Chilling Injury to Mangos

The Big Picture:

For repeated mango purchases by consumers, high-quality mangos are a must in the marketplace to increase mango demand. Consumers are engaged to buy more fruit when they have a great experience with taste. The National Mango Board (NMB) works diligently with researchers to increase mango quality for consumers to enjoy in the U.S. However, mangos are very susceptible to various physiological disorders that influence the fruit quality. Chilling injury (CI) is among the most damaging disorders.

Mangos are generally known to be susceptible to CI at temperatures below about 12.5°C (55°F), but the relative effects of exposure to chilling temperatures on the major varieties sold in the U.S. had never been determined. Since CI decreases the flavor quality of mangos, it may be compromising marketing in the U.S. and causing great economic losses to the mango industry. Since this is an important factor to increasing mango quality, the NMB commissioned a research study to determine the time-temperature combinations that lead to CI on the most prevalent mango varieties imported to the U.S.

The study was conducted by Dr. Jeffrey Brecht and Dr. Maria Cecilia do Nascimento Nuñes from University of Florida and Dr. Fernando Maul from Universidad del Valle, Guatemala. The researchers examined mango varieties during two seasons in Florida and Guatemala. The mangos were heat treated according to the USDA APHIS protocol and were then examined after being processed through one of two experiments. In one experiment, mangos were held at several time-temperature combination treatments: 5, 7.5, 10 or 12.5°C (41, 45, 50 or 55°F) for up to four weeks, with weekly transfers to higher temperatures of 20-23°C (68-73°F) for five to six days to allow ripening or possible CI symptoms development. In the second experiment, the fruit were placed in a 5°C (41°F) room (chilling temperature) to be cooled at three different rates (slow and rapid room cooling and forced-air cooling) or placed in a 12.5°C (55°F) room (control treatment); following the cooling treatments, all of the mangos were stored for two weeks at 12.5°C, then transferred to 20°C (68°F) for five days.

Overall Findings:

- **All mango varieties are susceptible to CI.** Symptoms include:
    - Loss of aroma- The first symptom to develop and it is irreversible as chilled mangos do not recover normal aroma levels even after five days at a higher temperature.
    - Lenticel discoloration- The earliest visual symptom, which appears as soon as one week at 5°C or 2 weeks at 7.5°C.
    - Skin discoloration (gray or brown appearance) and vascular (internal) browning are the next visual symptoms, occurring after two weeks at 5°C or three weeks at 7.5°C.
    - Scald-like skin collapse appears last.

- **Susceptibility to CI differs by variety.** The Ataulfo mango variety is the most sensitive with the worst internal browning, followed by Kent, which developed a dull, bleached external appearance.
    - For the Ataulfo variety, although flesh browning development occurred around the seed after two weeks at 5°C to 12.5°C, three or four weeks at 10 and 12.5°C resulted in the worst browning.
        - Other CI symptoms for Ataulfo were:
            - Skin shriveling
            - Aroma loss (most sensitive of all the varieties)

- **Color, firmness and composition related to CI.** Low temperatures have some effects on fruit softening but there were no major effects on fruit color, dry matter, soluble solids content (°Brix) or acidity.
    - Tommy Atkins fruit retained their pulp firmness well after five days at room temperature following low temperature storage. Other varieties such as Kent and Keitt lose firmness more dramatically during this ripening period.

- **Fruit maturity also affects CI susceptibility.** In general, CI decreases as the fruit develops, matures and ripens. Thus, immature fruit are more susceptible to CI than fruit undergoing ripening.
    - Based on comparisons of the distribution of CI symptoms after storage with the distributions of harvest maturity stages that were determined at the start of each experiment, researchers determined that there is a significant reduction in CI sensitivity between maturity stage 1 (unripe) and maturity stage 2 (ripening initiated).

- **Forced-air cooling did not increase CI.** Since some mango handlers believe that forced-air cooling causes CI, researchers speculate that this belief may stem from situations in which forced-air cooled mangos that are shipped long distances in marine containers at 7-8°C (i.e., chilling temperature) may develop CI, whereas, the same mangos 'stuffed hot' and shipped at 7-8°C may not develop CI. Researchers suggest this would be because the 'hot' mangos would cool very slowly, if at all, in a container and would thus be maintained above the chilling range during transport.

Looking ahead:

Further research is necessary to determine CI susceptibility for the same mango varieties examined (Ataulfo, Francis, Keitt, Kent and Tommy Atkins) grown in other regions, in different seasons and harvesting conditions. Other suggested research includes examining mangos on different harvest dates from the same orchard, testing additional varieties, and testing the effects of various treatments that may alleviate CI. If the best time-temperature combinations are determined for each variety imported to the U.S. with all factors accounted for, higher quality mangos will be available to consumers.