Hot Dip Treatments Reduce Chilling Injury in Long-term Storage of ‘Valencia’ Oranges

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Abstract. Postharvest treatment of ‘Valencia’ oranges [Citrus sinensis (L.) Osbeck] with hot dips of water or water suspensions of benomyl (500 mg liter⁻¹) or thiabendazole (TBZ) (1000 mg liter⁻¹) greatly reduced chilling injury (CI) incidence when fruit were stored for 15 weeks at 1°C. The hot TBZ dip treatment was significantly better than the other hot dip treatments for reducing CI. Pretreatment rind injury inflicted to the fruit before cold storage slightly increased CI incidence. Chemical names used: methyl 1-(butylcarbamoyl)-2-benzimidazole-carbamate (benomyl); 2-(4-thiazoleyl)-benzimidazole (thiabendazole).

Many factors have been investigated for their potential to reduce the risk of chilling injury (CI) in citrus fruit. Fruit age (11), fruit position in the tree canopy (13), growth regulator treatments (8), ethephon treatment (4), rind damage (ref. 4; and B. Patterson, personal communication), plastic wrapping (10, 16), and prestorage ‘curing’ (5–7) have all been shown to influence the extent of CI in citrus fruit. Additionally, postharvest thiabendazole (TBZ) and benomyl treatment of grapefruit (2, 9, 11, 14, 17) have been shown to reduce CI incidence.

Most of these responses, however, have been obtained with grapefruit; there is little information available on both the magnitude of, and ways of reducing, CI during the long-term storage of ‘Valencia’ oranges.

To examine further the effects of fungicide treatments on CI and as a possible way of enhancing fungicide response, as in anthracnose control in citrus (18), a trial was conducted where fruit was treated with hot dips before storage. In addition, the rind of some fruit was also damaged in an attempt to determine if fruit injury induced more CI.

‘Valencia’ oranges were obtained in early Nov. 1987 from two orchards in the Gosford region of New South Wales, Australia. On delivery of fruit to the laboratory, they were washed, but not waxed, and fruit from each orchard then was randomized into 10 treatment units of ~130 fruit each.

Five treatment units were subjected to rough handling, where damage to rind was induced by rolling the fruit several times in a barrel containing ~2 kg of coarse dry sands while the other five treatments were carefully handled. One of the following dip treatments was then applied to each unit of fruit from both groups: A) control (water dip at ambient temperature; 18°C for 2 min); B) hot water dip (53°C for 2 min); C) hot benomyl dip (500 mg liter⁻¹, 53°C for 2 min); D) hot thiabendazole dip (1000 mg liter⁻¹, 53°C for 2 min); and E) control (10°C storage, water dip only—same as treatment A).

Treatments A–D were stored for 15 weeks in a cold room with fan-forced air circulation operating at 1°C ± 0.5°C, whereas treatment E was stored under similar conditions but at 10°C. Fruit were held in covered, but vented, plastic boxes and stacked in the cold room in the two replicate groups, with treatment positions allocated at random within each stack.

After 15 weeks, fruit in the control treatments had developed extensive CI. All oranges were removed from the cold room, allowed to warm to ambient temperatures, and examined for chilling injury (Fig. 1).

Refrigeration was classified into one of four CI categories similar to those used by Hatton and Cubbedge (5), where 0 = nil, 1 = slight, 2 = moderate, and 3 = severe. The CI index was determined for each treatment by summing the products of the number of fruit in each category by the value of each category and then dividing this sum by the total number of fruit assessed. CI index values were then square-root-transformed for analysis as a 5 × 2 factorial experiment and means

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compared by using the Waller–Duncan k ratio LSD rule (3) at k = 100. This level is about equivalent to the 5% level of significance. The experiment was replicated twice. This analysis showed a significant (P < 0.05) overall effect of the method of handling on CI, for all dip treatments stored at 1°C. CI was highest in the control fruit dipped in ambient water and then stored at 1°C, with an average CI index of 2.5 and with 98.4% of fruit showing the disorder to some extent.

The dip treatment effects on CI were highly significant (P < 0.001). Mean separation revealed that the hot water dip treatment and hot benomyl significantly reduced CI (P < 0.05) to the level of the ambient temperature controls stored at 10°C. The hot TBZ treatment was significantly better than either the hot water or hot benomyl treatment (P < 0.05) (Fig. 2). There was no significant interaction between the method of handling and the dip treatments.

Reasons for the dramatic reduction in CI with the hot dip treatments could be either the result of physiological changes in the rind, equivalent to that obtained in the "curing" storage process (5) or an inactivation of latent fungal infections (18), such as Colletotrichum gloeosporioides, which are often present in the rind of citrus (1). Similar infections in mangoes have been controlled by hot dip treatments (12, 15). It is possible that, in association with the many other factors that govern chilling injury incidence (11), latent infections could be weakening cell walls and predisposing fruit to CI damage when placed under chilling stress.

Laboratory Cited


