Plum and Fresh Prune
Postharvest Quality Maintenance Guidelines

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Scientific Name and Introduction

Plums (*Prunus salicina)* are mainly used for fresh consumption and not for drying. Plums are also used for canning, freezing, and jam and jelly making. The Japanese plum is native to China, but was domesticated in Japan 400 years ago. It was first brought to California from Japan in 1870 by John Kelsey. In 1885, Luther Burbank imported about 12 seeds from Japan, and used them to breed many cultivars. The plum industry has increased throughout California (mainly in the central San Joaquin Valley) where most Japanese plums in the United States are grown.

Prunes are cultivars of European Plum (*Prunus domestica*, L.) which can be dried whole. Like plums, prunes can be eaten fresh (if a very sweet fruit is desired); but they also have the high sugar content necessary for successful drying. The European Plum, believed to have originated in the Near East, has been grown in parts of Europe for many centuries. Through its culture in France, the prune d'Agen was introduced to California from France by Louis Pellier, a French horticulturist who had come to California seeking gold.

Quality Characteristics and Criteria

High consumer acceptance is attained for fruit with high soluble solids content (SSC). Fruit titratable acidity (TA), sugar-to-acid ratio (SSC:TA), and phenolic content (astringency) are also important factors in consumer acceptance. There is no established minimum quality standard based on these factors. Plums with about 10

Newtons (1 kg-force) flesh firmness (penetration-force with an 8 mm tip) are considered "ready to eat".

Horticultural Maturity Indices

In most of the plum cultivars grown in California, harvest date is determined by skin color changes that are described for each cultivar. A color chip guide is used to determine maturity for some cultivars. Firmness, measured by squeezing fruit in the palm of the hand (“spring”), can also be used in a few cultivars as a maturity index.

A two tier maturity system is currently used in California: (1) US Mature (minimum maturity); and (2) California Well-Mature. Measurement of fruit firmness is recommended for plum cultivars where skin ground color is masked by full red or dark color development before maturation. Flesh firmness, measured with a penetrometer with an 8 mm-tip, can be used to determine a maximum maturity index, which is the stage at which fruit can be harvested without suffering bruising damage during postharvest handling. Plums are less susceptible to bruising than most peach and nectarine cultivars at comparable firmness.

Fresh prunes are picked on the basis of color (at least 50% of the fruit surface is red or purple) and soluble solids content (at least 16% in ‘Moyer’ and 19% in ‘French’ prunes).

Grades, Sizes and Packaging

Plums and fresh prunes are hand-picked into bags, then dumped in bins that are moved on trailers between tree rows in the orchard. At the packinghouse, plums are dumped (mostly using dry bin dumps) and washed. 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. In general, plums and fresh prunes are packed into 12.6 kg volume filled containers.

Optimum Storage Conditions

Plums and fresh prunes can be cooled in field bins using forced-air cooling, hydrocooling, or room cooling prior to packing. Packed plums and fresh prunes should be cooled by forced-air cooling to near 0°C. In late season plums and in fresh 'French' and 'Moyer' prunes, delays in internal breakdown development have been attained by storing IB-susceptible cultivars at -1.1°C. However, to store fruit at this low temperature, high soluble solids content and excellent thermostatic control are essential to avoid freeze damage during storage.

Optimum Temperature

-1.1 to 0°C. Freezing point varies from -2 to -1°C, depending on SSC. Optimum relative humidity during cold storage is 90-95% R.H.; an air circulation velocity of approximately 15 meters per minute is suggested.

Chilling Sensitivity

Postharvest life varies among cultivars and it is strongly affected by temperature management. Most of the plum and fresh prune cultivars tested in California are susceptible to chilling injury when stored at 5°C. Market life of 'Blackamber', 'Fortune', and 'Angeleno' plums at 0°C was at least five weeks. 'Show Time', 'Friar' and 'Howard Sun' plums developed CI symptoms within four weeks even when stored at 0°C. In all plum cultivars a much longer market life was achieved when stored at 0°C than at 5°C.

Responses to Controlled Atmospheres (CA)

The major benefits of CA during storage/shipment are retention of fruit firmness and delay of ground color changes. Decay incidence has not been reduced by CA of 1-2% O_2 + 3-5 % CO_2. Currently, CA has a limited use for storage (>1 month) of some cultivars such as 'Angeleno', 'Casselman', 'Santa Rosa', 'Laroda' and 'Queen Ann'.

Retail Outlet Display Considerations

If fruit firmness is below ≈22 N (2.3 kg-force), plums should be displayed on a cold table. If fruit firmness is higher than ≈22 N (2.3 kg-force), fruit should be displayed on a dry table.

Rates of Ethylene Production and Sensitivity

0.01-5 µl/kg•hr (range)* at 0°C, 0.02-15 µl/kg•hr at 5°C, 0.04-60 µl/kg•hr at 10°C and 0.1-200 µl/kg•hr at 20°C.

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

Most of the plums harvested at the California Well-Mature stage (higher than US-Mature) will ripen properly without exogenous ethylene application. However, for the slow ripening plum cultivars, exogenous application of ethylene (100 ppm) for at least 24 hours at 20°C is needed for faster and uniform ripening. These slow ripening cultivars are 'Black Beaut', 'Casselman', 'Late Santa Rosa', 'Kelsey', 'Nubiana', 'Queen Ann', and 'Roysum'.

Respiration Rates

1-1.5 ml CO_2/kg•hr at 0°C, 4-6 ml/kg•hr at 10°C, and 8-12 ml/kg•hr at 20°C.

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

- **Chilling injury**. Most plum and fresh prune cultivars express flesh translucency associated with flesh browning as chilling injury (CI) symptoms. Late plum cultivars also develop lack of juiciness in addition to these symptoms. In previous publications from South Africa, flesh translucency specifically in some plum cultivars has been called gel breakdown (Dodd, 1984). In the United States,

these symptoms are reported under internal breakdown (IB) or CI (Mitchell and Kader, 1989; and Crisosto et al., 1999). These CI symptoms normally appear after placing fruit at ripening temperatures following cold storage at 2-8 °C.

- **Internal browning.** This is a physiological disorder of 'Italian' and other cultivars of prunes that originates before harvest. It is associated with high temperatures during fruit maturation and delayed harvest.

Postharvest Pathology

- **Brown rot.** Caused by *Monilia fructicola*, this rot is the most important postharvest disease of stone fruits. Infection begins during flowering and fruit rot may occur before harvest, but often occurs during postharvest handling. Orchard sanitation to minimize infection sources, preharvest fungicide application and prompt cooling after harvest are among the control strategies. Fruit cracking makes late season cultivars more prone to decay. Postharvest fungicide treatments may be used to limit decay.

- **Gray mold.** Caused by *Botrytis cinerea*, this rot 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, good temperature management, and postharvest fungicides are effective control measures.

- **Rhizopus rot.** Caused by *Rhizopus stolonifer*, this rot can occur in ripe or near ripe stone fruits kept at 20 to 25°C. Cooling the fruits and keeping them below 5°C is very effective against this fungus.

Quarantine Issues

A phytosanitary certificate is required to import California plums into Taiwan. Plums must be free of *Anarsia lineatella* (peach twig borer), *Conotracherlus nenuphar* (plum curculio), *Cydia pomonella* (codling moth), *Erwinia amylovora* (fire blight), *Rhagoletis pomonella* (apple

maggot), *Tetranychus pacificus* (Pacific spider mite), and *Ceratitis capitata* (Mediterranean fruit fly). If these conditions can not be met, then fruit must be treated appropriately prior to shipment. Details of the treatment must be recorded on the phytosanitary certificate.

A phytosanitary certificate (PC) is required to import California plums into the British Columbia province in Canada. PC should claim that fruit is free of *Cydia molesta* (oriental fruit moth). Also it should be clearly advertised that the fruit in this shipment was produced and inspected in accordance with the "systems approach guidelines" agreed to by USDA/APHIS/PPQ and the CFIA. Fruit imports are unrestricted to all of the other Canadian provinces.

A similar "systems approach" program, between USDA/APHIS/PPQ and SAGAR/CONASAG/Dgsv, was established with Mexico to facilitate import of plums and assure that plums are free of *Cydia molesta* (oriental fruit moth), *Conotracherlus nenuphar* (plum curculio), *Rhagoletis pomonella* (apple maggot), and fruit flies (Tephritidae).

Suitability as Fresh-Cut Product

Fresh-cut plums are best kept at 0ºC in packages that would minimize water loss. Post-cutting life ranges from 2 to 5 days, depending on cultivar and ripeness stage (firmness) at the time of slicing.

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