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**POSTHARVEST TREATMENTS TO EXTEND THE STORAGE  
LIFE OF FEIJOA (*Acca sellowiana*)**

A thesis presented in partial fulfilment of the requirements for the degree  
of Doctor of Philosophy in Food Technology at Massey University  
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## ABSTRACT

Feijoas (*Acca sellowiana*) have a short harvest season and a limited postharvest life. In feijoa, usually there is a large variation between individual fruit in terms of size, colour, chemical composition and physiological stage. This variation could be attributed to the time of fruit set which is relatively long, which leads to great variation in fruit maturity. In order for the New Zealand feijoa industry to export to distant markets a postharvest life of at least 6 weeks is required. Determining the maturity index of a crop is vital especially for trade regulations and marketing strategy. Feijoa do not change colour significantly during ripening, so the only unequivocal way of assessing fruit maturity is to cut the fruit open. An internal maturity rating scale has been developed by Plant and Food Research primarily based on locular development. The use of 'touch picking' depending on fruit retention force is considered the most practical and reliable method for the time being for determining minimum harvest maturity of feijoa. The aims of this work were to investigate options for a non-destructive method in determining maturity index of feijoa fruit compared to the internal maturity rating scale; extending storage life of feijoa fruit by cool storage and controlled atmosphere conditions to allow long distance sea freight to increase export opportunities; and to develop an understanding of feijoa ripening physiology in relation to ethylene and propylene treatments.

In this study, differences between the commercial pack houses in identifying the optimum fruit maturity of feijoa at harvest were large. Compression firmness was more reliable than acoustic firmness in determining maturity stages of different feijoa cultivars, but acoustic firmness was quite reliable for some cultivars. The Sinclair unit device was not suitable for measuring maturity index of feijoa fruit tested. Spin-spin relaxation time ( $T_2$ ) and half height peak ( $\Delta H_2$ ) determined by NMR showed promise for identifying fruit maturity. In general, these non-destructive techniques used in this experiment showed some promise but further work is required to understand why the differences between cultivars and regions happen. Chemical changes such as total soluble solids, dry matter and titratable acidity were found unhelpful in determining maturity stages of feijoa fruits. There was no significant reduction in TSS or dry matter with maturity, but there was a clear reduction in titratable acidity. Even with this clear trend with titratable acidity, it is not helpful as it is still a destructive

measurement, nevertheless the internal chemical changes may be able to be estimated with a non-destructive technique such as Near Infrared Spectroscopy (NIRS). A combination of non-destructive methods such as firmness with NIR may be better than depending on a single index in identifying fruit maturity. In addition, the data clearly demonstrated that fruit at any particular internal maturity rating were clearly shown to have a wide range of firmness values, total soluble solids (TSS), titratable acidity (TA), skin colour, and aroma. This makes it likely that this maturity as measured by locular development is a poor descriptor for overall process of fruit ripening in feijoa.

As feijoa fruit mature, aroma volatile concentrations increase. The three characteristic compounds (ethyl butyrate, ethyl benzoate and methyl benzoate) of feijoa aroma were found more consistently in headspace analysis than solvent extracted flesh. Controlled atmosphere (CA) storage was found to suppress volatile production. Aroma could be used as a fruit quality measure. The e-nose has been shown to be sensitive to volatiles in other fruit, so it might have potential for measuring the changes in maturity of feijoa fruit. This technique is practical, non-destructive and cost effective. This technique should be tried in the future with feijoa cultivars.

To extend the postharvest life of feijoa fruit, cool storage in unlined trays at 4°C was tested. During cool storage, weight loss increased to about 6% after six weeks at 4°C and additional 5% during 7 days of storage at ambient temperature (20°C). Firmness (acoustic and compression) and other aspects of fruit quality decreased with time. Rate of ripening as measured by the change of internal maturity rating at 20°C increased with time. No significant changes were found in terms of total soluble solids during subsequent shelf life at 20°C for the entire period of storage. 'Unique', an early cultivar, generally had a shorter storage life than 'Opal Star'.

The effects of five controlled atmospheres were also studied. Fruit were stored in a matrix of two levels of oxygen (2% and 5%) and two levels of carbon dioxide (0% and 3%), or air control, at 4°C for 10 weeks. Fruit were transferred to ambient temperature (20°C) after storage for 4, 6, 8 and 10 weeks for shelf life assessment for 7 days. For the entire period of storage, fruit weight loss was approximately 1.5-2% of the initial weight. The firmness of the fruit stored under CA conditions decreased

regardless of atmospheric conditions. In 'Opal Star', fruit underwent a significant colour change from dark to light green after the 10 weeks of storage. However, for 'Unique' there was no significant change in colour observed in the period tested. In both cultivars, there was a slight decrease in TSS over time. 'Opal Star' showed a good storage life with better fruit acceptability as compared to 'Unique'. In both cultivars, all the treatments caused some signs of injury after week 6. Generally, CA conditions were effective in reducing weight loss and external injury, and maintaining fruit firmness compared with air. 'Opal Star' had a good storage life with over 60% of fruit rated acceptable after 73 days of storage in CA treatments without CO<sub>2</sub>. Hence 'Opal Star' may be suitable for export by sea.

The effect of three concentrations of ethylene (10, 100 and 1000 ppm) and one concentration of propylene (1300 ppm) applied for 24 hours on three different stages of maturity of 'Opal Star' and 'Unique' of feijoa suggests that 'Unique' and 'Opal Star' do not present typical climacteric activity. Feijoa fruit harvested at different stages of maturity were able to continue the ripening process without any acceleration by ethylene or propylene treatments. Different concentrations of exogenous ethylene or propylene had no effect on fruit firmness and colour changes. This could mean both cultivars are non-climacteric fruit according to the McMurchie et al., (1972) classification. However, this may also indicate that the fruit are already saturated with ethylene at early harvest stage. In 'Unique' highest ethylene production rates occur with early season fruit as they soften. Fruit at late harvest seems to be past the climacteric peak. In 'Opal Star' highest ethylene production occurred in late season, which may imply that climacteric peak happens at the ripe stage. There was no clear relationship between ethylene production and colour. This study supports the idea that the climacteric and non-climacteric classification is relatively general and unable to take into account the peculiarities of each species.

In conclusion, this thesis offers important insights into the regulation of postharvest loss of quality in feijoa. These insights should allow the future development of non-destructive at harvest maturity tests for feijoa. In addition, CA storage conditions are defined that could be used to support sea freight of feijoa to distant markets, although it remains to be seen whether aroma fully recovers after CA.

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