

Effect of Postharvest Calcium Treatment on Decay of Delicious Apples

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ABSTRACT

Conway, W. S. 1982. Effect of postharvest calcium treatment on decay of Delicious apples. Plant Disease 66:402-403.

Delicious apples were treated with 0, 2, 4, 6, or 8% solutions of calcium chloride by dipping, vacuum infiltration (250 mm Hg), and pressure infiltration (103 kPa). After 3 mo at 0 C, the fruits were removed from storage, wounded on two sides, and inoculated with a conidial suspension of *Penicillium expansum*. Following additional holding at 20 C for 7 days, the apples were rated for decay severity by calculating the area of decay at the inoculation sites. Fruit tissue was also analyzed after storage for calcium content. The least decay and the highest concentration of calcium in tissues were found in those apples pressure infiltrated with 8% calcium chloride. Effectiveness in decay reduction increased as the concentration of calcium chloride in the infiltrated solution increased.

Postharvest treatments of apples with low concentrations of calcium (Ca) salts have been found to reduce physiologic disorders and delay senescence. Internal breakdown (1), bitter pit (6), and softening (5) have been significantly reduced by Ca treatment. Most early workers applied Ca by dipping fruit in solutions of calcium salts, but more recent work has shown that vacuum or pressure infiltration of these solutions may be a more effective method of getting Ca into the apple (7). Infiltrated solutions also retain much of their effectiveness when the fruits are rinsed with water following treatment to reduce the possibility of injury to the fruit or damage to the equipment (7).

Although most efforts in treating fruit with Ca solutions have been directed towards reducing losses due to physiologic disorders, it has been reported that increased calcium content of fruit may also reduce losses due to decay-causing organisms (9).

The objectives of this study were to determine the effect of postharvest Ca treatment of apples on decay caused by *Penicillium expansum* Link ex Thom and to determine the optimum method of treating fruit with calcium solutions.

MATERIALS AND METHODS

Delicious apples were harvested from

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three commercial orchards, one in Virginia and two in Maryland. The apples were treated with laboratory grade USP calcium chloride (CaCl_2 ; 76%) made up as 0, 2, 4, 6, or 8% solutions. Methods of treatment with each of the solutions included dipping, vacuum infiltration, and pressure infiltration. Treatments involved placing the fruits in solution for 2 min for dipping and pressure infiltration (103 kPa). Fruits that were vacuum infiltrated were placed in CaCl_2 solution for 2 min under 250 mm Hg vacuum and then held in solution for 2 min after vacuum release. After each treatment, the fruits were lightly towel-dried in an attempt to reduce possible chemical injury. Fifteen fruits per orchard were used for each treatment. Following

treatment, the fruits were placed in air storage at 0 C.

After 3 mo of storage, the fruits were removed and inoculated with *P. expansum*. They were wounded on two sides to a depth of 2 mm by being pressed down on a nail head of 2 mm diameter. The fruits were then immersed for 15 sec in a conidial suspension (1×10^6 spores per milliliter) in nutrient broth containing 0.5% Tween 20. After additional holding at 20 C for 7 days, the apples were rated for decay severity by measuring the surface diameter of the decayed area as the mean of its width and length and then computing the area of decay.

Ca content of the apple tissue was determined by removing the peel and outer flesh of the entire fruit to a depth of 2 mm with a mechanical peeler. The next 2 mm of flesh tissue was then removed, again using the mechanical peeler, and this layer was used for Ca analysis because this was the depth to which the apples were punctured for inoculation. The flesh from three apples made up one sample, and three samples from each orchard were analyzed. After removal from the fruit, the flesh was immediately frozen in liquid nitrogen, freeze-dried, and ground. From each sample, 1 g of dried material was ashed, dissolved in 5 ml of 2N hydrochloric acid, filtered, and diluted into 100-ml flasks. The samples

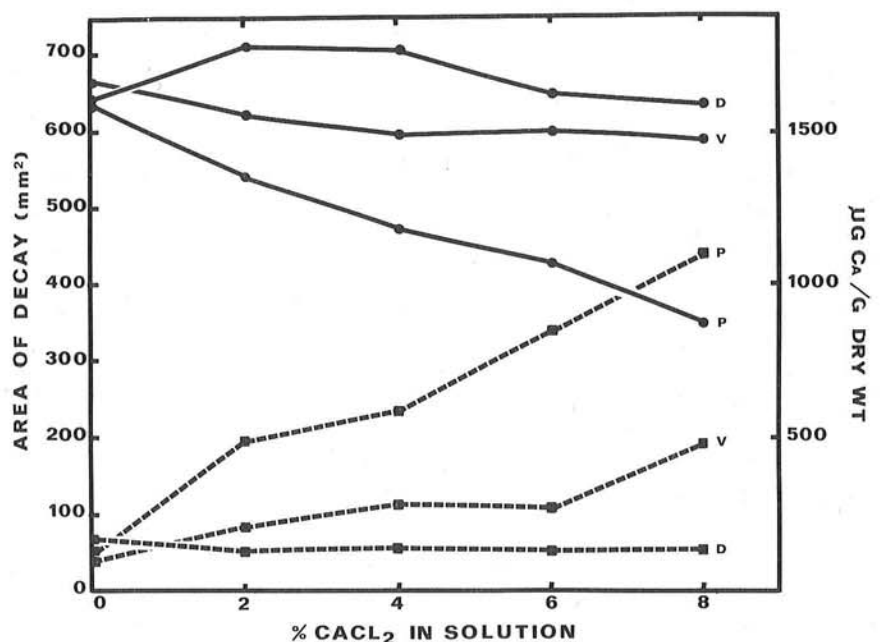


Fig. 1. Relation between area of decay (●) and calcium concentration (■) of apple tissue. Methods of treating fruit with calcium chloride (CaCl_2) solution included dipping (D), vacuum infiltration (V), and pressure infiltration (P).

were then analyzed for Ca content with a Jarrell-Ash atomic absorption spectrophotometer. All Ca values are reported on a dry-weight basis. No sensory evaluation was conducted to determine effect of Ca infiltration on fruit taste.

RESULTS AND DISCUSSION

Results of decay severity measurements and Ca analysis are shown in Figure 1. Each point on the graph is the mean of the samples taken from the three orchards. There was no decrease in decay severity nor increase in Ca concentration of the flesh in apples dipped in the various concentrations of CaCl₂. In vacuum-infiltrated fruit, Ca concentration increased as concentration of the CaCl₂ solutions increased; however, the concentration did not increase in sufficient amounts to decrease the area of decay by more than 10%, even with the 8% CaCl₂ solution. Pressure infiltration of CaCl₂ proved to be the most effective method of getting the solutions into the fruit, as shown by the large increase in Ca concentration of the flesh of apples treated in this manner. Pressure infiltration of the 2% CaCl₂ solution increased flesh Ca concentration and reduced decay area of fruit as much as vacuum infiltration of 8% CaCl₂ solution, indicating better penetration by pressure methods.

As the Ca concentration of the pressure-infiltrated CaCl₂ solution increased, so too did the resulting Ca concentration of the flesh after storage. Also, as the Ca concentration of the flesh increased, the area of decay decreased

correspondingly. The most effective treatment was pressure infiltration of an 8% CaCl₂ solution, which increased the Ca concentration of the flesh ninefold and decreased the decayed area by 44%. No evidence of fruit injury was observed with any of the treatments.

Uptake of CaCl₂ solution is primarily through the lenticels and calyx openings (2), and pressure infiltration proved to be the most successful method of forcing the CaCl₂ solution into the flesh. Increasing the vacuum used for vacuum infiltration might increase the amount of solution going into the fruit.

Fuller (4) found that apple fruits of low Ca content exhibited more severe symptoms of cell wall and membrane breakdown than fruits of high Ca content. Sharples (8) states that the effects of Ca on cell wall metabolism and structure not only confer greater resistance to changes that precede softening, fungal invasion, and the development of disorders, but also may delay the general rate of senescence of the tissue. Because it was found that apples dipped in CaCl₂ remain firmer than low-Ca apples (1), Faust (3) concluded that in Ca-treated apples, the Ca may prevent the pectic enzymes from destroying pectin. The role of infiltrated Ca in reducing decay, then, may be that of strengthening the cell wall and membrane structure, making them more resistant to fungal enzyme activity, and slowing the rate of decay. This protective role can be realized only if sufficient amounts of Ca can move into the fruit during production or as a postharvest application.

Postharvest infiltration of CaCl₂ solution into apples may not only reduce losses due to physiologic disorders but may also reduce decay caused by *P. expansum*.

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