Peach

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Scientific Name and Introduction

The peach, *Prunus persicae*, is native to China and Persia (Iran); at one time it was called "Persian apple." Chinese literature dates its cultivation in China to 1,000 B.C. Carried from China to Persia, the peach quickly spread from there to Europe. In the 16th century, it was established in Mexico, probably by the Spanish. Spanish missionaries introduced the peach to California in the 18th century.

California is a major producer and shipper of peaches in the United States. Recent development of white-fleshed peach cultivars is important. Current fresh peach shipments approach 19 million 10-kg (22-lb) packages from more than 155 cultivars. In the San Joaquin Valley, harvest of early cultivars starts in mid May, and harvest of late cultivars is completed in early October. The United States exports mainly to Canada, Taiwan, Hong Kong, Mexico, and South America.

Quality Characteristics and Criteria

There is high consumer acceptance of peaches with high SSC. TA and SSC:TA are also important factors in consumer acceptance. For mid-season peaches, a minimum of 11% SSC with TA $\leq$0.7% is required to satisfy about 80% of consumers. Fruit with 9 to 13.5 N (2 to 3 lb-force) flesh firmness are considered ready to eat. Fruit with firmness below about 30 N (7 lb-force) measured on the fruit cheek have high consumer acceptance.

Horticultural Maturity Indices

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

Measurement of fruit firmness is recommended for cultivars in which 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 damage. Bruising susceptibility varies among cultivars.

Grades, Sizes, and Packaging

Fruit are hand-picked into bags, baskets, or totes. Fruit are 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 the bins. Peaches are transported from orchard to packinghouse and cooled 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. Attention to details in sorting line efficiency is especially important with peaches, which have a range of colors, sizes, and shapes. Sizing segregates fruit by either weight or dimensions.

Most yellow-flesh peaches are packed into 2-layer (tray) boxes. Small yellow-flesh peaches are generally volume-fill packed. Most white-flesh and tree-ripe peaches are packed into 1-layer (tray) boxes. Limited volumes of high-maturity fruit are "ranch-packed" at the point of production. In a typical tree-ripe operation, high-maturity or high-quality 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.

Precooling Conditions

Fruit can be cooled in field bins using forced-air cooling or hydrocooling. Forced-air cooling in side-vented bins can be accomplished 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 of 5 to 10 °C (41 to 50 °F), provided packing will occur the next day. If packing is to be delayed beyond the next day, fruit should be thoroughly cooled in the bins to near 0 °C (32 °F). In cultivars susceptible to internal breakdown, fast cooling (within 8 h), as well as maintaining fruit temperature near 0 °C (32 °F), is recommended. Peaches in packed containers should be cooled by forced-air cooling to near 0 °C (32 °F). Even peaches that were thoroughly cooled in the bins will warm substantially during packing and should be thoroughly recooled after packing.

Optimum Storage Conditions

Optimum temperature for storage is -1 to 0 °C (31 to 32 °F). The freezing point varies, depending on SSC, from -3 to -1.5 °C (27 to 30 °F). RH should be 90 to 95%, and an air velocity of approximately 50 ft^3 min^{-1} is recommended during storage.

Controlled Atmosphere (CA) Considerations

The major benefits of CA during storage and shipment are retention of fruit firmness and ground color. CA of 6% O_2 and 17% CO_2 at 0 °C is recommended for reducing internal breakdown during shipping, but the efficacy is related to cultivar, preharvest factors, temperature, market life, and shipping time. Large-sized 'Elegant Lady' and 'O'Henry' peaches stored at 0 °C benefit from an atmosphere of 6% O_2 and 17% CO_2.

Fruit size, storage atmosphere, and temperature all affect development of chilling injury. Small peaches stored in air at 0 °C have a longer market life than large fruit. At both temperatures, large-sized 'Elegant Lady' and 'O'Henry' fruit have a longer market life under CA than under air storage. However, at 3 °C (38 °F) small-sized 'Elegant Lady' in CA showed flesh browning.

Retail Outlet Display Considerations

If fruit firmness is <27 N (6 lb-force), fruit 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

Most mid-season and late peach cultivars are susceptible to chilling injury or internal breakdown. Chilling injury develops faster and more intensely in fruit stored at 2 to 7 °C (36 to 45 °F) than in those stored at 0 °C (32 °F) or below.

Ethylene Production and Sensitivity

The lower end of this range is for mature but unripe fruit; higher values are for ripe fruit:

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

In general, peaches harvested at Well Mature (higher than U.S. Mature) will ripen properly without exogenous ethylene application. In most cultivars, ethylene application to fruit harvested at U.S. Mature will ripen the fruit more uniformly without speeding up the rate of ripening.

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 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}.

Physiological Disorders

The major physiological cause of deterioration is a low-temperature or chilling injury problem generically called *"internal breakdown" (IB)*. The disorder can manifest itself as dry, mealy, woolly, or hard-textured fruit; flesh or pit cavity browning; or flesh translucency usually radiating through the flesh from the pit. An intense red color development of the flesh ("bleeding") usually radiating from the pit may be associated with this problem in some peach cultivars. In all cases, flavor is lost before visual symptoms are evident. However, there is large variability in IB susceptibility among peach cultivars. In general, peach cultivars are more susceptible to IB than nectarine and plum cultivars. At the shipping point, fruit should be cooled and held near or below 0 °C (32 °F). If IB-susceptible cultivars are exposed to 5 °C (41 °F)

during transportation, their postharvest life can be significantly reduced. Several treatments to delay and limit IB have been tested. Among them, preripening fruit before storage is being used successfully in California. The success of CA (17% CO_2 and 6% O_2) depends on cultivar market life, shipping time, and fruit size.

Inking (black staining) is a cosmetic problem affecting only the skin. This disorder is characterized by black-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 contamination by heavy metals (iron, copper, and aluminum). It occurs usually during harvesting and hauling, though it may occur in other steps of postharvest handling. Gentle handling of fruit, short hauling, avoiding foliar nutrient sprays within 15 days of harvest, and following suggested guidelines for preharvest fungicide spray intervals will reduce inking.

Postharvest Pathology

Brown rot, caused by *Monilinia fructicola,* is the most important postharvest disease of peaches. Infection begins during flowering. Fruit rot may occur before harvest but often appears after harvest. 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 is caused by *Botrytis cinerea*. It can be a serious problem during wet spring weather. It can occur during storage if fruit have been contaminated through harvest and handling wounds. Avoiding mechanical injuries and good temperature management are effective controls.

Rhizopus rot is caused by *Rhizopus stolonifer*. It can occur in ripe or near-ripe peaches kept at 20 to 25 °C (68 to 77 °F). Cooling and keeping fruit below 5 °C (41 °F) is an effective control.

Quarantine Issues

Because some insects, such as *Conotracherlus nenuphar* (plum curculio), *Cydia pomonella* (codling moth), *Rhagoletis pommonella* (apple maggot), and *Tetranychus pacificus* are not present in some of our import markets, phytosanitary restrictions have been established. Issues associated with exotic pest quarantines, addressing either imported or exported peaches, can change rapidly. APHIS issues rules regarding import requirements. This agency provides information to assist exporters in targeting markets and defining countries' entry requirements. APHIS, in cooperation with State plant boards, developed a database called "Excerpt" to track phytosanitary requirements for each country. APHIS also provides phytosanitary inspections and certifications that declare peaches free of pests to facilitate compliance with foreign regulatory requirements.

For peaches, 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, and a systems approach. A phytosanitary certificate (PC) is required to import California peaches into Taiwan. Peaches must be free of *Anarsia ineatella* (peach twig borer), *Conotracherlus nenuphar* (plum curculio), *Cydia pomonella* (codling moth), *Erwinia*

amylovora (fire bright), *Rhagoletis pomonella* (apple maggot), *Tetranychus pacificus* (Pacific spider mite), and *Ceratitis capitata* (Mediterranean fruit fly). If these conditions are not met, fruit must receive an appropriate treatment prior to shipment. Details of the treatment must be recorded on the PC.

A phytosanitary certificate is required to import California peaches into British Columbia. The PC should state that fruit are free of *Cydia molesta* (oriental fruit moth). Also, it should clearly state that fruit were produced and inspected in accordance with the systems approach guidelines agreed to by APHIS and the Canadian Food Inspection Agency. Fruit imports are unrestricted to all other Canadian provinces.

A similar program between APHIS and several Mexican agencies exists to facilitate import and assure that peaches and nectarines are free of *Cydia molesta* (oriental fruit moth), *Conotracherlus nenuphar* (plum curculio), *Rhagoletis pomonella* (apple maggot), and fruit flies (Tephritdae). Peaches imported into the United States from other parts of the world are sometimes fumigated with methyl bromide, at shipping or arrival point, following treatment schedules issued by APHIS, to prevent entry of insect pests.

Suitability as Fresh-Cut Product

The optimal ripeness for preparing fresh-cut peach slices is a flesh firmness of 13 to 27 N (3 to 6 lb-force). These slices can be kept while retaining good eating quality for 2 to 8 days (depending on cultivar) at 5 °C (41 °F) with 90 to 95% RH. Postcutting dips in ascorbate and calcium lactate, or use of MAP, may slightly prolong shelf-life.

Special Considerations

Because peaches area a climacteric fruit, they are harvested after they reach a minimum maturity but before they are completely ripe (that is, ready to eat). Ripening must be initiated before consumption in order to satisfy consumers. Detailed ripening protocols for shippers, retail handlers, warehouse managers, and produce managers have been developed.

Further Reading

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Acknowledgments

Some of the information included was taken from the University of California, Davis, website on "Produce Facts" at http://postharvest.ucdavis.edu/produce_information.

The editors of this Handbook will appreciate your input for future editions of this publication. Please send your suggestions and comments to HB66.Comments@ars.usda.gov.