Optimising Sea Freight Fiji Papaya
(PC/2008/003)

Final Report

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Queensland Government

On 26 March 2009, the Department of Primary Industries and Fisheries was amalgamated with other government departments to form the Department of Employment, Economic Development and Innovation.

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Summary

A crucial part of the development of Papaya exports is to use sea freight rather than air freight to reduce the shipping costs and in the long term to overcome capacity constraints of air freighted fruit. With a weekly shipping schedule and a nominal 5 day shipping time to a major market in Auckland New Zealand sea freight appears to be a viable option. However existing systems developed for air freight are often incompatible with sea freight. In transit ripening, poor temperature control and a lack of ripening facilities often characterizes early attempts at sea freight.

In March 2011, a sea freight container was monitored from treatment and packing Nadi, Fiji to arrival and ripening in Auckland New Zealand. Fruit condition particularly ripening behavior and disease development was measured over the 12 days following treatment, packaging transport, customs clearance and ripening before dispatch. Fruit handling conditions and temperatures were monitored at all critical steps. A number of innovations in carton design, pre cooling and palletizing were trialed and evaluated.

This monitoring demonstrated that fruit quality was not adversely affected by sea freight. The fruit out turn on sea freight fruit had less colour development (21% yellow skin), than fruit held constantly at 22^{o}C (53%) but quickly ripened after 2 - 4 days ripening (53% and 79% yellow skin colour respectively. There was no effect on fruit softening, soft spots and disease development. A trial of fruit in sealed cartons showed that fruit in sealed cartons for 12 days showed symptoms similar to winter spot, which was not evident in other treatments or the controls.

A trial of fruit with higher levels of pre cooling (fruit cooled for 21 hours after heat treatment and followed by an additional 24 hours room cooling (12 ^{o}C) before loading into the sea container) had more fruit colour development than fruit without the pre cooling. This was unexpected but was due to the fruit re heating during packing and failing to re cool during storage due to inadequate facilities and carton design. This led to early fruit ripening before holding conditions were established in the sea container.

A comparison of vented cartons and non vented cartons showed that cartons with vents that allowed good air circulation in the shipping container had much better cooling which delayed ripening. Fruit in non vented cartons had reached 34% yellow skin colour on arrival while fruit in vented cartons had reached 10% colour. Fruit ripened successfully and after 4 days fruit in the vented cartons had reached 72% yellow skin colour and fruit in the non vented cartons reached 91 yellow skin colour.

Carton collapse was an issue in the consignment. Condensation during handling and transport led to weakening of the cartons even though the cardboard is waxed. A trial of an extra collar for carton strength was successful and reduced the level of carton collapse in the bottom 4 layers from 75% of cartons with significant damage to virtually nil.
This consignment used pallets that were made to accommodate the current carton and pallet nets to simulate full palletisation to understand the benefits of palletisation. The trial showed that there are advantages in palletisation if issues with carton collapse and pallet configuration can be overcome and the importers requirements accommodated.

This trial shipment demonstrated that high quality Fijian papaya can be delivered to market by sea freight without loss of quality. The strategy to send fruit in a backward condition and to ripen at the market worked well and was assisted by the ripening facilities and knowledge of the importers.

A number of areas for improvement were identified in the report and should be trialled before the next shipment.

Procedures

Fruit and treatments

Title	Optimizing sea freight - Fiji Papaya
What we tested	**1. Carton performance** Sealed cartons (control) vs. cartons with holes (treatment) to determine effect on temperature management. Standard cartons (control) vs. reinforced cartons (treatment)to evaluate required strength of cartons in sea freight conditions. **2. Pre-cooling effect on ripening performance/ disease development** 24 hours pre-cooling vs. 6 hours pre-cooling **3. Efficiency of palletising** Use of pallet socks, grading for colour, loading of pallets **4. Economic comparisons** FPP sea freight trial vs. Air freight
Partners	Fiji Papaya Project, Produce Specialties Ltd., DEEDI
Vessel	Pacific Voyager (Lautoka-Suva-Auckland)
Timeline	Harvest, packing - 1-3 days Cooling and loading into sea freight container – 0-2 days Transit time – 7 days (Lautoka – Auckland) Port and customs clearage – 2 days Repalletising, ripening – 1-2 days Distribution – 1 day **Total time – 16 days**
Container	20 ft Refrigerated container
Packing details	12 pallets/container 108 cartons/pallet Total cartons – 1296 Total volume – 6.5 tonnes Reefer set at +12deg C

Results

Trial 1: Effect of sea freight conditions on fruit quality

The temperature log (Fig One) for the inside logger on pallet 10 showed the temperature conditions for sea freight to New Zealand. Fruit were packed at 24 °C and cooled in about 36 hours to 12 °C in the sea freight container demonstrating the effectiveness of the carton venting for bottom air delivered refrigerated containers. Fruit were held at 12 °C until quarantine inspection and re palletising. Fruit were then ripened at 26 °C for 36 hours with 10 ppm ethylene, when the room temperature was lowered to 24 °C until dispatch.

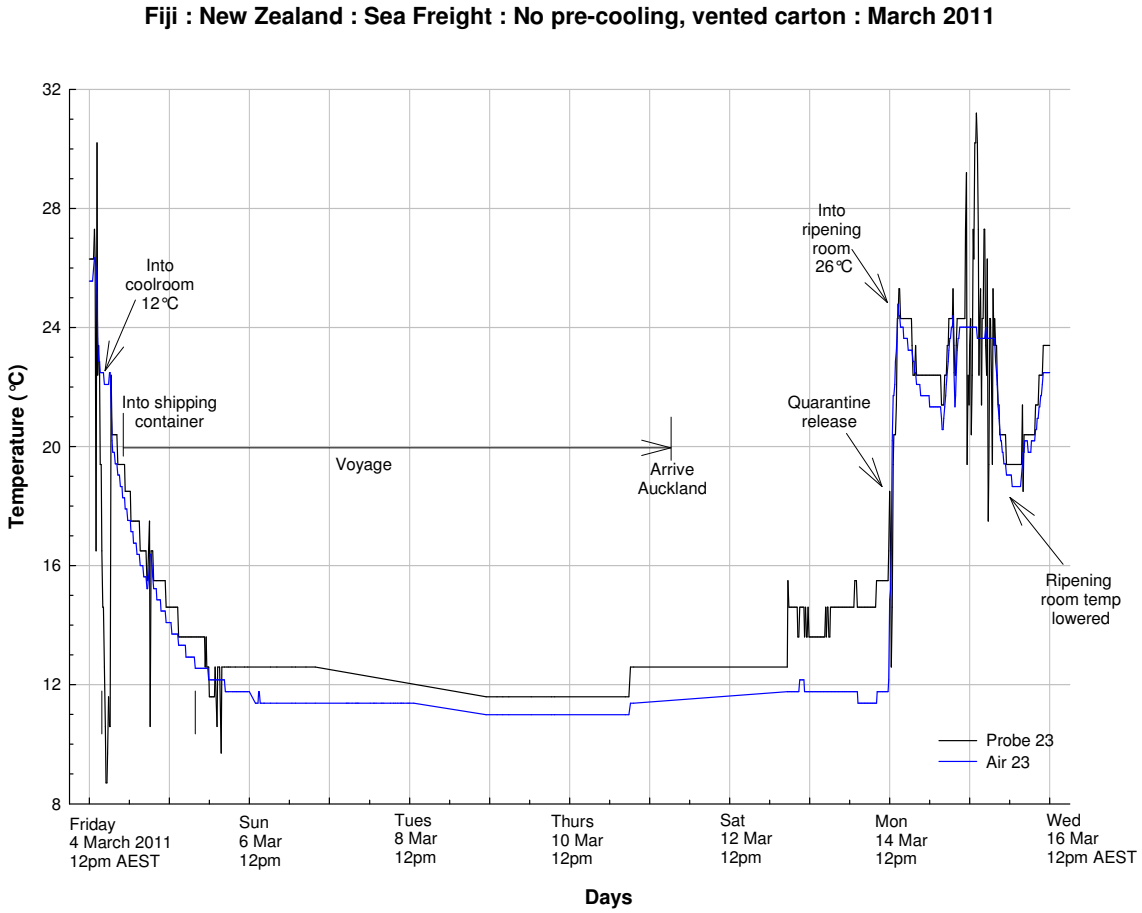


Figure One: Temperature log for typical pallet in sea freight container.

The effect on fruit quality was measured by sampling 3 trays in each sample pallet and monitoring fruit every 2 days for quality parameters particularly skin colour, firmness, soft patches, rots, physical damage and abrasion. Sample trays from the same pallet were sampled after packing and held at 22 °C to allow natural ripening. A comparison of fruit colour between the sea freighted fruit and the control fruit is shown in Figure Two.

This monitoring demonstrated that fruit quality was not adversely affected by sea freight. The fruit out turn on sea freight fruit had less colour development (10%), than fruit held constantly at 22°C (53%) but quickly ripened after 2 - 4 days ripening (53% and 79% yellow skin colour respectively. There was no effect on fruit softening, soft spots and disease development. A trial of fruit in sealed cartons showed that fruit in sealed cartons for 12 days showed symptoms similar to winter spot, which was not evident in other treatments or the controls.

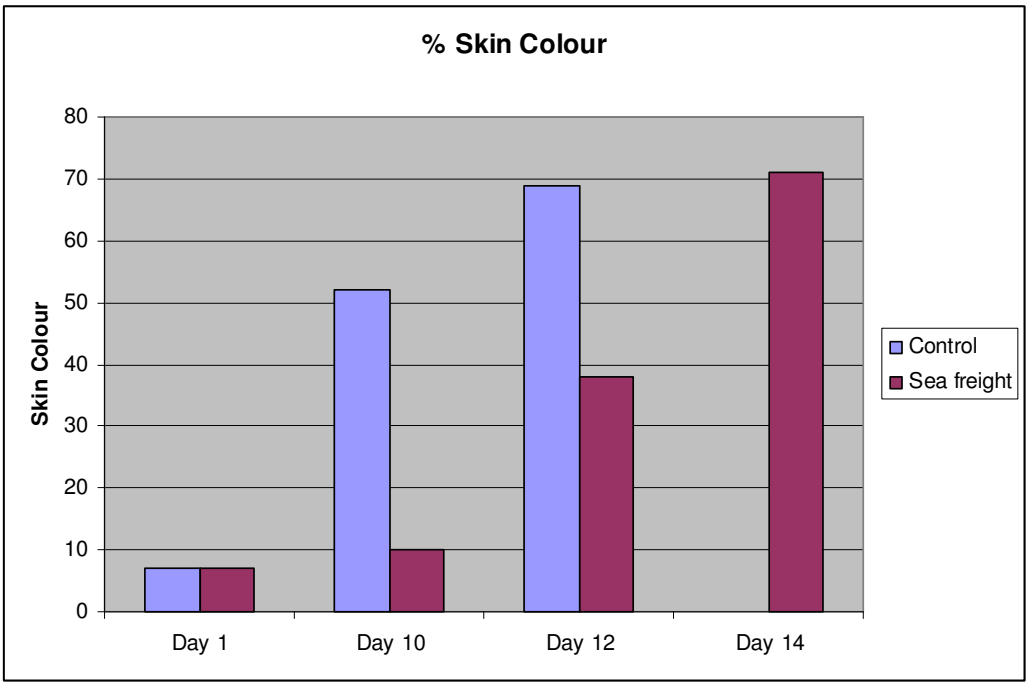


Figure Two: Comparison of sea freighted fruit in vented carton with fruit ripened after packing at 22 °C.

Trial 2: Effect of pre cooling on fruit out turn

A trial of fruit with higher levels of pre cooling (fruit cooled for 21 hours after heat treatment and followed by an additional 24 hours room cooling (12°C) before loading into the sea container) measured the effect of pre cooling on fruit colour development. The pre cooling treatment on before packing is shown in Figure Three.

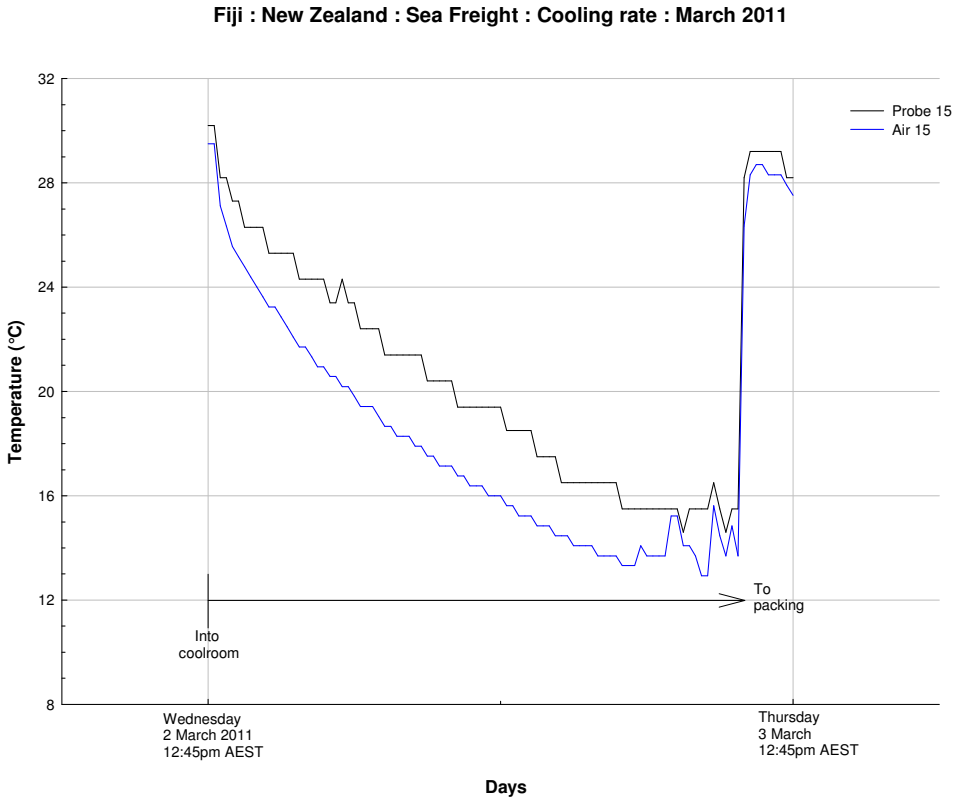


Figure 3: Cooling log for pre cooling treatment before packing.

The rate of pre cooling in the pallet is shown in figure Four.

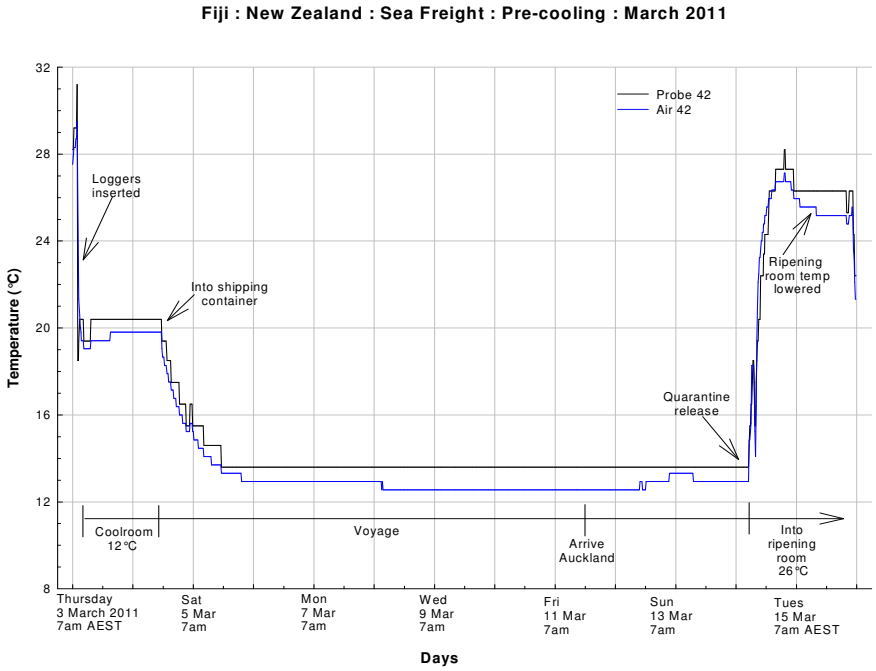


Figure Four: Rate of pre cooling in holding room and sea freight container for pre cooled treatment.

The delayed cooling shown in Figure four was unexpected but was due to the fruit re heating to 20 ^{o}C during packing and failing to re cool during storage due to inadequate facilities and carton design. The vented cartons did cool well in the sea container. Figure Five shows a comparison of skin colour development between pre cooled and non pre cooled fruit which showed early fruit ripening occurred in the pre cooled treatment probably before holding conditions were established in the sea container.

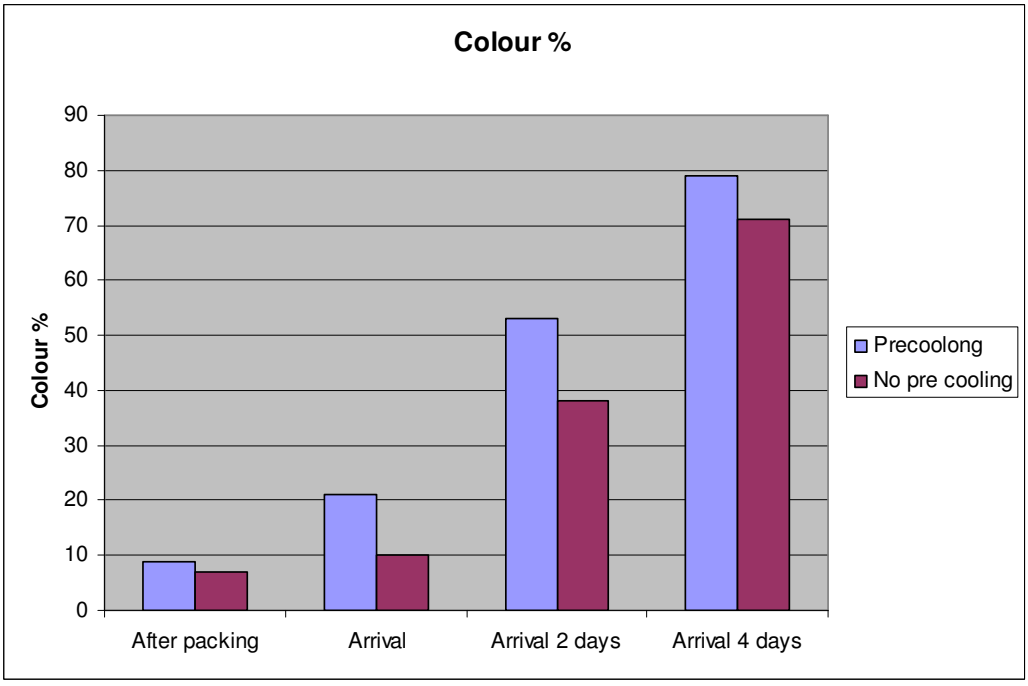


Figure Five: Comparison of skin colour development between pre cooling treatment and non pre cooled.

Trial 3: Effect of carton design on fruit out turn.

A comparison of vented and non vented cartons was undertaken on non pre cooled pallets that were packed side by side in the shipping container.

The temperature log for the non vented cartons is shown in Figure Six.

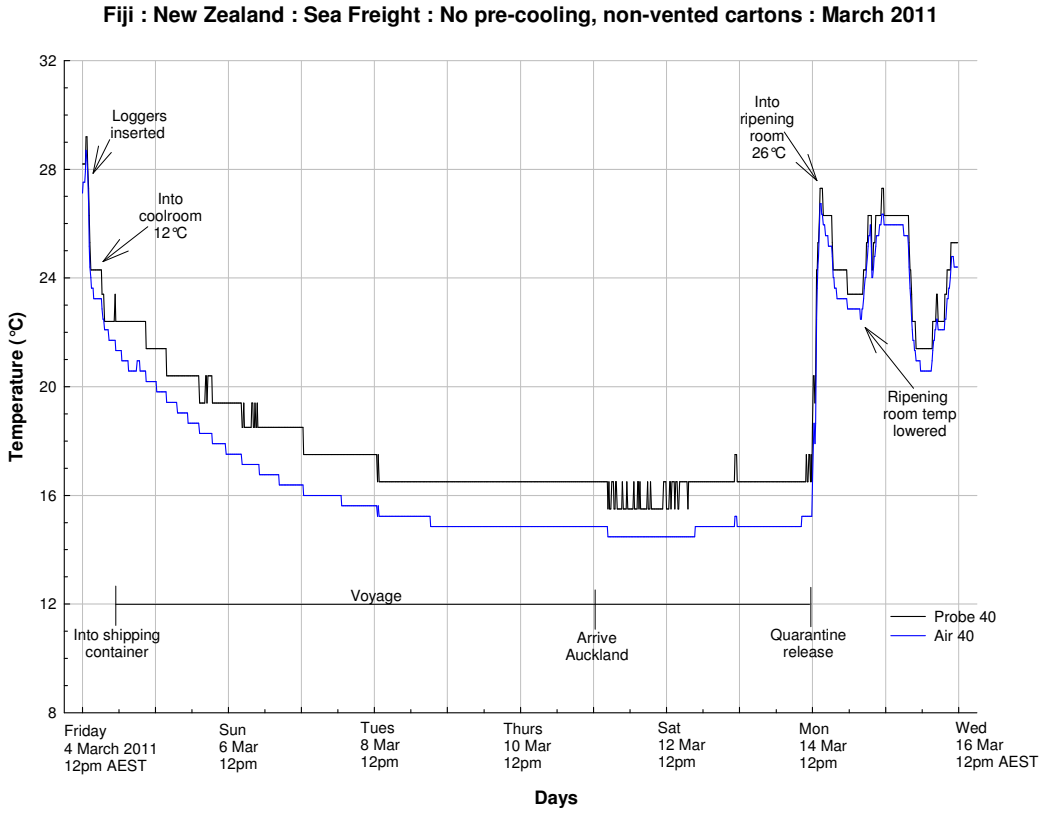


Figure Six: Cooling log for pallet 9 showing cooling of non vented cartons.

A comparison of vented cartons and non vented cartons showed that cartons with vents that allowed good air circulation in the shipping container had much better cooling. Fruit in vented cartons Figure one showed fruit cooled in 36 hours while fruit in non vented cartons took 96 hours to cool to transport temperature.

This had a marked effect on skin colour development as shown in figure seven. Fruit in non vented cartons had reached 34% yellow skin colour on arrival while fruit in vented cartons had reached 10% colour. Fruit ripened successfully and after 4 days fruit in the vented cartons had reached 72% yellow skin colour and fruit in the non vented cartons reached 91 yellow skin colour.

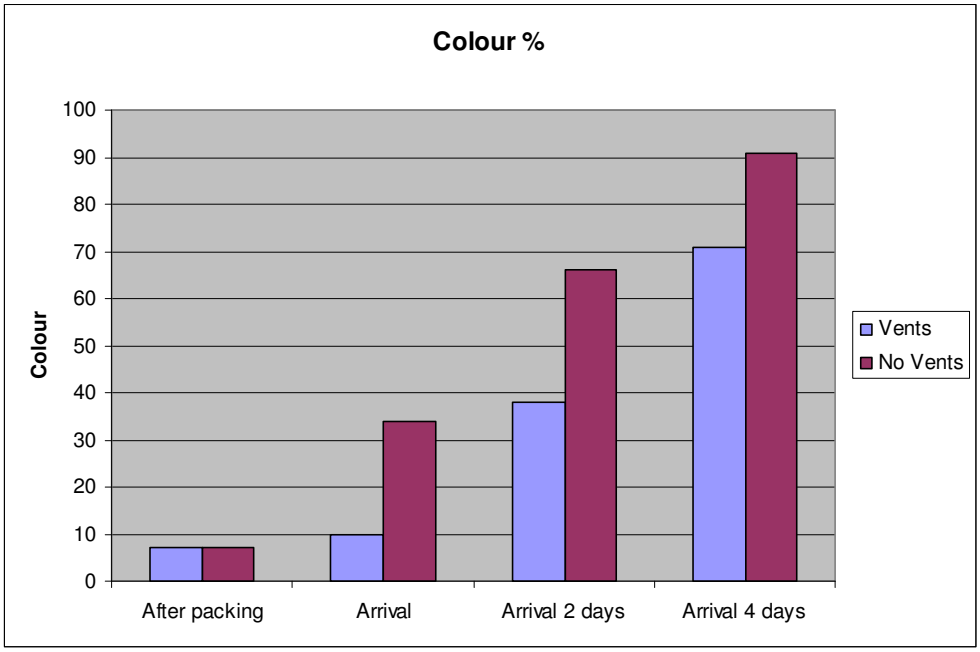


Figure Seven: comparison of skin colour development for fruit from vented cartons and vented cartons.

Trial 4: Effect of carton strength and palletisation

Carton collapse was an issue in the consignment. Condensation during handling and transport led to weakening of the cartons even though the cardboard is waxed. A trial of an extra collar for carton strength was successful and reduced the level of carton collapse in the bottom 4 layers from 75% of cartons with significant damage to virtually nil.

Figure Eight: Comparison of cartons with extra collar (left) to standard carton.

This consignment used pallets that were made to accommodate the current carton and pallet nets to simulate full palletisation to understand the benefits of palletisation. The trial showed that there are advantages in palletisation if issues with carton collapse and pallet configuration can be overcome and the importers requirements accommodated.

Conclusions

This trial shipment demonstrated that high quality Fijian papaya can be delivered to market by sea freight without loss of quality. The strategy to send fruit in a backward condition and to ripen at the market worked well and was assisted by the ripening facilities and knowledge of the importers. The benefits of these ripening facilities should not be underestimated.
A number of areas for improvement were identified and should be trialled/considered before the next shipment.
The system of packing then, loading and cooling in the refrigerated container gave most control of the product and the use of pre cooling fruit is not necessary and can only be accomplished if the cartons were re designed for room cooling.
Carton strength must be improved. Carton must be designed with a footprint to fit onto a standard sea freight pallet and have sufficient strength to be loaded to at least 12 layers and have resilience to high moisture conditions for at least 14 days. Pallet corners and strapping must be used to reduce carton damage. Pallets should be loaded to facilitate efficient handling in the destination. This includes loading pallets according to fruit count and level of ripeness.

A system of pre ripening fruit to an agreed colour standard would facilitate better handling in New Zealand. This was partly achieved in the pre cooling trial where fruit had 24 hours ripening before dispatch and cooling. This fruit arrived at an advanced colour and were ready for sale earlier than the fruit packed in a backward condition. A system of ripening and inspection before palletising would allow the fruit which were picked immature and are slow to ripen to be removed. This system would require the use of open top trays which allow inspection but also have the most rapid heating and pre cooling in room cooling and container refrigeration.

There are a number of modifications that can be made to the current Biosecuirty arrangements with Fiji that will improve the effcicieny and profitability of Sea Freight Fiji Papaya.

Recommended follow up

1. Facilitate improvements in the NZ Biosecurity requirements for Sea Freight Fiji Papaya.

There are a number of issues regarding the Biosecurity NZ requirements that should be addressed in order to facilitate improvements in the Sea Freight Fiji Papaya supply chain. These issues include:

- Biosecurity to accept sealed reefer container as a sufficient fruit fly exclusion barrier. With this approval in place NWC can invest in infrastructure to bring the reefer containers into the fruit fly free area of the chamber and pack cartons directly into the container without the use of pallet socks.
- Push Biosecurity to reduce inspection rate to 1 out of 10 consignments. This is will further drive down costs; direct and indirect and make the Fiji product more competitive.

2. Facilitate the sourcing of a more appropriate carton for sea freight.

There is an immediate need to find a better replacement for the current cardboard carton. Ideally this new carton should be open topped to allow for efficient cooling and heating as well as extra strength in the corners.

3. Investigate infrastructure improvements at NWC that will better facilitate Sea Freight Fiji Papaya.

The large cooler room at NWC is inefficient and not well suited to vented carton cooling. It is envisioned that papaya intended for sea freight would not have to use this cooler room if the reefer container could be accessed in the fruit fly free packing area. There are a variety of options available to facilitate this improvement and NWC should work jointly with the Fiji Papaya Project and exporters in designing the improvements.

4. Controlled ripening and cooling trials.

The Fiji Papaya Project should investigate effects on fruit quality when 50% colour papaya is dropped to 12 deg C and then raised up again to 24 deg C. This is to simulate what the market has asked for with some of the pallets being loaded in the reefer container at a much more advanced stage of ripeness.

5. Research and document a package of best practices for conditioning papaya

Further research into the best package of practices for conditioning fruit in the importing country; ideal temp, humidity, ripening gas levels etc. Develop information materials that can help importers handle fruit better.

6. Facilitate improvements in communication along the supply chain

Work to improve the flow of information from the exporter to the importer e.g. temperature at loading, colour of fruit, sizes, arrangements in container etc.

Annex 1: The Sea Freight Supply Chain Story

Colour break fruit is harvested from PSL farms at Nawamagi, Sigatoka over 3 days.

Harvest bins are lined with newspaper to limit physical damage during transport to PSL packing house.

PSL packing house in Namaka, Nadi.

Fruit is washed and graded prior to HTFA treatment.

Preliminary grading and loading into HTFA treatment bins.

HTFA treatment

Pre-cooling in NWC cold room immediately after completion of HTFA treatment.

Fruit is loaded with temperature loggers to monitor rate of pre-cooling.

Mechanical grading for size at NWC

Packing with foam and stickers

Temperature loggers inserted in selected cartons to measure core temperature of fruit and temperature within carton. Three pallets with three loggers per pallet are used.

Packed cartons are stacked on pallets.

Pallets are wrapped with sealing plastic to stabilize the load.

Quarantine pallet nets are raised over the top of the cartons and tied in a knot and sealed with a cable tie.

Cardboard pallet corners and strapping are put in place to further stabilze the load.

A pallet packed and ready.

12 pallets in NWC cool room prior to loading into reefer container.

Forklift loads pallets two-wide into reefer container.

NWC staff have to get creative in order to stow pallets deep inside container without a proper ramp for the forklift to enter the container.

A pleased crew pose in front of the loaded container.

New Zealand MAF Biosecurity inspection at Fresh Direct Facility. Inspection rate – 600 fruit, inspection time 1 hour, no issues raised.

Forklift and ramp system at Fresh Direct made for a very smooth unloading of sea freight pallets.

Carton treatment comparing the standard box with a box that has been reinforced with an extra cardboard collar, the pallet to the left had the bottom 6 rows with reinforcement while the pallet on the left had the standard cartons. There were low levels of crushing occurring on the bottom rows of the standard cartons while no crushing occurred on the reinforced cartons.

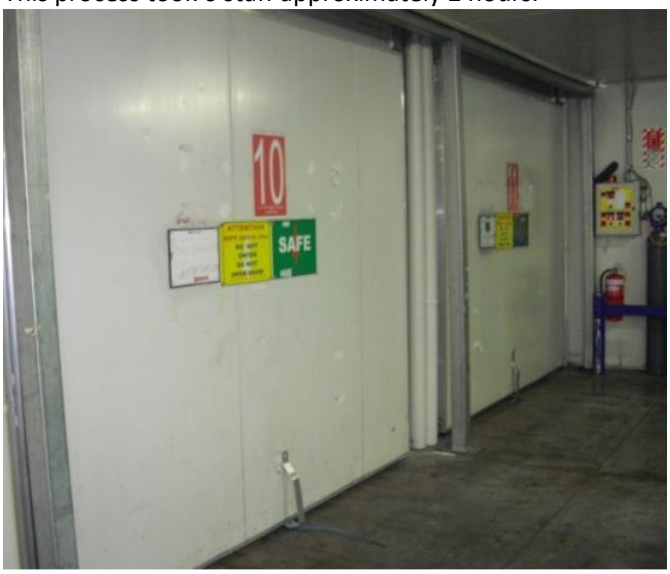
The pallets with reinforced cartons on the bottom rows performed well and at the time of off-loading at Fresh Direct the general appearance was no different than how they were loaded in Fiji.

Fruit pictured immediately after unloading from the sea freight container.

Preliminary observations on the carton performance trial indicate that the cartons with the holes (pictured on the right above) had not ripened during transit this is contrast to the standard carton (left above) which did show signs of ripening during transit.

Cartons had to be de-stacked and re-palletised according to size. This process took 6 staff approximately 2 hours.

Due to failure of the cardboard some cartons were severely damaged.



Fruit is placed in controlled temperature ripening rooms set at +26 deg C with ripe gas to condition for sale.

After 2.5 days in the ripening room, the fruit is almost full colour and ready for distribution. In addition to the pre-orders for papaya, the product is also displayed on the Fresh Direct market floor.

Fiji papaya loaded with only fresh produce to be delivered to small markets around Auckland. Only 1 day after ripening was complete 1200 of the sea freight cartons had been sold.

Fiji papaya on a tray wrapped in plastic on display in Fruit World, Auckland – NZD $7.99/kg

Fiji papaya on display in the high Jack Lum & Co Fruit store, Auckland - NZD $8.99/kg