



POST HARVEST HANDLING AND STORAGE



Once harvested, exposure of litchi fruits to the sun and air can increase water loss by many folds. Therefore, harvested fruits can be kept at cooler place in the orchard or in temporary thatched house for cooling. A tarpaulin can be used to protect the fruit, but must be kept clean to prevent the build-up of pathogens. Spraying the fruit with water may help to maintain fruit quality in hot, dry weather. The transfer of fruit to the pack house soon after harvest minimizes the opportunity for water loss in the field. Transporting the fruit dry and fairly tightly packed reduces the risk of vibration damage.

Sorting of produce can be done during the harvest operation itself. Scarred, cracked, discoloured or otherwise affected fruits can be placed in separate harvest containers or discarded completely and removed from the field later. Precise operations such as washing and grading according to critical size, colour, etc may be better performed in a pack house. There is a tendency/ practice of packing produce directly into final marketing containers in the field, reducing the number of times the produce is handled with a corresponding reduction in the amount of injury caused but this requires appropriate grading, precooling and packaging facilities and adequate supervision.

Collection and bringing harvested produce together for the purpose of further process is necessary. Field assembly should be planned bearing in mind the best location and the provision of basic facilities. Containers filled with produce should not be left exposed to sunlight. As with all aspects of post-harvest, the objective of assembly should be to develop a system which minimizes stress on the produce and keeps handling operations to a minimum but with maximum care and to keep the time between harvest and first destination of the produce as brief as possible.

Sorting and Grading

To get the produce from big orchard to a collection point by the roadside may involve passing over one or more kilometers of farm roads. Growers rarely give sufficient attention to the logistics of this operation but it should be done properly. Specific fruit quality is maintained

by removing damaged and inferior fruit during sorting. Close attention to all the fruits under good lighting is required at this stage. The entire surface of each fruit must be observed to ensure that damaged specimens are not packed. Damage extending to the aril rapidly leads to rots, which may spread to sound fruit within the package. For this reason, fruit with pulled stems, splits, cracks and insect damage should be rejected at this stage. Immature fruit and fruit showing any signs of rot are also removed during sorting.

Finally, the fruits are graded according to their size, weight, colour and maturity. Grading separates fruit into different grades to suit different markets. Most producers have at least two grades of fruit. Grading is normally carried out during or after sorting. Grading systems depend on market requirements, but are normally based on fruit size and colour, and the area of blemish. Export markets usually have higher standards than domestic markets, requiring uniform, unblemished fruit. There can also be differences within different sections of the domestic market. As per fruits and vegetables grading and marking rules, 2004 in schedule, the grade designation and quality of litchi for export will be:

- (i) Litchi shall be:
 - (a) whole, sound, fresh in appearance.
 - (b) clean, free from any visible foreign matter.
 - (c) free from pests affecting the general appearance of the produce.
 - (d) free from damage caused by pests.
 - (e) free from abnormal external moisture excluding condensation following removal from cold storage.
 - (f) free from any foreign smell and/or taste.
 - (g) free from damage and abrasion.
 - (h) free from brown markings.
- (ii) Litchis shall have minimum equatorial diameter of 23 mm.
- (iii) Litchis shall comply with the residue levels of heavy metals, pesticides and other food safety parameters as laid down by the Codex Alimentarius Commission for exports.
Litchis shall be presented under one of the following forms:
 - (a) *Individually*: In this case the pedicel must be cut at the first knot and the maximum length of the stalk must not extend more than 2 mm beyond the top of the fruit. Litchi in special grade must be presented individually.
 - (b) *In bunches*: In this case the bunch must include more than three attached and well formed litchis. The branch must not exceed 15 cm in length.

Pre-cooling

To remove the field heat litchi fruit should be hydro-cooled or air-cooled. Pre-cooling requirement of a fruit is largely determined by its physiology in relation to harvest maturity

Table 18.1: Criteria for grade designation

Grade designation	Grade Requirements	Grade tolerances
Extra class (Equatorial diameter 33 mm)	Litchis must be of superior quality. They must have the shape, development and colouring that are typical of the variety and/or varietal type. They must be free of defects, with the exception of very slight superficial defects, provided these do not affect the general appearance of the produce, the quality, the keeping quality and presentation in the package.	5% by number or weight of litchi not satisfying the requirements for the grade, but meeting those of Class I grade or exceptionally coming within the tolerances of that grade.
Class I (Equatorial diameter 28 mm)	Litchis must be of good quality. They must be characteristic of the variety and/or commercial type. The following slight defects however may be allowed provided these do not affect the general appearance of the produce, the quality, the keeping quality and presentation in the package: - slight defects in shape, - slight defects in colouring, - slight skin defects, Provided these do not exceed a total area of 0.25 sq.cm.	10% by number or weight of litchis not satisfying the requirements of the grade, but meeting those of Class II grade or, exceptionally coming within the tolerances of that grade.
Class II (Equatorial diameter 23 mm)	This grade includes litchis which do not qualify for inclusion in the higher grades, but satisfy the minimum requirements specified in general characteristics. The following defects may be allowed, provided, the litchis retain their essential characteristics as regards the quality, the keeping quality and presentation: -defects in shape. -defects in colouring. -skin blemishes provided these do not exceed a total area of 0.5 sq. cm.	10% by number or weight of Litchis not satisfying the requirements of the grade, but meeting the minimum requirements.

and ambient temperature at harvest time. Highly perishable litchi must be pre-cooled before storage, as the ambient temperature at the time of harvest in India varies from 25-30°C with 40-45% RH. This is highly detrimental for storage of litchi fruits causing rapid desiccation. There are two methods for pre-cooling of fruits after harvest i.e. hydro-cooling and air-cooling. Cooling speed is generally greater in hydro-cooling system without dehydration than air-cooling. When hydro-cooled, the internal temperature of the fruit is reduced to 5°C within 18 minutes, whereas air-cooling takes longer time. Hydro-cooled fruits packed in polyethylene-lined boxes remain fresh and give the best appearance after 6 days of storage at 5°C. The pre-cooling treatment, however, has also been found advantageous even for storage at relatively higher temperature. Pre-cooled litchi fruits, when treated with 0.5% lectithin and 2.5% sodium bicarbonate and packed in 0.04 mm polyethylene bags, retain their fresh colour upto 8 days of storage at room temperature (25°C). Hydro-cooling of litchi at 0-2°C and maintenance of a cold chain throughout its post harvest life i.e. from picking to retailers shop has been found useful (Fig. 18.1). Fruit which are to be sold in local markets should not be refrigerated, since on subsequent exposure to heat or humid air rotting will quickly set in.

Packaging and Transport

Sorting, grading and packing are often carried out in a pack house or shed, to protect workers and fruit from the heat. Where shelter is not available, operations are best located in a cool,

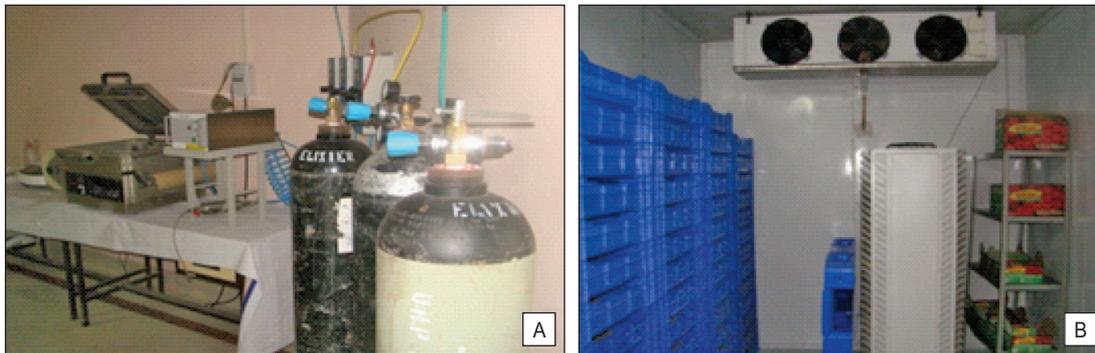


Fig. 18.1: Methods to enhance shelf life of litchi fruits by (A) MAP, and (B) cold storage

shady area. Where temperature should not be more than 12-15°C. Good hygiene in the pack house is required to avoid the spread of diseases during handling. Pathogens can build-up on packing surfaces and fruit crates. These surfaces should be washed with sanitizing agents such as chlorine every day. Water and fungicide dips also require frequent replacement or sanitizing. Waste fruit need to be regularly removed from the packing area to reduce the spread of spores. Proper packing, labeling and safe transport are to be done for good revenue.

After harvesting, fruit should be packed as quickly as possible, as their quality deteriorates markedly if they are exposed to sun even for a few hours. Litchi can be packed in panicles, or as individual fruit. Fruit are often sold on panicles in Asia, whereas loose fruit are more common in Australia, Europe and North America. De-stalking is required when fruit harvested on panicles and packed individually. The first step in the packing process consists of cutting but allowing a portion of the pedicel to each fruit. All the cracked or damaged fruits must be removed, because such fruit ferment within 1 or 2 days due to bacterial activity, thus creating favourable conditions for a fungus attack, which could then spread to healthy fruits.

Browning in litchi fruit occurs within 24 hours at ambient temperatures of 20-30°C due to enzyme activity, probably an aerobic system of oxidative poly phenolase which is accelerated by drying. Two conditions, humidity and low temperatures are vital to prevent darkening and to preserve the taste qualities of the fruit. This was a well-known fact in ancient China where it was customary to spray the fruits with a solution of cold salt water and then pack them in bamboo containers sealed with clay. It is worth noting that while low temperatures help to prevent rot from developing, high humidity has a negative effect and care should be taken to ensure that humidity is not excessive.

Selection of packaging depends on market preferences and availability. The ideal package protects fruit from damage and minimizes water loss and condensation. For domestic markets litchi is usually packed in small bamboo baskets or wooden crates. Much of the fruit marketed in Asia is transported in bamboo baskets. Square baskets less than 30 cm high give good protection against injury. Circular baskets can be improved by tying strings in two or three directions across the top, with padding underneath. The outer layers of fruit in these baskets

are prone to rapid water loss. This can be alleviated by lining the baskets or by covering them with a tarpaulin. Many of the larger commercial operations now consign their fruit in plastic trays or cardboard boxes, which provide better control of water loss. Some growers in Asia dip their fruit in cold water or cover their fruit with ice. However, very low temperatures can injure the fruit. Free water around the fruit as the ice melts can also increase the risk of diseases.

Proper packing of fruits is important in maintaining freshness and quality and preventing fruit decay during transit for marketing to distant places. These are lined with litchi leaves or other soft packing material as paper savings, wood-wool, etc. *Sissum* leaves are supposed to be the best material for packing. A good box for packing fruits should be light in weight, shallow and rigid enough to protect the fruits. It should have few holes for ventilation and rope handles on either side for lifting the box. Fruits are packed in clusters along with few leaves. Plastic packaging combined with cool storage or fungicides has also been recommended. However, without good temperature control, plastic covers result in condensation and an increased risk of rots.

Labeling

Growers packing litchi for sale in the domestic markets must mark on the top of the box the following information:

- The name of the grower or packing establishment.
- Street/road and area, not the postal address.
- The litchi variety, class and count if packed in litchi cartons.
- Date on which fruit was packed.
- Fruit in bulk packs must have the weight shown instead of count number.

Transport

Poor transport conditions are a major problem of litchi in India. The main limitations, including rough roads, lack of refrigeration and poor truck suspension which are out of the control of growers. However, with the advancement of transport facilities and road connectivity, the situation has improved in almost all the litchi growing states, the huge quantities of fruit are transported from distant producing centers mainly by road and sometimes by rail. For local market the harvested fruits are packed and transported by trucks. While transporting litchi, following care should be taken.

- Packing between vehicles and baskets with soft straw or leaves can help cushion the blow but it should be clean. Shelves can be used in the truck to avoid stacking of baskets, and reduce damage to fruit. Padding and strapping the baskets can restrict movement during transport. Vehicles should be driven slowly. Do not ride on top of the produce.
- Fruit are often damaged when baskets are overfilled, dropped, stacked or packed on their sides. Vehicle should be shaded from both sun and rain.

- Fruit can be protected by covering the baskets with a clean tarpaulin or similar material. However, it should not prevent ventilation of the produce.
- Often the above points are overlooked because the operators argue that the produce does not have far to travel and the produce is not expected to be on the vehicle for long. Unfortunately, drivers do have the habit of making unscheduled stops during their journeys. They may stop due to road blockage or due to personal work and often the Van is parked in the full sun.
- Exposure to warm air can dry out the fruit very quickly, so transport during the warmer part of the day is best avoided, if possible.
- For better quality fruits of litchi cool chain should be maintained.

The major concern to traders and growers is the exorbitantly high rates charged by truck operators for transporting litchi. Taking advantage of the very short shelf life of litchi, truck operators are demanding double the normal freight charge. The railways also provide facilities for transporting litchi by attaching bogies on a daily basis. However, the desired impact of this initiative is yet to be felt at the field level.

Storage

Storage is essential for extending the consumption period of fruits, regulating their supply to the market and also for transportation to long distances. Factors affecting storage life are, post harvest disease infection, pressure damage caused by over filling packages, package failure due to over stacking (collapse of bottom layers) and moist cartons losing compression strength when stacked. Litchi fruit cannot be kept for more than a few days after harvest, at room temperature. If marketing is delayed, fruits should be kept in cold storage to avoid rapid loss of colour and quality. Pre-cooling of fruits should be done before cold storage because without pre-cooling, browning could be more rapid compared to the storage of pre-cooled fruits at 2-5°C. It brings not only appreciable reduction in the rate of ageing and water loss in the fruits, but also makes litchi hardy on prolonged cold storage.

The cold storage without pre-cooling and chemical treatment has less impact on colour maintenance. Pre-cooling as well as chemical treatment has recorded shelf life upto 27 days at 5°C. Fruits treated with 2% sodium hypochlorite can be stored satisfactorily in perforated polythene bags at 0-3°C for 25 days. For short-term storage less than two weeks, a temperature of 7°C is satisfactory. A relative humidity should be kept at 90-95% throughout storage and transport. Controlled atmosphere storage (3-5% O₂ and 3-5% CO₂) reduces skin browning and slows down the losses of ascorbic acid, acidity, and soluble solids. Exposure to oxygen levels below 1% and/or carbon dioxide levels above 15% may induce off-flavors and dull gray appearance of the pulp.