Changes in Peaches After Hot-Water Treatment

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ABSTRACT

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Injury to peaches treated with hot water was examined in 24 tests during 1978 and 1979. Peaches were immersed in 45, 50, or 55 C water for 1.5, 2.5, or 5 min. Hot-water treatment increased staining by fast green dye, weight loss, and surface browning of the fruit. The increase of fast green dyeing indicates that hot-water treatment caused a subtle change in the surface tissues of the fruit.

Treating peaches with hot water effectively controls postharvest rots with little or no visible injury (2,7–13). High-temperature (52–60 C) hot-water treatments of peaches cause visible injury (2,7–10,12). At lower temperatures (46–50 C), little or no visible damage develops, but when the fruit is stored or recontaminated with *Monilinia fructicola* (Wint.) Honey, it is more susceptible to infection than untreated fruit (6,9,12).

To examine the quantitative effects of increasing heat dose, we determined weight loss, surface discoloration, and dye absorption by peaches after hot-water treatments. Dipping fruit in dye solution has been used to detect punctures in the surface of grapes (4) and oranges (1). A preliminary report has been published (5).

MATERIALS AND METHODS

Samples of sound fruits from 24 lots of peaches (nine in 1978, 15 in 1979) were obtained from bins of fruit coming from the orchard, before the fruit received any postharvest treatment. Samples from each lot were immersed for 0, 1.5, 2.5, or 5 min in water at 45 or 50 C (1978) or at 50 or 55 C (1979). Four replications of seven treatments per cultivar (10 fruits per replication) were made (280 fruits per test).

Five fruits from each treatment replication were dyed with fast green after the fruit had cooled to room temperature in air (1–2 hr). Fast green was selected as a dye after preliminary screening showed that heat-treated peaches absorbed fast green more selectively than they did methyl blue, crystal violet, light green S F, or orange II. Another five fruits were weighed, placed in plastic trays, and stored for 2 days at 2.5 C, then 4 days at 18 C and 70% relative humidity. After the storage period, we weighed the fruit and evaluated skin browning and rot development. Fruit was first weighed after the water treatments, because the water visibly removed dirt and trichomes (peach fuzz), and we wanted to evaluate the effect of heat but not the effects of the water.

The influence of delay before heat treatment was evaluated with seven cultivars in 1979. In these tests, we treated four 10-fruit replications for 2.5 min in 50 C water immediately or after a 1-day delay at 2.5 or 20 C.

Heat treatment. For each hot-water treatment, peaches were placed in a wire basket and immersed in an insulated stainless steel tank containing about 200 L of water. The water circulated constantly during the treatment, and a controller equipped with a thermistor probe regulated the temperature.

Dyeing. The peaches were dipped for 5 min in a solution containing 0.5 g of fast green FCG and 0.5 ml of detergent (Multi-film X 77, Colloidal Products, Sausalito, CA) per liter of water. The peaches were then washed for about 30 sec under running water, dried with cotton toweling, and immediately rated for dyeing on the following scale: 0 = none, 2 = trace, 4 = slight, 6 = moderate, and 8 = severe.

Weight loss and browning. The percentage of weight lost by each fruit was calculated by dividing the weight lost in storage by the fresh weight after treatment. Surface browning was rated on the same scale used for dyeing.

Rot. The incidence of rot was recorded for peaches held in storage. Because the quantity of inoculum was not controlled, these data do not relate cultivar or lot resistance to brown rot infection but may indicate the relative effectiveness of the heat treatments.

RESULTS

Hot-water treatment of peaches reduced brown rot and increased surface

Table 1. Effect of heat treatments on dyeing with fast green, external browning, weight loss, and brown rot development of peaches

Treatment		Staining with fast green after heat treatments[w,x]		Quality defects after storage[x,y]					
				External browning[w]		Weight loss[z] (%)		Brown rot (%)	
Water temperature (C)	Time (min)	1978	1979	1978	1979	1978	1979	1978	1979
55	1.5	···	4.1 d	···	3.4 e	···	11.0 b	···	1
55	2.5	···	5.0 e	···	4.2 f	···	11.0 b	···	2
55	5.0	···	5.5 f	···	6.7 g	···	11.3 b	···	3
50	1.5	3.6 cd	3.1 b	1.1 c	2.0 b	8.8 b	10.8 b	14	1
50	2.5	3.6 d	3.5 c	1.5 d	2.5 c	9.2 bc	10.6 b	13	0
50	5.0	4.0 e	4.4 d	2.2 e	2.8 d	10.0 d	10.7 b	12	0
45	1.5	2.7 b	···	0.8 b	···	9.3 c	···	24	···
45	2.5	3.2 c	···	0.7 b	···	9.0 bc	···	28	···
45	5.0	4.1 e	···	0.9 bc	···	9.8 cd	···	15	···
Untreated	···	2.2 a	2.3 a	0.4 a	1.0 a	7.9 a	9.3 a	52	18

[w] Rating scale for dyeing and external browning: 0 = none, 2 = trace, 4 = slight, 6 = moderate, 8 = severe.

[x] Each datum represents the overall mean of 180 fruit (1978) or 300 fruit (1979). Means in a column with no letters in common differ at the 5% significance level. Data on brown rot were not analyzed statistically.

[y] The peaches were held at 2.5 C for 2 days then at 18 C for 4 days after treatment.

[z] Moisture loss expressed as weight lost during storage divided by the fresh weight after treatment times 100.

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Table 2. Effect of heat treatment (55 C, 2.5 min) and storage on dyeing with fast green, external browning, and weight loss in seven lots of peaches

Holding before heat treatment	Fast green dyeing after treatment[w,x]	Quality defects after storage[x,y]	
		External browning[w]	Weight loss[z] (%)
None	4.3 c	3.7 b	10.5 b
1 day at 2.5 C	3.1 b	3.5 b	10.5 b
1 day at 20 C	3.4 b	3.8 b	10.3 b
Control (not heat-treated)	1.6 a	0.7 a	8.7 a

[w] Rating scale for dyeing and external browning: 0 = none, 2 = trace, 4 = slight, 6 = moderate, 8 = severe.

[x] Each datum represents the overall mean of 140 fruit (seven tests containing four replications of five fruit). Values in a column with no letters in common differ at the 5% significance level.

[y] The peaches were held at 2.5 C for 2 days then at 18 C for 4 days after treatment.

[z] Moisture loss expressed as weight lost during storage divided by the fresh weight after treatment times 100.

browning, weight loss, and staining of epidermal layers by fast green, but these responses were not equally affected by the heat treatment (Table 1). Hot water at 50 C for 1.5 min gave acceptable control with little phytotoxicity. Weight loss of the heat-treated fruit during the holding period was 1–2% greater than that of untreated fruit. The temperatures and duration of treatment often had no significant effect on weight loss; an increase of 5 C or of 3.5 min in length of a treatment increased weight loss less than 0.5% (Table 1).

In contrast, surface browning and fast green staining increased with both time and temperature. Surface browning was less than a trace on untreated controls and on fruit treated at 45 C but increased significantly with duration of the treatment at 50 and 55 C. Only fast green staining significantly and consistently increased with both time and temperature through all the treatments (Table 1).

Peaches harvested at different dates differed in weight loss, browning, and dye absorption. Although significant, these differences seem to reflect seasonal, cultural, and maturity variations of the fruit and were not consistent among the cultivars for the 2 yr (data not shown).

When peaches were held for 1 day before hot-water treatment, fast green dyeing was reduced, but weight loss and browning were not (Table 2). The change in dye absorption, without an accompanying change in weight loss or browning, indicates that the dye is staining a component(s) of the fruit that is influenced by the heat treatment but is not the same factor(s) that increases surface browning or moisture loss.

DISCUSSION

Peaches treated with hot water at all temperatures and times lost significantly more weight after storage than untreated controls. The increase in weight loss was independent of increased heat, as shown by the lack of a regular increase in weight loss with increasing temperature or duration of heat treatment. This suggests that water loss resulted from physical changes in the fruit caused by the water (presumably the result of the observed removal of trichomes). Increased browning was associated with longer treatments at higher temperatures (50 and 55 C). Surface browning may result from irreversible physiologic change of cells associated with heat and has usually been identified with heat injury of peaches (2,7–10,12). Like browning, fast green absorption increased with both time and temperature. The dye, however, appears to reveal a more subtle change than does the surface browning. Further, although surface browning and fast green dyeing are separate responses, they may be related indicators of heat injury.

Fast green, an acid stain, binds to positively charged components (3) and thus may stain a positively charged component(s) induced by heat and subject to change with storage and maturity of the fruit. The component(s) of the fruit may be formed as a result of a heretofore unrecognized physiologic change associated with heat treatment of peach fruit.

Discoloration of the surface, but not water loss, is a useful criterion for quantitatively evaluating hot-water injury. Further study is needed to identify the product(s) detected by the dye and its relationship to heat-induced susceptibility to brown rot.

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