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Post-Harvest Fruit Quality Changes in Grafted and Ungrafted 'Crimson Tide' Watermelon Variety

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ABSTRACT

In this study, changes in the post-harvest fruit quality of 'Crimson Tide' watermelon variety grafted onto Nun9075 and ungrafted 'Crimson Tide' were investigated. Watermelons were grown at the Alata Horticultural Research Institute, Erdemli, Mersin, Turkey, and stored at 4°C and 90-95% relative humidity for 5 weeks. The total soluble solid and titratable acid contents, weight loss, fungal decay, physiological disorders, vitamin C, antioxidant activity, total phenolic substance and sugars were evaluated. Quality analyses were determined at weekly intervals throughout the storage period. The results demonstrated that weight loss of grafted and control fruits were found to be very low (1%) during the storage. Fungal and physiological disorders were not observed in grafted or control watermelon fruits during storage. Total soluble solid, vitamin C, antioxidant activity, and total phenolic substance contents of the 'Crimson Tide' variety grafted onto Nun9075 were higher than in the control fruits.

Keywords: Grafted watermelon, Quality changes in cold storage.

INTRODUCTION

Soil-borne diseases (*Fusarium, Verticillium*, etc.) are a limiting factor for watermelon cultivation, both under cover and in the open fields, due to continuous and intensive production. Breeding on rootstocks such as *Lagenaria* and *Cucurbita* species resistant to soil-borne diseases provides advantages such as controlling diseases and increasing yield (Yetişir *et al*., 2003). Preparation of watermelons for the market is usually done in the field, and skin death, skin pre-chilling, cold storage, and cold transportation are mostly ignored in watermelons to be sent to the domestic and foreign markets. Watermelon fruit, whose ripening period coincides with the hot summer months, is exposed to high temperatures during marketing. Skin structure, cold storage, and transportation are important for extending the shelf life, especially when it comes to export. In recent years, grafted watermelon production has increased rapidly in Turkey. Skin necrosis of watermelon fruits is monitored according to criteria such as drying of the auricles and leech on the fruit stem, shedding of the hairs on the stem, and the fruit gaining the specific size of the variety (Aras *et al*., 2015). Grafting can increase yield and fruit size, improve or decrease external and/or internal fruit quality, and better preserve post-harvest quality compared to fruit from non-grafted plants (Zoran *et al*., 2022).

In comparison to ungrafted watermelon, post-harvest quality was preserved in fruits of the "Crisby" and "Crimson Tide" watermelon cultivars after 21 days of storage at 7°C (Özdemir *et al*., 2018). It was

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reported that watermelons could be stored at 0°C for 7 days without any damage to the skin or flesh of the fruit. Fruits of the "Crisby" and "Crimson Tide" watermelon varieties grafted on Ferro, RS841, Argentario, and Macis rootstocks had higher taste scores than control fruits (Çandir *et al*., 2021). In this study, postharvest fruit quality changes and changes in the quality of samples taken from different parts of the fruit were investigated in 'Crimson Tide' watermelon cultivars grafted on Nun9075 and ungrafted.

MATERIALS AND METHODS

Description of the Experimental Site

The research was conducted in open field (36° 37' 35.16" N and 34° 20' 28.51" E) conditions belonging to the Ministry of Agriculture and Forestry, Alata Horticultural Research Institute (Erdemli, Mersin, Turkey). The seedlings of the 'Crimson Tide' watermelon cultivar without grafting and grafted on Nun9075 were obtained from Antalya Agriculture Inc. The 'Crimson Tide' watermelon variety was first introduced to Turkey in1997, then, the registration was extended to 2017 at Syngenta Agriculture Industry and Trade Inc. Nun9075 rootstock was registered as a vegetable seed by Nunhems on 2017 and is a hybrid rootstock of *Cucurbita maxima*×*Cucurbita moschata*.

The soil pH value of the parcel where the study was carried out was 7.02 and has a loamy texture. According to the soil analysis results, the experimental parcel was highly calcareous, slightly salty, defficient organic matter (2.06 %,) with very high available potassium and high phosphorus.

The seedlings were planted with 2.5×0.7 m spacing and distances on the prepared beds with a width of 0.7 m and a height of 0.4 m, covered with black mulch. Irrigation was done using a drip irrigation system. Fertilizer application was conducted according to Güçdemir (2012) after soil analysis. Fertilization was done with a drip irrigation system at each irrigation period. Spraying against spider mites and other pests was done as soon as they were seen. Weed control was done mechanically and manually. The fruits of the 'Crimson Tide' watermelon variety were harvested when the spoon leaves and tendril were dry. Grafted and ungrafted watermelon fruits were stored at 4°C and 90–95% relative humidity for 5 weeks.

Measurements and Observations

In the study, fruit samples were taken from 6 different parts of the fruit for the analysis of the 'Crimson Tide' watermelon cultivar, which is ungrafted and grafted on Nun9075.

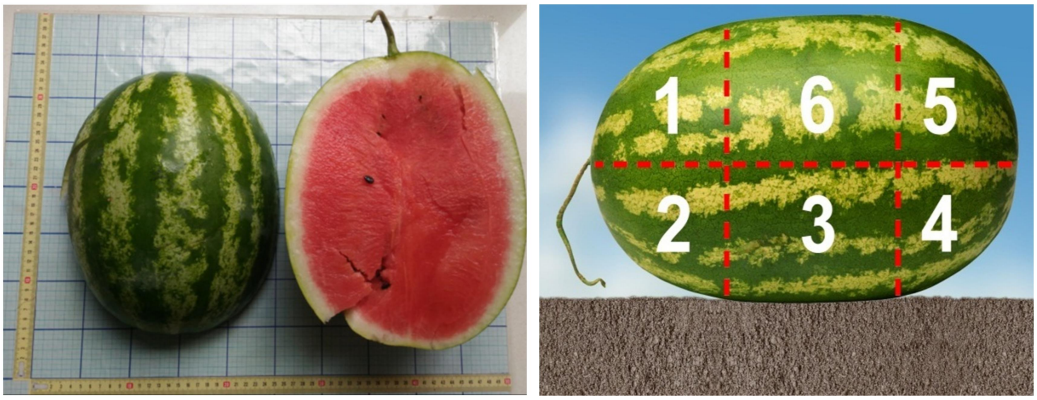

Figure 1. Fruit of the 'Crimson Tide' watermelon variety (left), locations of samples taken from different parts of the fruit (right).

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The order in which fruit samples were taken is given in Figure 1.

The weight losses (%) were determined compared to the initial weight with a balance sensitive to 0.01 g (Ohaus Adventurer, USA). Fruits were examined during storage, and fungal and physiological disorders were detected during storage period.

Total Soluble Solid (TSS, %) was determined on juice obtained from watermelons and was measured by hand refractometer (Atago ATC-1E Model, Atago Co. Ltd., Tokyo, Japonya). Titratable Acidity (TA) content (%) content was measured by a potentiometric method. To measure TA content, 5 mL of the obtained fruit juice was taken, and the acidity value was measured with the help of the 0.1N NaOH solution and the pH reached 8.1. Cemeroğlu (2010) determined the amount of vitamin C (L-ascorbic acid) using a High-Pressure Liquid Chromatography (HPLC) device (Shimadzu LC20AD, Tokyo, Japan). Klimczak *et al*. (2007) determined the amount of antioxidant activity (mmol TE 100 mL^{-1}) in the spectrophotometer (Biotek power wave HT, USA). Abdulkasim *et al*. (2007) determined the total amount of phenolic substance (mg GAE 100 mL^{-1}. Sugars (mg 100 mg^{-1}), including fructose, glucose, and sucrose, were obtained from fruit juices, were diluted by half before analysis and passed through a 0.45 mm membrane filter. Bartolome *et al*. (1995) modified the standard graph for analysis on high pressure liquid chromatography (HPLC, Shimadzu LC20AD, Tokyo, Japan); flow rate of 1.3 mL min^{-1}, mobile phase of 80% acetonitrile+20% distilled water, column temperature of 30°C, and 25 minutes calculated from the previously prepared standard graph based on peak area.

Statistical Analysis

The experiment was set up in a randomized plot design with 3 replications. Three grafted and ungrafted fruits were used in each repetition and statistical analysis of the obtained data was performed using JMP statistical software (JMP®, Version 7, SAS Institute Inc.; Cary, NC, 1989–2007; NC 27513-2414, USA). Differences between multiple means, the Tukey test, and differences between pairwise comparisons were calculated using T-Student ($P \leq 0.05$). Statistical analysis was performed after applying angle transformation to percentage values.

RESULTS AND DISCUSSION

The weight loss of grafted and control fruits of the 'Crimson Tide' watermelon variety was very low (< 1%) during cold storage, and the effects of rootstocks, fruit sample parts, and storage time were found to be statistically insignificant (data not given). Similar results to our findings regarding very low weight loss were reported by Perkins Veazie and Collins (2006), Özdemir *et al*. (2018), and Çandir *et al*. (2021). However, Araújo Neto *et al*. (2000) found a higher weight loss (3.8%) during storage than our findings. Suárez-Hernández *et al*. (2016) reported that some rootstocks caused a decrease in weight loss during 14 days of storage at 15 to 17 °C and 80% relative humidity conditions.

No fungal or physiological deterioration was observed in grafted and control watermelon fruits during storage. The findings of Özdemir *et al*. (2018) and Çandir *et al*. (2021) on fungal spoilage are similar to the results of this study. Also, on physiological deterioration, Özdemir *et al*. (2018) showed similarities with the current study's results.

The amount of TSS (8.9%) was higher in the fruits of the 'Crimson Tide' watermelon cultivar grafted on Nun9075 rootstock during cold storage than in the control fruits (8.8%). According to the fruit samples taken, the amount of TSS was found to be the highest in the 6^{th} part of the melon (9.5%) and the lowest in the 2^{nd} part (8.3%). The amount of TSS, which was 8.6% at the beginning, showed increasing and decreasing behaviour, and decreased to 7.7% at the end of 5 weeks. Among interactions, the amount of TSS

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reached the highest value with 10.5% in fruits grafted on Nun9075 rootstock in the 1st and 2nd weeks of the 6th part during storage (Table 1, Figure 2).

The content of TSS in watermelon is one of the most important quality criteria affecting the taste, and it has been reported that the amount of TSS is higher than in ungrafted watermelon (Suárez-Hernández *et al*., 2016; Balkaya *et al*., 2018; Kurum *et al*., 2018; Zaaroor-Presman *et al*., 2020). Unlike our findings, Özdemir *et al*. (2018) reported that TSS content remained above 10% in the fruits of 'Crisby' and 'Crimson Tide' cultivars grafted on Ferro and RS841 rootstocks during the storage period. Similar findings have been also reported by Çandir *et al*. (2021) In addition, it has been stated that grafted watermelons have lower TSS content during harvest compared to the control (Kyriacou and Soteriou, 2015).

The amount of TA (0.074%) in the fruits of the 'Crimson Tide' variety grafted on Nun9075 rootstock during cold storage was higher than the control fruits (0.065%). According to the fruit sample taken, the amount of TA was found to be the highest (0.075%) in the 6th part, and the lowest in the 2nd part (0.064%), while the others were statistically no differance among them (Figure 3). The amount of TA, which was 0.065% at the beginning, decreased to 0.063% at the end of 5 weeks, excluding 4 weeks. Among the interactions, TA amount was highest in ungrafted fruits in the 3rd part of the 4th week (0.11%) and the 6th part of the 4th week (0.113%) during storage, while the second part of the 2nd week had the lowest value with 0.048% in ungrafted fruits (Table 2). Similar to this study's findings, it has been reported in various studies that TA content increases and decreases in parallel with the changes in fruit juice pH during storage, and that there is a higher TA content in grafted samples (Proietti *et al*., 2008; Özdemir *et al*., 2018; Çandir *et al*., 2021).

The amount of vitamin C (71.77 mg 100 mL^{-1}) in the fruits of 'Crimson Tide' grafted on Nun9075 rootstock during cold storage was higher than the control fruits (53.81 mg 100 mL^{-1}). According to the fruit samples taken, the amount of vitamin C (67.15 mg 100 mL^{-1}) was found to be highest in the 3rd part, while it was the lowest in the 1st part (58.64 mg 100 mL^{-1}) (Figure 4). The amount of vitamin C, which was 76.50 mg 100 mL^{-1} at the

Table 1. Total soluble solid content (%) of 'Crimson Tide' watermelon cultivar during cold storage. [a]

Weeks	Graft status	Parts 1	2	3	4	5	6	Average weeks	Average graft
Initial	Grafted	9.0 mno	8.5 q-t	10.2 abc	8.7 o-r	9.0 lmn	9.7 f-ı	8.6 D	Grafted 8.9 A
	Ungrafted	8.3 t-w	7.0]	8.5 r-v	7.7 [	8.0 xyz	8.9 nop		
1 Week	Grafted	9.6 g-j	10.1 bc	9.9 c-f	10.2 bc	10.4 ab	10.5 a	9.9 A	
	Ungrafted	8.3 t-w	8.9 m-p	10.4 ab	9.7 e-h	10.0 cd	10.3 ab		
2 Weeks	Grafted	9.3 jkl	9.0 mno	10.0 cde	8.8 n-q	9.4 h-k	10.5 a	9.4 B	
	Ungrafted	8.3 t-w	8.7 p-s	9.9 c-f	9.2 klm	9.7 e-h	10.4 ab		
3 Weeks	Grafted	9.0 mno	8.5 q-t	10.2 abc	8.7 o-r	9.0 lmn	9.7 f-ı	8.6 C	Ungrafted 8.8 B
	Ungrafted	8.3 t-w	7.0]	8.5 r-v	7.7 [	8.0 xyz	8.9 nop		
4 Weeks	Grafted	8.3 t-w	8.1 wxy	8.5 r-u	8.2 v-y	8.0 xyz	8.2 u-x	8.8 D	
	Ungrafted	9.6 g-j	8.7 p-s	9.8 d-g	9.2 klm	9.4 ıjk	10.1 bc		
5 Weeks	Grafted	7.4 \	7.0]	7.2 \]	6.5 ^	7.9 yz[	8.4 t-w	7.7 E	
	Ungrafted	8.4 t-w	8.0 x-]	8.4 s-v	7.1]	7.8 z[	8.7 p-s		
Average parts		8.6 D	8.3 F	9.3 B	8.5 E	8.9 C	9.5 A		

CV: 0.48

	Weeks	Grafted/ ungrafted	Parts	Weeks×grafted/ Ungrafted*parts	Weeks×grafted/ Ungrafted	Weeks×parts	Grafted/ Ungrafted×parts
Prob> f	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001

[a] Values are mean of three replicates. Different capital letters show significant difference in each row and each column, different small letters show significant difference between the treatments interaction. All statistical analysis was performed at P< 0.05.

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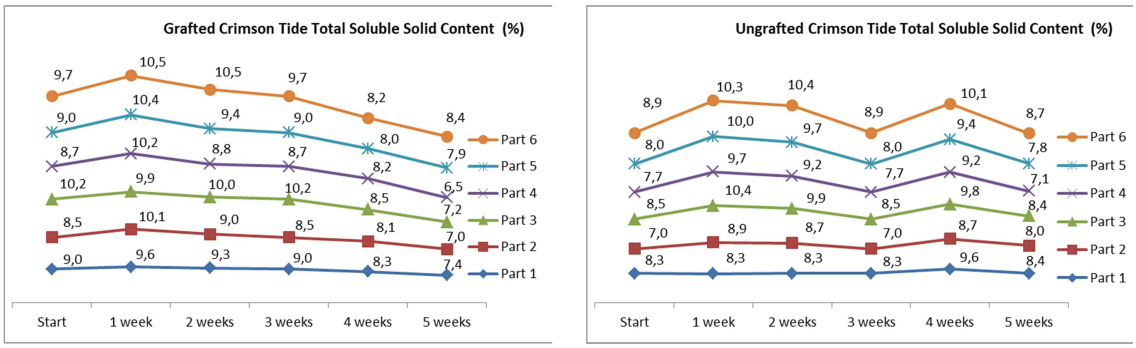

Figure 2. Changes in total soluble solid content (%) of 'Crimson Tide' watermelon variety according to the fruit samples taken during cold storage.

Table 2. Titratable acidity (%) of 'Crimson Tide' watermelon cultivar during cold storage. [a]

Weeks	Graft status	Parts 1	2	3	4	5	6	Average weeks	Average graft
Initial	Grafted	0.076 d-ı	0.069 f-l	0.074 d-j	0.069 f-l	0.078 d-h	0.074 d-j	0.065 C	Grafted 0.074 A
	Ungrafted	0.057 l-p	0.053 nop	0.061 j-p	0.055 m-p	0.057 l-p	0.063 ı-o		
1 Week	Grafted	0.074 d-j	0.071 e-k	0.067 g-m	0.078 d-h	0.095 bc	0.080 d-g	0.069 B	
	Ungrafted	0.050 op	0.059 k-p	0.063 ı-o	0.053 nop	0.067 g-m	0.069 f-l		
2 Weeks	Grafted	0.063 ı-o	0.065 h-n	0.074 d-j	0.063 ı-o	0.063 ı-o	0.065 h-n	0.064 CD	
	Ungrafted	0.059 k-p	0.048 p	0.063 ı-o	0.069 f-l	0.061 j-p	0.071 e-k		
3 Weeks	Grafted	0.076 d-ı	0.069 f-l	0.074 d-j	0.069 f-l	0.078 d-h	0.074 d-j	0.065 C	Ungrafted 0.065 B
	Ungrafted	0.057 l-p	0.053 nop	0.061 j-p	0.055 m-p	0.057 l-p	0.063 ı-o		
4 Weeks	Grafted	0.095 bc	0.076 d-ı	0.084 cde	0.084 cde	0.080 d-g	0.086 cd	0.090 A	
	Ungrafted	0.105 ab	0.082 c-f	0.111 a	0.082 c-f	0.084 cde	0.113 a		
5 Weeks	Grafted	0.074 d-j	0.063 ı-o	0.071 e-k	0.063 ı-o	0.071 e-k	0.067 g-m	0.063 D	
	Ungrafted	0.050 op	0.055 m-p	0.055 m-p	0.063 ı-o	0.050 op	0.069 f-l		
Average parts		0.070 B	0.064 D	0.071 B	0.067 C	0.070 B	0.075 A		

CV: 5.34

	Weeks	Grafted/ Ungrafted	Parts	Weeks×grafted/ Ungrafted×parts	Weeks×grafted/Ungrafted	Weeks×parts	Grafted/Ungrafted×parts
Prob > f	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001

[a] Values are mean of three replicates. Different capital letters show significant difference in each row and each column, different small letters show significant difference between the treatments interaction. All statistical analysis was performed at P< 0.05.

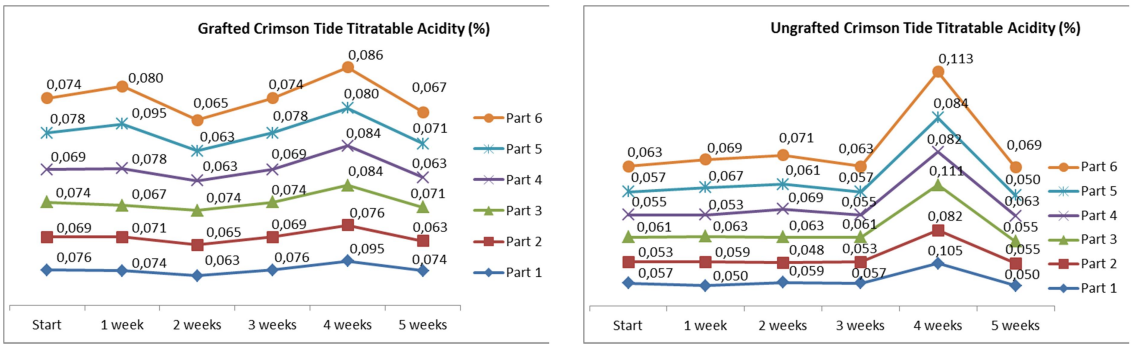

Figure 3. Changes in titratable acidity (%) of the 'Crimson Tide' watermelon variety according to the fruit samples taken during cold storage.

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Table 3. Vitamin C (mg 100 mL^{-1}) variation in 'Crimson Tide' watermelon variety under cold storage. [a]

Weeks	Graft status	Parts 1	2	3	4	5	6	Average weeks	Average graft
Initial	Grafted	84.39 b	89.44 b	100.40 a	96.62 a	84.07 bc	85.10	76.50 A	Grafted 71.77 A
	Ungrafted	59.17 n-r	47.97 uv	68.21 f-j	66.21 h-m	68.20 f-j	68.28 f-j		
1 Week	Grafted	71.55 d-h	69.61 e-ı	75.40 de	67.44 f-l	73.05 d-g	67.85 f-l	65.23 C	
	Ungrafted	53.70 q-u	53.25 r-u	61.56 l-p	61.73 k-o	68.16 f-k	59.50 n-r		
2 Weeks	Grafted	70.01 e-ı	67.18 g-l	70.14 e-ı	73.87 def	70.11 e-ı	70.21 e-ı	70.95 B	
	Ungrafted	69.64 e-ı	77.80 cd	69.68 e-ı	75.03 de	71.18 e-ı	66.60 h-l		
3 Weeks	Grafted	84.39 b	89.44 b	100.40 a	96.62 a	84.07 bc	85.10 b	76.50 A	Ungrafted 53.81 B
	Ungrafted	59.17 n-r	47.97 uv	68.21 f-j	66.21 h-m	68.20 f-j	68.28 f-j		
4 Weeks	Grafted	56.05 o-s	63.06 j-n	64.81 ı-n	65.29 h-n	56.26 o-s	54.43 q-t	51.87 D	
	Ungrafted	32.84 xy	42.61 vw	43.38 vw	55.20 p-s	51.09 stu	37.46 wx		
5 Weeks	Grafted	43.39 vw	60.07 m-q	54.75qrs	47.93 uv	43.13 vw	48.18 tuv	35.67 E	
	Ungrafted	19.40 z	29.87 y	28.82 y	17.09 z	17.88 z	17.56 z		
Average parts		58.64 E	61.52 D	67.15 A	65.77 B	62.95 C	60.71 D		

CV: 2.95

	Weeks	Grafted/ Ungrafted	Parts	Weeks×grafted/ Ungrafted×parts	Weeks×grafted/ Ungrafted	Weeks×parts	Grafted/ Ungrafted×parts
Prob>f	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001

[a] Values are mean of three replicates. Different capital letters show significant difference in each row and each column, different small letters show significant difference between the treatments interaction. All statistical analysis was performed at P< 0.05.

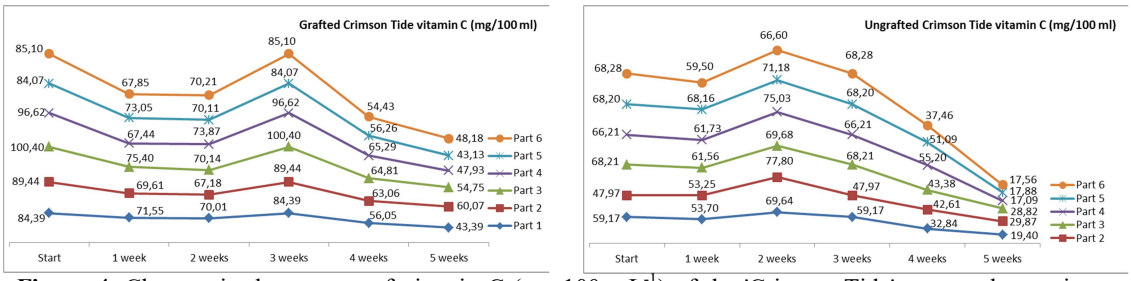

Figure 4. Changes in the amount of vitamin C (mg 100 mL^{-1}) of the 'Crimson Tide' watermelon variety according to the fruit sample taken during cold storage.

beginning, showed decreasesing and increasesing behaviour and decreased to 35.67 mg 100 mL^{-1} at the end of 5th weeks. In interactions, the amount of vitamin C in the fruits grafted on Nun9075 rootstock in the 3rd part at the beginning and in the 3rd week reached the highest value with 100.40 and 96.62 mg 100 mL^{-1} in the 4th part at the beginning and in the 3rd week. It decreased to 19.40 , 17.09 , 17.88, and 17.56 mg 100 mL^{-1} in ungrafted fruits in the 5th week in parts 1, 4, 5 and 6, respectively (Table 3).

Similar to our findings, Zaaroor-Presman *et al*. (2020) reported that the highest amount of vitamin C was obtained in grafted watermelons. 'Crisby F_1' grafted on gourd rootstock (Argentario F_1) and commercial hybrid rootstocks (Obez F_1 and Shintosa F_1). Rootstocks had a major impact on the amount of vitamin C; in grafted watermelons, the content rose by 30.30%, whereas in non-grafted watermelons, it decreased by 17.09% (Karaağaç *et al*., 2018). Unlike our findings, Balkaya *et al*. (2018) found that vitamin C content of grafted and ungrafted watermelons ranged from 2.6 to 3.5 mg 100 mL^{-1}, and vitamin C content of grafted watermelons was lower than that of ungrafted watermelons.

Antioxidant activity (293.04 mmol TE 100 mL^{-1}) in the 'Crimson Tide' grafted on Nun9075 rootstock during cold storage was higher than in the control fruits (254.97 mmol TE 100 mL^{-1}). The antioxidant

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Table 4. Changes in the amount of antioxidant activity (mmol TE 100 mL^{-1}) of 'Crimson Tide' watermelon during cold storage according to rootstocks and fruit sample part taken.

Weeks	Graft status	Parts						Average weeks	Average graft
		1	2	3	4	5	6		
Başlangıç	Grafted	266.99 k-r	289.44 d-m	290.07 d-m	293.23 d-l	272.68 j-q	267.31 k-r	258.24 D	Grafted 293.04 A
	Ungrafted	213.55 uvw	234.42 r-w	234.74 r-w	258.45 l-s	263.83 k-s	214.18 uvw		
1 Week	Grafted	344.14 ab	315.68 a-g	335.92 abc	334.02 abc	319.16 a-f	336.24 abc	320.90 A	
	Ungrafted	288.49 d-m	303.04 c-j	346.04 a	284.38 f-o	334.02 abc	309.68 b-ı		
2 Weeks	Grafted	322.01 a-d	315.05 a-g	315.68 a-g	312.21 a-h	315.37 a-g	320.43 a-e	284.33 B	
	Ungrafted	250.23 o-t	229.05 s-w	261.61 l-s	242.64 p-u	252.13 n-s	275.53 ı-p		
3 Weeks	Grafted	266.99 k-r	289.44 d-m	290.07 d-m	293.23 d-l	272.68 j-q	267.31 k-r	258.24 D	Ungrafted 254.97 B
	Ungrafted	213.55 uvw	234.42 r-w	234.74 r-w	258.45 l-s	263.83 k-s	214.18 uvw		
4 Weeks	Grafted	275.21 ı-p	308.73 b-ı	297.66 d-k	274.89 ı-q	262.88 k-s	286.28 e-n	251.92 D	
	Ungrafted	200.27 w	239.48 q-v	250.23 o-t	205.96 vw	216.40 t-w	205.01 vw		
5 Weeks	Grafted	269.20 j-r	262.88 k-s	260.35 l-s	282.80 g-o	266.67 k-r	256.56 m-s	270.42 C	
	Ungrafted	276.48 ı-p	281.85 g-o	269.20 j-r	277.11 h-p	267.31 k-r	274.58 ı-q		
Average parts		265.59 C	275.29 AB	282.19 A	276.45 A	275.58 AB	268.94 BC		
CV: 3.74									
	Weeks	Grafted/ Ungrafted	Parts	Weeks×grafted/ Ungrafted×parts	Weeks×grafted/ Ungrafted	Weeks×parts	Grafted/ Ungrafted×parts		
Prob> f	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001		

[a] Values are mean of three replicates. Different capital letters show significant difference in each row and each column, different small letters show significant difference between the treatments interaction. All statistical analysis was performed at P< 0.05.

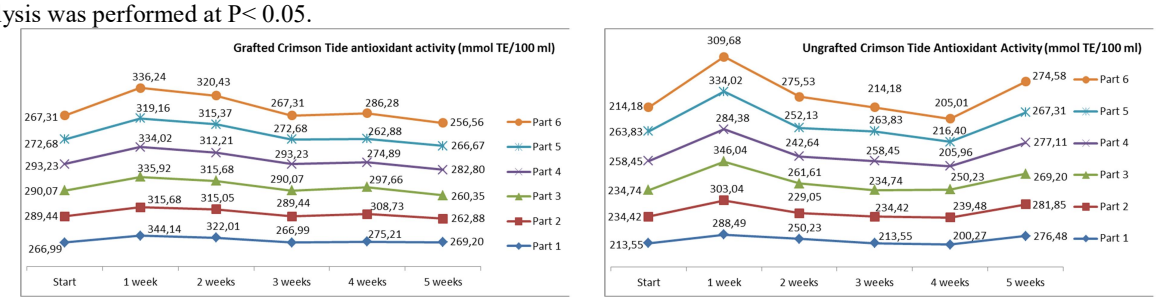

Figure 5. Changes in the amount of antioxidant activity (mmol TE 100 mL^{-1}) of the 'Crimson Tide' watermelon variety according to the portion of the fruit sample taken during cold storage.

activity in the fruit samples taken was between 265.59 – 282.19 mmol TE 100 mL^{-1} (Figure 5). Antioxidant activity, which was 258.24 mmol TE 100 mL^{-1} at the beginning, showed increases and decreases and reached 270.42 mmol TE 100 mL^{-1} at the end of 5 weeks. Among the interactions, while the antioxidant activity reached the highest value with 346.04 mmol TE 100 mL^{-1} in ungrafted fruits in the 3rd part of the 1st week during storage, it decreased to 200.27 mmol TE 100 mL^{-1} in the 1st part of the 4th week in ungrafted watermelon (Table 4).

The total amount of phenolic substances was higher in the fruits of the 'Crimson Tide' variety grafted on Nun9075 rootstock with 202.29 mg GAE100 mL^{-1} during cold storage than in the control fruits (176.33 mg GAE100 mL^{-1}. The total amount of phenolic substances, which was 197.27 mg GAE 100 mL^{-1} at the beginning, showed increases and decreases and decreased to 165.15 mg GAE 100 mL^{-1} at the end of 5 weeks. In interactions, the total amount of phenolic substance in fruits grafted on Nun9075 rootstock in the first part at the first week reached the highest value with 234.69 mg

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Table 5. Total phenolic substance (mg GAE 100 mL^{-1}) in 'Crimson Tide' watermelon cold storage. [a]

Weeks	Graft status	Parts						Average weeks	Average grafted
		1	2	3	4	5	6		
Initial	Grafted	221.51 a-e	202.18g-l	208.77d-ı	215.80b-g	233.38 ab	232.50 ab	197.27 C	Grafted 202.29 A
	Ungrafted	215.80 b-g	150.32 y-\	181.08 m-s	162.19 t-y	166.14 r-y	177.57o-t		
1 Week	Grafted	234.69 a	198.66 g-m	215.36 b-g	229.86 abc	206.57 d-ı	221.95 a-e	206.35 B	
	Ungrafted	184.16 l-r	205.25 d-j	208.33 d-ı	173.61 p-v	203.05 f-k	194.70 ı-o		
2 Weeks	Grafted	231.62 ab	210.96 d-ı	221.07 a-f	222.39 a-d	216.68 a-g	216.24 b-g	212.28 A	
	Ungrafted	203.93 e-j	213.16 c-h	209.65 d-ı	196.02 h-n	172.73 p-w	232.94 ab		
3 Weeks	Grafted	221.51 a-e	202.18 g-l	208.77 d-ı	215.80 b-g	233.38 ab	232.50 ab	197.27 C	Ungrafted 176.33 B
	Ungrafted	215.80 b-g	150.32 y-\	181.08 m-s	162.19 t-y	166.14 r-y	177.57 o-t		
4 Weeks	Grafted	152.96 x-\	170.54 p-x	158.67 u-[	164.82 s-y	153.40 x-\	156.03 v-\	157.54 E	
	Ungrafted	172.29 p-w	151.64 y-\	150.32 y-\	143.73 z[\	161.31 t-z	154.72 w-\		
5 Weeks	Grafted	185.04 k-q	178.89 n-t	178.45 n-t	166.14 r-y	174.93 p-u	188.11j-p	165.15 D	
	Ungrafted	150.76 y-\	163.07 s-y	167.46 q-y	138.02 \	141.09 [\	149.88 y-\		
Average parts		199.17 A	183.10 D	190.75 C	182.55 D	185.73 D	194.56 B		
CV: 2.74									

	Weeks	Grafted/ Ungrafted	Parts	Weeks×grafted/ Ungrafted×parts	Weeks×grafted/ Ungrafted	Weeks×parts	Grafted/ Ungrafted×parts
Prob> f	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001

[a] Values are mean of three replicates. Different capital letters show significant difference in each row and each column, different small letters show significant difference between the treatments interaction. All statistical analysis was performed at P< 0.05.

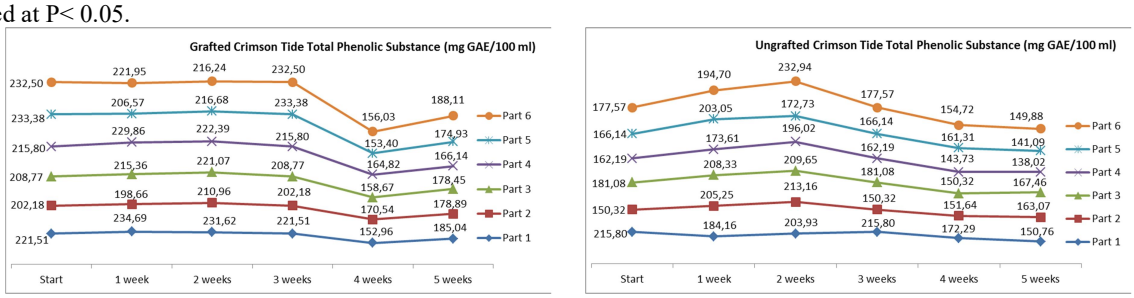

Figure 6. Changes in the amount of total phenolic substance (mg GAE 100 mL^{-1}) of the 'Crimson Tide' watermelon variety according to the portion of the fruit samples taken during cold storage.

GAE 100 mL^{-1}, while the 4th part in the ungrafted fruits at the 5th week reached the highest value with 138.02 mg GAE 100 mL^{-1} (Table 5, Figure 6). Evrenosoğlu *et al.* (2010) reported that fruits obtained from grafted plants had higher phenolic content than those obtained from ungrafted plants.

During the cold storage of the 'Crimson Tide' watermelon cultivar, the glucose content of the rootstocks was 0.84 mg 100 mg^{-1}, and the sugar content of the 'Crimson Tide' grafted on the Nun9075 rootstock was lower than the control fruits (0.96 mg 100 mg^{-1}). According to the fruit sample taken, the amount of glucose (1.03 mg 100 mg^{-1}) was the highest in the 6th part, and the lowest in the 4th part (0.72 mg 100 mg^{-1}) (Figure 7). The glucose level was 0.39 mg 100 mg^{-1} at the beginning, and showed increases and decreases. The glucose level was highest in the 1st week (1.67 mg 100 mg^{-1}) and decreased to 0.88 mg 100 mg^{-1} at the end of 5th week. Within the interactions, during storage, the glucose amount in the 6th part reached the highest value with 2.39 mg 100 mg^{-1} in the ungrafted fruits in the 1st week, while the 4th part decreased to 0.20 mg 100 mg^{-1} in the fruits grafted on the Nun9075 rootstock at the beginning (Table 6).

During cold storage, the amount of fructose (1.76 mg 100 mg^{-1}) was lower in the fruits of the 'Crimson Tide' grafted on

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Table 6. Analysis of glucose quantity (mg 100 mg^{-1}) in 'Crimson Tide' watermelon cultivar during cold storage according to rootstocks and fruit sample taken. [a]

Weeks	Grafting status	Parts 1	2	3	4	5	6	Average weeks	Average grafted
Initial	Grafted	0.42 B-E	0.38 DE	0.33 DEF	0.20 F	0.28 EF	0.34 DEF	0.39 D	Grafted 0.84 B
	Ungrafted	0.55 _-b	0.46 A-D	0.43 BCD	0.39 CDE	0.42 B-E	0.53 `-C		
1 Week	Grafted	1.63 cd	1.62 cde	1.48 ef	1.28 hı	1.44 fg	1.33 gh	1.67 A	
	Ungrafted	1.92 b	1.75 c	1.67 cd	1.54 def	2.03 b	2.39 a		
2 Weeks	Grafted	1.17 ıj	0.87 o-v	0.88 o-v	0.71 w-^	0.97 l-r	1.20 hıj	0.86 B	
	Ungrafted	0.74 v-]	0.83 r-y	0.82 r-z	0.61]-`	0.65 [-`	0.85 p-x		
3 Weeks	Grafted	0.84 p-x	0.75 v-]	0.66 [-`	0.39 CDE	0.55 _-B	0.68 z-`	0.79 C	Ungrafted 0.96 A
	Ungrafted	1.10 j-m	0.91 n-u	0.87 o-w	0.78 u-\	0.84 q-y	1.06 j-n		
4 Weeks	Grafted	0.81 s-[	0.78 u-\	0.78 u-\	0.73 v-^	0.95 m-s	1.10 j-m	0.81 C	
	Ungrafted	0.88 o-v	0.77 u-\	0.79 t-\	0.69 y-_	0.68 z-`	0.75 v-]		
5 Weeks	Grafted	0.88 o-v	0.71 x-^	0.59 ^-A	0.64 [-`	0.98 k-q	0.99 k-p	0.88 B	
	Ungrafted	1.02 k-o	0.94 n-t	0.82 r-z	0.75 v-]	1.10 ıjk	1.13		
Average parts		1.00 B	0.90 C	0.84 D	0.72 E	0.91 C	1.03 A		

CV: 4.86

	Weeks	Grafted/ Ungrafted	Parts	Weeks×grafted/ Ungrafted×parts	Weeks×grafted/ Ungrafted	Weeks×parts	Grafted/Ungrafted×parts
Prob>f	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001

[a] Values are mean of three replicates. Different capital letters show significant difference in each row and each column, different small letters show significant difference between the treatments interaction. All statistical analysis was performed at P< 0.05.

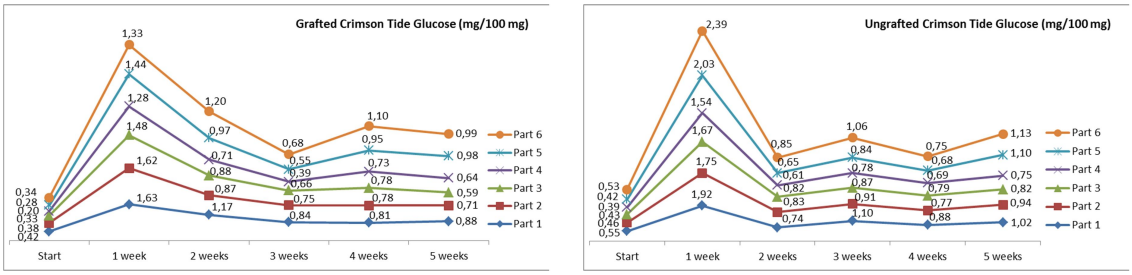

Figure 7. Changes in glucose (mg 100 mg^{-1}) amount of 'Crimson Tide' watermelon according to the fruit sample taken during cold storage.

Nun9075 rootstock than in the control fruits (2.14 mg 100 mg^{-1}). According to the fruit sample parts taken, the fructose amount was the lowest in the 3rd and 4th parts (1.92 and 1.90 mg 100 mg^{-1}, respectively), while the other parts were similar and the highest (Table 7, Figure 8).

The fructose level was 1.03 mg 100 mg^{-1} at the beginning, and showed increases and decreases. The 1st week (3.05 mg 100 mg^{-1}) was the highest and decreased to 1.59 mg 100 mg^{-1}after 5th week. Within the interactions, the fructose level in ungrafted fruits reached the highest value with 3.67 and 3.73 mg 100 mg^{-1} in the 5th and 6th parts of the first week of storage, while in all parts, in the fruits grafted on the Nun9075 rootstock, it was initially 0.65-0.82 mg 100 mg^{-1} and was the lowest (Table 7).

The amount of sucrose was 4.73 mg 100 mg^{-1} in the 'Crimson Tide' grafted on the Nun9075 rootstock during cold storage and was higher than the control fruits (4.00 mg 100 mg^{-1}). According to the fruit sample taken, the highest amounts of sucrose (4.88 and 4.79 mg 100 mg^{-1}, respectively) were

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Table 7. Changes of fructose (mg 100 mg^{-1}) in 'Crimson Tide' watermelon cultivar under cold storage based on rootstocks and fruit sample parts. [a]

Weeks	Graft status	Parts 1	2	3	4	5	6	Average Weeks	Average Graft
Initial	Grafted	0.75 `	0.82 `	0.79 `	0.81 `	0.77 `	0.65 `	1.03 E	Grafted 1.76 B
	Ungrafted	1.29 \-_	1.24]^_	1.29 \-_	1.29 \-_	1.29 \-_	1.34 [-^		
1 Week	Grafted	2.53 h	2.78 d-g	2.85 de	2.97 cd	2.58 fgh	2.80 def	3.05 A	
	Ungrafted	3.33 b	3.37 b	3.08 c	2.94 cd	3.67 a	3.73 a		
2 Weeks	Grafted	2.23 jkl	2.09 j-q	1.79 s-w	2.19 j-m	2.23 jk	2.14 j-p	1.95 C	
	Ungrafted	1.56 x-[	1.92 p-t	2.00 m-s	1.85 r-u	1.64 u-y	1.74 t-x		
3 Weeks	Grafted	1.50 y-\	1.65 u-y	1.57 w-z	1.62 v-y	1.54 x-[	1.30 \-_	2.05 B	Ungrafted 2.14 A
	Ungrafted	2.58 gh	2.48 hı	2.57 gh	2.59 fgh	2.58 gh	2.68 e-h		
4 Weeks	Grafted	2.18 j-o	2.00 m-s	1.97 o-s	1.82 r-v	2.13 j-p	2.29 ıj	2.03 B	
	Ungrafted	1.98 m-s	2.10 j-q	2.19 j-n	2.03 k-r	1.78 s-w	1.84 r-u		
5 Weeks	Grafted	1.44 y-]	1.37z-^	1.21 ^_	1.11 _	1.49 y-\	1.31 \-_	1.59 D	
	Ungrafted	2.01 l-s	2.00 m-s	1.72 t-x	1.62 v-y	1.89 q-t	1.97 n-s		
Average parts		1.95 AB	1.99 A	1.92 B	1.90 B	1.97 A	1.98 A		

CV: 3.25

	Weeks	Grafted/ Ungrafted	Parts	Weeks×grafted/ Ungrafted×parts	Weeks×grafted/ Ungrafted	Weeks×parts	Grafted/ Ungrafted×parts
Prob> f	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001

[a] Values are mean of three replicates. Different capital letters show significant difference in each row and each column, different small letters show significant difference between the treatments interaction. All statistical analysis was performed at P< 0.05.

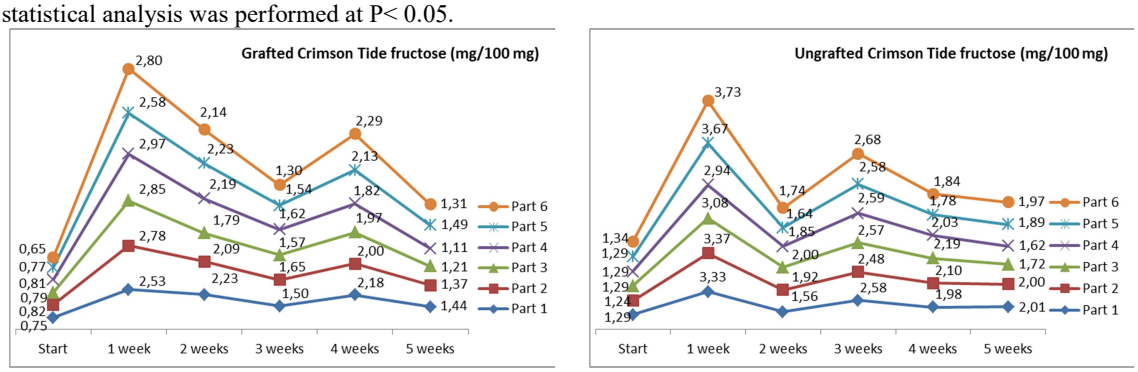

Figure 8. Changes in fructose (mg 100 mg^{-1}) amount of 'Crimson Tide' watermelon according to the fruit sample taken during cold storage.

found in the 3rd and 6th parts, while the 1st and 2nd parts (3.94 mg/100 mg and 3.93 mg 100 mg^{-1}) were the lowest values (Table 8, Figure 9).

The amount of sucrose was 2.23 mg 100 mg^{-1} at the beginning, and showed increases and decreases. During the 2nd week (5.86 mg 100 mg^{-1}) was the highest and decreased to 3.77 mg/100 mg after 5 weeks. Among the interactions, during storage, the amount of sucrose in ungrafted fruits reached the highest value with 7.33 mg 100 mg^{-1} in the 6th part and in the 2nd week, while the amount of sucrose in the 1st, 2nd and 4th parts was 1.53 mg 100 mg^{-1} in ungrafted fruits at the beginning, it decreasedto, respectively, 1.12 and 1.44 mg 100 mg^{-1} (Table 8, Figure 9). Several studies have found that sucrose is the most abundant sugar in watermelons during harvest and storage, which is consistent with our findings (Chisholm and Picha, 1986; Kyriacou and Soteriou, 2015; Özdemir *et al*., 2018; Çandir *et al*., 2021). In addition, in some studies, lower sugar content was found in grafted watermelon fruits at harvest than in ungrafted fruits

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Table 8. Changes in the amount of sucrose (mg 100 mg^{-1}) of 'Crimson Tide' watermelon under cold storage based on rootstocks and the fruit part. [a]

Weeks	Graft status	Parts 1	2	3	4	5	6	Average Weeks	Average Graft
Initial	Grafted	2.74 vxy	2.60 xy	3.50 r-v	2.76 wxy	2.76 wxy	3.19 u-x	2.23 E	Grafted 4.73 B
	Ungrafted	1.53 [	1.12 [	1.74 z[	1.44 [	1.56 z[	1.77 z[		
1 Week	Grafted	5.92 efg	6.49 b-e	6.49 b-e	6.71 a-d	7.03 abc	7.11 ab	5.82 A	
	Ungrafted	3.66 q-u	4.63 j-o	6.20 de	5.37 f-ı	5.04 h-l	5.16 h-k		
2 Weeks	Grafted	4.87 h-m	5.11 h-k	6.62 bcd	5.08 h-l	5.34 ghı	6.03 def	5.86 A	
	Ungrafted	5.08 h-l	5.44 fgh	6.56 b-e	5.90 efg	7.01 abc	7.33 a		
3 Weeks	Grafted	5.48 fgh	5.20 h-k	7.00 abc	5.52 fgh	5.51 fgh	6.38 cde	4.45 B	Ungrafted 4.00 A
	Ungrafted	3.06 u-x	2.24 yz	3.48 s-v	2.88 v-y	3.12 u-x	3.55 r-v		
4 Weeks	Grafted	3.53 r-v	3.62 q-u	3.93 p-t	4.02 o-s	3.28 t-x	3.19 u-x	4.05 C	
	Ungrafted	4.18 n-r	3.57 r-u	4.72 ı-n	4.40 l-p	4.90 h-m	5.29 g-j		
5 Weeks	Grafted	3.57 r-u	3.56 r-u	4.02 o-s	3.53 r-v	4.00 o-s	4.55 k-p	3.77 D	
	Ungrafted	3.67 q-u	3.54 r-v	4.29 m-q	3.40 s-w	3.16 u-x	3.92 p-t		
Average parts		3.94 D	3.93 D	4.88 A	4.25 C	4.39 B	4.79 A		

CV: 4.48

	Weeks	Grafted/ Ungrafted	Parts	Weeks×grafted/ Ungrafted×parts	Weeks×grafted/ Ungrafted	Weeks×parts	Grafted/ Ungrafted×parts
Prob> f	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001

[a] Values are mean of three replicates. Different capital letters show significant difference in each row and each column, different small letters show significant difference between the treatments interaction. All statistical analysis was performed at P< 0.05.

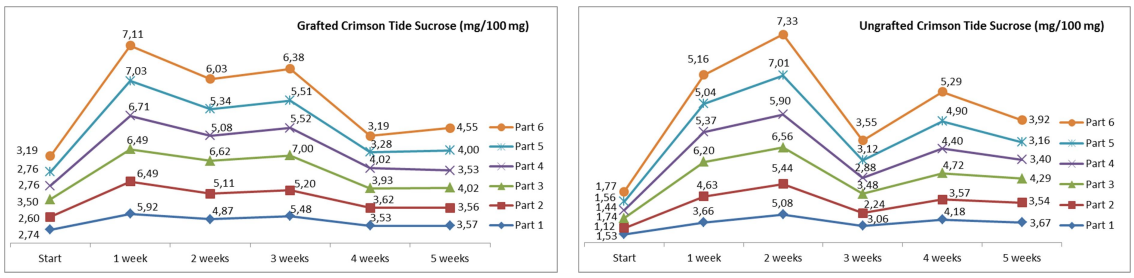

Figure 9. Changes in the amount of sucrose (mg 100 mg^{-1}) of 'Crimson Tide' watermelon variety according to the fruit sample taken during cold storage.

(Yetisir *et al*., 2003; Davis and Perkins-Veazie, 2005). Unlike our findings, Çandir *et al*. (2021), in the 'Crimson Tide' watermelon cultivar, after 21 days of storage at 0°C, the fructose and glucose contents of the fruits grafted on RS841 and Ferro rootstocks were higher than the control fruits, and the sucrose content was lower in RS841 and Ferro grafted fruits. Radulovic *et al*. (2007) reported a significant decrease in the total sugar content of watermelons during storage at 20°C for 14 days. It has been reported that the preservation of sugars at lower storage temperatures may possibly be attributed to the lower respiratory rate (Özdemir *et al*., 2018).

Many results have been reported on the changes in fruit quality resulting from grafting, rootstock, storage and shelf life (Lee and Oda, 2003; Davis and Perkins-Veazie, 2005; Karaca *et al*., 2012; Aras *et al*., 2015; Özdemir *et al*., 2018; Çandir *et al*., 2021). Moreover, besides rootstock effect, a field and year effect due to soil and climatic conditions on watermelon qualities was also observed (Bruton *et al*., 2009). The differences observed in previous studies may be explained by different production conditions, the type of rootstock/scion

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combinations used, or the harvest date and the storage conditions (Karaca *et al*., 2012; Çandir *et al*., 2013; Kyriacou and Soteriou, 2015; Özdemir *et al*., 2018; 2022). Yetişir and Sarı (2003) explained that grafting influenced the flowering and harvest time, prolonged the duration of fruit harvest, and increased the number of fruits per plant.

CONCLUSIONS

Grafting enhanced the outside and/or inside quality of the fruit, and it also conserved fruit quality after harvest better than fruit from non-grafted plants. Weight loss during storage was minimal (1%) in grafted and control fruits when the quality parameters were considered together. During storage, no fungal or physiological deterioration was observed in grafted and control watermelon fruits. Compared to the control fruits, the grafted 'Crimson Tide' watermelon increased TSS, vitamin C, antioxidant activity, and total phenolic compound concentrations. In order to manage watermelons growth with limited physiological problems, increase marketable yields, and maintain quality throughout storage, further study are required, either independently or in combination with grafting programs.

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REFERENCES

1. Abdulkasım, P., Songchitsomboon, S., Techagumpuch, M., Balee, N., Swatsitang, P. and Sungpuag, N. 2007. Antioxidant Capacity, Total Phenolics and Sugar Content of Selected Thai Health Beverages. International Journal of Food Sciences and Nutrition 58 (1) 77–85. doi: 10.1080/09637480601140946
2. Aras, V., Özdemir, A.E., Yetişir, H., Çandir, E., Güler, Z., Aslan, Ö., Üstün, D., Baltaer, Ö. and Ünlü, M. 2015. Changes in the Quality Parameters of Grafted Crimson Tide Watermelon Cultivar in Common Marketing Condition. *Alatarım J.,* **14(1):** 9–18.
3. Araújo Neto, S. E., Hafle, O. M., Gurgel, F. L., Menezes, J. B. and Silva, G. G. 2000. Quality and Postharvest Shelf Life of Crimson Sweet Watermelon Marketed in Mossoro. *Rev. Bras. Eng. Agric. Ambient.,* **4:** 235–239.
4. Balkaya, A., Güngör, B., Sarıbaş, Ş. and Yıldız, S. 2018. Determination of the Effects of Pumpkin Rootstock on Yield and Fruit Quality in Mini Watermelon Cultivation. *YYU J. Agr. Sci.,* **28:** 237–246.
5. Bartolome, A.P., Ruperez, P. and Fuster, C. 1995. Pineapple Fruit: Morphological Characteristics, Chemical Composition and Sensory Analysis of Red Spanish and Smooth Cayenne Cultivars. *Food Chem.,* **53:** 75–79.
6. Bruton, B. D., Fish, W. W., Roberts, W. and Popham, T. W. 2009. The Influence of Rootstock Selection on Fruit Quality Attributes of Watermelon. *Open Food Sci. J.,* **3**: 15-34.
7. Cemeroğlu, B. 2010. *Food Analysis*. No: 34, Food Technologies Association Publications.
8. Chisholm, D. N. and Picha, D. H. 1986. Effect of Storage Temperature on Sugar and Organic Acid Contents of Watermelons. *HortScience,* **21**: 1031–1033.
9. Çandir, E., Yetisir, H., Karaca, F. and Üstün, D. 2013. Phytochemical Characteristics of Grafted Watermelon on Different Bottle Gourds (*Lagenaria siceraria*) Collected from the Mediterranean Region of Turkey. *Turk. J. Agric. For.* **37:** 443-456.
10. Çandir, E., Özdemir, A.E., Yetişir, H., Aras, V., Arslan, Ö., Baltaer, Ö. and Ünlü, M. 2021. Effects of Chilling Injury, Physical and Biochemical Changes on Grafted Watermelons Stored at Low Temperature. *Hortic. Stud.,* **38(2):** 71–84.
11. Davis, A.R. and Perkins-Veazie, P. 2005. Rootstock Effects on Plant Vigor and

[DOI: 10.22034/JAST.26.5.1113]

Watermelon Fruit Quality. *CGC Reports*, **28**: 39–42.

12. Evrenosoğlu, Y., Alan, Ö. and Özdemir, N. 2010. Leaf Phenolic Content of Some Squash Rootstocks Used on Watermelon [*Citrullus lanatus* (thunb.) Matsum and Nakai] Growing and Phenolic Accumulation on Grafted Cultivar. *Afr. J. Agric. Res.,* **5:** 732–737.
13. Güçdemir, İ. H. 2012. Plant Nutrition Recipe Preparation Technique Based on Soil Analysis and Practical Examples. In: "Plant Nutrition", (Ed.): Karaman, M. R. Dumat Offset, Ankara, Turkey. PP. 961–1066.
14. Karaağaç, O., Balkaya, A. and Kafkas, N. E. 2018. Karpuzda (*Citrullus lanatus*) Meyve Kalitesi ve Aroma, Özellikleri Üzerine Anaçların Etkisi. [Effect of Rootstocks on Fruit Quality and Aroma Characteristics of Watermelon (*Citrullus lanatus*)]. *Anadolu Tarım Bilim. Derg. (Anadolu J. Agr. Sci.),* **33:** 92–104.
15. Karaca, F., Yetişir, H., Solmaz, İ., Çandir, E., Kurt, Ş., Sari, N. and Güler, Z. 2012: Rootstock Potential of Turkish *Lagenaria siceraria* Germplasm for Watermelon: Plant Growth Yield and Quality. *Turk. J. Agric. For.,* **36:** 1-11.
16. Klimczak, I., Malecka, M., Szlachta, M. and Gliszczyńska-Świglo, A. 2007. Effect of Storage on the Content of Polyphenols, Vitamin C and the Antioxidant Activity of Orange Juices. *J. Food Compos. Anal.,* **20:** 313–322.
17. Kurum, R., Çelik, İ. and Eren, A. 2018. Effects of Rootstocks on Fruit Yield and Some Quality Traits of Watermelon (*Citrullus lanatus*). *Derim,* **34(2):** 91–98.
18. Kyriacou, M. C. and Soteriou, G. 2015. Quality and Postharvest Performance of Watermelon Fruit in Response to Grafting on Interspecific Cucurbit Rootstocks. *J. Food Qual.,* **38:** 21–29.
19. Lee, J. M. and Oda, M. 2003: Grafting of Herbaceous Vegetable and Ornamental Crops. *Hortic. Rev.,* **28:** 61-124.
20. Özdemir, A.E., Çandir, E., Yetişir, H., Aras, V., Arslan, Ö., Baltaer, Ö., Üstün, D. and Ünlü, M. 2018. Rootstocks Affected Postharvest Performance of Grafted 'Crisby' and 'Crimson Tide' Watermelon Cultivars. *J. Agric. Sci.,* 24: 453–462.
21. Özdemir, A.E., Aras, V., Ünlü, M., Arslan, R.and Eroğlu, Ç. 2022. Postharvest Fruit Quality Changes in Grafted and Ungrafted 'Paskal' Watermelon Cultivar. Proceedings Book, *5th International Agriculture Congress,* 6–9 December 2022, PP. 207–215. (Online): https://utak.azimder.org.tr
22. Perkins-Veazie, P. and Collins, J. K. 2006. Carotenoid Changes of Intact Watermelons after Storage. *J. Agric. Food Chem.,* **54**: 5868–5874.
23. Proietti, S., Rouphael, Y., Colla G., Cardarelli, M., De Agazio, M., Zacchini, M., Rea, E., Moscatello, S. and Battistelli, A. 2008. Fruit Quality of Mini-Watermelon as Affected by Grafting and Irrigation Regimes. *J. Sci. Food Agric.,* **88:** 1107–1114.
24. Radulovic, M., Ban, D., Sladonja, B. and Lusetic-Bursic, V. 2007. Changes of Quality Parameters in Watermelon during Storage. *Acta Hortic.,* **731**: 451–456.
25. Suárez-Hernández, Á. M., Grimaldo-Juárez, O., García López, A. M., González-Mendoza, D. and Huitrón Ramírez, M. V. 2016. Influence of Rootstock on Postharvest Watermelon Quality. *Rev. Chapingo Ser. Hortic.,* **23(1):** 49–58.
26. Yetisir, H. and Sari, N. 2003: Effect of Different Rootstock on Plant Growth, Yield and Quality of Watermelon. *Aust. J. Exp. Agric.,* **43:** 1269-1274.
27. Yetişir, H., Sari, N. and Yücel, S. 2003. Rootstock Resistance to Fusarium Wilt and Effect on Watermelon Fruit Yield and Quality. *Phytoparsitica*, **31(2):** 163–169.
28. Zaaroor-Presman, M., Alkalai-Tuvia, S., Chalupowicz, D., Beniches, M., Gamliel, A. and Fallik, E. 2020. Watermelon Rootstock/Scion Relationships and the Effects of Fruit-Thinning and Stem-Pruning on Yield and Postharvest Fruit Quality. *Agriculture,* **10(366):** 1–8.
29. Zoran, I.S., Lidija, M., Ljubomir, S. and Fallik, E. 2022. Shading Net and Grafting Reduce Losses by Environmental Stresses during Vegetables Production and Storage. *Biol. Life Sci. Forum,* **2:** 1–12.

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تغییرات کیفیت میوه پس از برداشت در هندوانه رقم 'Crimson Tide' پیوندی و پیوند نشده

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چکیده

در این پژوهش، تغییرات کیفیت میوه پس از برداشت هندوانه رقم 'Crimson Tide' پیوند شده به Nun9075 و غیر پیوندی مورد بررسی قرار گرفت. هندوانه در مؤسسه تحقیقات باغبانی آلاتا (Alata) ، در اردملی، مرسین، ترکیه کشت شد و در دمای ۴ درجه سانتی گراد و رطوبت نسبی ۹۰-۹۵ % به مدت ۵ هفته نگهداری شد. کل محتویات مواد جامد محلول (total soluble solid) و قابل تیتراسیون، کاهش وزن، پوسیدگی قارچی، اختلالات فیزیولوژیکی، ویتامین C، فعالیت آنتی اکسیدانی، ماده فنلی کل و قندها مورد ارزیابی قرار گرفت. تجزیه و تحلیل کیفیت در فواصل هفتگی در طول دوره انبارداری تعیین شد.نتایج نشان داد که کاهش وزن میوه های پیوندی و شاهد در طول نگهداری بسیار کم (۱%) بود. اختلالات قارچی و فیزیولوژیکی در میوه های هندوانه پیوندی یا شاهد در زمان نگهداری در انبار مشاهده نشد. محتویات مواد جامد محلول، ویتامین C، فعالیت آنتی اکسیدانی و محتوای کل ماده فنلی در رقم Crimson Tide پیوند شده به Nun9075 بیشتر از میوه‌های شاهد بود.

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