Asian Pears
Postharvest Quality Maintenance Guidelines

Carlos H. Crisosto
Pomology Department
University of California
Davis, CA 95616

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 chromatographically 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 the 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 also the name of one of the three main groups of pears grown in China, as well as the name of an old variety within the group (Hu, 1937).

Quality Characteristics and Criteria

Freedom from mechanical injuries ('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^{o}C (32^{o}F). Asian pears should be juicy (not mealy) and sweet (11 to 14% soluble solids concentration 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 soluble solids concentration) 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 0ºC (32ºF) in trays complete with packet pack and polyliners. It is necessary to maintain a high humidity (greater than 90%) in the storage atmosphere because fruit are susceptible to water loss. When water loss has been greater than 5-7%, 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 soluble solids concentration) from rapid precooling. Furthermore, fruit are likely to have a higher incidence of flesh spot decay during storage if they have been rapidly cooled within 24 hours of harvest. Therefore, it is recommended that fruit be passively cooled after harvest.

Optimum Temperature

$0^{o}C \pm 1^{o}C$ ($32^{o}F \pm 2^{o}F$)
Freezing point: $-1.5^{o}C$ ($29^{o}F$); may vary depending on soluble solids concentration. Humidity: 90-95% R.H.

Rates of Respiration

1-4 ml CO_2 / kg•hr 0ºC (32ºF)
10-15 ml CO_2 / kg•hr 20ºC (68ºF)

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.

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 durations of some Asian cultivars by about 25% relative to storage in air. Oxygen levels of 1-3% for some cultivars (such as 'Nijisseiki') or 3-5% for others (such as 'Ya Li') help retain firmness and delay changes in skin color. Asian pears are sensitive to CO_2 injury (above 2% CO_2 for most cultivars) when stored longer than a month.

Retail Outlet Display Considerations

Cold table display.

Rates of Ethylene Production and Sensitivity

Some cultivars (such as 'Nijisseiki', 'Kosui', and 'Niitaka') produce very little ethylene (<0.1 µl/kg•hr) and have a non-climacteric respiratory pattern (no rise in CO_2 production with ripening).

Other cultivars (such as 'Tsu Li', 'Ya Li', 'Chojuro', 'Shinsui', 'Kikusui,' and 'Hosui') have a climacteric respiratory pattern (rise in CO_2 production with ripening) and produce ethylene, up to 9 to 14 µl/kg•hr ('Tsu Li' and 'Ya Li') or 1 to 3 µl/kg•hr (other cultivars) at 0^oC (32^oF).

Exposure of climacteric cultivars to >1 ppm ethylene accelerates loss of green color and slightly increases softening at 20^oC (68^oF). The effects at 0^oC (32^oF) are minimal.

Physiological Disorders

Internal Breakdown or Chilling Injury

Chinese pear cultivars such as 'Ya Li', 'Daisui Li,' 'Seuri,' 'Tse Li,' 'Shin Li,' and Korean pears such as 'Shingo,' 'Okysankichi,' and 'Dan Be' are affected. Internal browning of Asian pears is the main worldwide consumer complaint. Development of brown to dark brown water-soaked areas in the core and/or flesh occurs during storage. There is 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 a few at the top may begin to develop some light-yellow spots. Fruit picked when the skin is completely yellow will develop internal browning within one month after harvest. Prompt cooling of fruit is recommended as delays in cooling increase the incidence of internal browning in Chinese pears that are beginning to turn yellow.

Flesh Spot Decay (FSD)

Japanese pear cultivars such as 'Shinseiki,' 'Nijisseiki,' 'Kikusui,' and 'Hosui.' FSD is more frequent on large size ($\geq$300 g) and overmature fruit. FSD limits opportunities to grow and market Japanese pears.

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 2-6 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 oxygen injury: (discolored surface depressions) resulted from exposing 'Nijisseiki' pears to $\leq$1% O_2 for 4 months at 0^{O}C (32^{O}F) and from exposing 'Ya Li' and 'Tsu Li' pears to $\leq$1% O_2 for 2 months, $\leq$2% O_2 for 4 months, or $\leq$3% O_2 for 6 months at 0^{O}C (32^{O}F).

High carbon dioxide injury (core or medial flesh browning; cavities may develop in severe cases as a result of desiccation of dead tissue). 'Ya Li' pears exhibited CO_2 injury after exposure to $\geq$5% CO_2 for 6 weeks at 0^{O}C (32^{O}F).

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

Superficial scald or skin browning: The long-term storage (more than 16 weeks) of 'Shinsiki' and 'Nijisseiki' fruit 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 the fruit through wounds caused by mishandling of fruit during postharvest life. The rots develop slowly in fruit during storage and eventually the whole fruit becomes affected. The affected areas of the flesh become very soft and discolored. Damage to the fruit surface by birds while the fruit are still on the tree can also provide entry points for the pathogens.

Special Considerations

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

References

Beutel, J. 1990. Asian pears, p. 304-308. In: J. Janick and J.E. Simon (eds.). Advances in new crops. Timber Press, Portland, OR

Crisosto, C.H., K.R. Day, S. Sibbett, D. Garner, and G. Crisosto. 1994. Late harvest and delayed cooling induce internal browning of 'Ya Li' and 'Seuri' Chinese pears. HortScience 29(6):667-670.

Davis, L.D. and W.P. Tufts. 1941. Pear growing in California. Calif. Agr. Ext. Serv. Circ. 122.

Griggs, W. and B. Iwakiri. 1997. Asian pear varieties in California. Univ. of California DANR Publ. 4068, Oakland.

Hu, C.C. 1937. The variety and distribution of pears in China. Nanking J. 7(1): 103-193.

Lallu, Nagin. 1990. Fruit growth, handling and storage, p. 53-74. In A.G. White (ed.). Nashi, Asian pear in New Zealand, DSTR Publishing, Wellington.

Lidster, P.D., G.D. Blanpied, and R.K. Prange (eds.). 1990. Controlled-atmosphere disorders of commercial fruits and vegetables. Agric. Canada Publ. 1847/E, 58 p.

Porritt, S.W., M. Meheriuk, and P.D. Lindster. 1982. Postharvest disorders of apples and pears. Agr. Canada Publ. 1737/E.

Acknowledgments

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