FROM PADDOCK TO PAVLOVA

GETTING PASSIONFRUIT TO MARKET

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RIPENING

Like bananas, tomatoes and many other fruit, passionfruit are classified as 'climacteric'. That is, they go through a distinct ripening process during which colour develops, acids decrease, and the fruit becomes sweet and ready to eat (Figure 1). This is fuelled by an increase in respiration rate and a burst of ethylene gas production.

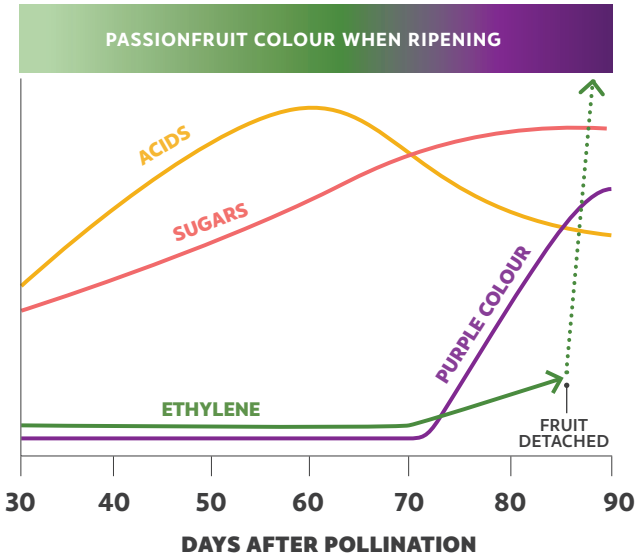

Figure 1. Passionfruit ripening

One of the effects of ethylene is to trigger fruit to detach from the vine. Once passionfruit have detached, ethylene production goes into overdrive.

In fact, they are one of the highest ethylene producers of all fruit. High levels of up to 500µl/L accumulate inside the fruit; only 1-5 µl/L is enough to turn carrots bitter and leafy greens yellow. The fruit itself may produce 370 to 1,000 µl/kg/hour.

For comparison, a rockmelon produces 80 to 150 µl/kg/hour while bananas – often thought of as the ethylene kings – only produce 8 to 12 µl/kg/hour. So, if people are trying to ripen a hard avocado, it would be far better to put it in a paper bag with a passionfruit than with a banana!

This means that passionfruit don't need to fully ripen on the vine, but can be picked once they start to change colour and ripened postharvest.

HARVEST

In most parts of the world, passionfruit destined for the fresh market are picked directly from the vines. For example, Hawaiian researchers suggest that only fruit that has been harvested directly are suitable for long distance transport. This is because fruit picked up after natural drop are more likely to suffer physical damage, increased moisture loss and disease.

They suggest that fruit should be picked once they are around 75% coloured, breaking the stem at the natural joint above the fruit. It is important not to simply pull fruit off the vine; creating an open wound lets out moisture and lets in rots.

However, there are also some clear disadvantages of harvesting directly from the vines. Searching for fruit takes time and can damage the vines. Harvest needs to be in daylight and workers need to be skilled - any backpacker can pick fruit off the ground, but care and attention are needed to pick fruit directly from vines.

Table 1. Advantages & disadvantages of different harvesting methods

	ADVANTAGES	DISADVANTAGES	WHEN TO USE
PICK UP DROPPED FRUIT	Fruit are fully ripe and ready to eat at harvest Quick and easy Can start before dawn (when the weather is cool) No damage to vines	Fruit may have reduced quality and storage life due to damage, disease or sunburn Reduces ability to plan transport and marketing	Mature vines Cool or overcast weather Overhead pergolas and A-frames where there is cushioning, groundcover
HARVEST DIRECTLY FROM VINES	Maximises storage life Avoids damage Avoids contamination from the ground Prevents fruit sunburn Can be scheduled, allowing more efficient transport and marketing	Fruit may not be fully ripe at harvest Searching for fruit can damage vines, especially the growing tips Harvest workers must be trained to identify ripe fruit Needs to be done during daylight	Young vines Panama types e.g. Pandora, McGuffies Red If sunburn is likely (e.g. single wire systems during hot weather) If there is bare soil under vines

Overhead (left) and A-Frames (right)

If fruit is being allowed to drop then:

- Maintain good groundcover
- Shake the trellis to release fruit caught in the vines or about to detach
- Pick up at least daily during hot weather to avoid sunburn

Whatever method is used, harvest should ideally be done when it's cool. Harvested fruit need to be kept shaded and transferred to the packing shed as soon as possible.

PACKING

AT THE PACKSHED

Temperature is the single most important factor governing the life of fruit and vegetables. Whenever possible, fruit should be packed – and cooled – on the day they are harvested. If fruit is going to be packed later, actions depend on fruit temperature.

As a "rule of thumb":

- HOT fruit (>30°C) need to be cooled immediately below 15°C, preferably using a fzorced air system, then packed within 2 days
- WARM fruit (20 to 30°C) can be placed in a cold room and packed within two days
- If fruit are COOL (<20°C) and overnight temperatures below 25°C, keep protected and pack the next day

Simply placing a bin in a cold room does not make fruit cold. Moreover, while passionfruit are warm they are actively respiring and producing ethylene, processes that produce more heat, which in turn increases respiration. Even if there is good air circulation, it can take many hours to cool fruit in the centre of a half-tonne bin.

Forced air systems cool fruit much faster. A forced air cooler can be as simple as putting a fan unit on top of a bin, wrapping the side vents, and pulling cold air through the fruit (Figure 2). This effectively changes the cooling surface from the outside of the bin to the individual fruit inside it.

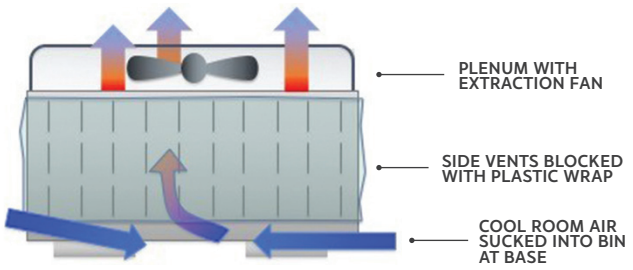

Figure 2. Forced air cooling system for bins

MANAGING DISEASE

The packing shed is NOT a hospital.

The best way to reduce disease development postharvest is to control infection in the field. This is particularly important as there are no postharvest fungicides registered for passionfruit.

To reduce the risk of disease:

- ALWAYS remove any dried remains of the flower before packing
- Don't pack fruit which already have disease, even if symptoms are minor
- If fruit are washed using recirculating water (rather than simply hosed off), ensure that the bath contains an effective sanitiser e.g. chlorine
- Dry fruit before packing
- Don't store in saturated humidity e.g. in sealed plastic packages

GRADING

A sure fire way to make a wholesaler cranky is to send poorly graded fruit, as it's so much harder to sell. While some growers may still pack directly in the field, this isn't the way to maximise returns. Accurate grading for size and quality level greatly improves presentation and, therefore, saleability and price.

Perhaps the most essential part of the packing line is a well-lit grading table which is comfortable to stand at. The sizer unit, accumulators and carton packing stands are also important. Fruit should not be packed if it is diseased, deformed, damaged or – worst of all – contains fruit fly maggots.

Slight sunburn (<25% of the fruit affected) scratches scuffs and blemishes downgrade fruit but don't make it unsaleable.

If fruit is big and beautiful, why not show it off? Pattern packing takes time and effort, but is an effective way to display exceptional quality fruit, and may result in better grower returns when carefully marketed to the right customers.

PACKAGING

Sadly, passionfruit are sometimes called "crinkleberries". What looks like a hard and leathery peel actually loses moisture very easily. The quality of the pulp is initially unaffected and, surprisingly, some customers think this is when they are best to eat. However, shrivelling reduces appeal and overall quality. Moreover, I suspect that "crinkleberry" is not the image the industry prefers to project!

A previous article in this journal discussed the use of waxes. Waxing is definitely one way to reduce shrivel and increase postharvest storage life, as well as give fruit an attractive sheen. However, appropriate equipment is required to apply wax and dry fruit afterwards. Using the wrong wax, or applying it too thickly, can cause off flavours or lesions on the fruit peel.

INCREASING RELATIVE HUMIDITY (RH)

Another way to reduce moisture loss is to use plastic wrapping to increase RH around the fruit. Most passionfruit are packed directly into unlined cardboard cartons. While these are good for ventilation, cardboard can absorb up to 17% moisture. For example, a 750g cardboard carton can absorb 128g of moisture from the fruit inside. If the carton holds 4kg of passionfruit then this is a direct weight loss of 3.2%, enough to start the shrivel.

Waxing the cartons, or using a plastic liner, keeps the cardboard dry and increases RH. However, liners need to be well perforated to allow fruit to cool.

Pre-packing passionfruit into punnets or trays overwrapped with plasticised plastic film can also increase storage life. These types of films are too thin to modify the internal atmosphere or cause excessive condensation, but do increase RH and reduce shrivel (Figure 3).

Although shrivelled passionfruit may taste sweeter to some, this is due to water loss and breakdown of acids. The total amount of sugar in a shrivelled passionfruit is similar, or less, compared to one protected from moisture loss. Overwrapping passionfruit could reduce food waste, add value and increase sales (i.e. pieces sold per transaction). Unfortunately, lack of market acceptance has limited commercial adoption.

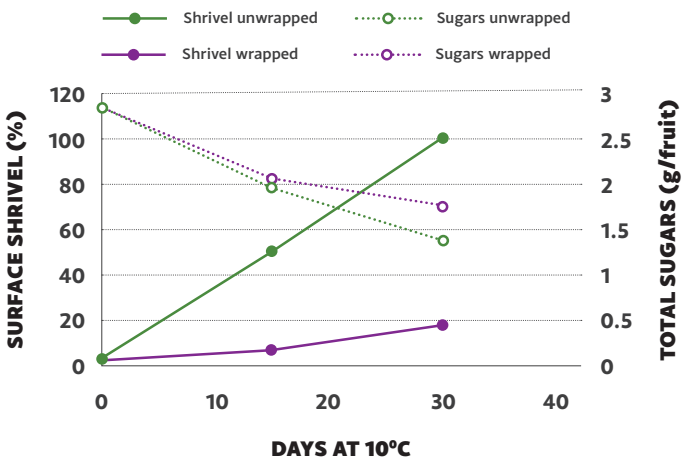

Figure 3. Effect of overwrapping purple passionfruit with plastic film on shrivel and total sugars during storage at 10°C. Derived from Arjona et. al. 1994.

CHANGING THE ATMOSPHERE

There are clear benefits to quality from using plastic packaging to increase RH. However, the benefits of using packaging to modify the atmosphere are less certain.

Modified atmosphere packaging (MAP) uses the respiration of the fruit to reduce oxygen (O_2) and increase carbon dioxide (CO_2) inside a permeable plastic package (Figure 4). After a time, the rate at which gas diffuses through the plastic and the respiration of the fruit inside come into balance. The objective is to achieve an atmosphere that slows respiration and ripening and yet also inhibits rots.

One problem is that passionfruit have an extremely high and variable respiration rate. Another is that respiration rate increases with temperature. This means that a package designed to work at 5°C will result in a damaging atmosphere (i.e. very low oxygen) once it warms up to room temperature. The result is something that tastes almost, but not entirely, completely unlike passionfruit grappa!

While various types of MAP have been trialled, the only reliably positive effects are from films which simply increase RH, not CO_2, around the passionfruit.

There are also films which can absorb ethylene. These are marketed to reduce ripening, extending fruit storage life. However, as already noted, passionfruit are truly the Olympic champions of ethylene production. This means such films are likely to be fully saturated very quickly indeed.

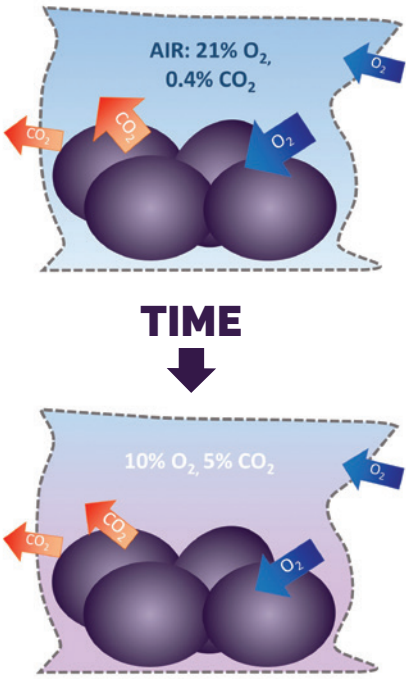

Figure 4. Respiration by passionfruit inside a sealed package depletes O_2 and increases CO_2 (top). After a time, diffusion through the plastic and respiration by the product come into balance, resulting in a stable modified atmosphere inside the package (bottom).

COOLING

Good temperature management is the key to extending storage life of all perishable products. Like many tropical fruits, passionfruit are sensitive to low temperatures. However, chilling damage is a function of time as well as temperature. Even temperatures below 3°C are unlikely to cause damage if purple passionfruit are exposed for only a few days. However, a few days at high temperature will definitely reduce storage life.

THE BEST STORAGE CONDITIONS ARE:

- 5 to 8°C with 85% RH for purple varieties
- 10 to 12°C with 85% RH for Panama types

Condition of passionfruit cv. Sweetheart (left) and cv. Misty Gem (right) following one month of storage at 2, 5 or 8°C then 3 days at ambient. Chilling damage, appearing as sunken patches on cv. Sweetheart and mould on cv. Misty Gem, occurred at the lowest temperature.

Full pallets of packed fruit can take a long time to cool. As the packed fruit cool unevenly, condensation can occur, weakening cartons and increasing disease.

Forced air systems cool fruit quickly and efficiently and can be constructed fairly simply inside an existing cold room. All you need is a plenum to rest the pallet/pallets against, a fan and a tarpaulin. The idea is to pull air evenly through the cartons so that the fruit all cool at the same rate.

Forced air cooling is best, room cooling is OK, but both are far better options than loading hot fruit onto a truck.

Refrigeration systems on trucks are designed to maintain, not reduce, temperature. Products loaded warm are likely to still be warm (or even warmer!) when they reach their destination. This could easily be three days or even more for distant markets.

Not managing temperature has major effects on shelf life. Even if damage is not obvious on arrival at wholesale, the fruit will not present as well at retail or last as long once a consumer takes it home (Figure 5).

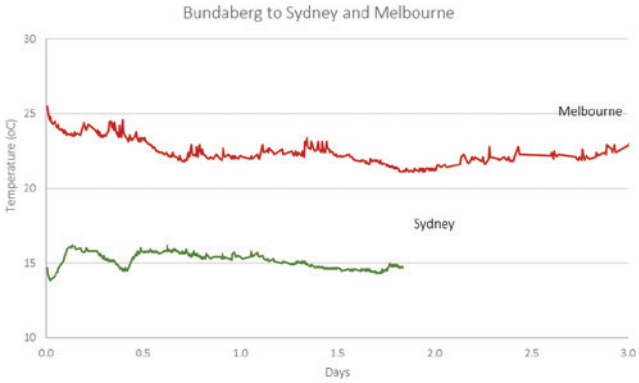

Figure 5. Typical transport temperatures for passionfruit transported to Melbourne, or pre-cooled for 6 hours before transport to Sydney. AHR data.

CONCLUSIONS

Harvested passionfruit are alive. Like us, passionfruit need oxygen to live, release CO_2, and interact with their environment. Once passionfruit detach from the vine that nourished and protected them, they are dependent on stored reserves of energy and water.

They also have limited defences against the fungal pathogens that have been waiting for their chance to grow. This means there is limited time for passionfruit to be packed, transported, sold and finally eaten.

Poor handling, condensation, lack of sanitation and high temperatures can exhaust those reserves much faster than needed, reducing shelf life, quality, and satisfaction for the end consumer.

Postharvest management is not the end of the process, but the beginning. It is where money is made or lost, and markets are grown or shrunk.

Only through good postharvest management can the passionfruit industry move forward, realising the true potential of what is surely one of the queens of fruits. And, of course, a pavlova essential!

Dr Jenny Ekman will be presenting her work at the Regional Field Day on Saturday 17 October – See PAGE 17 for details.