Strawberry quality depends on getting it right at the farm

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This article provides a project update from the levy-funded AM21000 Serviced Supply Chains II project

- Only 33% of strawberry supply chains monitored achieved average supply chain temperatures of 2-5°C
- Not enough time to pre-cool strawberries to the recommended temperature was a major factor impacting average supply chain temperatures
- Low relative humidity (60-65%) storage increases moisture loss 3-8 times more than high humidity (90%) resulting in decreased quality and shelf life
- Rapidly removing field heat from freshly picked strawberries was important for maintaining fruit quality and extending shelf life

Achieving quality and consistency in domestic and export strawberry supply chains can be challenging. There are many pre- and postharvest factors that can impact on strawberry quality by the time it reaches the consumer. Supply chains become more complex with multiple supply chain partners taking responsibility for the care of strawberry shipments.

The AM21000 Serviced Supply Chains II (SSCII) project is focussed on exploring and quantifying the factors that affect quality and shelf life within supply chains. It seeks to understand the associated risks and create decision support tools to aid supply chain businesses.

This article provides an update on the two-year effort to analyse domestic strawberry supply chains. Data from supply chain monitoring has informed lab simulations, aiding the creation of models to predict strawberry shelf life.

Strawberry quality assessment

Developing a set of quality assessment criteria was a critical step to ensure they met the expectations of the market. A wide scan of supply chain expectations was conducted to ensure a common language was developed to describe strawberry quality. Initial quality descriptions and an image set were developed to measure quality during monitoring and simulation studies. Industry was engaged to validate the quality assessment descriptors, quality levels and assessment of end of shelf life (Figure 1). This included growers, researchers, in-market quality assessors and other industry personnel to ensure a cross section of the supply chain provided their interpretations of strawberry quality.

Establishment of standardised quality assessment procedures were developed to collect consistent quality data essential for evaluating supply chain performance through monitoring and simulations. This protocol has since evolved into an app that enables real-time tracking and rapid reporting for strawberry shipments.

Figure 1. Participants at a strawberry industry quality workshop
Photo credit: Department of Primary Industries, Queensland

Strawberry monitoring and supply chain improvement

Strawberry shipment monitoring was conducted during the 2023 and 2024 Sunshine Coast (SC) and Bundaberg in Central Queensland (CQ) production seasons. The monitoring activities involved assessing quality, real time temperature, humidity, location and time from harvest to arrival at the Wholesaler or the Retail Distribution Centre in Melbourne. To analyse comparative production, weather and supply chain condition impacts on quality, the focus was on monitoring shipments of the predominate variety, '*Red Rhapsody*'.

Commercial strawberry businesses indicated that they felt they had good management and control of temperatures in their supply chains. Conducting monitoring activities on 21 strawberry shipments, across six businesses, identified departures from optimal temperature management in most of the chains that were analysed. Only 33% of the consignments had average supply chain temperatures that fell between the 2-5°C range. Inadequate pre-cooling to 5°C or less was identified as the main cause of above average temperatures in the supply chain.

Incorrect pre-cooling was identified as an issue with 20% of consignments achieving the correct dispatch temperature of 1-5°C. Improved pre-cooling was identified in the second year of monitoring. Collaboration with partner businesses facilitated enhancements in their temperature management strategies and motivated investments in new infrastructure.

Despite these improvements in pre-cooling, transport challenges emerged. Typically, transportation to market consolidates shipments from several growers in one truck. If the truck is pre-cooled to the proper temperature, but a few growers or packers have not pre-cooled their strawberries, it can raise the temperature for the entire shipment, affecting all businesses involved.

It's important to note that refrigerated trucks are intended to maintain, not reduce, the temperature of produce.

Most retailers specify receival temperatures of 1-6°C. If consignments do not meet this specification, then they may be rejected by the retailer. Half of consignments arrived in Melbourne, mainly to the Wholesale market, at 6°C or less and 81% at 7°C or less. One monitored

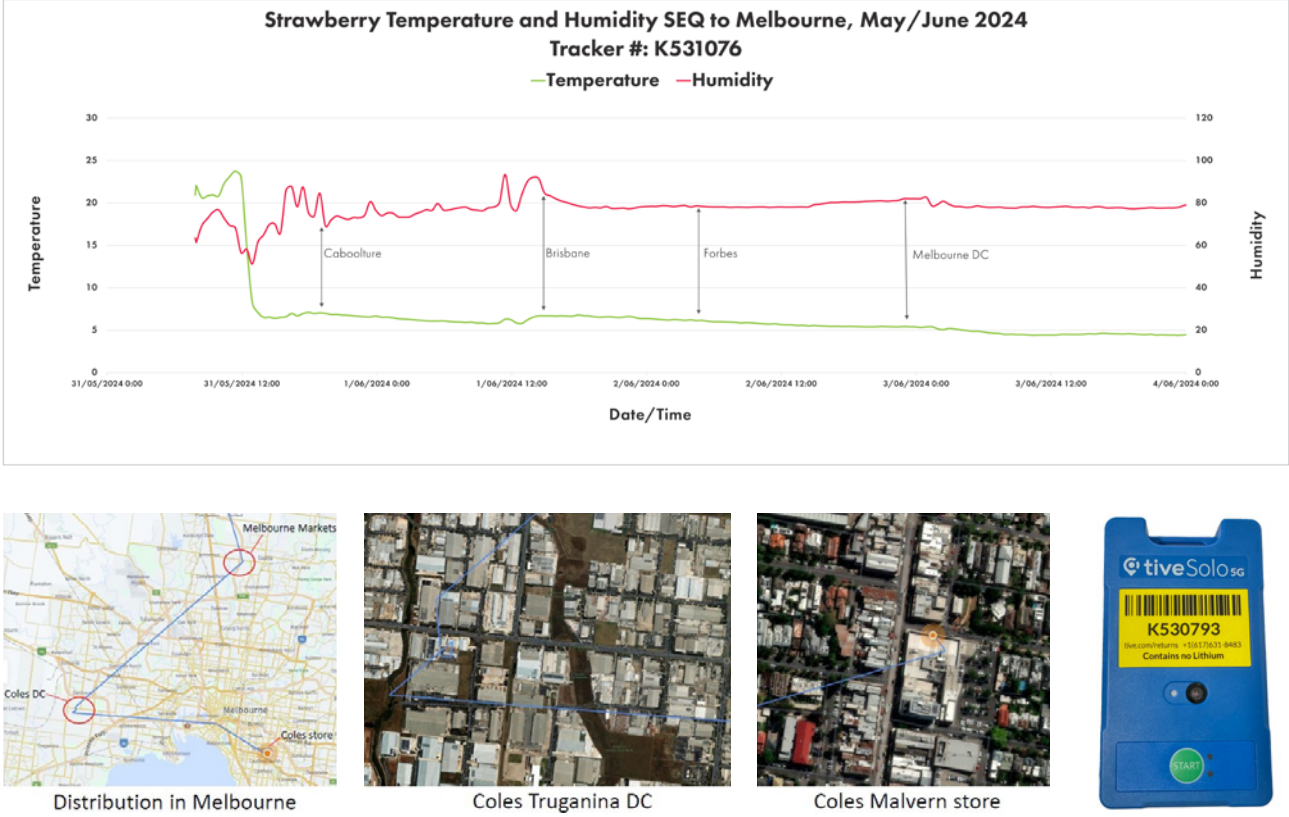

Figure 2. Example of strawberry shipment monitoring from the Sunshine Coast to Melbourne, 2024 season, indicating ideal temperature management throughout the supply chain
Photo credit: Department of Primary Industries, Queensland

consignment arrived at 10°C, with an average supply chain temperature of 9.6°C. The fruit in this consignment showed 20% bruising as a result of being transported by road at a higher temperature.

Interest in monitoring consignments using real time temperature and relative humidity (RH) monitors has increased with many wanting to be able to view what was happening to their shipments in real time.

In-market quality surveyor

Once consignments arrived in Melbourne, fruit samples were collected from the Wholesaler or Distribution Centre by an independent surveyor. Quality was assessed on arrival, stored at 4°C, and again at day 7 and day 10 or 14 after arrival to measure end of shelf life. Participating businesses were supplied with an individual report to identify opportunities to improve their supply chains.

De-identifying and analysing shipment quality data showed fruit quality on arrival in the market was assessed as more than 90% fruit meeting an acceptable standard in 19 of 20 shipments assessed for quality.

In 2024, at the day 7 assessment, an average of 89% of the strawberries were still of an acceptable standard for consumption. In 2023 the day 7 average was 27% across 7 consignments. Generally, half of the fruit was assessed as end of shelf life by day 10 or 14 assessments in 2024. Figure 3 demonstrates the influence of average supply chain temperature on acceptable quality fruit. Quality starts to drop off when the average temperature goes above 5°C. It also demonstrates that end of shelf life falls between 7 (red line) to 14 (green line) days after arrival at market.

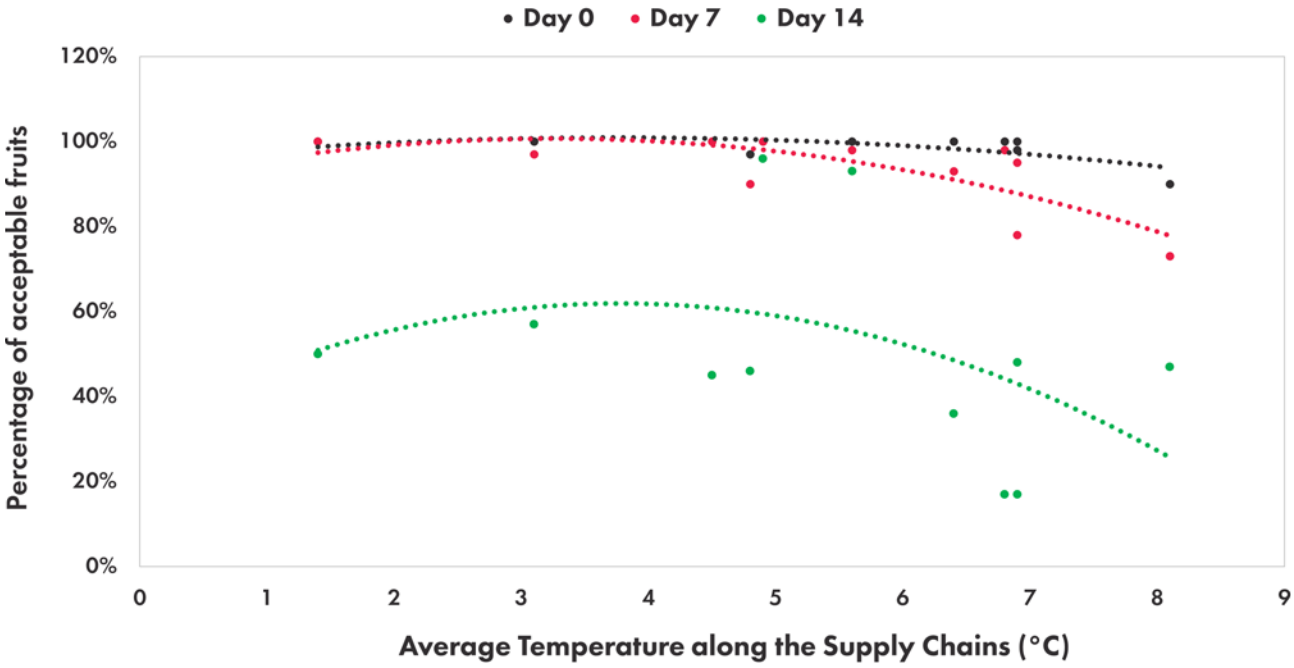

Figure 3. The relationship between average temperature along the supply chain and the percentage of acceptable fruits in the 2024 season

Predicting shelf life

Over the past two years, the project team simulated a range of consignment handling conditions to quantify impacts on fruit quality and shelf life. '*Red Rhapsody*' variety strawberries were sourced from CQ and SC growers throughout the season. They were held at 1, 4, 10, 15 and 20°C for up to 7 days and then stored at 4°C until the end of shelf life. Two RH levels (85-90 and 60-65%) were also tested at 4°C. Fruit quality was recorded over the duration of the trials.

The trials confirmed the importance of rapidly removing field heat from freshly picked strawberries and maintaining optimal RH levels for preserving fruit quality and shelf life.

Key observations included:

- Pre-cooling berries down to 1°C was optimal for maintaining quality
- Berries pre-cooled and maintained at 10°C for 1 day following harvest lost up to 36% of shelf life relative to those cooled to 1°C
- Berries held at 10°C for 3 days (e.g. mixed load transport) lost up to 46% of shelf life, as compared to berries always kept at 1°C
- Berries maintained at low (e.g. 60-65%) RH at 4°C lost 3-8 times more weight than those held at 90% RH
- The higher RH level delayed visible fruit dehydration and associated loss of surface gloss and softening

The simulation trials could also be used to examine impacts of other deviations from optimal cool-chain practice (e.g. during cross-docking). This information could help growers and their supply chain partners to prioritise improvements to handling practice. The project team is using the simulation trial data to predict remaining shelf life of strawberries on arrival at market. This could assist supply chain participants to make informed decisions on stock management.

Figure 4. Assessing strawberry quality during laboratory simulation trials
Photo credit: Department of Primary Industries, Queensland

In summary

Findings in the project so far identified that inadequate pre-cooling in 80% of monitored consignments is impacting the average supply chain temperature and reducing quality and shelf life. Simulation trials have been able to quantify the reduction in shelf life using the example of fruit stored at 10°C for 1 and 3 days respectively reducing shelf life by 36% and 46% compared to storage at 1°C. Simulation trails have also shown the importance of maintaining high RH (90%) to maintain fruit quality and improve shelf life.

What's next?

More monitoring activities will take place this year with plans to look at strawberry supply chains in other parts of Australia. Further laboratory simulation studies will be conducted to develop the shelf life prediction model for '*Red Rhapsody*' strawberries. Validation of the model in commercial supply chains will be conducted as part of the 2025 Queensland strawberry season before release to industry. Further work will also be conducted on other varieties such as '*Albion*' and '*Cabrillo*' as well as investigating the impacts on quality of postharvest disinfestation treatments such as Methyl Bromide and Irradiation.

This project offers a great opportunity for strawberry growers and their supply chain partners to get involved in monitoring their supply chains to identify areas of risk. Interested growers are invited to contact Jodie Campbell at jodie.campbell@daf.qld.gov.au or contact your local Berry Industry Development Officer.

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