Erzincan Üniversitesi
Fen Bilimleri Enstitüsü Dergisi
2023, 16(3), 918-927
ISSN: 1307-9085, e-ISSN: 2149-4584
Araştırma Makalesi

Erzincan University
Journal of ScienceandTechnology
2023, 16(3), 918-927
DOI: 10.18185/erzifbed.1328093
ResearchArticle

Determination of Yield and Quality Characteristics of Some Strawberry Varieties in Uşak Ecological Conditions

Ayşen Melda ÇOLAK [1*]

[1] Department of Horticulture, Faculty of Agriculture, Usak University, Turkey

Received: 15/.07/2023, **Revised:** 01/08/2023, **Accepted:** 09/08/2023, **Published:** 31/08/2023

Abstract

In this study, pomological properties, chemical compositions, and production possibilities of fruits harvested at the maturity stage of four strawberry varieties (Albion, Camarosa, Amiga, and Sabrina) grown in a commercially produced orchard were investigated. Fruit weight (16.33 g) was found to be higher in the Albion variety. The fruit length of the Camarosa strawberry variety was 42.05 mm and the longest fruit width was 31.56 mm. The Camarosa variety reached the highest yield with 736.55 g per plant, followed by the Albion variety (523.88 g) and the Amiga variety (324.48 g). The total phenol content of strawberry fruits (231.76 mg GAE 100 g^{-1}), and antioxidant capacity (322.51µmol TE 100 g^{-1}) were highest in Amiga and the lowest in Sabrina (43.61 mg GAE 100 $g^{-1)}$. In terms of the amount of soluble solid content (SSC) of strawberry fruits, the highest SSC content was determined in the Camarosa variety with 7.60%. The highest amount of titratable acid, pH, and vitamin C were found in the Sabrina varieties, 0.70 g citric acid 100 mL^{-1}, 4.04%, and 137.04 mg 100 g^{-1}, respectively.

Keywords: Strawberry, yield, quality, variety

Bazı Çilek Çeşitlerinin Uşak Ekolojik Koşullarında Verim ve Kalite Özelliklerinin Belirlenmesi

Öz

Bu çalışmada, ticari üretim yapılan bir bahçede yetiştirilen dört çilek çeşidinin (Albion, Camarosa, Amiga, Sabrina) olgunluk aşamasında hasat edilen meyvelerinin pomolojik özellikleri, kimyasal bileşimleri ve üretim imkanları incelenmiştir. Albion çeşidin de meyve ağırlığı (16.33 g) daha yüksek bulunmuştur. Camarosa çilek çeşidin de meyve boyu 42.05 mm ile en uzun ve meyve eni 31.56 mm olmuştur. Camarosa çeşidi bitki başına 736.55 g ile en yüksek verime ulaşmış ve bunu Albion çeşidi (523.88 g) ile Amiga çeşidi (324.48 g) takip etmiştir. Çilek meyvelerinin toplam fenol miktarı (231.76 mg GAE 100 g^{-1}), ve antioksidan kapasite (322.51µmol TE 100 g^{-1}) Amiga çeşidinde en yüksek Sabrina çeşidinde ise en düşük (43.61 mg GAE 100 g^{-1}) bulunmuştur. Çilek meyvelerinin suda çözünür kuru madde miktarı (SÇKM) bakımından en yüksek SÇKM içeriği %7.60 ile Camarosa çeşidinde tespit edilmiştir. Titre edilebilir asit, pH ve C vitamini miktarı en yüksek Sabrina çeşidinde bulunmuştur, sırasıyla 0.70 g sitrik asit 100 mL^{-1}, %4.04, 137.04 mg 100 g^{-1}.

Anahtar Kelimeler: Çilek, verim, kalite, çeşit

*Corresponding Author: aysenmelda.colak@usak.edu.tr
Ayşen Melda ÇOLAK, https://orcid.org/0000-0003-0113-2104

1. Introduction

Strawberry (*Fragaria×ananassa* Duch.), which is in the group of berry fruits, is a fruit species with a wide growing area in the world because it can be grown in different ecological conditions. It is cultivated in many regions of our country because it can be consumed in different ways, it is suitable for family business and it provides good income [1, 2]. The biggest reason for the increasing demand for strawberry cultivation is that strawberries can be grown economically in different soil and climatic conditions. In addition, strawberry has a good market advantage because it ripens during periods when fresh fruit is scarce in the market. Strawberry is an important fruit widely used in the Mediterranean diet, as it contains essential nutrients and beneficial phytochemicals with biological activity for human health. Among these beneficial phytochemicals, anthocyanin and ellagitannins are the main antioxidant compounds [3]. Strawberry is among the fruits with the highest antioxidant activity due to its high content of ascorbic acid, polyphenols, anthocyanins, and flavanols [4, 5, 6]. This fruit, which is especially rich in vitamin C and cellulose, contains significant amounts of salicylic acid, vitamins A, and B, minerals such as calcium, iron, phosphorus, and very small amounts of bromine, silicon, iodine, and sulfur [7].

The quality of strawberry fruit is closely related to various parameters such as texture, anthocyanin content, amount of soluble solid content, titratable acidity, vitamin C content, and pH value [8]. These quality parameters vary depending on the variety, ecology, care work, harvest time, and post-harvest conditions [9, 10, 11]. The chemical composition of strawberry fruits grown in the same ecology can show significant differences according to the varieties.

The variety and characteristics used, planting time, planting style and maintenance conditions are the most important factors affecting the yield per decare of strawberries. In addition, it is reported that mulch application in strawberry cultivation increases the soil temperature, and the yield increases with the increase in temperature [12]. It is possible to eliminate the problems that may occur in earliness, yield, and quality increase by using mulching, adjusting the planting time, and using different greenhouse structures and growing systems against the negativities caused by climatic factors [13, 14]. Climate and soil factors are effective on plant growth and yield in strawberries. Temperature and light are the most important climatic factors. It is important to determine the varieties suitable for cultivation in different ecologies in strawberry [15], which responds differently to light and temperature in terms of daily exposure time.

This study aims to determine the cultivation possibilities and yield characteristics of Albion, Camarosa, Amiga, and Sabrina strawberry varieties in Uşak in the years 2020-2021.

2. Material and Methods

The study was carried out by hand-harvesting Albion, Camarosa, Amiga, and Sabrina strawberry varieties in a producer orchard that produces commercial strawberries in Uşak province in 2020-2021. Before planting the seedlings, 35 kg of 15-15-15 fertilizer was given per decare and mixed with the soil. During the production, a total of 20 ammonium nitrate (33%), 10 kg mono ammonium phosphate (MAP), 35 kg potassium nitrate, 5 kg magnesium sulfate, and 5 kg calcium nitrate were given by drip irrigation. Frigo seedlings of strawberry varieties were planted in 3 replications and 20 plants in each replication in June 2020. Mulch was applied with black polyethylene plastic and the irrigation process was applied with a drip irrigation system. Strawberry fruits of each strawberry variety were harvested and brought to the laboratory during the ripening period when they acquired the red color. The study was established with 5 replications according to the randomized plots experimental design, and approximately 2 kg of fruit harvested from each replication was accepted as a replication.

The number of fruits (pieces) was counted and the number of fruits per plant was calculated by dividing the number of plants in the plot. The fruits in each replication were harvested and weighed on a 0.1 g sensitive balance, and the yield per plant was determined by dividing the total yield per plot by the number of plants in the plot. Fruit width and length ("mm" with a digital caliper) were measured.

Titratable acidity (TA) amount was calculated from the amount of NaOH consumed by titration of 5 mL strawberry juice with 0.1 N NaOH up to pH 8.1 and expressed as g citric acid 100 mL^{-1} [11].

A few drops of soluble solid content (SSC) obtained from the juice obtained by squeezing strawberry fruits were dropped onto a digital refractometer (PR-1, Atago, Japan) and the results were expressed as % [11].

The total amount of phenolic substance was homogenized with a homogenizer (Ika Ultra-Turrax T18 Basic, Germany) at medium speed for 2 minutes by adding 25 mL of methanol to a 5 g sample taken from strawberry fruits, and then kept in dark conditions at 4°C for 14-16 hours. The samples were filtered through filter paper, taken into tubes, and stored at -20 °C until analysis [16]. The total amount of phenolic substances was measured by spectrophotometer (Varian Bio 100, Australia) by modifying the Folin-Ciocaltaeu colorimetric method [17]. In this method, gallic acid was used as a standard, and the total amount of phenolic substance in the strawberry fruit was given as mg gallic acid equivalent (GAE 100 g^{-1}) as wet weight (WW).

The amount of vitamin C (L-ascorbic acid) was crushed by adding 25 mL of oxalic acid (0.4%) with a Waring commercial blender (Blender 8011ES, USA) to 25 g sample taken from strawberry fruits, filtered through filter paper. The amount of vitamin C (L-ascorbic

acid) in the samples taken from this filter was measured with 2,6-dichloroindophenol using the titrimetric method AOAC 1995, [18] at a wavelength of 518 nm in the spectrophotometer (Varian Bio 100, Australia) and the results were obtained in mg vitamin C 100 g^{-1} wet weight. given as.

The determination of antioxidant capacity by the DPPH method was done by Grajeda-Iglesias et al. (2016), and it was made with some modifications. First of all, 2.9 ml of DPPH solution prepared in 0.1 mM ethanol was added to the 0.1 ml extract and shaken and incubated at room temperature for 30 minutes in the dark. has been pending. The absorbance value was then measured in a UV-VIS spectrophotometer at a wavelength of 517 nm. Antioxidant capacity values are expressed as "µmol Trolox equivalent (TE) 100 g^{-1} sample" [19].

Statistical Analysis

Descriptive statistics for the studied variables were presented as Mean and Standard Deviation. Two-way ANOVA was performed to analysis of the characteristics. Following the ANOVA, Duncan multiple comparison test was used to identify different varieties. Statistical significance level was considered as 5% and SPSS (ver: 21) statistical program was used for all statistical computations.

3. Results and Disscussion

Total phenolic substance (TPC), Antioxidant capacity (DPPH), vitamin C, acidity (TA), pH, and soluble solid content (SSC) values determined in four different strawberry varieties are presented in Table 1.

Table 1. TPC, DPPH, vitamin C, SSC, pH, and TA values of strawberry cultivars

Variety	TPC (mg GAEa 100g^{-1})	DPPH (µmol TE 100 g^{-1})	Vitamin C (mg 100 g^{-1})	SSC %	pH %	TA (g citric acid 100 mL^{-1})
Albion	213.59 b	321.51 a	61.49 bc	7.00 b	3.93 ab	0.40a
Camarosa	110.26 c	322.51 a	118.11 b	7.60 a	3.95 ab	0.50a
Sabrina	43.61 d	321.82 a	137.04 a	6.80 c	4.04 a	0.70a
Amiga	231.76 a	329.95 a	33.29 c	7.13bc	3.82 b	0.55a

^{a,b,c} : The difference between the means with different letters in the same column is significant ($p<0.05$)

When the results were examined, it was determined that the Camarosa variety strawberry had the highest average soluble solid content; It is observed that this variety is followed by the Amiga variety. It is understood that acidity and pH values are compatible with each other, and the Sabrina strawberry variety has more acidic characteristics, Total phenolic substance, and Antioxidant capacity is the highest in the Amiga strawberry variety.

Ornelas-Paz et al. (2013) in their study, while titratable acidity values were 1.2% in the first period of immature strawberries, this value gradually decreased during the ripening period and was determined as 0.7% in strawberries that reached maturity. In research made with

different varieties in different ecologies, the amount of titratable acidity [20]; Islam et al. (2003) [21] 0.39-0.73%; Karakaya et al. (2015) [22] reported that it was between 0.50-1.07%, while Gündüz (2010) [23] 1.10%; Sezer (2010) [24] stated that it was 1.37%. Our findings are consistent with the reported values. Sezer (2010) [24] on the other hand, reported that the pH of the Albion strawberry variety grown under organic conditions was 3.70. Sezer (2010) [24] in the Albion strawberry variety grown under organic conditions; determined the content of soluble solids as 10.25%. In studies conducted with different varieties, it has been reported that the content of soluble solids varies between 8.20 and 9.90% [22, 25, 26, 27]. The results obtained in our study and the reported values show parallelism.

Mancilla et al. (2013) [28], the amount of vitamin C in strawberries (*Fragaria vesca* cv. Camarosa) analyzed in Chile was 47.09 mg $100g^{-1}$, Pineli et al. (2011) [29] found that the vitamin C amounts of strawberries belonging to Osogrande and Camino Real varieties grown in Brazil were 31.4-46.5 mg $100g^{-1}$, respectively, and Hakala et al. (2003) [30] found that 6 different strawberry varieties (Jonsok, Korono, Polka, Honeoye, Bouty and Senga Sengana) grown in Finland ranged from 32.40 to 84.70 mg $100g^{-1}$ of vitamin C. Yıldız et al. (2014) [31], on the other hand, the vitamin C amounts of 15 different kinds of wild strawberry grown in the northeastern region of our country were analyzed and it was reported that the amounts ranged from 38.55 mg $100g^{-1}$ to 57.37 mg $100g^{-1}$.

Ozdemir et al. (2022) [32] determined the total antioxidant capacity of the fruits of the 'Sabrina' strawberry variety grown in the "Kokopit" environment as an average of 10.42 mmol TE L^{-1}. Schöpplein et al. (2002) [33] found in their study with 12 strawberry varieties that the antioxidant capacity varied between 8.40–16.50 mmol L^{-1}, while Gündüz and Özdemir (2014) [34] determined that it varied between 8.20–8.90 mmol TE L^{-1}. The reasons for the differences in the results obtained in similar studies may be variety and genotype differences, climatic factors, ripening time, and breeding factors [8, 35, 36].

Pomological characteristics of Albion, Camarosa, Amiga, and Sabrina strawberry varieties are given in Table 2.

Table 2. Some Pomological trait values of strawberry varieties

Variety	Number of fruits (pieces)	Yield per plant (g)	Fruit width (mm)	Fruit size (mm)	Fruit weight (g)
Albion	33.00 b	523.88 b	28.87 b	39.63 b	16.33 a
Camarosa	49.00 a	736.55 a	31.56 a	42.05 a	14.21 b
Amiga	26.00 c	324.48 c	30.42 a	35.02 c	14.16 b
Sabrina	19.00 d	231.20 d	25.99 c	32.52 d	11.56 c

[a,b,c] : The difference between the means with different letters in the same column is significant ($p<0.05$)

When Table 2 is examined, it is seen that the difference between the varieties in terms of fruit yield is statistically significant. The Camarosa variety reached the highest yield with 736.55 g per plant, followed by the Albion variety (523.88 g) and the Amiga variety (324.48 g). It has been reported that the amount of yield in strawberries varies according to the varieties [37,

38]. Islam et al. (2003) [21] obtained the highest yield from Camarosa and Chandler varieties in Ordu ecology. It has been reported that the fruit yield per plant of the Sweet Charlie strawberry variety varies between 239.0 g in open fields in Samsun ecological conditions [39].

The difference between the varieties in terms of fruit number was found to be statistically significant. The number of fruits was 49.00 in the Camarosa variety, 33.00 in the Albion variety, 26.00 in the Amiga variety, and 19.00 in the Sabrina variety (Table 2). According to similar studies, it has been stated that fruit size can vary according to varieties [40, 41].

The highest fruit weight was found in the Albion variety (16.33 g). It was observed that the fruit weight of Camarosa (22.7 g) and Rubygem (21.8 g) strawberry cultivars were partially lower in the harvest made of strawberries grown in İzmir [42]. The fruit length and fruit width of the Camarosa strawberry variety were found 42.05 mm and 31.56 mm (Table 2). In a study, the fruit length of the Amiga strawberry variety was the longest at 49.91 mm, while the Camarosa variety was the shortest at 42.02 mm. The fruit length (46.22 mm) of the Rubygem strawberry varieties was between these two varieties. The fruit widths of the strawberry varieties were like each other and varied between 36.34 mm and 39.29 mm [43, 44].

4. Conclusion

In this study, the pomological and chemical properties of these four different strawberry cultivars, which have gained speed in the Uşak region, were investigated. Depending on the strawberry variety, differences in fruit quality characteristics and chemical compositions were revealed. In terms of chemical properties of strawberries, the amount of soluble solid content in the Camarosa variety, pH and acidity in the Sabrina variety, total phenolic substance, and antioxidant capacity in the Amiga variety; In terms of pomological characteristics, it is observed that the Camarosa variety stands out. In this study, the quality characteristics of Albion, Camarosa, Amiga, and Sabrina strawberry varieties were compared with other strawberry varieties grown in our country and in the world. To increase the market value of strawberry fruit and its benefits to human health, it is of great importance that its nutritional content is high. It is thought that expanding the cultivation of varieties rich in antioxidant content will contribute positively to the domestic and foreign markets in strawberry production in our region and our country.

Ethics in Publishing

There are no ethical issues regarding the publication of this study.

Conflict of Interest

The authors have no conflicts of interest to declare.

References

[1] Ağaoğlu, Y.S., (1986). Üzümsü Meyveler. Ankara Üniversitesi Ziraat Fakültesi Yayınları: 984. Ders Kitabı: 290. s377.

[2] Karaca, S., Altay, K., (1999). Çilek fidesi üretiminde waiting bad sisteminin geliştirilmesi. Mezuniyet çalışması, Adana.

[3] Giampieri, F., Tulipani, S., Alvarez-Suarez, J.M., Quiles, J.L., Mezzetti, B., Battino, M., (2012). The strawberry: composition, nutritional quality, and impact on human health. Nutrition, 28 (1), 9-19.

[4] Cordenunsi, B.R., Oliveira do Nascimento, J.R., Genovese, M. I., Lajolo, F.M., (2002). Influence of cultivar on quality parameters and chemical composition of strawberry fruits grown in Brazil. Journal of Agricultural and Food Chemistry, 50(9), 2581-2586.

[5] Sellappan, S., Akoh, C.C., Krewer, G., (2002). Phenolic compounds and antioxidant capacity of Georgia-grown blueberries and blackberries. Journal of Agricultural and Food Chemistry, 50 (8), 2432-2438.

[6] Rababah, T.M., Ereifej, K.I., Howard, L., (2005). Effect of ascorbic acid and dehydration on concentrations of total phenolics, antioxidant capacity, anthocyanins, and color in fruits. Journal of Agricultural and Food Chemistry, 53(11), 4444-4447.

[7] Türemiş, N., Özgüven, A.I., Paydaş, S., (2000). Güneydoğu Anadolu Bölgesi'nde çilek yetiştiriciliği. Türkiye Bilimsel ve Teknik Araştırma Kurumu. Türkiye Tarımsal Araştırma Projesi Yayınları, Adana.

[8] Cordenunsi, B.R., Genovese, M.I., do Nascimento, J.R.O., Hassimotto, N.M.A., dos Santos, R. J., Lajolo, F. M., (2005). Effects of temperature on the chemical composition and antioxidant activity of three strawberry cultivars. Food Chemistry, 91(1), 113-121.

[9] Crisosto, C.H., Mitchell, M.G., (2002). Postharvest handling systems: stone fruits, In Postharvest Technology of Horticultural Crops. California, USA: University of California Agricultural and Natural Resources Publication 3311.

[10] Özbahçalı G., (2014). Bazı Çilek Çeşitleri (*Fragaria x Ananassa* Duch.)'nin Erzurum ekolojisindeki performanslarının belirlenmesi. Fen Bilimler Enstitüsü Bahçe Bitkileri Anabilim Dalı Yüksek Lisans Tezi, Erzurum.

[11] Karaçalı, İ., (2016). Bahçe Ürünlerinin Muhafazası ve Pazarlanması. Ege Üniversitesi Ziraat Fakültesi Yayınları, Yayın No: 494, Bornova, İzmir.

[12] Galetta G.J, Bringhurst R.S., (1990). Strawberry management. In: Galetta, G.J., Himelrick, D. (Eds.). Small fruit crop management. Prentice-Hall, Englewood Cliffs, NJ, 83-156.

[13] Öztürk, A., Demirsoy, L., (2004). Değişik gölgeleme uygulamalarının Camarosa çilek çeşidinde verim ve büyüme üzerine etkileri. Bahçe. 33(1-2): 39-49.

[14] Yılmaz, H., Oğuz, H.İ., Yıldız, K., Geçer, M.K., (2006). Soğuk Bölgelerde Çilek Yetiştiriciliğinde Karşılaşılan Sorunlar ve Bazı Çözüm Önerileri. II. Ulusal Üzümsü Meyveler Sempozyumu,14-16 Eylül 2006, Tokat. 61-69.

[15] Demirsoy, L., Öztürk, A., Serçe, S., (2012). Çileklerde (Fragaria) çiçeklenme ile fotoperiyot arasındaki ilişkiler. Anadolu Tarım Bilimleri Dergisi. 27(2):110-119.

[16] Thaiponga, K., Boonprakoba, U., Crosbyb, K., Cisneros-Zevallosc, L., Byrne, D.H, (2006). Comparison of ABTS, DPPH, FRAP, and ORAC assays for estimating antioxidant activity from guava fruit extracts. Journal of Food Composition and Analysis, 19, 669-675.

[17] Zheng, W., Wang, S.Y., (2001). Antioxidant activity and phenolic compounds in selected herbs. Journal of Agricultural and Food chemistry, 49(11), 5165-5170.

[18] AOAC., (1995). Official Methods of Analysis. AOAC, Arlington, Virginia.

[19] Grajeda-Iglesias, C., Salas, E., Barouh, N., Barea, B., Panya, A., Figueroa-Espinoza, M. C., (2016). Antioxidant activity of protocatechuates evaluated by DPPH, ORAC, and CAT methods. Food Chemistry, 194, 749- 757.

[20] Ornelas-Paz, J.D.J., Yahia E.M., Ramírez-Bustamante, N., Pérez-Martínez, J.D., Escalante-Minakata, M.D.P., Ibarra-Junquera, V., Acosta-Muñiz, C., GuerreroPrieto, V., Ochoa-Reyes, E. (2013). Physical attributes and chemical composition of organic strawberry fruit (*Fragaria x ananassa* Duch, Cv. Albion) at six stages of ripening. Food Chemistry, 138 (1), 372-381.

[21] İslam, A. Cangi, R., Özgüven, A.I., (2003). Doğu Karadeniz Bölgesinde Çilek Yetiştirme Olanakları. Ulusal Kivi ve Üzümsü Meyveler Sempozyumu, 23- 25 Ekim 2003, Ordu. 203-207.

[22] Karakaya, M., Öztürk, B., İslam, A., Karakaya, O., Kaçar, E., Turga, E., Gün, S., (2015). Ordu ekolojik koşullarında yetiştirilen bazı çilek çeşitlerinin meyve kalite özellikleri. VII. Ulusal Bahçe Bitkileri Kongresi, Çanakkale, s: 25-29.

[23] Gündüz, K., (2010). Farklı yetiştirme yerlerinin bazı çilek genotiplerinin verim, meyve kalite özellikleri ve antioksidan kapasitesi üzerine etkisi. Mustafa Kemal Üniversitesi Fen Bilimleri Enstitüsü, Doktora Tezi, Basılmamış, Antakya.

[24] Sezer, L., (2010). Mardin ili Kızıltepe ilçesinde organik çilek yetiştiriciliği olanaklarının araştırılması. Yüksek Lisans Tezi Bahçe Bitkileri Anabilim Dalı.

[25] Atasay, A., Türemiş, NF., Demirtaş, İ., Göktaş, A., (2006). Eğirdir (Isparta) Koşullarında Yaz Dikimi Yapılan Bazı Çilek Çeşitlerinin Verim ve Kalite Özellikleri. II. Ulusal Üzümsü Meyveler Sempozyumu, Tokat, 14-16 Eylül 2006, ss: 100-105.

[26] Kaleci, N., Günay, S., (2006). Çanakkale koşullarında yetiştirilen bazı çilek çeşitlerinin fenolojik, pomolojik ve verim özelliklerinin belirlenmesi. Bahçe, 35(1): 47-54.

[27] Özbahçalı, G., (2014). Bazı Çilek Çeşitleri (Fragaria x Ananassa Duch.)'nin Erzurum ekolojisindeki performanslarının belirlenmesi. Fen Bilimler Enstitüsü Bahçe Bitkileri Anabilim Dalı Yüksek Lisans Tezi, Erzurum.

[28] Nuñez-Mancilla, Y., Pérez-Won, M., Uribe, E., Vega-Gálvez, A., DiScala, K., (2013). Osmotic dehydration under high hydrostatic pressure: effects on antioxidant activity, total phenolics compounds, vitamin C and colour of strawberry (Fragaria vesca). LWT-Food Science and Technology, 52 (2): 151-156. DOI: https://doi.org/10.1016/j.lwt.2012.02.027.

[29] Pineli, L.D.L.D.O., Moretti, C.L., dos Santos, M.S., Campos, A.B., Brasileiro, A.V., Córdova, A.C., Chiarello, M.D., (2011). Antioxidants and other chemical and physical characteristics of two strawberry cultivars at different ripeness stages. Journal of Food Composition and Analysis, 24 (1), 11- 16.

[30] Hakala, M., Lapveteläinen, A., Huopalahti, R., Kallio, H., Tahvonen, R., (2003). Effects of varieties and cultivation conditions on the composition of strawberries. Journal of Food Composition and Analysis, 16 (1), 67-80.

[31] Yildiz, H., Ercisli, S., Hegedus, A., Akbulut, M., Topdas, E.F., Aliman, J., (2014). Bioactive content and antioxidant characteristics of wild (Fragaria vesca L.) and cultivated strawberry (Fragaria × ananassa Duch.) fruits from Turkey. Journal of Applied Botany and Food Quality, 87 (1), 274-278.

[32] Özdemir, A.E., Kılıç, D., Demirkeser, Ö., Çulha, F., Karaşahin, Z., (2022). Serada ve topraksız kültürde yetiştirilen 'Sabrina' çilek çeşidinin kış mevsiminde kalite parametrelerindeki değişimler. Mustafa Kemal Üniversitesi Tarım Bilimleri Dergisi, 27(1): 88-98.

[33] Schöpplein, E., Kruger, E., Rechner, A., Hoberg, E., (2002). Analytical and sensory qualities of strawberry cultivars. Acta Horticulturae, 567(2): 805-808.

[34] Gündüz, K., Özdemir, E., (2014). The effects of genotype and growing conditions on antioxidant capacity, phenolis compounds, organic acid and ındividual sugars of strawberry. Food Chemistry, 155: 298-303.

[35] Wang, S.Y., Zheng, W., Galeta, G., (2002). Cultural system affects fruit quality and antioxidant capacity in strawberries. Journal of Agricultural and Food Chemistry, 50: 6534-6542.

[36] Tulipani, S., Mezzetti, B., Capocaso, F., Bompadre, S., Beekwilder, J., Vos, C., Çapanoğlu, E., Bovy, A., Battino, M., (2008). Antioxidants, phenolic compounds, and nutritional quality of different strawberry genotypes. Journal of Agricultural and Food Chemistry, 56: 696-704.

[37] Kanmaz, G., (1995). Yeni Bazı Çilek Çeşitlerinde Günü Kısaltma Uygulamalarının Verim ve Kalite Üzerine Etkileri. (yüksek lisans tezi, basılmamış). Çukurova Üniv. Fen Bil. Enst., Adana.

[38] Türemiş, N., Özdemir, E., Kaşka, N., (1996). Bazı Önemli Çilek Çeşitlerinde Değişik Dikim Mesafelerinin Fide Verim ve Kalitesi Üzerine Etkileri. Bahçe Dergisi, 25 (1-2): 3-10.

[39] Demirsoy, L., Demirsoy, H., Uzun, S., Öztürk, A., (2007). The Effects of Different Periods of Shading on Growth and Yield in 'Sweet Charlie' Strawberry. Europ. J. Hort. Sci., 72(1):26–31

[40] İştar, A., Güleryüz, M., Şen, SM., (1983). Erzurum Koşullarında Çilek Yetiştiriciliği Üzerine Araştırmalar. Atatürk Üniv. Ziraat Fakültesi Dergisi, 14: 3-4.

[41] Lopez-Aranda, JM., Lopez-Montera, R., Chaves, M., Alvarez, A., Bartual, R., (1993). Eveluation of New Spanish Cultivars of Strawberry in Huelva, Southwestern Spain. Acta Horticulture, 348: 207- 213.

[42] Özer, K.B., Aksoy, U., Işın, Ş., Can, H.Z., Çetinkaya, N., Çakıcı, H., Gürbüz Kılıç, Ö., Arda, E., Çolak Esetlili, B., Kaygısız, T., Çetinel, B., Özsoy, N., Küçük, E., (2015). Menemen koşullarında yüksek tünel altında yetiştirilen bazı çilek çeşitlerinin organik ve konvansiyel üretimde agronomik ve ekonomik açıdan değerlendirilmesi. Ege Üniversitesi Rektörlüğü Bilimsel Araştırmalar Projesi (2010-ZRF-049) Sonuç Raporu.

[43] Türk, B., Şen, F., (2020). Manisa İli Köprübaşı İlçesinde Yetiştirilen Çilek Çeşitlerinin Fizikokimyasal Özelliklerinin Belirlenmesi. Uluslararası Tarım ve Yaban Hayatı Bilimleri Dergisi (UTYHBD), 6 (3): 407 - 415.

[44] Yeşil, B., Okatan, V., Çolak, A.M, Kafkas, N.E., (2022). Effect of Applications of Boron and Gibberellic Acid (GA3) on Phytochemical Contents in Different Strawberry Varieties. International Journal of Agriculture, Forestry and Life Sciences, 6(2): 34-38