

Determination of pomological characteristics and biochemical contents of some pitaya varieties grown in Muğla region

Original Article

Abstract:

This study aimed to determine the fruit quality and antioxidant properties of „Siam Red” and „Vietnam White” varieties grown in greenhouse conditions in Muğla region. The fruit weight ranged from 203.55 to 232.20 g, with peel weight between 54.53 and 77.29 g, and flesh weight between 149.02 and 154.91 g. Peel thickness varied from 2.69 to 3.32 mm, while flesh firmness ranged from 0.57 to 1.41 kg/cm². Fruit width and length measured 65.63–68.88 mm and 84.50–102.92 mm, respectively. Regarding color parameters, the peel's L* value ranged from 39.70 to 41.54, a* from 35.37 to 37.74, and b* from 11.03 to 13.35. The flesh color L* value varied between 33.67 and 74.62, a* between 10.22 and 45.73, and b* between -2.14 and 4.33. The total soluble solids (TSS) content was 10.94–12.57%, pH ranged from 4.46 to 4.60, and titratable acidity (TA) was between 0.36 and 0.46%. The total phenolic content was 406.42–432.77 mg GAE/100 g, total flavonoid content ranged from 20.10 to 22.99 mg catechin/100 g, and total antioxidant capacity was 73.74–79.40%. In this study, it was found that the pitaya cv. „Vietnam White” produced larger, firmer, and brighter fruits with higher antioxidant content than the „Siam Red” variety.

Key words:

pitaya, total phenolics, total flavonoids, antioxidant, pomological properties

Apstrakt:

Određivanje pomoloških karakteristika i biohemijskog sastava nekih sorti pitaje, gajenih u regionu Muğla

Ova studija je imala za cilj utvrđivanje kvaliteta plodova i antioksidativnih svojstava sorti pitaje „Siam Red” i „Vietnam White” gajenih u plastenicima regiona Muğla. Masa plodova se kretala od 203,55 do 232,20 g, masa kore od 54,53 do 77,29 g, a masa pulpe od 149,02 do 154,91 g. Debljina kore varirala je od 2,69 do 3,32 mm, a čvrstoća pulpe od 0,57 do 1,41 kg (cm²)-1. Širina i dužina plodova iznosila je 65,63 do 68,88 mm i 84,50 do 102,92 mm. Što se tiče parametara boje, L* vrednost kore varirala je od 39,70 do 41,54, a* od 35,37 do 37,74, a b* od 11,03 do 13,35. L* vrednost boje mesa ploda kretala se između 33,67 i 74,62, a* između 10,22 i 45,73, a b* između -2,14 i 4,33. Sadržaj ukupnih rastvorljivih čvrstih materija (TSS) iznosio je 10,94–12,57%, pH vrednost se kretala od 4,46 do 4,60, dok je titrabilna kiselost (TA) bila između 0,36 i 0,46%. Ukupan sadržaj fenola bio je 406,42–432,77 mg GAE/100 g, sadržaj ukupnih flavonoida varirao je od 20,10 do 22,99 mg katehina/100 g, dok je ukupni antioksidativni kapacitet bio u rasponu od 73,74 do 79,40%. U ovom istraživanju utvrđeno je da sorta pitaje „Vietnam White” ima veće, čvršće, svetlije plodove i veći sadržaj antioksidanasa u poređenju sa sortom „Siam Red”.

Ključne reči:

pitaja, ukupni fenoli, ukupni flavonoidi, antioksidansi, pomološka svojstva

Introduction

Pitaya, also known as dragon fruit, is a type of fruit belonging to the genus *Hylocereus* (A. Berger) Britton & Rose. There are three species in the genus *Hylocereus*. *Hylocereus undatus* (Haw.) Britton & Rose (Colombia, Mexico, South America), *H.*

polyrhizus (F.A.C. Weber) Britton & Rose (Mexico) and *H. megalanthus* (K. Schum. ex Vaupel) Ralf Bauer (Bolivia, Peru, Ecuador, Colombia, Venezuela) are the white fleshy ones with red rinds, red fleshy ones with red rinds and white fleshy ones with yellow rinds (Zainoldin et al., 2009; Nizamlioglu et al., 2021). Pitaya originates from Mexico, Central

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and South America, but is also grown commercially in Malaysia, Vietnam and Taiwan. In recent years, it has been cultivated in countries such as Israel, the USA and Australia (Merten, 2003; Attar et al., 2022). Pitaya can be eaten raw and is also used in juice, wine, pate, desserts, and traditional medicine (Sofowora et al., 2013). Pitaya contains high levels of betalain. Betalain is a water-soluble pigment with high protein and fiber content and high antioxidant activity (Tze et al., 2012). In recent years, the use of betalain as a natural colorant in cosmetic products has become widespread. Among the pitaya species, *H. polyrhizus* is considered to be the species with the highest betalain content (Kamairudin et al., 2015). Previous studies reported that the linoleic acid content of pitaya seeds was higher than that of canola, flax, sesame seeds, and grapes (Ariffin et al., 2009). In addition, pitaya fruits are consumed as table food and used as food additives. It was stated that adding pitaya fruit pulp to yogurt increased lactic acid content, total phenols, and antioxidant activity (Zainoldin et al., 2009). It has also been reported that fruit peel powder benefits dieters and can be used instead of fat, especially in ice cream (Attar et al., 2022). Pitaya fruits are reported to contain high levels of vitamin C, phenolic compounds, and organic acids. Fruits are also rich in minerals such as potassium, calcium and magnesium (Le Bellec et al., 2006; Tenore et al., 2012). In addition, it has been reported that it facilitates digestion, is good for asthma when consumed regularly, balances cholesterol levels, and reduces blood pressure (Nomura et al., 2005). Pitaya has attracted great attention from both growers and consumers in recent years due to its early yield, resistance to drought, and richness in nutrients and antioxidants. In fact, greenhouse cultivation has gained popularity in the Aegean region in recent years. In this study, pomological and biochemical characteristics of „Siam Red” (*H. polyrhizus*) and „Vietnam White” (*H. undatus*) varieties grown in greenhouse conditions in Muğla were investigated.

Materials and Methods

This study was carried out on „Siam Red” (*H. polyrhizus*) and „Vietnam White” (*H. undatus*) varieties grown in greenhouse conditions in Muğla between 2023 and 2024. The study was carried out in 2 different varieties, with 3 replicates, 4 fruits in each replicate and 3 trees in each replicate according to the coincidence plots experimental design.

Measurement and Analyses

Fruits were harvested from different plant parts for each variety at the commercial harvest time, and fruit weight was determined in g using a precision

balance (sensitive to 0.01 g). Fruit length and fruit width were measured in mm by a digital caliper with a precision of 0.01 mm. Fruit peel color and fruit flesh color were measured from both sides of the fruit with the MINOLTA CR-400 color meter and evaluated in terms of L*, a*, and b* (Öztürk et al., 2012). The harvested fruits were cleaned and peeled, and the juices were filtered. Afterward, the fruit juices were analyzed by a digital refractometer to determine the TSS with the help of a digital pH meter. To determine the TA content of the juice, 10 ml of filtered fruit juice was added to 100 ml of distilled water and titrated with 0.1N NaOH to 8.1. TA was calculated as % citric acid (Öztürk et al., 2012). Total phenolic content was determined using Folin-Ciocalteu's chemical according to the method of Singleton & Rossi (1965). Readings in the spectrophotometer were made at 750 nm wavelength. Total flavonoid content was determined according to the method described by Zhishen et al. (1999). Readings in the spectrophotometer were made at 510 nm wavelength. Total antioxidant capacity (DPPH) (1,1-diphenyl-2-picrylhydrazyl) was determined according to the method of Kumaran & Karunakaran (2006). Readings in the spectrophotometer were made against methanol at a wavelength of 517 nm (Çakır et al., 2021).

Statistical Analysis

The data obtained from the research were subjected to analysis of variance using the MINITAB package programme. Tukey's multiple comparison test was used to determine the significant differences between the varieties.

Results and discussion

The pomological characteristics of the varieties are presented in **Tab. 1**. Statistically significant differences were found between the varieties at $p \leq 0.05$ level regarding fruit peel weight, fruit peel thickness, fruit flesh firmness and length. Fruit weight ranged between 203.55 („Siam Red”) - 232.20 g („Vietnam White”), fruit peel weight 54.53 („Siam Red”) - 77.29 g („Vietnam White”), fruit flesh weight 149.02 („Siam Red”) - 154.91 g („Vietnam White”), fruit peel thickness 2.69 („Siam Red”) - 3.32 mm („Vietnam White”), fruit width 65.63 („Siam Red”) - 68.88 mm („Vietnam White”), fruit length 84.50 („Siam Red”) - 102.92 mm („Vietnam White”) and fruit flesh firmness 0.57 („Siam Red”) - 1.41 kg (cm²)⁻¹ („Vietnam White”).

The highest values in terms of all pomological characteristics were obtained in „Vietnam White” variety. Parmar & Karetha (2020) determined the highest fruit weight as 265.86 g, the highest fruit

Table 1. Pomological characteristics of pitaya varieties

Variety	„Vietnam White”	„Siam Red”
Fruit weight (g)	232.20±20.30	203.55±0.97
Fruit peel weight (g)	77.29±10.73 ^a	54.53±2.49 ^b
Fruit flesh weight (g)	154.91±7.54	149.02±68
Fruit peel thickness (mm)	3.32±0.12 ^a	2.69±0.25 ^b
Fruit width (mm)	68.88±0.71	65.63±1.97
Fruit length (mm)	102.92±4.60 ^a	84.50±0.59 ^b
Fruit flesh firmness (kg (cm ²) ⁻¹)	1.41±0.29 ^a	0.57±0.06 ^b

length as 9.51 cm, and the highest fruit width as 7.19 cm among the species.

It has been reported that, in general, the varieties with white fruit flesh have higher values in terms of fruit weight, fruit peel weight, flesh weight, peel thickness, flesh firmness, width, and length than the varieties with red fruit flesh (Parmar & Karetha, 2020; Altinkaya, 2024).

Table 2. Peel and fruit flesh colour values of pitaya varieties

Variety		„Vietnam White”	„Siam Red”
Shell colour feature	L*	41.54±0.80 ^a	39.70±0.50 ^b
	a*	35.37±0.27 ^b	37.74±0.90 ^a
	b*	11.03±0.49 ^b	13.35±0.28 ^a
Meat colour characteristic	L*	74.62±1.17 ^a	33.67±2.02 ^b
	a*	10.22±0.46 ^b	45.73±3.52 ^a
	b*	4.33±0.18 ^a	-2.14±2.06 ^b

Fruit color characteristics of the varieties are presented in **Tab. 2**. Statistically significant differences at $p \leq 0.05$ level were found between the varieties in terms of peel and flesh color L*, a*, and b* values. In the study, the highest L* value was obtained in the „Vietnam White” variety (41.54) and the highest a* and b* values were obtained in the „Siam Red” variety (37.74, 13.35, respectively). Colour and brightness properties in foods are one of the important sensory properties in terms of consumer preference (Bilek, 2010).

Mahayothee et al. (2019) determined L* value as 29.56, a* value as 36.68, b* value as 5.19 of red pitaya in their study. Uğuz & Gezici (2021) determined the highest L* value (51.69), the highest a* value (33.06), and the highest b* value (6.33) in *H. undatus*. Abirami et al. (2021) determined the highest L* value (51) in *H. undatus*, the lowest L* value in *H. costaricensis*, the highest a* value in *H. costaricensis*, the lowest a* value (-0.6) in *H. undatus*, the highest b* value (2.5) in *H. undatus*, the lowest b* value (-2.5) in *H. costaricensis*. Altinkaya

(2024) determined the highest fruit peel L* value as (KBxVJ) 51.59, the highest fruit flesh L* value as (VJxKB) 67.45, the highest fruit peel L* value as (RRxTK) 48.08, the highest fruit flesh L* value as (RRxRRR) 44.26 in the fruits obtained as a result of crossbreeding of varieties with white parents and red parents. In general, they found that the L* value of the varieties with white fruit flesh was higher than the varieties with red fruit flesh (Demirkaplan, 2020; Abirami et al., 2021; Uğuz & Gezici, 2021).

In this study, the values of TSS, pH, TA, total phenolic content, total flavonoid content, and total antioxidant capacity of the varieties are presented in **Tab. 3**. There was no statistically significant difference between the varieties in terms of total antioxidant capacity ($p \leq 0.05$).

The highest TSS was determined in the „Vietnam White” variety (12.57%), and the highest pH, TEA, total phenolic content and total flavonoid content were determined in the „Siam Red” variety (4.60, 0.45%, 432.77 mg GAE 100g⁻¹, 22.99 mg CE 100g⁻¹, respectively). The highest total antioxidant capacity was found in the „Vietnam White” variety (79.40%). Liaotrakoon (2013) compared the biochemical properties of red and white pitaya fruits and found that the amount of TSS varied between 9.84% and 10.18%. Esquivel et al. (2007) reported that the pH value of red pitaya fruit varied between 4.26 and 4.98 in their study with different pitaya varieties.

Table 3. Biochemical characteristics of pitaya varieties

Variety	„Vietnam White”	„Siam Red”
TSS (%)	12.57±0.29 ^a	10.94±0.80 ^b
pH	4.46±0.02 ^b	4.60±0.00 ^a
TA (%)	0.36±0.01 ^b	0.45±0.02 ^a
Total phenolic content (mg GAE 100g-1)	406.42±1.87 ^b	432.77±10.80 ^a
Total flavanoid content (mg catechin 100g-1)	20.10±0.70 ^b	22.99±0.27 ^a
Total antioxidant capacity (%)	79.40±3.65	73.74±11.57

Barcelon et al. (2015) analyzed the biochemical content of red pitaya fruit and found the pH value as 4.90. Yılmaz et al. (2022) determined the total phenolic content of red pitaya fruit as 715 mg GAE 100g⁻¹. Wu et al. (2006) determined the total phenolic content of fresh red pitaya pulp as 42.4 mg GAE 100g⁻¹. Adnan et al. (2011) determined the phenolic content in red pitaya fruit seed oil as 1356 mg GAE 100g⁻¹. Contreras-Calderón et al. (2011) determined that the total phenolic content of seeds ranged between 61.5 and 1712 mg GAE 100g⁻¹ in a study of peel and seeds of 24 different exotic fruits. Luu et al. (2021) reported that pitaya is an exotic tropical plant beneficial for human health due to its high nutritional value, bioactive molecules, and natural antioxidants. Attar et al. (2022) reported that pitaya fruits with red-purple flesh had a higher total phenolic content than those with white flesh, and the total phenolic content of red-purple and white-fleshed pitaya species was 16.66 and 17.11 mg GAE 100g⁻¹ FW, respectively. Abirami et al. (2021) found that the total phenolic content of different pitaya varieties varied between 32.5 and 42.5 mg GAE 100g⁻¹ FW. Khatun et al. (2022) determined the antioxidant capacity of pitaya fruit to be 73.38%. Attar et al. (2022) reported that pitaya fruits with red fruit flesh had higher antioxidant capacity than those with white fruit flesh. Esquivel et al. (2007) reported that pitaya with purple flesh has a high antioxidant capacity and is rich in betalains. It was also reported that the antioxidant capacity of pitaya fruits with red and yellow flesh was higher than some other tropical fruits such as mango, lychee, longan, and papaya (Chaves et al., 2004; Wojdylo et al., 2007; Beltrán-Orozco et al., 2009).

Our research results showed differences from previous studies, which may be caused by a variety of factors such as location, maturity, cultural practices, and temperature (Esquivel et al., 2007; Tran et al., 2015; Berk et al., 2022; Çelik et al., 2024; Pepe et al., 2024).

Conclusion

In this study, some fruit quality characteristics and biochemical contents of „Siam Red’ and „Vietnam White” pitaya varieties grown in greenhouse conditions in the Aegean Region were determined. As a result, it was found that the „Vietnam White” variety produce the largest and brightest-colored fruits, with the highest fruit peel weight, fruit flesh weight, flesh firmness, width, length, TSS, and total antioxidant capacity. The „Siam Red” variety was found to have the highest pH, TA, total phenolic content, and total flavonoid content. When evaluating the income obtained in recent years in

our country, it is clear that there is a great interest in the cultivation of tropical fruits. Moreover, due to its high antioxidant capacity, it is in high consumer demand. It is possible to say that it will be beneficial to carry out similar studies to increase the cultivation of tropical fruits in Türkiye. This study will contribute to the literature on the determination of pomological and biochemical contents of pitaya varieties, which are newly known in Türkiye, and will shed light on future studies.

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