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ARAŞTIRMA MAKALESİ **RESEARCH ARTICLE**

Comparison of Aroma Compounds and Pomological Characteristics of The Fruits of 'cv. Mondial Gala' and Local Apple Genotype 'Gelin' Cultivated in Çanakkale, Turkey

Çanakkale, Türkiye'de Yetiştirilen 'Gelin' Yerel Elma Genotipi ve 'cv. Mondial Gala' Meyvelerinin Pomolojik Özellikleri ile Uçucu Bileşiklerinin Karşılaştırılması

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Abstract

Volatiles directly affect the sensorial quality of fresh fruits and therefore consumer preferences. The types and concentrations of volatile compounds show great variability in different apple types and varieties. In this experiment some pomological characteristics and aroma potential of local apple genotype called 'Gelin' or 'Yazlik Elma' and commercial standard apple cultivar 'Mondial Gala' were evaluated. Fruit length and diameter (mm), fruit weight (g), soluble solid content (% Brix), pH, titratable acidity (malic acid ml 100 ml-1), skin and flesh color (L, hue, chroma) were investigated within scope of pomological characteristics. The identification of volatile constituents was performed by Gas Chromatography/Mass Spectrometer (GC/MS) instrument by liquid–liquid extraction using diethyl ether solvent. The amount of the aroma volatile determined with a gas chromatograph-mass spectrometer (Shimadzu® QP2010 GC/MS) fitted with a DB-WAX column (30 m x 0.25 mm ID, 0.25 µm film thickness; J & W, USA). According to the obtained results, 23 volatile constituents including 9 aldehydes (45.56%), 7 esters (46.78%), 6 alcohols (6.85%), and 1 other compound (0.81%), were detected in 'Gelin' genotype; 20 volatile constituents including 6 esters (56.08%), 7 aldehydes (34.76%), 6 alcohols (8.13%) and 1 other compound (1.03%), were detected in 'Mondial Gala' cultivar. Aldehydes and esters are main volatiles to fruity and floral aroma especially for apples. Especially, E-2-Hexenal and acetaldehyde for aldehydes and butyl acetate and hexyl acetate for esters are the main volatile compounds detected for the fruits studied. The high contents of these compounds that give pleasant flavor and aroma in fruits play very important part in the preference of fruits by consumers. In addition, the 'Gelin' genotype population can represent a novel source of breeding materials for improvement of aroma characteristics of standard cultivars.

Keywords: *Malus communis* L., Aroma compounds, Ecotype, Gala cultivar, Flavor

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Özet

Aroma bileşenleri, taze meyvelerin duyusal kalitesini ve böylelikle müşteri tercihlerini direk etkilemektedir. Ülkemizin farklı ekolojik koşullarında elmalarda uçucu bileşiklerin türü ve konsantrasyonları bakımından büyük varyasyonlar görülmektedir. Bu çalışmada 'Gelin' veya 'Yazlık Elma' olarak bilinen yerel elma genotipi ile ticari olarak yetiştirilen 'Mondial Gala' standart elma çeşidinin aroma potansiyeli ve bazı pomolojik özellikleri değerlendirilmiştir. Pomolojik özellikler kapsamında meyve eni ve boyu (mm), meyve ağırlığı (g), suda çözünen kuru madde miktarı (% Brix), pH, titre edilebilir asitlik (malik asit ml 100 ml-1), meyve kabuk ve et rengi (L, hue, chroma) incelenmiştir. Uçucu bileşenlerin tanımlanması ise gaz kromatografisi kütle spektrometresi cihazı ile dietil eter çözgeni kullanılarak sıvı-sıvı ekstraksiyonuyla gerçekleştirilmiştir. Aroma bileşenlerinin miktarlarının belirlenmesinde Gaz kromatografisi kütle spektrometresi cihazında takılı DB-WAX kolonu (30m x 0.25 mm iç çapı x 0.25 µm film kalınlığı) kullanılmıştır. Elde edilen sonuçlara göre; Gelin genotipinde tespit edilen 23 aroma bileşeninin 9'u aldehit (%45.56), 7'si ester (%46.78), 6'sı alkol (%6.85) ve 1'i (%0.81) diğer bileşendir. Mondial Gala çeşidinde ise 6'sı ester (%56.08), 7'si aldehit (%34.76), 6'sı alkol (%8.13) ve 1'i (%1.03) diğer bileşen olmak üzere 20 adet aroma bileşeni saptanmıştır. Elmalar için özellikle meyvemsi ve çiçeksi kokuyu oluşturan esas bileşenler aldehit ve esterlerdir. Özellikle aldehitler için E-2-Hekzenal ve asetaldehit, esterler için bütil asetat ve heksil asetat incelenen meyvelerde tespit edilen başlıca uçucu bileşiklerdir. Meyvelere hoş koku ve tat veren bu bileşenlerin yüksek oranlarda bulunması tüketicilerin meyve tercihlerinde önemli bir rol oynamaktadır. Bununla birlikte, 'Gelin' genotipi popülasyonları, standart çeşitlerin aroma özelliklerinin iyileştirilmesi için yeni ıslah materyalleri kaynağını da oluşturabilir.

Anahtar Kelimeler: *Malus communis* L., Aroma bileşenleri, Ekotip, Gala çeşidi, Lezzet

1. Introduction

Turkey has a wide production potential both because it is the homeland of the apple and because there are many regions suitable for apple cultivation. It is observed that the number of trees and the production increase year by year. Canakkale is a province where the cultivation of the horticulture products is extremely important and has a orcharding culture that goes back to ancient times. The amount of annual apple production in Çanakkale province is 105.295 tons and 'Golden Delicious', 'Starking Delicious' and 'Granny Smith' are the most produced varieties, in addition to 'Gala', 'Fuji', 'Summer Red' and 'Jersey Mac' varieties are followed, respectively (Kaynaş et al., 2009; Anonymous, 2020).

Gala cultivar was breed in the 1939 as 'Kidd's Orange Red'x'Golden Delicious' hybrids. 'Mondial Gala'® is a limb mutation of Gala in New Zeeland. Fruits of 'Mondial Gala' are firm, juicy and have unique sweet, tangy flavour (Echeverria et al., 2008). Fruits have a peel of red top color on a yellow background and mature on from mid-July to late-August.

In Turkey, which has a huge fruit culture, the evaluations of the local genotypes (ecotypes) are revealed with the pomological studies carried out. Since our country is the homeland of apple and has been cultivated for hundreds of years, our local genotypes are too many to be clearly defined. However, in recent years, the studies carried out in the context of the importance of local genetic materials have increased awareness on this issue. Collection, protection and improvement of apple genetic resources are fundamental for improving of new promising apple genotypes with enhanced desirable qualities and protection of unique genetic traits available in ecotypes.

Either name similarity or name complexity is frequently encountered in ecotypes. Although 'Gelin' apple genotype is cultivated as ecotype in many different regions of Turkey, the colours of ripe fruits can be red in some regions and in some regions it can be green (Coskun and Askin, 2016; Dumanoglu et al., 2018).

Production of aroma volatile compounds is an important factor determining quality of fruit produce and is directly influenced by fruit maturity. Flavor is one of the most important factor of fruit quality, especially apple. The formation of flavor and aroma components in fruits is a dynamic process. Aroma substances are incessantly synthesized and developed during fruit ripening. Volatile compositions of fruits change qualitatively and quantitatively (Gundogdu, 2018).

Recently, improvement of the phytochemical composition has gained importance for the breeders in the development of genotypes with superior properties (Mertoglu and Evrenosoglu, 2019). According to Mertoglu and Evrenosoglu (2019), in this context, recently studies are conducted primarily on the determination of the phytochemical contents of the existing genetic resources. (Zhang et al., 2018; Oszmianski et al., 2018; Polat et al., 2018; Gundogdu et al., 2018; Acero et al., 2019). Parents, who have superior qualifications in terms of desired characteristics, are developed in classical and modern breeding methods and new genotypes are developed (Cevallos-Casals et al., 2006; Ramirez-Ambrosi et al., 2015; Yazici and Sahin, 2016; Sahoo et al., 2017).

Aromatic compound analysis plays an important role in the process of quality apple breeding. The aroma of a fruit is the result of a complex mixture of esters, alcohols, aldehydes, terpenoid compounds, etc. The concentration of volatile compounds and their types show great changeability in apple under different ecological conditions of Turkey (Duran, 2013).

In this experiment some pomological characteristics and aroma potential of fruits of local apple genotype named 'Gelin' or 'Yazlik Elma' and standard apple cultivar 'Mondial Gala' were evaluated.

2. Materials and Methods

Six years old 'Mondial Gala' and 'Gelin' (Yazlik) apple trees on MM106 rootstock which grown in same commercial orchard in Çanakkale-Turkey, were used as the plant materials for this study in 2013 year. The trees were randomly selected from trees showing optimum general characteristics of the apple cultivar.

The fruits were harvested carefully by hand. Starch contents of apples were determined by standard procedures

using a starch index (Generic Starch Iodine Index Chart for Apples). When the average starch index reached 5, at the end of July and beginning of August, the fruits were picked up for the experiment (Karaçalı, 2006; Sakaldaş, 2013). These analyses were carried out with 5 repeats and every repeat had 4 fruits.

Some pomological characteristics determined on harvested fruit samples were:

Fruit diameter (mm) and fruit length (mm) were measured by digital caliper on 4 apples for each repeats.

Fruit weight (g) was determined by digital balance on 4 apples for each repeats.

Soluble solids contents (SSC %brix) were measured by using digital refractometer Atago PAL^{-1} (Atago, Tokyo, Japan) on one reading for each repeats (mixed of 4 fruits) (Karaçalı, 2006; Kaynaş et al., 2012).

Fruit skin colours were assessed using Minolta colorimeter CR 400 (Minolta, Osaka, Japan) on blushed side of 4 apples for each repeats and Lightness (L), Hue and Chroma values were determined (Kaynaş et al., 2012).

Malic acid content (titratable acidity) was evaluated by one reading for each repeats (mixed of 4 fruits) using titration method and expressed as mL 100 mL^{-1} (Karaçalı, 2006; Kaynaş et al., 2012).

After the pomological analyses were completed, the extractions for determine the volatile components were carried out.

The aroma volatile contents of the apples were determined by GC/MS analysis followed by liquid-liquid extraction. Diethyl ether solvent is widely used for liquid-liquid extraction of aroma volatiles in fruits, vegetables and spices. Furthermore, most of the volatile components reported earlier in apples are readily soluble/miscible in the diethyl ether (Young et al., 1996; Lopez et al., 1998; Duran, 2013; Ekinci et al., 2016-a).

Each extraction contained four replications and each replication contained 100 g apple pulp with puree obtained by using a homogenizer. Thereafter, 100 mL diethyl-ether solvent was added into the Erlen flask with 100 g apple pulp with puree. After solvent treatment, the extracts were concentrated to 1 mL with concentrator and centrifuge. Then the solvent was injected to GC/MS for volatile compounds (Ekinci et al., 2016-a).

The amount of the aroma volatile determined with a gas chromatograph-mass spectrometer (Shimadzu® QP2010 GC/MS) fitted with a DB-WAX column (30 m x 0.25 mm ID, 0.25 µm film thickness; J & W, USA). Identification of volatile content was carried out by mass spectrometry using a mass spectrometer set at 250 °C of capillary direct interface temperature, the ionization energy of the mass spectrometer was programmed for 70 eV. Also the ion source temperature was set at 250 °C and 40-350 amu of mass interval and 666 amu s^{-1} scan rate. WILEY and NIST libraries were used for identification of compounds. One microliter samples were injected in 1:50 split ratio (with 220 °C injection temperature) by an auto injector. Firstly, the column temperature was set at 40 ºC for 4 min. After the column reached at 280 °C by 10 °C min^{-1} and held for 10 min.

The pomological characteristics of two genotypes were designed as complete randomised factorial designs. Four apple fruits for each repeat and five repeats were used in each genotype. Both pH of fruit juice, soluble solid content and malic acid measurements were done from mixed of four fruits at each repeat. For statistical analysis the means of five measurements were taken. Four replicates were used in each genotype for identification of volatile compounds. Data's were statistically analysed and expressed using T-test ($p<0,05$) by the software 'SAS ver. 9' (SAS Institute Inc., Cary, NC, USA).

3. Results and Discussion

Some pomological characteristics of cv. 'Mondial Gala' and 'Gelin' apple genotype are shown in Table 1.

According to results, fruits of 'Mondial Gala' cultivar are wider, longer and heavier than fruits of 'Gelin' genotype. It was determined that the fruits of cv. 'Mondial Gala' and 'Gelin' genotype were 70.49-47.60 mm diameter and 64.39-41.44 mm length, respectively. In addition, cv. 'Mondial Gala' had approximately 3 times heavier fruit weight than 'Gelin' genotype (156.59 g and 52.67 g).

Table 1. Some Pomological Characteristics of fruits of cv. 'Mondial Gala' and 'Gelin' genotype on commercial harvest date

Pomological Parameters	'Gelin' Genotype	cv. 'Mondial Gala'	LSD**
Fruit Diameter (mm)	47.60 ± 1.17 b*	70.49 ± 1.08 a	**1.6443**
Fruit Length (mm)	41.44 ± 1.33 b	64.39 ± 1.02 a	**1.7243**
Fruit Weight (g)	52.67 ± 11.89 b	156.59 ± 5.42 a	**13.478**
Lightness of peel (L)	62.78 ± 1.24	61.50 ± 1.72	**NS**
Hue color angle of peel	90.67 ± 1.15 a	52.85 ± 1.92 b	**2.309**
Chroma of peel	37.51 ± 2.16 b	41.96 ± 1.96 a	**3.0041**
Lightness of flesh (L)	63.71 ± 1.65 b	74.68 ± 2.16 a	**2.8053**
Hue color angle of flesh	97.01 ± 1.54 a	93.80 ± 1.71 b	**2.3714**
Chroma of flesh	16.56 ± 1.87 b	31.62 ± 2.37 a	**3.1176**
pH of fruit juice	3.60 ± 0.18	3.79 ± 0.19	**NS**
Soluble Solid Content (%)	12.35 ± 0.54	12.86 ± 0.22	**NS**
Malic acid (mL 100 mL^{-1})	1.25 ± 0.06	1.33 ± 0.05	**NS**

*Data are the means of 5 replicates with standard deviation. Values followed by different letters are significantly different on at $p \leq 0.05$

Yaşasın et al. (2006) determined fruit diameter, fruit length and fruit weight of 'Mondial Gala' cultivar in Yalova ecological conditions 70.4 mm, 63.1 mm and 160.1 g. Iglesias and Alegre (2009) detected fruit weights of cv. 'Mondial Gala' which was grafted on M9 rootstock in 2000, 2001 and 2002 years in Lleida-Spain ecological conditions, 166.7 g, 158.5 g, 138.7 g, respectively. Bozbuga and Pirlak (2012) explained fruit diameter, fruit length and fruit weight of 14-years old 'Mondial Gala' grafted on M9 rootstock in Nigde ecological conditions 72.2-70.5 mm, 60.1-57.6 mm and 152.0-149.6 g in 2006 and 2007, respectively. Öztürk et al. (2015) determined fruit width, length and weight of fruits of cv. 'Mondial Gala' as 74.02 mm, 67.99 mm and 186.9 g, respectively, on Black Sea (Ordu province) ecological conditions in Turkey.

Fruits of cv. 'Mondial Gala' were determined redder and dense peel color than 'Gelin' apple genotype, because of lower hue (52.85 and 90.67, respectively) and higher chroma values (41.96 and 37.51, respectively), However, there was not a statistically significant difference on lightness of peel between cv. 'Mondial Gala' and 'Gelin' genotype fruits (61.50 and 62.78). 'Gelin' apple genotype had more yellowish green peel on commercial harvest date.

Although, fruits of cv. 'Mondial Gala' had brighter (74.68 and 63.71, respectively) and dense (31.62 and 16.56, respectively) than 'Gelin' genotype; fruits of 'Gelin' genotype had more greenish fruit flesh (93.80 and 97.01, respectively).

Echeverria et al. (2008) explained hue color of light exposed side of peel as 52.33 on commercial harvest dates of cv. 'Mondial Gala'. Iglesias and Alegre (2009) detected lightness (46.3, 52.2 and 55.1), hue color of peel (31.8, 44.6 and 43.5) on commercial harvest dates of cv. 'Mondial Gala' on 2000, 2001 and 2002 years. Öztürk et al. (2015) determined lightness, hue color and chroma values of fruits of cv. 'Mondial Gala' as 42.54, 31.39 and 43.48, respectively, on Black Sea (Ordu province) ecological conditions in Turkey.

The absence of a statistically significant difference in pH of fruit juice (3.79 and 3.60), soluble solid content (SSC, 12.86% and 12.35%) and malic acid contents (TA 1.33 mL 100 mL-1 and 1.25 mL 100 mL-1) confirms that the approximation of the harvest dates and starch tests of the two genotypes.

Yaşasın et al. (2006) determined that SSC of cv. 'Mondial Gala' as 12.7%. Iglesias and Alegre (2009) detected SSC and TA of cv. 'Mondial Gala' in 2000, 2001 and 2002 years on Lleida ecological conditions, 12.4%, 11.7%, 11.4% and 2.8 mL 100 mL-1, 2.9 mL 100 mL-1, 3.4 mL 100 mL-1, respectively. Bozbuga and Pirlak (2012) explained SSC of fruits of cv. 'Mondial Gala' as 12.5 %. Öztürk et al. (2015) determined 11.25 % SSC and 3.81 pH of cv. 'Mondial Gala' in Black Sea ecological conditions.

According to the obtained results, 23 volatile constituents including 9 aldehydes (48.56%), 7 esters (43.78%), 6 alcohols (6.85%), and 1 other compound (0.81%), were detected in 'Gelin' genotype; 20 volatile constituents; including 6 esters (56.08%), 7 aldehydes (34.76%), 6 alcohols (8.13%) and 1 other compound (1.03%), were detected in 'Mondial Gala' cultivar (Table 2).

Generally, the most important volatile compounds on 'Gelin' genotype and cv. 'Mondial Gala' fruits were E-2-hexenal, acetaldehyde and hexanal, from the aldehydes; butyl acetate, hexyl acetate and 2-methylbutyl acetate from the esters, butanol and hexanol from the alcohols, α-farnesene from the other compound (Figure 1.). The active volatile components differed according to the genotypes. Especially the esters in cv. 'Mondial Gala' and the aldehydes in 'Gelin' genotype were found higher ratio. A preliminary study presented by Gur and Gundogdu (2017) on aroma compounds of mondial Gala and Gelin apples.

According to many researchers ester compounds are the most important compounds that are contribute to the aroma of ripe apples (Dimick et al., 1983; Rowan et al., 1996; Rowan et al., 1999; Dixon and Hewett, 2010; Vallat et al., 2005; Mattheis et al., 2005; Espino-Diaz et al., 2016). Esters form a significant part of the volatile components both of cv. 'Mondial Gala' (56.08%) and 'Gelin' genotype (43.78%). According to analyzes, although 7 identified ester compounds were quantified in 'Gelin' genotype and 6 aldehydes were identified in cv. 'Mondial Gala'. Butyl acetate (13.67% in 'Gelin' genotype and 16.06% in cv. 'Mondial Gala'), hexyl acetate (11.96% and 15.13%, respectively) and 2-methylbutyl acetate (8.82% and 11.21%, respectively) compounds were identified as the most important ester compounds in fruits of both genotypes. Pentyl acetate (5.25% and 6.46%, respectively), hexyl butanoate (1.09% and 4.49%, respectively) and butyl butanoate (2.02% and 2.73%, respectively) compounds were other identified ester compounds in 'Gelin' genotype and cv. 'Mondial Gala'. In addition to these compounds, butyl 2-methyl butanoate (0.97%) were detected only in fruits of 'Gelin' genotype. In the previous studies, it was stated that butyl acetate was the main ester compound in Golden Delicious, Royal Gala and 'Mondial Gala' apples (Song and Bangerth 1996; Young et al., 1996; Lara et al., 2007; Echeverria et al., 2008; Salas et al., 2011). Espino-Diaz et al., (2016) were described butyl acetate as red apple and banana flavor; hexyl acetate as red apple and pear flavor and 2-methylbutyl acetate as apple and fruit flavor. According to De Pooter et al (1983), 'Golden Delicious' apples treated with hexanal and hexanoic acid vapors had increased hexyl, butyl, and ethyl esters (Dixon and Hewett, 2010). Researchers explained that volatiles in fruits are formed via the β-oxidation biosynthetic pathway, whereas when fruit tissue is damaged, volatiles are formed via the lipoxygenase pathway. Because acetyl-CoA that produced in β-oxidation is the most common CoA in apple fruits, most identified esters are acetate esters (Dixon and Hewett, 2010; Espino-Diaz, 2016). However, yellow-skinned apple varieties have been reported to produce mainly acetate esters and red-skinned varieties mostly butanoate esters; butyric acid is rapidly transformed by β-oxidation into acetic acid, forming acetate esters (Paillard 1979).

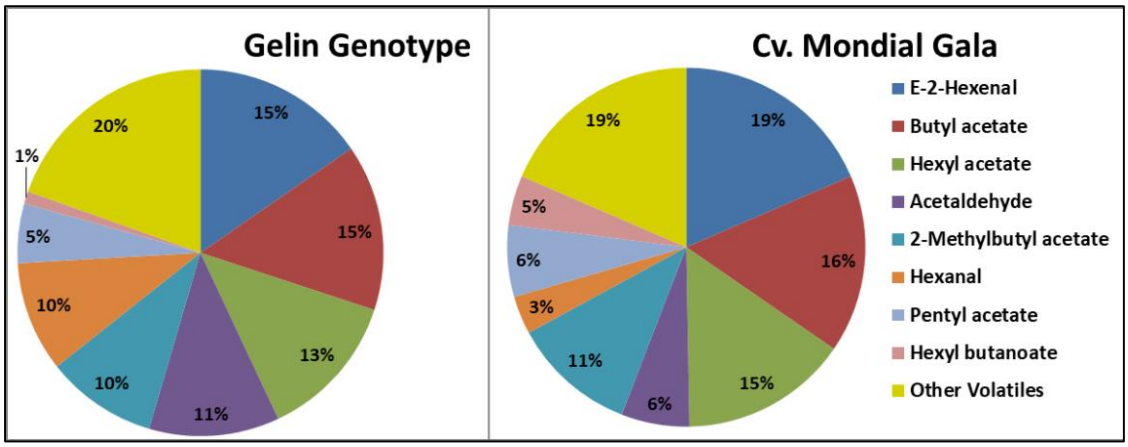

Figure 1. Major volatile compounds of fruits of 'Gelin' genotype and cv. 'Mondial Gala'

According to Paillard (1979); contributing to apple aroma additionally, aldehydes were intermediate compounds between fatty acids and alcohols. Aldehydes form a significant part of the volatile components both of 'Gelin' genotype (45.56%) and cv. 'Mondial Gala' (34.76%). According to analyzes, although 9 identified aldehyde compounds were quantified in 'Gelin' genotype and 7 aldehydes were identified in cv. 'Mondial Gala'. Among these compounds, E-2-hexenal (15.38% in type 'Gelin' and 18.53% in cv. 'Mondial Gala') was found to be the highest aldehyde component in fruits of both genotypes. Secondary and tertiary importance aldehyde components were determined as acetaldehyde (11.52% in type 'Gelin' and 6.16% in cv. 'Mondial Gala') and hexanal (9.74% in type 'Gelin' and 3.44% in cv.

'Mondial Gala') compounds. Butanal (2.08% and 2.10%, respectively), propanal (1.51% and 2.23%, respectively), 2-methyl propanal (1.89% and 1.41%, respectively) and pentanal (0.71% and 0.89%, respectively) compounds were other identified aldehyde compounds in 'Gelin' genotype and cv. 'Mondial Gala'. Furthermore, nonanal and 2-methyl-2-butenal aldehyde compounds were detected only in 'Gelin' genotype. Rizzolo et al (1989) were described acetaldehyde and E-2-hexenal compounds as green and sharp perception and hexanal compound as green, sharp and earthy perception in cv. Golden Delicious. Aldehydes, not only derive from the catabolism of fatty acids, but they can also derive from branced-chain amino acids such as valine, leucine and isoleucine (De Pooter et al, 1986; Rowan et al., 1996; Rowan et al., 1999; Liu et al., 2008).

Table 2. Volatile Contents of fruits of cv. 'Mondial Gala' and 'Gelin' genotype on commercial harvest date*

	COMPOUNDS	'Gelin' Genotype	Cv. 'Mondial Gala'	LSD
Aldehydes	E-2-Hexenal	15.38 ± 0.22 b**	18.53 ± 0.17 a	0.45
	Acetaldehyde	11.52 ± 0.11 a	6.16 ± 0.06 b	0.20
	Hexanal	9.74 ± 0.09 a	3.44 ± 0.11 b	0.23
	Propanal	1.51 ± 0.11	2.23 ± 0.12	0.26
	Butanal	2.08 ± 0.08	2.10 ± 0.10	N.S.
	2-Methyl Propanal	1.89 ± 0.14 a	1.41 ± 0.09 b	0.27
	Pentanal	0.71 ± 0.09	0.89 ± 0.11	N.S.
	Nonanal	0.96 ± 0.09	N.D.	-
	2-Methyl-2-Butenal	1.77 ± 0.23	N.D.	-
	TOTAL ALDEHYDES	**45.56 ± 0.32 A**	**34.76 ± 0.36 B**	**0.77**
Esters	Butyl acetate	14.67 ± 0.14 b	16.06 ± 0.14 a	0.32
	Hexyl acetate	12.96 ± 0.27 b	15.13 ± 0.13 a	0.48
	2-Methylbutyl acetate	9.82 ± 0.12 b	11.21 ± 0.11 a	0.26
	Pentyl acetate	5.25 ± 0.16 b	6.46 ± 0.20 a	0.41
	Hexyl butanoate	1.09 ± 0.09 b	4.49 ± 0.13 a	0.25
	Butyl butanoate	2.02 ± 0.09 b	2.73 ± 0.12 a	0.24
	Butyl 2-methyl butanoate	0.97 ± 0.08	N.D.	-
	TOTAL ESTERS	**46.78 ± 0.77 B**	**56.08 ± 0.09 A**	**1.24**
Alcohols	Butanol	1.89 ± 0.11 a	1.49 ± 0.11 b	0.24
	Hexanol	1.51 ± 0.12 b	1.96 ± 0.14 a	0.26
	2-Methyl Butanol	1.13 ± 0.13 b	1.66 ± 0.09 a	0.25
	Propanol	0.91 ± 0.09	0.92 ± 0.08	N.S.
	E-2-Hexanol	0.87 ± 0.08	N.D.	-
	Ethanol	0.54 ± 0.06 b	0.96 ± 0.06 a	0.14
	Pentanol	N.D.	1.14 ± 0.09	-
	TOTAL ALCOHOLS	**6.85 ± 0.33 B**	**8.13 ± 0.45 A**	**0.89**
Other	α-Farnesene	0.81 ± 0.09 b	1.03 ± 0.08 a	0.19
	TOTAL OTHER	**0.81 ± 0.09 B**	**1.03 ± 0.08 A**	**0.19**

*Percentages obtained by GC/MS peak area normalization
**Data are the means of 4 replicates with standard deviation. Values followed by different letters are significantly different on at $P \leq 0.05$.

According to Dimick et al. (1983), 25 aldehyde compounds, mostly hexanal, E-2-hexenal and butanal, were identified in apples (Espino-Diaz et al., 2016). Aldehyde compounds are copious in early maturation stages on apples; but the content of some aldehydes becomes almost imperceptible on over-ripening stages of apples, while some aldehyde compounds such as acetaldehyde etc. were increasing (Vallat et al., 2005; Mattheis et al., 2005; Espino-Diaz et al., 2016).

Alcohols are formed by the reduction of corresponding aldehydes, by the action of the enzyme alcohol dehydrogenase and also linear alcohols are obtained from the fatty acid catabolism, whereas branched-chain alcohols are consisted of the metabolism of branched amino acids (Espino-Diaz, 2016). Alcohols are the second significant

volatile components that understanding the maturity of apples after esters. It was detected 6.85% alcohols in fruits of 'Gelin' genotype, furthermore 8.13% alcohols in cv. 'Mondial Gala'.

According to analyzes, 6 identified alcohol compounds were quantified in both genotypes. Butanol (1.89% in 'Gelin' genotype and 1.49% in cv. 'Mondial Gala') and Hexanol (1.51% and 1.96%, respectively) compounds were identified as the most important ester compounds in fruits of both genotypes. 2-methyl butanol (1.13% and 0.66%, respectively), propanol (0.91% and 1.92%, respectively) and ethanol (0.54% and 0.96%, respectively) compounds were other identified ester compounds in fruits of both genotypes. In addition to these compounds, E-2-hexanol (0.87%) was detected only in 'Gelin' genotype and also pentanol (1.14%) was detected in cv. 'Mondial Gala'. Espino-Diaz et al., (2016) were described butanol as harsh fusel or banana flavor; hexanol as sweet alcohol and 2-methyl butanol as pleasant flavor; though propanol as alcoholic-nauseating and ethanol as mild and wine or whisky flavors were described as unpleasant flavors. According to Dixon and Hewett (2010), the alcohol acyltransferase enzymes are transferred an acyl group from acetyl CoA to the hydroxide group of an alcohol to form an ester in the last stage of synthesis of volatiles. This reaction happens not only in fatty acid but also amino acid catabolism.

Terpenes are one of the main volatile components from the isoprenoid family in fruits of apples. According to Rupasinghe et al. (1998), the acyclic branched sesquiterpene α-farnesene, synthesized predominantly in epidermal and hypodermal cell layers of the fruit, is the most associated with ripe apple fruit (Espino-Diaz et al., 2016). α-Farnesene that is responsible for the characteristic green apple odour, is primarily synthesized in peel of apple (Kondo et al., 2005). According to the analysis, it was detected 0.81% α-farnesene in fruits of 'Gelin' genotype, furthermore 1.03% α-farnesene in cv. 'Mondial Gala'. α-Farnesene is an unstable aromatic compound of the sesquiterpene that can be oxidized in existence of the oxygen. α-Farnesene oxidation by air forms compounds that are damaging to the fruit in scald progress (Ju and Bramlage, 1999; Anonymous, 2019). α-Farnesene concentrations of apples are lower level in beginning of the ripening. However, they increase during maturation due to rising concentrations of ethylene (Barden and Bramlage, 1994). It usually takes about 3 months for a little decrease in α-farnesene accumulation to occur and at least 3 months for storage scald (Ekinci et al., 2016-b).

4. Conclusions

In this research, it was characterized pomological characteristics and volatile constituents of the local apple genotype called 'Gelin' or 'Yazlik' cultivated only in Canakkale and compared with 'Mondial Gala' commercial standard apple cultivar.

The fruit characteristics of the 'Gelin' genotype were different from 'Mondial Gala'. 'Gelin' genotype has smaller fruit size and yellowish green peel color is less attractive than cv. 'Mondial Gala'. However, flavor composition of the 'Gelin' genotype may have novel potential for Malus genus.

Our results demonstrated that 'Gelin' apple genotype contained much more volatile compounds. Also 'Gelin' genotype had much more aldehyde constituents compared to cv. 'Mondial Gala' especially for E-2-hexenal, acetaldehyde, hexanal and 2-methyl propanal compounds. Although cv. 'Mondial Gala' contained more ester ratio, 'Gelin' genotype contained more ester components. It was also found that the distribution of aroma components was more balanced especially aldehyde:ester:alcohol ratio.

These results reflect the difference between 'Gelin' genotype and cv. 'Mondial Gala'. Aldehydes and esters are main volatiles to fruity and floral aroma especially for apples. High contents of these compounds give pleasant flavor for consumers. Furthermore, presence of undesirable alcohol compounds is higher in the cv. 'Mondial Gala'.

This novel local type called 'Gelin', that described its pomological properties and volatile constituents, is not a standard apple cultivar. In addition, the 'Gelin' genotype population can represent a novel source of breeding materials for improvement of aroma characteristics of standard cultivars.

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