J. Amer. Soc. Hort. Sci. 103(1):90–91. 1978.

Rehardening of Peach Fruit in Cold Storage[1]

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Abstract. **Fruit of peach (*Prunus persica* (L.) Batsch) exhibited rehardening when returned to low-temperature storage after softening at room temperature. Rehardening was progressively more pronounced as the temperature decreased. The process occurred in either air or nitrogen atmosphere. The softening of the fruit that occurred normally at room temperature was accompanied by a decline in protopectins and a concomitant increase in water-soluble pectic fraction. By comparison, the rehardening of the fruit at low temperatures was accompanied by little or no change in pectic substances. The results suggest that rehardening is not related to the metabolic changes associated with fruit ripening.**

Earlier workers observed that low temp induce rehardening in small fruit, including strawberries, raspberries, cherries (3, 4, 12) and, to a certain extent, pears (10). The present metabolic study was undertaken to determine whether peach similarly undergo rehardening at low storage temp.

Materials and Methods

Peach fruits of various cultivars were obtained from the Fruit Tree Experiment Station of Rutgers University, Cream Ridge, N. J., allowed to undergo ripening at room temp (20°C), and then transferred at different stages of softening to cold storage maintained at relative humidity of about 65%. Rehardening of softening fruit was tested at 0°, 5°, and 10°C. In another experiment the rehardening of peaches at 0°C was measured in fruit held in air and in 100% N_2. The change in fruit firmness was tested immediately after removal from the treatment condition using a Magness-Taylor fruit pressure-meter (1) with the HP 11 mm in diam. Ten fruit constituted a sample. All measurements were run in duplicate.

The changes in pectic substances were assayed in fruit undergoing softening at room temp and in fruit that underwent rehardening at 0°C. Tissue increments weighing 100 g each, representing 10 fruits, were extracted with ethanol to obtain the alcohol-insoluble solids (AIS) fraction. This fraction was then used for the extraction of a protopectin and water-soluble pectins (7). The method of McCready and McComb (8) was used for the quantitative estimation of the isolated pectic compounds, based on the enzymatic hydrolysis of the pectic polysaccharides and the determination of the released uronides.

Results and Discussion

Softening of harvested peaches including 'Redhaven' (A) and NJ244 (B) (both freestone cultivars) proceeds rapidly at room temp (Fig. 1). When the fruit is placed in cold storage (0°C) immediately after harvest the softening process is retarded. By comparison, peaches softened at room temp and then returned to cold storage, increased in firmness. Several other cultivars responded in like manner. The present results are in agreement with other observations showing rehardening at low temp in small fruit (3, 4, 12) and, to a certain extent, in pears (10) but not in apples (2).

This phenomenon was examined further by relating rehardening of the fruit to storage temp. Fig. 2 shows the effect of

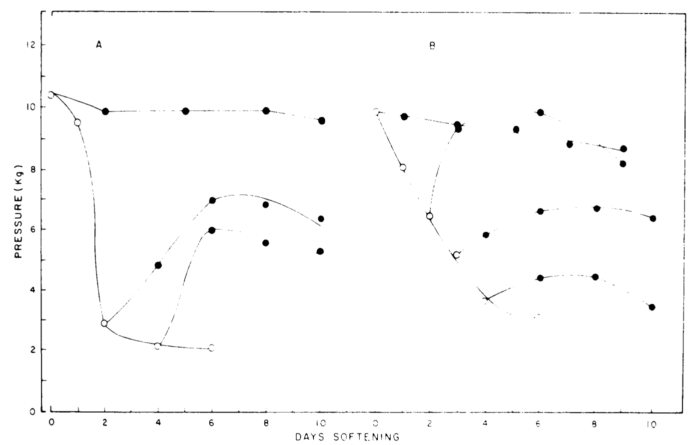

Fig. 1. Changes in the firmness of peaches occurring at 20°C (○), and following the transfer of fruit at different ripening stages to 0°C (●). Peach cultivars used were 'Redhaven' (A) and NJ244 (B).

different storage temp on the rate of rehardening in softening peaches. Rehardening was most pronounced at 0°C, but diminished as storage temp increased. The data suggest that rehardening is in inverse proportion to the storage temp.

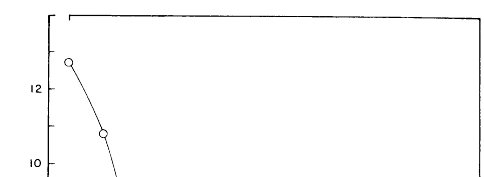

Fig. 2. Changes in the firmness of 'Redhaven' peaches occurring at 20°C (○), and following the transfer of softening fruit to storage temperatures of 10° (▲), 5° (■), and 0°C (●).

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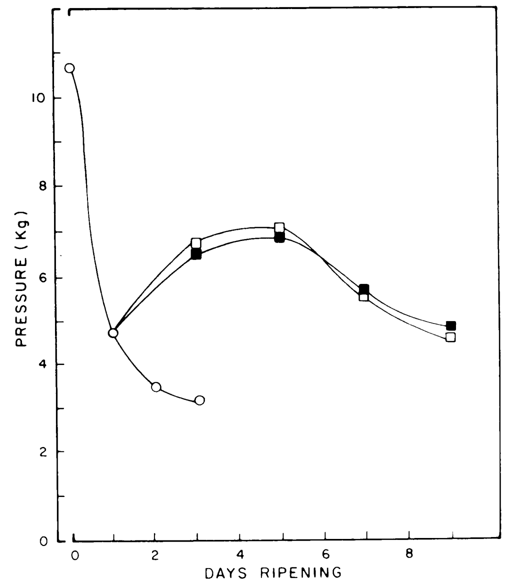

Fig. 3. Changes in the firmness of 'Marhigh' peaches occurring at 20°C (○), and following the transfer of softening fruit to 0°C in air (□), and in N_2 (■).

Additional experiments were designed to examine whether the rehardening of peaches, as induced by low temp, reflects changes in metabolic pathways in the fruit. When softening 'Marhigh' peaches were placed in cold storage and kept in either air or 100% N_2 there was virtually no difference between the changes in fruit, as induced at low temp (Fig. 3).

When the softening fruit is returned to low temp there was an increase and then a decline in firmness, suggesting reconstitution followed by a breakdown of cell wall components that contribute to firmness. As the formation of a cell wall is energy-dependent (5), the processes leading to cell wall reconstitution, as reflected in fruit firmness, are not likely to occur under anaerobic conditions. Likewise it was shown that the loss of fruit firmness could not occur under anaerobic conditions (6). These results suggest that the low-temp-induced rehardening in peaches may not be related to the metabolic changes in the fruit cell wall.

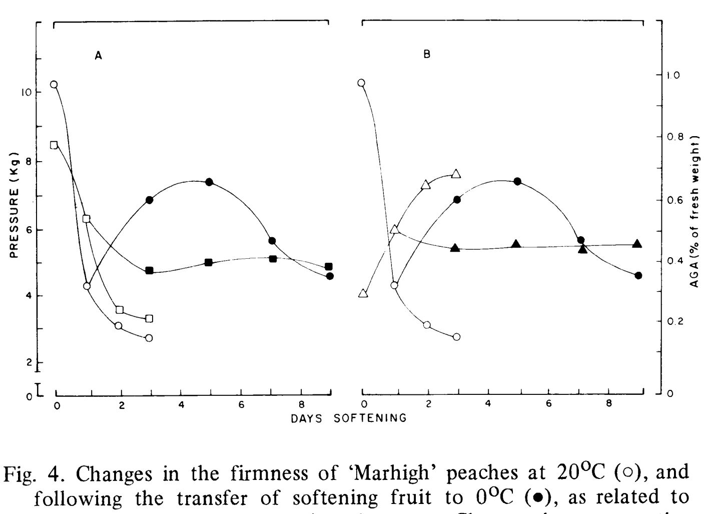

Fig. 4. Changes in the firmness of 'Marhigh' peaches at 20°C (○), and following the transfer of softening fruit to 0°C (●), as related to comparable changes in pectic substances. Changes in protopectins (A) are shown in fruit at 20°C (□) and at 0°C (■). Also shown are changes in water-soluble pectins (B) in fruit at 20°C (△) and 0°C (▲). The quantity of the pectic compounds is based on their content of anhydrogalacturonic acid (AGA).

To further test this hypothesis, the changes in pectic substances in fruit undergoing softening at room temp were compared with those occurring in rehardening peaches during cold storage. Changes in fruit softening at room temp are accompanied by a parallel decline in the protopectin fraction (Fig. 4A), as observed by other workers (11, 13). In contrast, the changes in firmness in the fruit that showed rehardening at low temp were not accompanied by corresponding changes in the protopectin fraction. The initial increase in firmness was not associated with a corresponding increase in the protopectin fraction, but rather with a further decline and little or no change afterward. Results of a comparable test, in which the changes in the water-soluble pectic substances were compared, are shown in Fig. 4B. In the fruit that were allowed to soften at room temp, the process was accompanied by an increase in the water-soluble pectin fraction. As with the protopectin fraction, rehardening was not accompained by changes in the water-soluble fraction.

Softening in ripening peaches has been shown to be accompanied by, and attributed to, the degradation of the protopectin fraction leading to the release of water-soluble pectic substances (9), as also suggested by the present results. Thus, it might be deduced that the reversal of the process represents the reassembling of the water-soluble pectic substances into the protopectin, the parent compound. Actually, during the rehardening at low temp, the protopectin fraction declined somewhat, while the water-soluble pectin fraction showed little or no further change as the fruit rehardened. These results suggest that rehardening in peaches cannot be attributed to a reconstitution of the pectic substances, which would represent the reversal of the normal softening process in ripening fruit, or the metabolic processes normally associated with cell wall composition.

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