 0.29^{ab}	90.59 ± 4.26^{a}	7.96 ± 0.54^{de}	82.63 ± 3.80^{a}	12.14 ± 0.22^{ab}
Sorahi	7.75 ± 0.38^{ab}	92.14 ± 12.04^{a}	10.04 ± 1.58^{a}	82.10 ± 10.47^{a}	11.86 ± 1.10^{ab}
Poost Ghermez	8.00 ± 1.24^{a}	90.49 ± 3.74^{a}	9.02 ± 0.99^{bc}	81.47 ± 2.75^{a}	11.46 ± 1.56^{ab}
Mirzaei	7.09 ± 0.66^{b}	90.78 ± 3.22^{a}	8.94 ± 1.35^{bc}	81.84 ± 1.87^{a}	12.85 ± 0.77^{a}
Lop Sorkhi	8.28 ± 0.83^{a}	89.85 ± 4.07^{a}	7.38 ± 0.82^{e}	82.47 ± 3.26^{a}	10.89 ± 0.62^{b}
Gar	7.52 ± 0.76^{ab}	92.42 ± 7.79^{a}	8.45 ± 0.93^{cd}	83.97 ± 6.88^{a}	12.31 ± 0.51^{ab}
Ali-Akbari	8.33 ± 0.70^{a}	91.24 ± 5.17^{a}	9.31 ± 0.91^{ab}	81.93 ± 4.29^{a}	10.98 ± 0.67^{b}
Mean	7.84	91.08	8.70	82.37	11.68

Mean in each column followed by different letters are significantly different ($P \leq 0.05$)

4. Discussion

The aim of this study was to investigate the lipid content and fatty acid compositions of oil seeds of eight Iranian pomegranate cultivars. The lowest and the highest measured oil were seen in Lop-Sorkhi and Sorahi cultivars, respectively. These values were partially consistent with the results obtained from some Iranian commercial varieties ranged from 13.5 % for Shahvar to 16.9 % for Pust Sefid [27]. The observed differences in Iranian studies could be related to the varieties, environmental condition and latitude that make

various temperatures, different amount of rainfall, not the same received light for the trees, and finally. The harvesting year which leads to the different chemical composition of pomegranates.

The range of total oil in our study was in agreement with the study carried out in Spain [13] on seed oil of nine European pomegranate varieties that showed the total lipids ranged between 4.44-13.70 %. Given that, the minimum amount of total oil in our study related to Lop-Sorkhi (10.81 %) is twice more than the minimum amount reported in European varieties (4.44 % for Valenciana) [13]. In Turkey, the study on the oil content of 15 commercial pomegranate seed varieties showed the ranging from 13.95 to 24 [19]. It is considerable that the mean of seed oil of the varieties in our study is in a lower level than the minimum of the seed oil of all varieties studied in Turkey [19]. These differences may be contributed to the varieties being studied and also to the environmental conditions.

The total saturated fatty acids (SFA) in seed oil of nine European pomegranate varieties ranged from 4.9 to 7.3 % [13], and in our study, it ranged from 7.09 to 8.33 %. In terms of unsaturated fatty acids (UFA) as it was shown in Table 2, all oil samples had high amount. Our results confirmed the presence of linolenic acid (C18:3) and linoleic acid (C18:2) in all seed oils of pomegranates as previously reported [1, 17]. Also, total lipid of red pomegranate seed oil was dominated by linoleic acid (20-21 %) and oleic acid (19-21 %), but about purple pomegranates, the main fatty acids were reported oleic acid (41-43 %), punicic acid (0-25 %) and linoleic acid (0-19 %) [28]. In our study, this consequence was seen: heptadecanoic acid < behenic acid < arachidic acid < eicosenoic acid < palmitic acid < oleic acid < linoleic acid < linolenic acid. Our results were similar to those obtained in Iran on 25 different varieties which reported that pomegranate seeds contain 6 to 15.7 % oil and achieved the following results concerning the fatty acid composition: behenic acid < myristic acid < stearic acid < palmitic acid < oleic acid < linoleic acid < linolenic acid [29].

Pomegranate seed oil contains high amount of unsaturated fatty acids such as punicic acid, a geometric isomer of linolenic acid which makes up over 70 % of the total fatty acids present in the oil [18]. Our results about these fatty acids were similar to five different varieties of Iranian pomegranate seeds [18]. In comparison with non-Iranian cultivars, results showed 3.81-20.25 % for oleic acid, while in our study the maximum amount was seen 8.92 % in Sorahi cultivar. Reported values in another study for oleic (6.82-7.17 %) and Eicosenoic (0.64-0.66 %) acids [22] were less than amounts that were obtained in this study.

Linoleic and linolenic acids are synthesized in various plants whereas human and other mammals, because of their bio-system disabilities to produce, should be provided these fatty acids from external sources [30]. Vitality effects of unsaturated fatty acids in cholesterols control and heart disease risk reduction were approved in studies [31, 32]. Linoleic acid has a crucial role in protection of cardiovascular diseases and as a regulator of low-density lipoprotein, enhances its clearance [15]. According to our results, it can be stated that Iranian pomegranate cultivars are good sources of fatty acids especially unsaturated fatty acids like linoleic and linolenic acids. On the other hand, since all pomegranate cultivars were collected from the same experimental condition, it could be concluded that the observed variation were affected by the genetic factors.

[DOR: 20.1001.1.2717204.2021.20.77.2.3]
[DOI: 10.52547/jmp.20.77.26]

When considering the overall fatty acids composition, pomegranate seed oils in our study had the following sequence: PUFA > MUFA > SFA, but in Spanish [13] and China-grown pomegranate [33] the sequence was PUFA > SFA > MUFA which can be contributed to the differences among cultivars, environmental condition and latitude. Regarding PUFA/SFA ratio, it varied between 9.83 (Ali-Akbari) and 11.54 (Mirzaei) cultivars. Differences among cultivars were observed depending on the cultivars, with values of PUFA ranging from 88.1 to 90.3 % for Katirbasi and Cis 127 cultivars, SFA ranged between 6.1 to 7.4 % for CG8 and Mollar de Elche and MUFA ranged between 3.9 to 6.3 % for White and Wonderful 2 in Spanish cultivars [13] whereas PUF arranged between 81.47 to 83.97 for Gar and Poost-Ghermez, SFA ranged 7.09 to 8.33 % for Mirzaei and Aliakbari and MUFA ranging from 7.38 to 10.04% for Lop-Sorkhi and Sorahi in our Iranian pomegranate cultivars. The minimum amount of this ration recommended by HMSO [34] is equal to 0.45 and so, this ratio in our samples is well above.

5. Conclusion

In this study, we assessed the composition of fatty acids of eight Iranian pomegranate cultivars from the central area of Iran. Pomegranate seeds are a byproduct of this fruit, but according to recent reports and this research, it could be recommended to use it as a source of seed oil with beneficial health aspects. The results of the present study indicated that seed oils of studied pomegranate cultivars are rich sources of fatty acids. The oil extracted from pomegranate seed contains a high concentration of linolenic acid. It is known as a precious fatty acid because of its beneficial effect on human health [35, 36]. The composition of seed oil in Iranian pomegranate cultivars showed very high levels of unsaturated fatty acids especially in linolenic acid. Based on the research literature about the application of pomegranate seed oils in pain management, obesity diet and their anti-toxic effects [37, 38], it is necessary to pay more attention to the Iranian cultivars that can improve health and may use them in the pharmaceutical industry. The studied Iranian cultivars were only selected from the central of Iran represent only a portion of the native germplasm. It is important to evaluate and conserve Iranian pomegranate cultivars as genetic materials, not only for general consumption, but also for their health advantages.

Author contributions

N. M. performed the experiment and collected data and HA. A-Gh. guided aspects of the research and participated in writing of manuscript.

Conflict of interest

The authors declare that there is no conflict of interest.

References

1. Parashar A, Sinha N and Singh P. Lipid contents and fatty acids composition of seed oil from twenty-five pomegranates varieties grown in India. *Adv. J. Food Sci. Technol.* 2010; 10; 2(1): 12-15. doi: 10.1080/15538362. 2010. 530129.

2. Khadivi A, Mirheidari F, Moradi Y and Paryan S. Morphological variability of wild pomegranate (*Punica granatum* L.) accessions from natural habitats in the Northern parts of Iran. *Sci. Hortic*. 2020; 264: 109-165. doi: 10.1016/j.scienta.2019.109165.

3. Derakhshan Z, Ferrante M, Tadi M, Ansari F, Heydari A, Hosseini MS, Conti GO and Sadrabad EK. Antioxidant activity and total phenolic content of ethanolic extract of pomegranate peels, juice and seeds. *Food Chem. Toxicol.* 2018; 1; 114: 108-111. doi: 10.1016/j.fct.2018.02.023.

4. Asadi-Gharneh HA, Mohammadzamani M and Karimi S. Evaluation of physico-chemical properties and bioactive compounds of some Iranian pomegranate cultivars. *Int. J. Fruit. Sci.* 2017; 3; 17(2): 175-187. doi: 10.1080/ 15538362.2016.1275923

5. Ozgen M, Durgaç C, Serçe S and Kaya C. Chemical and antioxidant properties of pomegranate cultivars grown in the Mediterranean region of Turkey. *Food Chem.* 2008; 1; 111(3): 703-706. doi: 10.1016/j. foodchem.2008.04.043.

6. Goula AM and Adamopoulos KG. A method for pomegranate seed application in food industries: seed oil encapsulation. *Food Bioprod. Process.* 2012; 1; 90(4): 639-652. doi: 10.1016/j.fbp.2012.06.001.

7. Eikani MH, Golmohammad F and Homami SS. Extraction of pomegranate (*Punica granatum* L.) seed oil using superheated hexane. *Food Bioprod. Process*. 2012; 1; 90(1): 32-36. doi: 10.1016/j.fbp.2011.01.002.

8. Parashar A, Gupta SK and Kumar A. Anthocyanin concentration of KANDARI Pomegranate fruits during different cold storage conditions. *ACI, XXXIV C.* 2008; 3: 529-536.

9. Goula AM, Papatheodorou A, Karasavva S and Kaderides K. Ultrasound-assisted aqueous enzymatic extraction of oil from pomegranate seeds. *Waste Biomass Valori*. 2018; 1; 9(1): 1-10. doi: 10.1007/s12649-016-9740-9.

10. El-Nemr SE, Ismail IA and Ragab M. Chemical composition of juice and seeds of pomegranate fruit. *Food Nahrung*. 1990; 34(7): 601-606. doi: 10.1002/food. 19900340706.

11. Yoshime LT, Melo IL, Sattler GA, Torres RP and Mancini-Filho G. Bioactive compounds and the antioxidant capacities of seed oils from pomegranate (*Punica granatum* L.) and bitter gourd (*Momordica charantia* L.). *Food Sci. Technol. Campinas* 39(Suppl. 2) 2019: 571-580. doi: 10.1590/fst.23218.

12. Hernandez F, Melgarejo P, Olias JM and Artes F. Fatty acid composition and total lipid content of seed oil from three commercial pomegranate cultivars. Production, Processing and Marketing of Pomegranate in the Mediterranean Region: *Adv. Sci. Tech*. 2000; 205-209.

13. Fernandes L, Pereira JA, Lopéz-Cortés I, Salazar DM, Ramalhosa E and Casal S. Lipid composition of seed oils of different pomegranate (*Punica granatum* L.) cultivars from Spain. *Int. J. Food Stud*. 2015; 18; 4(1): 13-22. doi: 10.7455/ijfs/4.1.2015.a8.

14. Melgarejo P, Salazar DM, Amoros A and Artes F. Total lipids content and fatty acid composition of seed oils from six pomegranate cultivars. *J. Sci. Food Agric.* 1995; 69(2): 253-256. doi: 10.1002/jsfa.2740690216.

15. Wijendran V and Hayes KC. Dietary n-6 and n-3 fatty acid balance and cardiovascular health. *Annu. Rev. Nutr*. 2004; 14; 24: 597-615. doi: 10.1146/annurev.nutr.24.012003.132106

16. Fleming JA, and Kris-Etherton PM. The evidence for α-linolenic acid and cardiovascular disease benefits: Comparisons with eicosapentaenoic acid and docosahexaenoic acid. *Adv. Nutr*. 2014; 5(6): 863S-76S. doi: 10.3945/an.114.005850.

17. Melgarejo P and Artes F. Total lipid content and fatty acid composition of oilseed from lesser known sweet pomegranate clones.

J. Sci. Food Agric. 2000; 80(10): 1452-1454. doi: 10.1002/1097-0010(200008)80:10<1452.

18. Habibnia M, Ghavamie M, Ansaripour M and Vosough S. Chemical evaluation of oils extracted from five different varieties of Iranian pomegranate seeds. *JFBT*. 2012; 2: 35-40.

19. Kýralan M, Gölükcü M and Tokgöz H. Oil and conjugated linolenic acid contents of seeds from important pomegranate cultivars (*Punica granatum* L.) grown in Turkey. *J. Am. Oil Chem. Soc*. 2009; 86 (10): 985-990. doi: 10.1007/s11746-009-1436-x.

20. Gasmi J and Sanderson JT. Growth inhibitory, antiandrogenic, and pro-apoptotic effects of punicic acid in LNCaP human prostate cancer cells. *J. Agric. Food Chem.* 2010; 10; 58(23): 12149-12156. doi: 10.1021/jf103306k.

21. Boussetta T, Raad H, Lettéron P, Gougerot-Pocidalo MA, Marie JC, Driss F and El-Benna J. Punicic acid a conjugated linolenic acid inhibits TNFα-induced neutrophil hyperactivation and protects from experimental colon inflammation in rats. *PloS one*. 2009; 31; 4(7): e6458. doi: 10.1371/journal.pone.0006458.g003.

22. Sassano G, Sanderson P, Franx J, Groot P, van Straalen J and Bassaganya-Riera J. Analysis of pomegranate seed oil for the presence of jacaric acid. *J. Sci. Food Agric.* 2009; 89(6): 1046-1052. doi: 10.1002/jsfa.3552.

23. AACC. Method 46-11, Approved Methods of the AACC. American Association of Cereal Chemists, Inc., 1987, USA.

24. Animal IS, Fats V. Oils-Preparation of Methyl Esters of Fatty Acids (method ISO 5509). Geneva: International Organization for Standardization. 1978.

25. Metcolf LC, Schmitz AA and Pelka JR. Rapid preparation of methyl esters from lipid for gas chromatography analysis. *Analytical Chem*. 1966; 38: 514-515. doi: 10.1155/2020/6691298.

26. Mekni, M., Flamini, G. Garrab, G. Hmida, R. Cheraief, I. Mastouri, M and Hammami, M. Aroma volatile components, fatty acids and antibacterial activity of four Tunisian *Punica granatum* L. flower cultivars. *Ind. Crop. Prod.* 2013; 48: 111-117. doi: 10.1016/j.indcrop.2013.04.005.

27. Dadashi S, Mousazadeh M, Emam-Djomeh Z and Mousavi SM. Pomegranate (*Punica granatum* L.) seed: A comparative study on biochemical composition and oil physicochemical characteristics. *Int. J. Adv. Biol. Biomed. Res*. 2013; 1(4): 351-363. doi: 10.26655/IJABBR.2016.12.3.

28. Soetjipto H, Pradipta M and Timotius KH. Fatty acids composition of red and purple pomegranate (*Punica granatum* L.) seed oil. *IJCC*. 2010; 30; 1(2): 74-77. doi: 10.137/journal.pone.0006458.

29. Fadavi A, Barzegar M, and Azizi M. Determination of fatty acid and total lipid content in oilseed of 25 pomegranate varieties grown in Iran. *J. Food Compos. Anal.* 2006; 19, 676–680. doi: 10.1016/j.jfca.2004.09.002.

30. Horrocks LA and Yeo YK. Health benefits of docosahexaenoic acid (DHA). *Pharmacological Res*. 1999; 40(3): 211-225. doi: 10.1006/phrs.1999.0495.

31. Foran JA, Good DH, Carpenter DO, Hamilton MC and Knuyh BA. Quantitative analysis of the benefits and risks of consuming farmed and wild salmon. *Nutrition* 2005; 135: 2639-2643. doi: 10.1093/jn/135.11.2639.

32. Park S and Johnson MA. Awareness of fish advisories and mercury exposure in women of childbearing age. *Nutrition J*. 2006; 64: 250-256. doi: 10.1301/nr.2006.may.250-256

33. Jing P, Ye T, Shi H, Sheng Y, Slavin M and Gao B. Antioxidant properties and phytochemical composition of China-grown pomegranate seeds. *Food Chem*. 2012; 132: 1457-1464. doi: 10.1016/j.foodchem.2011.12.002.

34. HMSO UK. Nutritional aspects of cardiovascular disease. *Rep Health Soc. Subj*. (Lond). 1994: 46: 1-186.

35. Kandylis P and Kokkinomagoulos E. Food applications and potential health benefits of pomegranate and its derivatives. *Foods*. 2020; 9(2): 122. doi: 10.3390/foods9020122.

36. Guerrero-Solano JA, Jaramillo-Morales OA and Velázquez-González C. Pomegranate as a potential alternative of pain management: A review. *Plants (Basel)*. 2020; 9(4): 419. doi: 10.3390/plants9040419.

37. Raffaele M, Licari M and Amin S. Cold press pomegranate seed oil attenuates dietary-p obesity induced hepatic steatosis and fibrosis through antioxidant and mitochondrial pathways in obese mice. *Int. J. Mol. Sci*. 2020; 21(15): 5469. doi: 10.3390/ijms21155469.

38. Minisy FM, Shawki HH and El Omri A. Pomegranate seeds extract possesses a protective effect against tramadol-induced Testicular toxicity in experimental rats. *Biomed Res. Int*. 2020; 2020:2732958. doi: 10.1155/2020/2732958.

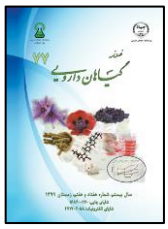
How to cite this article: Momeni N, Asadi-Gharneh HA. Fatty acids composition of seed oils obtained from eight Iranian pomegranate cultivars. ***Journal of Medicinal Plants*** 2021; 20(77): 26-36.
doi: 10.29252/jmp.20.77.26

فصلنامه گیاهان دارویی ۱۳۹۹؛ ۲۰(۷۷): ۲۶-۳۶

فصلنامه گیاهان دارویی

Journal homepage: www.jmp.ir

پژوهشکده گیاهان دارویی
جهاد دانشگاهی



مقاله تحقیقاتی

بررسی ترکیب اسیدهای چرب روغن بذر هشت رقم انار ایرانی

نفیسه مومنی، حسینعلی اسدی قارنه*

گروه علوم باغبانی، دانشگاه آزاد اسلامی واحد اصفهان (خوراسگان)

اطلاعات مقاله

گل‌واژگان:
اسیدهای چرب ضروری
پروفایل اسیدهای چرب
اسید لینولنیک
محتوای روغن
اسیدهای چرب غیراشباع

چکیده

مقدمه: انار یکی از قدیمی‌ترین میوه‌های خوراکی و متعلق به خانواده انار است که قسمت‌های مختلف آن به‌عنوان گیاه دارویی مورد استفاده قرار می‌گیرد. بذرهای انار منبع چربی، قندها، پروتئین و عناصر مهم معدنی است. **هدف:** این مطالعه به منظور بررسی ترکیب اسیدهای چرب هشت رقم انار ایرانی انجام شد. **روش بررسی:** میوه‌های رسیده هشت رقم انار ایرانی از یک باغ میوه تجاری برداشت شدند. بذرها به‌وسیله آون خشک شدند و استخراج روغن به‌وسیله دستگاه سوکسله و با استفاده از حلال پترولیوم اتر انجام شد. در نهایت، شناسایی اسیدهای چرب در روغن بذر انار به‌وسیله دستگاه گاز کروماتوگرافی انجام شد. **نتایج:** تنوع قابل ملاحظه‌ای از نظر ترکیب اسیدهای چرب و میزان روغن در ارقام انار مشاهده شد. محتوای روغن در ارقام انار ایرانی از ۱۰/۸۱ تا ۱۵/۰۳ گرم در صد گرم وزن خشک بذر متفاوت بود. اسیدهای پالمیتیک، استئاریک، اولئیک، لینولئیک و لینولنیک مهم‌ترین اسیدهای چرب در بذر ارقام مورد مطالعه بودند. اسید لینولنیک مهم‌ترین اسید چرب شناسایی شده بود که دامنه آن از ۷۱/۳۵ درصد در رقم پوست قرمز تا ۷۴/۵۸ درصد برای رقم گر متفاوت بود. در بین اسیدهای چرب اشباع، اسید پالمیتیک با میانگین ۰/۴۱۴ گرم در صد گرم ماده خشک و در میان اسیدهای چرب غیراشباع اسید لینولنیک با میانگین ۷/۳ گرم در صد گرم ماده خشک، اسیدهای چرب غالب در بذر ارقام انار مورد مطالعه بودند. همچنین نتایج نشان داد که رقم سورهی دارای بیشترین میزان روغن (۱۵/۰۳ درصد)، اسید اولئیک (۸/۹۲ درصد) و اسید ایکوزنوئیک (۱/۱۲ درصد) در بین ارقام بود. در روغن بذر ارقام مورد مطالعه ۷/۸۴ درصد اسیدهای چرب اشباع و ۹۱/۰۸ درصد اسیدهای چرب غیراشباع بودند. همچنین نسبت اسیدهای چرب غیراشباع به اشباع بین ۹/۸۳ تا ۱۱/۵۴ بود. **نتیجه‌گیری:** روغن بذر در هشت رقم انار ایرانی در این مطالعه دارای مقادیر بالایی اسیدهای چرب غیراشباع به‌ویژه اسید لینولنیک بود که می‌تواند در بهبود سلامتی انسان نقش داشته باشد.

مخففها: SFA، اسیدهای چرب اشباع؛ UFA، اسیدهای چرب غیراشباع؛ MUFA، اسیدهای چرب با یک پیوند غیراشباع؛ PUFA، اسیدهای چرب با چند پیوند غیراشباع

* نویسنده مسؤول: h.asadi@khuisf.ac.ir

تاریخ دریافت: ۲۳ دی ۱۳۹۸؛ **تاریخ دریافت اصلاحات:** ۱۸ آبان ۱۳۹۹؛ **تاریخ پذیرش:** ۱۹ آبان ۱۳۹۹

doi: 10.29252/jmp.20.77.26