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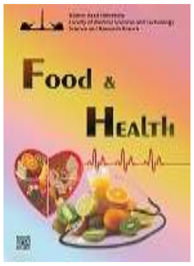

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Nutritional evaluation of 24 Iranian *Punica granatum* genotypes

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ABSTRACT

Punica granatum L. is one of Iran's native medical plants which represents many nutritional compounds and pharmaceutical properties. The amount of biochemical composite of the fruit depends on the cultivar, environment, climate, ripeness stage, cultivating operations, and method of storage. The point of this research focuses on describing, assessing, and comparing 24 genotypes of the Iranian pomegranate using some noticeable nutritional features belonging to different provinces. In October 2017 pomegranate fruits from the collection of Yazd Agricultural and Natural Resources Research and Training Center were harvested in three repetitions. The results revealed significant differences between genotypes of the pomegranates in terms of nutritious characteristics at 1%. Our finding showed that the most amount of anthocyanin was seen in genotype *Tabestani shirin Saveh* (S783) while the maximum level of polyphenols and total soluble solids were in genotype *Gell mamouli Taft* (Y491). The highest amount of antioxidant capacity was obtained in genotype *Malas Daneh ghermez Kan* (T191) when the maximum level of total acidity was observed in *Malas zoodras Kan* (T411). (T191) *Malas Daneh ghermez Kan* and (Y976) *Malas Poost Nazok Yazd* which have good appearance quality and red-colored juice. The grouping of all the existing genotypes in the mentioned collection, due to biochemical and nutritional properties, should be considered a research priority.

1. Introduction

Pomegranate is a popular medicinal plant belonging to the *Punicaceae* which is of high importance in terms of nutrition, medicine, horticulture, green zones, and environment. Other important information regarding this plant domestication can be referred to ancient Iran and Egypt. The pomegranate fruit widely is used in both forms fresh and processed such as pomegranate paste, juice, seeds, vinegar, and concentrated extract. It is said that different parts of fruit, juice, leaves, and bark have been applied in Iranian herbal medicine (1). This is a natural source of phenolic compounds that contains anti-oxidants including Tannin, polyphenols, flavonoid, and vitamin C. Its anti-oxidants contains tocopherols and anthocyanin, which have preventive and healing properties (2). Pomegranate juice contains 85.4% water, 10.4% sugary ingredients, 1.4% pectin and 0.2-1% polyphenols. Other substances contain a very low amount of, fatty acids, amino acids, alkalis, indoleamines, sterols, triterpenoids, and alpha-tocopherol (3). Pomegranate juice has many biological activities such as anti-cancer properties (4), anti-bacterial (5), anti-oxidant activities, and the ability to scavenge free radicals (6), boost the immune system (7), prevent heart diseases (8), and preventing peroxidation of lipid even in densities lower than vitamin E (9). Pomegranate extracts have been used since ancient times to treat several conditions including parasitic and microbial infections, diarrhea, ulcers, aphthae, hemorrhage, and respiratory complications. Modern applications include hormone replacement therapy and oral hygiene as well as the treatment of immune suppression and cardiovascular complications. Moreover, other therapeutic properties such as antitumor, anti-inflammatory, antiviral, antibacterial, antidiarrheal, and antiobesity are currently under investigation. Pomegranate compounds that could be beneficial for human

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health in seed: ursolic acid and ɑ-tocopherol (apoptosis in cancer cells), sterols (inhibition of pro-inflammatory), punicic acid (enhance B-cell function), hydroxybenzoic acids (inhibition and apoptotic death of human DU-145 prostate cancer); in juice and peels: hydroxycinnamicacids (strong inhibitor in cell cancer), procanthocyanidins and anthocyanidins (antiangiogenic, antioxidant and anticarcinogenic activities), in a peel: flavonols and flavones (anti-cancer), flavanone glycosides, in leaf apigenin human (inhibition of breast cancer), in flower: maslinic acid (macrophages), asiatic acid (control of prostate cancer cells) (10). Anthocyanins which are flavonoids with antioxidant abilities and cause shining in pomegranate juice increase during the ripening of the fruit and decrease after the fruit turns placid (11). The physicochemical properties of the pomegranate change during the fruit ripening (12). Zarei et al. (13) measured the qualitative traits and the amount of ascorbic acid, sugar, total soluble solid, tannin, antioxidant activity, and anthocyanin and reported that there were significant differences between six cultivars based on these parameters. Fadavi et al. (14) stated significant differences in ten pomegranate cultivars in terms of peel thickness, fruit juice, minerals, vitamin C, protein, pH, TA, and TSS. Feyzi et al. (15) expressed some biochemical quality of two commercial Iranian pomegranate cultivars including *Malas* and *Yoosfakhani* in three different regional situations of Iran (Ali abad, saari and saaveh). They concluded that cultivars and climates have important effects on vitamin C, acidity, EC, and TSS. In another research, it was proven that the amount of anthocyanin changes in different pomegranates and different regional situations but the flavonoid content did not have any significant variation while the phenolic compounds have significant fluctuation in different locations. Borges et al. (16) compared 36 common juices in Europe to assess the antioxidant capacity and polyphenolic compounds existing within them. Three kinds of pure pomegranate juice had the most ellagic tannins leading to the most anti-oxidant capacity. Therefore, this experiment was conducted to evaluate the qualitative amount of the compounds in some pomegranate genotypes. The identified groups can be used as a kind of valuable genetic resource in the future breeding programmers to create pharmaceutical and food industry and introducing it to researchers.

2. Materials and methods

2.1. Plant material

In October 2017, the 24 available genotypes were obtained from the Iranian pomegranate genetic collection in Yazd, with different origins (Yazd, Markazi, Saveh) in 3 repetitions. Traits were measured at the laboratory of Isfahan’s biotechnology institutes (Table 1).

2.2. Testing phytochemical traits

They were measured during this research including the amount of anthocyanin, polyphenols, antioxidant capacity, total soluble solids, and total acidity. To measure the amount of anthocyanin, polyphenols, and antioxidant capacity, the top phase of the juice was centrifuged at 4500 RPM for 3 min. Non-centrifuged juice was used for the total soluble solids and total acidity. Total anthocyanin in pomegranate seeds was evaluated using the absorption difference method at different pH with buffers 1 and 2. Buffer 1 includes potassium chloride and chloric acid 0.2 molar (pH=1) and buffer 2 contains acetic acid and sodium acetate, each one with 0.2 molar density (pH=4.5). The total anthocyanin was read at 520 and 700 nm

Table 1. List of evaluated pomegranate genotypes.

Number	Genotype		Origins	
	Code	Name	Province	City
1	Y110	Goroch Shahvar Yazd	Yazd	Yazd
2	Y111	Zagh Yazdi	Yazd	Yazd
3	Y112	Malas Yazdi	Yazd	Yazd
4	Y382	Amene Khatooni Yazd	Yazd	Yazd
5	Y491	Gell mamouli Taft	Yazd	Taft
6	Y499	Gell peyvandi Taft	Yazd	Taft
7	Y612	Gell Gabri Taft	Yazd	Taft
8	Y782	Malas Daneh siah Bafgh	Yazd	Bafgh
9	Y866	Gell torsh mamouli Taft	Yazd	Taft
10	Y871	Gabri sourati Abrandabad	Yazd	Abrandabad
11	Y947	Abanmahi Yazd	Yazd	Yazd
12	Y950	Gabri Daneh siah Yazd	Yazd	Yazd
13	Y976	Malas Poost Nazok Yazd	Yazd	Yazd
14	S716	Alak shirin Saveh	Markazi	Saveh
15	S733	Agha mohamad ali Saveh	Markazi	Saveh
16	S742	Malas shirin Saveh	Markazi	Saveh
17	S764	Alak poost ghermez Saveh	Markazi	Saveh
18	S783	Tabestani shirin Saveh	Markazi	Saveh
19	S948	Torsh Malas Saveh	Markazi	Saveh
20	T173	Malas PishvaVaramin	Tehran	Varamin
21	T191	Malas Daneh ghermez Kan	Tehran	Kan
22	T411	Malas zoodras Kan	Tehran	Kan
23	T475	Ghojagh PishvaVaramin	Tehran	Varamin
24	T484	Siahdaneh Malas Shahvar	Tehran	Tehran

(17). Polyphenols were recorded according to the Folin-Ciocalteu method. 100 µl diluted pomegranate juice with the ratio of (25:100) with methanol was mixed with 100 µl of Folin and 1.58 ml distilled water and was kept for 8 -10 min at room temperature, afterward 300 µl sodium carbonate solution was added the at 7.5%. After 90 min, the absorption rate was noted at 750 nm using the spectrophotometer (18). DPPH (2, -2 diphenyl-1- diphenyl-1- picryl hydrazyl) solution absorption was started after 15 min of being preserved in darkness, at 515 nm using a spectrophotometer, model: SHIMADZU UV-Visible, connected to UV-Prob software (19). Total soluble solids (TSS) in pomegranate extracts were measured with a digital Refractometer device, model: MTD045nD with a temperature corrector with Brix domain of 0-45% in the temperature of 20$^{\circ C}$ and were shown with °Brix. Total acidity (TA) according to the dominant acid in pomegranate (Citric acid) was measured using a G-Won Acidometer model: GMK-825 (20).

2.3. Testing fruit's quality

In order to test the quality of the fruit's appearance and juice color, a spectrum of numbers was assigned to their range, which was explained and analyzed in a quantitative form. Nondestructive methods used to measure the quality parameters of fruit, as 5(very good); 4(good); 3 (medium); 2 (week); 1(very week) (21). Analysis of variance for all traits was done using the SAS software ver.7 and average comparison was done with Duncan's multiple range tests.

3. Results and discussion

The results from the variance analysis showed that pomegranate genotypes have significant differences in terms of nutritional value at the level of 1% (Table 2). The considerable changes in anthocyanin were seen from the lowest amount (2.05 mg/l extract) in genotype T191 (*Malas Daneh ghermez Kan*) to the highest amount (87.39 mg/l extract) in genotype S783 (*Tabestani shirin Saveh*). Genotypes Y491 (*Gell mamouli Taft*) and Y782 (*Malas Daneh siah Bafgh*) also had high amounts of anthocyanin (Fig. 1).

Table 2. Analysis of variance of fruit biochemical properties in pomegranate genotypes.

		Mean Square						
SOV	**DF**	**Anthocyanin**	**polyphenols**	**Antioxidant capacity**	**TSS**	**TA**	**fruit appearance quality**	**Juice color**
Genotype	23	2144.79**	123974.05**	322.07**	5.7688**	0.505**	8.55**	10.55**
Error	48	21.37	6402.90	5.98	0.43	0.01	0.64	0.11
CV%	-	10.57	10.70	3.39	3.95	12.63	11.67	10.2
SE	-	2.66	46.19	1.41	0.38	0.67	0.46	0.32

**significant difference at the level

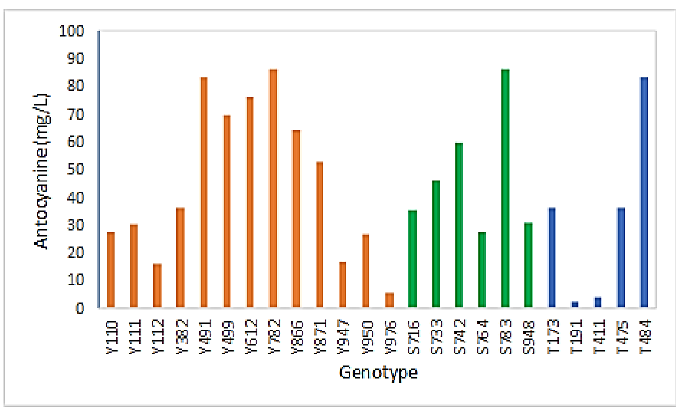

Fig. 1. The effect of genotype on anthocyanin content in pomegranate. **Y110:** Goroch Shahvar Yazd; **Y111:** Zagh Yazdi; **Y112:** Malas Yazdi; **Y382:** Amene Khatooni Yazd; **Y491:** Gell mamouli Taft; **Y499:** Gell peyvandi Taft; **Y612:** Gell Gabri Taft; **Y782:** Malas Daneh siah Bafgh; **Y866:** Gell torsh mamouli Taft; **Y871:** Gabri sourati Abrandabad; **Y947:** Abanmahi Yazd; **Y950:** Gabri Daneh siah Yazd; **Y976**: Malas Poost Nazok Yazd; **S716:** Alak shirin Saveh; **S733:** Agha mohamad ali Saveh; **S742:** Malas shirin Saveh; **S764:** Alak poost ghermez Saveh; **S783:** Tabestani shirin Saveh; **S948:** Torsh Malas Saveh; **T173:** Malas PishvaVaramin; **T191:** Malas Daneh ghermez Kan; **T411:** Malas zoodras Kan; **T475:** Ghojagh PishvaVaramin; **T484**: Siahdaneh Malas Shahsavar.

Previous research showed different amounts of total anthocyanin content in the pomegranate. Tehranifar et al. (22) reported 30.11 mg/ 100 g of anthocyanin for "*Malas Yazdi*" cultivar as the highest amount of total anthocyanin among other cultivars. Tatari et al. (23) also reported "*Malas shirin* (77 mg/l) as a superior, in terms of anthocyanin amount. The results of this experiment are close to the amounts of the measured eleven pomegranate cultivars, collected from the garden of Yazd's pomegranate collection. Differences in amount of anthocyanin can be related to the difference of harvesting time (24). On the other hand, the difference between the obtained numbers can be caused by the destruction and instability of anthocyanin. The stability of anthocyanin changes with temperature, pH, light, and oxygen and is sensitive to the destruction caused by oxidizing enzymes (25-26). Variation of total polyphenol ranges from the highest rate: 1120.92 mg/l in genotype Y491 (*Gell mamouli Taft*) to the lowest: 251.47 mg/l in genotype Y947 (*Abanmahi Yazd*). Genotypes Y782 (*Malas Daneh siah Bafgh*) and S783 (*Tabestani shirin Saveh*) also indicated a high level of polyphenols (Fig. 2). In comparing research (26), which proved the total content of polyphenols between 2376 and 9304 mg/l and with the range of 3000 to 8000 mg/l, less amount was obtained (23) but is close to (22) with the range of 306 to 985 mg/l. According to total polyphenols content, which includes anthocyanin as well (27), therefore all factors that affect anthocyanin's stability, also effects the amount of polyphenol. From these factors, we can point out cultivar, temperature, light, and oxygen (25-24). Antioxidant capacity among studied genotypes differs from 89.98 in genotype T191

(*Malas Daneh ghermez Kan*) with the highest to 54.29 in genotype S733 (*Agha mohamad ali Saveh*) with the lowest variable.

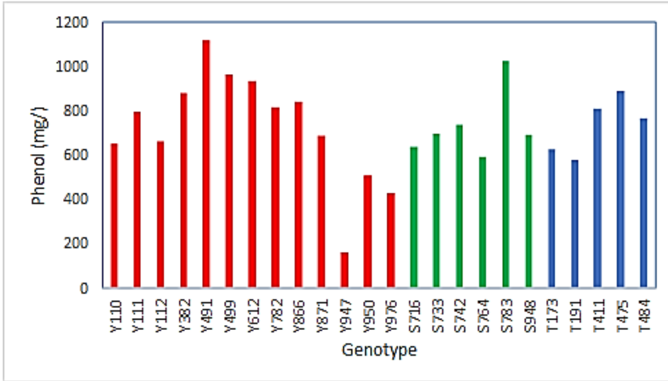

Fig. 2. The effect of genotype on phenol content in pomegranate. **Y110:** Goroch Shahvar Yazd; **Y111:** Zagh Yazdi; **Y112:** Malas Yazdi; **Y382**: Amene Khatooni Yazd; **Y491:** Gell mamouli Taft; **Y499:** Gell peyvandi Taft; **Y612:** Gell Gabri Taft; **Y782:** Malas Daneh siah Bafgh; **Y866:** Gell torsh mamouli Taft; **Y871:** Gabri sourati Abrandabad; **Y947:** Abanmahi Yazd; **Y950:** Gabri Daneh siah Yazd; **Y976:** Malas Poost Nazok Yazd; **S716:** Alak shirin Saveh; **S733:** Agha mohamad ali Saveh; **S742:** Malas shirin Saveh; **S764:** Alak poost ghermez Saveh; **S783:** Tabestani shirin Saveh; **S948:** Torsh Malas Saveh; **T173:** Malas PishvaVaramin; **T191:** Malas Daneh ghermez Kan; **T411:** Malas zoodras Kan; **T475:** Ghojagh PishvaVaramin; **T484:** Siahdaneh Malas Shahsavar.

According to the obtained results, the antioxidant capacity in genotypes S764 (*Alak poost ghermez Saveh*) and Y871 (*Gabri sourati Abrandabad*) and Y382 (*Amene Khatooni Yazd*) were low. Anti-oxidant capacity in genotypes S948 (*Torsh Malas Saveh*) and Y491 (*Gell mamouli Taft*) were also high (Fig. 3). It ranges in (23) between 42 and 80 which were reported to be the highest capacity related to the "*malas shirin Saveh*" cultivar.

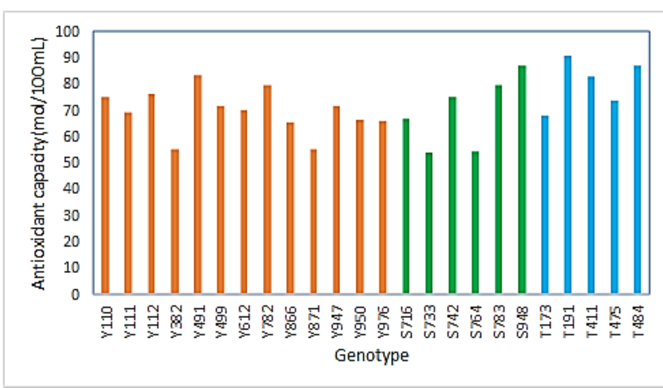

Fig. 3. The effect of genotype on antioxidant capacity in pomegranate. **Y110:** Goroch Shahvar Yazd; **Y111:** Zagh Yazdi; **Y112:** Malas Yazdi; **Y382**: Amene Khatooni Yazd; **Y491:** Gell mamouli Taft; **Y499:** Gell peyvandi Taft; **Y612:** Gell Gabri Taft; **Y782:** Malas Daneh siah Bafgh; **Y866:** Gell torsh mamouli Taft; **Y871:** Gabri sourati Abrandabad; **Y947:** Abanmahi Yazd; **Y950:** Gabri Daneh siah Yazd; **Y976:** Malas Poost Nazok Yazd; **S716:** Alak shirin Saveh; **S733:** Agha mohamad ali Saveh; **S742:** Malas shirin Saveh; **S764:** Alak poost ghermez Saveh; **S783:** Tabestani shirin Saveh; **S948:** Torsh Malas Saveh; **T173:** Malas PishvaVaramin; **T191:** Malas Daneh ghermez Kan; **T411:** Malas zoodras Kan; **T475:** Ghojagh PishvaVaramin; **T484:** Siahdaneh Malas Shahsavar.

Mousavinejad et al. (27) reported the anti-oxidant capacity to differ from 18 to 42.8 on 8 cultivars of the Iranian pomegranate, of which the highest amount was related to the "*Ostekhani Tabas*" cultivar. Tehranifar et al. (22) also proved the variation range of anti-oxidant capacity of their studied Iranian cultivars from 15.59 in "*Torsh Shahvar Kashmir*" to 40.7 in "*Malas poust sefid*" cultivar, while the average anti-oxidant capacity in studied genotypes in the present studies (T191, *Malas Daneh Ghermez Kan*) is higher. Borochov-Neori et al. (29) believe that the anti-oxidant capacity of pomegranates depends on the type of cultivar, environmental conditions, and ripening stage. Differences in cultivar type (genotype), cultivation conditions, extraction, and calculation methods effects anti-oxidant capacities. According to the obtained results, the most total soluble solid value was related to genotype Y491 (*Gell mamouli Taft*) with 18.46 ° Brix while the lowest was seen in genotype S733 (*Agha mohamad ali Saveh*) with the content at 11.73°Brix. Genotype Y110 (*Goroch Shalvar Yazd*) also has a high amount of TSS in genotypes T191 (*Malas Daneh ghermez Kan*), T173 (*Malas Pishva Varamin*) whereas S742 (*Malas shirin Saveh*) have an average lower than 16 °Brix (Fig. 4).

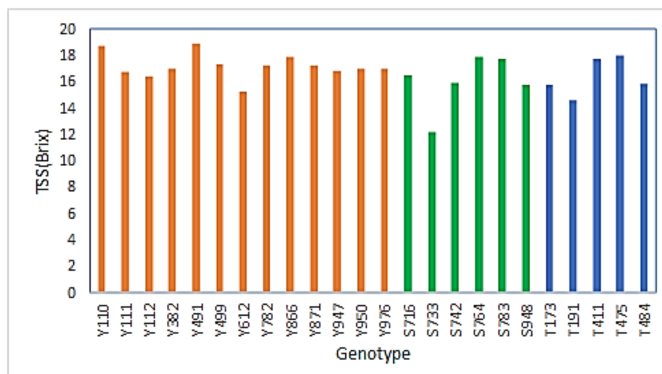

Fig. 4. The effect of genotype on TSS in pomegranate. **Y110:** Goroch Shahvar Yazd; **Y111:** Zagh Yazdi; **Y112:** Malas Yazdi; **Y382**: Amene Khatooni Yazd; **Y491:** Gell mamouli Taft; **Y499:** Gell peyvandi Taft; **Y612:** Gell Gabri Taft; **Y782:** Malas Daneh siah Bafgh; **Y866:** Gell torsh mamouli Taft; **Y871:** Gabri sourati Abrandabad; **Y947:** Abanmahi Yazd; **Y950:** Gabri Daneh siah Yazd; **Y976:** Malas Poost Nazok Yazd; **S716:** Alak shirin Saveh; **S733:** Agha mohamad ali Saveh; **S742:** Malas shirin Saveh; **S764:** Alak poost ghermez Saveh; **S783:** Tabestani shirin Saveh; **S948:** Torsh Malas Saveh; **T173:** Malas PishvaVaramin; **T191:** Malas Daneh ghermez Kan; **T411:** Malas zoodras Kan; **T475:** Ghojagh PishvaVaramin; **T484:** Siahdaneh Malas Shahsavar.

Mirjalili et al., (30) stated the most total soluble solid in genotype *(Malas Naalout Baneh Kordestan*) with 18.53 ° Brix when the lowest amount was in genotype (*Malas Shahvar*

Dastjerd) with 13.96° Brix. Barzegar et al., (31) reported the average amount of total soluble solid to be 12.1-18.3°Brix by researching 15 pomegranate cultivars. Taste is an indicator of the fruit's quality which depend on the ratio of the amount of sugar to acid and is affiliated with the cultivar. The amount of total soluble solid, above 17 percent is optimal in most of Iran's industrial cultivars (32). The most amount of total acidity was observed in genotype T411 (*Malas zoodras Kan*) with an average of 2.06, Y491 (*Gell mamouli Taft*) at 1.95, respectively. The lowest TA belonged to S733 (*Agha mohamad ali Saveh*) with a value of 0.51. The studied genotypes can be divided into three groups. The first group includes genotype T411 (*Malas zoodras Kan*) with average acidity above 2. Cultivars of Y491 (*Gell mamouli Taft*), Y499 (*Gell peyvandi Taft*), Y111 (*Zagh Yazdi*), T475 (*Ghojagh Pishva Varamin*), and Y976 (*Malas Poost Nazok Yazd*) with acidity between 1-2 and the rest was up to 1 level (Fig. 5).

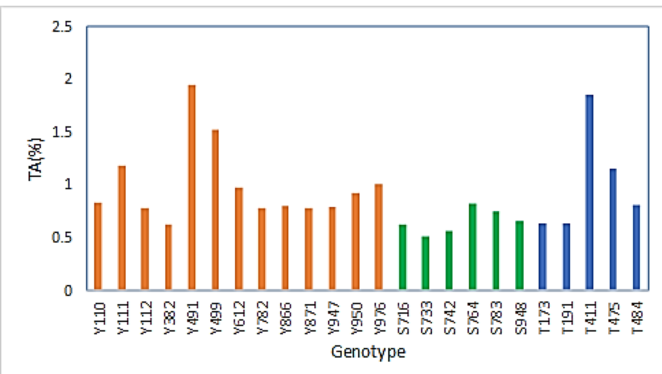

Fig 5. The effect of genotype on TA in pomegranate. **Y110:** Goroch Shahvar Yazd; **Y111:** Zagh Yazdi; **Y112:** Malas Yazdi; **Y382**: Amene Khatooni Yazd; **Y491:** Gell mamouli Taft; **Y499:** Gell peyvandi Taft; **Y612:** Gell Gabri Taft; **Y782:** Malas Daneh siah Bafgh; **Y866:** Gell torsh mamouli Taft; **Y871:** Gabri sourati Abrandabad; **Y947:** Abanmahi Yazd; **Y950:** Gabri Daneh siah Yazd; **Y976:** Malas Poost Nazok Yazd; **S716:** Alak shirin Saveh; **S733:** Agha mohamad ali Saveh; **S742:** Malas shirin Saveh; **S764:** Alak poost ghermez Saveh; **S783:** Tabestani shirin Saveh; **S948:** Torsh Malas Saveh; **T173:** Malas PishvaVaramin; **T191:** Malas Daneh ghermez Kan; **T411:** Malas zoodras Kan; **T475:** Ghojagh PishvaVaramin; **T484:** Siahdaneh Malas Shahsavar.

Fruit's quality appearance showed group one includes genotypes: Y871 (*Gabri sourati Abrandabad*), Y112 (*Malas Yazdi)*, T191 (*Malas Daneh ghermez Kan)*, and Y976 (*Malas Poost Nazok Yazd*) which have good appearance quality. Cultivars in group two S764 (*Alak poost ghermez Saveh)*, Y782 (*Malas Daneh siah Bafgh)*, Y947(*Abanmahi Yazd*), S783 (*Tabestani shirin Saveh)*, S733 (*Agha mohamad ali Saveh*) and S948 (*Torsh Malas Saveh*) are weak in terms of appearance quality and other genotypes are of average quality (Fig. 6). Genotypes S783 (*Tabestani shirin Saveh)*, Y612 (*Gell Gabri Taft*), Y782 (*Malas Daneh siah Bafgh*), Y866 (*Gell torsh mamouli Taft*), Y950 (*Gabri Daneh siah Yazd*), T191 (*Malas Daneh ghermez Kan*) and Y976 (*Malas Poost Nazok Yazd*) have a red colored juice and genotypes T475 (*Ghojagh PishvaVaramin*), S948 (*Torsh Malas Saveh*), S733 (*Agha mohamad ali Saveh*), Y110 (*Goroch Shahvar Yazd*), Y947 (*Abanmahi Yazd*), S742(*Malas shirin Saveh*), S764 (*Alak poost ghermez Saveh*) have a cream-colored juice and other cultivars' juices are between these two colors (Fig. 7).

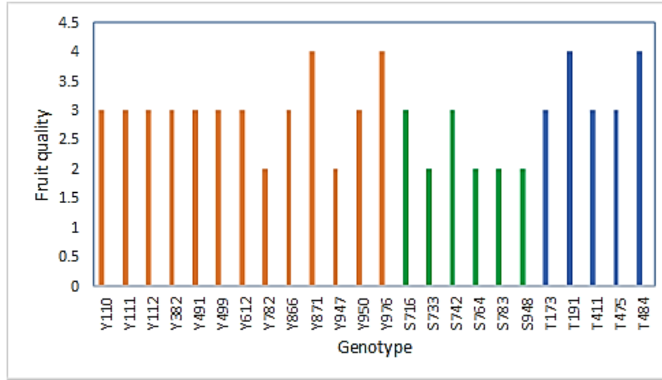

Fig. 6. The effect of genotype on fruit quality in pomegranate. **Y110:** Goroch Shahvar Yazd; **Y111:** Zagh Yazdi; **Y112:** Malas Yazdi; **Y382**: Amene Khatooni Yazd; **Y491:** Gell mamouli Taft; **Y499:** Gell peyvandi Taft; **Y612:** Gell Gabri Taft; **Y782:** Malas Daneh siah Bafgh; **Y866:** Gell torsh mamouli Taft; **Y871:** Gabri sourati Abrandabad; **Y947:** Abanmahi Yazd; **Y950:** Gabri Daneh siah Yazd; **Y976:** Malas Poost Nazok Yazd; **S716:** Alak shirin Saveh; **S733:** Agha mohamad ali Saveh; **S742:** Malas shirin Saveh; **S764:** Alak poost ghermez Saveh; **S783:** Tabestani shirin Saveh; **S948:** Torsh Malas Saveh; **T173:** Malas PishvaVaramin; **T191:** Malas Daneh ghermez Kan; **T411:** Malas zoodras Kan; **T475:** Ghojagh PishvaVaramin; **T484:** Siahdaneh Malas Shahsavar.

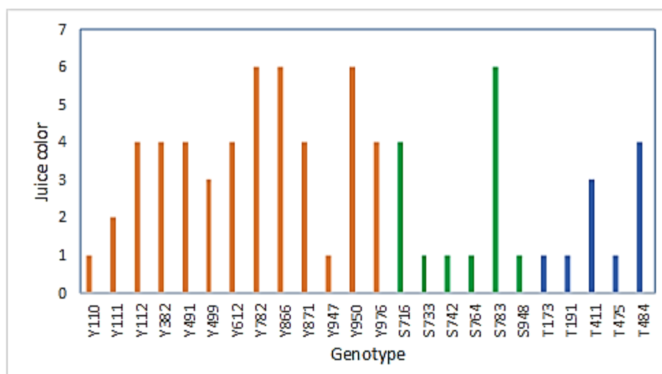

Fig. 7. The effect of genotype on juice color in pomegranate. **Y110:** Goroch Shahvar Yazd; **Y111:** Zagh Yazdi; **Y112:** Malas Yazdi; **Y382**: Amene Khatooni Yazd; **Y491:** Gell mamouli Taft; **Y499:** Gell peyvandi Taft; **Y612:** Gell Gabri Taft; **Y782:** Malas Daneh siah Bafgh; **Y866:** Gell torsh mamouli Taft; **Y871:** Gabri sourati Abrandabad; **Y947:** Abanmahi Yazd; **Y950:** Gabri Daneh siah Yazd; **Y976:** Malas Poost Nazok Yazd; **S716:** Alak shirin Saveh; **S733:** Agha mohamad ali Saveh; **S742:** Malas shirin Saveh; **S764:** Alak poost ghermez Saveh; **S783:** Tabestani shirin Saveh; **S948:** Torsh Malas Saveh; **T173:** Malas PishvaVaramin; **T191:** Malas Daneh ghermez Kan; **T411:** Malas zoodras Kan; **T475:** Ghojagh PishvaVaramin; **T484:** Siahdaneh Malas Shahsavar.

The amount of TA also affects the fruit's quality and taste.

The dominant acid existing in pomegranate juice is acetic acid. The effect of acidity on pomegranate juice is increasing the sour taste (27). Jalili Moghadam, (32) believes that cultivars with less acidity have commercially valuable; but the choice in the market for pomegranate taste depends on the people of every country. In Iran, people mostly are interested in sour/sweet-tasting but in India, sweet pomegranates with soft and juicy seeds are preferred whereas, for creating products such as pomegranate paste, sour cultivars are used more (33). Therefore, a range of tastes, based on needs and processing method, is used which makes it necessary for genotypes separation. Mirjalili et al. (30) introduced the lowest amount of TA in genotype "*Malas poost ghermez*" with an average of 0.57% and the highest amount in genotype "*Malas zoodras Kan*" with an average of 2.06%. Tatari et al. (23) reported numbers between 1.02% for "*Poust siah*" cultivar to 2.35% for "*Mala torsh Saveh*" in their study of eleven cultivars of Saveh pomegranates. Our results were matched with fifteen different cultivars that were collected from the garden of Yazd's research center collection and their acidity was reported to be between 0.42% and 2.05% (31). Pomegranate genotypes were analyzed to determine the similarity, and the dendrogram diagram shows these genotypes at a similarity level of 50% (Fig. 8). Based on analysis results registered in the dendrogram at a 50% similarity level, pomegranate genotypes were classified into the nine main groups of A, B, C, D, E, F, G, H, and I.

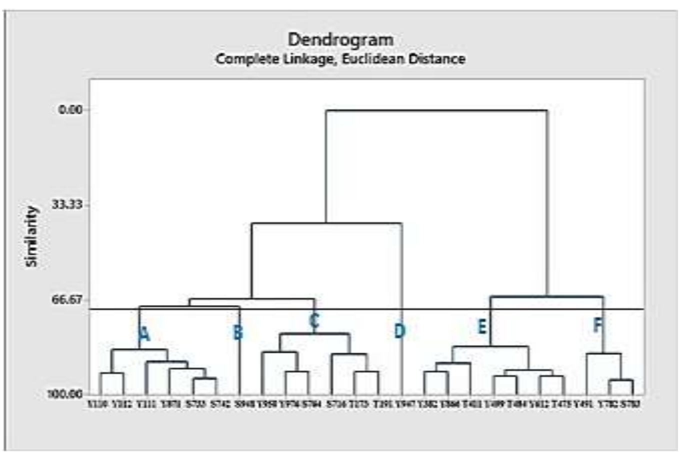

Fig. 8. Dendrogram diagram of biochemical properties of pomegranate genotypes (abbreviation of each genotype is recorded in Table 1).

Group A consists of Y110 (*GorochShahvar Yazd*) and Y112 (*Malas Yazdi*) & S733 (*Agha mohamadaliSaveh*) and S742 (*Malas shirin Saveh*) are very similar in terms of biochemical and morphological properties. Group B includes S948 (*Torsh Malas Saveh*). Group D contains Y947(*Abanmahi Yazd*). Group E has two clusters, which in first cluster genotypes Y382 (*Amene Khatooni Yazd*) and Y866 (*Gelltorshmamouli Taft*) and in second cluster genotypes Y499 (*Gellpeyvandi Taft*) and T484 (*Siahdaneh Malas Shahvar*) have major similarities with each other. Group F is related to genotype Y491 (*Gell mamouli Taft*) and two genotypes Y782 (*Malas Daneh siah Bafgh*) and S783 (*Tabestani shirin Saveh*) which have shown the most amount of similarity with each other.

4. Conclusion

In order to compare biochemical and nutritional content, 24 Iranian pomegranate genotypes were studied as indexes. All the studied genotypes were collected from the collection of genetic reserve and were grown under the same conditions in terms of the climate, temperature, and geography, nevertheless, the nutritional content and biochemical differences indicated a significant genetic impact. The grouping of all the existing genotypes in the mentioned collection, due to biochemical and nutritional properties, should be considered a research priority.

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