Pre-harvest melatonin for postharvest quality improvement in Blackberries

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Melatonin is well-known as a hormone that regulates your sleep cycle, but did you know that plants produce and use melatonin too?

In plants, melatonin is thought to play a role in growth regulation, day-night cycles, and abiotic stress management. Studies over the last decade have also found that it can increase the storage potential of different crops without adversely affecting eating quality.

In other crops, melatonin has been reported to:

- induce anthocyanin biosynthesis in blueberry fruit (Magri and Petriccione, 2022)
- maintain higher total phenolics and flavonoid concentrations in nectarines and peaches
- preserve better sensory attributes and reduce fungal decay in strawberries (Aghdam and Fard, 2017)
- inhibit pericarp browning in longans
- improve antioxidant potential in sweet cherries
- delay senescence in peaches

This article summarises the findings of research into the post-harvest quality effects of pre-harvest applications of melatonin on '*Elvira*' blackberries. The research was conducted by students and staff at the Horticulture School of Science at Edith Cowan University in Western Australia.

Red drupelet reversion

Red drupelet reversion (RDR) was the focus of this study as it is one of the most pronounced postharvest issues in blackberries, lowering the cosmetic value of fruit and grower returns.

RDR is a physiological disorder that causes the postharvest reddening of drupelets in a blackberry. Sometimes all drupelets in a piece of fruit will change from black to red. Symptomatic fruits also exhibit weight loss, shrivelled drupelets, and textural changes.

Most of the colour change associated with RDR occurs in the first 24 hours of postharvest cold storage. Further colour change can occur for up to two weeks.

Anthocyanins are responsible for retaining the black colour in blackberries. It is thought their degradation, triggered by moisture loss in the drupelets, is associated with RDR.

Experimental design

A total of 60 plants of blackberry cv. *Elvira* were selected for the trial at a commercial orchard in Bullsbrook, Western Australia. A randomised block design was used, with three replications of each treatment (15 plants per treatment, 5 plants per replication).

The plants were 5-6 months old, propagated through tissue culture, and grown under polytunnels.

Melatonin was applied to the point of run-off in a single spray, early in the morning just after sunrise, two weeks before anticipated harvest. Treatment concentrations of melatonin were 0, 50, 100, and 200 umol L-1.

200 to 250g of fruit with uniform black colour, that were free from pests and disease, mechanical bruising, and juice leakage were manually harvested from each replicate 15 days after the melatonin spray.

Harvested fruit was placed in commercial plastic punnets and stored at 2°±1° and 85-90% Relative Humidity for 12 days, with a four-day sampling interval.

At each sampling interval, the fruit was examined for RDR, fruit weight loss, and fruit decay. The juice of 10 blackberries (a single replication of each treatment) was used to assess biochemical quality. Blackberries containing three or more bright red coloured (but not leaky) drupelets were considered RDR positive.

Results

Irrespective of the treatment type, RDR, fruit weight loss, and fruit decay increased with time in cold storage. Blackberries sprayed with melatonin showed less of these postharvest changes than the control.

The 100 umol L-1 melatonin treatment had the least RDR and fruit decay after 12 days of cold storage compared to all other treatments and the control (Figure 1).

> **Overall, the 100 umol L-1 melatonin treatment reduced RDR by 40.9%, weight loss by 44.8%, and fruit decay by 24.6% compared to control.**

Analyses also revealed that RDR was positively correlated with fruit weight loss, and negatively correlated with anthocyanin and other antioxidant levels (lower antioxidant levels were present in fruit with RDR).

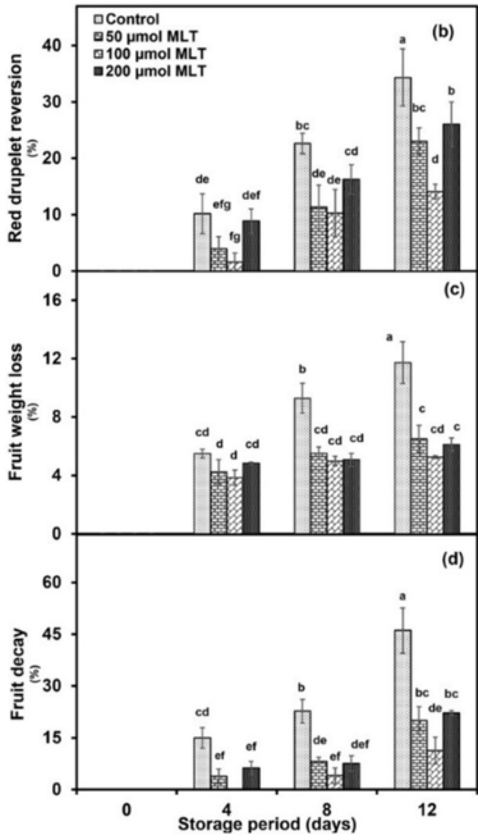

Figure 1. Effect of preharvest melatonin (MLT) treatments and storage time on red drupelet reversion (b), fruit weight loss (c), and fruit decay (d) during cold storage. Vertical bars represent ± standard errors of means. Vertical bars with different letters represent significant difference.

Figure 2. (L) Control fruit after 12 days of cold storage and (R) fruit treated with 100 umol after 12 days of cold storage
Photo credit: Zora Singh

The effect of preharvest melatonin spray on soluble solids content (SSC) and titratable acidity (TA) was also measured (Figure 3). While treatment effects appear minor, and sometimes mixed, the overall pattern of change in SSC, TA and SSC/TA ratio over the storage time is interesting. TA showed a continuously declining trend throughout the cold storage period. A decrease in TA contributes to a higher SSC/TA ratio, which is associated with better sensory attributes in berries.

Fruit sprayed with melatonin generally had slightly higher SSC compared to control fruit throughout cold storage despite having similar levels at harvest. Sprayed fruit had significantly lower TA than control fruit up to day 4 of cold storage, but after that differences were insignificant. The combined impact of this on the SSC/TA ratio was also only significant on day 4 of cold storage.

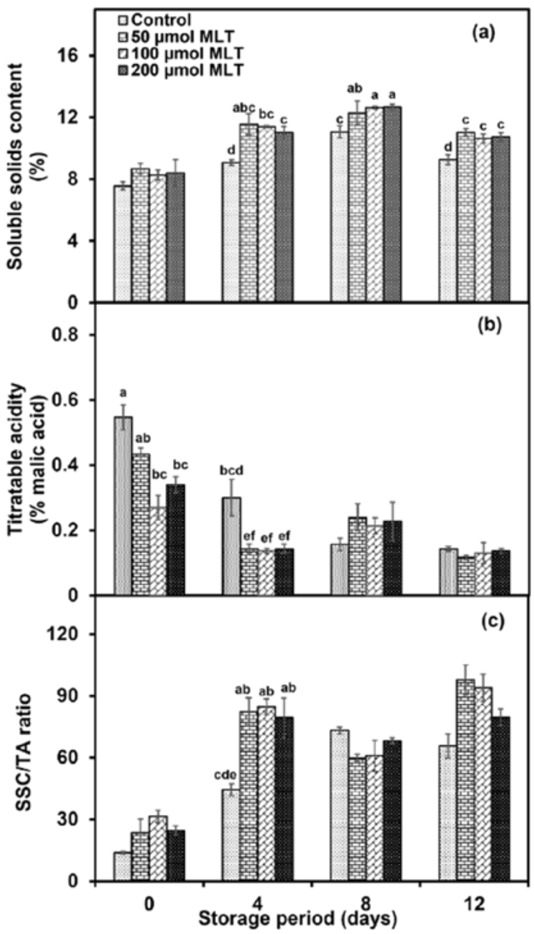

Figure 3. Effect of preharvest melatonin (MLT) spray on soluble solids content (a), titratable acidity (b) and SSC/TA ratio (c).

Vertical bars represent ± standard errors of means. Vertical bars with different letters represent significant difference.

Anthocyanins

But what about the anthocyanins you ask? This study also included a detailed analysis of several antioxidants including anthocyanins. It found that melatonin spray application (100 umol L-1) significantly delayed the degradation of total non-enzyme antioxidants including anthocyanins, glutathione, and ascorbic acid in cold stored blackberries. This fruit also expressed higher activities of antioxidant enzymes and reduced levels of oxidising compounds.

Conclusion

In conclusion, melatonin spray application (100 umol L-1) two weeks before anticipated harvest alleviated red drupelet reversion in '*Elvira*' blackberries by reducing oxidative stress and improving antioxidant potential. This has resulted in better postharvest quality during 12 days of cold storage.

This appears to be the first study on the efficacy of melatonin in suppressing RDR and oxidative stress in blackberries during cold storage. It enhances understanding of the relationship between RDR and melatonin-mediated anthocyanins and antioxidant potential, an area that may warrant future research.

References for melatonin studies in other berries

Aghdam, M.S., Fard, J.R., 2017. Melatonin treatment attenuates postharvest decay and maintains nutritional quality of strawberry fruits (Fragaria x anannasa cv. Selva) by enhancing GABA shunt activity. Food Chem. 221, 1650-1657. https://doi.org/10.1016/j.foodchem.2016.10.123

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Reference

Shah, H.M.S., Singh, Z., Hasan, M., Afrifa-Yamoah, E., and Woodward, A. (2023), *Preharvest melatonin for red drupelet reversion, improves antioxidant potential and maintains postharvest quality of 'Elvira' blackberry.* Postharvest Biology and Technology, 203. https://doi.org/10.1016/j.postharvbio.2023.112418