Mandarin (Tangerine)

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Scientific Name and Introduction

Mandarin originated in China and southeast Asia. The names "tangerine" and "mandarin" have often been used synonymously. The term "tangerine" was first used in the 19th 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* (satsuma), *C. deliciosa* (Mediterranean mandarin), *C. nobilis* (king mandarin) and *C. reticulata* (common mandarin) are known worldwide, but only *C. reticulata* and associated hybrids are of economic importance in the United States (Saunt 2000). 'Dancy,' 'Fallglo,' 'Robinson,' 'Sunburst,' and 'Clemantine' are popular varieties in the United States. Mandarin-like varieties, either tangors (mandarin × orange hybrids) such as 'Temple' and 'Murcott' or tangelos (mandarin × grapefruit hybrids) such as 'Minneola' and 'Orlando,' are also grown.

Quality Characteristics and Criteria

High-quality mandarin 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.

Horticultural Maturity Indices

Maturity standards require that mandarin have a set minimum SSC:TA ratio and have at least 50% peel surface color break.

Grades, Sizes, and Packing

Mandarin are packed in 4/5-bushel cartons for shipping and storage. Marketable mandarin range from size 56 (56 fruit per carton) to size 210 (210 fruit per carton).

Optimum Storage Conditions

Mandarin are stored at 5 to 8 °C (41 to 46 °F) with 95% RH for periods up to 4 weeks. Chilling injury can occur in storage if temperatures fall below 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.

Ethylene Production and Sensitivity

Mandarin are nonclimacteric and do not exhibit a rise in respiration and ethylene associated with ripening. Ethylene production is typically <0.1 μL kg^{-1} h^{-1} at 20 °C (68 °F).

Respiration Rates

Respiration rates at optimum storage temperatures are generally <10 mg CO2 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 CO_2 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 ton^{-1} day^{-1} or by 61 to get kcal $tonne^{-1}$ day^{-1}.

Degreening

Some mandarin-growing areas, such as 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) early-season mandarin. Ethylene is used at 1 to 5 μL L^{-1} at 28 to 29 °C (82 to 84 °F) with 95% RH. Duration of ethylene exposure ranges from 12 h to 3 days. One complete air change per hour should enter the degreening room to avoid buildup of CO_2, which can inhibit ethylene action, and to assist in uniform temperature and ethylene distribution (Wardowski 1996).

Physiological Disorders

Mandarin have thin peels that are readily injured under conditions that promote high peel-water content. Excessive soil moisture before harvest predisposes mandarin to zebra-skin. Normal handling on packing-line 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 is characterized by separation of the peel from the pulp on the tree or in storage. Fruit of advancing maturity appear to be most susceptible to puffiness.

Stem-end rind breakdown, 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 mandarin are most susceptible to SERB. Chilling injury is characterized by peel pitting followed by increased susceptibility to postharvest decay. Severity of chilling injury increases with temperatures below 5 °C (41 °F) and longer durations. Mandarin are susceptible to granulation, or section-drying. Susceptibility is influenced by variety and overmaturation (Grierson 1986).

Postharvest Pathology

Stem-end rot (Diplodia natalensis and *Phomopsis citri)* is a significant problem on mandarin, especially where degreening is required in early season fruit. Stem-end rots develop as latent infections on the fruit button (calyx and disc) before harvest and begin to grow 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 mandarin. Characterized by brown peel lesions, anthracnose appears on early-season mandarin 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 mandarin as a result of wounds made during harvesting and handling (Eckert and Brown 1986, Whiteside et al. 1988).

Drenching harvested mandarins with TBZ before they arrive at the packinghouse is recommended for controlling *Diplodia, Phomopsis,* anthracnose, and *Penicillium*. 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 preharvest 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 mandarin grown in affected areas in Florida. Compliance with the Citrus Canker Eradication Program (Florida Department of Agriculture and Consumer Services 2000) is required for harvesting, packing, and shipping mandarin 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. Cold treatment involves storage of fruit below 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 ºC (50 to 59 °F) for about 1 week prior to cold treatment to increase resistance to chilling injury.

Suitability as Fresh-Cut Product

Some potential exists for separated segments.

References

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