

Evaluation of Oil Content and Fatty Acid Composition in some Iranian Local Melon (*Cucumis melo* L.) Cultivars

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ABSTRACT

This study was carried out in 2024 in the Islamic Azad University, Isfahan (Khorasgan) Branch, to assess the seed oil content and fatty acid composition of four traditional Iranian melon (*Cucumis melo* L.) landraces: Tow-Qhermez, Haj-Nadali, Gorgab, and Mashhadi. The experiment was arranged in a completely randomized design (CRD) with three replications. Data were subjected to analysis of variance (ANOVA) using SPSS software. Mean comparisons were performed using the Least Significant Difference (LSD) test at the 5% significance level. Analysis of variance revealed significant genetic variation ($P \leq 0.05$) among the cultivars for most fatty acid traits, with particularly high determination coefficients ($R^2 = 0.72\text{--}0.95$) for oil percentage, palmitic acid (C16:0), total saturated fatty acids (SFA), the unsaturated/saturated fatty acid (USFA/SFA) ratio, and linoleic acid (C18:2 n-6), indicating strong genetic control over these parameters. Among the evaluated landraces, Gorgab exhibited the highest oil content (31.30%) and linoleic acid level (61.6%), while Mashhadi had the lowest oil content (23.60%) and the highest proportion of saturated fatty acids (16.8%). The USFA/SFA ratio, an important indicator of oil nutritional quality, was greatest in Tow-Qhermez (5.44) and Gorgab (5.62), suggesting a more favorable lipid profile from a health perspective. These results are consistent with previous findings in Cucurbitaceae species, confirming the presence of considerable genetic diversity in seed oil composition and highlighting the nutritional value of local germplasm. Furthermore, the dominance of linoleic and oleic acids among the unsaturated fatty acids aligns with earlier reports, underscoring their contribution to oxidative stability and potential health benefits. Based on these findings, Gorgab and Tow-Qhermez can be considered promising genetic resources for breeding programs aimed at enhancing seed oil content and nutritional value. This research provides a solid foundation for the valorization of native Iranian melon germplasm and supports its utilization in functional food and nutraceutical industries.

Keywords: Melon (*Cucumis melo* L.), Seed oil, USFA/SFA ratio, Linoleic acid, Oil quality.

INTRODUCTION

Melon (*Cucumis melo* L.), a member of the Cucurbitaceae family, is widely cultivated in temperate and tropical regions for its sweet and aromatic fruits (Pitrat, 2016). In addition to its economic and nutritional value as a fruit, the seeds of melons are increasingly recognized for their oil content and beneficial fatty acid composition. Melon seed oil is emerging as a potential alternative source of vegetable oil with applications in food, pharmaceutical, and cosmetic industries (Lazreg-Aref *et al.*, 2014).

Previous studies have indicated that melon seed oil is rich in essential polyunsaturated fatty acids, particularly linoleic acid (C18:2) and oleic acid (C18:1), while saturated fatty acids such as palmitic (C16:0) and stearic (C18:0) are present in lower amounts. Studies on Iranian melon (*Cucumis melo* L.) cultivars reveal high-unsaturated fatty acid content. Gharibzahedi and Mohammadnabi (2016) reported that *C. melo* var. *flexuosus* seeds contain 68.5% linoleic acid, making them a valuable source of omega-6 fatty acids. Similarly, Farrokhi *et al.* (2019) analyzed 12 Iranian landraces and found linoleic acid ranging from 63% to 71%, with oleic acid between 15% and 22%, highlighting Iran's genetic diversity in melon seed oil quality.

Turkish melon cultivars also exhibit high nutritional value. Özcan *et al.* (2020) demonstrated that the Kirkagac variety contains 67.2% linoleic acid and 18.4% oleic acid, comparable to Iranian cultivars.

A meta-analysis by Kyriakopoulou *et al.* (2023) compared 120 melon cultivars worldwide, noting that Iranian melons consistently rank highest in linoleic acid (avg. 69%), while Turkish varieties excel in tocopherol content. Spanish Piel de Sapo melons are particularly rich in phytosterols (84% β -sitosterol) (Marrero *et al.*, 2022), whereas Indian Sarda melons contain exceptionally high linoleic acid (72%) (Kaur *et al.*, 2021).

In Tunisian melon cultivars, linoleic acid content ranged from 62–70%, oleic acid from 14–22%, palmitic acid from 7–12%, and stearic acid from 3–6% (Lazreg-Aref *et al.*, 2014). Similarly, in Egyptian honeydew melons (*C. melo* var. *inodorus*), linoleic and oleic acids were reported at 65.2% and 18.3%, respectively (Hamed *et al.*, 2018). These characteristics make melon seed oil a rich source of essential fatty acids, which are associated with cardiovascular health due to their anti-hypertensive and anti-inflammatory effects (Zhou *et al.*, 2016).

The high linoleic acid content in melon seed oil supports cardiovascular health by improving lipid metabolism (Zhou *et al.*, 2016). Additionally, the presence of tocopherols and phytosterols enhances its antioxidant and anti-inflammatory properties (Yılmaz & Öztekin, 2017).

The oil yield of Iranian melon seeds has been reported to range between 43% and 47%, with significant variation among cultivars in terms of fatty acid profiles (Jalili and Rashidi, 2024). These genetic resources remain underutilized and may provide opportunities for selecting cultivars with optimal lipid profiles suitable for industrial exploitation.

Iran is recognized as a center of diversity for melon, with numerous local landraces adapted to a broad spectrum of climatic conditions. Despite this genetic wealth, systematic evaluation of Iranian melon seeds for oil content and fatty acid composition remains limited. The objective of the present study is to evaluate the oil content and fatty acid composition of seeds from selected Iranian local cultivars of *Cucumis melo* L. The findings may contribute to the identification of high-quality oilseed resources and support the valorization of melon seeds as economically viable by-products in sustainable agricultural systems.

MATERIALS AND METHODS

Plant Material Collection

The experiment was conducted in 2024. Fruits of various Iranian local cultivars of melons were harvested at full maturity from cultivated fields in the Gorgab District, Isfahan Province, Iran. The harvest was conducted during the peak physiological ripening stage to ensure maximum seed development and oil content, following standard horticultural practices (Kader, 2002). Immediately after collection, the fruits were transported to the Horticultural Sciences Laboratory at the Islamic Azad University, Isfahan (Khorasgan) Branch for further processing.

Seed Preparation

Seeds were manually extracted from the fruits, washed thoroughly with distilled water to remove adhering fruit pulp, and dried under controlled laboratory conditions ($25 \pm 2^\circ\text{C}$, 50–60% RH) until they reached a constant weight. The dried seeds were stored in sealed paper bags at 4°C in the dark to prevent oxidation prior to oil extraction, based on the method outlined by Yanty *et al.* (2008).

Oil Extraction

Oil was extracted using the Soxhlet extraction technique. Approximately 20 g of ground seed material was placed in a cellulose extraction thimble and extracted with 200 mL of n-hexane (analytical grade, Merck, Germany) for 6 hours in a Soxhlet apparatus (BÜCHI Extraction System B-811, Switzerland) as described by Akinoso and Oni (2012). After extraction, the solvent was evaporated under reduced pressure using a rotary evaporator (Heidolph, Germany) at 40°C . The extracted oil yield was calculated as: $(\text{weight of extracted oil (g)} / \text{dry seed weight (g)}) \times 100$, then immediately transferred to amber glass vials and stored at 4°C to minimize oxidative degradation (AOAC, 2016).

Fatty Acid Analysis

Fatty acid methyl esters (FAMES) were prepared using a modified transesterification method according to AOAC Official Method 969.33 (AOAC, 2016). The FAMES were

analyzed using gas chromatography (GC) equipped with a flame ionization detector (FID) (Agilent 6890N, USA) and an HP-88 capillary column (100 m $\times$ 0.25 mm i.d., 0.20 μ m film thickness; Agilent Technologies). The injector and detector temperatures were set at 250°C and 260°C, respectively. The oven temperature was programmed from 140°C (held for 5 min) to 240°C at 4°C/min, with a final hold of 10 min. Helium was used as the carrier gas at a flow rate of 1.0 mL/min. Fatty acid peaks were identified by comparing retention times with those of a standard FAME mixture (Supelco 37 Component FAME Mix, Sigma-Aldrich, USA), following the approach described by El-Adawy and Taha (2001).

Statistical Analysis

All measurements were conducted in triplicate. The results were subjected to analysis of variance (ANOVA) using SPSS software (Version 26.0, IBM Corp., Armonk, NY, USA). Mean comparisons were performed using the Least Significant Difference (LSD) test at a significance level of $p < 0.05$ (Steel & Torrie, 1980). Multivariate analysis was performed using principal component analysis (PCA) followed by cluster analysis. PCA was conducted to reduce data dimensionality while preserving maximum variance, with components selected based on the Kaiser criterion (eigenvalue >1) (Jolliffe & Cadima, 2016). Subsequently, hierarchical clustering with Ward's linkage method was applied to the principal component scores to identify natural groupings in the data, with cluster validity assessed using silhouette coefficients (Kaufman & Rousseeuw, 2009). This combined approach effectively revealed underlying patterns and relationships in the multivariate dataset.

RESULTS

Analysis of variance revealed that cultivar effects were statistically significant ($p < 0.05$ or $p < 0.01$) for most fatty acid components and oil content (Table 1 and 2) and confirm the strong genotypic influence on lipid composition in melon seeds. The coefficient of determination (R^2) values ranged from 0.62 for C18:0 to 0.95 for C16:0, suggesting that the model explained a substantial proportion of the observed variance.

Table 1. Analysis of variance for oil percent and fatty acids composition in Iranian melon

S.O.V	df	Oil percent	C16:0 (%)	C18:0 (%)	C20:0 (%)	C18:1(n-9) (%)	C20:1(n-9) (%)	C18:2(n-6) (%)
Cultivar	3	32.81*	0.683*	1.17*	0.002*	36.18*	0.0014*	54.00*
Error	8	4.68	0.004	0.26	0.001	4.75	0.0001	5.70
C.V. (%)	-	7.91	3.76	8.16	7.54	8.03	8.35	4.27
R-Square	-	0.72	0.95	0.62	0.94	0.74	0.79	0.78

Table 2. Analysis of variance for some fatty acids composition in Iranian melon

S.O.V	df	C18:3(n-6) (%)	C18:3(n-3) (%)	Total SFA (%)	Total USFA (%)	USFA/SFA
Cultivar	3	0.0018*	0.001 ^{ns}	2.18*	2.29 ^{ns}	0.34*
Error	8	0.0001	0.0001	0.42	1.55	0.02
C.V. (%)	-	4.55	4.34	4.08	1.49	2.98
R-Square	-	0.93	0.45	0.66	0.35	0.83

Oil Yield

Significant differences ($p < 0.05$) were observed in seed oil content among the four *Cucumis melo* L. cultivars. The Gorgab cultivar produced the highest oil content (31.30%), followed by Tow-Qhermez (28.50%), Haj-Nadali (26.00%), and Mashhadi (23.60%). The observed variability highlights the genotypic influence on oil biosynthesis potential in melon seeds, with Gorgab demonstrating superior suitability for oil extraction purposes (Figure 1).

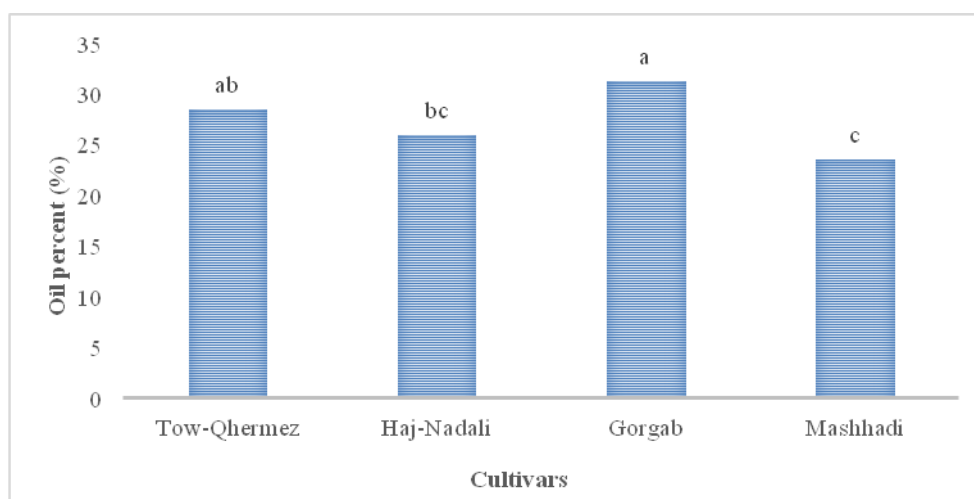


Figure 1. Oil percent in seeds of some Iranian local melon cultivars

Composition of Saturated Fatty Acids (SFAs)

Palmitic acid (C16:0) was the predominant saturated fatty acid, ranging from 9.15% in Tow-Qhermez to 10.22% in Mashhadi cultivar. Stearic acid (C18:0) content varied significantly ($p < 0.05$) among the cultivars, with Gorgab containing the lowest level (5.52%) and Haj-Nadali the highest (7.03%). Arachidic acid (C20:0) content was relatively low across all cultivars, ranging from 0.07% in Tow-Qhermez to 0.14% in Mashhadi (Table 3).

Table 3. The concentration of oil percent, saturated and unsaturated fatty acids in different cultivars of Iranian melon

Fatty acids / Cultivars	Tow-Qhermez	Haj-Nadali	Gorgab	Mashhadi	LSD
Oil percent	28.5 ^{ab}	26.00 ^{bc}	31.30 ^a	23.60 ^c	4.07
Palmitic acid (C16:0)	9.15 ^c	9.32 ^b	9.39 ^b	10.22 ^a	0.12
Stearic acid (C18:0)	6.21 ^{ab}	7.03 ^a	5.52 ^b	6.46 ^{ab}	0.96
Arachidic acid (20:0)	0.07 ^d	0.11 ^b	0.09 ^c	0.14 ^a	0.01
Oleic acid (C18:1, n-9)	27.9 ^a	27.5 ^a	22.3 ^b	30.6 ^a	4.10
Eicosenoic acid (C20:1, n-9)	0.15 ^a	0.16 ^a	0.15 ^a	0.11 ^b	0.02
Linoleic acid (C18:2, n-6)	55.5 ^b	54.8 ^b	61.6 ^a	51.4 ^b	4.49
Linolenic acid (C18:3, n-6)	0.17 ^a	0.17 ^a	0.12 ^b	0.17 ^a	0.01
Total SFA	15.4 ^{bc}	16.4 ^{ab}	15.0 ^c	16.8 ^a	1.22
USFA/SFA [†]	5.44 ^a	5.04 ^b	5.62 ^a	4.90 ^b	0.29

Different lower letters in the same row within each cultivar indicate significant difference with cultivar

[†]: SFA; total saturated fatty acids, USFA; total unsaturated fatty acids.

Composition of Unsaturated Fatty Acids (USFAs)

Linoleic acid (C18:2, n-6) was the most abundant fatty acid in all cultivars. Gorgab exhibited the highest linoleic acid content (61.6%), followed by Tow-Qhermez (55.5%), Haj-Nadali (54.8%), and Mashhadi (51.4%) (Figure 2).

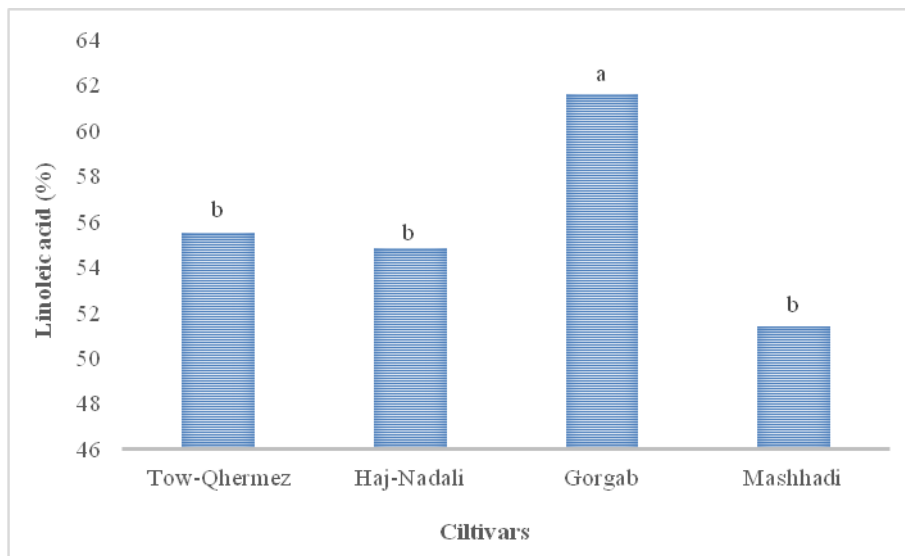


Figure 2. Linoleic acid content (C18:2, n-6) in seeds of Iranian local melon cultivars

Oleic acid (C18:1, n-9) ranged from 22.3% in Gorgab to 30.6% in Mashhadi, with significant differences ($p < 0.01$) observed. Eicosenoic acid (C20:1, n-9) was present in minor amounts (0.11–0.16%) across all cultivars. Linolenic acid (C18:3, n-6) was detected in small but consistent quantities (0.12–0.17%) (Table 3).

Total Fatty Acid Profile and Ratios

The total saturated fatty acids (SFA) content ranged from 15.0% in Gorgab to 16.8% in Mashhadi. The unsaturated-to-saturated fatty acid ratio (USFA/SFA) was highest in Gorgab (5.62) and Tow-Qhermez (5.44), followed by Haj-Nadali (5.04), and Mashhadi (4.90), indicating a generally favorable nutritional lipid profile across all cultivars (Table 3).

DISCUSSION

Variability in Oil Yield and Genotypic Influence

The significant differences in seed oil content among the four *Cucumis melo* cultivars (ranging from 23.60% in Mashhadi to 31.30% in Gorgab) highlight the strong influence of genotype on oil biosynthesis in melon seeds. Gorgab's superior oil yield (31.30%) aligns with previous studies on melon cultivars, such as those by Petkova and Antova (2015), who reported oil contents of 25-33% in Bulgarian melon varieties. The higher oil yield in Gorgab may be attributed to genetic factors that enhance lipid accumulation in the seed, such as increased activity of enzymes involved in fatty acid synthesis, including acetyl-CoA carboxylase and fatty acid synthase (Baud and Lepiniec, 2010). In contrast, Mashhadi's lower oil content (23.60%) suggests a potential limitation in lipid storage capacity, possibly due to differences in seed size, embryo development, or environmental adaptation (Yermanos *et al.*, 1972). These findings underscore the importance of cultivar selection for oil production purposes, with Gorgab emerging as a promising candidate for commercial oil extraction in Iran, a region renowned for its diverse melon germplasm.

Composition of Saturated Fatty Acids (SFAs)

Palmitic acid (C16:0) was the predominant saturated fatty acid across all cultivars, with values ranging from 9.15% in Tow-Qhermez to 10.22% in Mashhadi. These results are consistent with reports by de Melo *et al.* (2000), who found palmitic acid to be the primary SFA in melon seeds, typically ranging from 8-12%. The slight variation observed in this study may reflect genotypic differences in the regulation of palmitic acid biosynthesis, particularly through the activity of the ketoacyl-ACP synthase II enzyme, which elongates fatty acid chains (Harwood, 2005). Stearic acid (C18:0) content also varied significantly, with Gorgab exhibiting the lowest level (5.52%) and Haj-Nadali the highest (7.03%). This variability aligns with findings by Yanty *et al.* (2014), who reported stearic acid levels of 4.5-7.0% in melon seeds, attributing differences to genetic factors and environmental conditions such as temperature during seed development. The low levels of arachidic acid (C20:0, 0.07-0.14%) are typical for cucurbit seeds, as noted by Anwar *et al.* (2011), and suggest a minor role for long-chain SFAs in melon seed oil composition.

Composition of Unsaturated Fatty Acids (USFAs)

Linoleic acid (C18:2, n-6) was the most abundant fatty acid in all cultivars, with Gorgab showing the highest content (61.6%) and Mashhadi the lowest (51.4%). These values are within the range reported for melon seeds (50-70%) by Petkova and Antova (2015) and indicate that melon seed oil is a rich source of essential polyunsaturated fatty acids (PUFAs). The high linoleic acid content in Gorgab is particularly notable, as this fatty acid is a precursor to omega-6 fatty acids, which play a critical role in human health by reducing low-density lipoprotein (LDL) cholesterol levels and supporting cardiovascular health (Simopoulos, 2008). The variation in linoleic acid content among cultivars may be linked to differences in the expression of desaturase enzymes, such as $\Delta 12$ -desaturase, which converts oleic acid to linoleic acid (Shanklin and Cahoon, 1998). Oleic acid (C18:1, n-9) levels ranged from 22.3% in Gorgab to 30.6% in Mashhadi, reflecting an inverse relationship with linoleic acid content. This trade-off is consistent with the competitive nature of fatty acid desaturation pathways, as reported by Dar *et al.* (2017) in cucurbit seeds. The presence of minor amounts of eicosenoic acid (C20:1, n-9) and linolenic acid (C18:3, n-6) further supports the nutritional value of melon seed oil, though their low concentrations limit their contribution to overall health benefits.

Cluster Analysis of Genotypes Based on Fatty Acid Composition

To evaluate the similarities and differences among the studied genotypes in terms of their fatty acid profiles, hierarchical cluster analysis (HCA) was performed using standardized data (Z-scores). The analysis was conducted based on Ward's method with Euclidean distance, and the resulting dendrogram revealed meaningful grouping among the genotypes (Figure 3).

Genotypes grouped within the same cluster possess the potential to be selected as genetically similar sources for breeding programs or the development of oilseed products with specific nutritional or industrial purposes.

The dendrogram clearly categorized the four genotypes into three main clusters: Cluster I included the genotypes Haj-Nadali and Tow-Qhermezi, which showed the closest similarity in fatty acid composition. These genotypes exhibited relatively moderate levels of linoleic and stearic acids and a comparable USFA/SFA ratio, suggesting a similar biochemical behavior and possibly shared environmental or genetic influences. Cluster II was formed by the genotype Gorgab, which was positioned near Cluster I but remained distinct due to its notably higher levels of unsaturated fatty acids, particularly linoleic and linolenic acids, as well as a higher USFA/SFA ratio. These characteristics imply a superior nutritional quality and suggest this genotype may be valuable for the production of health-promoting oil products. Cluster III consisted solely of the Mashhadi genotype, which was clearly separated from the other genotypes at a greater distance (Figure 3). This separation reflects its distinctive profile, characterized by elevated levels of saturated fatty acids such as palmitic and arachidic acids, and a significantly lower USFA/SFA ratio. The clustering pattern highlights the unique fatty

acid composition of Mashhadi, indicating its potential utility in applications requiring higher oxidative stability.

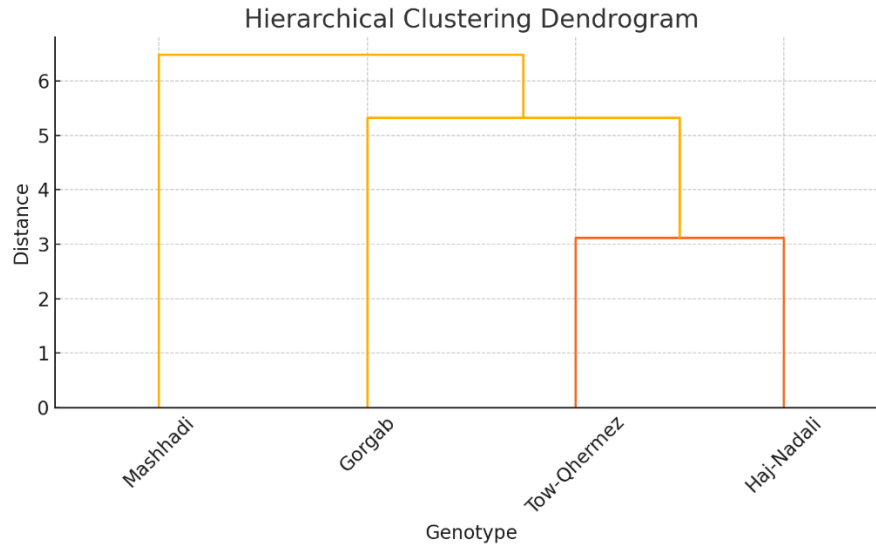


Figure 3. Cluster analysis of oil content and fatty acids composition in different melon cultivars

The clustering results underline the genetic and biochemical diversity among the genotypes and provide a useful framework for selecting promising candidates based on specific fatty acid traits. Genotypes within the same cluster may serve as suitable parents in breeding programs aimed at enhancing oil quality. For example, Gorgab can be considered a superior genotype for the enrichment of unsaturated fatty acids, while Mashhadi may be more suitable for uses where stability is prioritized over nutritional quality.

Principal component analysis (PCA)

To further interpret the interrelationships between fatty acid traits and to group genotypes based on their overall profiles, a Principal Component Analysis (PCA) was performed. The first two principal components accounted for 93.3% of the total variance (PC1: 74.4%, PC2: 18.9%).

The biplot of PCA revealed a clear distinction between genotypes, particularly between 'Gorgab' and 'Mashhadi', suggesting significant differences in their fatty acid composition. PC1 had high positive loadings for linoleic acid, linolenic acid, USFA/SFA ratio, and oil percentage, and negative loadings for total SFA and palmitic acid. PC2 was primarily associated with variations in stearic and arachidic acids. Gorgab cultivar grouped in the positive PC1 axis, indicating higher levels of unsaturated fatty acids and oil content. Mashhadi cultivar appeared on the negative side of PC1, correlating with higher saturated

fatty acid content. Finally, Tow-Qhermezi and Haj-Nadali were located in intermediate positions, representing mixed fatty acid profiles (Figure 4).

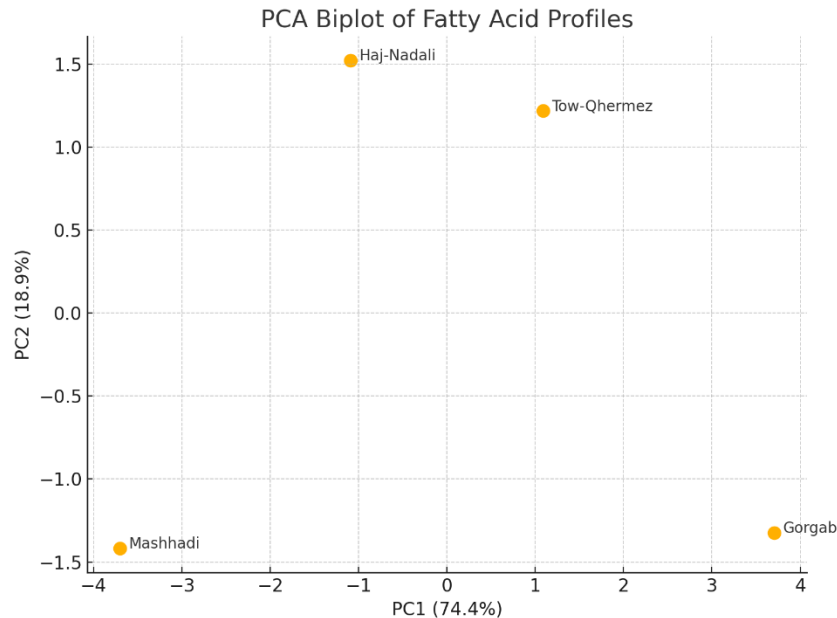


Figure 4. Principal component analysis (PCA) biplot of fatty acid profiles among four Iranian melon genotypes

Total Fatty Acid Profile and Nutritional Implications

The total saturates fatty acids (SFA) content ranged from 15.0% in Gorgab to 16.8% in Mashhadi, which is relatively low compared to other oilseeds like sunflower (20-25%) (Gupta *et al.*, 2015). This low SFA content, combined with a high USFA/SFA ratio (4.90-5.62), indicates a favorable nutritional profile for melon seed oil. The highest USFA/SFA ratio in Gorgab (5.62) suggests that this cultivar may offer superior health benefits, as diets rich in unsaturated fatty acids are associated with reduced risk of cardiovascular diseases (Hu *et al.*, 2001). Tow-Qhermez and Haj-Nadali, with USFA/SFA ratios of 5.44 and 5.04, respectively, also exhibit desirable lipid profiles, making them suitable for functional food applications. The lower ratio in Mashhadi (4.90) may be due to its higher SFA content (16.8%), particularly palmitic and stearic acids, which could reduce its nutritional appeal compared to the other cultivars. These findings are in line with those of Veronezi and Costa (2021), who emphasized the importance of USFA/SFA ratios in evaluating the nutritional quality of seed oils.

This high R^2 value suggests that genotypic factors account for a substantial proportion of the variation in linoleic acid content, consistent with studies by Yanty *et al.* (2014), who reported similar R^2 values for PUFAs in cucurbit seeds. The lower R^2 for arachidic acid (0.62)

may reflect the minor contribution of this fatty acid to the overall lipid profile, as well as potential environmental influences that were not accounted for in the model (Harwood, 2005).

The results of this study have several practical implications for the food and nutraceutical industries. The high oil yield and linoleic acid content of Gorgab make it an ideal candidate for commercial oil production, particularly for use in functional foods and dietary supplements aimed at improving cardiovascular health. Tow-Qhermez and Haj-Nadali, with their balanced USFA/SFA ratios, could be utilized in blends to enhance the nutritional quality of edible oils. Mashhadi, despite its lower oil yield and USFA/SFA ratio, may still be valuable for niche markets where specific fatty acid profiles are desired. Additionally, the variability in fatty acid composition among cultivars highlights the potential for targeted breeding programs to enhance desirable traits, such as increasing linoleic acid content or reducing SFAs (Dar *et al.*, 2017).

Future research should focus on the environmental factors (e.g., soil type, irrigation, and temperature) that may influence oil yield and fatty acid composition in melon seeds. Moreover, studies on the bioaccessibility and bioavailability of these fatty acids in human diets could further elucidate their health benefits. Finally, integrating genomic approaches, such as quantitative trait loci (QTL) mapping, could help identify the genetic basis of oil content and fatty acid profiles, facilitating the development of improved melon cultivars for oil production.

CONCLUSION

This study provides a comprehensive analysis of the seed oil content and fatty acid composition of four Iranian melons (*Cucumis melo* L.) cultivars (Gorgab, Tow-Qhermez, Haj-Nadali, and Mashhadi) highlighting significant genotypic variability in lipid profiles. Gorgab emerged as the cultivar with the highest oil yield (31.30%) and linoleic acid content (61.6%), making it a promising candidate for commercial oil extraction and functional food applications. In contrast, Mashhadi exhibited the lowest oil content (23.60%) and USFA/SFA ratio (4.90), indicating a less favorable nutritional profile compared to the other cultivars. The predominance of linoleic acid (51.4–61.6%) and oleic acid (22.3–30.6%) across all cultivars underscores the potential of melon seed oil as a rich source of essential unsaturated fatty acids, which are beneficial for cardiovascular health. The total SFA content and high USFA/SFA ratios further confirm the nutritional quality of these oils, particularly in Gorgab and Tow-Qhermez.

The significant differences ($p < 0.05$ or $p < 0.01$) in oil yield and fatty acid composition among the cultivars emphasize the importance of genotypic factors in lipid biosynthesis, supported by high R^2 values (0.62–0.95) in the statistical model. These findings contribute to the growing body of knowledge on Iranian melon germplasm and provide valuable insights for breeding programs aimed at enhancing oil yield and nutritional quality. Future research

should explore the environmental factors influencing fatty acid profiles, such as soil composition and climate, and investigate the bioaccessibility of these fatty acids in human diets. Additionally, integrating genomic tools to identify quantitative trait loci (QTLs) associated with oil content and fatty acid composition could further support the development of improved melon cultivars for industrial and nutritional applications.

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