

Asian Pear

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Scientific Name and Introduction: The cultivated varieties of Chinese and Japanese pears were developed from *Pyrus ussuriensis* Maximowicz, *P. serotina* Rehder (*P. pyrifolia* [Burman] Nakai), and possibly other native species, according to Kikuchi (1948). Hu (1937) included the Chinese varieties 'Tsu Li' and 'Ya Li' under the binomial *P. bretschneideri* Rehder. Catlin and Olsson (1966) reported the Japanese pears 'Kikusui', 'Nijisseiki' ('20th Century'), 'Seigyoku', 'Shinseiki', 'Chojuro', 'Doitsu', 'Imamura Aki', and 'Ishiiwase' were varieties of *P. serotina*, and were unable to distinguish 'Tsu Li' and 'Ya Li' from the Japanese varieties.

Asian pears remain firm, and are crisp and juicy when eating-ripe, whereas 'Bartlett' and other *Pyrus communis* Linnacus varieties become soft and melting when ripe. Asian pears are also called Oriental pears, Chinese pears, Japanese pears, nashi, sand apples, and salad pears. In fresh-fruit market reports, they are usually called "apple pears," an unfortunate and misleading term. Although most Japanese pear varieties are roundish, their texture and flavor are entirely different from those of apples. The main Chinese pear varieties are pyriform. Sometimes market reports refer to Asian pears as "apple (Shalea) pears." The name Shalea probably is derived from the word "sha li", which means "sand pear" in Chinese. 'Sha Li' is the name of one of three main groups of pears grown in China, as well as the name of an old variety in the group (Hu, 1937).

Quality Characteristics and Criteria: Freedom from mechanical injury ('Nijisseiki' pears are very sensitive to impact and compression bruising; 'Tsu Li' and 'Ya Li' pears increase in susceptibility to bruising after storage; 'Chojuro' pears are firmer and more resistant to mechanical damage). Flesh firmness (penetration force using an 8-mm tip) of 7 to 10 lb-force depending on cultivar is optimum for eating; only small changes in firmness occur during storage at 0 °C (32 °F). Asian pears should be juicy (not mealy) and sweet with 11 to 14% SSC depending on cultivar).

Horticultural Maturity Indices: Change in skin color from green to yellowish green ('Nijisseiki', 'Shinseiki', 'Tsu Li', 'Ya Li') or to golden brown ('Hosui', 'Kosui', 'Niitaka', 'Shinko'). Delayed harvest (which does not always mean higher SSC) results in increased incidence and severity of physiological disorders and greater susceptibility to physical injury.

Grades, Sizes and Packaging: Fruit should be held lightly in the palm of the hand and an upward twisting motion used to remove the fruit from the spur. A natural abscission layer forms at the spur end of the stalk and separation at this zone becomes easier as fruit mature. A pulling motion can result in damage as the stalk can be removed from the fruit.

The skin of Asian pears is very susceptible to abrasion and friction marks. Smooth-surfaced containers such as polystyrene trays, shallow plastic buckets, or plastic trays with foam pads should be used for collecting fruit.

Fruit should be placed into trays or buckets with the stem end up, preferably in single layers and packed firmly to avoid movement. Care must be taken to avoid stem punctures if fruit are packed as two or more layers. Bulk handling of fruit should be confined to the use of single trays stacked together in a large bin rather than volumes of fruit packed into large trays or bins. Once fruit is harvested it should be placed in the shade and not left in direct sunlight.

Optimum Storage Conditions: Asian pears should be stored at 0 °C (32 °F) in trays complete with packet pack and polyliners. It is necessary to maintain a RH > 90% in the storage atmosphere because fruit are

susceptible to water loss. When water loss has been greater than 5 to 7%, fruit become dehydrated and have a shriveled appearance, especially in 'Kosui' and 'Hosui.' Eating quality is also affected and fruit lack a crisp and juicy texture.

The continued presence of ethylene in the storage environment may enhance the development of skin browning and fruit senescence. Therefore, ethylene levels in the coolstore should be kept as low as possible. Asian pears should not be stored for long periods with fruit that produce high levels of ethylene.

Damaged or decayed fruit or fruit with disorders produce higher levels of ethylene than sound fruit and should not be stored alongside sound fruit.

Forced-air cooling is not recommended for Asian pears. Results from experiments conducted with Asian pears grown in New Zealand indicate that there is no benefit to fruit quality (fruit firmness and SSC) from rapid pre-cooling. Furthermore, fruit are likely to have a higher incidence of flesh spot decay during storage if they have been rapidly cooled within 24 h of harvest. Therefore, it is recommended that fruit be room cooled after harvest.

Optimum Temperature: Optimum storage conditions are $0\text{ }^{\circ}\text{C} \pm 1\text{ }^{\circ}\text{C}$ ($32\text{ }^{\circ}\text{F} \pm 2\text{ }^{\circ}\text{F}$) with RH of 90 to 95%. The freezing point is $-1.5\text{ }^{\circ}\text{C}$ ($29\text{ }^{\circ}\text{F}$); it will vary depending on SSC.

Respiration Rates:

Temperature	mg CO ₂ kg ⁻¹ h ⁻¹
0 °C	2 to 8
20 °C	20 to 30

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.

Controlled Atmosphere (CA) Considerations: Based on limited studies it appears that the magnitude of CA benefits for Asian pears is cultivar-specific and is generally less than that for European pears and apples. CA may extend storage duration of some Asian cultivars by about 25% relative to storage in air. O₂ levels of 1 to 3% for some cultivars (such as 'Nijisseiki') or 3 to 5% for others (such as 'Ya Li') help retain firmness and delay changes in skin color. Asian pears are sensitive to CO₂ injury ($> 2\%$ CO₂ for most cultivars) when stored > 1 mo.

Retail Outlet Display Considerations: Display shelf should be kept as cold as possible without freezing or ice.

Rates of Ethylene Production and Sensitivity: Some cultivars (such as 'Nijisseiki', 'Kosui', and 'Niiitaka') produce very little ethylene at $< 0.1\text{ }\mu\text{L kg}^{-1}\text{ h}^{-1}$ and have a non-climacteric respiratory pattern (no rise in CO₂ production during ripening). Other cultivars, such as Tsu Li, Ya Li, Chojuro, Shinsui, Kikusui, and Hosui have a climacteric respiratory pattern and produce ethylene up to 9 to 14 $\mu\text{L kg}^{-1}\text{ h}^{-1}$ (Tsu Li and Ya Li) or 1 to 3 $\mu\text{L kg}^{-1}\text{ h}^{-1}$ (other cultivars) at 0 °C (32 °F).

Exposure of climacteric cultivars to $> 1\text{ }\mu\text{L L}^{-1}$ ethylene accelerates loss of green color and slightly increases softening at 20 °C (68 °F). The effects at 0 °C (32 °F) are minimal.

Physiological Disorders: Internal breakdown and chilling injury can be a problem with Chinese pear cultivars, such as Ya Li, Daisui Li, Seuri, Tse Li, Shin Li, and Korean pears, such as Shingo, Okysankichi, and Dan Be. Internal browning or core breakdown is the main worldwide consumer complaint. Development of brown to dark-brown water-soaked areas in the core and/or flesh occurs during storage, with no visible external indication of internal browning.

Fruit grown under California conditions and picked later than 180 days (3000 degree days) after full bloom are likely to develop browning during storage. The fruit should be picked when most of the pears on the tree are still green, although it is alright if a few at the top have begun to develop some light-yellow spots. Fruit picked when the skin is completely yellow will develop internal browning within 1 mo after harvest. In China, reduction of 'Ya Li' internal breakdown has been accomplished using a temperature program that decreases storage temperature gradually.

Flesh Spot Decay (FSD) can be a problem with Japanese pear cultivars. FSD is more frequent on large (± 300 g) and over-mature fruit. FSD limits opportunities to grow and market Japanese pears. Symptoms include partial browning of spots and/or development of cavities in Asian pear flesh. It appears along and around the vascular bundles when the symptoms are severe, but there is no external indication of the disorder. Generally, FSD is more pronounced above the equator of the fruit (towards the stem end), but it can also be observed all the way down to the calyx. Cavities are usually dry and surrounded by apparently healthy tissue. This disorder can occur in fruit while still on the tree. It is more obvious, however, after 2 to 6 weeks cold storage. The cause of FSD is still unknown. However, climatic factors, such as a fluctuating hot and cool Summer, or high rainfall right before harvest may enhance the incidence of this disorder. There is no effective way to control FSD since definite causes have not been identified. The problem is the inability to predict FSD without cutting the fruit. Further research needs to be done to determine the causes, variety susceptibility in local climates, and other control methods either pre- or postharvest that will reduce FSD symptoms to a commercially acceptable level. Meanwhile, avoid whenever possible the following conditions that might induce FSD: low crop load (large fruit), later picking (advanced maturity), extreme temperature changes during the maturation season, sunburn, erratic irrigation or precipitation (frequency, amount and timing), harvesting fruit under warm temperatures, and cooling the fruit rapidly.

Low O₂ injury manifests itself as discolored surface depressions from exposing 'Nijisseiki' pears to $\leq 1\%$ O₂ for 4 mo at 0 °C (32 °F) and from exposing 'Ya Li' and 'Tsu Li' pears to $\leq 1\%$ O₂ for 2 mo, $\leq 2\%$ O₂ for 4 mo, or $\leq 3\%$ O₂ for 6 mo at 0 °C (32 °F).

High CO₂ injury is manifested as core or medial flesh browning, with cavities developing in severe cases as a result of desiccation of dead tissue. 'Ya Li' pears can exhibit CO₂ injury after exposure to $\geq 5\%$ CO₂ for 6 weeks at 0 °C (32 °F).

Watercore symptoms (glassy diffuse water-soaked areas in flesh; affected areas may taste sweet and turn slightly brown) occur in some cultivars (eg., 'Nijisseiki', 'Shinseiki', 'Hosui') under conditions favoring vigorous tree growth. Avoid harvesting over-mature fruit to reduce watercore incidence and severity.

Superficial scald or skin browning can occur after long-term (> 16 weeks) storage of 'Shinsiki' and 'Nijisseiki' fruit. Long-term storage can lead to the development of a skin disorder that is characterized by the appearance of scald-like browning symptoms. Initially, the affected areas of the skin are light brown in color, but as the disorder progresses the skin becomes dark brown and develops a bronze, scald-like appearance. The disorder is confined to the skin and is similar to superficial scald in apples. Scald appears to be a problem associated with packaging in that most of the scald appears at the calyx end or that portion of the fruit which is tightly confined within the pocket of the pocket pack. However, the whole fruit surface is susceptible to the disorder, which is rapidly induced if Asian pears are stored together with apples.

To avoid the disorder, adequate ventilation during storage and storage of fruit in a relatively ethylene-free atmosphere is recommended.

Postharvest Pathology: Asian pear fruit are susceptible to many pathogens, such as *Botrytis*, *Alternaria* and *Phomopsis* species. These pathogens invade fruit through wounds caused by mishandling of fruit after harvest. The rots develop slowly in fruit during storage and eventually the whole fruit becomes affected. Affected flesh areas become soft and discolored. Damage to fruit surfaces by birds while fruit are on the tree can provide entry points for pathogens.

Quarantine Issues: Limited import (Chile) and export (Canada) activity is occurring. If imported from Chile, Asian pear shipments must be accompanied by a PPQ (Plant Pest Quarantine Form 203) signed by the USDA - Animal Plant Health Inspection Service (APHIS) inspector on site in Chile. If shipments were not pre-cleared at origin, sampling at arrival time is necessary. APHIS issues rules regarding import requirements. They provide information to assist exporters in targeting markets and defining what entry requirements a particular country has. APHIS, in cooperation with the State plant boards, developed a database called “Excerpt” to track phytosanitary requirements for each country. APHIS also provides phytosanitary inspections and certifications that declare fruit are free of pests to facilitate compliance with foreign regulatory requirements. Issues associated with exotic pest quarantines, addressing both imported and exported fruit, change rapidly.

Suitability as Fresh-cut Product: Preliminary research (Kader et al, unpublished) has shown that fresh-cut Asian pear slices have a very short shelf-life, even at optimal temperature of 0 to 2 °C (32 to 35.6 °F) due to tissue browning. Dipping slices in 1% ascorbate + 1% CaCl₂ for 2 min soon after slicing delays browning, but shelf-life is < 5 days at 2 °C (35.6 °F).

Special Considerations: The five varieties ‘Shinsui’, ‘Shinseiki’, ‘Kosui’, ‘Hosui’, and ‘Nijisseiki’ all have an adequate storage-life. If fruit are harvested at the recommended maturity, a storage-life of 12 to 20 weeks and a subsequent shelf-life of 10 to 15 days can be expected, depending on the variety. The major limitation to the storage-life of Asian pears is development or enhancement of maturity-related disorders.

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