narrow size range rather than treating the total orange juice vol.

Several methods of treatment for particle size reduction such as homogenization, screening, pulverization, sonication, and enzymatic might find application here. The need for additional studies in this area is indicated.

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FLESH TEXTURE AND RESPIRATION OF WAXED PEACHES[1]

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Abstract. **Respiration of fresh peaches waxed after harvest with a paraffin-base emulsion was significantly lower than that of unwaxed fruit as determined by gas-liquid chromatography. Waxed peaches evolved 12.80 ml of CO_2 per Kg of fruit per hour at 21°C, compared to 14.56 ml for unwaxed fruit. The decrease in respiration correlated with a significant increase in texture breakdown of the flesh of waxed peaches held for 3 weeks at 1°C compared to unwaxed checks. Flesh texture breakdown is one of the limiting factors in maintaining the market quality of peaches during storage. Although waxing peaches after harvest is an effective treatment to preserve fresh appearance and market quality, its effect on respiration may lead to a significant decrease in internal quality after prolonged refrigerated storage.**

Peaches (*Prunus persica* [L.] Batsch) are a perishable commodity that are often shipped long distances to market and retailed under unfavorable storage and display conditions. Many growers wax their peaches in combination with a fungicide for decay control. Postharvest waxing extends the marketing life of the fruit by reducing moisture loss and shrivel, and by enhancing general appearance (5). Peaches of most cultivars are held in refrigerated storage for 2 weeks without significant quality deterioration (3). Fresh market quality, however, deteriorates after 2 to 3 weeks in storage. Although the external appearance of the fruit may be acceptable, flavor is lost and flesh texture becomes dry and mealy—a condition known as "wooliness." Wooliness, or internal texture breakdown, occurs most noticeably in fruit stored in advanced stages of maturity and increases as a function of time in storage (2).

[1]The authors wish to acknowledge the assistance of Bethany LeDuc.

Little is known of the effect of postharvest waxing treatments on the physiology, flavor, and texture of peaches in storage. Vines et al (4) reported that waxing did not affect the organoleptic qualities of citrus fruits in storage but did reduce the internal concn of oxygen and raise that of carbon dioxide (CO_2). Wells (unpublished results) observed that peaches coated with an excessive amount of wax developed off-flavors after 5 days at room temp. Peaches waxed under commercial conditions, however, were unaffected. This report describes experiments conducted at the U. S. Department of Agriculture's Southeastern Fruit and Tree Nut Laboratory in Byron, Ga. to study the effects of commercial waxing treatments on the respiration and market quality of peaches during prolonged storage periods.

Materials and Methods

Peaches were selected for uniformity of size and freedom from bruises from local packing sheds in Houston County, Ga. Fruit were color-sorted into 3 maturity grades, green, firm-ripe, and ripe with a Spectrosort (FMC, Lakeland, Fla.), and brush defuzzed and waxed with a commercial peach waxer. Wax was applied as a 10x dilution of a water soluble, paraffin-base emulsion sprayed against rotating brushes under conditions simulating those of commercial practice. Fungicides were incorporated into the wax to control postharvest decays (5). Some fruit were waxed without brush defuzzing, and unbrushed and unwaxed fruit served as checks. A total of 120 fruit per treatment were packed in trays in cardboard peach containers and held at 1°C. Sixty fruit per treatment were removed after one day for respiration studies at room temp, and the remainder removed after 3 weeks for quality tests.

Flesh texture was first evaluated subjectively by rating 30 peaches per treatment according to the pressure required to break the skin with the thumb. A rating of 1 = firm texture, or not breakdown, and 2 through 4 = slight, moderate, and severe texture breakdown, respectively. A rating of 2 or above was considered unacceptable market quality.

Objective texture evaluations were based on pressure tests on 30 fruit per treatment measured with an Instrom TM (Amer. Instrom, Silver Spring, Md.). A patch of skin was peeled from each side of the peach suture and the pressure required to puncture the flesh recorded as kg force.

Respiration of peaches was measured as ml CO_2 evolved per kg fruit at 21°C. An average of 2.4 kg peaches per treatment were placed in sealed 10 liter jars equipped with gas inlets and outlets. Airflow through the jar was 120 ml/min. Air samples from the jars were collected by syringe at 24 hr intervals and analyzed for CO_2 with a Varian Aerograph Model 2800 gas-liquid chromatograph equipped with a thermal-conductivity detector and a 7.5 x 60 cm stainless steel column packed with activated alumina. Carrier gas was helium, and oven and detector temperatures set at 50 and 70° C, respectively.

Flesh texture experiments were replicated 8 times with the cultivars 'Coronet', 'Keystone', 'Swanee', 'Southland', and 'Loring'. Respiration data was taken on 4 of these replications with the cultivars 'Keystone', 'Swanee', 'Southland', and 'Loring'. Data were treated by analysis of variance and by Duncan's multiple range tests.

Results

Ratings of flesh texture breakdown of waxed peaches held for 3 weeks at 1°C were significantly higher than those of unbrushed and unwaxed checks. The average rating for waxed fruit was 2.07 compared to 1.83 for unwaxed fruit (Table 1). Wax alone, applied with no brushing, resulted in a similar increase of texture breakdown, however, the effect was statistically significant with green fruit only. Ratings were also significantly higher for the ripe fruit compared to the green fruit.

Table 1. Ratings of flesh texture breakdown of peaches brushed and waxed after harvest and held for 3 weeks at 1°C.

Postharvest treatment	Flesh texture ratings[z]		
	Maturity level		
	Green	Ripe	Average
Check	1.49 a	2.09 a	1.79 a
Brush (defuzz)	1.44 a	2.23 a	1.83 a
Brush-wax[y]	1.69 b	2.46 b	2.07 b
Wax only	1.80 b	2.29 ab	2.05 ab
Average	1.60 a	2.26 b	

[z]Based on a scale of 1 to 4 corresponding to none, light, medium, and severe texture breakdown. Averages are of 30 fruit per treatment, replicated 8 times, and those within each block not followed by the same letter are significantly different at the 95% level.

[y]Fruit brushed with a 10x dilution of a water-soluble concentrate of a paraffin-base wax.

Differences in texture firmness of waxed and unwaxed peaches held for 3 weeks at 1°C were also confirmed by objective evaluations. Firmness values for waxed peaches averaged 1.21 kg force compared to 1.43 kg force for the unwaxed checks.

Respiration of waxed peaches was significantly lower than that of unwaxed checks. Average rate of CO_2 evolution of mid-ripe, waxed peaches was 12.80 ml/kg/hr compared to 14.56 ml/kg/hr in the checks (Table 2).

Ripe fruit evolved greater quantities of CO_2 than green fruit (Table 3). Brushing alone had no significant effect on the respiration of either green or ripe fruit. Wax applications alone, without brushing, caused a decrease in respiration.

Table 2. Respiration at 21°C of mid-ripe peaches 48 hr after a postharvest waxing treatment.

Postharvest treatment	Respiration[z] per replication[w]				
	1	2	3	4	Average
Check	15.68[y]	11.20	12.96	18.40	14.56 a
Brush-wax[x]	14.40	9.76	10.56	16.48	12.80 b

[z]Ml CO_2 evolved per Kg fruit per hr at 21°C.

[y]Average of 4 replications per treatment, 2.4 Kg fruit per rep. Averages not followed by the same letter are significantly different at the 95% level.

[x]Fruit brushed with a 10x dilution of a water-soluble concentrate of a paraffin-base wax.

[w]1 = Keystone, 2 = Swanee, 3 = Southland, 4 = Loring.

Table 3. Respiration at 21° of green and ripe peaches 48 hr after postharvest brush and waxing treatments.

Postharvest treatment	Respiration[z] at each maturity level	
	Green	Ripe
Check	9.54 a[y]	14.94a
Brush	9.90 a	13.92 a
Brush-wax[x]	7.36 b	11.68 b
Wax only	7.52 b	11.02 b
Average	8.58 a	12.89 b

[z]Ml CO_2 evolved per Kg fruit per hr at 21°C.

[y]Average of 5 replications, 2.4 Kg fruit per rep. Averages not followed by the same letter are significantly different at the 95% level.

[x]Fruit brushed with a 10x dilution of a water-soluble concentrate of a paraffin-base wax.

Conclusions

Waxing has been generally adopted to improve the market quality of peaches during the normal storage life of the fruit. Waxing prolongs the shelf life of peaches in the sense of reducing losses due to post-harvest decays and to shrivel—losses than can otherwise occur in untreated fruit. But there is no evidence published that the fresh quality of peaches in storage is extended by waxing treatments. There is some evidence, however, herein presented, that waxing may actually shorten the storage life of peaches under conditions of prolonged refrigerated storage.

Buescher and Griffith (2) and others (1) have associated flesh texture breakdown of peaches with low temp injury. The condition develops after 2 to 3 weeks in refrigerated storage depending on the cultivar and on the physiological condition of the fruit. We have demonstrated that waxing peaches under the conditions described accelerates flesh texture breakdown. Further tests must be conducted, however, to determine the effects of thickness of the wax coating, uniformity of coverage, and type of wax on texture breakdown. It should be possible to deliver a satisfactory application of wax that minimizes the hazard of loss of quality while retaining the benefits of the treatment. The trouble-free use of waxing by the peach industry for many years suggest this balance is generally achieved, or that the marketing period for waxed peaches generally does not exceed their normal storage life.

The rate of respiration of peaches is affected by the presence or absence of a wax coating and by the physiological state of development on the fruit. No other postharvest handling process, such as brushing or the method of precooling (Wells, unpublished results), affects respiration significantly. Flesh texture breakdown of peaches in storage is similarly affected by physiological maturity of the fruit or by waxing, but not by any other handling process. Such similarities suggest that the 2 processes are closely related, that fresh flavor and texture depends on a normal rate of respiration, and that any factor restricting respiration will adversely affect the storage life of the fruit. Further studies are needed, and are in progress, to test this relationship further.

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GLYCOSIDE AND PECTIN SUCCESSIVELY EXTRACTED FROM CITRUS[1,2]

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Abstract. **Orange albedo and whole lemon peel were subjected to a hot water leach to remove the soluble solids from the peel prior to pectin extraction. Neither room temp nor 90°C water leached appreciable quantities of hesperidin from the peel. Jelly units of recovered pectin ranged from 75 to 86 for orange and lemon peel leached at 90°C. For a control on the hesperidin yield, a commercial type of caustic leach was used. Yields of hesperidin ranged from 1.2 g to 4.3 g per kg of peel for the single strength press liquor and between 2.3 g and 5.5 g per kg of peel for a threefold concn.**

A pectic enzyme was tested as a substitute for $Ca(OH)_2$ to degrade the water soluble pectin from the hot leach water during the extraction of naringin and pectin from grapefruit peel. By using 100 ppm of enzyme and treating for an hr at 35°C, we recovered an average of 70% of the 4 g of naringin per kg of whole peel recovered by the original hot water leach method.

Glycosides are recovered in most commercial procedures by treating the peel with $Ca(OH)_2$, pressing and then crystalizing them from the press liquor after pH adjustment. This process renders the pectin in the peel nonrecoverable because it has been precipitated as calcium pectate.

In commercial operations, pectin is normally extracted by heating in a mineral acid solution after first leaching the peel with room temp water to remove the soluble solids (mostly sugars). If the glycosides are not leached from the peel, they will be destroyed by the heat and mineral acids used to extract the pectin (4). Thus, from either of the commercial methods only the glycoside or pectin, not both, are recovered from the same raw material.

Earlier, we found naringin could be efficiently leached from grapefruit peel followed by pectin extraction (2). In this procedure, calcium hydroxide was used to precipitate the water soluble pectin from the hot leach water.

The purpose of this research is to extend a previously reported method used to recover both naringin and pectin in an attempt to recover both hesperidin and pectin consecutively. Additionally, yields of naringin are compared using the reported hot water leach which uses $Ca(OH)_2$ to ppt. the water soluble pectin in the leach water and a new method using an enzyme to degrade the water soluble pectin.

Materials and Methods

Each of the commercially shaved albedo samples of Pineapple and 'Valencia' oranges (*Citrus sinensis* [L.] Osbeck) together with whole peel samples of 'Sicilian' lemon (*Citrus limon* [L.] Burm. f.) was divided into 2 equal batches. One half was processed using a caustic leach (Fig. 1) which served as a control and the other half using the hot water leach (Fig. 2). A room temp leach was also tested on 1 sample. The leaching procedures and subsequent extraction of pectin from the press cake (Fig. 3) were similar to those reported earlier (2). The $Ca(OH)_2$ leach procedure in Fig. 1 was modified for hesperidin extraction by using additional $Ca(OH)_2$ to reach an initial pH of 11.1 to 11.3 for 1 hr, instead of pH 8.8 to 9.0, pressed, then lowered to pH 4. In this paper, the term 'peel' refers to both the whole peel and shaved albedo samples collectively.

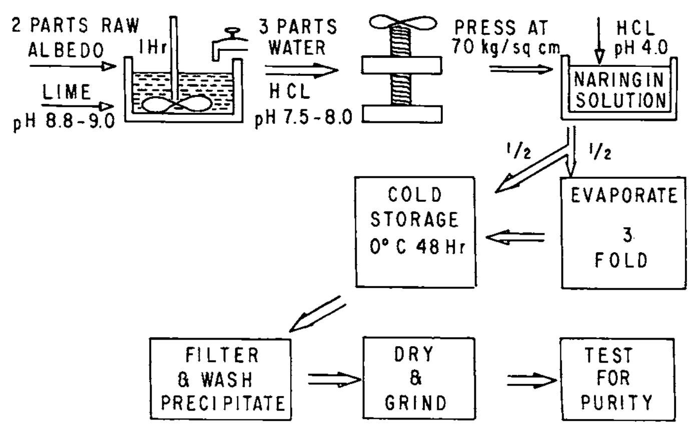

Fig. 1. Naringin extraction using $Ca(OH)_2$.

Whole peel samples of 'Marsh' grapefruit (*Citrus paradisi* Macf.) were also divided into 2 batches. One half was processed by the hot leach (Fig. 2). One half was processed by a modification of the hot leach procedure in which Irgazyme 100 (Ciba-Geigy) was used instead of $Ca(OH)_2$ (upper right corner in Fig. 2) to degrade the water soluble pectin prior to evaporation. Enzyme (100 ppm by wt of solution) was added to the sample and held 1 hr at approx 35°C. Then the sample was handled as in the hot leach procedure.

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