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Evaluation of Some Qualitative Characteristics of Wild Plum Genotypes in Northern Iran

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ABSTRACT: Guilan forests are one of the natural habitats for the varieties of wild plum and tomato that will be consumed fresh and processed by the residents of the areas. In this study, the amount of total phenol, antioxidant capacity, total acid, the amount of total soluble solids and the ratio of total soluble solids to total acid for each genotype were analyzed under completely randomized plan with three replications. Results from this study indicate that the total soluble solids of fruits were different in the range between 03/0 and 93/15 ° Brix. So that the genotype of "sour red plum" had the highest and genotype of "sour Black plum" had the lowest percentage of soluble solids. Genotype of "large sloe" with an average of 13/6 and the genotype of "golden plum" with an average of 64/3% of malic acid had the highest and lowest rates of the total acid. The ratio of total soluble solids to total acid of fruits was different in the range between 008/0 to 815/3. The genotype of "golden plum" had the highest and genotype of "sour black plum" had the lowest ratio of total soluble solids to total acid. The amount of total phenol in fruits peel and pulp mixture was in the range between 282 and 333/600. Genotypes of "golden plum" and "red sloe" had, respectively, the highest and lowest total phenol amount. Peel and pulp mixture of "sour red plum" genotype with an average of 58/66% had the highest, and "sour black plum" with 35/62% had the lowest antioxidant activity. It was also found that there is a positive linear correlation between total phenol and antioxidant activity of different genotypes of tomato tree.

Keywords: plum and tomato, antioxidant capacity, genotype, total phenol, total acid, soluble solids

INTRODUCTION

Plums and tomatoes are of the most important stone fruits which have been compatible to a wide range of soil and climatic conditions. These plants are in the Rosacea family, Prunoideae subfamily, and Prunus genus. The most common varieties under cultivation are European plums and Japanese plums. European plums are consumed dry and fresh, while Japanese plums are mostly consumed fresh (Artekien *et al,* 2006).

Many foods, especially fruits are rich in polyphenolic substances (Gonzalez - Molina *et al,* 2009). These substances are the most common phytochemical substances in most fruits (Muir *et al*, 2002). There are significant differences between different genotypes of plum in the total amount of phenolic substances, flavonoids and antioxidant activity. Reports have shown that the antioxidant activity of plums vary between different genotypes. It is also specified that genetic differences are caused the differences in secondary metabolites (Gill *et al*, 2003; Vasanta Ropasing *et al*, 2006; Vizoto *et al*, 2007). Genotypes with higher phenolic substances have more antioxidant activity (Boyer and Liu, 2004; Awad et al, 2000). It is known that plums have plenty of polyphenolic substances that are nontoxic (Bridle and Timberlake, 1996). Polyphenolic substances in plums have many benefits for human health and prevent diseases such as cataracts and atherosclerosis (Kaher and Smith, 1994), heart disease (Chang *et al*, 2010) and neurological diseases such as Parkinson and Alzheimer (Thomasset *et al,* 2006). The purpose of this study is to investigate the qualitative characteristics of the different genotypes of wild plum and compare the amount of total phenol and antioxidant capacity.

MATERIALS AND METHODS

This study was conducted on 20 varieties of tree tomato in the area of Amlash. Fruits of each variety were harvested when they are fully ripe. Considering that light plays an essential role in the synthesis of phenolic compounds, the sampling was made from the outer parts of the trees crown.

After harvest, the fruits were transferred to Horticulture Laboratory in Faculty of Agricultural Sciences (Guilan University). The fruits of plum different genotypic of Amlash area were evaluated in the terms of some features including total soluble solids, total acid, the ratio of soluble solids to total acid, total phenol and antioxidant capacity.

The amount of fruits soluble solids were measured by Refractometer digital device (Ceti-Belgium) at the temperature of 22°C. For this purpose, from each genotype, three fruits and each fruit three times was read out. Finally, the amount of soluble solids was expressed in °Brix. 5 ml of fruit juice after leaching with distilled water was reached to a volume of 35 ml. The amount of solution pH was measured and then with adding one-tenth normal sodium hydroxide to reach a pH of 3/8 to 1/8, the titration continued. The amount of consumed benefit was noted and after putting it on the following formula, the titratable amount of acid was expressed based on the malic acid percentage.

$$\text{Titratableacid(percent)} = \frac{Vb \times 072/0}{Vs \times 100}$$

Vb, the volume of consumed benefit; Vs, the volume of juice samples; 072/0, the coefficient related to malic acid

After measuring the soluble solids and titratable acidity, the TSS/TA ratio was calculated according to the following formula:

$$TSS/TA = \frac{Soluble\ solids}{Titratable\ acidity}$$

The measurement of total phenol of fruits was conducted using the Folin-Ciocalteu method (Singleton et al, 1999). To read the absorption rate of total phenol, 100 micro liter mixed extract of fruits pulp and peel was brought to a volume of 500 micro liters with distilled water and the amount of 2500 micro liter Folin (5 ml Folin with distilled water to a volume of 50 ml) was added. After 5 minutes from adding the Folin diluted with distilled water, the amount of 2000 micro liter of 5/7 percent sodium carbonate (adding 5/1 g of sodium carbonate in 20 ml of distilled water) were added and the samples were placed in dark conditions. After 5/1 h incubation at room temperature and dark conditions, the absorption rate of extract was read at the wavelength of 760 nm using a UV/Vis spectrophotometer (JENWAY – 6405).

Antioxidant capacity of the extracts was determined by neutralizing of free radical DPPH (2, 2-Diphenyl-1-picrylhydrazyl). For this purpose, 50 micro liter of the mixed extract of peel and pulp were poured inside the small Falcon tubes and 950 micro liter of normal solution of DPPH 1/0 was added to them. The resulting solution was stirred rapidly and then for 15 min was kept in a dark chamber at room temperature. Blank (zero) and standard samples was included 1 ml of extraction solvent and 1 ml of mixed extraction solvent and 1/0 normal solution of DPPH, respectively. Then the absorption rate of standard and sample was determined using a UV/Vis spectrophotometer (JENWAY - 6105) at the wavelength of 515 nm. This experiment was conducted for peel and pulp mixed samples, each cultivar separately in 3 iterations. Antioxidant capacity of the extracts was calculated as the DPPH inhibition percentage using the following equation.

Analysis of variance of the studied traits and comparison of the averages was done with Tukey's method by using SAS software Version 1/9.

RESULTS

Soluble solids; the results from data variance analysis showed that amount of soluble solids of different genotypes are significantly different at the 1% probability level (Table 1).

Table 1: Results of analysis of variance data related to soluble solids, total acid and the ratio of TSS/TA in different genotypes of tree tomato.

Sources of changes	Degrees of freedom	Pr > F measured traits		
		Soluble solids	total acid	TSS/TA Ratio
Genotype Error Total	19 40 59	<0.0001	<0.0001	<0.0001
Coefficient of Variation (%)	----	14.0323	7.69930	32.1842

According to the results obtained from the comparison of data average (Fig. 1), the amount of total soluble solids of fruits varied ranged between 03/0 and 93/15° Brix. So that the genotype of “sour red plum” has the highest and the genotype of **“**sour black plum” has the lowest amount. The amount of soluble solids varied in different genotypes of tree tomato. Genotypes with higher levels of soluble solids have the higher food quality.

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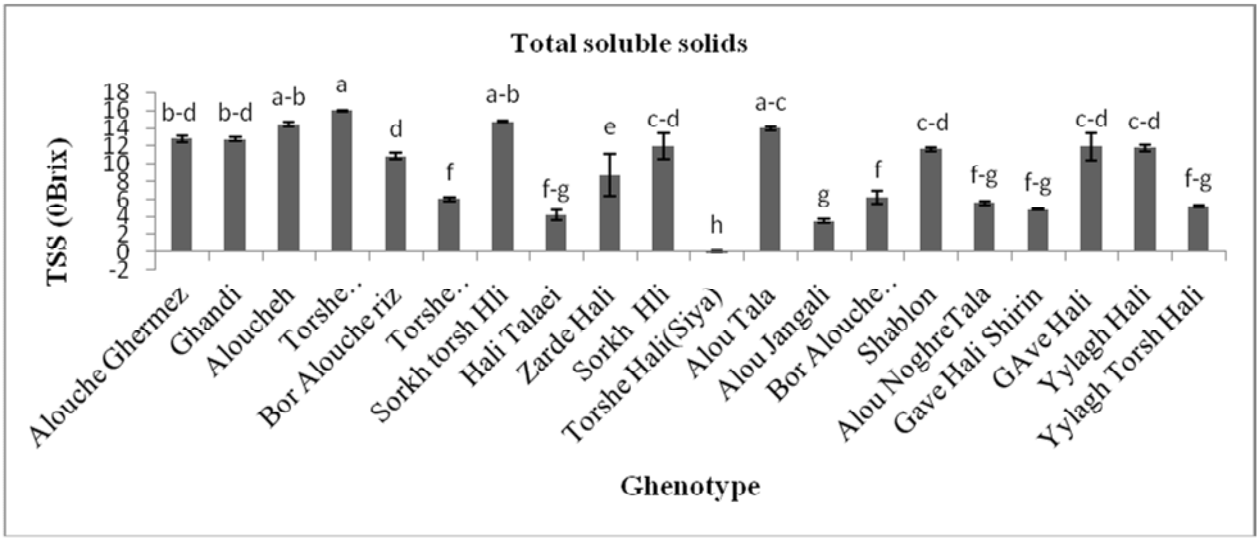

Fig. 1. Comparisons of the average of soluble solids in tree tomato with different genotypes in °Brix (SE ±) at Guilan province. The vertical lines indicate the standard error of the average. Averages with common letters have no significantly difference at the 1% probability level.

The amount of studied fruits TSS in this research was less that examined fruits by Voka *et al,* (2009) and TSS of examined fruits by Nance *et al,* (2009) was higher than reviewed fruits by Kaskouro and Guerra (2009). While the TSS amount in fruits under investigation was almost accordance with investigated fruits by Christel *et al,* (2011) and Ortork *et al,* (2009). TSS amount in plums plays an important role in marketability of this fruit. Sensory quality of the fruit such as its taste and sweetness is significantly associated with amount of TSS (Krisosto *et al*, 2004). The more TSS amount is, the sweeter the fruit will be.

Total Acid (TA)

Examine the table of data variance analysis showed that the amount of total acid of fruits different genotypes is significant at 5% probability level (Table 1).

According to the results from the data comparison (Fig. 2), the maximum amount of total acid was in the genotype of "large sloe" with an average of 13/6% of malic acid, and lowest amount of total acid was in the genotype of “Golden plum” with an average of 64/3% of malic acid. Overall, the amount of titratable acid in different genotypes of tree tomato was varying. In premature plums with high acid, TA plays an important role in the marketability of fruits with TSS less than 12 percent (Krisosto *et al*, 2004). So the importance of TA in the fruits with low TSS is greater than fruits with high TSS (Kaskouro and Guerra, 2009).

TSS/TA Ratio

Examine the Table of data variance analysis (Table 1) show that the ratio of soluble solids to the total acid of fruits is significant at the 1% probability level. The results from comparison of data average (Fig. 3) showed that the ratio of soluble solids to total acid of fruits varied in the ranges between 008/0 and 815/3 g. The genotype of “Golden plum” has the highest and genotype of "sour black plum" has the lowest ratio.

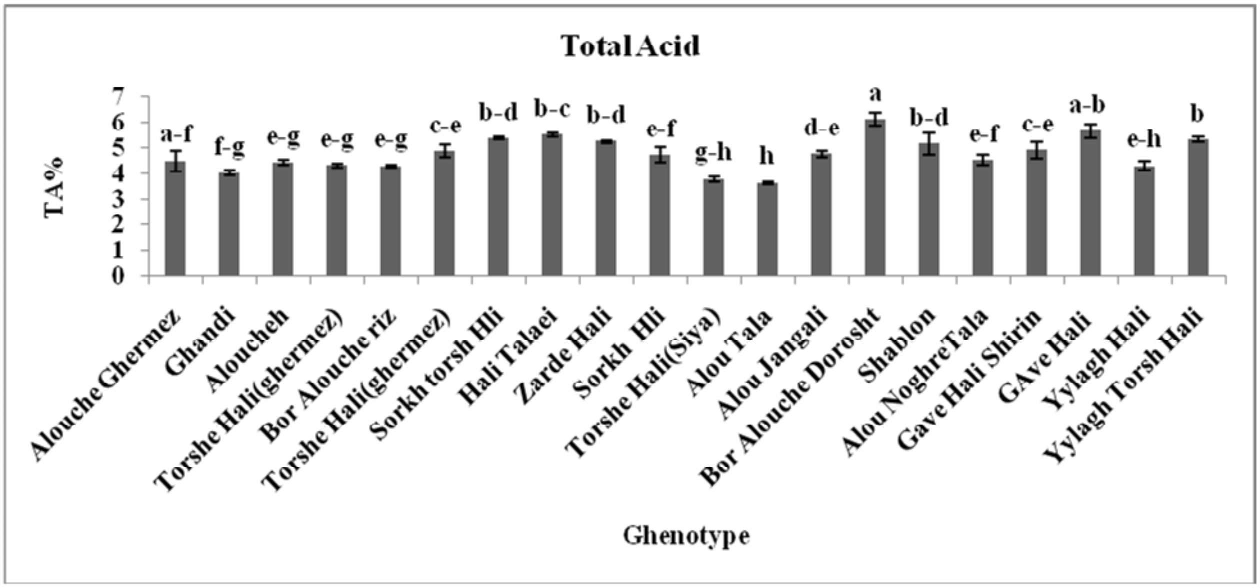

Fig. 2. Comparison of the average of total acid in different genotypes of tree tomato in Guilan province based on the percentage (SE ±). The vertical lines indicate the standard error of the average. Averages with common letters have no significantly difference at the 1% probability level.

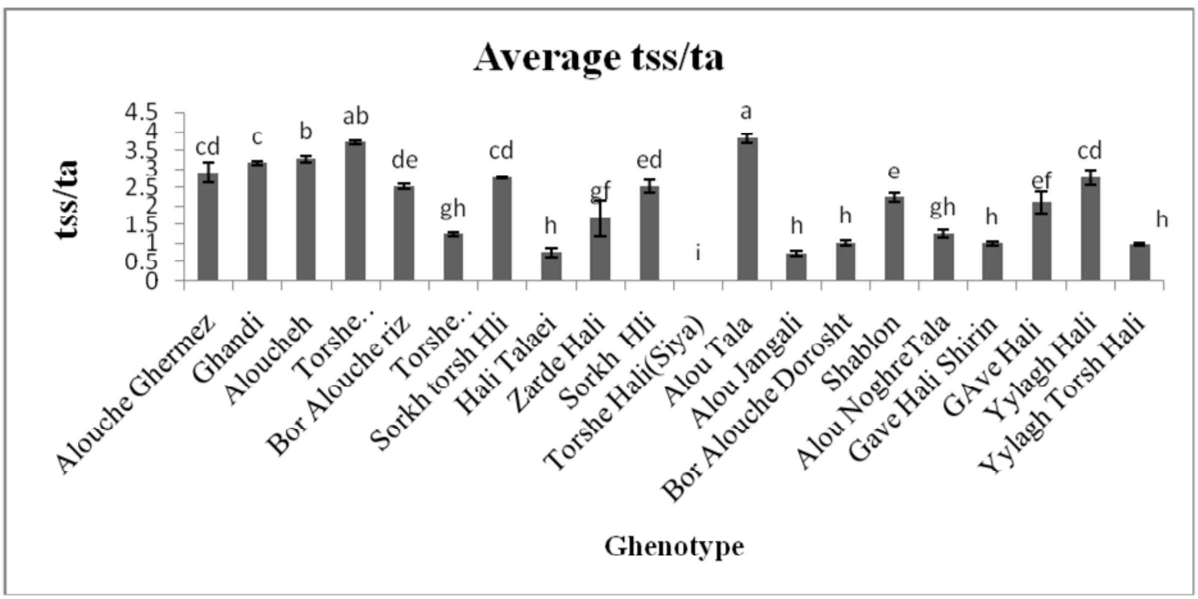

Fig. 3. Comparison of the average of TSS/TA ratio in different genotypes of tree tomato in Guilan province (SE ±). The vertical lines indicate the standard error of the average. Averages with common letters have no significantly difference at the 1% probability level.

Generally create the taste takes place in the fruits due to the increment of sweetness, reduction of acidity and sugar and organic acid accumulation in sugar-acid ratio (Prasana *et al*, 2007). It has been found that the ratio of TSS/TA has greater effect on fruit quality than the amount of TSS and TA alone.

Also there is high correlation between the ratio of TSS/TA and qualitative characteristics in plums (Kaskouro and Guerra, 2009).

Total phenol amount in peel and pulp mixture: Review the results of data variance analysis table (Table 2) show that total phenol amount in the mixture of peel and pulp of mentioned genotypes were significantly different at 5% probability level.

Table 2: Results of data variance analysis related to total phenol amount and antioxidant actuality of peel and pulp mixture in different genotypes of tree tomato.

Sources of changes	Degrees of freedom	$Pr > F$ measured traits	
		total phenol	Antioxidant capacity
		peel and pulp	
Genotype Error Total	19 40 59	<0.001	<0.0001
Coefficient of Variation (%)	----	18.29130	2.113153

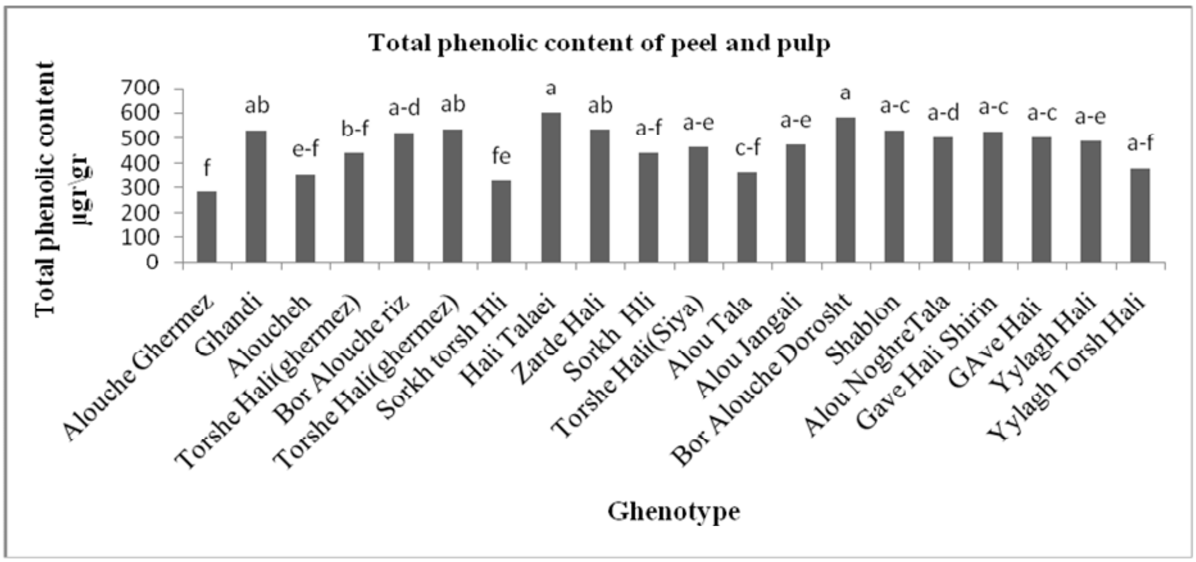

Fig. 4. Comparison of the average of peel and pulp mixture in different genotypes of tree tomato in Guilan province based on micrograms per gram (SE ±). The vertical lines indicate the standard error of the average. Averages with common letters have no significantly difference at the 1% probability level (n = 3).

It has been found that plums have plenty of polyphenolic substances which are non-toxic (Bridle and Timberlake, 1996). Total phenol amount in the peel and pulp mixture of the fruits was in the range between 333/600 and 282 (micrograms per gram). Peel and pulp mixture in genotypes of "Golden plum" and "Red sloe" have respectively the highest and the lowest total phenol amount (Fig. 4). Total phenol amount measured in this study was roughly in accordance with the amount of phenol calculated by Kim, Gyeong *et al*, (2003), and Kim, Chan *et al*, (2003). The difference of total phenol amount in different varieties of plums may be a result of the influence of cultivar, geographic location, growing season, and agricultural operations (Kim, Gyeong *et al*, 2003; Kim, Chan *et al*, 2003; Vasanta Ropasing *et al*, 2006; Vizoto *et al*, 2007; Gill *et al*, 2002). Accumulation of phenolic compounds is of the most effective natural methods of plants to adapt against the various environmental stresses, particularly high intensity of UV-B (Solochenko and Shemitze - Eberger, 2003).

Phenolic compounds play an important role in the nutritional, organoleptic and commercial characterization of agricultural crops and products resulted from their processing (Alonsa - Salsez *et al*, 2001; Lancaster, 1992), because they are involved in sensory characterization of products such as color, astringency, bitterness, taste and Perfume (Kim, Gyeong *et al*, 2003; Kim, Chan *et al*, 2003; Alonsa - Salsez *et al*, 2001; Latanzio, 2003; Troter, 2001).

Antioxidant activity of the peel and pulp mixture extract: According to the results from data variance analysis (Table 2), studied genotypes, in terms of antioxidant activity in the peel and pulp mixture of fruits had also significant differences at 1% probability level. Peel and pulp mixture in genotypes of "sour red plum" with 58/66% had the highest percentage of antioxidant activity and genotypes of "sour black plum" with 35/62% had the lowest percentage of antioxidant activity (Fig. 5).

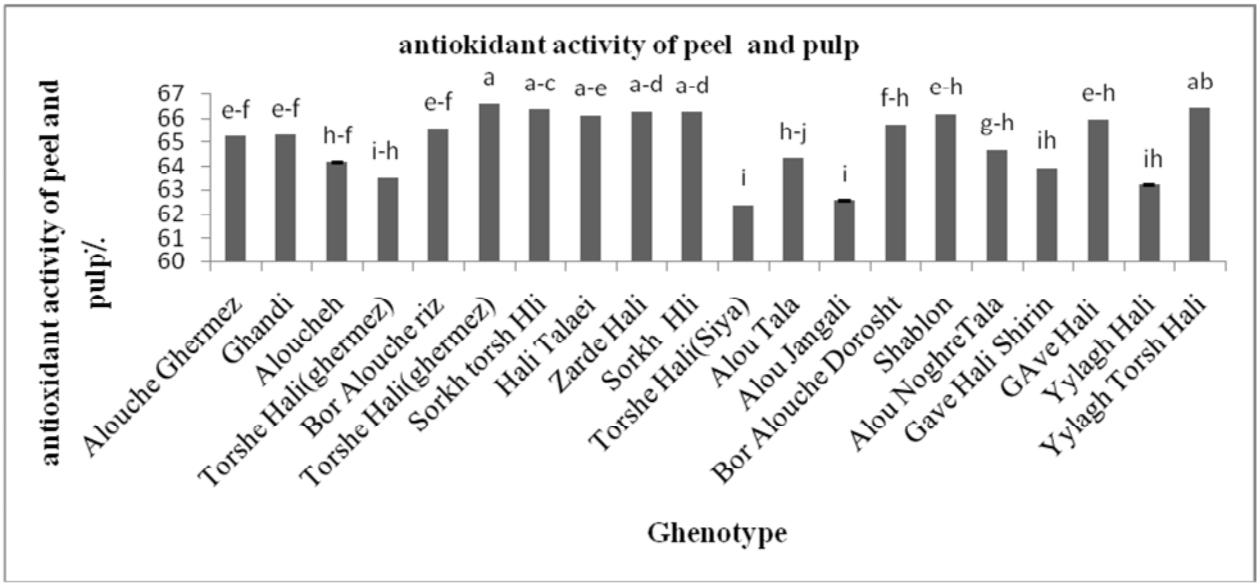

Fig. 5. Comparison of the antioxidant average of peel and pulp mixture in different genotypes of tree tomato in Guilan province based on the percentage (SE ±). The vertical lines indicate the standard error of the average. Averages with common letters have no significantly difference at the 1% probability level.

According to the previous reports, as well as data obtained from the present study it has been indicated that plums are one of the best sources of natural antioxidants and are very beneficial to human health. Recently, high levels of phenolic compounds and antioxidant activity have been reported in plums (Kim, Chan *et al*, 2003). Evaluate the antioxidant activity of 25 different varieties of fruits nectarines, peaches and plums showed that plums, and after them, nectarines and peaches, respectively, have the highest antioxidant activity (Gill *et al*, 2002).

The genotypes of products with more antioxidant activity have better stress resistance, nutritional quality and storage properties (Lata, 2008). The use of plums in commercial processing of foods may effectively prevent the oxidation of lipids which therefore prevents the insipidity or creating unpleasant smells in products and also increases their survival. With this new approach in food industry, plums can be used as a substitute for synthetic antioxidants such as propyl gallate and Butylated hydroxyl Toluene in food processing (Kim, Chan *et al*, 2003). Among the studied genotypes, very rich varieties of phenolic compounds including genotypes of “plum”, “large sloe”, “sugary” and “red sloe” can be investigated further for use in the food industry.

The correlation between the total amount of phenolic substances and total antioxidant activity: The results obtained from data regression analysis of total phenol (x) and antioxidant activity (y) is also proved a positive correlation between the amount of phenolic substances and antioxidant activity percentage of peel and pulp.

Table 4: Results of regression analysis of the data related to total phenol and antioxidant activity of peel and pulp of the tree tomato fruit.

Segments of fruit	The regression equation	R^2	R
peel and pulp	y = 0.0308x + 24.987	0.4397	0.842**

** Significant at the one percent level of probability

San *et al* (2002) stated that there is a direct correlation between the total amount of phenolic substances and total antioxidant activity in phytochemical extracts of different fruits. Comparison of the antioxidant activity of blueberries showed that there is a close correlation between phenolic substances content and antioxidant activity as well as between the oxygen free radical absorption capacity and total phenol content (Gill *et al*, 2002). According to previous reports, including research conducted by Kim *et al* (2003) and Gill *et al* (2002) it has been found that there is a positive association between total phenol and antioxidant activity among different genotypes of plum and it is also known that polyphenols play an important role in eliminating free radicals, the findings of present study confirms these reports.

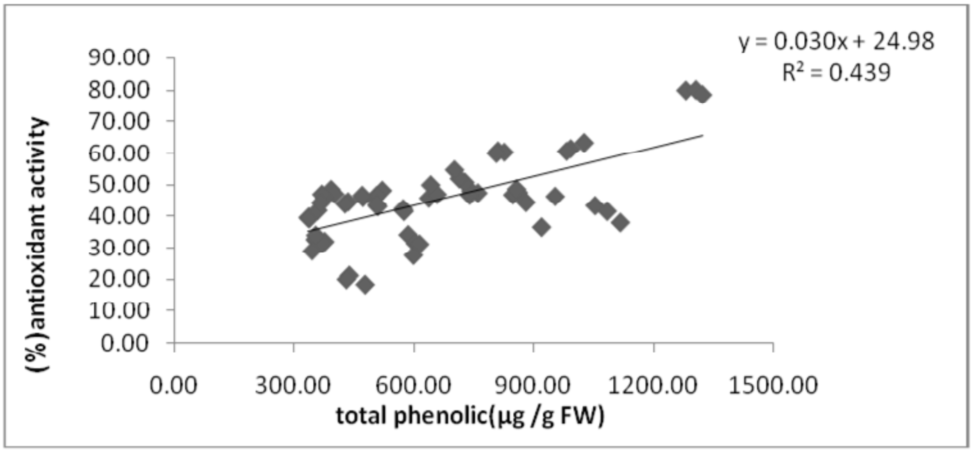

Fig. 6. Graph of correlation between total phenolic amount and antioxidant activity of peel and pulp mixture of the tomato tree fruit.

CONCLUSIONS

Obtained results showed that there is a very wide diversity among studied genotypes and there are very valuable varieties in terms of nutritional quality both as fresh consumption and use in processing industries. Evaluation of antioxidant activity, total phenol and phenolic compounds including catechin and quercetin showed that the amount of these compounds vary among the different genotypes, therefore, genotype has an important role in the synthesis of phenolic compounds. Evaluate the correlation between total phenol amount and antioxidant activity of the peel and pulp mixture showed that there is a significant relationship between antioxidant activity and total phenol amount.

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