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EFFECT OF POSTHARVEST UV-C TREATMENTS ON QUALITY ATTRIBUTES OF FRESH FIG

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Abstract

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The objective of this study was to determine effects of postharvest UV-C treatment on fresh figs. Figs were subjected to UV-C irradiation at doses 0, 5, 10 and 20 min irradiation at 50 cm distance. Treated fruits were stored at 0-1^{0}C and 90-95 % relative humidity for four weeks. During the storage period weight loss, soluble solid content, titratable acidity, total sugar, cracking rate, decay rate and visual quality were determined at 7 days intervals. During storage period, total sugar and titratable acidity decreased while weight loss, total soluble solid content and cracking rate increased. Decay in control fruits increased faster than in UV-C treated fruits. The experiment results showed that the most effective treatment for maintaining fruit quality was UV-C 20 treatment. At the end of the cold storage all the fruits were in unmarketable stage except for UV-C 20 treated fruits.

Key words: Fresh fig, storage, UV-C, fruit quality

Introduction

Turkey is the leading country in the world fig production and trade. According to FAO statistics world fig production is 1184884 tonnes (t) and Turkey fig production is 244 351 t which is 20% of the world's total production (Anonymous, 2010). Black figs are mainly grown in the South Marmara region of Turkey and most are exported to European Union countries.

Fresh figs are fully ripened on the tree for the best flavor. Unfortunately, fully ripened figs are very delicate and difficult to store for long time. This is mainly due to their fast ripening, which accelerates (Celikel and Karacalı, 1998; Venditti et al., 2005), and high susceptibility to decay (Plaza, 2003; Venditti et al., 2005), as a function of an easily damaged epidermis and high sugar content (Kaynak et al., 1998). Decay reduction is a more difficult task (Venditti et al., 2005), due in part to the lack of registered postharvest product for fresh figs.

The most sensitive part of figs to fungal decay is the ostiole, a natural opening of the fruit. Any water-based treatment after harvest may leave free water in the ostiole, and this may induce germination of pathogen spores, mostly from contamination in the preharvest stage and subsequently cause significant losses during shelf-life (Karabulut et al., 2009).

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The expected storage life of fresh figs depends on the fig variety. One of the best fig cultivars for fresh consumption is 'Bursa Siyahi' of Turkish origin, characterized by large dark-colored firm fruit, high sugar content, and long postharvest life (Flaishman et al., 2008). Optimal storage conditions for fresh figs are temperatures around -1 to 0^0C with a relative humidity (RH) of 90-95 % (Bremer, 2008). At room temperature of 20 ^{0}C and 60% RH the fruit could be kept for 1-2 days (Mercantialia, 1989). It was reported that postharvest life of figs is limited to only 1-3 week at 0^0C (Mercantialia, 1989; Snowdon, 1990).

Still, its commercial use is not practiced primarily due to technological gaps at the packinghouse level and to the inconstancy of its efficacy (D'hallewin et al., 2005). However, there is a clear need for alternative methods to maintain quality and postharvest disease control.

In recent years, studies focused on cold sterilization methods and have been used industrially as an alternative to thermal processing (Turhan et al., 2006). Treating fresh fruits and vegetables with Ultra Violet (UV) radiation is a new approach that holds promise for the extension of storage life of fresh horticultural crops (Arul, 1994: Ben-Yehoshua, 2003). In the fruits exposed to low doses of UV, a number of changes are induced including the production of anti-fungal compounds and delays in ripening (Shama and Alderson, 2005).

The objective of this study was to determine effects of UV-C treatments in differrent doses on postharvest quality attributes of fresh figs.

Materials and Methods

Experiments were performed on black figs (*Ficus carica* L. cv. Bursa Siyahi). Harvested fruit were selected for uniformity of size, color, ripening and absence of defects. Selected figs were irradiated using three germicidal, low-pressure vapor lamps (Osram HNS OFR). Each lamp (2.5 cm tube diameter; 88 cm length) had a nominal power output of 30 W and a peak wavelength emission of 253.7 nm. The lamps were assembled 50 cm apart and the UV-C field area under the lamps was 60x100 cm (Nigro et al. 1998). UV-C treatments onto figs were performed for 5 min (UV-C 5), 10 min (UV-C 10) and 20 min (UV-C 20) at 50 cm. Untreated fruits were used as control.

After treatments, figs were placed in wooden boxes (40cm×60cm×10 cm) and were stored at 0-1^0C and 90-95% of RH for 28 days.

Postharvest fruit quality was assessed at 7-day intervals during the storage period. Analyses and measurements such as weight loss (%), total soluble solids (%) (TSS), titratable acidity (as citric acid, TA) (%), total sugar (%) (Rose, 1959), cracking rate (%), decay rate (%), visual quality (9 = excellent, 7 = very good, 5 = good (limit of marketable), 3 = fair (limit of usability), 1 = very poor) were done.

The data for the experiment was analyzed as completely randomized blocks design with three replicates. LSD (p test < 0.05) analyzed data using ANOVA with mean separation.

Results

Weigth loss

In the study, depending upon the treatments weight loss of figs increased as storage time extended (Figure 1). The highest weight loss was detected in UV-C 5 (5.5%) treatment followed by control group (5.2%) in 7th day. After 28 days of storage period, the lowest weight loss was obtained 16.1% from UV-C 20 treatment and the highest weight loss was obtained 17.8% from UV-C 5 treatment.

Total soluble solids

Although fluctuations occurred in TSS content in the form of increases and decreases in 7th day, increases occurred in all treatments at the end of the storage (Figure 2). At the beginning of storage, TSS of figs was 18.2%. At 28th day of storage period, the highest TSS content of figs was detected in UV-C 5 treatment (20.8%), the lowest TSS content was detected in UV-C 20 treatment (20.1%).

Titratable acidity

Changes in the titratable acidity values of figs are given in Figure 3. In the study, initial acidity of figs was 0.19% and during storage, it was also reduced slightly, irrespective of different treatments. At the end of 28th day, the highest values of TA were determined in fruits treated with UV-C 10 (0.17%) and UV-C 20 (0.17%), the lowest TA content was determined in UV-C 5 (0.15%) treatment.

Total sugar

Results on the average content of total sugars of fig fruits are given in Figure 4. Total sugar content at harvest was 18.6 % and slowly decreased toward the end of storage period. At the end of storage, the minimum total sugar loss occurred in fruits treated with UV-C 20 (16.7%) while the highest total sugar loss occurred in fruits treated with UV-C 5 (15%).

Cracking rate

In the study, on the 0th day (harvest time) and 7th day there was no cracking in figs (Figure 5). At the end of the storage, the highest cracking rate was recorded in control group (32.4%) while the lowest cracking rate was recorded in fruits treated with UV-C 20 (20.4%).

Decay rate

No decay development was observed in all treatments including control fruits during the first 14 days of storage (Figure 6). The most effective

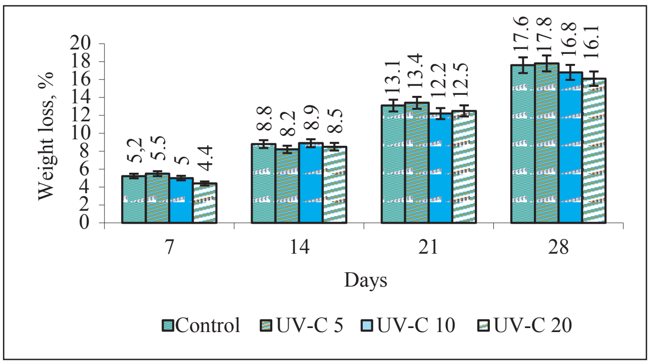

Fig. 1. The effect of various doses of UV-C on weight loss of fig.
(treatments x duration interaction LSD 0.05= NS)
NS : Non significant

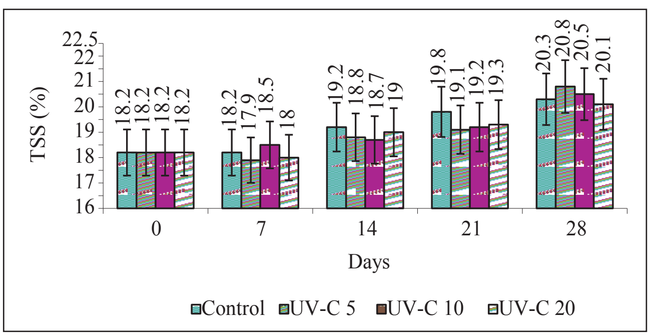

Fig. 2. The effect of various doses of UV-C on total soluble solids of fig.
(treatments x duration interaction LSD 0.05= NS)

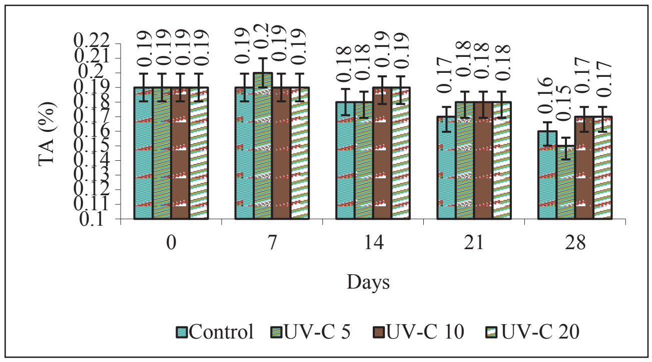

Fig. 3. The effect of various doses of UV-C on titratable acidity of fig.
(treatments x duration interaction LSD 0.05= NS)

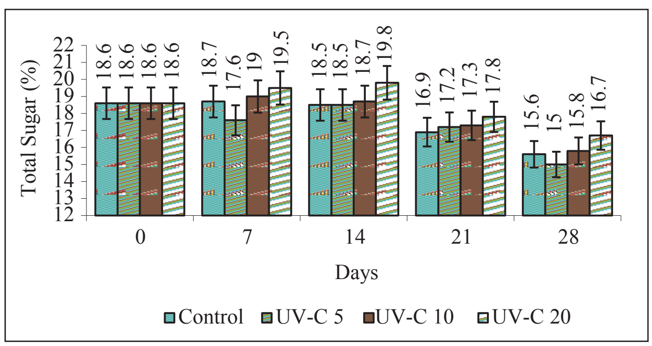

Fig. 4. The effect of various doses of UV-C on total sugar of fig.
(treatments x duration interaction LSD 0.05= NS)

treatment controlling decay was irradiation of figs with UV-C 20. Percentage of decay was 10.8% after 28 days storage in this treatment. The maximum decay rate occurred in control fruits (25.5%) followed by the fruit treated with UV-C 5 (19.4%).

Visual quality

The visual quality ratings for each treatment are given in Figure 7. In present study, it was found that as the storage time proceeded the visual quality loss percentage was also increased and the maximum visual quality loss was recorded after 21 days. At the end of the storage, the highest visual quality was recorded in UV-C 20 treatment (5.6%) and the lowest visual quality was recorded in control group (3.5%) followed by the fruit treated with UV-C 5 (3.6%).

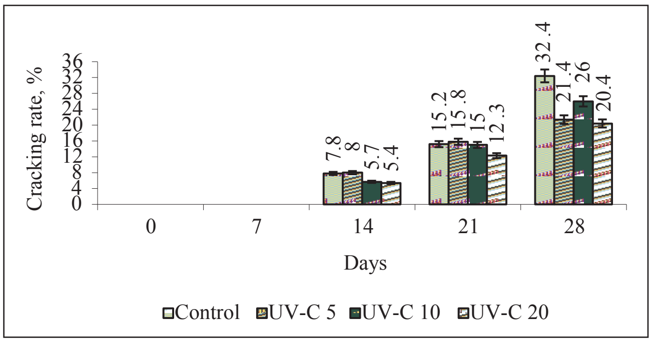

Fig. 5. The effect of various doses of UV-C on cracking rate of fig. (treatments x duration interaction LSD 0.05= NS)

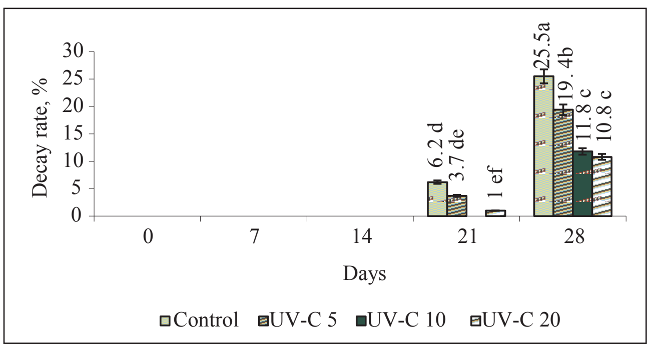

Fig. 6. The effect of various doses of UV-C on decay rate of fig. (treatments x duration interaction LSD 0.05=3.66)

Discussion

Postharvest water loss can cause rapid deterioration and reduction in marketable quality of fresh figs. In the present study, the rapid increase in weight loss in figs can be explained by the structure of thin skin of the fruits. Similar weight losses occurred in other fig studies (Celikel and Karacali, 1998; Koyuncu et al., 2005). However, UV-C 20 and UV-C 10 treatments were considered as successful in reducing weight losses compared to control group. Previous works on plum and tomato showed that weight loss can be delayed by UV-C light (Bal and Celik, 2008; Maharaj et al., 1999).

When the results of TSS in figs were considered, increases were determined along the storage. Smilarly, in some studies on figs as storage time extended, TSS content increased (Celikel et al., 1996; Bernalte et al., 2003). The increase in TSS may be related to the moisture loss and hydrolysis of polysaccharides. UV radiation checks the moisture loss, thereby, increasing TSS retardation (Lu et al., 1993).

The acidity of the fruit is an important character to determine its quality and acceptability. The results of this study show that TA tended to decrease during storage in all applications and UV-C treatments have little effects on TA content in figs.

Generally, sugars are one of the biochemical components of fruits and amount of sugars di-

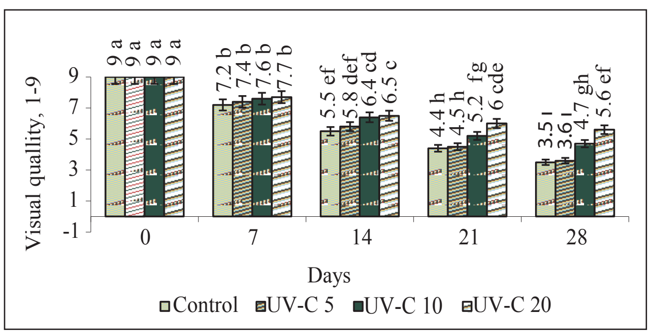

Fig. 7. The effect of various doses of UV-C on visual quality of fig. (treatments x duration interaction LSD 0.05=0.67)

rectly effect the taste of fruit. In present study, the minimum total sugar loss occurred in fruits treated with UV-C 20. The higher content of total sugar in UV-C 20 treated fruits could be due to reduction in respiration rate, thereby decreasing internal oxygen concentration and increasing carbon dioxide level, leading to higher retention of total sugar in fruits. It is known that the rate of respiration and ethylene production reduces after UV-C treatment (Maharaj et al., 1999; Vicente et al., 2004).

Fruit keeping quality is characterized by the rate of changes of quality parameters during storage, for example skin cracking (Flaishman et al., 2008). The thin and firm rubbery texture of the skin of 'Bursa Siyahi' fig is important for transport and storage. The skin has a waxy appearance and almost no cracks or checking (Celikel and Karacali, 1998). In this study, UV-C treatments gave a better effect on cracking rate compared to control. Cracking rate of control fruits rapidly increased in 28th day. It was found that cracking rate was parallel with decay rate.

Fresh figs are very perishable, delicate and highly susceptible to postharvest decay and infection (Venditti et al., 2005). Ostiole splitting is more susceptible to decay (Karabulut et al., 2009). In the study, first decays were usually seen on ostiole splitting and all of UV-C doses reduced decay in figs during storage. Our work corroborates several studies that have shown that UV-C treatments can control postharvest diseases of fresh fruits and vegetables (Nigro et al., 1998; Ben-Yehoshua, 2003). The lowest decay rate in our research was obtained from UV-C 20 treatment while the highest decay rate was obtained from control group. Smilarly, D'hallewin et al. (2005) reported that the incidence of decay on fig fruit was significantly reduced by UV illumination

Visual quality of figs has a direct effect on the percentage of consumer acceptance. In the study, symptoms of visual quality decline included shriveling, surface mold and decreasing in flesh lightness. At the end of the storage, application of UV-C 20 was more effective in preventing of visual quality loss compared to other treatments. UV-C 20 treated fruits maintained acceptable visual quality during 28 days of storage, but in other treatments visual quality was not maintained at convenient level.

Conclusions

The results suggest that postharvest life of fresh 'Bursa Siyahı' figs pottentially can be extended by UV-C treatments. No UV damage was observed on treated fruits after storage. One of the most important effects of UV-C treatment on figs was the reduction in mold growth. Especially UV-C 20 doses are more effective in preventing decay in figs. Fruit treatment of figs with UV-C 20 helped maintaining fruit quality while prolonging storage life by seven days.

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