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YIELD AND TASTE RELATED COMPONENTS VARIATION IN NEW SUPERIOR BRED STRAWBERRY GENOTYPES AND COMMERCIAL CULTIVARS DURING THE WIDE HARVEST SEASON

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As a result of the hybridization of 'Sevgi' and 'Kaşka' cultivars with 'Fortuna' cultivar, which are bred within Cukurova University, superior characteristic strawberry genotypes with codes of '33', '36' and '61' were selected. In this study, these genotypes and three cultivars commonly grown in the Mediterranean region were compared in terms of yield, fruit size and taste determining parameters (sugar and organic acids) at different harvest date monthly under Mediterranean climate condition. The highest yield was measured generally in April, while the genotype-dependent yield varied between 628.9 g / plant ('36') and 951.5 g / plant ('Fortuna'). Besides, average fruit weight varied (6.8 - 23.9 g) during the season depending on the harvest date and genotype. The sucrose content varied between 0.06 g / 100 g and 4.83 g / 100 g, while the ascorbic acid content showed huge variation depending on the harvest date and genotype with 1.5 mg kg and 393.8 mg/kg values. Generally, the 33-advanced selection attracted attention with its relatively high yield, glucose, fructose, and ascorbic acid content. As a result, genotype and environmental conditions are quite determinant in terms of observed parameters in strawberry cultivation. Furthermore, biotechnological methods could be utilized to shorten breeding time in classical crossbreeds to improve the deficiencies of these genotypes.

Key words: Crossbreeding, eating quality, *Fragaria × ananassa*, individual sugars, organic acids

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INTRODUCTION

Strawberry breeding programs are carried out in approximately 40 countries around the world. The most widely planted cultivar in the world is 'Camarosa', released from the University of California (UC) breeding program (HANCOCK *et al*., 2008). Strawberry breeding in the USA is still carried out in California, Florida and the Northwest. Some important cultivars such as Aliso, Douglas, Chandler, and Ventana have been also improved at the University of California (HANCOCK *et al*., 2008). The other cultivars that have earliness and low chilling requirement were registered at Florida University named Sweet Charlie, Festival, and Fortuna (SANTOS *et al*., 2007). Along with these developments, new production fields in Turkey were opened by bringing California-originated cultivars such as Portola, San Andreas, and Monterey that have day-neutral character. Recently, San Andreas is widely cultivated in Turkey, which was obtained in 2009, is the result of the hybridization of Albion × Cal. 97.86-1 at the California University (SHAW and LARSON, 2009b). Other new varieties are less cultivated in Turkey, such as Portola, which is a strong day-neutral cultivar that was bred in the same year, is a hybridization of Cal. 97.93-7 ×Cal. 97.209-1 at the same university (SHAW and LARSON, 2009c). Furthermore, Monterey is a day-neutral strawberry that was bred in 2009 as a result of hybridization of Albion ×Cal. 97.85-6 at the University of California (SHAW and LARSON, 2009a), while Mojave is a short-day strawberry cultivar that was bred at the same university (SHAW and LARSON, 2012).

In line with the strawberry breeding efforts in the world, several studies have been conducted in Turkey so far. The cultivars Erenoğlu-77, Dorukhan-77, Doruk-77, Bolverim-77, Hilal-77, Eren-77 and Ata-77 were registered in 2012 from the breeding program conducted under the direction of Dr. Burhan Erenoğlu. In addition, three strawberry cultivars, which are flavorful with medium-hard fruit flesh, Kaşka, Sevgi, and Ebru, were registered in 2009 at Cukurova University, Faculty of Agriculture, Department of Horticulture.

It is not possible to have a perfect cultivar that has all fruit quality parameters at optimum levels due partly to physiological and genetic reasons. CORREIA *et al*. (2011) found that there is an inverse relationship between fruit size and total soluble solid (TSS). Similarly, CAPOCASA *et al*. (2008a) stated a negative relationship between fruit size and nutritional values. Moreover, this negative relationship between yield and taste is an important situation that might result in limitations in breeding programs. KEUTGEN and PAWELZIK (2007), studied quality and consumer acceptance, emphasized that consumer satisfaction ratio decreased along with the reduced TSS content. Besides, many studies indicated an adverse correlation between total sugar content and yield parameters (ZORRILLA-FONTANESI *et al*., 2011; WHITAKER *et al*., 2012). On the contrary, CORREIA *et al*. (2011) found that there was no such relationship in the 'Camarosa' cultivar, although the total soluble solids (TSS) value was higher in the 'Ventana' cultivar which has low yield value. In another study, PAPAROZZI *et al*. (2018) stated that 'Albion' contained higher levels of sugar than other cultivars, despite lower health-related components. Moreover, SARIDAŞ (2021) reported variation in the individual sugars depending on the genetic structure of genotype and harvest date. AKBAŞ *et al*. (2021), indicate obtaining the best cultivar could not be possible due to the antagonism of sugar and nutritional values. In this context, one of the different strategies developed by breeders in recent years is to improve the taste in fruits without causing any loss in yield by developing volatile organic compounds such as γ-decalactone that increase the perception of sweetness in fruits (SCHWIETERMAN *et al*., 2014). In these studies, it has been emphasized that even if hybridization and biotechnological applications are continued for the development of some bioactive compound, it is still not easy to reach all the desired content inside a genotype.

It has been reported in many studies that the characteristics determining fruit quality in strawberries are strongly influenced by the genotype (CAPOCASA *et al*., 2008a, b; CRESPO *et al*., 2010; NOWICKA *et al*., 2019; SARIDAŞ, 2021; SARIDAŞ *et al*., 2021a). However, it has been determined that the harvest date is also among the important determinants of quality parameters along with the effect of environmental conditions such as temperature (CARDEÑOSA *et al*., 2015; WINARDIANTIKA *et al*., 2015; SARIDAŞ, 2021; SARIDAŞ *et al*., 2021b).

In this study, 33, 36 and 61-advanced selections, and 'Fortuna', 'Rubygem' and 'Festival' cultivars, which are widely grown in the Mediterranean region, were compared in terms of individual sugars and acids, yield, and fruit size during the harvest season with one-month intervals. In addition, it was evaluated whether the yield and fruit size were effective on the parameters relating to the taste by examining the interrelationships among the parameters in these genotypes that obtained different genetic origins through the principal component analysis.

MATERIAL AND METHODS

Experiment field and growing environment

The study was carried out at Cukurova University Faculty of Agriculture Department of Horticulture during the 2019-2020 growing season. The experiment field is in Adana at 36°59' N latitude and 35°18' E longitude with a 40 m average altitude from the sea. While winters are warm and rainy, summers are hot and dry in Adana, which is in the Mediterranean climate zone. The perennial average rainfall of the region is 654.6 mm according to the long-term average climate data of the place.

Plants were grown under a Spanish type-high tunnel covered plastic that contains UV, IR, AB, EVA, LD additives, 6.5 m wide, 2.75 m high, 40 m long and 36 months durable. A total of one tunnel was used for this experiment.

Characteristics of strawberry cultivars and genotypes used in the experiment

In the present study, the 'Fortuna' and 'Rubygem' cultivars are originated from American breeding programs, the 'Festival' was obtained from Spanish breeding program (Figure 1).

33-advanced selection: This genotype, which is properly shaped in the early period and preserves its fruit shape throughout the season, was obtained as a result of crossing Fortuna × Kaşka. It is a genotype that produced a significant part of the yield in the period when there is little product, especially in the period between cultivation in the coastal and highland regions. Besides its high yield, it has dark red fruits close to claret red. Common fungal diseases were not observed visually in this genotype during the season (SARIDAŞ, 2018) (Figure 1).

36-advanced selection: This genotype, which produces shapely and large fruits despite its small plant structure, was obtained from the crossing Fortuna × Kaşka. It stands out with its unique aroma along with its light red fruit color. It also maintains its fruit shape throughout the season and yields approximately 750-900 g / plant (SARIDAŞ, 2018) (Figure 1).

61-advanced selection: This genotype, which has a strong plant structure, was obtained by crossing Fortuna × Sevgi. Besides the high yield of this genotype, it has huge and well-shaped fruits. Pedicle of this genotype are quite long, and it improves fruit set and growth as well as minimizes the development of fungal diseases (SARIDAŞ, 2018) (Figure 1).

Figure 1 Fruit pictures of commercial cultivars and selected superior genotypes: (a) 33-advanced selection, (b) 36-advanced selection, (c) 61-advanced selection, (d) Festival, (e) Fortuna, (f) Rubygem

Method

The starting and ending date of harvest period of the experiment was 01/01/2020 and 26/06/2020, respectively.

Average fruit yield (g / plant) and average fruit weight (g)

Fruits were harvested once or twice a week depending on ripening during the growing season. All fruits obtained were counted and weighed after the harvest. Thus, the average yield values per plant were determined monthly and throughout the season. The average fruit weight was determined by dividing the total fruit weight obtained at each harvest by the total number of fruits for each application (0.1 g) (KERN PCB Germany).

Determination of individual sugar and organic acids

The method suggested by STURM *et al*. (2003) was used to analyze sugar and organic acids in strawberry samples. Strawberry fruits were first cut in a high-speed shredder for analysis. In the next step, 1 g of this mixture was taken and transferred to a 15 mL centrifuge tube and ultrapure water was added until the weight reached 10 grams. After mixing, the tubes were centrifuged (6000 rpm, 4°C, 10 min). The obtained upper clear part was taken, and the injection glass vials were prepared by passing through 0.45 µm nylon filters then, this extract was directly injected into HPLC (Shimadzu, LC-20AT, Kyoto, Japan). The amount of organic acid in the samples was determined in mg/kg and sugar components in g / 100 g. In these analyses; Coregel Ion 300 (Concise, USA) column were used with PDA/RID (PDA wavelength: 210 and 244 nm) detector. Samples were injected 20 µL inside the 5mM H_2SO_4 mobile phase (isocratic flow) in 30 °C column temperature with 0.4 mL / min flow rate during the 55 minutes elution time.

Statistical analysis

The experiment was designed as two factor randomized complete block design with split plot combined over harvest date. JMP 8.1 software (from SAS) was used to evaluate all obtained data. The comparison of results was carried out by LSD test at 5%, 1%, 0.1% thresholds. In addition, the principal component analysis (PCA) was performed by using XL Stat trial software to reveal relations among observed parameters (Addinsoft, New York, NY, USA).

RESULTS

Temperature and humidity during the growing season

The temperature and humidity measurement values recorded with the Hobo device inside of the Spanish type-high tunnel are presented in Figures 2 and 3. During the growing season, the average daily temperature varied between 1.2 and 32.7°C, while the lowest temperature recorded as -5.75°C on 11 February and the highest temperature at 48.5°C on 7 June. Large fruit losses were observed when the flowers were exposed to chilling injury less than -1°C depending on the genotype, especially, between 9 and 14 February.

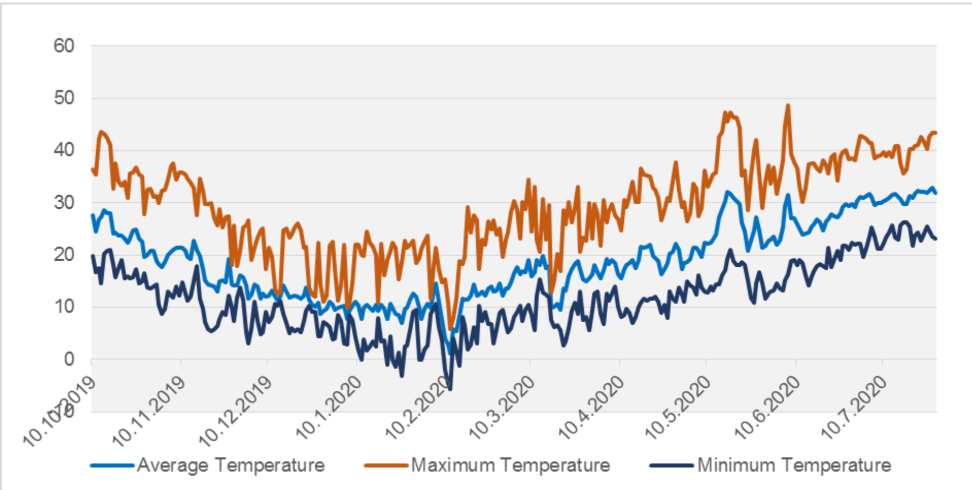

Figure 2. The recorded temperature values throughout the season (ºC)

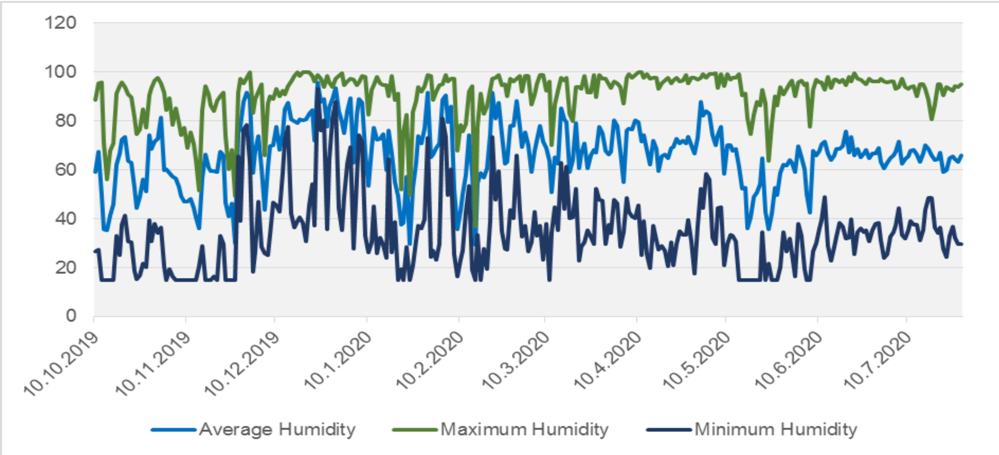

Figure 3 The recorded humidity values throughout the season (%)

Daily average humidity values varied between 29-95% during the season. The highest humidity value was measured on April 10-11 with 100%, while the lowest humidity value was measured on June 6-7 with 15%.

During the experiment, the humidity values inside the high tunnel were mostly (average 62.7%) between 60% and 80% according to the results of a 293-day long observation. During the season, the humidity was higher than 80% approximately on 33 days, which accounts for 11% of the total growing season days.

Total and seasonal distribution of yield (g / plant)

Yield performance of promising genotypes, which was obtained because of breeding, and other important commercial cultivars throughout the season are given in Table 1. Most of the genotypes were in the same statistical group in terms of yield except for the 36-advanced selection that had the lowest yield with 628.9 g / plant. While the highest yield was obtained in 'Fortuna' with 951.5 g/plant, the 33-advanced selection took attention with a value of 914.6 g / plant which had a higher yield even than Rubygem and Festival commercial cultivars that are widely grown in the Mediterranean region. The harvest date with the highest yield was April except for the 36-advanced selection, as May was more favorable with 241.5 g / plant value for this genotype. The secondary highest yield values were generally determined in June except for '36' that had 176.3 g / plant yield in April, and Rubygem yielded 117.9 g / plant in March. Production amount is the main component in determining strawberry crop price. Thus, the results of the present study have revealed the importance of using different strawberry genotypes in strawberry cultivation that provides the more stable amount of strawberry to the markets during the active harvest time, especially in the period when the production amount decreased in the coastal area and desired production amount in the highland regions by using day-neutral cultivars could not be obtained. The '33' advanced selection and Fortuna cultivar came to the fore with the high June yield which could cover this gap. On the other hand, 'Fortuna' cultivar has the highest precocity among all of them with its high value in January. In addition, in all these findings, the '61' advanced selection was more negatively affected than the others in terms of total yield due to having the highest flower density at the beginning of February, when lowest temperature was observed. This genotype can show better performance than it had in our data, if the necessary precautions are taken for this low temperature or when cultivation is carried out in controlled greenhouses.

Table 1. Total yield (g / plant) of strawberry cultivars and genotypes during the harvest date

Genotype	Harvest Date						Total Yield
	January	February	March	April	May	June	
33	33.5 j-n	18.7 lmn	62.6 g-n	497.4 a	82.6 g-n	219.9 cd	*914.6 A*
36	25.5 k-n	5.5 n	100.3 e-l	176.3 c-f	241.5 c	79.9 g-n	*628.9 B*
61	12.4 mn	4.3 n	115.6 e-j	397.9 b	125.5 e-h	140.7 d-g	*795.0 AB*
Rubygem	38.3 i-n	12.1 mn	117.9 e-i	438.5 ab	92.6 f-m	109.7 e-k	*809.1 AB*
Festival	52.4 h-n	35.7 i-n	82.6 g-n	413.1 b	77.5 g-n	123.9 e-h	*759.5 AB*
Fortuna	79.1 g-n	37.9 i-n	118.3 e-i	473.3 ab	64.9 g-n	178.0 cde	*951.5 A*
Date Avg.	40.2 D	19.0 D	99.6 C	399.4 A	114.1 BC	141.9 B	
LSD_{gen*}= 34.4			LSD_{per***}= 34.4			$LSD_{gen\ x\ per***}$= 84.2	

(1): Differences between averages are shown in separate letters

(2): N.S.: Non-Significant. *: p<0.05; **: p<0.01; ***: p<0.001

(3): gen: genotype; per; period (harvest dates)

Average fruit weight (g)

Another important quality parameter, affecting trade of strawberry, is average fruit weight. In this context, it was determined that the examined factors (genotype and harvest time) and their interaction significantly affected the average fruit weight (Table 2). While the highest fruit weight was determined in the Fortuna cultivar with 15.8 g, Festival and Rubygem cultivars were statistically similar with 15.0 g and 14.6 g values, respectively. Although the 61-advanced selection was placed in the same statistical group as Rubygem and Festival cultivars, the lower fruit weight was observed in 33 and 36-advanced selections than the commercial cultivars with 12.2 and 12.9 g, respectively. Regarding the harvest date, as expected, the heaviest fruits (19.3 g) were obtained in January when the least product was obtained. Fruits harvested in March with a value of 18.9 g were in the same statistical group. In terms of genotype and harvest date interaction, the heaviest fruits were obtained from fruits harvested in January (33, 61, and Festival) or March (36, Rubygem, and Fortuna) depending on the genotype. Although it was earlier than March, lower fruit weight was measured in February. The main reason for this decrease in fruit weight could be related to negative effects of the low temperatures on plant growth. Although environmental factors are the most suitable for plant development in April, as can be seen in Table 2, it has been determined that the fruit weight has decreased significantly because of the increasing competition due to the highest yield as shown in Table 1. In the following months, it was determined that the fruit weight gradually decreased due to the decreasing ripening time and plant nutrition storage inside the plant power. Although the responses of genotypes to environmental factors differ in terms of average fruit weight, the lowest fruit weight was detected in fruits harvested in June for all of them. It is assumed that this situation may be related to the shortening of the period from full bloom to harvest due to the increasing temperature in addition to decreasing the storage materials in the plant by the aging.

Table 2. Average fruit weight (g) of the strawberry cultivars and genotypes during the harvest date

Genotype	Harvest Date						Genotype
	January	February	March	April	May	June	Average
33	19.5 bcd	11.9 h-l	15.1 e-h	9.9 j-n	8.9 lmn	7.8 mn	*12.2 D*
36	12.7 h-k	7.6 mn	17.5 de	13.2 g-j	17.4 def	9.4 k-n	*12.9 CD*
61	21.6 abc	14.6 e-i	19.1 bcd	12.9 g-j	10.7 j-m	6.8 n	*14.3 BC*
Rubygem	16.3 d-g	12.2 h-l	21.1 abc	16.3 d-g	14.1 f-ı	7.7 mn	*14.6 AB*
Festival	23.9 a	16.8 def	18.6 cd	13.2 g-j	10.1 j-n	7.6 mn	*15.0 AB*
Fortuna	21.9 ab	17.5 de	22.2 ab	11.9 h-l	11.7 i-l	9.3 lmn	*15.8 A*
Date Avg.	19.3 A	13.5 B	18.9 A	12.9 B	12.1 B	8.1 C	
LSD_{gen***}= 1.38			LSD_{per***}= 1.38			$LSD_{gen\ x\ per***}$= 3.38	

(1): Differences between averages are shown in separate letters

(2): N.S.: Non-Significant. *: p<0.05; **: p<0.01; ***: p<0.001

(3): gen: genotype; per; period (harvest dates)

Individual organic acid content

As a result of the statistical analysis, it was seen that all examined factors and their interactions had a significant effect on the individual acid content of fruits (Table 3, Figure 4). In this context, considering the seasonal average of fruit acids, it was seen that citric acid content was dominant with of 7168.5 mg/kg a value, while the malic and ascorbic acid were followed with values of 2069.4 and 89.7 mg/kg, respectively. Regarding the genotypes, it was observed that the 'Festival' cultivar was differed from the others with its significantly higher ascorbic acid (135.7 mg/kg) values, while the 33-advanced selection had a significantly higher citric acid and malic values (8257.9 mg/kg, 2675.1 mg/kg, respectively) than the others. The fruits that were harvested in January, taken attention by the highest malic (2380.9 mg/kg) and ascorbic acid (219.4 mg/kg) contents. Although the highest citric acid was detected in May with 8980.9 mg/kg value, it did not change significantly in the March harvested fruit with 8796.6 mg/kg value.

Individual sugar content of fruits

The variation of individual sugars in fruits of different genotypes and commercial strawberry cultivars during the harvest dates are presented in Table 4 (Figure4). It was determined that the examined factors and the interaction of these factors result in a statistical variation in individual sugars. Considering the whole seasonal average, the highest individual sugar was determined as fructose with 2.57 g / 100 g, followed by glucose with 2.11 g / 100 g value. The lowest individual sugar value was sucrose with 1.31 g / 100 g. Regarding advanced selections, the '36' was significantly higher than the others in terms of sucrose with of 2.65 g / 100 g value, while the highest fructose (2.74 g / 100 g) and glucose (2.32 g / 100 g) content were the 61. In this context, the commercial cultivars had generally very low-level individual sugar content except for Festival and Rubygem in terms of fructose.

Table 3. Fruit individual organic acid contents of strawberry cultivars and genotypes during the harvest date

	Genotype	Harvest Date					Genotype
		January	February	March	April	May	Average
Citric Acid (mg/kg)	33	6933.9 hij	6285.5 ijk	9293.5 bcd	8024.1 efg	10752.7 a	*8257.9 A*
	36	5967.3 klm	4722.6 no	8228.1 ef	6406.1 ijk	8379.3 def	*6740.7 C*
	61	7072.8 hi	5982.8 klm	9445.0 bc	6617.1 ijk	10013.9 ab	*7826.3 B*
	Rubygem	7564.8 fgh	4387.8 o	8032.9 efg	6254.6 ijk	7133.9 ghi	*6674.8 C*
	Festival	5309.7 lmn	4396.9 no	9286.1 bcd	6369.7 ijk	8910.4 cde	*6854.6 C*
	Fortuna	6066.4 jkl	4914.5 no	8494.0 de	5111.9 mno	8695.5 cde	*6656.5 C*
	Date Avg.	6485.8 B	5114.9 C	8796.6 A	6463.9 B	8980.9 A	
	LSD_{gen***}= 408.9			LSD_{per***}= 373.2		$LSD_{gen\ x\ per***}$= 914.2	
Malic Acid (mg/kg)	33	3462.7 a	2732.2 bcd	2181.0 fgh	2784.0 bc	2215.3 fgh	*2675.1 A*
	36	2920.6 bc	2340.6 f	1791.0 ijk	2649.5 cde	1862.8 ij	*2312.9 B*
	61	1470.4 lm	1480.6 lm	1061.7 n	1666.5 jkl	1513.4 klm	*1438.5 D*
	Rubygem	1541.6 klm	1251.6 mn	1655.6 jkl	1242.5 mn	1058.9 n	*1350.1 D*
	Festival	2914.4 bc	2002.5 hi	3003.8 b	2422.4 ef	2439.1 def	*2556.4 A*
	Fortuna	1975.8 hi	2330.5 fg	2308.8 fg	2033.4 ghi	1768.6 i-l	*2083.4 C*
	Date Avg.	2380.9 A	2022.9 BC	2000.3 C	2133.1 B	1809.7 D	
	LSD_{gen***}= 136.5			LSD_{per***}= 124.6		$LSD_{gen\ x\ per***}$= 305.3	
Ascorbic Acid (mg/kg)	33	119.8 efg	32.7 hij	185.3 bc	95.3 fg	11.7 hij	*88.9 B*
	36	182.6 bc	4.2 ij	157.2 cd	135.3 de	3.2 ij	*96.5 B*
	61	218.5 b	1.5 j	29.8 hij	44.9 h	3.1 ij	*59.6 C*
	Rubygem	184.4 bc	1.6 j	128.5 def	121.9 def	2.7 ij	*87.8 B*
	Festival	393.8 a	1.8 j	91.8 fg	188.0 bc	2.9 ij	*135.7 A*
	Fortuna	217.2 b	2.2 j	84.5 g	39.6 hi	3.7 ij	*69.4 C*
	Date Avg.	219.4 A	7.33 C	112.8 B	104.2 B	4.56 C	
	LSD_{gen***}= 16.6			LSD_{per***}= 15.1		$LSD_{gen\ x\ per***}$= 37.0	

(1): Differences between averages are shown in separate letters

(2): N.S.: Non-Significant. *: p<0.05; **: p<0.01; ***: p<0.001

(3): gen: genotype; per; period (harvest dates)

Table 4. Fruit individual sugar contents of strawberry cultivars and genotypes during the harvest date

	Genotype	Harvest Date					Genotype Average
		January	February	March	April	May	
Sucrose (g/100 g)	33	1.13 jk	0.06 p	0.59 lmn	1.01 k	0.58 mn	*0.67 D*
	36	4.83 a	1.95 fg	2.15 ef	2.80 cd	1.53 hij	*2.65 A*
	61	2.92 c	0.50 no	0.53 n	1.61 ghi	0.56 mn	*1.22 C*
	Rubygem	2.51 de	0.06 p	0.21 nop	0.50 no	0.11 op	*0.68 D*
	Festival	3.75 b	0.11 op	0.24 nop	0.93 klm	0.26 nop	*1.06 C*
	Fortuna	3.48 b	1.23 ijk	0.98 kl	1.68 gh	0.48 no	*1.57 B*
	Date Avg.	3.10 A	0.65 CD	0.78 C	1.42 B	0.59 D	
	LSD_{gen***}= 0.18			LSD_{per***}= 0.16		$LSD_{gen\ x\ per}$= 0.39	
Glucose (g/100g)	33	2.76 a	2.42 bcd	1.81 hi	2.05 fgh	2.08 efg	*2.22 AB*
	36	2.40 bcd	2.22 def	1.63 ijk	1.95 gh	2.42 bcd	*2.13 BC*
	61	2.37 bcd	2.42 bcd	1.90 gh	2.34 bcd	2.58 ab	*2.32 A*
	Rubygem	2.53 abc	1.96 gh	1.41 kl	1.81 hi	2.57 ab	*2.06 C*
	Festival	2.32 cde	2.30 cde	1.62 ijk	1.99 fgh	2.73 a	*2.19 B*
	Fortuna	1.99 fgh	1.94 gh	1.37 l	1.56 jkl	1.81 hij	*1.73 D*
	Date Avg.	2.39 A	2.21 B	1.62 D	1.95 C	2.36 A	
	LSD_{gen***}= 0.11			LSD_{per***}= 0.10		$LSD_{gen\ x\ per***}$= 0.25	
Fructose (g/100g)	33	2.29 ab	2.95 c-f	2.25 kl	2.53 hij	2.53 hij	*2.71 A*
	36	2.81 efg	2.61 ghi	1.99 lmn	2.31 jk	2.88 c-f	*2.52 B*
	61	2.76 fgh	2.83 d-g	2.28 jk	2.73 fgh	3.09 bcd	*2.74 A*
	Rubygem	3.07 b-e	2.43 ijk	1.84 n	2.26 kl	3.15 bc	*2.55 B*
	Festival	2.79 fgh	2.81 efg	2.17 klm	2.43 ijk	3.44 a	*2.72 A*
	Fortuna	2.37 ijk	2.37 ijk	1.78 n	1.98 mn	2.32 jk	*2.17 C*
	Date Avg.	2.85 A	2.67 B	2.05 D	2.37 C	2.90 A	
	LSD_{gen***}= 0.12			LSD_{per***}= 0.11		$LSD_{genxper***}$= 0.27	

(1): Differences between averages are shown in separate letters
(2): N.S.: Non-Significant. *: p<0.05; **: p<0.01; ***: p<0.001
(3): gen: genotype; per; period (harvest dates)

In this study, it was found that harvest dates have different effects on sugar composition and amount of fruit. The individual sugars were generally quite high due to strong plant structure as well as the low yield in January. In this context, sucrose was significantly higher compared to other harvest dates with 3.1 g / 100 g value, while the second lowest fruit sucrose contents had values of 0.65 g / 100 g in February, when low temperature damage was observed, also the lowest (0.59 g / 100 g) sucrose content was measured in May when the highest temperatures were recorded. It is well known that sucrose is the first product of plant photosynthesis. Therefore, as seen in our results, the accumulation of the sucrose can be more sensitive to environmental conditions than the other sugars. While the fructose and glucose contents of fruits were higher in the earlier harvested dates, they gradually decreased until March due to low temperature damage and increasing competition. It was determined that these two sugar contents of the fruits significantly increased in April, when better optimum growing conditions for strawberry cultivation than in March were observed. By the decrease in yield in May, fruits had higher fructose and glucose than January values. In this study, when the interaction of harvest time and genotype was evaluated throughout the season, the sucrose content varied between 0.06-4.83 g / 100 g, while the fructose and glucose contents ranged from 1.78 to 3.44 g / 100 g, and 1.37-2.76 g / 100 g, respectively. In this context, the sucrose accumulation in fruit is more sensitive than the other two individual sugars depending on environmental conditions.

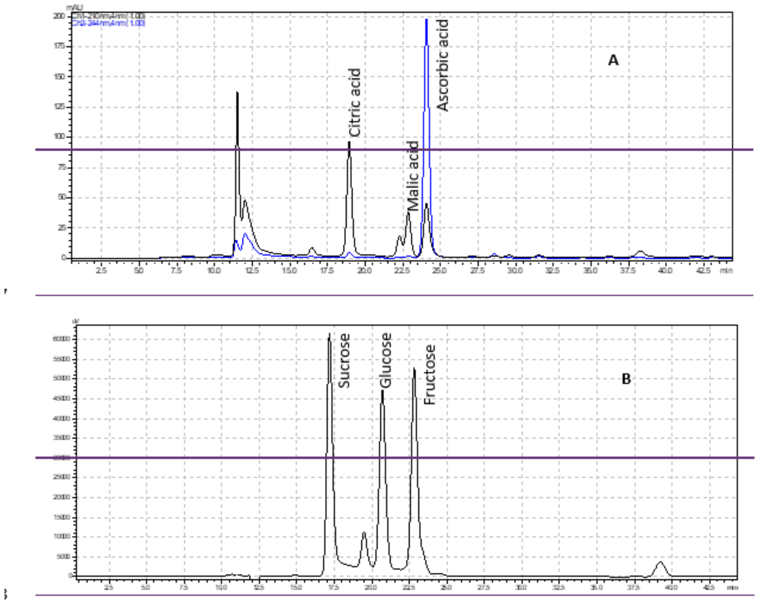

Figure 4. HPLC chromatograms for the detected peaks (A: PDA chromatogram of the organic acids, B: RID chromatogram of the sugar compounds)

As a result of the principal component analysis, 28.6% and 26.9% of the total variation were explained by PC1 and PC2, respectively (Figure 5). Yield was different from the other parameters. As expected, the March or April values were quite close to the yield factor. The January values were very close to the fructose and glucose by clearly separating on the secondary axis (PC2). A similar trend was seen at Rubygem and 33-advanced selection that has higher fructose and glucose contents in January. It was observed that genotypes were close to each other and to the zero point of the axis in February and May harvest dates, when yield and individual sugars and acids values were quite low. Another point, fructose, glucose and citric acid were negatively located with yield component by PCI results. This finding is explained why the lower taste compound were determined in March and April regarding higher flowering, fruiting, and harvesting dates, respectively. On the other hand, according to PC2 result, the yield negatively affects all examined parameters except to citric acid.

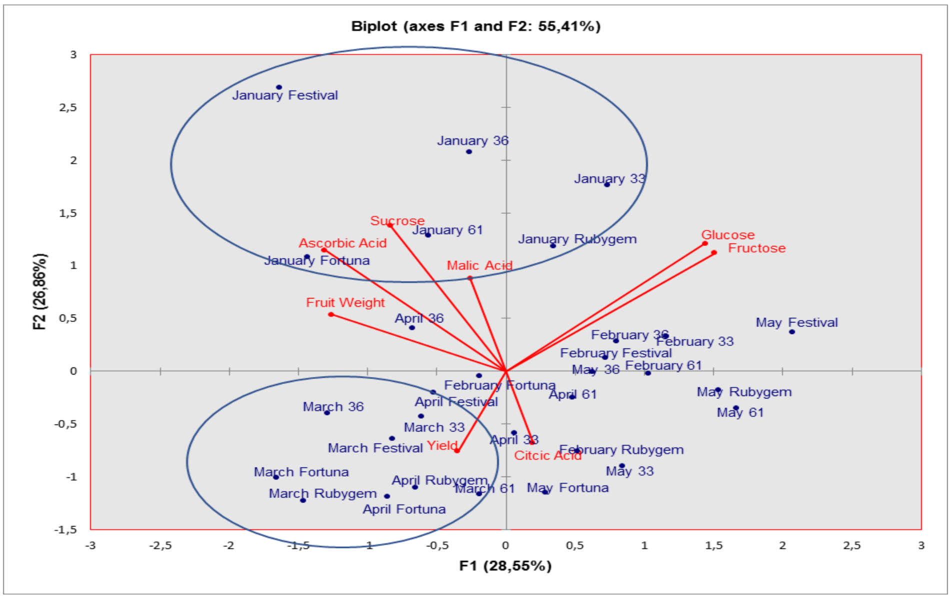

Figure 5. Principal component analysis (PCA) for interrelation of all examined variables with the combination of genotypes and harvest date

DISCUSSION

Although modern consumers are interested in the taste and nutritional value of the product, the yield value should be at a satisfactory level that can compete with commercial cultivars to be chosen by farmers. SINGH *et al*. (2011) found that the yield value varied up to 9.33 times depending on the genotype, ranging between 26.6 g / plant and 248.2 g / plant. Similarly, HOSSAIN *et al*. (2016) reported that the yield varies between 202.67 g / plant and 330 g / plant depending on the genotype. In another study yield varied between 210 g / plant and 457 g / plant under the different growing systems by using three strawberry cultivars (SARIDAŞ *et al*., 2016). It can be emphasized that the yield is mainly influenced by the genotype, as seen in the previous studies and current findings.

Size, one of the other fruit quality parameters, is important as well, considering the average fruit weight varied between 6.8 and 22.2 g depending on genotype and harvest date (Table 2). Similar variation was also indicated by GASPEROTTI *et al*. (2013) who found that fruit weight varied between 10.4 g (‘Clery’) and 15.8 g (‘Portola’) depending on the genotypes. While ZELIOU *et al*. (2018) obtained higher fruit weight values than ours ranging from 23.8 g to 27.27 g among cultivars. Moreover, NOUR *et al*. (2017) reported that the lower values ranged between 5.26 g and 5.66 g. In another study, LIU *et al*. (2016) determined that the average fruit weight varied between 21.50 g (‘Tochiotome’) and 35.00 g (‘Benihoppe’) depending on the cultivar. In addition, SARIDAŞ *et al*. (2021a) determined a huge variation in average fruit weight that ranged between 5.36 - 34.48 g depending on harvest date and genotype among the bred lines and their parents. As it is seen in literature, genetic structure is the main component to determine the fruit size as well as harvest date. According to the findings of the present study, it is necessary to improve these bred lines to reach the commercial cultivar level in terms of fruit weight. In this context, these bred lines can be re-hybridized with the genotype that has a high average fruit weight such as 'Fortuna'.

Although the fruit acid content and type are important for formation of fruit taste and some secondary compounds, it is known that the total acid content which is higher than a certain concentration (0.7%) affects the fruit taste negatively. In addition to this, higher ascorbic acid content of fruit is generally desirable due to the contribution (approximately 10%) to antioxidant activity (KALT *et al*., 1999). Regarding the fruit's individual acids, while the 36-advanced selection attracted attention with its low citric acid content which is taken in the same statistical group as commercial cultivar, the malic acid content of fruit was not separated between commercial cultivar and bred lines. The lowest value measured was in 'Rubygem' with 1350.1 mg/kg, that followed the 61-advanced selection that had 1438.5 mg/kg value in terms of fruit malic acid content. At the same time, the highest malic acid content was determined in 33-advanced selection with 2675.1 mg/kg value. Similar to the KAPUR *et al*. (2018), fruit's citric acid content was found higher than malic acid in all the examined strawberry genotypes. Although the citric acid content of 36-advanced selection was significantly higher than the commercial cultivar, there was similar malic acid accumulation inside the fruits that ranged between 1438 - 2675 mg/kg and 1350 - 2556 mg/kg for bred lines and commercial cultivars, respectively. It has been reported that ascorbic acid is even higher in strawberry fruits than oranges (AYUB *et al*., 2010). Although this acid accumulation was mainly determined by harvest date, genetic structure also significantly influenced this acid content. In this context, it has been determined that the ascorbic acid content in strawberry fruits showed huge variation than ranging between 1.52 and 393.8 mg/kg depending on harvest date and genotype. This variation, up to 260 times higher, shows the sensitivity of ascorbic acid accumulation inside fruit as well as how the content can be improved providing sweet growing conditions and choosing the right genotype. Similar to the current study, there have been numerous research reporting that citric acid content is at top level among organic acids in strawberry fruits, followed by malic acid (KAPUR *et al*., 2018; HWANG *et al*., 2019; IKEGAYA *et al*., 2019; SARIDAŞ *et al*., 2021b). Moreover, it was observed that the citric acid in fruits decreased with maturity and varied between 440.9 and 768.1 mg/100 g depending on the cultivar (HWANG *et al*., 2019). In another study, it was reported that the harvest date significantly affected the citric acid level of the fruit, according to the current study, this value ranged between 2.91 and 8.04 mg/g (WINARDIANTIKA *et al*., 2015). In another study, the citric acid level of ripe fruits was determined as 1200 mg/100g - 1434 mg/100g in strawberry cultivars, followed by ascorbic acid with a 10-fold lower concentration of 90 mg / 100g - 131 mg / 100 g (MAHMOOD *et al*., 2012). As seen in the previous studies, the current citric acid values were generally compatible. All the examined factors and their interaction significantly influenced fruit ascorbic acid content that was varied between 1058.9 and 3462.7 mg/kg value. Although WINARDIANTIKA *et al*. (2015) found no significantl variation due to the genotype and harvest date, their values were also quite compatible with ours. However, it was pointed out that the interaction of these two factors significantly affects the malic acid content, whereas this value ranged between 0.02 and 3.35 mg / g. In another study, it was found that this value varied between 77.2 and 305.6 mg / 100 g depending on the maturity stage and cultivar (HWANG *et al*., 2019). In the current study, ascorbic acid ranged between 1.52 and 393.8 mg/kg. ŠAMEC *et al*. (2016) reported that the ascorbic acid values of the cultivars varied between 41.35 mg / 100 g ('Carpi') and 57.96 mg / 100 g ('Albion'). KIM *et al*. (2015) cited that ascorbic acid content was significantly variated that ranging from 56.8 mg / 100 g to 108.1 mg / 100 g value, depending on the harvest year. In another study carried out in the same experimental field, ascorbic acid accumulation was significantly different in two strawberry cultivars that varied between 34.3 and 60.5 mg / 100 g value, depending on the irrigation regimes and bio stimulant applications (KAPUR *et al*., 2018). It has been determined that ascorbic acid content may be vary depending on the pre-harvest factors. According to the study of LEE and KADER (2000), increasing light intensity had positive effect on sugar accumulation along with ascorbic acid amount in fruit. On the contrary, KIM *et al*. (2013) discovered an inverse relationship between temperature and ascorbic acid formation. They also observed that increasing day and night temperature caused a decrease in sugar and ascorbic acid production. These findings confirmed the lowest ascorbic acid content that was observed to be 4.6 mg/kg in fruits harvested in May, when high temperatures were measured. The second lowest ascorbic acid content was measured in February due to chilling injury on plants, which cause unfavorable growing condition for strawberry cultivation. These results show that the accumulation of fruit ascorbic acid content is more sensitive than citric and malic acid content against environmental conditions.

Taste is mainly determined by total sugar content of fruit. Although a similar trend has been reported by many researchers (CASTRO *et al*., 2002; MAHMOOD *et al*., 2012; LIU *et al*., 2016; KAPUR *et al*., 2018), some study found that sucrose is the predominant individual sugar in strawberry fruits (HWANG *et al*., 2019; IKEGAYA *et al*., 2019). These differences are sourced from the variation of the genetic structure of genotypes as they are obtained from different gene pools. In addition to the importance of genotype effect on individual sugars, the amount of these sugar was found different depending on genotype. In the present study, Fortuna had the lowest fructose and glucose content, while Rubygem had the lowest sucrose content. Similar to our results, LIU *et al*. (2016) determined that fructose ranged between 22.87 g / kg (Benihoppe) and 35.15 g / kg (Guimeiren), while the glucose varied between 17.10 g / kg (Benihoppe) to 25.60 g / kg (Guimeiren). Moreover, it was determined by HWANG *et al*. (2019) that sugar accumulation in fruits is associated with ripening, that is, these sugar content increase with progress of maturity. Besides the influence on the fruit taste, sugar content of fruit is one of the most important indicators to determine fruit maturity. However, the accumulation of these sugar can show variation even in different parts of the same fruit (IKEGAYA *et al*., 2019). There are many studies indicating that growing condition, pre-harvest application and their effect on genotype have significantly different influences on fruit sugar content and its composition (KAPUR *et al*., 2018; SARIDAŞ, 2021). In this context, harvest date is another component on taste related parameters. In line with the finding of WINARDIANTIKA *et al*. (2015), it was observed that the highest individual sugars were obtained in January, the coldest harvest date, and fruit sugar content gradually decreased the until April harvest date. According to our findings, while the genotype is the main determinant on taste related parameters, it can show variation depending on the harvest date due to different reactions to environmental conditions, similar to the findings of SARIDAȘ (2021).

Our PCA results found similar outcomes reported by many researchers (ZORRILLA-FONTANESI *et al*., 2011; WHITAKER *et al*., 2012). Besides, CORREIA *et al*. (2011) stated that this situation changes depending on the cultivar. CAPOCASA *et al*. (2008a) found a negative relationship between fruit size and nutritional values. Similarly, in the study, glucose and fructose took place in different axes with the average fruit weight as seen in PC1 as well as this case has also been reported by CORREIA *et al*. (2011). This situation, which is confirmed by our study, is an important factor that limits the breeding of productive and high-tasting cultivars. Important progress has been achieved in strawberry breeding programs that are related to increasing productivity and consumer satisfaction in last decade. In this context, it is a strategy to develop volatile organic compounds such as γ-decalactone, which increases the sweetness perception in fruits, without causing any loss in yield (SCHWIETERMAN *et al*., 2014). In addition, classical crosses and different biotechnological methods are used to improve fruit average weight and taste related parameters (RYU *et al*., 2020; SARIDAȘ *et al*., 2021a). More productive and sweet cultivars can be developed as a result of better understanding of plant biosynthesis mechanisms with advancement of molecular genetic approaches.

CONCLUSION

As can be seen in this study, the parameters affecting consumer satisfaction are negatively affected by the increase in yield component. At the same time, it was reported that the cultivar and the harvest date had a strong role in influencing these parameters. Furthermore, the responses of each genotype to the environmental conditions could be different even under the same cultivation condition. For that reason, it is not easy to provide the optimum growing condition in terms of taste and yield related parameters for all genotypes at the same time. As a result, it was determined that the 33-advanced selection attracted attention with its high yield, glucose, and fructose contents, while it has a higher citric and malic acid content compared to commercial cultivars. It was also noted that fructose and glucose were quite high in the 61-advanced selection, although the yield was partially low due to chilling injury during the February period when intense flowering was observed. It is seen that glucose, fructose, and ascorbic acid are quite low in Fortuna, which stands out with its high yield and average fruit weight. With the current study, it has been determined that the existing cultivars are insufficient in all aspects, as can be seen in these breeding genotypes. Classical and biotechnological methods should be applied to increase the potential of these genotypes to become commercial cultivars.

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REFERENCES

AKBAŞ, F.C., M.A., SARIDAŞ, E., AĞÇAM, G.S., KESKINASLAN, R., KAMAR, S., PAYDAŞ KARGI (2021): Önemli Çilek Genotiplerinin Tat Parametreleri Bakımından Değerlendirilmesi. Turk. J. Agric. - Food Sci. Technol., *9*(1):241-248.

AYUB, M., J., ULLAH, A., MUHAMMAD, A., ZEB (2010): Evaluation of strawberry juice preserved with chemical preservatives at refrigeration temperature. Int. J. Nutr. Metab., *2*(2):027-032.

CAPOCASA, F., J., DIAMANTI, B., MEZZETTI, S., TULIPANI, M., BATTINO (2008a): Breeding strawberry (Fragaria × ananassa Duch) to increase fruit nutritional quality. BioFactors, *34*(1):67-72.

CAPOCASA, F., J., SCALZO, B., MEZZETTI, M., BATTINO (2008b): Combining quality and antioxidant attributes in the strawberry: The role of genotype. Food Chem., *111*(4):872-878.

CARDEÑOSA, V., E., MEDRANO, P., LORENZO, M.C., SÁNCHEZ-GUERRERO, F., CUEVAS, I., PRADAS, J.M., MORENO-ROJAS (2015): Effects of salinity and nitrogen supply on the quality and health-related compounds of strawberry fruits (Fragaria × ananassa cv. Primoris). J. Sci. Food Agric., *95*(14):2924-2930.

CASTRO, I., O., GONÇALVES, J.A., TEIXEIRA, A.A., VICENTESC (2002): Comparative study of Selva and Camarosa strawberries for the commercial market. J. Food Sci., *67*(6):2132-2137.

CORREIA, P.J., M., PESTANA, F., MARTINEZ, E., RIBEIRO, F., GAMA, T., SAAVEDRA, P., PALENCIA (2011): Relationships between strawberry fruit quality attributes and crop load. Sci. Hortic., *130*(2):398-403.

CRESPO, P., J., GINÉ BORDONABA, L.A., TERRY, C., CARLEN (2010): Characterisation of major taste and health-related compounds of four strawberry genotypes grown at different Swiss production sites. Food Chem., *122*(1):16-24.

GASPEROTTI, M., D., MASUERO, G., GUELLA, L., PALMIERI, P., MARTINATTI, E., POJER, F., MATTIVI, U., VRHOVSEK (2013): Evolution of ellagitannin content and profile during fruit ripening in Fragaria spp. J. Agric. Food. Chem., *61*(36):8597-8607.

HANCOCK, J.F., T.M., SIULIN, G.A., LOBOS (2008): 2008. "Strawberries". Temperate Fruit Crop Breeding. Editör: Hancock, J. F., New York: Springer. pp 393–437.

HOSSAIN, A., P., BEGUM, M., SALMA ZANNAT, M., HAFIZUR RAHMAN, M., AHSAN, S.N., ISLAM (2016): Nutrient composition of strawberry genotypes cultivated in a horticulture farm. Food Chem., *199*:648-652.

HWANG, H., Y.J., KIM, Y., SHIN (2019): Influence of ripening stage and cultivar on physicochemical properties, sugar and organic acid profiles, and antioxidant compositions of strawberries. Food Sci. Biotech., *28*(6):1659-1667.

IKEGAYA, A., T., TOYOIZUMI, S., OHBA, T., NAKAJIMA, T., KAWATA, S., ITO, E., ARAI (2019): Effects of distribution of sugars and organic acids on the taste of strawberries. Food Sci. Nutr., *7*(7):2419-2426.

KALT, W., C.F., FORNEY, A., MARTIN, R.L., PRIOR (1999): Antioxidant capacity, vitamin C, phenolics, and anthocyanins after fresh storage of small fruits. Journal of Agricultural and Food Chem., *47*(11):4638-4644.

KAPUR, B., M.A., SARIDAŞ, E., ÇELIKTOPUZ, E., KAFKAS, S., PAYDAŞ KARGI (2018): Health and taste related compounds in strawberries under various irrigation regimes and bio-stimulant application. Food Chem., *263*:67-73.

KEUTGEN, A., E., PAWELZIK (2007): Modifications of taste-relevant compounds in strawberry fruit under NaCl salinity. Food Chem., *105*(4):1487-1494.

KIM, S.K., D.S., KIM, D.Y., KIM, C., CHUN (2015): Variation of bioactive compounds content of 14 oriental strawberry cultivars. Food Chem., *184*:196-202.

KIM, S.K., R.N., BAE, H., NA, K.D., KO, C., CHUN (2013): Changes in physicochemical characteristics during fruit development in June-bearing strawberry cultivars. Hortic. Environ. Biotech., *54*(1):44-51.

LEE, S.K., A.A., KADER (2000): Preharvest and postharvest factors influencing vitamin C content of horticultural crops. Postharvest Biol. Technol., *20*(3):207-220.

LIU, L., M.L., JI, M., CHEN, M.Y., SUN, X.L., FU, L., LI, D.S., GAO, C.Y., ZHU (2016): The flavor and nutritional characteristic of four strawberry varieties cultured in soilless system. Food Sci. Nutr., *4*(6):858-868.

MAHMOOD, T., F., ANWAR, M., ABBAS, M.C., BOYCE, N., SAARI (2012): Compositional variation in sugars and organic acids at different maturity stages in selected small fruits from Pakistan. Int. J. Mol. Sci., *13*(2):1380-1392.

NOUR, V., I., TRANDAFIR, S., COSMULESCU (2017): Antioxidant compounds, nutritional quality and colour of two strawberry genotypes from Fragaria × ananassa. Erwerbs-Obstbau, *59*(2):123-131.

NOWICKA, A., A.Z., KUCHARSKA, A., SOKÓŁ-ŁĘTOWSKA, I., FECKA (2019): Comparison of polyphenol content and antioxidant capacity of strawberry fruit from 90 cultivars of Fragaria × ananassa Duch. Food Chem., *270*:32-46.

PAPAROZZI, E.T., G.E., MEYER, V., SCHLEGEL, E.E., BLANKENSHIP, S.A., ADAMS, M.E., CONLEY, B., LOSEKE, P.E., READ (2018): Strawberry cultivars vary in productivity, sugars and phytonutrient content when grown in a greenhouse during the winter. Sci. Hortic., *227*:1-9.

RYU, J., W.J., KIM, S.H., KIM, K.S., LEE, H.J., JO, E.Y., KIM, S.H., KIM, S.Y., KANG, J.H., LEE, B.K., HA (2020): Characterization of genetic variation and antioxidant properties in strawberry (Fragaria × ananassa Duch.) mutant genotypes. Genet. Resour. Crop Evol., *67*(6):1457-1471.

ŠAMEC, D., M., MARETIĆ, I., LUGARIĆ, A., MEŠIĆ, B., SALOPEK-SONDI, B., DURALIJA (2016): Assessment of the differences in the physical, chemical and phytochemical properties of four strawberry cultivars using principal component analysis. Food Chem., *194*:828-834.

SANTOS, B.M., C.K., CHANDLER, S.M., OLSON, T.W., OLCZYK (2007): Performance of strawberry cultivars in Florida. In Proceedings of the Florida State Horticultural Society, *120*:155-156.

SARIDAŞ, M.A. (2018): Determination of yield, quality properties of selected strawberry genotypes obtained by cross breeding and molecular characterization (dissertation). Adana (TR): Cukurova University.

SARIDAŞ, M.A. (2021): Seasonal variation of strawberry fruit quality in widely grown cultivars under Mediterranean climate condition. J. Food Compos. Anal., *97*:103733-103733.

SARIDAŞ, M.A., B., KAPUR, E., ÇELIKTOPUZ, Y., ŞAHINER, S., PAYDAŞ KARGI (2021b): Land productivity, irrigation water use efficiency and fruit quality under various plastic mulch colors and irrigation regimes of strawberry in the eastern Mediterranean region of Turkey. Agric. Water Manage., *245*:106568-106568.

SARIDAŞ, M.A., G., NOGAY, ATTAR Ş.H, S., PAYDAŞ KARGI, E KAFKAS (2016): Farklı yetiştirme ortamlarının bazı çilek çeşitlerinde verim ve kalite üzerine etkileri. Bahçe, *45*:163-172.

SARIDAŞ, M.A., O., SIMSEK, D., DONMEZ, Y.A., KACAR, S., PAYDAŞ KARGI (2021a): Genetic diversity and fruit characteristics of new superior hybrid strawberry (Fragaria × ananassa Duchesne ex Rozier) genotypes. Gen. Res. Crop Evol., *68*(2):741-758.

SCHWIETERMAN, M.L., T.A., COLQUHOUN, E.A., JAWORSKI, L.M., BARTOSHUK, J.L., GILBERT, D.M., TIEMAN, A.Z., ODABASI, H.R., MOSKOWITZ, K.M., FOLTA, H.J., KLEE *et al.* (2014): Strawberry flavor: Diverse chemical compositions, a seasonal influence, and effects on sensory perception. PLoS One, *9*(2):e88446-e88446.

SHAW, D.V., K.D., LARSON (2009a): Inventors; University of California, assignee (2009 Feb 24). Strawberry Plant Named 'Monterey'. United States patent USPP19767P2.

SHAW, D.V., K.D., LARSON (2009b): Inventors; University of California, assignee (2009 May 12). Strawberry plant named 'San Andreas'. United States patent USPP19975P2.

SHAW, D.V., K.D., LARSON (2009c): Inventors; University of California, assignee (2009 Nov 06). Strawberry Plant Named 'Portola'. United States patent US20090144866P1.

SHAW, D.V., K.D., LARSON (2012): Inventors; University of California, assignee (2012 March 20). Strawberry Plant Named 'Mojave'. United States patent USPP22542P3.

SINGH, A., B.K., SINGH, B.C., DEKA, S.K., SANWAL, R.K., PATEL, M.R., VERMA (2011): The genetic variability, inheritance and inter-relationships of ascorbic acid, β-carotene, phenol and anthocyanin content in strawberry (Fragaria×ananassa Duch.). Sci. Hortic., *129*(1):86-90.

STURM, K., D., KORON, F., STAMPAR (2003): The composition of fruit of different strawberry varieties depending on maturity stage. Food Chem., *83*(3):417-422.

WHITAKER, V.M., L.F., OSORIO, T., HASING, S., GEZAN (2012): Estimation of genetic parameters for 12 fruit and vegetative traits in the University of Florida strawberry breeding population. J. Am. Soc. Hort. Sci., *137*(5):316-324.

WINARDIANTIKA, V., Y.H., LEE, N.I., PARK, Y.R., YEOUNG (2015): Effects of cultivar and harvest time on the contents of antioxidant phytochemicals in strawberry fruits. Hortic. Environ. Biotechnol., *56*(6):732-739.

ZELIOU, K., V., PAPASOTIROPOULOS, Y., MANOUSSOPOULOS, F.N., LAMARI (2018): Physical and chemical quality characteristics and antioxidant properties of strawberry cultivars (Fragaria × ananassa Duch.) in Greece: assessment of their sensory impact. J. Sci. Food Agric., *98*(11):4065-4073.

ZORRILLA-FONTANESI, Y., A., CABEZA, A.M., TORRES, M.A., BOTELLA, V., VALPUESTA, A., MONFORT, J.F., SÁNCHEZ-SEVILLA, I., AMAYA (2011): Development and bin mapping of strawberry genic-SSRs in diploid Fragaria and their transferability across the Rosoideae subfamily. Mol. Breed., *27*(2):137-156.

VARIJACIJE KOMPONENTI PRINOSA KOJE SE ODNOSE NA UKUS U NOVIM SUPERIORNIM GENOTIPOVIMA JAGODE I KOMERCIJALNIM SORTAMA TOKOM ŠIROKE SEZONE BERBE

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Izvod

Kao rezultat hibridizacije sorti „Sevgi“ i „Kaška“ sa sortom „Fortuna“, koje se uzgajaju u okviru Univerziteta Čukurova, izabrani su superiorni karakteristični genotipovi jagode sa šiframa „33“, „36“ i „61“. U ovoj studiji, ovi genotipovi i tri sorte koje se uobičajeno uzgajaju u mediteranskom regionu upoređene su u pogledu prinosa, veličine ploda i parametara koji određuju ukus (šećer i organske kiseline) u različitim datumima berbe mesečno u uslovima mediteranske klime. Najveći prinos je generalno izmeren u aprilu, dok je prinos zavisan od genotipa varirao između 628,9 g po biljci („36“) i 951,5 g po biljci („Fortuna“). Osim toga, prosečna težina ploda varira (6,8 - 23,9 g) tokom sezone u zavisnosti od datuma berbe i genotipa. Sadržaj saharoze je varirao između 0,06 g/100 g i 4,83 g/100 g, dok je sadržaj askorbinske kiseline pokazao velike varijacije u zavisnosti od datuma berbe i genotipa sa vrednostima od 1,5 mg kg i 393,8 mg/kg. Generalno, genotip 33 je privukao pažnju svojim relativno visokim prinosom, sadržajem glukoze, fruktoze i askorbinske kiseline. Kao rezultat toga, genotip i uslovi sredine su prilično determinantni u pogledu posmatranih parametara u gajenju jagode. Štaviše, biotehnološke metode bi se mogle koristiti za skraćivanje vremena razmnožavanja kod klasičnih ukrštanja kako bi se poboljšali nedostaci ovih genotipova.

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