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Original article

Quality Characteristics of Pembe Patlıcan; A Local Eggplant (*Solanum melongena* L.) Genotype from Çanakkale Ezine

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Abstract

There are many local eggplant (*Solanum melongena* L.) genotypes produced by our producers from their own seeds in various regions of our country. These genotypes are an important breeding resource and have been produced for many years due to their unique characteristics such as taste, smell, color and their health benefits. Çanakkale Ezine region has many unique local agricultural products. Evaluating these genotypes in terms of their health effects, some important quality characteristics and external appearance is an important issue for the agricultural development of the region. The 'Pembe Patlıcan' eggplant genotype, grown in significant quantities in the Ezine region, is a local genotype known in the region for its color, taste and nutritional properties. First aim of the study was to determine the Pink Eggplant genotype, which is produced intensively by different producers in Çanakkale Ezine region; in terms of ascorbic acid content, total carotenoid content, total phenolics content, water-soluble dry matter, titratable acidity, color parameters (L, a, b, Hue) and some important flavonoids (luteolin, apigenin, naringin, catechin). Second aim is to contribute to the agriculture of the region by determining the characteristics of this genotype in the samples produced in the region. Third aim is to have preliminary information about the characteristics of this genotype to guide other possible studies on it. It has been observed that the 'Pembe Patlıcan' genotype, in addition to its unique color that evokes red and purple color perceptions, is an eggplant genotype with high levels of ascorbic acid. In terms of flavonoid components, it was determined that the catechin component was the highest and the luteolin component was the lowest.

Keywords: *Solanum melongena* L. cv. 'Pembe Patlıcan', ascorbic acid, total amount of carotenoids, total soluble solids, luteolin, apigenin, naringin, catechin.

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INTRODUCTION

According to TUIK data, 781242 tons of eggplants were produced in Türkiye in 2022 (Anonymous, 2022). Türkiye ranks 4th in the world eggplant production amount and produces 1.5% of the world production amount (Alas et al., 2022).

“Kemer”, “Halkapınar”, “Bostan”, “Kirmastı”, “Yalova-49”, and “Gönen” are the eggplant varieties grown in abundance in our country (Anonim, 2023). In addition, many eggplant genotypes with geographical indication that are produced locally are produced in our country, such as Yamula eggplant in Kayseri and Birecik eggplant in Urfa (Alas et al., 2022). Geographical indication is important because it shows the relationship of a product with the region where it is produced. In this way, the quality of the products is preserved, it ensures that the product is known by the name of the region where it is located, and it provides some advantages to the regional producers in terms of this product. However, in order for this to happen, some important quality features of the products identified with the region, need to be highlighted through research.

Heirloom cultivars traditionally passed onto future generations have an important place in terms of appearance, name and usage. There is a need to investigate these heirloom cultivars, especially in terms of factors such as productivity, stress tolerance and sensory quality. In terms of unique taste, color, texture, stress tolerance and form characteristics, these heirlooms are important collection as a source of breeding germplasm for future varieties (Dwivedi et al., 2019).

Today, the marketing of agricultural products is influenced by the fact that they are grown traditionally, obtained with minimal external intervention, such as local genotypes, as well as the health benefits determined by some studies. Accordingly, the functional properties of an agricultural product have become important. For this reason, especially important agricultural products need to be examined in terms of components such as some vitamins, carotenoids and flavonoids. Flavonoids, which have been the subject of many studies in recent years and have begun to be included in some drugs, are important antioxidants of plant origin.

Flavonoids are structurally diverse secondary metabolites in plants and they have functions such as plant development and pigmentation in plants. Many flavonoids are used to prevent inflammation and cancer (Mathesius, 2018). Flavonoids are metabolic compounds found in plant vacuoles and serve as antimicrobial defense compounds, protecting plants from biotic and abiotic stresses (Samanta et al., 2011). In a study, four eggplant (*Solanum melongena* L.) local genotypes were evaluated in terms of water stress tolerance and it was observed that the total amount of flavonoids increased with water stress in three of the cultivars (Plazas et al., 2019).

Apigenin (4', 5, 7,-trihydroxyflavone) from plant flavones is found in vegetables and fruits such as parsley and onion. It has inflammatory, antioxidant and anti-carcinogenic properties (Patel et al., 2007). Abid et al. (2022) stated that apigenin is a flavonoid that has been considered a traditional medicine that stimulates the immune system for years and has health-supporting properties against various cancers, cardiovascular diseases and different diseases.

Catechin is a polyphenol abundantly found in plants. It has antimicrobial, anticancer, antihypertensive, anticoagulant and antiulcer effects. It is a phytochemical with multiple pharmacological activities (Ganeshpurkar and Saluja, 2020). One study (Cavia-Saiz et al., 2010) determined that naringin and naringin flavones were equally effective in reducing DNA damage in vitro. It has been mentioned that luteolin promoted antioxidant activity in human colon cancer cells (HT-29); reducing cell viability with no effect on normal colon cells (FHC) (Kang et al., 2017),.

Ascorbic acid, total carotenoid amount and water-soluble dry matter parameters are also important quality components in the products. Among the water-soluble solids that contribute to the °brix value, the most common are sugars, pectins, organic acids and amino acids. Sugars are the most abundant water-soluble solids found in fruit and vegetable juices. °Brix value provides an estimate of the sugar content in fruits and vegetables. One of the important criteria of product quality is sweetness. Sugar content affects sweetness. However, there is a possibility that sweetness may be overpowered by other taste criteria. This shows that a high °brix value does not guarantee sweetness (Kleinhenz and Bumgarner, 2012). Vitamin C is a water-soluble antioxidant that has been linked to preventing scurvy. It is necessary for bone formation, connective tissue development, and wound healing. It is necessary for the immune system to function adequately. In its absence, disorders such as anemia, scurvy, bleeding gums, degeneration of muscles, and atherosclerotic plaques may occur (Iqbal, 2004). Carotenoids mainly show antioxidant effects. There is evidence that carotenoids have positive effects on eye health, cognitive functions, cardiovascular health and reducing the risk of some types of cancer. Humans cannot synthesize carotenoids and must obtain them externally (Eggersdorfer and Wyss, 2018). Therefore, it's important to evaluate agricultural products especially local genotypes constituting our breeding sources concerning these important quality criteria.

The aim of the study is to examine the eggplant genotype “Pembe Patlıcan”, which is a well-known for some important quality criteria and grown widely in the Ezine region. One of the aims of this study is to contribute to the region by increasing the importance of this genotype with examining samples of this product which are produced in this region by farmers. Thus, a step will be taken towards the recognition of this genotype. In this way, it will increase the possibility of other studies that can be done on this genotype. There are advantages that our local genotypes can provide to the region. They are also important breeding materials. But there is a need some preliminary information about the characteristics of this genotype to guide other possible studies on it. Some of our local genotypes stand out in their region with their interesting colors and their importance in terms of their contribution to our health.

Flavonoids, in particular, are a research topic that has increased in importance in recent years. However, studies on the amounts of different flavonoid components in agricultural products are limited.

MATERIALS and METHODS

Material

In the study, the fruits of Pembe Patlıcan genotype, which is widely grown and known in Çanakkale Ezine region, were obtained from local eggplant producers and formed the material of the study.

The analyses of the experiment were done with 3 replications. Fruits were obtained as 16 fruits from each of 3 different producers and each replication consist of 9 fruits as homojen 3 fruits selected from each producer.

Figure 1. Pembe Patlıcan genotype

Measurements and Analyzes:

Color (L, a, b, hue) Values:

In eggplant samples, skin color was determined with the help of Konica Minolta CR-400 chromameter (color measuring device). In color measurement, L* (brightness, L*:0 black, L*:100 white), a* (+a* value: purplish red color degree, -a* value: bluish green color degree), b* (+b* value: color values: yellow color degree, -b* value: blue color degree) and hue° (indicates color, according to its degree) color values were determined (Voss, 1992).

Amount of Total Soluble Solids (°Brix):

Soluble solids (Brix°) was measured with the help of a digital refractometer.

pH and Titratable Acidity (g 100g^{-1}) Values:

The pH value was read using the pH meter. For titratable acidity, 10 ml sample taken from fruit juice was completed to 50 ml with pure water. Then, it was titrated with the help of 0,1 N NaOH solution until it reached the value of 8,1. Titratable acidity was determined in terms of citric acid (Anonymous, 1968).

Total Carotenoids Content (mg ml^{-1}):

Discs with a diameter of 1 cm were taken from pepper fruits; 5 ml methanol was added to them; shaked gently for 48 hours; then, the samples were read at wavelengths of 470, 653, 666 nm using a spectrophotometer. Chlorophyll-a, chlorophyll-b and total carotenoid contents were calculated (Wellburn, 1994; Kaleci et al., 2016).

Vitamin C (Ascorbic acid) Analysis (mg 100g^{-1}):

The sample (25 g) was weighed and treated with 175 ml of 0,4% oxalic acid. The mixture was filtered through filter paper, 1 ml of each sample was taken and 9 ml of pure water was added. L1 value was determined by reading of Oxalic acid / 2.6 Diclorophenol indophenol: 1/10 solution in response to Oxalic acid / Pure water: 1/10 solution at 520 transmittance value. L2 value was determined by reading of filtered sample / 2.6 Diclorophenol indophenol: 1/10: solution in response to Oxalic acid / Pure water: 1/10 solution at 520 transmittance value (Shimadzu UV-VIS-1800 spectrophotometer). In this way, ascorbic acid content was calculated by using the formulation. (Pearson and Churchill, 1970).

Total Phenolic Compounds Content (mg/100ml GAE):

Extraction Method: 20 ml (80%) methanol-water was added to 5 g of sample. The solution was vortexed for 1 minute, filtered, and then transferred to 50 ml falcon tubes. Analysis Method: A mixture of 100 µl standard (taken from the gallic acid standard when gallic acid curing is done; taken from the extract when measuring total phenolics in the fruit) + 3400 µl (3.4 ml) of pure water was obtained. 2000 µl of 10% Folin-ciocalteu was added to this mixture and vortexed for 15 seconds. Then, 2000 µl Na_2CO_3 (10% 1M Na_2CO_3 solution) was added and vortexed for 15 seconds. Then, it was kept in a hot water bath for 30 minutes and read on a spectrophotometer at 765 nm. A mixture of 100 µl of pure water was used as counter reading in the spectrophotometer (Göttingerova et al., 2021; Singleton and Rossi, 1965; Slinkard and Singleton, 1977).

Calculation of Flavonoids (mg/kg):

HPLC Method: System Used: Shimadzu Prominence Brand HPLC, CBM: 20ACBM, Detector: DAD (SPD-M20A), Column Oven: CTO-10ASVp, Pump: LC20 AT, Autosampler: SIL 20ACHT, Computer Program: LC Sotution

Mobile Phase: A: 3% Formic acid B: Methanol (The method of Gomes et al., (1999) was modified and used in HPLC analysis).

Sample preparation: Ethanol (96%, 10 ml) was added to 2 g of sample. It was mixed in the homogenizer for 2 minutes. It was kept in a water bath at 45°C for 1 night. At the end of this period, it was centrifuged at 4000 rpm for 5 minutes. The supernatant was taken and evaporated in a rotary evaporator at 45°C until it was completely dry. Then, the extracts were dissolved in 1 ml methanol and used in phenolic compound analyzes (Kiselev et al., 2007).

RESULTS and DISCUSSION

Considering the hue angle of the genotype (Voss, 1992), it is seen that the color of the genotype is between purplish red and red color values, but is closer to purplish red color (Table 1).

Table 1. Color (L, a, b) values of Pembe Patlıcan genotype

L*	a*	b*	Hue°*
23,13	19,84	1,32	3,81

The water-soluble dry matter value of the Pembe Patlıcan genotype was determined as 6,3%, the pH value was 5,51, and the titratable acidity (g $100g^{-1}$) value was determined as 0,2 (Table 2). Talhouni et al. (2017) found pH values between 6,00 and 6,28 in the combinations of four rootstocks (Köksal F1, AGR703, Vista, local Turkish eggplant breeding line Burdur) and two scions (Naomi F1, Artvin) in eggplant (*Solanum melongena* L.) grown under greenhouse conditions. They determined titratable acidity values between 0,28 and 0,86, and soluble solids values between %4,67 and %5,32.

Table 2. Total soluble solids, pH, titratable acidity values of Pembe Patlıcan genotype

Total Soluble Solids (%)	pH [-log(H^+)]	Titratable Acidity (g $100g^{-1}$)
6,3	5,51	0,2

Ascorbic acid value of the Pembe Patlıcan genotype was determined as 47,55 mg 100 g^{-1}, total carotenoid value was 0,12 mg ml^{-1} and total phenolic substance amount value was determined as 11,02 mg/100ml (Table 3).

Kandoliya et al. (2020) determined that the total amounts of soluble solids were between 8,17% and 9,33%; the amounts of phenolic components were between 18,49 and 44,86 mg/100g; the amounts of ascorbic acid were between 11 and 23,97 mg/100g in fifteen eggplant varieties and genotypes in their study.

Ayub et al. (2022) conducted a study in open agricultural land conditions in three eggplant varieties (*Solanum melongena* L. Punjab Raunak, Pusa Purple Long, Punjab Sadabahar). In their study (Ayub et al., 2022) ascorbic acid values were determined between 22,56 and 24,46 (mg/100g); phenolic components were determined between 24,87 and 34,81 (mg/100g).

Nino-Medina et al. (2014) determined that the ascorbic acid amounts of eggplant (*Solanum melongena* L.) types representing Chinese, Philippine, American, Hindu and Thai, grown under open agricultural land conditions in Mexico, were between 7,4±2,9 and 22±4,1 mg/100g in fresh samples.

Stable open-pollinated landrace eggplant genotypes (*Solanum melongena* L. MEL3, MEL4, MEL5, MEL6) were grown in the greenhouse (Plazas et al., 2019). In the study (Plazas et al., 2019), total carotenoid values in the control were determined between values higher than 0,2 and lower than 0,6.

Table 3. Ascorbic acid (mg $100g^{-1}$), total carotenoids (mg ml^{-1}), total thenolic content (mg/100ml) values of Pembe Patlıcan genotype

Ascorbic Acid (mg 100g-1)	Total Carotenoids (mg ml-1)	Total Phenolic Content (mg/100ml)
47,55	0,12	11,02

In the Pembe Patlıcan genotype, the flavonoid determined at the highest value (30,383 mg/kg) was the catechin flavonoid. Apigenin flavonoid was determined in less than half of the catechin flavonoid (14.15 mg/kg). Naringin flavonoid was determined in the amount of 2.818 mg/kg. Luteolin flavonoid was determined to be less than half of the naringin flavonoid (1,015 mg/kg). Marsic et al. (2014) found that catechin amounts in eggplant fruits grown in the greenhouse were between 150.2 (Domaci srednje dolgi eggplant variety) and 270 (Blackbell F1 eggplant variety) in the first year of their study. In the second year, they determined the catechin amounts between 151.4 (Blackbell F1eggplant variety) and 258.4 (Epic F1 eggplant variety).

Table 4. Luteolin, apigenin, naringin, catechin values of Pembe Patlıcan genotype

Luteolin (mg/kg)	Apigenin (mg/kg)	Naringin (mg/kg)	Catechin (mg/kg)
1,015	14,15	2,818	30,383

Conclusion

As seen in the figure (Figure 1), it was determined that the local eggplant genotype called Pembe Patlıcan (*Solanum melongena* L.) genotype in Çanakkale Ezine region has an original color value (Hue: 3,81) between purplish red color and red color, being closer to purplish red in terms of color value.

It can also be said that the Pembe Patlıcan genotype has a high soluble solids-Brix° value (6.3%). It is known that the brix° value, which is an important quality parameter, indicates the estimated value of the amount of sugar in fruits and vegetables. This can also affect the taste value.

It can be said that the Pembe Patlıcan genotype has a high value (47.55 mg $100g^{-1}$) in terms of the amount of ascorbic acid, which is an important antioxidant. In addition, the total carotenoids (0.12 mg ml^{-1}) and total phenolics content (11.02 mg/100ml) of the genotype were determined. It is known that phenolic compounds are important in the formation of taste, smell and color of fruits and vegetables. Flavonoids, which are important antioxidants, have begun to be included in medicines against some diseases in recent years. They are widely found in plants. However, studies on contents of flavonoids in different agricultural studies are limited. In the study, it was observed that the four flavonoid types determined in the Pembe Patlıcan genotype were listed from highest to lowest, as catechin (30.383 mg/kg), apigenin (14.15 mg/kg), naringin (2.818 mg/kg), luteolin (1.015 mg/kg).

In conclusion it can be said that Pembe Patlıcan has an unique color, high soluble solids and ascorbic acids and a good source of flavonoids especially catechin and apigenin.

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