Mandarin (Tangerine)

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Scientific Name and Introduction: Mandarins originated in China and southeast Asia. The names "tangerine" and "mandarin" have often been used synonymously. The term "tangerine" was first used in the nineteenth century to describe mandarins with deep orange-red external color. The mandarin/tangerine citrus group is very diverse, and attempts have been made to assign members into different categories and species. *Citrus unshiu* (satsumas), *C. deliciosa* (Mediterranean mandarin), *C. nobilis* (King mandarin) and *C. reticulata* (common mandarins) are known world-wide, but only *C. reticulata* and associated hybrids are of economic importance in the U.S. (Saunt, 2000). Dancy, Fallglo, Robinson, Sunburst and Clemantine are popular varieties in the U.S. Mandarin-like varieties, either tangors (mandarin x orange hybrids) such as Temple and Murcott or tangelos (mandarin x grapefruit hybrids) such as Minneola and Orlando, are also grown.

Quality Characteristics: High quality mandarins will have a turgid, deep orange-red peel relatively free of blemishes. The fruit should be elliptical and firm. The peel should be easily removed from the flesh. The edible portion should be juicy and contain few or no seeds.

Maturity Standards, Grade Standards and Packing: Maturity standards require that mandarins have a set minimum SSC:TA ratio and have at least 50% peel surface color break. Mandarins are packed in 4/5 bushel cartons for shipping and storage. Marketable mandarins range from size 56 (56 fruit/carton) to size 210 (210 fruit/carton).

Ethylene Production: Mandarins are non-climacteric and do not exhibit a rise in respiration and ethylene associated with ripening. Ethylene production is typically < 0.1 $\mu L\ kg^{-1}\ h^{-1}$ at 20 °C (68 °F).

Respiration Rates: Respiration rates at optimum storage temperatures are generally < 10 mg $CO_2\ kg^{-1}\ h^{-1}$ (Arpaia and Kader, 2000).

Temperature	mg $CO_2\ kg^{-1}\ h^{-1}$
5 ºC	4 to 8
10 ºC	6 to 10
15 ºC	12 to 20
20 ºC	20 to 30

To get mL $kg^{-1}\ h^{-1}$, divide the mg $kg^{-1}\ h^{-1}$ rate by 2.0 at 0 °C (32 °F), 1.9 at 10 °C (50 °F), and 1.8 at 20 °C (68 °F). To calculate heat production, multiply mg $kg^{-1}\ h^{-1}$ by 220 to get BTU per ton per day or by 61 to get kcal per metric ton per day.

Degreening: Some mandarin-growing areas, like Florida, have persistent high temperatures that prevent natural color break in the peel. In these cases, ethylene is used to degreen (cause the destruction of chlorophyll) with early-season mandarins. Ethylene is used at 1 to 5 $\mu L\ L^{-1}$ at 28 to 29 °C (82.4 to 84.2 °F) with 95% RH. Duration of ethylene exposure range from 12 h to 3 days. One complete air change per hour should enter the degreening room to avoid buildup of CO_2 that can inhibit ethylene action and assist in uniform temperature and ethylene distribution (Wardowski, 1996).

Storage: Mandarins are stored at 5 to 8 °C (41.0 to 46.4 °F) with 95% RH for periods up to 4 weeks. Chilling injury can occur in storage if temperatures fall < 5 °C (41 °F). Storage duration depends on variety, maturity and decay control. Thiabendazole (TBZ) can be incorporated into fruit coatings and used to control postharvest decays during storage.

Physiological Disorders: Mandarins have thin peels that are readily injured under conditions that promote high peel water content. Excessive soil moisture before harvest predisposes mandarins to zebra-skin. Normal handling on packingline machinery causes peel epidermal cells to rupture in areas over the fruit segment. Zebra-skin can be exacerbated by degreening.

Oleocellosis can occur on the peel when excessive squeezing force is used to harvest fruit by hand. Cells encircling oil glands die when oil from ruptured glands leak into the surrounding tissues. Generally fruit are more susceptible to oleocellosis when peel turgidity is high.

Puffiness, characterized by separation of the peel from the pulp on the tree or in storage, can also occur in mandarins. Fruit of advancing maturity appear to be most susceptible to puffiness.

Stem-end rind breakdown, or SERB, is characterized by collapse and sinking of the peel in irregularly-shaped regions near the stem end. SERB is closely associated with excessive water loss. Late-season mandarins are most susceptible to SERB.

Chilling injury is characterized by peel pitting followed by increased susceptibility to postharvest decays. Severity of chilling injury increases with temperatures below 5 °C (41 °F) and longer durations. Mandarins are susceptible to granulation, or section-drying. Susceptibility is influenced by variety and over-maturation (Grierson, 1986).

Postharvest Pathology and Control: *Stem-end rot (Diplodia natalensis* and *Phomopsis citri*) is a significant problem on mandarins, especially in areas where degreening is required in early season fruit. Stem end rots develop as latent infections on the fruit button (calyx + disc) before harvest and begin growth through the core after harvest. Decay develops unevenly at the stem and stylar ends resulting in uneven margins.

Anthracnose, caused by *Colletotrichum gloesporiodes*, is a major decay of mandarins. Anthracnose, characterized by brown peel lesions, appears on early-season mandarins that have undergone lengthy degreening periods.

Brown rot (*Phytophthora citrophthora*) develops from infections that take place in the grove before harvest. Brown rot has a characteristic rancid odor and is characterized by tan lesions that quickly overtake the entire fruit under optimum conditions.

Green and Blue Mold (*Penicillium digitatum* and *P. italicum*, respectively) develop on mandarins as a result of wounds made during the harvesting and handling process (Eckert and Brown, 1986; Whiteside et al.,1988).

Drenching harvested mandarins with TBZ before packinghouse arrival is recommended for Diplodia, Phomopsis, anthracnose and Penicillium control. Application of aqueous imazalil or TBZ in the coating treatment aids in control. Minimizing degreening time by delaying harvest will assist in controlling stem end rot caused by Diplodia and anthracnose. Brown rot is most effectively controlled by pre-harvest treatment with copper-containing fungicides. Careful harvesting and handling can reduce injuries that allow entrance of wound pathogens, such as *Penicillium*. Good sanitation of packinghouse equipment and storage areas will help control the spread of postharvest pathogens.

Quarantine issues: The recent appearance of citrus canker (*Xanthomonas axonopodis* pv. *citri*) has restricted movement of mandarins grown in affected areas in Florida. Compliance with the Citrus Canker Eradication Program (2000) is required for harvesting, packing and shipping mandarins from quarantined areas to domestic markets.

Cold treatment is an approved quarantine treatment for citrus grown in areas infested with tropical fruit flies. In Florida, the Caribbean fruit fly (*Anastrepha suspensa*) may be found in citrus groves during late

Spring and Summer months. Cold treatment involves storage of fruit below 2.2 ºC (36 °F) for specified periods to ensure their freedom from fly infestation. However, because of susceptibility to chilling injury, fruit may be stored at higher temperatures of 10 to 15 °C (50 to 59 °F) for about 1 week prior to cold treatment to increase resistance to chilling injury.

Suitability as a fresh-cut product: Some potential exists for separated segments.

References:

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