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Reevaluation of Heated Water Dip as a Postharvest Treatment for Controlling Surface and Decay Fungi of Muskmelon Fruits[1]

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Abstract. **Fruits of muskmelon (*Cucumis melo* L.) dipped in water at 24° and at 57°C did not differ significantly in incidence of *Fusarium roseum* (LK) emend. Syn. & Hans. 'Semitectum' and *Diaporthe melonis* Beraha & O'Brien and stem scar and rind decay fungi. Immersion time of fruits, regardless of water or chemical treatment, had no significant effect on stem-scar decay, rind fungal growth, fusarium lesions, or general appearance. The value of hot water as a postharvest treatment of muskmelon fruits was to increase efficacy of fungicides.**

Heated water, alone or in combination with fungicides, has been experimentally tested both in Texas (3) and California (4, 5, 6) for use as a postharvest dip treatment to control surface, stem-scar and decay fungi of muskmelon (cantaloup) fruits. Johnson (2) showed that Cladosporium rot and unidentified fungal growth on fruits could be delayed by dipping the fruits 15 or 30 sec in 57°C water alone or in combination with sodium-o-phenylphenate (SOPP). Wells and Stewart (6) noted a significant reduction in stem-scar fungi on muskmelon fruits treated with 57° water. Also, the efficacy of the fungicide captan (N-[(trichloromethyl)thio]-4-cyclohexene-1,2-dicarboximide) in water was significantly greater at 57° than at 22° (5).

Because of these findings and the advantages of using water rather then chemical treatments, several packinghouses in the Rio Grande Valley of Texas currently apply hot water treatments to muskmelon fruits. Other findings, however, cast doubt on the value of hot water as a postharvest treatment. McDonald and Buford (3) found that hot water alone was ineffective in controlling rind fungi and did not improve the general appearance of fruits. In view of these differences, hot water and 2 chemicals approved by the Environmental Protection Agency (EPA) (1) were reevaluated as agents for controlling fungi causing postharvest decay of muskmelon fruits.

'Perlita' muskmelon fruits were obtained from a packinghouse prior to grading or treatment, then sized for uniformity and culled for visible fungal growth, decay and injury. All fruits were at the full-slip (complete abscission of the peduncle) maturity stage and had a firm texture. The fruits were then washed in running tap water to remove adhering soil. Fruits were used in experiments within 24 hr from harvest.

In a test to determine the effect of temperature treatment on the control of postharvest decays, fruits were individually dipped in water or in aqueous fungicide suspensions at either 24 or 57°C (±1°), for 0.5 min. The suspensions were maintained to within 1° during treatment, and pulp temperature of fruits before treatment was about 24°. Fungicides and concentrations used were 4000 mg active ingredient (a.i.) sodium dimethyldithiocarbamate (SDDC)/liter and 2500 mg a.i. SOPP/liter. To determine the effect of immersion time, fruits were dipped in water or a solution of SDDC at either 24 or 57° for 0.5, 1 or 3 min. Fruits were drained, air dried and stored in open cardboard boxes at 90% relative humidity (RH) and 5° for 5 days followed by 4 days at 26°. After storage, fruits were rated for surface fungal growth on stem-scars and rinds, general appearance and browning (discoloration) of vein tracks and rind. Fruits were then individually peeled with a knife to a depth of about 2 mm. Subepidermal lesions caused by *Fusarium roseum* 'Semitectum', *Diaporthe melonis* and miscellaneous fungi were identified by symptoms and counted.

Each treatment, applied to 4 fruits, was replicated 5 times, so the number of completely randomized fruits per treatment totaled 20.

Muskmelon fruits treated with SDDC at 57°C had significantly (≤5%) less fusarium and diaporthe lesions as well as unidentified fungal growth on stem-scar and rinds than fruits with any other treatment (Table 1). SDDC at 24° was no more effective than water at 24° in reducing fungal growth on rinds or the number of fusarium lesions. Fruits treated with SOPP at 57° had significantly less non-identified fungal growth and fusarium lesions than those treated with SOPP at 24°. No significant differences were found between the 2 water treatments except that the warmer one controlled stem-scar fungal growth more effectively.

The general appearance of fruits treated with SDDC 57° was significantly (P≤5%) better than that of fruits with any other treatment (Table 2). Although fruits from all treatments showed only a trace or less of vein track or rind browning, browning of fruits was significantly higher in the 57° SDDC and 57° SOPP treatments than in most other treatments.

Immersion time of the fruits, regardless of treatment, had no significant effect on fusarium lesions, stem-scar and rind fungus growth, or general appearance (Table 3). The severity of vein track or rind browning was significantly greater at 3 min than at 1 min for SDDC at 57°C. Browning was significantly greater at 3 min than at 0.5 min in the heated water treatments. As compared with fruits

Table 1. Fungus growth on stem-scars and rinds and number of fusarium and diaporthe lesions on muskmelon treated with hot water and fungicides after 5 days at 5° and 4 days at 26°C.

		Fungus growth index		No. lesions per fruit	
Treatment[z]	Temperature of suspension (°C)	Stem scars[y]	Rinds (%)[x]	Fusarium	Diaporthe
SDDC	57	2.2a[w]	5.0a	2.9a	0.9a
	24	2.9b	36.5c	20.4c	1.6b
SOPP	57	3.2b	17.8b	12.7b	2.3bc
	24	4.3c	54.1	29.7d	2.9c
Water	57	4.4c	55.9d	21.8c	3.0c
	24	4.9d	50.0cd	20.8c	2.5c

[z]Concentration of SDDC and SOPP = 4000 and 2500 mg a.i./liter, respectively.
[y]Fungus growth index, stem scars: 1 = none, 2 = trace to ¼ of the stem scar covered; 3 = ¼ to ½ covered; 4 = ½ to ¾ covered; and 5 = stem scar ¾ to completely overgrown by fungi.
[x]Fungus growth index, rinds: Estimated percentage of the rind covered by fungus growth. (Percentages transformed to degrees, percentage = $\sin^2\theta$ for analysis)
[w]Mean separation in columns by Duncan's multiple range test, 5% level.

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Table 2. General appearance and vein track and rind browning of muskmelon treated with hot water and fungicides after 5 days at 5° and 4 days at 26°C.

Treatment[z]	Temp of suspension (°C)	Relative index	
		Appearance[y]	Browning[x]
SDDC	57	1.8a[w]	1.9c
	24	3.4bc	1.0a
SOPP	57	3.1b	1.6bc
	27	4.1c	1.1a
Water	57	4.1c	1.4ab
	24	3.9c	1.0a

[z]Concentration of SDDC and SOPP = 4000 and 2500 mg a.i./liter, respectively.
[y]Relative general appearance index: 1 = excellent, no decay, no rind or stem scar fungus growth, ad no rind or vein track browning (detrimental factors); 2 = good, melons salable, trace of detrimental factors; 3 = fair, melons salable, moderate detrimental factors; 4 = poor, melons marginally salable, severe detrimental factors; 5 = nonsalable due to excessive detrimental factors.
[x]Relative browning index: 1 = none; 2 = trace; 3 = slight; 4 = moderate; and 5 = severe browning of vein tracks and rind.
[w]Mean separation in columns by Duncan's multiple range test, 5% level.

Table 3. The effect of immersion time on general appearance, fungus growth, browning, and the number of Fusarium lesions on muskmelon treated with hot water and a fungicide after 5 days at 5° and 4 days at 26°C.

Suspension	Temp (°C)	Immersion time (min)	Fungus growth index		No. fusarium lesions/fruit	Relative index	
			Stem-scar[z]	Rinds (%)[y]		Appearance	Browning[w]
Water	24	3.0	4.9a[v]	50.0a	20.8a	3.9a	1.0d
	57	0.5	4.4ab	55.9a	21.8a	4.1a	1.4c
	57	1.0	4.3ab	53.4a	20.2a	4.1a	1.7bc
	57	3.0	4.0b	45.8ab	19.8a	3.8a	2.4ab
SDDC	24[u]	3.0	2.7c	40.1b	18.5a	3.1b	1.0d
	57	0.5	2.2cd	11.6c	2.9b	1.8c	1.9bc
	57	1.0	2.0cd	4.1c	3.1b	1.7c	2.2b
	57	3.0	1.7d	2.1c	2.4b	2.0c	2.9a

[z]Fungus growth index, stem scars: 1 = none, 2 = trace to ¼ of the stem scar covered; 3 = ¼ to ½ covered; 4 = ½ to ¾ covered; and 5 = stem scar ¾ to completely overgrown by fungi.
[y]Fungus growth index, rinds: Estimated percentage of the rind covered by fungus growth. (Percentages transformed to degrees, percentage = $\sin^2\theta$ for analysis.)
[x]Relative general appearance index: 1 = excellent, no decay, no rind or stem scar fungus growth, and no rind or vein track browning (detrimental factors); 2 = good, melons salable, trace of detrimental factors; 3 = fair, melons salable, moderate detrimental factors; 4 = poor melons marginally salable, severe detrimental factors; 5 = nonsalable due to excessive detrimental factors.
[w]Relative browning index: 1 = none; 2 = trace; 3 = slight; 4 = moderate; and 5 = severe browning of vein tracks and rind.
[v]mean separation in columns by Duncan's multiple range test, 5% level.
[u]SDDC concentration, 4000 mg a.i./liter.

treated with 57° water, fruits treated with SDDC at 57°, regardless of immersion time, had significantly fewer fusarium lesions, less stem-scar and rind fungal growth, and a significantly better general appearance rating.

Heated water (57°C) alone was no more effective than unheated (24°) water in controlling unidentified rind fungal growth and decay fungi on muskmelon fruits. These results agree with those of McDonald and Buford (3), but contradict those of other research in Texas (2) and California (5, 6). Wells and Stewart (6) found that hot water (57°) effectively controlled Fusarium decay of muskmelon fruits caused by *F. roseum* and *F. solani* (Mart.) Appel & Wr. In our studies, the incidences of *F. roseum* 'Semitectum' and *D. melonis* were the same whether the fruits were treated with water at 57 or 24°. Water temperatures required to eradicate fungi in a reasonable treatment time probably approach the injury threshold of the fruit.

Increasing the immersion time of the fruits in heated water alone appeared to have no value in controlling stem-end and rind fungal growth of fusarium decay. Longer immersion times did have the disadvantage of increasing fruit vein track and suture browning. The immersion time of fruits is 0.5 min (5). However, I have found (unpublished data) that in practice, 0.5 min is not practical under commercial conditions, 2 to 3 min being more realistic. Although both water and SDDC treatment at 57°C for 3 min significantly increased the incidence of browning, this increase did not affect the marketability of the fruits.

The results of this study indicate that in postharvest treatments of muskmelon fruits with aqueous mixtures of fungicides, heated water is beneficial because it increases the efficacy of the fungicides. In south Texas SDDC and SOPP are the only registered fungicides used to treat muskmelon fruits for postharvest decay.[2] However, the same beneficial effect of heated water was observed with 1000 mg benomyl (methyl 1-[butylcarbamoyl]-2-benzimidazolecarbamate/liter (unpublished data) and with captan (5).

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