HortScience 11(2):107–108. 1976.

Hydrocooling Peaches after Waxing: Effects on Fungicide Residues, Decay Development and Moisture Loss[1]

John M. Wells and Larry G. Revear
Agricultural Research Service, U.S. Department of Agriculture, Southeastern Fruit and Tree Nut Research Station, Byron, GA 31008

Additional index words. brown rot, rhizopus rot, Botran, DCNA, benomyl, *Prunus persica*

Abstract. **Postharvest decay and weight loss of peaches (*Prunus persica* (L.) Batsch) coated with a nonemulsified, water-insoluble blend of mineral oil, petrolatum, and paraffin (wax) containing 5000 ppm Botran and 2500 ppm benomyl was unaffected by subsequent hydrocooling. Botran residues on peaches waxed and hydrocooled under experimental conditions averaged 2.8 ppm, significantly less than those on peaches that were waxed but not hydrocooled (4.2 ppm). Under commercial conditions, however, Botran residues were slightly less (2.1 to 2.2 ppm) but not significantly different than those on unhydrocooled fruit (2.5 ppm). Therefore weight loss and decay of peaches can be controlled if a nonemulsified wax containing adequate fungicide is applied prior to hydrocooling.**

Quality and shelf life of peaches can be maintained by precooling of the fruit in the packing shed to remove field heat (4) and by a postharvest application of a fungicide to prevent the development of decay (5, 6). Untreated fruit may be of acceptable quality at the packing shed but may rot, shrivel, or become overripe at destination causing consumer dissatisfaction and a direct loss to the grower.

In the southeastern U.S. freshly harvested peaches are generally hydrocooled in water treated with chlorine or with other fungicides before being shipped. Hydrocooling efficiently cools the fruit before transit so as to retard ripening, and the fungicides help prevent the spread and development of rots such as brown rot, caused by *Monilinia fructicola* (Wint.) Honey, and rhizopus rot caused by *Rhizopus stolonifer* (Fr.) Lind. Postharvest decay, however, can be controlled by waxing peaches with a wax-fungicide combination (7). Waxing also reduces moisture loss and shriveling (3). Thus, many shippers both hydrocool and wax their fruit.

Peach waxers usually follow the hydrocooler in the packing line. However, many growers hydrocool their fruit at the very end of the packing line, and, thus, a waxer would have to precede the hydrocooler. These growers hesitate to wax their fruit before hydrocooling for fear that drenching may wash most, if not all, of the wax and fungicide residues from the fruit.

We now present evidence that peaches may be hydrocooled after treatment with a nonemulsified, water-insoluble wax.

In preliminary tests, freshly harvested peaches, uniform in size and maturity, and free from bruises or blemishes, were selected from a packing shed in Houston County, Georgia, and were experimentally waxed and cooled within 24 hr of harvest. Sixty to 120 fruit constituted a treatment lot. Peaches were waxed with a nonemulsified, water-insoluble blend of mineral oil, petrolatum and paraffin (Durand Mfg. Co., LaGrange, Ga.)[2], containing 5000 ppm Botran (2,6-dichloro-4-nitroaniline) plus 2500 ppm benomyl (methyl 1-[butylcarbamoyl]-2-benzimidazolecarbamate) applied against rotating brushes in a commercial unit. Following waxing, peaches were placed in unlidded shipping containers of 18 kg capacity and were hydrocooled for 20 min in recirculating water containing 40 to 100 ppm chlorine. Chlorine was added as calcium hypochlorite and concn of free chlorine determined by iodemetric titration with sodium thiosulfate (1). Ph of chlorine solution ranged from 6.5 to 7.2. Water temp was 1°C and the flow rate was 630 liters/min/m^2. Tests were replicated 6 times with 3 cultivars of peaches: 'Red Globe', 'Dixiland', and 'Blake'.

Larger-scale studies were conducted with 4 peach cultivars, 'Springold', 'Coronet', 'Dixiland', and 'Redcap', under commercial conditions in a packing shed. The peaches were waxed with a Durand peach waxer (Durand Mfg. Co., LaGrange, Ga.) and hydrocooled with ice as the refrigerant. One-half bushel ,samples of peaches (*ca* 9 to 10 kg) were taken from 5 locations on the packing line: 1) the field bins (as they entered the packing shed), 2) the water dump tank into which peaches are transferred from the bins, 3) the washer which cleans fruit over rotating brushes, 4) the waxer, and 5) the hydrocooler. In addition, a sample collected after the washer was hydrocooled but not waxed. Samples were drawn on 9 days during 1974.

All treated fruit were stored 7 days at 1°C and then ripened 3 to 4 days at 21°, simulating commercial shipping and storage conditions. Fruit were individually examined for brown rot, rhizopus rot, and any other decay. Subsamples of 10 fruit were drawn from each treatment lot and weighed before and after having been stored 1 week at 1°C plus 3 days at 21°C. Botran residue in the edible portion of a composite sample from 6 peaches taken from 2 levels in the shipping containers was measured by gas-liquid chromatography (2). Benomyl residues were not determined.

In the laboratory tests there was significantly less fungicide residue on peaches that were waxed and then hydrocooled than on peaches that were waxed only (Table 1). However, postharvest decay and weight loss were the same for all waxed peaches whether hydrocooled or not. Our preliminary data thus suggested that if hydrocooling did result in any loss of wax coating, it was not enough to affect the major benefits of the wax treatment.

In testing under packing-shed conditions, waxing with fungicides reduced the level of postharvest decay to about 1/6 of that in unwaxed fruit (Table 2). Throughout the sampling period (June 3 to July 19, 1974) decay development was severe in untreated samples of fruit. Decay of fruit hydrocooled after being waxed was less but not significantly different than that of the waxed but unhydrocooled fruit.

Botran residues in waxed fruit averaged 2.5 ppm and were not significantly different from those on fruit hydrocooled after waxing (2.1 to 2.2 ppm). Fruit sampled from the bottom or the top layers of the shipping containers did not differ significantly in

Table 1. Fungicide residues, decay, and weight loss of peaches experimentally waxed and hydrocooled, then held 7 days at 1°C and 3 days at 21°.

Treatment	Botran residues[z] (ppm)	Brown rot[y] (%)	Wt loss[x] (%)
None	1.2 a	22.2 c	10.4 b
Hydrocooled only	0	13.3 b	13.6 b
Waxed only	4.2 c	5.2 a	7.2 a
Waxed + hydrocooled	2.8 b	4.8 a	8.6 a

[z]Mean separation in columns by Duncan's multiple range test, 5% level.

[y]% decay in 60 to 120 peaches per treatment. Treatments repeated 6 times, twice each with the cultivars 'Red Globe', 'Dixiland', and 'Blake'.

[x]Avg wt loss after 1 week at 1°C plus 3 days at 21° and 70 to 80% relative humidity.

[1]Received for publication October 11, 1975.

[2]Mention of a trademark does not constitute a guarantee of the product by the U. S. Department of Agriculture, and does not imply its approval to the exclusion of other suitable products.

Table 2. Percent decay on peaches selected at various sampling points in a commercial packing line and held for 7 days at 1°C plus 3 days at 21°.

Sampling point in packing shed (in sequential order)	% decay[z] on indicated cultivars and sampling dates (1974)									
	Springold		Redcap	Coronet			Dixiland			
	Je 3	Je 4	Je 6	Je 14	Je 21	Je 26	Jy 12	Jy 17	Jy 19	Avg[y]
Bulk bin	49	46	27	24	15	6	19	17	21	24.9 b
Dump tank	77	54	40	53	29	26	25	27	26	39.7 bc
Washer	54	53	42	53	29	13	48	57	52	44.5 c
Waxer	7	7	12	7	2	1	7	7	10	6.7 a
Hydrocooler	11	7	16	6	0	0	11	10	12	8.1 a
Hydrocooler (by-passed waxer)	50	51	40	21	30	33	40	46	43	39.3 bc

[z]Brown rot, rhizopus rot, and miscellaneous decay on 9 to 10 kg samples.

[y]Mean separation in columns by Duncan's multiple range test, 5% level.

levels of fungicide residues.

The average weight loss of waxed peaches after a simulated marketing period was 6.5%, compared to 9.4% for washed fruit and 9.7% for unwaxed (but hydrocooled) peaches. Weight loss of waxed, hydrocooled peaches was 6.7 to 7.3% – again, not significantly different from that of the waxed but nonhydrocooled peaches.

As demonstrated under commercial conditions, decay and weight loss were controlled even when 5000 ppm Botran and 2500 ppm benomyl incorporated into a nonemulsified wax were applied after hydrocooling. Loss of some fungicide and presumably, of wax coating did occur, but the loss was statistically not significant and did not reduce the effectiveness of the wax treatment. We have shown that shippers with hydrocoolers at the end of the packing-lines can safely install a suitable waxer without costly alterations to the packing-line configuration and thus benefit from both postharvest treatments.

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HortScience 11(2):108–109. 1976.

The Effect of Covering Apples during Development[1]

J. T. A. Proctor and E. C. Lougheed[2]
Horticultural Research Institute of Ontario, Canada

Additional index words. anthocyanin, chlorophyll, soluble solids

Abstract. **Covering apples with foil bags about 1 month after bloom to harvest had no effect on fruit size or starch content, had inconsistent effects on fruit firmness, and reduced soluble solids, anthocyanin and chlorophyll. Uncovering fruits at various times before harvest allowed formation of anthocyanin, maximum amounts being dependent on cultivar and time of exposure.**

Recent reports describe the Japanese practise of covering apples during development (2, 6). Initially the technique was used to prevent fruit injury by insects and diseases but now its main purpose is to obtain fruit with a smooth finish and often uncharacteristic but desirable color (2).

This paper describes experiments in which fruit of 3 North American apple cultivar and the Japanese cultivar 'Mutsu' were covered during development with aluminum foil bags. Attendant changes in some fruit characteristics, particularly pigments, are presented.

Fruit from the periphery of 11 to 13-year-old trees of 'Mutsu', 'McIntosh', 'Delicious' strain Vance, and 'Golden Delicious' on 3 rootstocks Malling (M) 2, Malling Merton (MM) 106, and MM 111 were used.

Bags of aluminum foil, brown paper, and black cloth were compared for their suitability for apple covering. Spot measurements of temperature with matched thermistors showed that when air temp (shaded but non-aspirated) was 22°C, temp in foil bags were 1° higher, in brown bags 3° higher, and in black bags 12° higher. Severe scalding of apples in black bags was observed when maximum temp (screened and aspirated) reached 28°.

Light transmission of bags was compared using an Eppley precision pyranometer uniformly sensitive to all wavelengths from 285 to 2800 nm. Brown bags allowed 41% of the incident global radiation through while black bags allowed 19% and foil bags 15%. Brown paper bags did not withstand weathering and had to be replaced. From the foregoing it was decided that aluminum foil bags were most suitable.

Apples were covered with foil bags on June 26 about 1 month after full bloom. Enough were covered to allow for 6 to 10 fruits in each sample in each experiment. The bag was placed over the fruit, gathered and tied with a plastic tie around the pedicel. Apples with long pedicels e.g. 'Delicious' and 'Golden Delicious' were easy to cover while others with short pedicels e.g. 'McIntosh' were difficult. Because the bags were large, allowed fruit expansion and withstood weathering, they did not have to be replaced. About 5% of the bags were lost to air blasts from spray machinery. Another 2% of the bags split during fruit development especially with the larger fruited cultivars. The resultant exposed part of the apple rapidly turned red. These samples were discarded.

Anthocyanin and chlorophyll content of the apple skin were measured by previously discussed methods (1, 4, 5). Fruit size was measured with a Cranston fruit thinning gauge, soluble solids with a Toshiba hand refractometer and fruit firmness of the pared flesh with an Effegi fruit tester fitted with the 1.12 cm (7/16 inch) tip. Starch content was judged by applying a solution of iodine in aqueous potassium iodide to a traverse equatorial section and relating the

[1]Received for publication July 7, 1975.

[2]Addresses respectively are: Horticultural Experiment Station, Box 587, Simcoe, N3Y 4N5; Department of Horticultural Science, University of Guelph, Guelph, N1G 2W1.