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Periodic Research

Hot Water Treatment of Fruit Apple CV. Red Delicious to Reduce Penicillium expansum Decay

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Abstract

Apple fruit cv. Red delicious is cultivated extensively in the North Indian states of Himachel Pradesh and Jammu and Kashmir. This variety has comparatively long shelf period after harvest and is therefore, transported to far–flung areas for marketing. However, being succulent and rich in nutrients, the fruits are easily susceptible to attack by a variety of microorganisms during the various phase of marketing .Loss of this apple variety due to fungal infection varied between 25 to 35 percent (1).Among the various post- harvest mycopathogens of apple fruits, *Penicillium expansum* link ex. Fries is a major one that can cause infection even below 0^{o}C.This notorious pathogens produces abundant spores on the infected site, which get easily carried to other susceptible variety of apple in storage and market through improper handling procedure and even by fruit fly *Drosophila melangaster* (2). In addition, *P.expansum* also produces two major toxins-patulin and citrinin in the diseased fruits tissue, which may spread into the surrounding healthy tissue (3) and are even known to exhibit mutagenic, neurotoxic, nephrotoxic and immunosuppressive effect (4).

Keywords: Apple, Post-Harvest, Hot Water, Management, *Penicillium expansum.*

Introduction

Therefore, protection of the harvested fruits so that they reach the consumer in a healthy condition is of utmost importance. A variety of fungicidal treatment have been developed for controlling market diseases of fruits (5,6) but their use on fruit is not recommended as they pose a threat to food safety (7). Since post-harvest fungicides are applied close to the time when fruits are consumed, they present special pesticides residue problems. National Research Council (8) reported that children are more at risk from pesticides residue on fruits than adults as children consume a larger proportion of these treated commodities and their tissues are more susceptible to the carcinogenic capability of some of these pesticides.

Hot water treatment at a temperature slightly higher than the thermal death point of the suspected pathogen has been used with success in eradicating or suppressing the development of fungi on the fruit surface as well as those situated just below the surface as a result of pre-harvest infection. Hot water treatment to eliminate fungal infection is a cheap and convenient method and does not involve a residue problem. (9-11). During the past decade, many investigators have advocated suitability of hot water treatment in controlling post harvest fruit rot pathogens.

Materials and Methods

P.expansum was isolated from rotten apples on sterilized PDA petriplates and incubated at 28±20C, until proper growth of the pathogen was prepared by flooding 5days old culture grown on PDA slant with 10ml. of sterile distilled water containing 0.1% Tween 20. Counted the spores with a haemocytometer and adjusted with sterile distilled water to obtain 105spores per milliliter.

Sound and healthy fruits were weighed, surface sterilized with 70% ethyl alcohol, wounded (4mm x 10mm deep) and then inoculated with 50µl of spore suspension (105 spore ml-) of P.expansum. After inoculation, the fruits were held for 12hrs at 28±2oC and then given hot water treatment in a thermostatic water bath at 48, 52 and 54oc for 2, 5 and 10 minutes. Fruit dipped in water at room temperature for the same time period served as control. Treated fruits were then stored in sterilized polyethylene bags at 28±2oC for 15 days and thereafter, percent rot and percent control were calculated by the following formulae;

$$\text{Percent rot} = \frac{(W - w)X100}{w}$$

Where W = weight of the fruit before inoculation

w = weight of the fruit after removal of the rotten tissue.

$$\text{Percent control} = \frac{\text{Percent decay in untreate} - \text{Percent decay in treated}}{\text{Percent decay in untreated}} X\ 100$$

Data obtained at each stage were analyzed statistically. Decay data were transformed with arc-sine transformation before analysis, but are reported as percentage values for presentation in table (12). Treatment mean comparisons were made with Duncan's multiple range test (13). Standard error (S.E) and critical difference (CD) was determined by using the formula suggested by Burton (14).

Results and Discussion

During market survey, maximum loss of apple cv. Red Delicious was observed due to P.expansum infection both at cold storage temperatures and in the warm environment of the fruit shops (15). In view of this, investigation was conducted to examine the effect of hot water treatment in reducing the decay development caused by P.expansum in harvested apples cv. Red Delicious.

An appraisal of the data given in Table 1 indicates that hot water treatment at 480C for 5 minutes and at 520C and 540C for 2 minutes had statistically an equal and good effect in controlling P.expansum rot of apples. The effect of heating on the decay of apples caused by P.expansum may not only be the result of direct inhibition of fungal germination and growth by high temperature, but may also partly due to the formation of an inhibitory substance in the heated peel (15) or due to activation of two major proteins which may induce resistance in fruits(16) or due to the melting of wax layer which fills the small cracks, as suggested by Roy et al.(17) for heated Golden Delicious apples . In this present investigation, no change in colour and texture of the fruits was recorded when they were subjected to hot water treatment for 2 and 5 minutes duration.

Dip treatment for 10 minutes at 54^0C demonstrated cent percent control of P. expansum but simultaneously symptoms of heat injury development on the test fruits. The response of apples to heat treatments may vary according to cultivar variety .Kin et al. (18) have shown that cultivar Golden Delicious and Delicious posses strong tolerance heat. However, present investigation recommends moderate exposure of 2 minutes at 520C or 5 minutes at 480C for effective treatment of P.expansum rot of cv. Red Delicious .In recent years, several other workers including Williams et al. (19); Porat et.al., (10); Prakash and Pandey (20); Inkha et al,(21), Inkha & Boonyakiat (22); Karabulut et al.(23) ,Lee et al.(24) and Jabar et al.(25) have also used heat treatment with success in reducing post- harvest decay of other fruits. This treatment has been found most suitable for the control of such disease where there is a wide gap in the thermal death point of the pathogen and its host and where the temperature of the water does not spoil the appearance of produce. However, such a dip may also remove part of the natural antagonistic flora inhabiting the fruit peel which may act as biocontrol agent of post harvest pathogen (Droby et al.26) or may even inhibit the ripening of some fruits and alleviate storage disorder (27,28).

Heat presumable kills the pathogen by denaturation of its enzymes and other proteins and the results depend both on the temperature and the time of expose. An outstanding advantage of this treatment is the complete destruction or great reduction in the population of pathogens even after they have entered the host. In recently, Kou,et.al (29) reported that hot water treatment is better than other treatments as it results significantly higher oxygen retention and lower carbon dioxide accumulation in package headspaces, maintained firmer texture, higher overall visual quality, lower decay rate and lower microbial population than other treatment during the entire storage period. Therefore, most of the incipient and surface infections can be eliminated through environmentally safe and acceptable treatment.

Hot water treatment is generally best used as a component of an integrated control system, where it is employed in combination with other treatments, such as conventional chemical fungicides (30), ethanol (31), biological control (32,33), or modified atmospheres (33). In contrast, no benefits were reported by the addition to hot water of different soluble food additives or GRAS (generally regarded as safe) compounds to control fruit rots (34). Despite their good activity against Penicillium expansum and other fruit post – harvest pathogens, shortcomings of hot water treatments applied alone are the risk of injury to the fruit, especially in high-volume commercial applications where absolute control of treatment conditions is challenging. Our results indicate that short duration hot water treatments are a promising technological tool that improves their feasibility as part of integrated non-pesticidal alternative treatments for the control of P. expansum rot of fruits. Furthermore, they could be an effective approach to manage postharvest decay for the organic fruit industry.

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Table 1
Effect of hot water dip treatment on the incidence of *Penicillium expansum* rot of apple cv. Red Delicious.

Duration of dip treatment (min.)	Hot water temperature						Remarks
	48^0c		52^0c		54^0c		
	PR	PC	PR	PC	PR	PC	
10	6.3	87.1^b(68.9)*	3.3	93.3^c(75.0)	0.0	100.0^d(90.0)	Colour of the fruits changed to brown and the tissue became soft at all the three temperature
05	2.4	95.1^b(77.0)	6.7	86.3^b(75.0)	10.6	78.3^b(62.2)	No change observed
02	9.0	81.6^b(64.6)	2.9	94.1^c(75.9)	3.2	93.5^c(75.2)	No change observed
Control	48.9	0.0^a(0.0)	48.9	0.0^a(0.0)	48.9	0.0^a(0.0)	No change observed
S.E	1.2		0.2		0.4		
CD at 0.05%	5.4		0.9		1.8		

PR = Percent rot; PC = Percent control; *Figure within the parenthesis is the arc sin transformed value.
Mean with the same superscript are not significantly different from each other at 0.05 level according to ANOVA and Duncan's new multiple range test.