



SME Solutions Centre Case Study

Anthocyanin retention in Queen Garnet plums during processing and bottling

The challenge

The Queen Garnet is a unique variety of plum that is high in anthocyanins, a group of antioxidants. Developed in Queensland, Nutrafruit sells these plums and their value-added products at a premium due to the Queen Garnet's higher antioxidant content compared to other plum varieties. Currently, >300,000 Queen Garnet (QG) plum trees have been planted across Australia. In 2020, 20% of the fruit was composite, lower-grade fruit sent for processing, however, some was still disposed in landfill. Nutrafruit's business plan is to expand its reach by spreading awareness of the benefits of the QG plum and grow the product market so this surplus fruit can be used. This can be achieved if the value-added products retain the key anthocyanin that gives the plum its renowned benefits. Nutrafruit worked with researchers at the University of Southern Queensland to understand more about the health benefits of the QG plum, and how to maximise the anthocyanin concentrations in the fruit, associated value-added products and utilise the entirety of the crop.

The initial objectives of this project were to first identify any potential new product opportunities, quantify any potential issues regarding anthocyanin content loss throughout supply chain, propose potential strategies to overcome this issue if it is significant, and enable some analytical capability at Nutrafruit to inform QA/QC and product claims. During the project some product focus pivots occurred which informed project activities as the work progressed and additional work in alternative process and storage trials were also carried out. A stretch objective of in-line and in-situ monitoring of anthocyanin content was achieved through development of a rapid colourimetric analysis and calibration tool that could be easily used by farmers and factories.

By developing an in-house capability to measure the anthocyanin levels in the QG plum, Nutrafruit will be able to investigate cost-effective strategies to retain or fortify anthocyanin and anthocyanidin content in nectar products during processing and shelf-life.

This appears to be the first time that the ripening and associated increase in anthocyanin content of QG plums was tracked from fruit set to harvest, and this was done at Warroo Orchard for both the 2020-21 and 2021-22 seasons (~October-February). The rise in anthocyanin content was highly comparable in both seasons, however ripening and harvest occurred earlier in the 2021-22 season. Anthocyanin content increases only marginally in the first ~50 days, which is then followed by a rapid quadrupling in anthocyanin by the next test date 15 days later. This is the start of the exponential increase in anthocyanin content, measured in mg/100g of Fresh Weight (FW), that occurs from day 50 – 75. The total anthocyanin content at harvest was 158 mg/100g FW in 2022, which was similar to the 2021 season where the harvest plums contained 154 mg/100g FW. However, anthocyanin content of QG plums varies considerably between different growers (68 - 158 mg/100g fresh weight) as well as varying moisture content (80-86%). This difference in plum quality is potentially detrimental to the Nutrafruit brand and could impact product consistency and quality.

A new rapid analysis approach was developed to address this problem using an affordable colourimeter suitable for distribution to growers and manufacturers. Using the colourimeter, it was found that anthocyanin content is negatively correlated to the skin and flesh b^* value (correlation -0.90 , $P < 0.001$). This was followed by linear regression modelling, that showed that 94% of the variance in anthocyanin content is explained by the plum skin and flesh becoming bluer (b^* value becoming more negative). This will assist growers in being able to conduct quality control and will potentially help in preventing early harvest, as anthocyanin content is also correlated to moisture content. Preliminary work investigating the effects of blanching for 2 minutes or placing the plums at room temperature in brown paper bags for 2 days was promising, as this resulted in a 17.4% and 22.6% increase in anthocyanin content respectively. Freeze-dried plum powder was sent to Southern Cross University for HPLC analysis, and these results were highly comparable to the UV-Vis spectrophotometer results for anthocyanin content and also highlighted that QG plums contain ~4mg carotenoids/100g FW.



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Project impacts

1. The project has provided insight into the opportunities for high-value anthocyanin containing products for Nutrafruit which have knock on effects for increased product potential and reduced waste.
2. Investigation into the differences in QG plum quality and anthocyanin content between different growers has highlighted that improvements need to be made to increase consistency and average plum quality. Improving this will reduce the harvest of QG plums with suboptimal aesthetic and eating quality, which end up being wasted due to being unsaleable.
3. An affordable colourimeter has been successfully used to predict anthocyanin content of QG plums as 94% of the variance in anthocyanin content is explained by the QG plums becoming bluer in colour (b* value becoming more negative). This has implications for use as a rapid quality control tool to track anthocyanin content across the fruit supply chain from fruit onset to harvest through to processing. Training documents and an interactive spreadsheet containing the calculations required will be provided to Nutrafruit for this purpose.
4. It is estimated that 5% of plums previously lost as waste can now be retained and/or upcycled using the colourimetric QC method and commercialisation of the higher-value, longer shelf-life QG extract and essence - this equates to an estimated 300 Mt per annum saved from food loss.
5. Nutrafruit have begun commercialisation of their QG essence and extract, which are a higher-value product with a longer shelf-life than QG plum nectar. This longer shelf-life will help to protect Nutrafruit against future supply chain disruptions such as occurred during COVID-19. Production of the QG essence and extract does not require heat and therefore has greater retention of anthocyanin.
6. Tools and training have been provided to Nutrafruit by USQ to assist with Nutrafruit's planned workshop for growers in January 2023.

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Participants

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Conclusions & recommendations

QG plum anthocyanin content has been shown to be consistently high across multiple growing seasons, however variations in harvesting time and grower practices can result in this anthocyanin content being more than halved in the final harvest plum. Both long-term storage at 4°C and pasteurisation reduce anthocyanin and total flavonoid content, and this affects quality of product. Nutrafruit have pivoted to a new range of products (QG essence and extract). As a result of the research, more fruit will be picked to specifications, delivering higher returns for growers and more useable waste. In previous seasons, fruit that was underripe would go to waste due to the suboptimal aesthetic and eating quality. With improved characteristics, the fruit will move through the stores quicker, increasing demand and therefore increasing the moving supply to reduce waste at the orchards. Outside of the fresh fruit season, the processing fruit used to produce value-added products will be of superior quality with higher volumes and less unusable waste. The optimisation of anthocyanin has been a highlight because this is the key component in supplying health benefits to consumers.

Nutrafruit will be hosting a workshop with its growers to review findings from the FFW CRC project. This will be a platform for them to ask any questions and will serve as a basic training session for next year's fresh fruit season. The tools and strategies recommended by USQ will be included in the workshop. Growers will be given individual feedback based on their crop this year and Nutrafruit will assist them in improving quality. Nutrafruit will also use recommendations set by USQ to improve the current and future value-added product range.

Use of the findings from this research to investigate the relationship between anthocyanin content and the grower practices used in each farm to improve the quality and consistency of QG plums. Tools such as the affordable colourimeter tested in this project will assist growers in being able to conduct quality control and will potentially help in preventing early harvest and consequently unsaleable product. Total carotenoid content was found to be 2-fold higher in QG plum compared to other plum varieties, and this should be explored further with the possibility of marketing this as another benefit of consuming QG plum.

Authors and acknowledgements

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