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Tazziberry™ (Myrtus ugni)

-Production protocols

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by M. Forbes-Smith

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Foreword

Myrtus ugni berries, or Myrtus berries, are the fruit of a hardy evergreen shrub native to Chile. The berries are red, about 10mm in diameter with a similar shape to blueberries, and have excellent aroma and flavour. Tas Myrtus Berries Pty Ltd (TMB) recently started commercial production of *M. ugni* berry under the registered trade name "Tazziberry™" in Tasmania, Australia. Demand for the fruit is very high but due to the lack of commercial operating experience anywhere in the world, research into cultivation, transport and storage, as well as promotional strategies to penetrate new market connections, is crucial to ensure success of this new berry industry and minimise the risk of failure by TMB and growers in Tasmania.

The aim of the study was to gain a firm knowledge base for successfully delivering *M. ugni* berry to the world. This report covers the following research findings:

- Improved post harvest specifications for fresh Myrtus berries
- Expanded range of foods containing Myrtus berries through product development
- Novel marketing strategies used to promote Myrtus berries (Tazziberry™) in Australia and overseas
- Information on the sensory, nutritional and antioxidant characteristics of Myrtus berries

This project was funded from RIRDC core funds, which are provided by the Australian Government.

This report is an addition to RIRDC's diverse range of over 1500 research publications. It forms part of our New Plants Products R&D sub-program, which facilitates the development of new industries based on plants or plant products that have commercial potential for Australia. Most of our publications are available for viewing, downloading or purchasing online through our website:

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Peter O'Brien

Managing Director
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Executive Summary

Myrtus ugni, a small evergreen shrub originating from Chile, yields small red berries of unique flavour and fragrance. Tas Myrtus Berries Pty. Ltd (TMB) has recently taken on commercial production of Myrtus berry (Tazziberry™) in Australia. Essentially, the Tazziberry™ industry is TMB and its growers in Tasmania. No other significant commercial venture is known to exist, even in Chile where harvesting from wild *M. ugni* bushes is still practiced.

Current demand for Myrtus berries in Australia is strong, while a recent market research project (RIRDC TMB-1A) demonstrated further interest for the fruit with chefs and food suppliers in Asia. Clearly, there is a need for ongoing research on cultivation, storage and transport of Myrtus berries, as well as proper promotion in target markets, to ensure stable supplies of high quality berries and success for growers and TMB in this emerging berry industry.

The aim of this study was to gain a firm knowledge base for successfully supplying the fruit of *M. ugni* to the world. Pertaining to this objective, the project covered the following research topics:

Extension of post harvest shelf-life: Quality of Myrtus berries can only be provided through proper temperature management and post harvest packaging in the supply chain. In this study, storage at 0ºC in conjunction with MA/high CO_2 using the Controlled Atmosphere Longlife Module (CALM) system, or packaging Myrtus berries in punnets with no air ventilation holes (some air transfer occurs via the punnet lid and compartment seam) were demonstrated to allow storage of high quality Myrtus berries for up to 2 months. Warmer storage temperature and unsuitable packaging promoted respiration rates, weight loss, rot development and resulted in senescence, as indicated by discolouration (*eg*. browning) of the berry skin and calyx leaves.

Treatment of berries with chlorine prior to packaging or placing a paper pad at the bottom of punnets to absorb any condensation moderately reduced post harvest rots, although a hot water treatment of 55ºC for 30 sec (as a natural alternative to eliminate rots) had no effect in controlling berry disease. Punnets of Myrtus berries with 4 or more ventilation holes caused undue weight loss in berries during storage, leading to undesirable flesh softening and shrivelling. Ethylene showed no obvious impact on post harvest quality, although additional research on ethylene response of Myrtus berry tissue is necessary to confirm this result.

Temperature monitoring of berries conveyed from Tasmania to Sydney, NSW, indicated that conditions were not ideal for transport. Refrigerated transportation of 0ºC is necessary to ensure Myrtus berries keep in good order. Given this limitation, it is very likely that considerably longer storage times than found here would achievable using cool storage from harvest until sale.

Adoption of these outcomes will provide considerable improvements in the post harvest handling of Myrtus berry and increase quality standards for the market.

Sensory analysis: The behaviour of a quality attribute not only depends on the physiological characteristics of a food product but also of the consumer. Sensory analysis confirmed the excellence and marketability of CALM treated Myrtus berries and berries in punnets without ventilation holes after 2 months storage at 0ºC. A strong, desirable aroma was especially maintained in berries stored in the CALM system. Main drivers of acceptance as determined by consumers included liking of appearance, aroma and initial flavour of berries.

Frozen whole berries (8 weeks at -24ºC) were also included in the sensory evaluation to determine the willingness of consumers to accept frozen berries (fruit were thawed for the analysis). Overall, frozen berries tended to have less appeal, but it was thought that the presentation of berries was a major factor to acceptance, rather than the sensory flavours themselves. Acceptability of frozen berry material is likely to improve when consumed in or with other foods. Supply of high quality frozen Myrtus berry

throughout the year would increase the value of Myrtus berries (Tazziberry™) in both Australia and overseas.

Nutritional and antioxidant properties: People are now more aware of the significance of a healthy and nutritious diet. While the nutritional value of Myrtus berries was similar to other selected fruits and berries, and only contained moderate levels of vitamin C, it did demonstrate considerable antioxidant ability when tested in a linoleic acid reaction assay. Natural antioxidant(s) in Myrtus berries that provide functional and/or health benefits would facilitate a sustainable industry growth of Tazziberry™. Further studies using a combination of antioxidant assays are recommended to establish the antioxidant potential of Myrtus berry.

Commercialisation strategies: A number of promotional activities were accomplished by TMB to advance commercialisation and marketing of Tazziberry™. Organised growers meetings lead to the initiation of a Southern Growers Collaborative Group in Tasmania, with further regional grower groups currently forming. Publicity activities conducted at Food Fairs etc contributed to expand fresh berry sales in the Tasmanian tourism and hospitality markets, as well as certain wholesale markets in Melbourne. The venture to explore value-added products of Myrtus berry with food businesses was extremely beneficial. As a result, selected commercial value-added products are envisaged in the near future.

The means to promote strong market connections for Myrtus berries in Australia and overseas depends on the ability to consistently deliver a desired product quality. Outcomes from this project (improved marketing and post harvest management, value-adding through product development, sensory, nutritional and antioxidant information) have all contributed to achieve this goal.

1. Introduction

1.1 Background

A hardy small evergreen shrub, *Myrtus ugni* Molina or *Ugni molinae* Turcz, also commonly known as Chilean guava, murtilla or Myrtus berry, is native to Chile where the people have long appreciated the red fruit (berry) for its unique and delicious flavour. While *M. ugni* is typically grown as an ornamental outside of Chile, the culinary delights of berries are relatively unknown.

Tas Myrtus Berries Pty. Ltd. has registered Myrtus berry (Tazziberry™) for commercialisation in Australia. The crop is cultivated in Tasmania, which has production areas with a suitable climate. *Myrtus ugni* prefers moist acidic or rich humus soils but will adapt to any condition, including clay, rocky terrain and sandy loam. Flowering takes place in late spring, with berries following in late March to May in Tasmania. When ripe, the berries have a full fruity aroma, which persists after harvesting and packaging.

However, TMB and growers now face production and marketing challenges. Demand for fresh berries in Australia currently exceeds supply and previous market research has indicated keen interest and support for *M. ugni* fruit among chefs and food purveyors in Asia, particularly Hong Kong and Taiwan (see RIRDC project TMB-1A final report). Since no other major commercial production of Myrtus berries is known anywhere in the world - even in Chile, where harvesting from wild bushes still persists - TMB must undertake its own scientific and market research to ensure the success of this new berry industry in Australia.

Major opportunities exist to advance commercial outcomes of Myrtus berries. An important approach is the improvement of quality and shelf-life extension of Myrtus berries, leading to better acceptance and increased sales of Myrtus berries in Australia and overseas. Standards that ensure quality, acceptability and extension of shelf-life of Myrtus berries have not been determined and formalised on an industry wide basis.

Myrtus berries have a superb and uniquely delicious flavour *ie*. a combination of wild strawberries, pineapple, and Gravenstein apple with a rich and unusual aromatic after-taste sensation. Commercial value of Myrtus berries would be strongly related to the uniqueness and strength of flavours imparted to food preparations. Cuisine uses of Myrtus berries are unlimited, from sauces for meat dishes, jams and jellies and fruit pies, glazed fruit, flavoured muffins and crepes for desserts. Development and marketing of new, Myrtus berry products with agreeable appearance and high food quality standards would urge bigger food manufacturers to use Myrtus berries in the conventional retail and wholesale food markets.

Sales of fruit and vegetable products with health-promoting characteristics are a valuable growth area in the food industry. Possible nutritional and antioxidant components in Myrtus berries might also achieve such capabilities. Utilisation of Myrtus berries as natural health food source would certainly have substantial consumer appeal.

TMB and growers see that the priority at present is the defining of the nutrition attributes and antioxidant benefits of the Tazziberry™. A complete nutrition panel and assessment of antioxidant and medicinal properties is urgently required to move on from fresh berry sales and prepare for value added product manufacture.

1.2 Objectives

The general objective of this research was to gain a firm knowledge base for successfully supplying the fruit of *Myrtus ugni* to the world. In relation to this objective, the project consisted of following studies:

- Determination of transport, storage and packaging requirements for Myrtus berries
- Evaluation of sensory characteristics of Myrtus berries
- Nutritional analyses of Myrtus berries
- Screening for antioxidant capability of Myrtus berries
- Exploration of strategies for developing and marketing Myrtus berry products

2. Extension of post harvest shelf-life

Temperature management and packaging are two of the most important factors affecting the quality of fresh berries in the supply chain. Even short exposures to changes in temperature can cause a marked decrease in shelf life and quality. An initial objective of this study was to evaluate temperature conditions of Myrtus berries freighted from Tasmania to the Sydney Post harvest Laboratory (SPL), Sydney, via various commercial air transport services used by TMB. Further objectives included determining the optimum storage temperature and the relationship between temperature and shelf-life, as well as systems using a range of packaging materials and storage atmospheres to ensure that the berry reliably reaches its target markets in peak condition.

2.1 Transport temperature survey

Data loggers were used to monitor temperature stability of two consignments of Myrtus berries from Tasmania to Sydney (designated as Consignment 1 and Consignment 2). To prevent injury of fruit during transport, berries in clamshell punnets with ventilation holes (commercial packaging typically used by TMB) were firmly packed in cardboard cartons reinforced with polystyrene wadding. For consignment 2, several loggers tracked various temperatures within the transport carton, including:

- within a punnet of berries placed in the middle of the carton
- within a punnet of berries next to the wall of the carton
- inner sidewall of the carton

Logging intervals of 10 min ensured accurate monitoring of temperatures, as well as a comfortable maximum logging capacity for transit from Tasmania to Sydney.

2.11 Results and discussion

Figs. 1 and 2 describe the temperature profiles of Myrtus berries for Consignments 1 and 2 sent by air from Tasmania to Sydney, respectively. The distinct temperature spikes at 0hr and 26hr seen during Consignment 2 (see Fig. 2) designate when berries were first packed for transport in Tasmania and unpacked at the completion of the journey in Sydney (spikes were caused by immersing loggers in warm water for 20-30min).

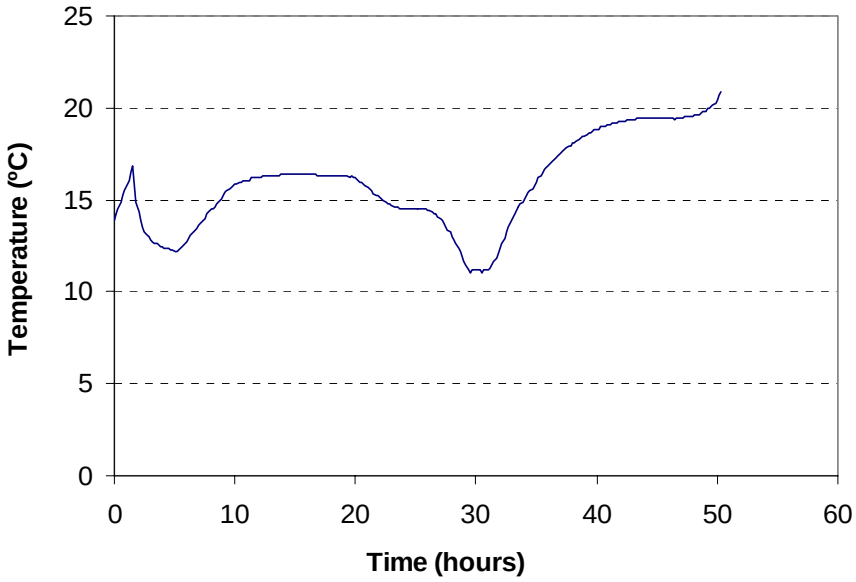


Fig. 1 Temperature profile of Myrtus berries conveyed from Tasmania to Sydney - consignment 1

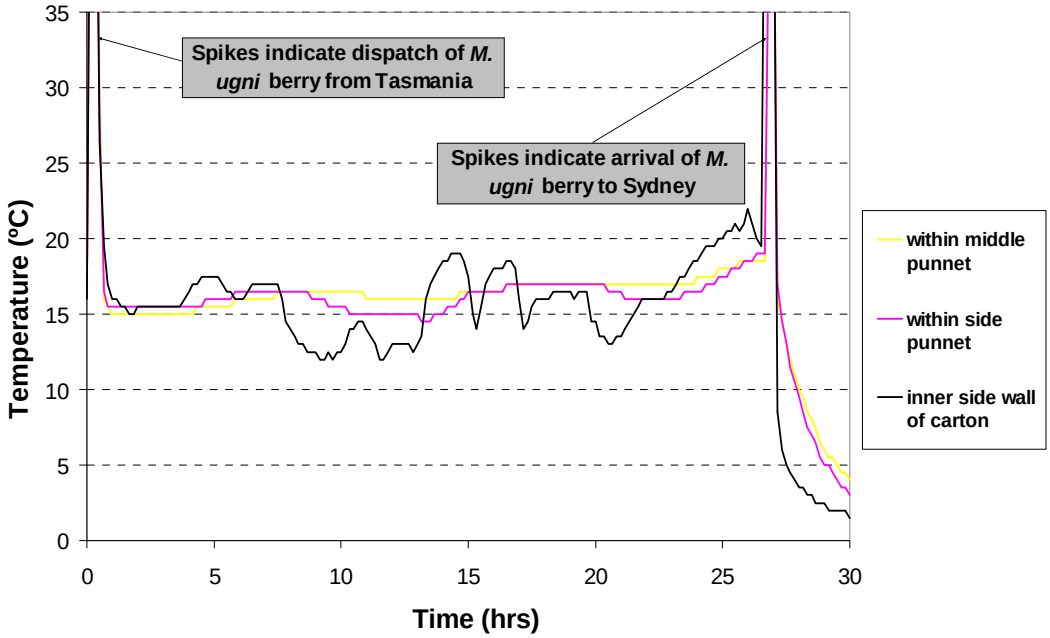


Fig. 2 Temperature profile of Myrtus berries conveyed from Tasmania to Sydney - consignment 2

Cool chain management is an important strategy for preserving post harvest quality of horticultural commodities. However, data from these transport trials indicated temperature conditions were not ideal, with average temperatures being *ca*. 15ºC during transport for Consignment 1 and *ca*. 16ºC in both the middle and side berry punnets for Consignment 2. During Consignment 2, variability of temperature was considerably higher at the inner sidewall of the transport carton (max and min temperatures were 22ºC and 12ºC, respectively) than within punnets of berries (*eg*. max and min temperatures within the middle punnet were 18ºC and 15ºC, respectively) (see Fig. 2). For future deliveries of Myrtus berries, refrigerated transport of around 0ºC is recommended to minimise loss of water (weight) caused by evaporation, and to slow metabolic activity (respiration) and development of rots (see Section 2.2 for temperature management of Myrtus berries).

Travel time was also shorter for Consignment 2 (*ca*. 26hr) compared to Consignment 1 (*ca*. 50hr), where berries unexpectedly travelled from Tasmania to Sydney via Perth, Western Australia.

2.2 Temperature management

Myrtus berries (*ca*. 100g) in clamshell punnets with 20 ventilation holes were stored at 0, 5, 15 and 20ºC and assessed at regular intervals for quality. Berry quality parameters evaluated included weight (water) loss, appearance and presence of rots. Samples were replicated 3 times.

For determining the respiration rate of berries at different temperatures, samples of air from receptacles containing the berries (*ca*. 100 g) were measured for carbon dioxide by gas chromatography.

2.21 Results and discussion

Optimal post harvest life of horticultural produce is usually just above temperatures that cause chilling or freezing injuries. In this study, the ideal storage temperature for Myrtus berries was found to be 0ºC. The main factors affecting quality - weight loss, which causes shrivelling and softening, and development of rots – all accelerated with warmer temperatures (Figs 3 and 4). For example, weight loss after 8 days storage at 0ºC was 1.8%, compared to 10.3% after 8 days at 20ºC. Discoloration (*eg.* browning) of the red berry skin and green calyx leaves was also more rapid with warmer storage temperatures.

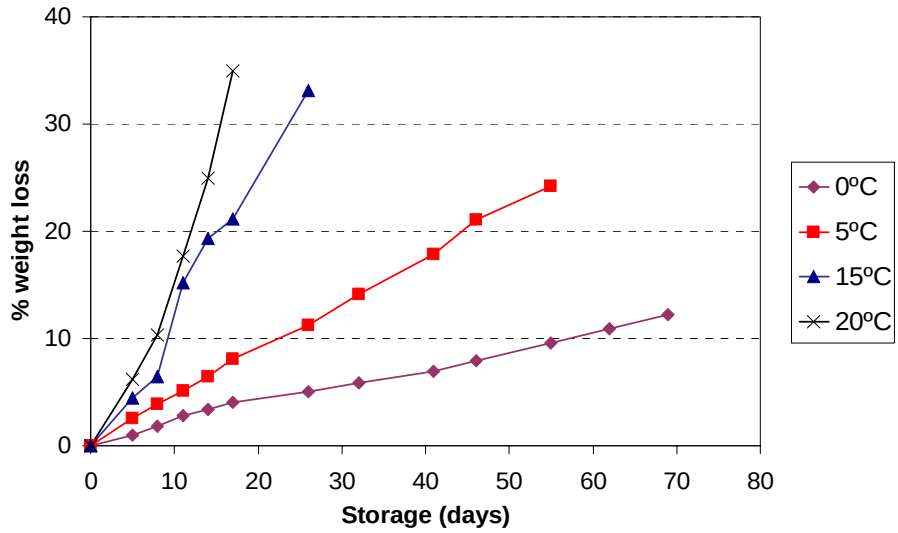


Fig. 3 Weight loss of Myrtus berries stored in clamshell punnets (with 20 holes) at different temperatures

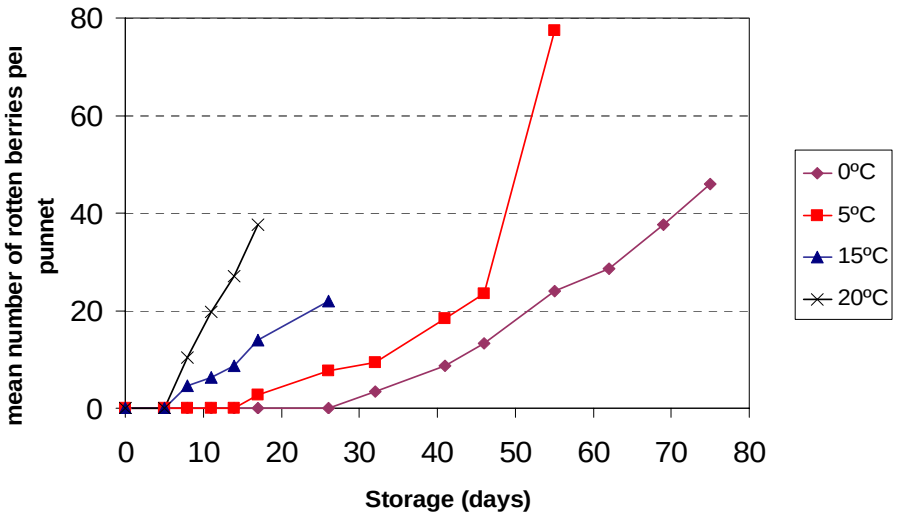


Fig. 4 Incidence of rots in Myrtus berries stored in clam punnets at different temperatures. Punnets contain approximately 140-160 berries (100g)

The rate of respiration is regarded a good indicator of potential post harvest longevity. Generally, the higher the rate of respiration, the shorter the post harvest life of produce. Exposure of commodities to higher temperatures often gives rise to increased respiration and a reduced shelf-life. For Myrtus berries, the rate of respiration characteristically increased as temperature increased (Fig. 5). The relative increase in respiration between 15ºC and 20ºC was greater than the increase between 0ºC and 5ºC. The respiration at 0°C is about double that of cranberries, similar to blueberries and about half of that of strawberries and raspberries (Optimal Fresh 2005). At 20°C respiration is about a fifth of raspberries, quarter of other Myrtaceae fruit such as feijoa and guava and also strawberries, half of cowberries and blueberries, three tines that of cranberries (Optimal Fresh 2005).

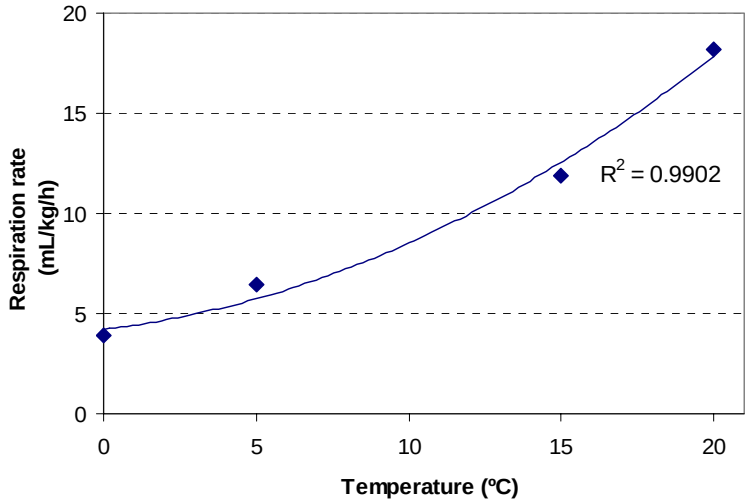


Fig. 5 Respiration rate (estimated as ml CO_2/kg/h) of Myrtus berries at different temperatures.

2.3 Package development - stage I

Previous results indicated that the optimum storage temperature for extending shelf-life of Myrtus berries was 0ºC. Further shelf-life extension of Myrtus berries was investigated using a range of different packaging options, the first trial involving:

- Dip treatment in 200ppm chlorine sanitizer for 1 min to facilitate eradication of possible latent microorganisms and reduce rots. The berries were permitted to air dry before packaging in standard clamshell punnets with 20 holes.
- Paper pad in the bottom of the punnet to absorb free water such as condensation. Condensation can be particularly detrimental to the quality of berries as it encourages the growth of rots.
- Modified Atmosphere (MA)/high CO_2 using the Controlled Atmosphere Longlife Module (CALM). Punnets were stored in an atmosphere of *ca*. 7% CO_2; 13% O_2 to potentially reduce the proliferation of spoilage fungi. The ideal atmosphere would have been probably about 15% CO_2 and 6% O_2, however, fine tuning of the storage system would be required to allow for the packaging used and respiration of Myrtus berries.

Treatments were compared to controls that consisted of berries stored in clamshell punnets only. All berries were stored at 0ºC and assessed regularly for weight loss, rots and appearance.

2.31 Results and discussion

Modified Atmosphere using the CALM system was undoubtedly the most beneficial treatment to ensure berry quality for the market. The advantage of MA to curb weight loss and reduce shrivelling of berries was evident early into the trial, where for example, weight loss of berries stored for 14 days in the absorbent pad, chlorine and control treatments was significantly higher than that in the CA treatment (3.6, 3.8, 4.6 and 1.1% weight loss, respectively) ($P<0.01$) (Fig. 6). With further storage, weight loss of berries increased considerably in the absorbent pad, chlorine and control treatments, where at 92 days the weight loss was approximately 10 fold greater in the pad, control and chlorine treatments (26.3, 30.5 and 32.3%, respectively) than MA (2.7%) ($P<0.01$). Untreated berries in punnets (controls) were unmarketable after 3-4 weeks at 0ºC. Work by Berger *et al* (1998) also demonstrated that storage of Myrtus berries at 1ºC in controlled and modified atmospheres were effective means to control weight loss.

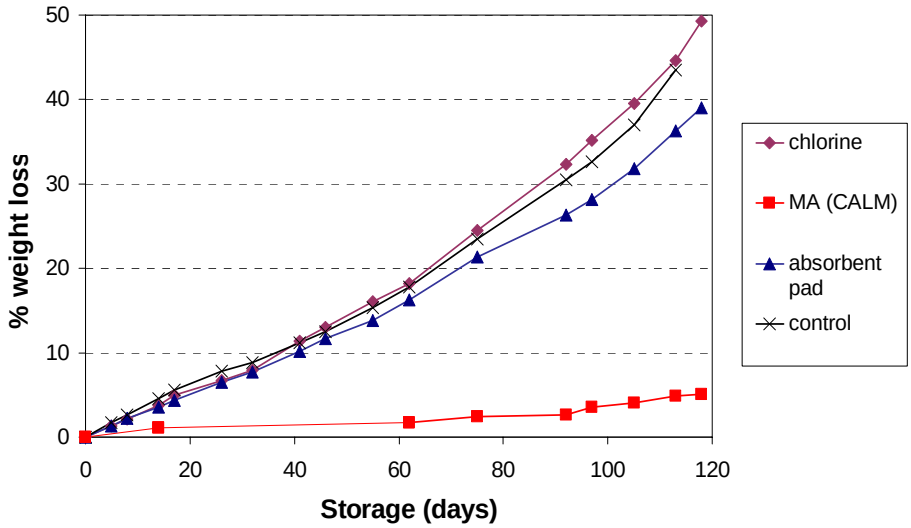


Fig. 6 Weight loss of Myrtus berries stored in various packaging materials at 0ºC.

Loss of post harvest commodities caused by pathological spoilage can be very significant. In general, the majority of infections are by opportunistic (weak) pathogens that enter through wounds and natural openings, such as stomata, or lesions created by true pathogens or physiological disorders. Invasion of microbes can occur prior to harvest and remain dormant until conditions favour microbial growth (latent infections), or invasion can occur during storage.

Through the initial stages of storage of Myrtus berries, the incidence of rots was relatively low in all treatments (*eg*. the mean number of berries with rots was less than 3 per punnet at 3-4 weeks of storage). However, with further storage, rots became more apparent particularly in the control berries. Absorbent pads or chlorine helped to reduce rot development, but were not as effective as the CALM system. After 75 days storage at 0ºC, the mean number of diseased berries per punnet for the control, chlorine, pad and CALM treatments was *ca*. 62, 31, 33 and 7 respectively ($P<0.05$) (Fig. 7). The predominate mould identified on Myrtus berries was *Botrytis cinerea*, also commonly found on fruits such as grapes and strawberries.

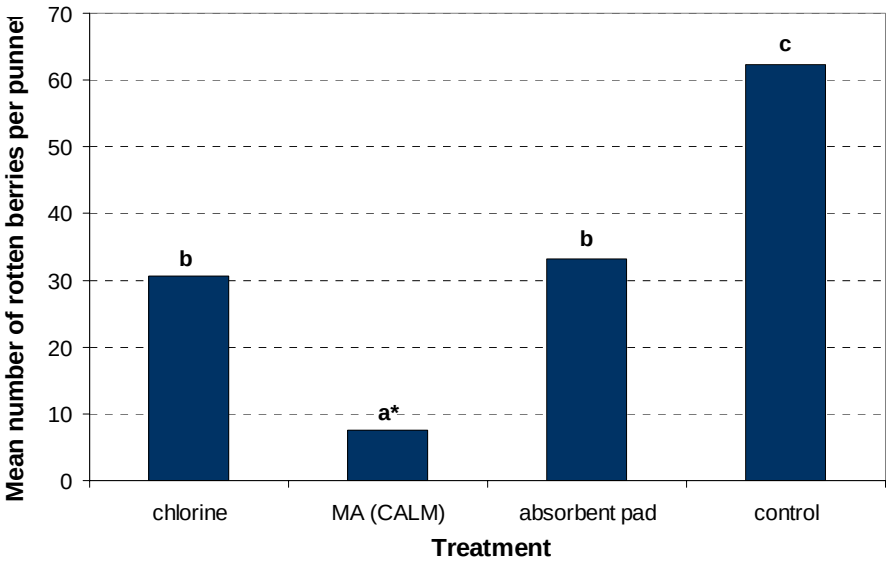


Fig. 7 Incidence of rots in Myrtus berries after 75 days storage at 0ºC. * different letters indicate significant difference at P=0.05

The basic principle of CALM is storage under high CO_2 and low O_2 to inhibit the growth of spoilage moulds, while adequately sustaining fruit respiration. In MA (CALM) storage of *M. ugni* berries, the procedure initially involved cooling punnets to 0ºC, then tightly sealing within a plastic sleeve (bag). The CALM unit was attached to the sleeve via an air-tight interface with an air oxygen sensor and tubing going through the interface to provide adequate fresh air to the berries and to maintain the ideal storage atmosphere.

On further storage (>90 days) in MA (CALM), discoloration and browning of berry skin and calyx leaves became more noticeable. Fruit also discoloured in other treatments but many of these were severely shrivelled and/or infected with rots.

2.4 Package development - stage II

Results from Stage I package trial indicated that MA/high CO_2 generated by CALM was the most effective treatment to reduce rot development and weight loss (shrivelling) in Myrtus berries. High RH atmosphere within the CALM system was the probable cause for the reduced rate of weight loss during storage, as the plastic film used with CALM would restrict the movement of water vapour and produce high RH, thus preventing excessive water loss from the berries.

The punnets used in the stage I package trial (and used commercially by TMB) have 20 ventilation holes of about 5mm in diameter. A simple strategy to encourage high RH and reduce weight loss of Myrtus berries during storage would be to use modified punnets with no or few ventilation holes. Inclusion of a porous paper pad to absorb condensation in the bottom of the punnet would also assist to control development of rots. Post harvest treatments investigated in the stage II package trial included:

- Berries in punnets without ventilation holes. An absorbent pad was also included in the punnet
- Punnets with 4 holes at 5mm diameter each, absorbent pad included
- Hot water pre-treatment, as a natural alternative to chlorine to potentially eradicate rots. Berries were dipped in water at 55ºC for 30s, then air dried before placing into punnets each with 4 holes and an absorbent pad
- CALM storage of berries in punnets with absorbent pad
- Controls (untreated) – berries in clamshell punnets (with 20 ventilation holes) only

Treatments were replicated 4 times; the storage temperature was 0ºC. Objective measurements of berries included weight loss, rot development, appearance and fruit firmness using a TA-XT2 texture analyser, as well as sensory assessment of marketability, which is the decisive factor by which a consumer assesses and selects produce.

2.41 Results and discussion

Modified punnets with no or few (4) ventilation holes significantly reduced the rate of weight loss of Myrtus berries, but not to the same extent as the CALM system (P<0.05) (Fig. 8). After 56 days at 0ºC, weight loss control was optimum in the CALM system (1.4% weight loss), followed by punnets without ventilation holes (3.5%), punnets with 4 holes (6.2%) and the control (15.2%). Weight loss of berries pre-treated in hot water and stored in punnets with 4 holes was 7.3%, slightly higher (but not significant at P=0.05) than berries stored only in punnets with 4 holes. Berries in punnets without holes had higher weight loss than berries stored in the CALM system, most likely because of the narrow gap(s) present between the punnet lid and compartment, allowing a little air movement and subsequent loss of moisture from the berries.

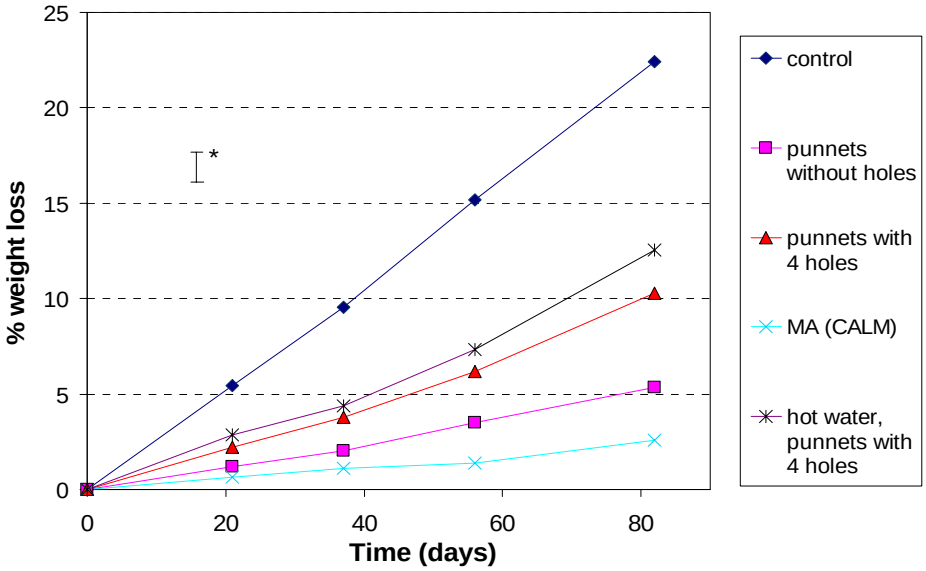


Fig. 8 Weight loss of Myrtus berries stored under different conditions at 0ºC. * indicates LSD at 0.01 level

An important quality parameter for Myrtus berries is flesh firmness, as consumers favour firm, moist berries, in preference to soft (shrivelled), dry berries. As the level of weight loss is generally related to the level of fruit softening, minimizing weight loss is likely to preserve flesh firmness in berries during storage. Fig. 9 shows that the CALM system and to a slighter extent, punnets without holes, adequately maintained berry firmness for up to 56 days storage. This extension of berry firmness indicates that quality is preserved in storage and as a result, this extends the marketable life of the berry. Indeed, appearance of berries stored in the CALM system was overall more appealing than berries in other treatments, particularly the controls (Fig. 10).

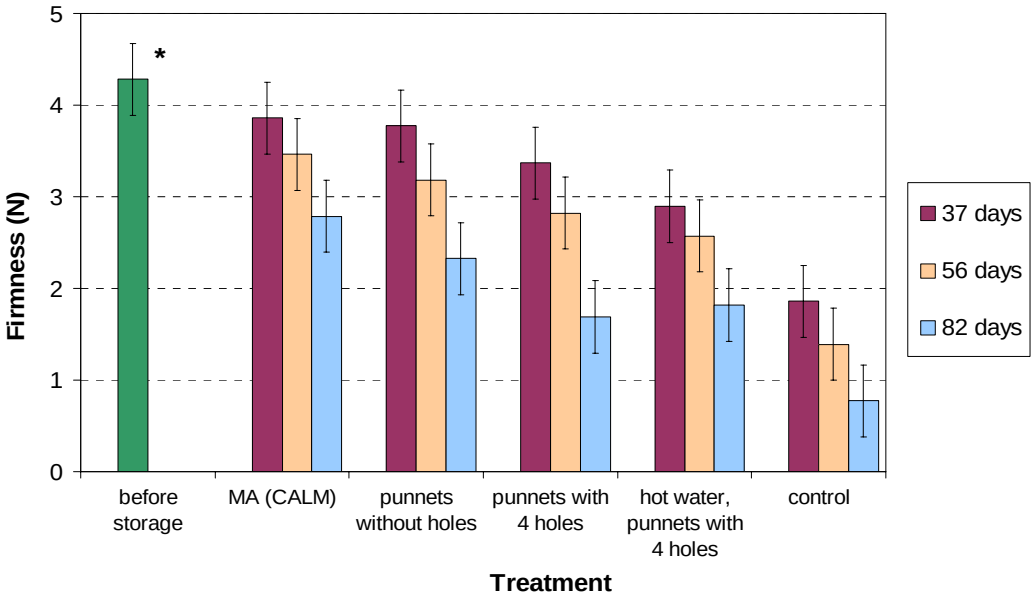


Fig. 9 Firmness of Myrtus berries stored in different packaging for 37, 56 and 82 days at 0ºC. *indicates LSD at P=0.05 level

Fig. 10 Comparison of untreated Myrtus berries (left punnet) and Myrtus berries using CALM (right punnet) after 8 weeks at 0ºC

With regards to pathological spoilage, berries in this packaging trial (stage II) had fewer incidences of post harvest rots than berries sourced in the previous (stage I) package development study. Nonetheless, fruit in both the CALM and punnets without holes treatments showed significantly less number of rots (*eg*. 5-6 rotten berries per punnet after 56 days) than the other packaging treatments and controls (*eg*. 11-16 rotten berries per punnet after 56 days) ($P<0.05$) (Fig. 11).

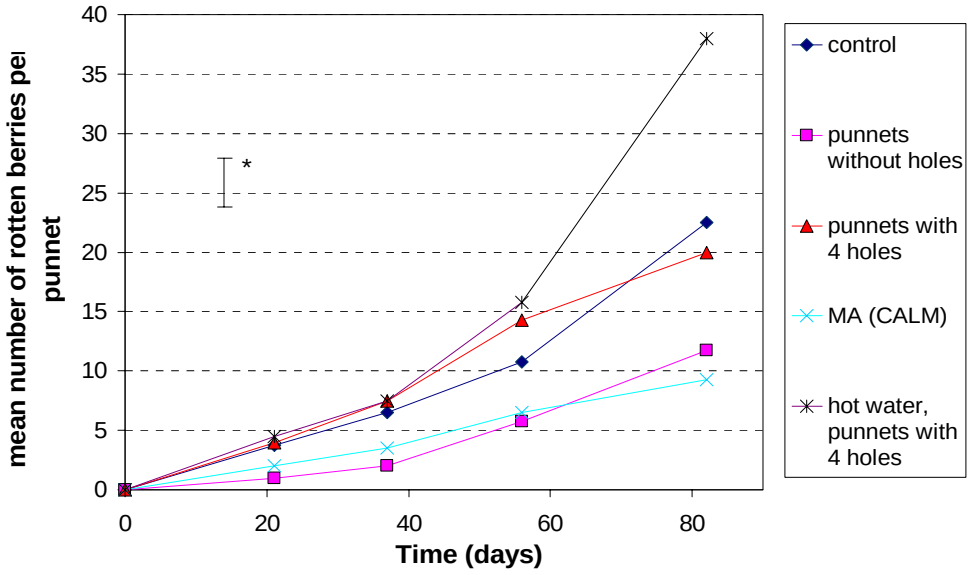


Fig. 11 Post harvest spoilage in Myrtus berries stored under different conditions at 0ºC. * indicates LSD at 0.05 level

Surprisingly, the hot water treatment was rather ineffective in controlling development of rots. Hot water dipping essentially has the benefit of reducing microbial spore loads on or enmeshed in the commodity skin without leaving chemical residues. Perhaps the water treatment used (55ºC for 30s) to control wastage in the berries also caused some physiological damage, thus facilitating infection by spoilage micro organisms.

To summarise, significant improvement in post harvest quality is achieved by application of MA through the CALM system, closely followed by packaging berries in punnets with no air ventilation holes, for up to 2 months at 0ºC. However, it should be kept in mind that the very large reduction in rots of the control berries with no ventilation is quite different to that observed in the first series (Stage I) of experiments, while the CALM treated berries were similar in having low rots and weight loss in both series. In addition, by adjusting the CO_2 and O_2 levels of the CALM system, improved control of moulds should be possible.

2.5 Sensory analysis

An important element for determining shelf-life of horticultural produce is to consider quality characteristics as perceived by the human senses (sight, smell, taste etc). Quality assessments incorporating sensory data, especially taste, assist to ascertain the real quality preferences of produce demanded by consumers.

In this study, a sensory analysis was organised for the two of the most favourable post harvest treatments reported in the section 2.41 *ie*. CALM treated Myrtus berries and berries in punnets without ventilation holes, after 2 months storage at 0ºC. In addition, frozen berries (8 weeks at -24ºC) were included in the analysis to determine general willingness of consumers to accept frozen berries (fruit were thawed immediately prior to the analysis), in relation to the two post harvest treatments.

A hedonic sensory testing method was employed (scale 0-10) to determine the intensity and liking of sensory attributes. Panellists (48) evaluated properties such as strength and/or liking of appearance, aroma, flavour and textural properties of Myrtus berries, as well as specific descriptors including sweetness, bitterness, astringency, aftertaste etc (see Appendix 1 for the sensory evaluation questionnaire).

2.51 Results and discussion

Fresh storage at 0ºC:
Sensory analysis showed no difference in overall liking of berries stored in MA (CALM) and in punnets without holes after 8 weeks at 0ºC (Table 1). Although individual scores for CALM treated berries tended to be slightly higher, consumers could not perceive significant differences in any of the attributes surveyed between treatments (P>0.05), except aroma strength, which was significantly higher in CALM treated berries (P<0.05). As one would expect, intense fruity aroma would be a valuable asset for selling Myrtus berries to consumers and food manufacturers.

In both packaging types, the degree and strength of sensory attributes generally lay in the median range of the scale (*eg*. mean scores for strength of aftertaste in berries ranged 4.8 to 5.0, suggesting the aftertaste detected was not weak nor excessively strong), and liking of attributes was mostly above 5, which indicates berries were acceptable and desirable to consumers. Main drivers of acceptance included liking of appearance, aroma and initial flavour (*eg*. scores of 6.6, 6.6 and 5.8 for CALM treated berries, respectively). Comments from panellists also stated that the berries were a unique taste experience, some noting spiciness in the berry flavour.

ATTRIBUTE	Frozen (thawed)	MA (CALM)	Punnets without holes
Liking of appearance	3.3a*	6.6b	6.5b
Strength of aroma	5.9b	5.7b	4.6a
Liking of aroma	6.1a	6.6a	5.9a
Degree of firmness	1.8a	5.7b	5.2b
Degree of moistness	7.2b	4.0a	3.9a
Strength of initial flavour	5.0a	5.3a	5.4a
Liking of initial flavour	4.8a	5.8b	5.7b
Strength of ongoing flavour	5.4a	5.6a	5.7a
Liking of ongoing flavour	4.3a	5.2b	4.9ab
Degree of coarse texture	3.7a	5.1b	4.9b
Degree of sweetness	4.7a	4.5a	4.3a
Degree of astringency	4.0a	4.3a	4.8a
Degree of bitterness	3.1a	3.7a	3.7a
Strength of aftertaste	4.6a	5.0a	4.8a
Liking of aftertaste	4.5a	5.0a	4.6a
Overall liking	4.5a	6.0b	5.4b

* Mean scores followed by different letters within rows are significantly different at P=0.05 level

Table 1. Mean scores for Myrtus berry attributes. The scores are out of 10 - the greater the score, the greater the liking, strength or level of the attribute tested

Frozen berries (-24ºC)
The attributes related to berry appearance, aroma, firmness, moistness, texture, and initial and ongoing flavours varied considerably following freezing and thawing (Table 1). Frozen berries were perceived less appealing in appearance, too moist (soggy), undesirably soft and initial and ongoing flavours, irrespective of their perceived strength, were less liked than fresh berries stored at 0ºC for 8 weeks ($P<0.05$). However, aroma intensity in frozen berries compared favourably to CALM treated berries, and frozen berries were considered less coarse (gritty) in texture.

Texture stability of cellular foods such as fruits during frozen storage is often poor. The formation of ice directly impairs the rigid cell structure (water transformed to ice increases 9% in volume), and causes indirect damage when solute molecules become more concentrated in the unfrozen phase (all foods contain an unfrozen phase at all storage temperatures used commercially). Measuring firmness of berries with a TA-XT2 Texture Analyser also confirmed significant flesh softening after freezing and thawing of Myrtus berries (mean firmness score = 0.54N), in comparison to berries stored in MA (CALM) after 8 weeks at 0ºC (mean firmness score = 3.46N; see Fig. 9).

Although frozen berries were not very well received in the test, it is believed that the presentation of berries was a contributing factor to acceptance, rather than the sensory flavours themselves. Better approval of frozen Myrtus berries is envisaged if fruit are offered to consumers in a semi-iced form *ie*. partially frozen in order to bite into, or incorporated within, for example, value-added food products (see section 4.2 for product development concepts).

The benefit of supplying quality Myrtus berries in a frozen form to complement fresh Myrtus berries is significant - improving market potential due to extended storage and availability of raw berry material, compared to fresh Myrtus berries, which have a maximum market life of 8 weeks during/following the peak season from late March to May in Tasmania.

2.6 Ethylene effects

A further limitation in extending shelf-life of produce is the undesirable effects of ethylene gas. Ethylene can promote premature ripening or aging in climacteric fruits (*eg*. banana, apple) and hasten the onset of senescence in non-climacteric produce (*eg*. strawberry, citrus), often exhibited as loss of green colour (chlorophyll), detrimental changes in texture and flavour, and/or higher sensitivity to disorders and microbial decay (Wills *et al*., 1998).

Subsequently, a small study was undertaken to determine any adverse effects of exogenous ethylene on Myrtus berries. Glass vessels (vol: 1l) containing berries were flushed with ethylene (10ppm), sealed and held at 20ºC. To avoid accumulation of stale air, vessels were opened twice daily for 5min, then re-flushed with ethylene and sealed repeatedly for up to 14 days. Controls (untreated) contained air only.

Results indicated that Myrtus berries are quite tolerant to ethylene. No obvious differences in appearance were detected between ethylene treated and untreated (controls) berries for the duration of the trial. However, we recommend further investigations on possible detrimental effects of ethylene as the rate of response of plant tissue to ethylene might vary with different batches of Myrtus berries.

2.7 Summary

In light of these results, storage at 0ºC together with selected MA using the CALM system or packaging Myrtus berries in punnets with no air ventilation holes (some air transfer occurs via the punnet lid and compartment seam) significantly improved post harvest quality of Myrtus berries for up to 2 months. Absorbent paper pads were also included in the bottom of punnets. Sensory analysis confirmed the excellence and marketability of berries using these storage protocols, particularly the CALM system which allowed berries to retain a strong, desirable aroma.

Higher storage temperature and inappropriate packaging promoted respiration rates, weight loss, rot development and characteristics of senescence. Ethylene appears to have no apparent effect on post harvest quality, although further work on ethylene response of Myrtus fruit tissue is necessary to validate this outcome. Sensory qualities of frozen (thawed) berries were less favourable than hoped, but acceptability should improve when consumed in or with other foods.

These recommendations should help to consistently deliver a desired product quality and increase the value of Myrtus berries (Tazziberry™) in both Australia and overseas.

3. Nutritional and antioxidant qualities

There is increasing awareness among consumers of the importance of a nutritious diet, especially from fresh fruit and vegetables. Nutritional composition (carbohydrates, fats, proteins, vitamins, minerals) might be an important factor in determining whether a consumer purchases Myrtus berries. In addition, components of Myrtus berries with antioxidant potential might offer health benefits and have application for preservation of foods. This study involved (i) ascertaining nutritional properties of Myrtus berries and (ii) screening for antioxidant activity.

3.1 Nutritional composition

To establish a food composition panel for Myrtus berries, samples were dispatched to accredited food nutrition laboratories for analysis (Table 2). In general, protein amounts in Myrtus berries (0.9g protein/100g) were comparable to other berries and fruits, including blueberry (0.7g/100g), strawberry (0.6g/100g), raspberry (1.2g/100g), sweet cherry (1.1g/100g), grape (0.7g/100g), apple (0.3 g/100g) and orange (0.9g/100g). Carbohydrate content of Myrtus berries (17g/100g) was slightly higher than blueberry (9.6g/100g), strawberry (7.7g/100g), raspberry (11.9) and apple (13.8g/100g) but about the same of sweet cherry (16.1g/100g) and grape (18.1g/100g). Energy (kJ) level of Myrtus berries (302kJ) was high in relation to blueberry (239kJ), strawberry (134kJ) and raspberry (217kJ) (USDA, 2005).

Vitamin C levels in Myrtus berries (5-8mg/100g), although similar to apple (4.7mg/100g), sweet cherry (7.1mg/100g), banana (8.7mg/100g) and blueberry (9.7mg/100g), was considerably lower than strawberry (37mg/100g), raspberry (26.2mg/100g) and orange (59mg/100g) (USDA, 2005). This low level of vitamin C in Myrtus berries was originally thought because the first analysis did not include both vitamin C (L-ascorbic acid) and dehydroascorbic acid, which exhibits about the same vitamin activity as vitamin C since it is almost entirely converted to vitamin C in the human body. However, after further analysis that included both the L-ascorbic acid and dehydroascorbic acid components, there was a little increase in the total vitamin C quantity (8mg/100g) (see Table 2). Mature Myrtus berries (*M. ugni*) have been previously reported to be low (less than 1% fresh weight) in vitamin C (Birch, 2005).

Due to the effects of season, locality and maturity, data presented in Table 2 should essentially be considered as a guide to the nutritional content of Myrtus berries. Other important nutritional constituents, including carotenoids (*eg*. β-carotene, which is ultimately metabolised to vitamin A in the human body), folic acid and minerals (*eg*. iron), require investigation in Myrtus berries.

Components	Units	Amount
Moisture	g/100g	81.6
Fat (Mojonnier extraction)	g/100g	<0.2
Saturated fat	g/100g	<0.2
Protein (Nx6.25)	g/100g	0.9
Ash	g/100g	0.6
Carbohydrates - total	g/100g	17
Energy (kJ)	kj/100g	302
fructose	g/100g	4.7
glucose	g/100g	3.2
sucrose	g/100g	1.8
maltose	g/100g	<0.1
lactose	g/100g	<0.1
Total sugars	g/100g	9.7
Vitamin C	mg/100g	5.0
Vitamin C incl. dehydroascorbic acid*	mg/100g	7.95

Table 2 Nutritional composition panel for Myrtus berries (Analysis done by Australian Government Analytical Laboratory and AgriQuality Ltd Australia*)

3.2 Antioxidant activity

Antioxidants delay the onset, or reduce the rate, of oxidation of autoxidisable substances. Antioxidants are generally arranged into two categories:

- Primary antioxidants, which disrupt the free-radical chain reaction during lipid peroxidation to form relatively stable end-products. Examples of primary antioxidants include tocopherols, which constitute the principal antioxidants in vegetable oils, and butylated hydroxyanisole (BHA), a synthetic antioxidant often used in the food industry to retard lipid oxidation in foods.
- Secondary antioxidants, which are essentially reducing agents or oxygen scavengers. Ascorbic acid functions as an oxygen scavenger and asserts its antioxidant action when oxidised to form dehydroascorbic acid.

Antioxidants also have a number of health-promoting benefits in people, including reducing the risk of some cancers, cardiovascular disease, development of cataracts and pathological disorders, including gastric and duodenal ulcers, allergies, vascular fragility and viral and bacterial infections (Bravo, 1998; Leake, 1997).

Antioxidant behaviour of Myrtus berries was determined at SPL by appraisal of the formation of conjugated diene compounds (linoleic acid hydroperoxides), under accelerated shelf-life conditions (Lingnert, Vallentin and Eriksson, 1979). The procedure involved freeze-drying Myrtus berries, which were ground to a powder and extracted with solvents (methanol, tetrahydrofuran) overnight at 5ºC. After filtering, extracts were concentrated to dryness with a cold stream of nitrogen and the material obtained was made up to 0.5 g/ml solvent. Samples were stored at -80ºC until required for analysis.

Using crude solvent extracts of Myrtus berries and an emulsified linoleic acid reaction mixture as the substrate, the formation of conjugated dienes during oxidation at 37ºC was determined by

spectrophotometric measurement of absorption at λ234 nm. The magnitude of the absorbance relates well to the level of oxidation in the reaction mixture, during the initial stages of oxidation. Blueberry extracts and BHA were also tested to evaluate antioxidant efficacy against Myrtus berries.

Myrtus berries showed a positive antioxidative response in the emulsified linoleic acid system (Table 3). Berry samples extracted with tetrahydrofuran (THF) showed greater antioxidative effect (AE) than methanolic extractions, suggesting that THF, which is a less polar solvent than MeOH, was more capable in withdrawing antioxidant component(s). With samples assayed to 48 hours, AEs tended to decrease, probably because the antioxidant(s) present depleted within the reaction mixtures. Assessments were stopped after 48 hours as the oxidation products (hydroperoxides) formed are rather unstable and often disappear by further reactions, leading to a decline in absorbency values.

Sample	**AE**	
	24h	**48h**
Myrtus berry (MeOH extract)	0.54	0.10
Myrtus berry (THF extract)	0.86	0.70
Blueberry (MeOH extract)	0.49	0.27
Blueberry (THF extract)	0.61	0.18
BHA (0.002mM in reaction substrate)	0.93	0.80

Table 3 Linoleic acid reaction assay measuring the relative antioxidative effect (AE) of Myrtus berry and blueberry extracts (1mg material / ml reaction substrate) assayed at 37ºC for 24 and 48h. The AE was expressed in values from 0 to 1, where 0 represents no antioxidative effect and 1 total inhibition of oxidation. Data are mean values of three replicates

Based on the assay using THF, Myrtus berries have considerably more antioxidant activity than blueberries at both 24 and 48 hours of testing. Myrtus berries and blueberries are more similar using methanol, which doesn't extract as much non-polar antioxidant activity. Blueberries themselves contain pigments named anthocyanins, which are known to possess antioxidant properties. Butylated hydroxyanisole, a commonly used food additive to control oxidation in foods, was included in the linoleic acid assay as a positive control. As expected, BHA used as a reference provided a strong antioxidant result.

Flavonoids and related phenolics (*eg*. proanthocyanidins, anthocyanins) contribute greatly to the total antioxidant activity of many fruits and vegetables. They have been reported to inhibit lipid peroxidation, to act as free radical terminators, single oxygen quenchers and metal chelators, and to inactivate the enzyme lipoxygenase (Amiot, Fleuriet and Cheynier, 1997). It is possible that flavonoid compounds in Myrtus berries play a major role in demonstrating antioxidant efficacy in the linoleic acid reaction test.

Although Myrtus berries show marked antioxidant capacity, lipid oxidation is a complex dynamic system that involves many chemical and physical reactions and a single test cannot possibly evaluate all oxidative events. Therefore, a combination of measuring assays is essential to validate the effects of antioxidant(s) in natural products. Unquestionably, natural antioxidant(s) in Myrtus berries that offer functional and/or health benefits would be potentially beneficial to advance growth of the Tazziberry™ industry.

4. Commercialisation strategies

Various tasks were undertaken by TMB in developing strategies for successful commercialisation and marketing of Tazziberry™ in Australia and overseas. Activities performed to increase awareness of the Tazziberry™ industry and offer valuable commercial information include (i) promotional activities, for example at meetings and presentations, and (ii) development of value-added products.

4.1 Promotional activities

TMB convened two grower meetings at the Olde Tudor Motor Inn, a centrally located venue for state wide growers in Tasmania. A transfer of knowledge gained from the preliminary RIRDC projects was presented to growers, as well as experience gained from the company's and growers' work. Matters relating to the structure of the fruit business - berry production, supply and the globalisation of food markets - were provided as well as potential scenarios for cooperatively working as a group within that framework. Information pertaining to food standards, compliance costs, quality assurance and matters of importance for future value adding to the berry were also presented at these forums.

A subsequent meeting with Southern Tasmanian growers has initiated a Southern Growers collaborative group, which is spinning off to two other regional grower groups forming. TMB's hope was that a state wide grower association would be formed, however this small step is positive in that others now see the benefits of collaboration, as demonstrated by the first body.

The Southern Growers Group is attracting interest and collaboration from other Tasmanian growers, and is supplying markets provided to it by TMB Pty Ltd from previously established markets. Attempts by TMB Pty Ltd to encourage growers to form an association at a previous grower general meeting were unsuccessful. However, TMB persevered with a small number of growers in the south of the state, providing them with access to established market buyers from previous sales of fresh and frozen berries in the Tasmanian and Victorian marketplaces. Quality control is outside of the direct daily influence of TMB so the strategy is considered somewhat risky, although it is felt that growers needed to be more autonomous at this time. Product specifications have been presented to growers as the requirements for the market. Growers appear to be happy with the situation, prices received and market demand. One grower has established a presence in the supply of accredited organic berries to the Melbourne market.

Other promotional activities have included:

- Festivale Launceston. Presentation at the New Products Pavilion at this fine food products fair in Launceston, Tasmania. Seven bench-top cooked trial products were presented to patrons over two days. These ranged from sweet through savoury to spicy. Tasters' responses were surveyed, data was collated and information provided by the responses is considered highly beneficial.
- Organic Food Festival, Penguin, Tasmania. Presentation of plants and potential for organic growing of the fruit.
- Ten Days on the Island Celebrations Smithton Long Table Lunch 2004 and 2005. Twice the eminent chef Tetsuya has presented the berry in Tasmania and is enamoured of it at least as much as the other Tasmanian products he promotes so well.
- Chefs Association Dinner. Presentation of promotional material and products previously presented to the public at Festivale Launceston. Featured as dessert in the evening meal and festivities.
- Tasting Australia. Presentation of the fruit Tazziberry™ dessert as a showcase dessert entry by the Tasmanian Drysdale House, Institute of TAFE team, in the Tasting Australia competition held in Adelaide 2004.
- Trinity Gourmet Magic Promotion. Chef John Bailey presented the berry in various forms to chefs and function attendees at this promotion undertaken in Queensland and Palazzo Versace.
- Love This Place. A promotion undertaken by Chef John Bailey in Launceston City Celebrations.
- Pure South. Provision of fruit to the Kennedy Brothers' and Chef Neale White's restaurant 'Pure South' on Melbourne's Southbank.

A number of other hotels and restaurants were also provided with complimentary fruit to present on menus to make the public aware of the Tazziberry™.

These actions have provided a very good awareness campaign in the promotion of the Tazziberry™. This is now very evident in the number of advertisers of Myrtus plants around Australia sold on the fact that they are Tassie Berries or Tazziberries - the fruit that chefs adore and are after. However, this has provided TMB Pty Ltd with an issue in protecting Intellectual Property rights - in the first instance that of the Trademark.

This is the culmination of exhaustive and meticulous promotional work and supply by TMB Pty Ltd after receipt from various first mover growers, grading, packaging and distribution. A small volume of lesser grade fruit is being put aside for product development. The rejection of considerable volumes of fruit from early growers was a necessary part of this process and strained company and grower relationships.

As a result of these promotional activities, sales to fresh outlets are continuing to expand in the growing Tasmanian tourism and hospitality markets. Small volumes are also being delivered to two Melbourne market wholesalers. One was established as the preferred wholesaler last year and the additional one is dealing with the first deliveries of certified organic fruit.

4.2 Product development

TMB assessed the viability of various value-added products for the food service sector, including:

Coulis product
This was undertaken by eminent chef, John Bailey in Southern Tasmania. Bench top trials have been done to date and the sensory testing is about to be undertaken. Should any of the five product trials be selected as worthy of further work in an industrial kitchen environment, it will be undertaken with this season's fruit in storage. These trials will be conducted using a minimal volume (because of the high demand for berries) and subsequently, will be insufficient to launch a commercial product this year. A sorbet product is also under consideration with another value-adding firm.

Jams and jellies
Discussions and product evaluations were undertaken with three leading Tasmanian food manufacture suppliers. One is a firm with diverse capability in manufacture, presentation and distribution of berry products. However, a trial volume of product was lost by the manufacturer in the first phase and a second quantity languished in store without the trial going ahead because management were undertaking a whole firm HACCP plan. This delayed non-core work beyond a timely result and beyond the useful life of the stored berries. The firm's management remains interested and TMB has considered the manner of re-visiting these trials at some future date.

Sauces and syrups
Discussions and trial work have been undertaken with a company, which produces sauce products for sale in retail outlets in Australia and overseas including the South East Asia and West Coast USA. The firm owners undertook bench top trials privately, however these proved inconclusive. This was not surprising as there are some aspects of cooking and retention of flavour and product colour that TMB management has established is part of the intellectual property of TMB. The trials were undertaken without TMB transferring that knowledge prior to that work, in an attempt to view another's potential success with their own methodology. Follow up work was not undertaken because of other work commitments both by the firm completing the cooking tests and TMB.

Another award winning food enterprise with expanding markets for its gourmet range within Australia and the South East Asia is interested in creating a sauce and a relish for retail sales. This is to be followed up during this calendar year.

Freeze Dried Product

Investigation of two potential freeze dried Tazziberry™ products was undertaken by TMB with a company specializing in Freeze Dried Products in Launceston. Two potentially viable products are on hold and have not been progressed due to drier capacity constraints, and lack of berries supply. One product was intended as a line extension to a current product range owned by another party. The other product was an innovative version of that same product. There is some risk that the contracting firm may not be able to meet HAACP requirements in potential markets. Contact with another (HACCP approved) producer is expected to lead to discussions on using the contractor's intended additional capacity, to work on freeze dried products.

5. Conclusions and implications

The key to develop strong market connections for Myrtus berries in Australia and overseas lays in the ability to consistently deliver a desired product quality. Before this study, very little published work had been carried out on the post harvest specifications for Myrtus berries. Results demonstrated that temperature management and packaging are important issues influencing the condition of berries. Storage at 0ºC with MA/high CO_2 generated by the CALM system or packaging Myrtus berries in punnets with no air ventilation holes (some air transfer occurs through compartment-lid joining) facilitates shelf-life extension and ensures berry quality for the market. This should increase the value of Myrtus berries and offer a better return for growers and TMB. Consumer sensory tests supported the marketability of berries after 2 months storage using these protocols, particularly through the CALM system which maintained a rich, pleasant aroma in the berries.

Sensory aspects of frozen berries were also examined to explore the general willingness of consumers to accept berries in a frozen state. Although sensory approval of whole, frozen berries (after thawing) was less positive than hoped, it is believed that frozen berry material would be better received if accompanied with other foods (*eg*. fresh fruits, desserts) or incorporated into value-added food products. Reliable export of premium frozen Myrtus berries throughout the year would lead to expanded market prospects and growth of the Tazziberry™ industry.

Consumers are now more conscious of the importance of a nutritious diet. Myrtus berries have equal or slightly superior nutritional quality compared to other selected fresh fruit and berries (carbohydrates are a bit higher). While vitamin C content is similar to some common fruit types, it is lower than most berries. However, Myrtus berries do show quite high level of antioxidant potential. Myrtus berries with recognised antioxidant properties might be an important factor in increasing berry sales. Oxidation is also a major degenerative process that food products undergo during storage. Use of natural antioxidants from Myrtus berries for improvement of foodstuffs, as well as formulating new nutraceutical products that offer both functional and health advantages, would be a potentially beneficial for the Tazziberry™ industry. Further research using a range of antioxidant assays is warranted in order to confirm the effects of antioxidant(s) in Myrtus berries.

Various actions were completed by TMB to increase awareness of the Tazziberry™ industry and provide worthwhile commercial information about Myrtus berries in Australia. Growers meetings brought about the induction of a Southern Growers Collaborative Group, with additional local grower groups presently taking shape. Promotional work at Food Fairs etc helped to increase berry sales in the Tasmanian tourism and hospitality markets, in addition to selected wholesale markets in Melbourne. The approach to research and develop value-added products with food establishments was very advantageous with various commercial value-added products of Myrtus berries now imminent.

Deliverables from this project - improved marketing and post harvest management, value adding through product development, sensory and nutritional details - have all play a role to strengthen market links for Myrtus berries and reduce the possibility of failure by growers in Tasmania and TMB.

6. Appendices

Appendix 1 Sensory evaluation questionnaire used for assessing sensory qualities of post harvest and frozen Myrtus berries

Sensory evaluation of Myrtus Berry (Tazziberry™)

Sample 142

Name: _____

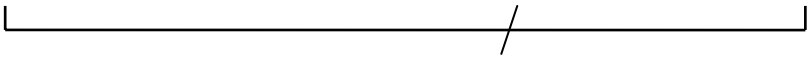
Age bracket (please circle): <21 21-25 26-30 31-40 40+

Female / Male

You have been invited to conduct a sensory evaluation on the acceptability of Tazziberry™, a new type of berry commercialised in Australia. There are no harmful chemicals added that are likely to cause adverse effects in individuals.

Please follow the instructions on the sheet. Answer the questions by placing a mark through the horizontal line where you think your appraisal best lies.

Eg. How much do you like the colour of the product?



Dislike extremely Like extremely

The mark drawn across the horizontal scale indicates that the colour is more liked than disliked as it appears closer to the 'like extremely' end of the horizontal line.

Thank you for your participation.

Sample 142

Q1. Look at the berries in the bag. How much do you like the appearance of the berries?

Dislike extremely Like extremely

Q2. Open the bag and smell the berries. How strong is the aroma?

Not at all strong Extremely strong

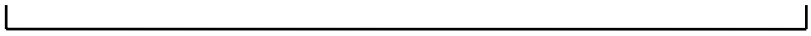
Q3. How much do you like the aroma?

Dislike extremely Like extremely

Q4. Taste some of the berries - remove the small calyx leaves if you wish. How firm are the berries?

Not at all firm Too firm

Q5. How moist (juicy) is the sample?



Not at all moist Too moist (soggy)

Q6. How strong is the flavour when you first bite into the berry?

Not at all strong Extremely strong

Q7. How much do you like the flavour when you first bite into the berry?

Dislike extremely Like extremely

Q8. How strong is the flavour as you continue chewing the berry?

Not at all strong Extremely strong

Q9. How much do you like the flavour as you continue chewing the berry?

Dislike extremely Like extremely

Q10. How coarse (gritty) is the texture of the sample?

Not at all coarse Too coarse

Q11. How sweet is the sample?

Not at all sweet Too sweet

Q12. How astringent (dry crinkle feeling in the mouth) is the sample?

Not at all astringent Too astringent

Q13. How bitter is the sample?

Not at all bitter Too bitter

Q14. After you have swallowed the berry, how strong is the aftertaste?

Not at all strong Extremely strong

Q15. How much do you like the aftertaste?

Dislike extremely Like extremely

Q16. Please rate your overall liking of product 142.

Dislike extremely Like extremely

Any comments would be much appreciated: _____

_____

_____

_____

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