Papaya Postharvest Losses During Marketing

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Postharvest losses generally are categorized into those that occur during storage, during transport, or at the wholesale, retail, or consumer level. Wholesale and retail losses are sometimes referred to as "shrink" (Kasmire 1975). Losses at the consumer level have been measured by holding samples under conditions that simulate those in home kitchens (Ceponis and Butterfield 1973), by analyzing the garbage thrown away by various segments of the population (Rathje et al. 1976), or by asking housewives to weigh all discarded food during a given test period (Rathje et al. 1976). In all of these procedures the amount of loss is determined, and in general no allowance is made for losses in quality aspects (Kader 1983).

Losses of papaya along the marketing chain can be ascribed to a number of specific causes. As with other fruit losses in handling chains, these loss causes are normally due to parasitic diseases, physiological disorders, mechanical damage, and overripe fruit (Ceponis and Butterfield 1981). In addition, quality losses can be a problem due to changes in appearance, texture, and flavor (Kader 1983).

The National Academy of Science in 1978 estimated postharvest losses of papaya as ranging from 40 to 100 percent. This figure was derived from a personal communication and probably only applies to the situation in a developing country. Pantastico et al. (1979) estimated for the Philippines that papaya postharvest loss ranged from 20 to 26 percent, with 8–12 percent of the loss being due to decay, 2–4 percent due to overripening, and 10 percent due to mechanical injury. A similar total loss figure of 21 percent was determined for Taiwan (Liu and Ma 1983). The loss in Taiwan occurred mainly at the retail level (14.3 percent), with 7.3 percent loss at wholesale and 2.1 percent during transportation. Though these figures were obtained in a different handling environment, they do indicate an upper level of possible loss.

In 1992, Hawaii shipped 37.5 million pounds of fresh papaya. Most of this went to the mainland U.S. and Japan. Before specific interventions to reduce losses can be introduced, it is necessary to determine what is causing the various losses. The need for this information is heightened by the change to the forced hot air disinfestation treatment. In 1992, USDA inspected 59,638 cartons of Hawaii papaya and reported a range of defects (Table 1). Decay and mold were found in 73 percent of the inspected cartons, with 52 percent of the cartons having sunken defects. Total percentage higher than 100 percent indicates that more than one defect was found in one carton. Scarring and bruising were found on fruit in 72 percent of cartons; both indicate mechanical injury. It is unclear if overripe and soft fruit are the same conditions. These do not include losses that would occur at the retail level.

An additional object of the current program to estimate sources and extent of losses is to show wholesalers and retailers that Hawaii's shippers are interested in shipping high quality papayas. This perception could lead to better communication on loss problems and suggestions for changes. Also, shippers' concerns regarding the subsequent handling of this commodity would be made known to the wholesalers and, more particularly, retailers. At all steps, proper handling procedures could be reinforced and greater care taken in the handling of Hawaii papaya.

Table 1. Postharvest defects of papaya shipped to the U.S. mainland, reported on USDA 1992 inspection reports.

Defect	Percent
Decay	70.2
Mold	3.1
Sunken	51.5
Discoloration	11.8
Overripe	5.8
Soft	43.7
Scar	21.0
Bruising	51.4
Brown spot	5.2
Shrivelled	6.5

On March 31 and April 1 we interviewed and inspected papaya handling by the Los Angeles wholesalers. The wholesalers visited included Pacific Banana (Mr. Papaya), host: Adolph Robles; Vegland (Calavo), host: Jeffrey Long; Los Angeles Wholesale Markets; Umina Brothers (Calavo), host: Larry Hoy; Olympic Distributors (Mr. Papaya and Calavo), hosts: Adolph Robles and Manny Del Toro; Valley Produce (Calavo), host: Bill Flynn; and Blue Pacific (Ono Pac), host: Sam Nomura. Supermarkets were also visited.

The following problems were seen or voiced by distributors during the visit. These are not in order of significance, but grouped as to marketing, physiological, and pathological. Papaya fruit observed on the retail shelves were, almost without exception, of very poor quality. Fruit had chilling injury scald and were diseased, shriveled, and had many mechanical injuries. This damaged fruit was not being removed from the display as new fruit were put out for sale. We were embarrassed by the fruit condition.

All cartons of papaya shipped to California are repacked by the distributor or wholesaler to cull diseased and damaged fruit and to sort for color uniformity. Air-shipped fruit usually arrived in much better condition but good fruit quality was also seen in surface-shipped fruits. The fact that all distributors/wholesalers repack papayas shows that they do not have confidence in the quality of Hawaiian papayas shipped to the U.S. mainland. Apparently, papaya quality was so poor that retailers now insist on receiving papaya that have been repacked and will not accept sealed boxes. If fruit are received that have less than desired color (usually), the fruit are held to color them up prior to repacking and distribution to retailers. This "coloring" phase appears to be done with little thought as to optimum ripening temperature and time. Distributors use whatever space is available with little or no control of temperature. Some do better than others. The most problems observed were with distributors that held fruit for too long at temperatures that were often too low. This is a problem especially during the winter months and may have been a major factor responsible for the "outbreak" in January-February 1993. Papaya shippers are assessed a repacking fee for this service, and all culled fruit are deducted from the charges. Some distributors/wholesalers have created a "Number 2" grade where blemished but useable fruit are placed.

The current system needs to be improved to eliminate this time-consuming and costly practice of repacking. Several options are possible. Fruit can be shipped in bulk bins sealed to meet quarantine requirements or in larger cardboard boxes. Fruit can be ripened in bulk bins to the proper color level prior to packing. Anthracnose and related diseases usually begin to appear on the ripe parts of the papaya by this time, and diseased fruit can be more readily culled. Papaya can be ripened by proper temperature maintenance enroute on the ship. However, fruit color must be uniform when packed. This procedure is made more difficult by changing wholesaler seasonal requirements, greener fruit in summer when ripening can be done on the mainland, and riper fruit in winter when low temperatures make it more difficult to ripen on the mainland. Improve quality of fruit so confidence increases, and repacking is not necessary. This would require developing techniques to assure ripening of all fruits in one carton as a cohort.

Cartons collapse due partly to incorrect stacking on pallets, rough handling, and loss of structural integrity due to damp boxes. Almost every pallet had one or more collapsed boxes. Cartons loaded in LD3 containers also had crushed boxes as a result of forcing boxes into uneven spaces. Collapsed boxes usually resulted in all or most fruit being squashed and unsalable. Boxes should be properly stacked – boxes should be stacked in the same pattern on the pallet six high before cross stacking is done. This technique makes use of the structural strength of the boxes.

Some wholesalers are keeping fruit 1½ weeks or longer before they even open the cartons to repack; others move the fruit out within two days. Much of the decay and quality problems appear to be related to the length of time the wholesaler holds onto the fruit. The usual reason given by the wholesaler as to why fruit are held so long is because the fruit are too green, and they need to ripen them before selling. In general, fruit disease becomes a serious problem after three weeks storage at 50°F, due to the physiological stress suffered during this storage period. The primary reason for holding on to fruit for extended periods is to "color-up" the fruit; a system needs to be developed and followed to "ripen" fruit under the proper conditions before shipping or after receiving on the West Coast. Storage/ripening space is a problem locally but a lot of the subsequent problems could be eliminated if this ripening were done properly.

The consumers, according to the wholesalers, prefer smaller fruit. Hence, the market prefers

smaller fruit (#8 and smaller). Number 7 fruit had a lot of bruising (squashing) because of the non-symmetrical packing scheme with seven fruit in a rectangular box. This is also true of fruit such as avocado and mango, partly due to the cost-per-fruit factor. Restaurants may not object to the larger fruit, as fruit will be sliced or cubed before serving. The local market probably will also accept the larger fruit. Consumer preferences as to acceptable fruit sizes need to be determined. The industry needs to reevaluate fruit size as a marketing tool. Perhaps smaller fruit can be targeted for home use and larger fruit for institutional use. Most of the papaya seen on the retail shelves were beyond their prime. Unless displays are improved, the Hawaii papaya will have a difficult time maintaining its position in the market.

Physiological

All distributors mentioned the "soft fruit" problems that caused serious quality problems last October. The "soft fruit" can be divided into two types; some distributors refered to bruised or squashed fruit as "soft" fruit. The "soft" fruit problem that occurred last October and November is a physiological problem associated with low fruit calcium. Part of the confusion is due to the fact that this low-calcium fruit is much more susceptible to mechanical injury when compared to fruit with the same degree of fruit coloring and adequate calcium. The low-calcium "soft" fruit problem is sporadic but appears to be most common in the fall. It is not known when during fruit development the critical period is for calcium uptake. Foliar application of calcium is ineffective; thus soil applications are necessary.

Numerous mechanical injuries were observed on fruit at the distributors and at the retailers. It was not unusual to find mechanical injury on all fruit in a carton. Fruit at some retailers are displayed in wicker baskets, and all the riper fruit had indentations caused by the wicker.

Papaya at all ripeness levels are susceptible to scratches and punctures when in contact with rough or sharp surfaces. These wounds can then serve as infection sites for numerous wound pathogens that result in much of the postharvest diseases. These wounds, even without infection by pathogens, are unsightly and cause moisture loss and excessive shriveling. Fruit with 60 percent or more color are also very susceptible to internal bruising. Bruising is caused by rough handling of fruit during harvesting, heat treating, packing, and shipping. Bruising results in localized soft parts of the fruit and a water-soaked region in the flesh when cut open.

Careful handling is essential from the time it is harvested to the time it is sold. Liners for wooden bins should be evaluated for cost and efficiency in reducing abrasive mechanical injury, as well as using bins made out of materials less prone to have rough surfaces. The latter may have a higher initial cost but might last longer. Handling at the packing shed during treatment, packing, and shipping must be evaluated to identify points at which injury may occur to the fruit (sharp edges, rough surfaces, high drops, etc.). Different packing materials should also be evaluated. One shipper recently converted to shredded newspapers and the distributor/wholesaler thought it made a big difference in bruising damage.

A few fruit with heat damage were observed. It appeared as a mild surface scald and failure to ripen (soften). The reason for having heat damage, however slight, is uncertain. We do know that there is a seasonal (temperature) effect on susceptibility to heat damage. Post-treatment storage at lower than recommended temperatures before the fruit ripeness may also compound the effect.

Chilling injury was seen on ripe fruit at the retailer. The injury is related to the length of storage at temperatures less than 50°F. Retailers and distributors need to be educated to refrain from long-term storage (three weeks) at temperatures below 50°F.

Pathological

The most common disease problems observed were those caused by the fungus *Colletotrichum gloeosporioides*: anthracnose, chocolate spot, and grey-depressed lesion. These diseases are initiated on developing fruit in the field, but symptoms do not appear until the fruit ripens. Field sprays are required to prevent fruit infection. Postharvest heat and fungicide treatments can reduce but rarely eliminate these infections. Rainy weather favors the development and spread of the disease. A single hot-water dip done after the vapor heat treatment has been shown to slightly reduce postharvest disease and might be an additional step that shippers could use during periods of heavy disease pressure (rainy periods).

Postharvest diseases caused by wound pathogens were also a problem. *Phomopsis* and *Rhizopus* were two other diseases that were commonly seen on fruit in LA. These two fungi

are wound pathogens and take advantage of open wounds to gain entry into the fruit. They are both fast growers and cause a soft rot leaving the cuticle intact. The latter causes the infected area to become soft and watery, often causing the boxes to become soggy and weak. All precautions to minimize wounds should be made. Ripening to about 1/3 color prior to packing would bring out most of these diseases and allow culling. Proper use of chlorinated water in dumps, packing house sanitation, and postharvest fungicides should also reduce disease incidence.

One shipment of fruits packed on March 1, 1993, was being repacked in Los Angeles on March 31 by the distributor/wholesaler. These fruit need to last at least another week to pass through the retailers' hands to the consumer. Fruit was received about 1½ weeks earlier, ripened (?), and stored at 45–48°F until the day of repacking. Fruit were infected with numerous chocolate spots, anthracnose, *Phomopsis*, *Rhizopus*, and *Guignardia*. Some fruit showed some minor heat-scald damage. A recurring pattern that became obvious was that the longer fruits were held, the more disease was present. This agrees with all storage studies done in Hawaii. Fruit received a day or two prior (both surface- and air-shipped) were generally in good condition with little disease. Distributors are holding on to fruit primarily to ripen fruit to a color that is acceptable to their buyers. As discussed earlier, refrigeration at temperatures below 50°F for extended times (three weeks) puts additional stress on the fruit and will intensify disease problems.

Conclusions

There are a few simple steps that can be taken to reduce the problems seen at the LA wholesalers. All individuals involved in handling papaya need to recognize that their actions can significantly influence the fruit condition. These steps include avoiding mechanical injury, sanitation, more attention to the range of fruit color stages in one carton, and more care in stuffing LD3s. Long-term steps include incorporation of calcium in grower fertilizer practices, evaluating alternative physiological and economic aspects of different ripening and handling practices, and educating wholesalers and retailers as to proper handling procedures. A component of the long-term education would be to develop a comprehensive brochure or handbook giving symptoms of disorders and diseases and correct handling procedures.

We will be expanding the current project to include an evaluation of the next step in the marketing chain: retailing.