Nectarines

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Postharvest Quality Maintenance Guidelines

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Scientific Name and Introduction

The nectarine (*Prunus persica var. nectarina*) has been known and described for nearly as long as the peach, but its origin is not known. Because nectarines may have arisen from peach seeds, most of the world's peach-growing areas have also introduced nectarine cultivars.

California is a major producer and shipper of nectarine in U.S. In recent years, an important development of white-flesh nectarine cultivars has occurred. Fresh nectarines current shipments approach 20 million 10 kg (25 pound) packages from 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 on fruit with high soluble solids content (SSC). Titratable acidity (TA) and SSC/TA are also important factors in consumer acceptance. In general, nectarines have more TA than peaches. There is no established minimum flavor-quality standard for nectarines.

Fruit with 9-13.5 N (2-3 pounds-force) flesh firmness is considered "ready to eat." Fruit below 27 N (6.0 pounds-force) firmness are highly accepted by consumers.

Horticultural Maturity Indices

In California, harvest date is determined by skin ground color 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) US Mature (minimum maturity); 2) Well-Mature and/or Tree Ripe. The 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 fruits can be handled without bruising damage. Bruising susceptibility varies among nectarine cultivars.

Grades, Sizes and Packaging

Fruit are hand picked into bags, baskets or totes. Fruit are then dumped in bins that are on trailers between tree rows in the orchard. If fruit are picked into totes, the totes are usually placed directly inside the bins.

Nectarines are transported from the orchard to a packinghouse and cooler as soon as possible after harvest. At the packinghouse the 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 two 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 one 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. The packers work directly from the 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 hydrocooling. Forced-air cooling in side-vented bins can be by either the tunnel or the serpentine method. Hydrocooling is normally done by a conveyor type hydrocooler or “in situ”.

Fruit in field bins can be cooled to intermediate temperatures (5^{o} to 10^{o}C (41^{o}-50^{o}F)) provided packing will occur the next day. If packing is to be delayed beyond the next day, then fruit should be thoroughly cooled in the bins to near 0^{o}C (32^{o}F). In internal breakdown (IB) susceptible cultivars fast cooling (within 8 hours) and maintaining fruit temperature near 0^{o}C (32^{o}F) are recommended.

Nectarines in packed containers should be cooled to near 0^{o}C (32^{o}F). Even nectarines that were thoroughly cooled in the 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^{o}C (32^{o}F). Maintaining these low temperatures requires knowledge of the freezing point of the fruit and of the temperature fluctuations in the storage and transport systems. Temperature during truck transportation within the U.S., Canada and Mexico should be below 2^{o}C (32^{o}F). Holding stone fruits at these low temperatures minimizes both the losses associated with rotting organisms, excessive softening, water losses, and severity of internal breakdown in susceptible cultivars.

Optimum Temperature

-1 to 0°C (30-32°F)
Freezing point varies, depending on SSC, from -3 to -1.5°C (26.5 to 29.5°F).

90-95% Relative humidity; an air velocity of approximately 50 CFM is suggested during storage.

Controlled Atmosphere (CA) Considerations

The major benefits of CA (1-2% O_2 + 3-5% CO_2) during storage/shipment are retention of fruit firmness, color changes and limit IB. 10% O_2 + 10% CO_2 are sometimes used for reduction of internal breakdown during storage/shipments. Oxygen levels below 1% and CO_2 levels above 20% should be avoided because of associated development of off-flavors and brown discoloration.

Retail Outlet Display Considerations

If fruit firmness is below 27 N (6 pounds-force), nectarines should be displayed on a cold table. If fruit firmness is higher than 27 N (6 pounds-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 (IB). Chilling injury 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 in those stored at 0°C (32°F) or below. Recently-released mid- and late-season cultivars have low susceptibility to IB.

Rates of Ethylene Production and Sensitivity

μl C_2H_4/kg.hr (range)[z]			
0°C (32°F)	5°C (41°F)	10°C (50°F)	20°C (68°F)
0.01-5	0.02-10	0.05-50	0.1-160

[z] The lower end of this range is for mature but unripe fruit; higher values are for ripe fruit.

In general, nectarines harvested at the "Well-Mature" or riper stages will ripen properly without exogenous ethylene application. In some cultivars, exposure to 100 ppm ethylene results in more uniform ripening of nectarines picked at the "US Mature" stage.

Respiration Rates:

- 2-3 ml/kg hr at 0°C (32°F), 8-12 ml/kg hr at 10°C (50°F), and 32-55 ml/ kg hr at 20°C (68°F).
- To calculate heat production multiply ml CO_2/kg hr by 440 to get Btu/ton/ day or by 122 to get kcal/metric ton/day.

Physiological Disorders

Internal Breakdown or Chilling Injury: This physiological problem is characterized by internal flesh browning, flesh mealiness or leatheriness, flesh bleeding, failure to ripen, and flavor loss. In most of the 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 therefore should be cooled and held near or below 0^{o}C (32^{o}F) if possible. During transportation if IB-susceptible cultivars are exposed to approximately 5^{o}C (41^{o}F), it can significantly reduce their postharvest life.

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

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

Postharvest Pathology

Brown Rot: Caused by *Monilinia fructicola* 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, preharvest fungicide application, and prompt cooling after harvest are among the control strategies. Also, postharvest fungicide treatment may be used.

Gray Mold: Caused by *Botrytis cinerea* 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: Caused by *Rhizopus stolonifer* can occur in ripe or near ripe stone fruits kept at 20 to 25^{o}C (68 to 77^{o}F). Cooling the fruits and keeping them below 5^{o}C (41^{o}F) is very effective against this fungus.

Quarantine Issues

Because some insects such as Conotracherlus nenuphar (plum curculio), Cydia pomonella (codling moth), Rhagoletis pommonella (apple maggott), tetranychus pacificus are not present in some of our import markets, phytosanitary restrictions have been established. Issues associated with exotic pest quarantines, either addressing imported or exported nectarines, can change rapidly. Rules regarding import requirements are issued by the USDA Animal and Plant Health Inspection Service (USDA-APHIS). This agency provides information to assist exporters in targeting markets and defining what entry requirements a particular country might have for nectarines. USDA APHIS, in cooperation with the State plant boards, developed a data base, called Excerpt, to track the phytosanitary requirements for each country. USDA APHIS also provides phytosanitary inspections and certifications that declare the nectarines are 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 “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 (>27-49 N) or ripe (>13-27 N flesh firmness) stages. These slices can be kept at 0°C (32°F) and 90-95% relative humidity for 2 to 12 days (depending on cultivar and ripeness stage at cutting), while retaining good eating quality.

Special Considerations

Because nectarines are a climacteric fruit, they are harvested when they reach a minimum or higher maturity, but are not completely ripe ("ready to eat"). Initiation of the ripening process must occur before consumption to satisfy consumers. Most consumers will be satisfied after eating ripe nectarines, however, when consumers eat even high quality but unripe fruit, they will not be satisfied. Detailed ripening protocols for shippers and retail handlers, and for warehouse and produce managers have been developed.

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Acknowledgments

Some of the information included is from the University of California - Davis website on “Fresh Produce Facts” at http://postharvest.ucdavis.edu/produce/producefacts/