Combined Hot Water And Uv-C Treatments Reduces Postharvest Decay And Maintains Quality Of Eggplants

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Abstract

Hot water and Ultraviolet-C light (254 nm) are proposed as alternative physical techniques for the use of chemicals to reduce fungal decays of eggplants during storage. In order to investigate the effects of combined hot water and UV-C treatments, fruits were dipped into hot water at 40°C for 3 minutes duration and exposed to UV-C dose at 3.6 kJm-2. Combination treatments were performed in two different ways. Fruits were divided into two groups. First group was dipped into hot water followed by UV-C treatment and second group was exposed to UV-C followed by hot water treatment. After treatments, eggplants were stored at 10°C temperature with 90-95% relative humidity for 20 days. Untreated fruits were used as control. Both combination treatments tested, reduced the percentage of decay. But UV-C followed by hot water treatment was found to be more effective in controlling decay. During storage period, the lowest weight loss was 0.68% at hot water followed by UV-C treated fruit. Titratable acidity content was higher in treated fruits than untreated controls. There was no significant interaction between TSS% and combination treatments observed.

INTRODUCTION

The eggplant, is a cultivated herb of nightshade family (Solanaceae). Its fruit is a non-climacteric, large berry and is an important market vegetable, especially in Asia and the Mediterranean countries (Nothmann, 1986). Accelerated senescence of calyx during storage and shelf life is a major factor in decay development (McColloch et al., 1982) Until now, pesticides have been largely used to control decays on postharvest commodities (Eckert, 1991). Neverthless, the increased demand for pesticide-free commodities and restrictions on the use of chemical treatments have revived interest in the use of non-chemical procedures such as heat treatment and Ultraviolet-C irradiation (Lurie, 1998; Rodov et al., 1994). Recent studies showed that the use of a low dose(s) of UV-C light (254 nm) resulted in the reduction of storage rots of many vegetables (Lu et al., 1987; Mercier et al., 2001, Erkan et al., 2001). Heat treatment with water dips was shown to be efficient for controlling postharvest diseases and insect pests in vegetables (Fallik et al., 1996). The aim of this study was to determine the effect of hot water and UV-C treatments applied in combination for controlling postharvest decay and maintains quality of eggplants.

MATERIALS AND METHODS

Eggplants 'Faselis F1' were harvested between December and April during two harvest seasons (2001-2002) from a commercial greenhouse in Antalya, Turkey. Fruit was delivered to the Postharvest Physiology Laboratory of Agricultural Faculty of Akdeniz University on the day of harvest and divided into two treatment groups. In order to investigate the effects of combined hot water and UV-C treatments, fruits were dipped into hot water at 40°C for 3 minutes duration and exposed to UV-C dose at 3.6 kJm-2. Combination treatments were performed in two different ways. First group was dipped into hot water followed by UV-C treatment and second group was exposed to UV-C followed by hot water treatment. After treatments, eggplants were stored at 10°C temperature with 90-95% relative humidity for 20 days. Untreated fruits were used as control. Each treatment was replicated at least three times.

UV-C treatment was performed in a small (60x150x45 cm) irradiaton chamber with ten lamps (Philips, model G15T8, 15 W). The peak wavelength emitted by each lamp was 254 nm. The processing line beneath the UV-C lamps consisted of rollers (50 cm in width) that rotate the fruit. The speed of the rollers was adjusted by changing the speed of the motor that propelled it. The height of UV-C lamps and the processing line can be changed manually as needed. With the conveyor speed at 0.42 m.min-1 and height with the 24 cm above the processing line UV lamps delivered 3.6 kJm-2 (with 2 lamps). The UV-C fluency was measured with a UVX radiometer (UV products Inc., San Gabriel, CA).

During the storage period, various chemical and physical analyses were performed and fungal decay was determined by taking samples at certain intervals. The fruit were evaluated for weight loss, titratable acidity (TA) and total soluble solids content (TSS). Furthermore, the effects of both combination treatments on fungal decays were investigated. Each fruit (Four plastic boxes for each treatment, 30 fruits per box) was numbered and weighed after UV-C irradiation. Fruit with no signs of decay was weighed again on 8th, 14 th and 20 th days of storage. The result was expressed as percentage of weight loss. Treated and non-treated fruits were examined at same intervals for postharvest diseases. Fruit showing any sign of infection were removed from their box to avoid spread of infection to adjacent fruit. Decay incidence was expressed as the percentage of infected fruit. Titratable acidity (TA) and total soluble solids (TSS) content was determined on juice extracted from three replicates of ten fruit from each treatment. Acidity was determined by titrating 2 ml of juice to pH 8.1 with 0.1 N NaOH. Acidity was expressed as percentage citric acid. Percentage total soluble solid content was determined with hand refractometer.

The trials were arranged in a completely randomized factorial design (storage time x treatments) and analysis of variance was performed with the General Linear Model procedure of Statistical Analysis Systems (SAS Institute, 1987). The mean values compared using Least Significant Difference test (LSD) at p=0.05 (Nigro et al., 1998).

RESULTS

Weight Loss

Depending upon the combination treatments weight loss of eggplants increased progressively with extended storage (Table 1). At the end of different storage periods statistically significant ($p \leq 0.05$) differences in weight losses were found. After 20 days of storage period, the lowest weight loss was obtained 1.06% from hot water followed by UV-C treatment. During storage period, the lowest weight loss was 0.68% at hot water followed by UV-C treated fruit (Table 1).

Titratable Acidity (TA)

At the beginning of storage titratable acidity of eggplants was 0.21%. TA decreased slightly with extended storage in all treatments. The highest values of TA detected in fruit treated with UV-C followed by hot water during storage period were 0.16%. Titratable acidity content was higher in treated fruits than untreated controls (Table 2).

Total Soluble Solids (TSS)

At the beginning of storage TSS of eggplants was 5.53%. There was no significant interaction between TSS% and combination treatments observed. Over 20 days storage period, TSS% loss was lower at hot water followed by UV-C treated fruit than other treatments (Table 3).

Decay

During storage depending upon combination treatments, decay increased progressively with extended storage (Table 4). At the end of different storage periods statistically significant ($p \leq 0.05$) differences in percent decay were found. The percentage incidence of decay was less than 5% during the first 8 days of storage and reached about 20% during the next 20 days. Both combination treatments reduced significantly ($p \leq 0.05$) fungal decay of eggplants. Control fruit had 28.38% decay after 20 days of storage whereas the hot water followed by UV-C had 22.05% and UV-C followed by hot water treated eggplants had 16.13%. During storage period the lowest decay incidence 9.59% was found at fruit treated with UV-C followed by hot water (Table 4).

DISCUSSION

In this study, we report that untreated eggplants had higher weight loss than combined hot water and UV-C treatments after 20 days (Table 1). A slower weight loss rate is desirable from an economical point of view. Wu (1995) showed that UV-C treated sweet potato storage roots had smaller weight loss compared with the control. Our study indicate that it is feasible to treat eggplants online during processing with UV-C light for controlling postharvest decay. These results confirmed those of other workers (Wilson et al., 1997). Both combination treatments reduced significantly ($p \leq 0.05$) fungal decay of eggplants (Table 4). The most effective combination treatment in controlling decay was found to be UV-C followed by hot water. During storage period decay incidence 9.59% was found at fruit treated with UV-C followed by hot water (Table 4). Recently Liu et al. (1993) reported that the application of low dose of 3.6 kJm-2 UV-C light on tomato fruits, controlled storage rot and extended the shelf life. There are at least two explanations for effects of UV-C low dose(s) on storage rot control in fruits and vegetables: (1) germicidal effect and (2) induced resistance of the host against pathogens (Stevens et al., 1996). The reduction in decay in the irradiated commodities might be related to the increase in decay-resistance of tissues due to the accumulation of antifungal compounds. Additional work is therefore needed possibly to identify other UV-induced antifungal compounds, but also to elucidate the nature of the signal that may be transmitted within the fruit. The use of hot water dips at 39-52ºC for 2-10 min. has been reported to control in-vitro and in-vivo spore germination of postharvest fungi and decay development in broccoli (Forney, 1995), melon (Teitel et al., 1991) and sweet red pepper (Fallik et al., 1996). Nonetheless, UV-C irradiation with the combination of hot water dip treatments is a promising innovative approach as a potential alternative to chemical control of postharvest diseases of fruits and vegetables.

CONCLUSION

In conclusion, the research indicates that the greenhouse-grown 'Faselis F1' eggplants in Antalya region of Turkey can be stored succesfully for a longer time at 10ºC and 90-95% RH if they are exposed to combined hot water and UV-C treatments before storage. The most effective treatment in controlling decay was found to be UV-C (3.6 kJm-2) followed by hot water (40°C for 3 minutes) in our results. It was determined that under these conditions this eggplant cultivar can be stored for longer than 20 days without losing much of its quality.

Nonetheless, UV-C irradiation with the combination of hot water dip treatments is a promising innovative approach as a potential alternative to chemical control of postharvest diseases of fruits and vegetables.

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Tables

Table 1. Effects of different combined hot water (40°C+3 min.) and UV-C (3.6 kJ.m-2) treatments and storage times on weight loss (%) of eggplants

Combination Treatments	Storage Time (days)			Mean of Physical Treatments
	8	14	20	
Control	0.44 a	0.69 a	1.12 a	0.75 cz
Hot water followed by UV-C	0.38 b	0.59 b	1.06 b	0.68 b
UV-C followed by hot water	0.41 ba	0.65 ba	1.11 ba	0.72 a
Mean of Storage Time	0.41 c	0.64 b	1.09 a	

z Values marked with the same letter are not statistically different ($p \leq 0.05$).

Table 2. Effects of different combined hot water (40°C+3 min.) and UV-C (3.6 kJ.m-2) treatments and storage times on titratable acidity (%) (citric acid) of eggplants

Combination Treatments	Storage Time (days)				Mean of Physical Treatments
	0	8	14	20	
Control	0.21	0.15 c	0.13 b	0.12	0.15 cz
Hot water followed by UV-C	0.21	0.17 b	0.14 b	0.13	0.16 b
UV-C followed by hot water	0.21	0.18 a	0.16 a	0.12	0.17 a
Mean of Storage Time	0.21	0.17 b	0.14 c	0.12 d	

z Values marked with the same letter are not statistically different ($p \leq 0.05$).

Table 3. Effects of different combined hot water (40°C+3 min.) and UV-C (3.6 kJ.m-2) treatments and storage times on total soluble solids content (%) of eggplants

Combination Treatments	Storage Time (days)				Mean of Physical Treatments
	0	8	14	20	
Control	6.31	5.71	5.56 a	5.40 a	5.74 az
Hot water followed by UV-C	6.31	5.68	5.29 b	5.22 b	5.62 b
UV-C followed by hot water	6.31	5.57	5.37 b	5.25 b	5.62 b
Mean of Storage Time	6.31 a	5.65 b	5.41 c	5.29 d	

z Values marked with the same letter are not statistically different ($p \leq 0.05$).

Table 4. Effects of different combined hot water (40°C+3 min.) and UV-C (3.6 kJ.m-2) treatments and storage times on decay incidence (%) of eggplants

Combination Treatments	Storage Time (days)			Mean of Physical Treatments
	8	14	20	
Control	7.77	19.26 a	28.38 a	18.47 az
Hot water followed by UV-C	3.33	14.49 ba	22.05 ba	13.29 b
UV-C followed by hot water	3.44	9.20 b	16.13 b	9.59 c
Mean of Storage Time	4.84 c	14.31 b	22.19 a	

z Values marked with the same letter are not statistically different ($p \leq 0.05$).

Effet Combiné de Traitements à l'Eau Chaude et aux UV-C pour Réduire les Pourritures et Préserver la Qualité des Aubergines.

Mots-clés *: Solanum melongena, traitements physiques, maladies fongiques, qualité des fruits*

Résumé

Une immersion dans l'eau chaude à 40°C et l'application d'un rayonnement Ultraviolet-C (254 nm) ont été testés comme traitements physiques en alternative à l'utilisation des produits phytosanitaires pour réduire les pourritures des aubergines pendant le stockage. Afin évaluer les effets combinés de l'eau chaude et des traitements aux UV-C, les fruits ont été immergés pendant 3 minutes dans de l'eau chaude à 40°C et exposés à une dose d'UV-C de 3.6 kJm-2. Les traitements combinés ont comporté deux modalités : un premier groupe de fruits a été soumis au bain d'eau chaude suivi du traitement aux UV-C, et le second groupe a été d'abord traité aux UV-C avant immersion. Après le traitement, les aubergines ont été stockées pendant 20 jours à la température de 10°C, sous 90-95% d'humidité relative, des fruits non traités constituant le témoin. Les deux traitements combinés ont réduit l'incidence des pourritures, mais le traitement aux UV-C suivi de l'immersion dans l'eau chaude s'est montré le plus efficace. Pendant le stockage, la plus faible perte de poids enregistrée (0.68%) a été observée pour les fruits immergés dans l'eau chaude puis traités aux UV-C. L'acidité titrable s'est avérée supérieure chez les fruits traités par rapport aux fruits témoins. Aucune relation significative n'a été enregistrée entre le taux de matière sèche soluble des fruits (%) et les traitements physiques réalisés.