Nectarine

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Scientific Name and Introduction: Nectarine (*Prunus persica var. nectarina*) has been described for nearly as long as peach, but its origin is unknown. Because they may have arisen from peach seeds, most peach-growing areas world-wide have also introduced nectarine cultivars.

California is a major producer and shipper of nectarines in the U.S. In recent years, an important development of white-flesh nectarine cultivars has occurred. Current shipments of fresh nectarines has approached 20 million 10-kg (25-lb) packages, including more than 130 cultivars. In the San Joaquin Valley, harvest of early cultivars starts in mid-May, and harvest of late cultivars of nectarines is completed in mid-September. Nectarines are exported mainly to Canada, Taiwan, Hong Kong, Mexico, and Brazil.

Quality Characteristics and Criteria: Greater consumer acceptance is attained for fruit with high SSC. TA and SSC:TA are also important in consumer acceptance. In general, nectarines have more TA than peaches. There is no established minimum flavor-quality standard for nectarines. Fruit with 9 to 13.5 N (2 to 3 lb-force) of flesh firmness are considered ready-to-eat. Fruit < 27 N (6 lb-force) firmness are highly accepted by consumers.

Horticultural Maturity Indices: In California, harvest date is determined by skin ground color which changes from green to yellow in most cultivars. A color chip guide is used to determine maturity of each cultivar except for white-flesh cultivars. A two-tier maturity system is used in California: 1) U.S. Mature (minimum maturity); 2) Well-Mature and/or Tree Ripe. Well-Mature and Tree Ripe have the same definition according to the California Department Food and Agriculture, Division of Inspection Services.

Measurement of fruit firmness is recommended in cultivars where skin ground color is masked by full red color development before maturation. In these cases, a maximum maturity index can be applied. Maximum maturity is defined as the minimum flesh firmness (measured with a penetrometer with an 8-mm tip) at which fruit can be handled without bruising. Bruising susceptibility varies among nectarine cultivars.

Grades, Sizes and Packaging: Fruit should be hand-picked into bags, baskets or totes and then dumped into bins on trailers between tree rows in the orchard. If fruit are picked into totes, the totes are usually placed directly inside bins.

Nectarines should be transported from the orchard to a packinghouse and cooler as soon as possible after harvest. At the packinghouse, fruit are dumped (mostly using dry bin dumps) and cleaned. Sorting is done to eliminate fruit with visual defects and sometimes to divert fruit of high surface color to a high-quality pack. Sizing segregates fruit by either weight or dimension.

Most of the yellow-flesh nectarines are packed into 2-layer (tray) boxes. Small size, yellow-flesh nectarines are generally volume-fill packed. Most of the white-flesh and “tree ripe” nectarines are packed into 1-layer (tray) boxes.

Limited volumes of partially-ripe to ripe nectarines are “ranch packed” at the point of production. In a typical “tree ripe” operation, fruit are picked into buckets or totes that are carried by trailer to the packing area. Packers work directly from buckets to select, grade, size, and pack fruit into plastic trays.

Optimum Storage Conditions: Fruit can be cooled in field bins using forced-air cooling or hydro-cooling. Forced-air cooling in side-vented bins can be done by the tunnel or the serpentine method. Hydro-cooling is normally done by a conveyor type hydro-cooler or *in situ*.

Fruit in field bins can be cooled to intermediate temperatures of 5 to 10 °C (41 to 50 °F), provided packing occurs the next day. If packing is to be delayed beyond the next day, fruit should be thoroughly

cooled in bins to near 0 °C (32 °F). With cultivars susceptible to internal browning, fast cooling (within 8 h) and maintaining fruit temperature near 0 °C (32 °F) are recommended.

Nectarines in packed containers should be cooled to near 0 °C (32 °F). Even nectarines that were thoroughly cooled in bins will warm substantially during packing and should be thoroughly re-cooled using forced-air cooling after packing.

Stone fruit storage and long-distance shipments should be at or below 0 °C (32 °F). Maintaining these low temperatures requires knowledge of the freezing point of the fruit and of the temperature fluctuations in storage and transport systems. Temperature during truck transportation within the U.S., Canada and Mexico should be < 2 °C (32 °F). Holding stone fruits at these low temperatures minimizes losses due to rotting organisms, excessive softening, water losses, and severity of internal browning in susceptible cultivars.

Optimum Temperature: The optimum storage temperature is -1 to 0 °C (30 to 32 °F). The freezing point varies, depending on SSC, from -3 to -1.5 °C (26.5 to 29.5 °F). A RH of 90 to 95% with an air velocity of approximately 50 ft^3 min^{-1} is suggested during storage.

Controlled Atmosphere (CA) Considerations: The major benefits of CA (1 to 2% O_2 + 3 to 5% CO_2) during storage/shipment are retention of fruit firmness, color changes and limiting of internal browning. CA of 10% O_2 + 10% CO_2 is sometimes used for reduction of internal breakdown during storage/shipments. O_2 < 1% and CO_2 > 20% should be avoided because of associated development of off-flavors and browning.

Retail Outlet Display Considerations: If firmness is < 27 N (6 lb-force), nectarines should be displayed on a cold table. If firmness is > 27 N (6 lb-force), fruit should be displayed on a dry table.

Chilling Sensitivity: Some of the mid- and late-season cultivars are susceptible to chilling injury or internal breakdown. Chilling injury symptoms develop faster and more intensely when fruit are stored between about 2.2 to 7.8 °C (36 to 46 °F) than in those stored at 0 °C (32 °F) or below. Recently released mid- and late-season cultivars have low susceptibility to internal browning.

Rates of Ethylene Production and Sensitivity: In the following table, the lower end of the range is for mature but unripe fruit; higher values are for ripe fruit.

Temperature	µl C_2H_4 kg^{-1} h^{-1}
0 ºC	0.01 to 5
5 ºC	0.02 to 10
10 ºC	0.05 to 50
20 ºC	0.10 to 160

In general, nectarines harvested at the “well-mature” or riper stages will ripen properly without exogenous ethylene application. In some cultivars, exposure to 100 µL L^{-1} ethylene results in more uniform ripening of nectarines picked at the “U.S. mature” stage.

Respiration Rates:

Temperature	mg CO_2 kg^{-1} h^{-1}
0 °C	4 to 6
10 °C	16 to 24
20 °C	64 to 110

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.

Physiological Disorders:

Internal Breakdown (IB) or Chilling Injury is a physiological problem characterized by internal flesh browning, flesh mealiness or leatheriness, flesh bleeding, failure to ripen, and flavor loss. In most cases, the red color development inside the flesh (bleeding) is not an IB symptom, and it does not affect taste. These symptoms develop during ripening after a cold storage period, and thus, are usually detected by consumers. However, there is large variability in susceptibility to IB among cultivars. In general, nectarines are less susceptible to IB than peaches.

In susceptible cultivars, IB symptoms develop faster and more intensely when fruit are stored at temperatures between about 2.2 and 7.8 °C (36 and 46 °F) than when similar fruit are stored at 0 °C (32 °F) or below. At shipping point, fruit should therefore be cooled and held near or below 0 °C (32 °F) if possible. During transportation if IB-susceptible cultivars are exposed to approximately 5 °C (41 °F), it can significantly reduce their postharvest life.

Several treatments to delay and limit development of this disorder have been tested. Among them, pre-ripening fruit before storage is a successful, commercially-used treatment in the U.S. Success of CA (10% CO_2 + 10% O_2) depends on cultivar market-life and shipping time.

Inking (black staining) is a cosmetic problem affecting only the skin of nectarines. It is characterized by black or brown spots or stripes. These symptoms appear generally 24 to 48 h after harvest. Inking occurs as a result of abrasion damage in combination with heavy metals (iron, copper and aluminum) contamination. This usually occurs during harvesting and hauling, although it may occur during subsequent steps of postharvest handling. Careful fruit handling, short hauling, avoiding any foliar nutrient sprays within 15 days before harvest, and following suggested pre-harvest fungicide spray guidelines are recommended for reducing inking.

Postharvest Pathology:

Brown Rot is caused by *Monilinia fructicola* and is the most important postharvest disease of stone fruits. Infection begins during flowering and fruit rot may occur before harvest but often occur postharvest. Orchard sanitation to minimize infection sources, pre-harvest fungicide application, and prompt cooling after harvest are among the control strategies. Also, postharvest fungicide treatment may be used.

Gray Mold is caused by *Botrytis cinerea* and can be serious during wet Spring weather. It can occur during storage if the fruit has been contaminated through harvest and handling wounds. Avoiding mechanical injuries and good temperature management are effective control measures.

Rhizopus Rot is caused by *Rhizopus stolonifer* and can occur in ripe or near-ripe fruit at 20 to 25 °C (68 to 77 °F). Cooling fruit and keeping them < 5 °C (41 °F) is effective against this fungus.

Quarantine Issues: Because some insects such as *Conotracherlus nenuphar* (plum curculio), *Cydia pomonella* (codling moth), *Rhagoletis pommonella* (apple maggott), and *Tetranychus pacificus* (Pacific spider mite), are not present in some of our import markets, phytosanitary restrictions have been established. Issues with exotic pest quarantine, addressing imported and exported nectarines, can change rapidly. Rules regarding import requirements are issued by APHIS. They provide information to assist exporters in targeting markets and defining what entry requirements a particular country might have for nectarines. APHIS, in cooperation with the State plant boards, developed a database called “Excerpt” to track phytosanitary requirements for each country. APHIS provides phytosanitary inspections and certifications that declare nectarines free of pests to facilitate compliance with foreign regulatory requirements.

For nectarines, there are three main ways to deal with these phytosanitary requirements: inspection prior to shipment (including use of screened crates transported in sealed containers), methyl bromide fumigation treatments, and a systems approach.

A phytosanitary certificate is required to import California nectarines into Taiwan. Nectraines must be free of *Anarsia ineatella* (peach twing borer), *Conotracherlus nenuphar* (plum curculio), *Cydia pomonella* (codling moth), *Erwinia amylovora* (fire bright), *Rhagoletis pomonella* (apple maggott), *Tetranychus pacificus* (Pacific spider mite), and *Ceratitis capitata* (Mediterranean fruit fly). If these conditions can not be met, then fruit must be treated with an appropriate treatment prior to shipment. Details of the treatment must be recorded on the phytosanitary certificate.

Suitability as Fresh-cut Product: The optimal ripeness for preparing fresh-cut nectarines slices is the partially-ripe (> 27 to 49 N; 6 to 11 lb-force) or ripe (> 13 to 27 N; 3 to 6 lb-force) flesh firmness stages. These slices can be kept at 0 °C (32 °F) with 90 to 95% RH for 2 to 12 days, depending on cultivar and ripeness, while retaining good eating quality.

Special Considerations: Because nectarines are a climacteric fruit, they are harvested at a minimum or higher maturity, but are not fully ripe, ie., not ready-to-eat. Initiation of ripening must occur before consumption to satisfy consumers. Most consumers are satisfied after eating ripe fruit. However, when consumers eat unripe fruit, even of high quality, they are often not satisfied.

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