

Final Report

Monitoring avocado quality at retail

Project leader:

Adam Goldwater

Delivery partner:

Applied Horticultural Research

Project code:

AV19003

Project:

Monitoring avocado quality at retail (AV19003)

Disclaimer:

Horticulture Innovation Australia Limited (Hort Innovation) makes no representations and expressly disclaims all warranties (to the extent permitted by law) about the accuracy, completeness, or currency of information in this Final Report.

Users of this Final Report should take independent action to confirm any information in this Final Report before relying on that information in any way.

Reliance on any information provided by Hort Innovation is entirely at your own risk. Hort Innovation is not responsible for, and will not be liable for, any loss, damage, claim, expense, cost (including legal costs) or other liability arising in any way (including from Hort Innovation or any other person's negligence or otherwise) from your use or non-use of the Final Report or from reliance on information contained in the Final Report or that Hort Innovation provides to you by any other means.

Funding statement:

This project has been funded by Hort Innovation, using the avocado research and development levy and contributions from the Australian Government. Hort Innovation is the grower-owned, not-for-profit research and development corporation for Australian horticulture.

Publishing details:

ISBN 978-0-7341-4873-5

Published and distributed by: Hort Innovation

Level 7

141 Walker Street

North Sydney NSW 2060

Telephone: (02) 8295 2300

www.horticulture.com.au

© Copyright 2022 Horticulture Innovation Australia

Contents

Final report	1
Monitoring avocado quality at retail.....	1
Contents	3
Public summary	4
Keywords	4
Introduction.....	5
Methodology	6
<i>Retail quality monitoring</i>	<i>6</i>
<i>Maturity monitoring</i>	<i>7</i>
<i>Data management, analysis and reporting</i>	<i>7</i>
<i>Feedback to packhouses, retailers and industry.....</i>	<i>8</i>
<i>Project management, monitoring and evaluation and liaison with AV18000.....</i>	<i>10</i>
Results and discussion.....	11
<i>Acceptable fruit quality by variety.....</i>	<i>11</i>
<i>Quality defects by variety</i>	<i>12</i>
<i>Quality by production region</i>	<i>15</i>
<i>Quality by country of origin</i>	<i>16</i>
<i>Quality by retailer group.....</i>	<i>17</i>
<i>Fruit age and quality.....</i>	<i>18</i>
<i>Retail display method</i>	<i>18</i>
<i>Stages of ripeness at retail and effects on quality.....</i>	<i>19</i>
<i>Quality by retail city.....</i>	<i>21</i>
<i>Suppliers meeting the acceptable quality standard.....</i>	<i>22</i>
<i>Maturity monitoring</i>	<i>22</i>
Outputs.....	25
Outcomes	27
Monitoring and evaluation.....	29
Recommendations.....	31
Refereed scientific publications	32
References	32
Intellectual property.....	32
Acknowledgements	32
Appendices	33

Public summary

Improving the quality of avocados on retail shelves is an essential part of the broader goal of increasing the demand for Australian avocados. The Australian quality target is that 90% or more of the avocados on display in stores are acceptable to consumers. Previous industry quality monitoring between 2008 and 2015 identified that only 78% of Hass avocados met the consumer acceptance standard.

This project measured avocado quality at retail between 2020 and 2023 to help the industry gauge how it's tracking towards the target of 90% acceptable fruit at retail. Avocado fruit quality was monitored at supermarkets and specialty retailers nationally, and fruit maturity was monitored monthly at the Sydney wholesale market. Feedback was provided to suppliers and retailers within 2-3 days of sample assessment, and to the wider industry through regular communications.

Industry investments in quality improvement have paid off. Hass fruit quality (Australian and imported) at retail increased to 85% acceptable fruit in 2020-22 from 78% in 2008-15. Similarly, Shepard improved to 97% acceptable fruit in 2021-23, up from 90% in 2008-15. Bruising remains the main defect affecting Hass avocados, followed by rots, with 6% of Hass unacceptable due to bruising.

Differences in quality by production region were identified. Highest quality was from the Western Australia and Tristate regions. Quality of Australian grown Hass outperformed imported fruit, with only 76% of imported avocados acceptable at retail.

Major retailers outperformed independent retailers. This suggests that future quality improvement programs need to work with the independent retailers, as well as major retailers.

Links between quality and retail factors were identified. Ripe fruit displayed in trays, rather than loose on display, had less bruising. Samples of fruit which were more uniform in firmness had less bruising. Firmer fruit had less bruising and rots. Fruit which spent less time in the supply chain between harvest and retail had lower levels of rots.

The supply of immature fruit remains an issue. Immature Hass and Shepard were identified at the start of the supply season in samples grown in North Queensland. Future maturity monitoring should be targeted to these periods of risk.

Suppliers and retailers were well engaged. 83% of suppliers are now more aware of their fruit quality issues, and 79% are more aware of fruit quality by production region. In response to quality feedback received, 58% of suppliers said they have made practice changes, or conducted follow up activities. All major retailers used their results to make practice changes in their businesses. Retailers and suppliers are supportive of continuing quality monitoring at retail.

Keywords

avocado; quality; retail; maturity; defect; bruising; rot; diffuse flesh discolouration; vascular browning; monitoring; firmness; ripeness; merchandising.

Introduction

Fruit quality is one of the largest issues facing the avocado industry, with consumer quality perceptions accounting for three of the top five barriers to purchase in the domestic market (Kantar, 2022). Domestic consumption of avocados needs to increase to meet supply, with Australian production set to rise from 123,872 tonnes in 2022 to approximately 170,000 tonnes in 2026 (Avocados Australia, 2022). To achieve this, the avocado industry has identified improving quality as a key priority to increase demand and global competitiveness (Hort Innovation, 2022)

Consumer sensory studies indicate that consumers are likely to tolerate up to 10% of internal flesh affected by defects, without negatively impacting purchasing decisions (Gamble et al., 2010). Based on this work, the Australian avocado industry set a target that at least 90% of fruit at retail will have less than 10% internal defects.

Avocado retail quality was monitored previously (projects AV08034 and AV11015), when there was a trend for Hass quality improvement from about 72% acceptable fruit in 2008, to 80% acceptable in 2015 (Tyas, 2016). These projects also monitored fruit maturity at the wholesale market, identifying regular supply of immature fruit early in a region's supply period.

Quality monitoring discontinued after 2015, and it was unclear if the avocado industry was progressing towards their target of 90% acceptable fruit, despite numerous industry R&D investments to improve fruit quality (e.g. AV15009, AV15010, AV15011, AV17005, and AV18000).

This project monitored avocado retail quality from 2020 to 2023, with the following objectives:

1. Monitor the quality of avocados at retail, on a frequent and consistent basis, with a strong focus on country of origin.
2. Provide confidential feedback to retailers, marketing groups, growers and packers where appropriate, and de-identified results to the avocado industry via the Avocados Australia Limited website, with the aim of improving the quality of avocados in retail.
3. Provide an objective measure of how well the industry is tracking on their mission to improve the consumer eating experience of avocados.

Methodology

Retail quality monitoring

A summary of the retail quality monitoring methodology is provided below, with further detail provided in Appendix 1. All methodologies were reviewed at the start of the project by the project team and the PRG to ensure the integrity of data collected.

Retail quality sampling plan

The project measured avocado fruit quality at major supermarkets (Coles, Aldi and Woolworths), as well as a sample of independent retailers in Brisbane, Sydney, Melbourne, Adelaide and Perth. The original sampling plan was for Sydney and Melbourne retailers to be sampled every month, Brisbane and Perth every six weeks and Adelaide four times per year. This plan was adjusted slightly due to COVID-19 restrictions during 2020-22. Sampling was put on hold at times, and any missed sampling was added to the same months later in the project, where possible.

A total of 60 stores were monitored across the five cities (Table 1), and these stores remained the same throughout the project, except any stores that closed permanently. Where possible, stores were monitored on the same day of the week (mostly Monday and Tuesday), and in the same order for each sampling event.

The number of stores visited in each city was allocated according to population data, with additional stores sampled in larger cities. The split of stores between retailer groups was determined according to market share, while still allowing for a minimum sample size for useful data.

Table 1. Annual fruit sample collection plan for each city and retailer

	Number of stores visited per sampling event					No. of stores visited per sampling event	Targeted sampling events per year
	Coles	WW	Aldi	IGA	Ind		
Sydney	4	4	3	1	4	16	12
Melbourne	3	3	2	1	4	13	12
Brisbane	3	3	2	1	2	11	9
Perth	3	3	1		3	10	8
Adelaide	3	3	1		3	10	4
Totals	16	16	9	3	16	60	45

Within each city, stores were selected according to demographics in the area, and included 'premium', 'mainstream' and 'budget' areas. These were determined based on ABS median income data, and advice from the major retailers on store types.

The timing of collections was staggered so that the industry and retailers received feedback from at least one city nearly every week through the year. Additionally, during COVID-19 lockdowns, sampling was put on hold at times, and any missed sampling was added to the same months later in the project.

Retail quality sampling method

Samples of ten (10) fruit from an individual supplier were randomly selected from each retail store. Only Hass and Shepard varieties were sampled. Both Australian grown and imported fruit were purchased. Fruit selected represented what consumers were likely to purchase, including:

- Fruit without obvious, and severe external damage, like fruit with skin split open
- Ripe and unripe fruit
- Fruit from the main store display

Information on the store display, including levels of ripeness, and layers of fruit on display were recorded. Where

possible, supplier details from trays were also recorded. Full details of all information recorded is available in Appendix 3.

Fruit were placed in avocado trays, and transported to the laboratory. On the same day, fruit firmness was assessed using a Turoi durometer.

Fruit assessment method

Fruit were stored at ambient temperature for a minimum of 24hrs from purchase, or longer until the average firmness of the sample reached stage 5 ripe (45 or less on Turoi durometer). Fruit were then cut into quarters, skin removed, and damaged flesh scooped out and weighed. Remaining good flesh was also weighed, allowing calculation of the percentage of damaged flesh per fruit. Defects were identified as bruising, body rot, stem-end rot, flesh discolouration, vascular browning, and 'other'.

Sampler training and monitoring

Retail samplers were all trained together at the start of the project to ensure consistent sampling and fruit assessments across each city. They were provided with a detailed assessment protocol and follow up training was provided throughout the project. All samplers were carefully monitored via the real-time dataset to ensure they were assessing fruit at a consistent stage of ripeness and classifying defects correctly.

Maturity monitoring

A summary of the maturity monitoring methodology is provided below, with further detail provided in Appendix 2.

Avocado maturity (percentage dry matter) was monitored at the Sydney Markets from March 2022 to March 2023. This market is Australia's largest market for avocados, has a diverse supply base and is likely to be the most representative market in Australia.

A target of sixteen trays of Hass or Shepard were sampled on a monthly basis, from a range of wholesale market agents. This included a mix of premium and class 1&2 fruit to capture avocados destined for retail and food service. Additional follow up sampling was conducted the week after immature fruit were identified.

Fruit were collected from as many growers as possible, from a range of growing regions, including those early in their supply season. Only hard-green fruit were collected, as this most closely resembles fruit sampled directly from the orchard. Tray label details were recorded.

After purchase, fruit were immediately transported to the AHR laboratory, and assessed using the Hofshi coring method. Two cores were removed from the equator of each fruit, using a 16mm corer. The skin and seed coat were removed from the cores, and flesh cut in half. Cores were weighed before and after drying in a 60°C dehydrator, usually for 3 days. Samples were returned to the dehydrator and reweighed until there was no change in weight on further drying.

Percentage dry matter was calculated using the weight of the cores before and after drying. Values were compared with the industry maturity standard of a minimum 21% dry matter for Shepard and 23% dry matter for Hass.

Data management, analysis and reporting

All project data was collected using AgKonect software, in a single database. All samples had unique codes, providing records of purchase information and quality results in one dataset. Sources of error were reduced, by allowing for careful monitoring of sampler assessments in each city.

Reports were produced semi-automatically using Power BI software. This software was also used to analyse the full dataset for insights into factors affecting fruit quality at retail, such as type of display, fruit age, fruit firmness, and fruit origin etc.

This data management and reporting system provided real-time data capture, upload, review by the project team, and rapid feedback for decision making.

Feedback to packhouses, retailers and industry

Packhouses

Packhouses were provided with a one-page report on retail fruit quality (Figure 1) or fruit maturity (Figure 2), during the week following sampling (usually within 7 days of sample collection). These reports were distributed to the packhouse by email and included notes on the methodology used and contact details for further information on improving fruit quality. Some packhouses also requested ad hoc analysis of their results, including fruit quality trends through the season.

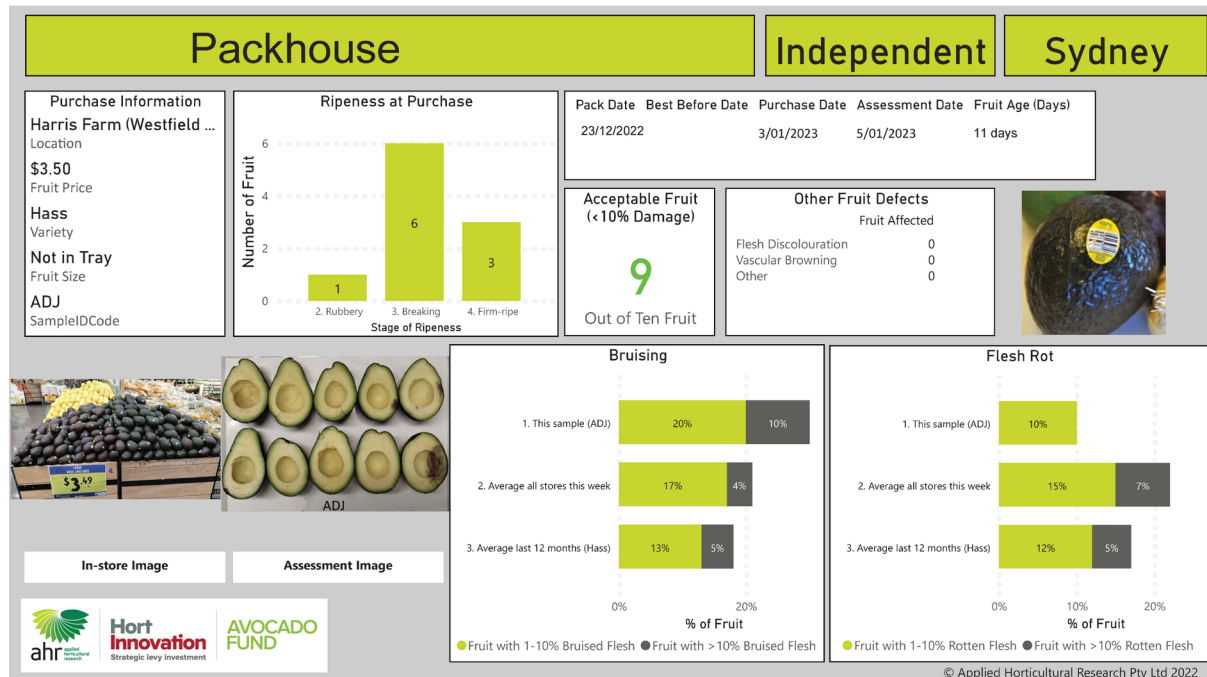


Figure 1. Example of a retail quality report provided to the supplying packhouse



Figure 2. Example of a maturity monitoring report provided to the supplying packhouse

Retailers

Major and independent retailers were provided with a one-page report (Figure 3) similar to the packhouse, for each sample collected in their stores. In most cases these reports were provided by email to the retailer within 7 days of sample collection. Effort was made to remove information which may clearly identify the supplying packhouse.



Figure 3. Example of a retail quality report provided to the retailer. No information identifying the supplying packhouse was provided on reports to retailers.

Quarterly online meetings were held with the major retailers (Coles, Woolworths and Aldi) to review a summary of their quality results for that period. The meetings were held with the avocado category managers and product technologists, as well as Avocados Australia Limited's (AAL) market development manager, and Hort Innovation's marketing manager.

Quality results were benchmarked against each retailer's deidentified competition, and included:

- Percentage of acceptable fruit over time
- Major defects by retailer
- Percentage of acceptable fruit by retail city
- Fruit age at purchase
- Stage of ripeness at purchase
- Quality by individual stores
- Comparison of Australian and imported fruit quality

Ad hoc analysis was provided to retailers, particularly where the project team identified fruit quality issues for a specific retailer.

Retailers were also provided with deidentified results via monthly updates on the Avocados Australia Limited (AAL) Best Practice Resource (BPR), as well as via the AAL market development manager's quarterly retail report.

Industry

Monthly retail quality and maturity monitoring results summaries were uploaded to the [AAL BPR](#) via the avocado industry communications program (AV21004). Retail results include an industry monthly snapshot, retail monthly snapshot, and long-term results by variety. Maturity monitoring results were presented each month, identifying average dry matter per sample, by growing region.

A summary of the results was provided in the fortnightly *Guacamole* newsletter, including links to the full reports. Quarterly articles were written for *Talking Avocados* magazine, including quality results, data insights, and where to go for more information. Presentations were made at industry events, including regional forums, webinars, Avo Connections, and conferences (see outputs section for further details)

Project management, monitoring and evaluation and liaison with AV18000

Project reference group

A project reference group (PRG) was established to provide strategic advice and ensure that project outputs were ‘fit for purpose’, useful and relevant. Members included packhouse owners or managers, an integrated grower/packer/marketer, the AV18000 project leader, Avocados Australia representatives, and the Hort Innovation R&D Manager. Members met biannually, or as needed.

Coordination with AV18000 (Avocado supply chain)

Regular meetings were held with project AV18000 to ensure the two projects used consistent fruit assessment methodologies where possible, and for comparison of results between the two projects. Fruit quality results from AV19003 were used to help verify data collected by the AV18000 project.

Monitoring and evaluation

The project used a Monitoring, Evaluation, Review and Improvement (MERI) approach to plan, implement and evaluate the project’s activities. The project team met regularly to discuss plans and progress. Intermediate and end-of-project outcomes were monitored through project milestone reports, the PRG, and interactions with industry members.

Feedback from suppliers was sought through an end-of-project survey (Appendix 4). There were 30 responses, including growers and packers from all key growing regions. A total of 8 independent retailers were surveyed instore in Sydney and Melbourne. All major retailers were asked for feedback in the quarterly meetings, and practice changes were noted throughout the project.

Results and discussion

Summaries of quality results, and analysis of trends are provided in the following sections. In most cases, results are presented as the average of the three-year sampling period, given that annual quality varies due to weather and other factors. All three years of data therefore provides a representative dataset.

Detailed monthly records of retail quality and maturity monitoring are available on the AAL BPR - <https://avocado.org.au/bpr-articles/retail-quality-archive/> and <https://avocado.org.au/bpr-articles/maturity-monitoring-archive/>.

Acceptable fruit quality by variety

Hass quality improvement has continued from the previous monitoring project (AV11015) (Figure 4). The level of acceptable Hass at retail lifted from an average of 77.9% in 2008-15, to 85.1% in 2020-22. Quality of Australian grown Hass (excluding imported fruit) lifted from 79.6% in 2011-2015, to 87.2% acceptable fruit in 2020-22 (Figure 5). The industry is progressing towards the quality target of 90% acceptable fruit.

Shepard avocado quality was considerably better than Hass, a trend also identified in AV11015. Quality at retail lifted from an average 90% acceptable fruit between 2008-15, to 97% acceptable fruit in 2021-23 (Figure 6).

Consideration should be given to the project methodology in AV11015, where only fruit which were ripe, or likely to be ripe by the next day were purchased from retail stores. This compares with AV19003, where any fruit on display were purchased, regardless of stage of ripeness, as this is most representative of the range of fruit which consumers purchase. Ripe fruit are more likely to be of poor quality (see: Stages of ripeness at retail and effects on quality), which creates a bias towards better quality in the AV19003 dataset. When unripe fruit (stages 1-2, or >65 durometer reading) are excluded from the AV19003 dataset, an improvement in Hass quality can still be identified – acceptable quality lifted to 83% for all Hass at retail, and to 84% for Australian grown Hass. For Shepard, acceptable quality (ripe fruit only) was 96%.

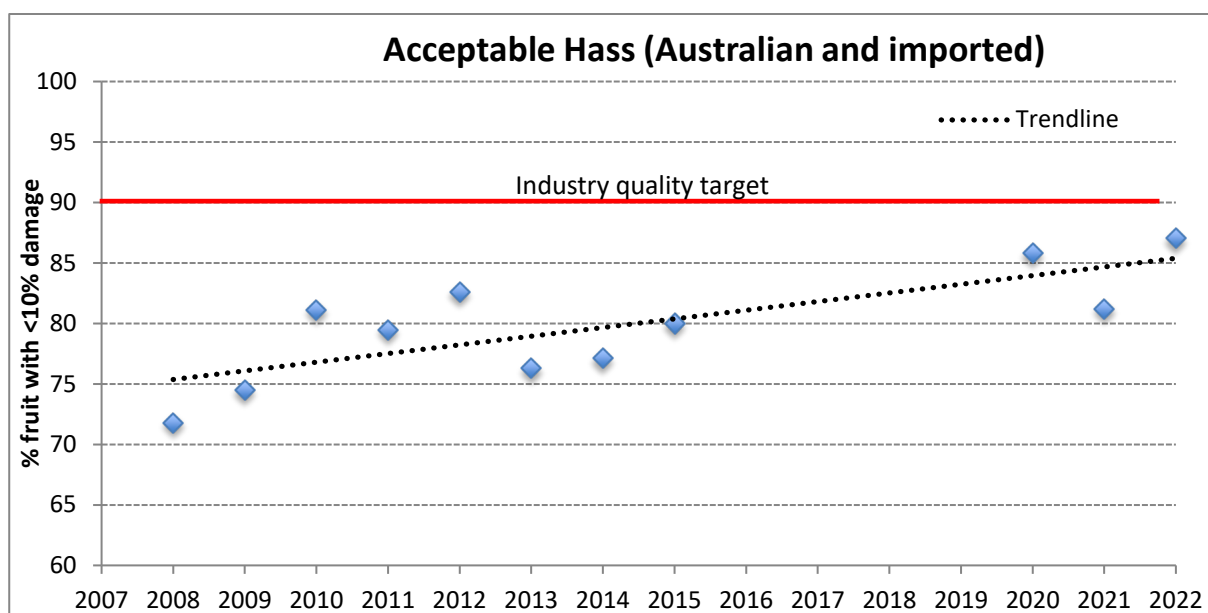


Figure 4. Percentage acceptable Hass fruit (Australian and Imported fruit) in Australian retail stores from 2008 to 2022. Datapoints from 2008 to 2015 are from project AV11015, and 2020 onwards is from AV19003.

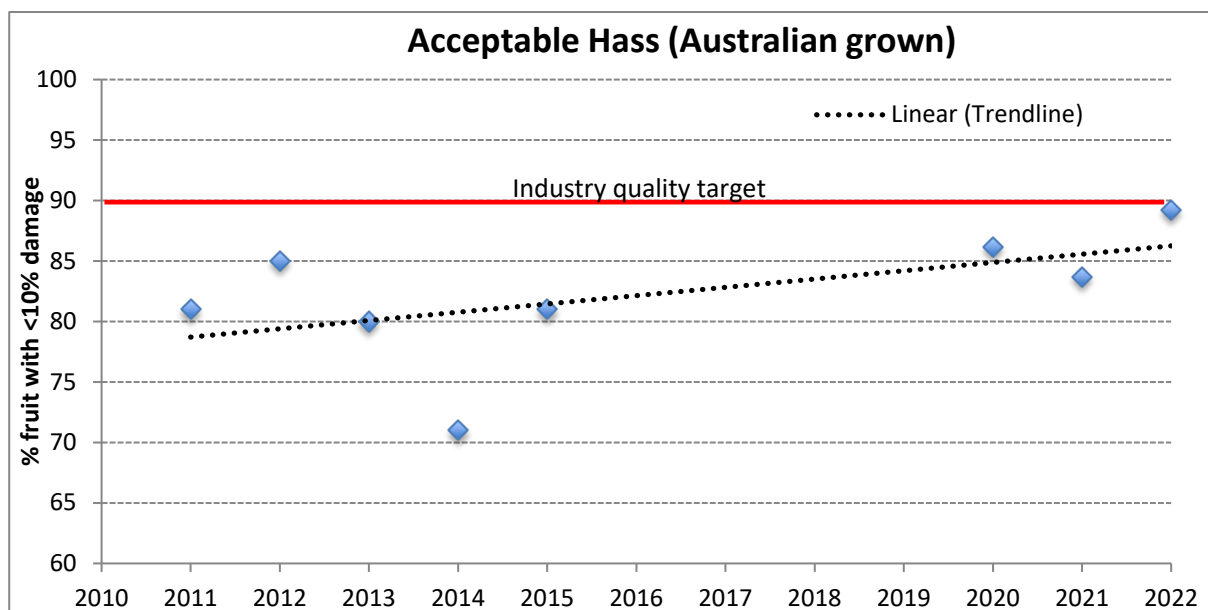


Figure 5. Percentage acceptable Hass fruit (Australian grown) in Australian retail stores from 2008 to 2022. Datapoints from 2008 to 2015 are from project AV11015, and 2020 onwards is from AV19003.

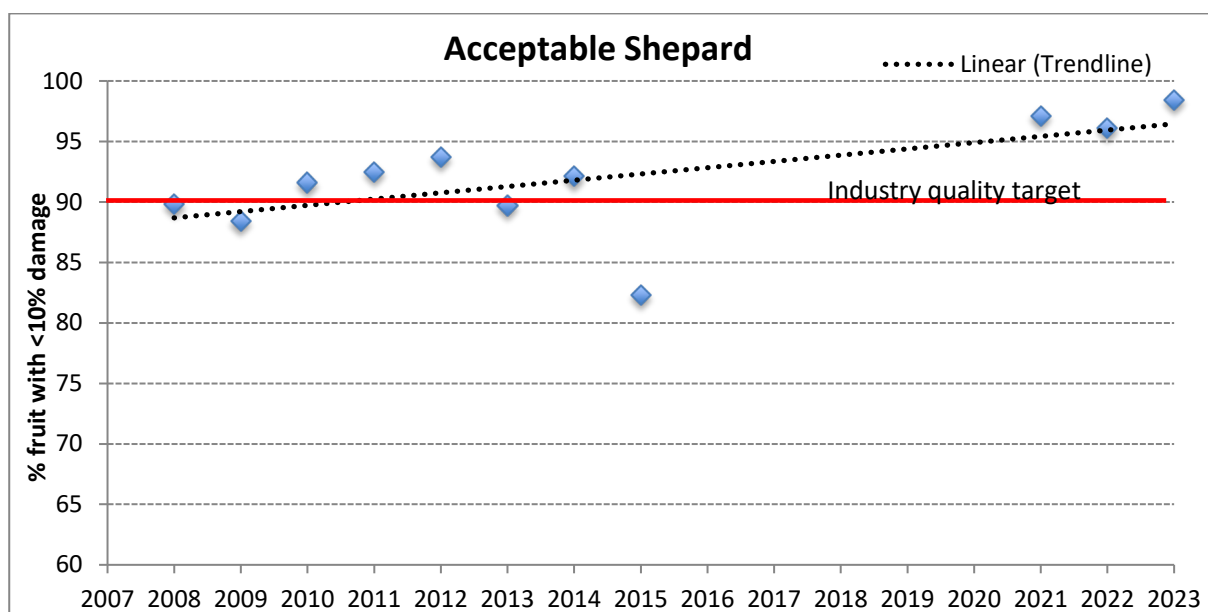


Figure 6. Percentage acceptable Shepard fruit in Australian retail stores from 2008 to 2023. Datapoints from 2008 to 2015 are from project AV11015, and 2021 onwards is from AV19003.

Quality defects by variety

The main Hass quality defect remains bruising, followed by body rots. A reduction in bruising, body rots and stem-end rots has contributed to quality improvement, while flesh discolouration and vascular browning remain at similar levels to 2013-15 (Figure 7).

When imported Hass are included, average levels of rots and vascular browning are slightly higher (Figure 8).

Shepard quality improvement is mostly due to a reduction in bruising, as well as vascular browning and flesh discolouration, while rots remain similar, albeit at low levels (Figure 9).

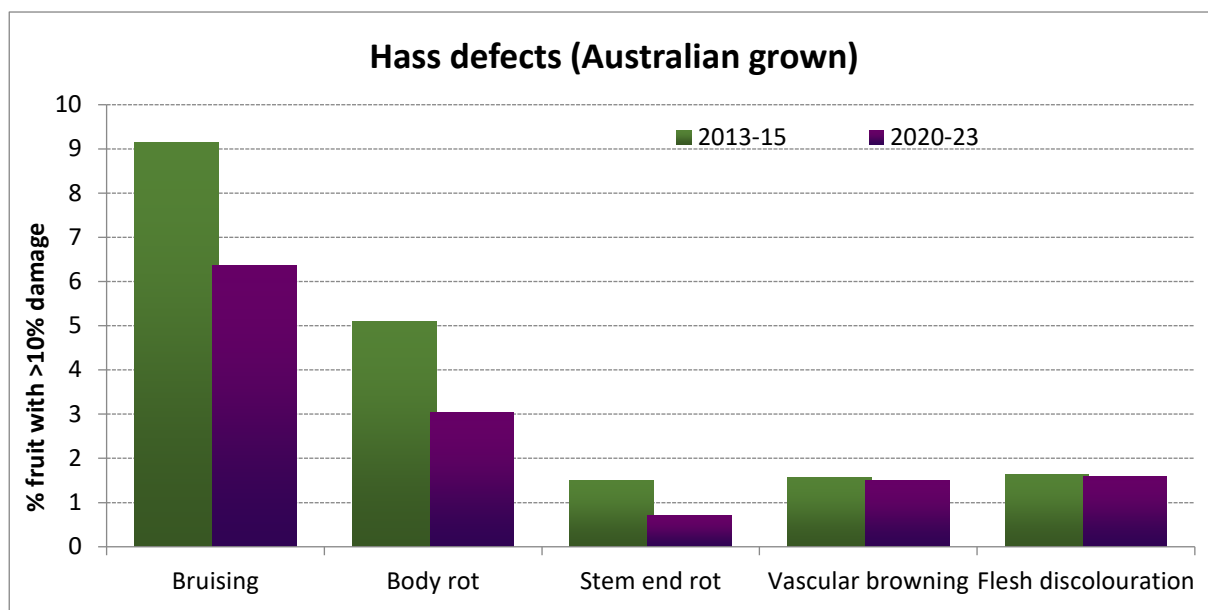


Figure 7. Levels of Hass defects (Australian grown fruit) in 2020-23 (AV19003 data) and 2013-15 (AV11015 data).

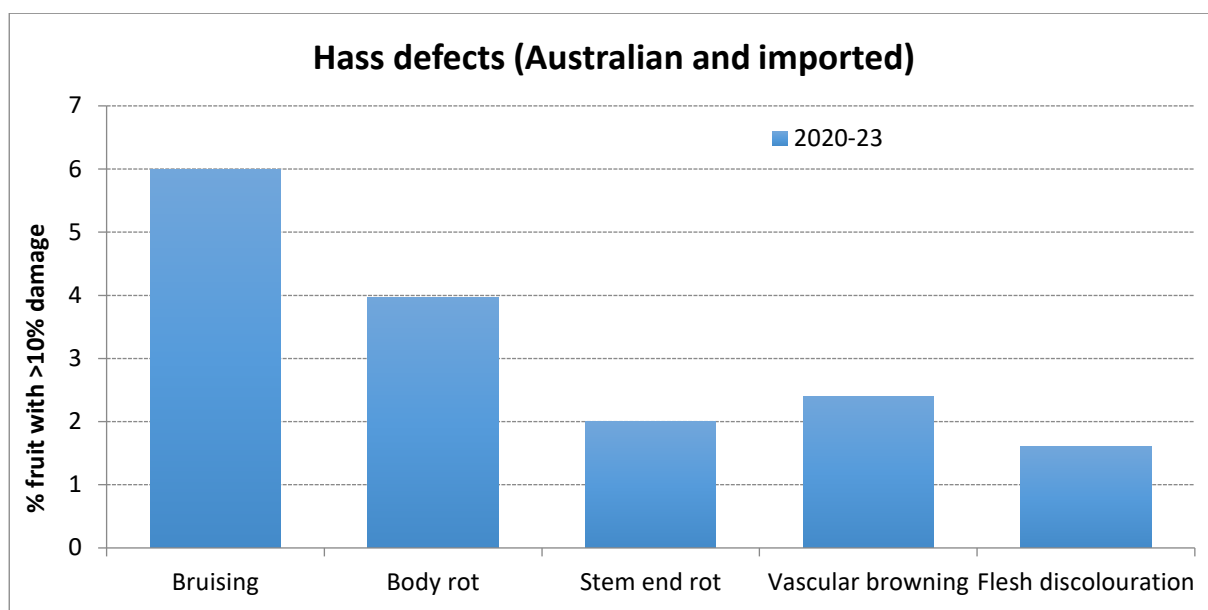


Figure 8. Levels of Hass defects (Australian and imported fruit) in 2020-23.

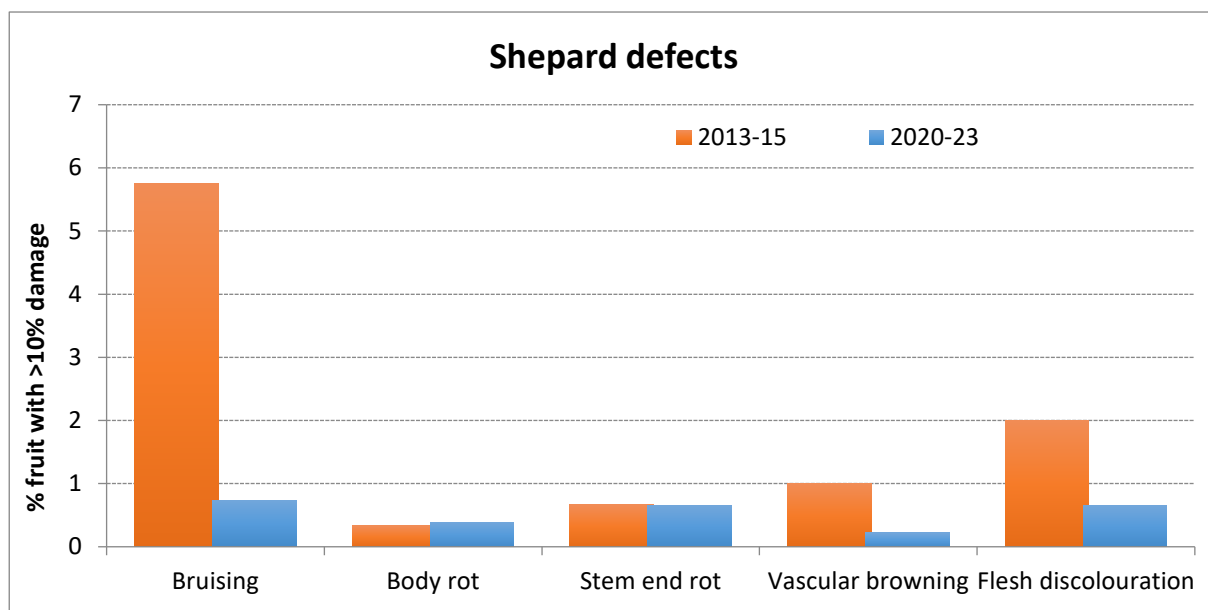


Figure 9. Levels of Shepard defects in 2020-23 (AV19003 data) and 2013-15 (AV11015 data).

Analysis of bruise and rot severity helps identify future opportunities for quality improvement. For example, Hass bruising which exceeds 10% of total flesh (fruit unacceptable to consumers) is mostly in the 10-20% severity category (Figure 10). If bruise severity can be reduced, then many of the bruises in the 10-20% category would shift below 10%. This could halve the level of Hass avocados which are unacceptable to consumers due to bruising. This could be achieved by practices such as the reduction in the size and number of impacts during fruit handling, refrigeration of ripe fruit, reducing time between harvest and retail, and harvesting fruit with higher dry matter levels (Joyce, 2018).

Rot severity data suggests that acceptable quality would lift by 2%, if severity is halved. Equally, there is a risk that poorer pre and postharvest practices could increase severity of rots. For example, increased time in storage could double rot severity, which would shift rots from the 5-10% category to 10-20%, almost doubling the level of rotten fruit considered unacceptable to consumers (Figure 11).

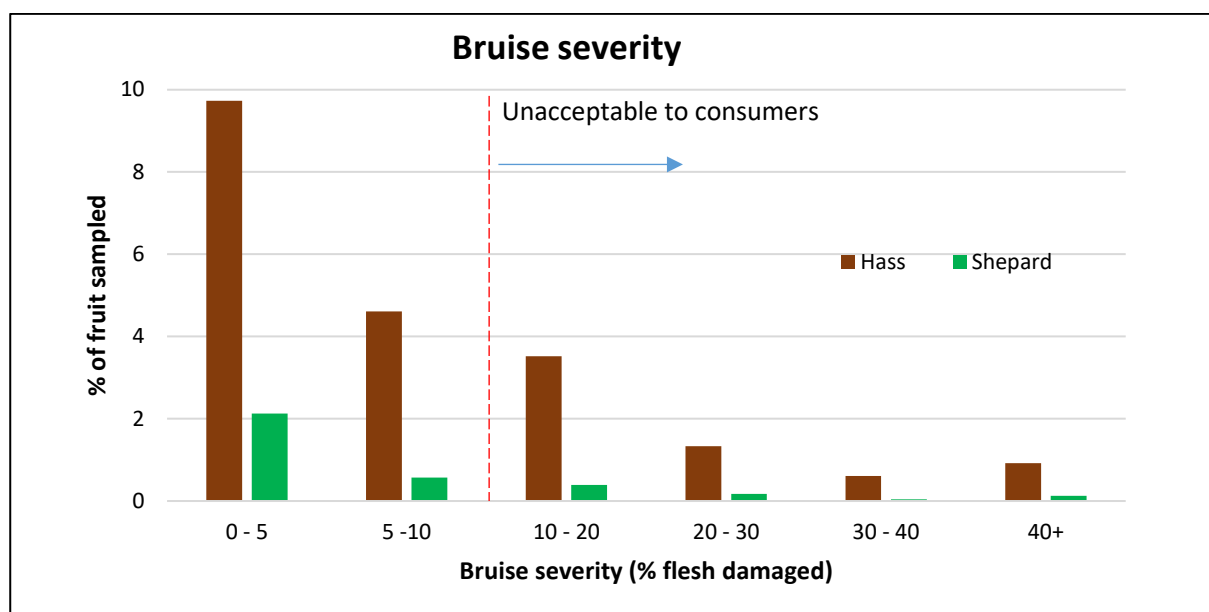


Figure 10. Severity of flesh bruising in Australian grown Hass and Shepard avocados in 2020-23.

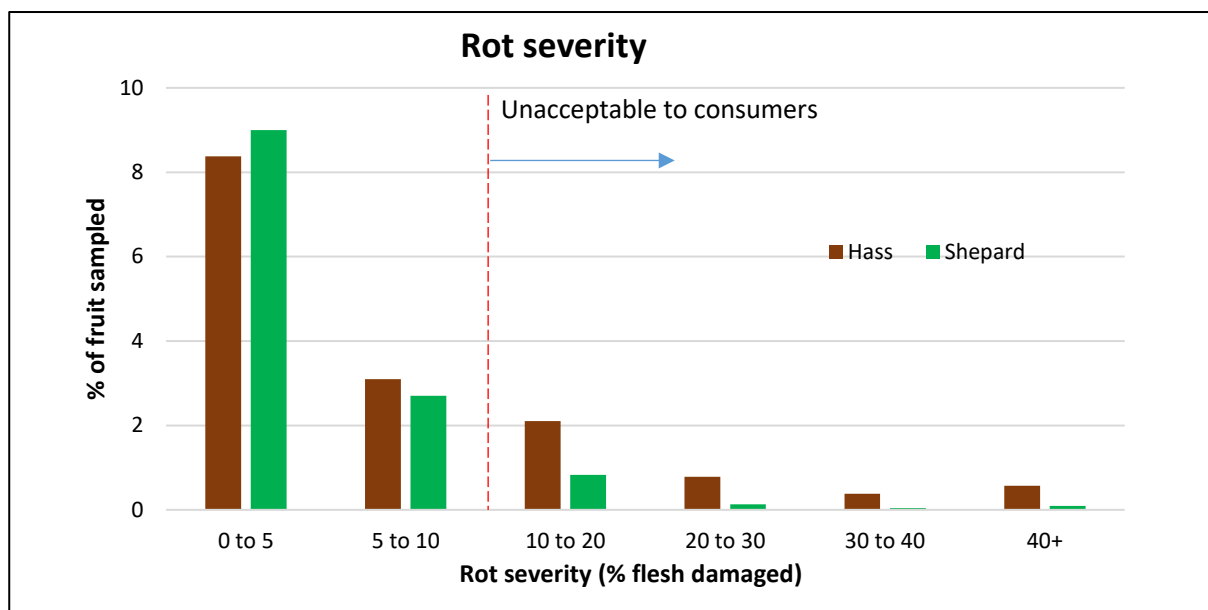


Figure 11. Severity of rots in Australian grown Hass and Shepard avocados in 2020-23.

Quality by production region

Acceptable quality of Hass was highest from fruit grown in the Western Australia and Tristate regions, followed by Central, North and South Queensland. Quality from New South Wales was lowest at 81% (Figure 12). Shepard quality was similar from both North and Central Queensland (Figure 13). Breakdowns of types of defects by production region are provided in Appendix 5.

Acceptable fruit (Hass) by production region

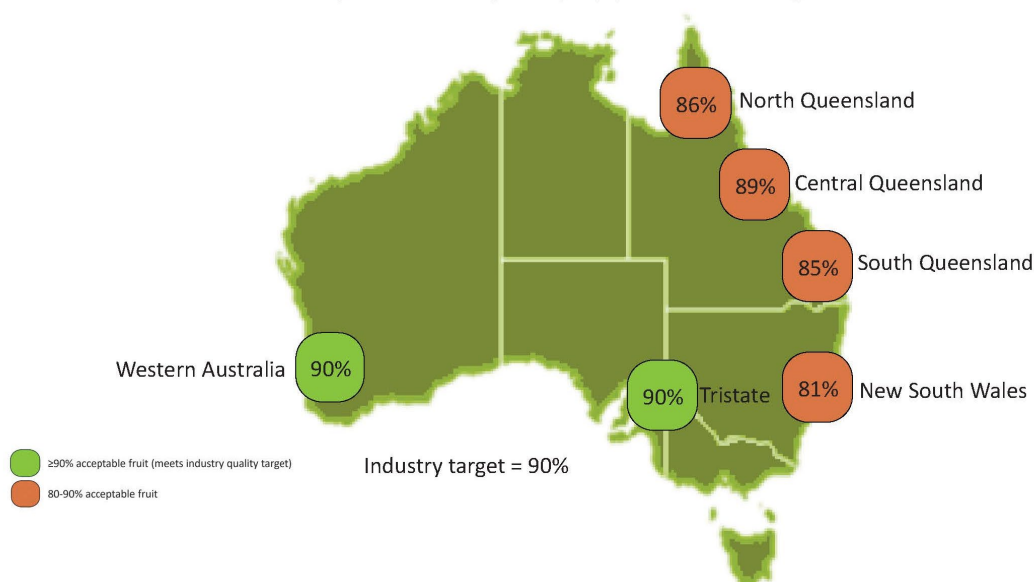


Figure 12. Percentage of acceptable Hass by production region (2020-23)

Acceptable fruit (Shepard) by production region

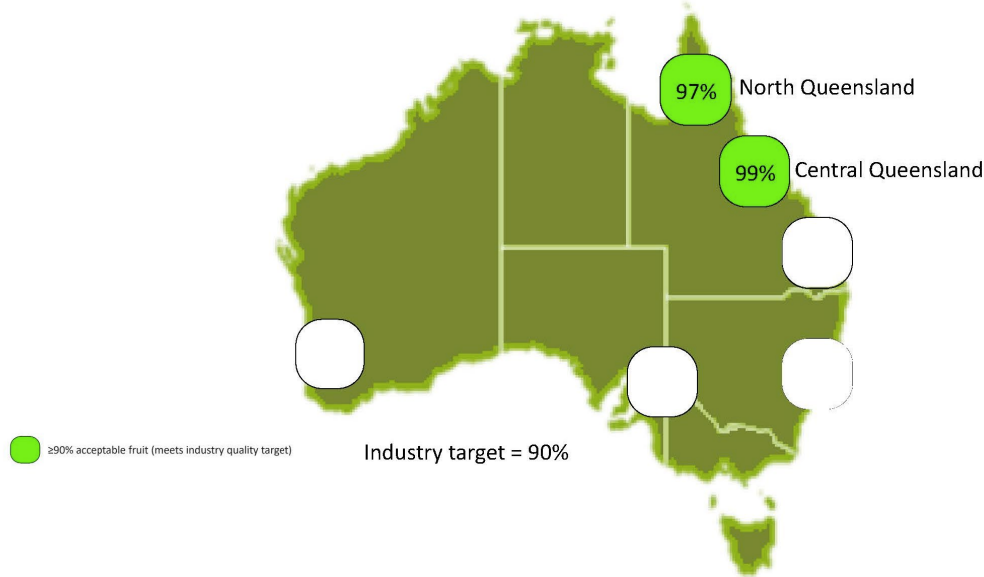


Figure 13. Percentage of acceptable Shepard by production region (2020-23)

Quality by country of origin

Quality of Australian grown Hass avocados exceeded that of imported fruit (Figure 14). However, quality was only slightly lower for a small number of Chilean samples (13 samples, or 130 fruit) assessed. New Zealand fruit quality was consistently poorer than Australian fruit during the main supply period from October to February, from higher levels of rots and vascular browning. This result is not surprising given that the average age (days from packing to purchase at retail) of New Zealand fruit samples was 25.4 days, compared to 13.5 days for Australian Hass.

Results were similar to a previous comparison of New Zealand and Australian Hass in 2018-19, which identified 78% acceptable New Zealand fruit (Goldwater, 2018).

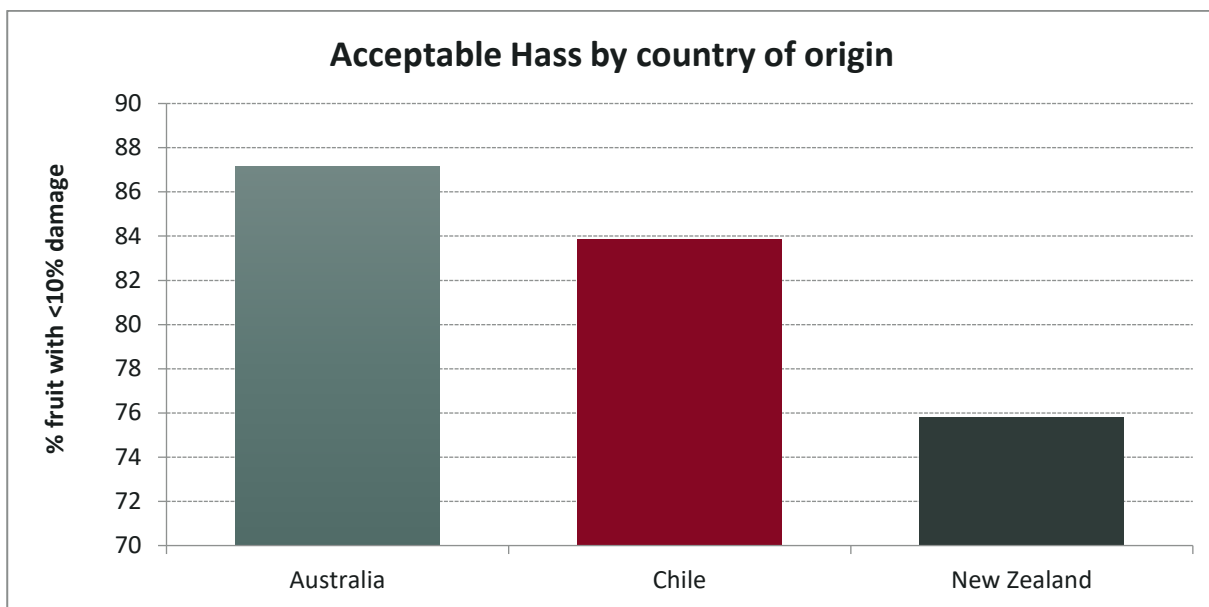


Figure 14. Percentage of acceptable Hass in Australian retail stores by country of origin (2020-23). Note that only 13 Chilean samples (130 fruit) were collected.

Quality by retailer group

Quality varied between retailer groups, with two of the major retailers close to 90% acceptable fruit, another major retailer at 86.7%, and the independent retailers at 83.7% (Figure 15). Differences in quality were mostly due to rots, vascular browning, and flesh discolouration (Figure 16). The identity of each major retailer is purposely deidentified, and they are not presented in the same order in each chart.

Independent retailers had slightly more firm-ripe and ripe (firmness stages 4-5) fruit (Figure 17). This could explain the slightly poorer quality at independent stores (see: Stages of ripeness at retail and effects on quality). Independent retailers make up about 25% of avocado retail market share, so there is a need to improve quality in this retailer group.

Differences in stages of ripeness and fruit defects by retailer groups were identified and monitored during the project. Feedback was provided to retailers following shifts towards more firm fruit which could reduce sales.



Figure 15. Percentage of acceptable avocados (Shepard and Hass) by retailer group (2020-23). This includes the three major retailers (purposely deidentified) and a group of independents.

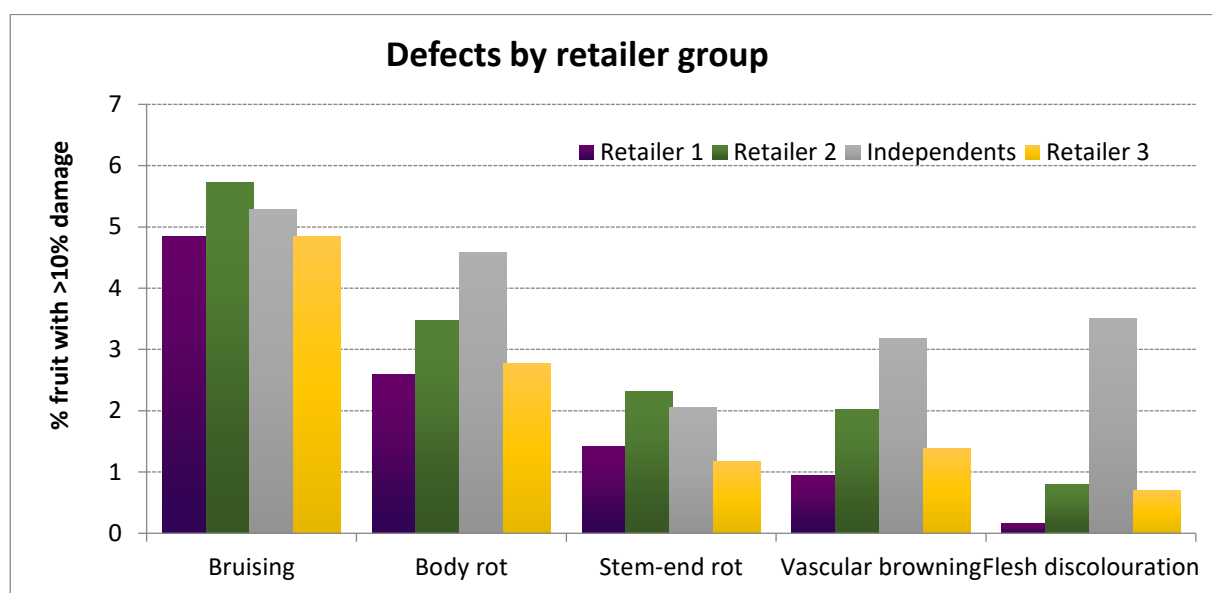


Figure 16. Defect levels (Shepard and Hass) by retailer group (2020-23). This includes the three major retailers (purposely deidentified) and a group of independents.

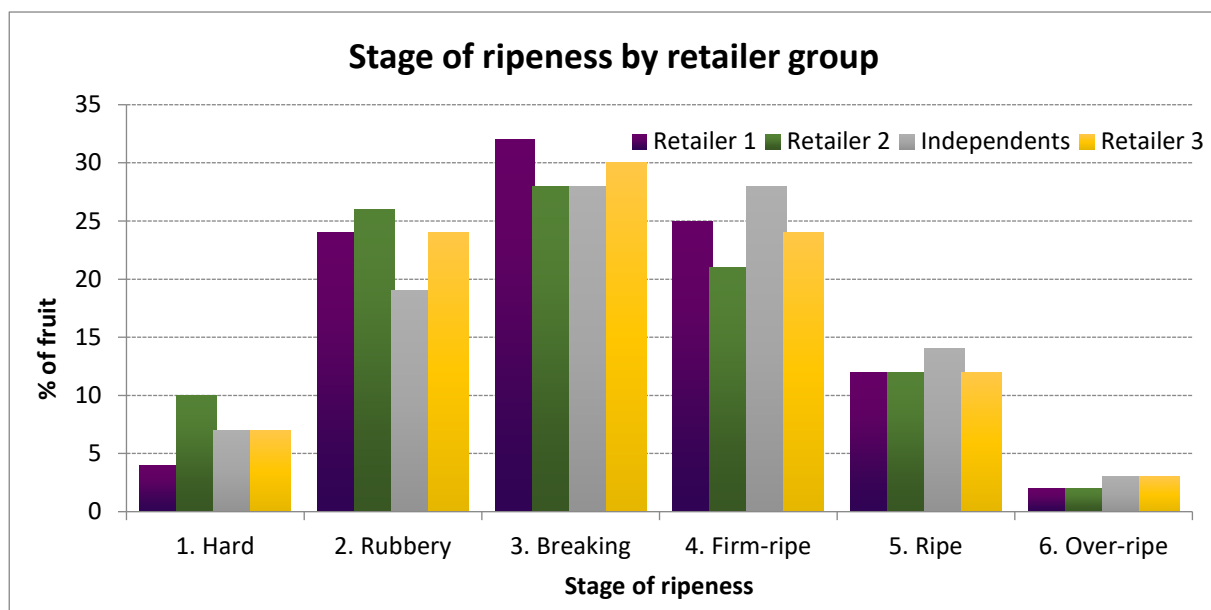


Figure 17. Stages of ripeness of Shepard and Hass avocados by retailer group (2020-23). This includes the three major retailers (purposely de-identified) and a group of independents.

Fruit age and quality

The more time between packing and sale at retail, the poorer the fruit quality was (Figure 18). Extending time between harvest and retail from 10-15 days to 20-25 days more than doubled the level of rots in Australian Hass. Hass grown in New Zealand had more fruit affected by rots, and when fruit age exceeded 25 days, nearly 20% of fruit were unacceptable due to rots. The effect of fruit age on quality of ripe avocados is well documented in best practice materials (Applied Horticultural Research, 2018).

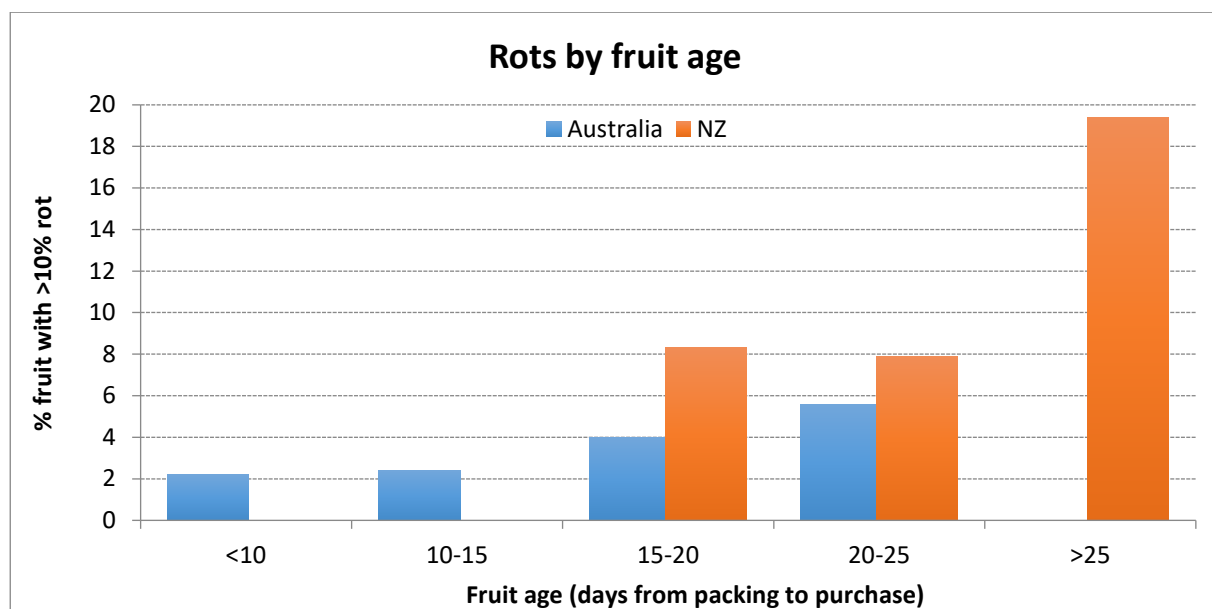


Figure 18. Effect of fruit age (days from packing to purchase at retail) on rots of Hass avocados grown in Australia and New Zealand.

Retail display method

Most loose displays were maintained with less than 3 layers of stacked fruit, which meets industry best practice. However almost 20% of displays had three or more layers of fruit at the time of sampling (Figure 19).

Bruising levels of ripe Hass were higher on loose displays than on tray displays. Loose displays had 8.8% unacceptable fruit due to bruising, compared to only 5.8% of fruit on tray displays (Figure 20). Keeping fruit in trays reduces handling by store staff, so this is a logical result given that handling ripe fruit can cause bruising. Approximately half the stores sampled in this project had loose displays, so the transition of these displays to tray displays is an opportunity for quality improvement.

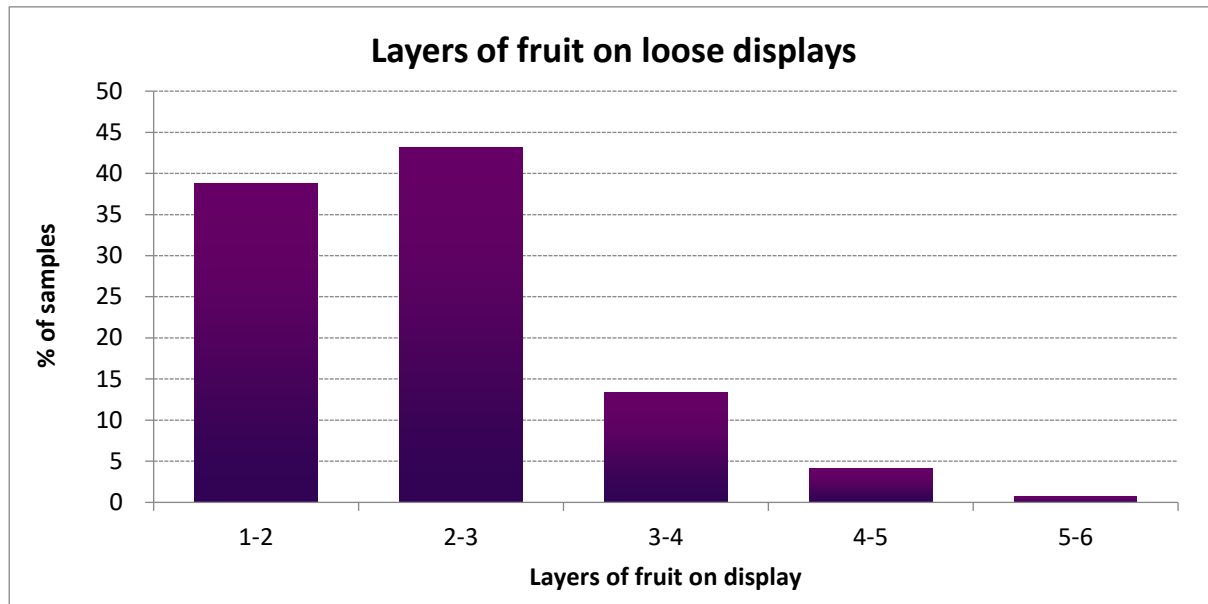


Figure 19. Layers of fruit stacked on loose retail displays.

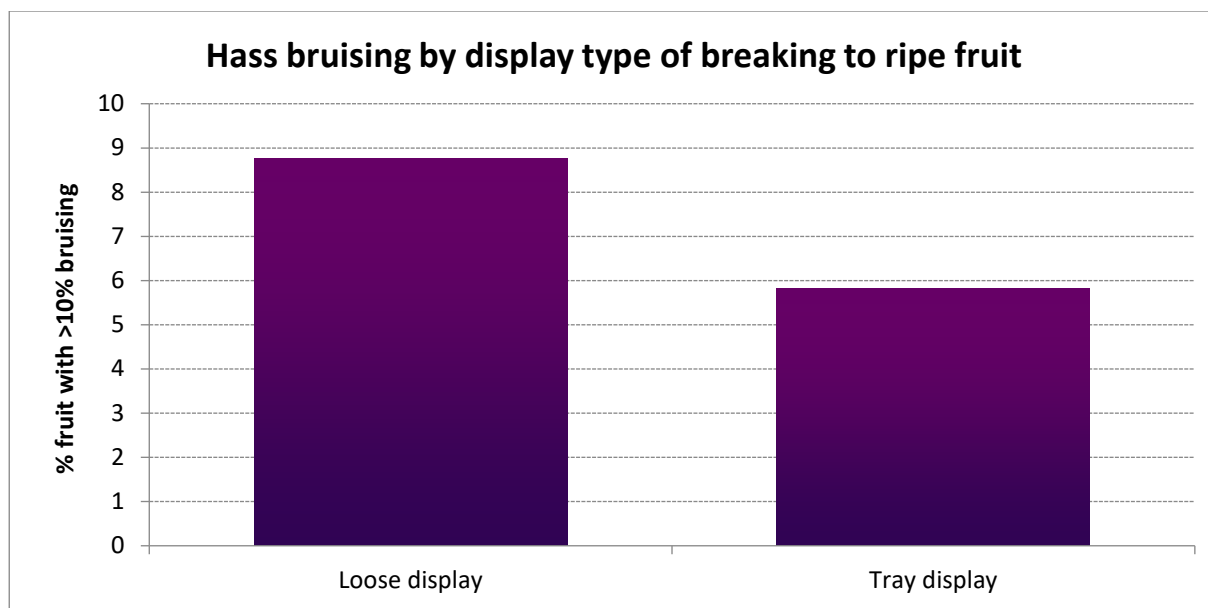


Figure 20. Hass bruising on loose versus tray retail displays of fruit which were at breaking firmness, or softer (stages 3+).

Stages of ripeness at retail and effects on quality

There were higher levels of breaking, and ripe Hass avocados (stages 3-5) than Shepard. Nearly 70% of Hass avocados were at ripeness stages 3-5 at purchase, compared to less than 60% of Shepard avocados (Figure 21, Figure 22).

Softer fruit had more bruising and rots (Figure 23), which implies that firmer fruit should be sold at retail. However, consumers demand ready to eat fruit, so there is a clear trade-off between sales, and quality. Providing ripe fruit at stages 3-4, rather than stage 5 ripe could help reduce flesh damage.

Samples with more variability in firmness between fruit had more bruising (Figure 24). Project AV15011 (Rogers, 2018) identified that consumers squeeze more fruit if it is difficult for them to find one at the preferred ripeness stage. This suggests that uniformly ripe fruit should be displayed to minimise bruising.

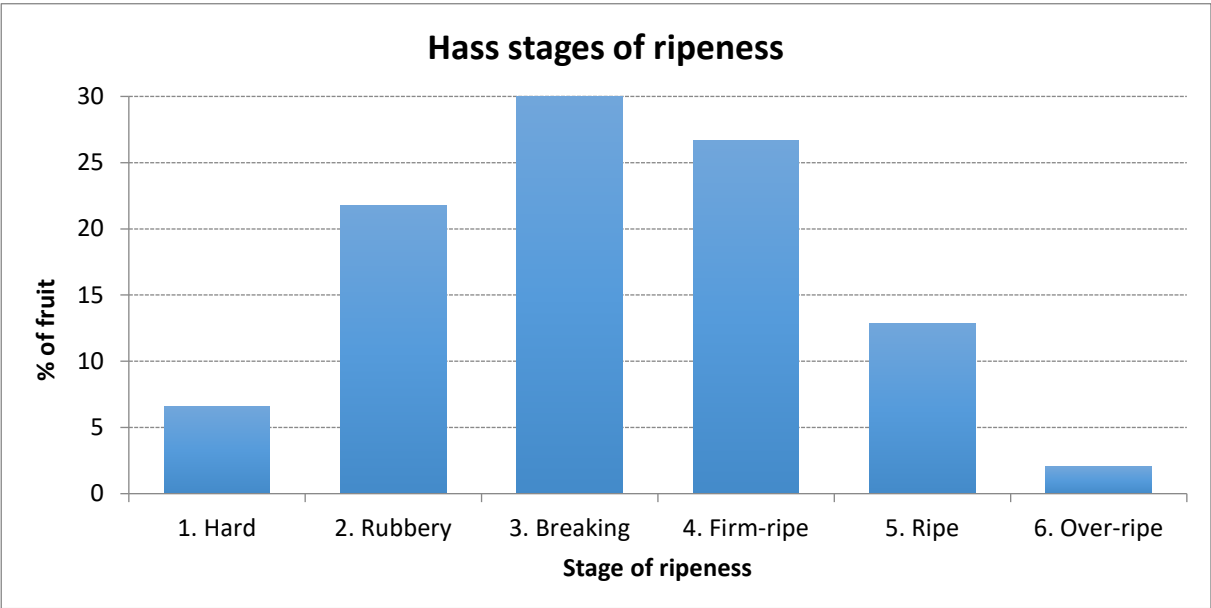


Figure 21. Hass stages of ripeness at purchase.

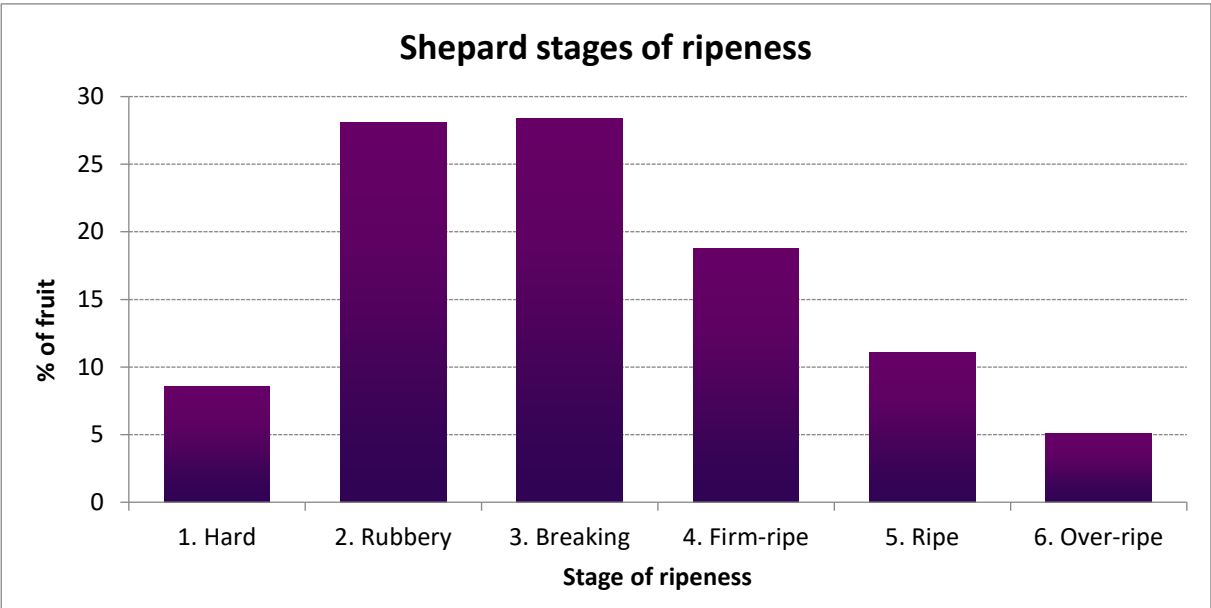


Figure 22. Shepard stages of ripeness at purchase.

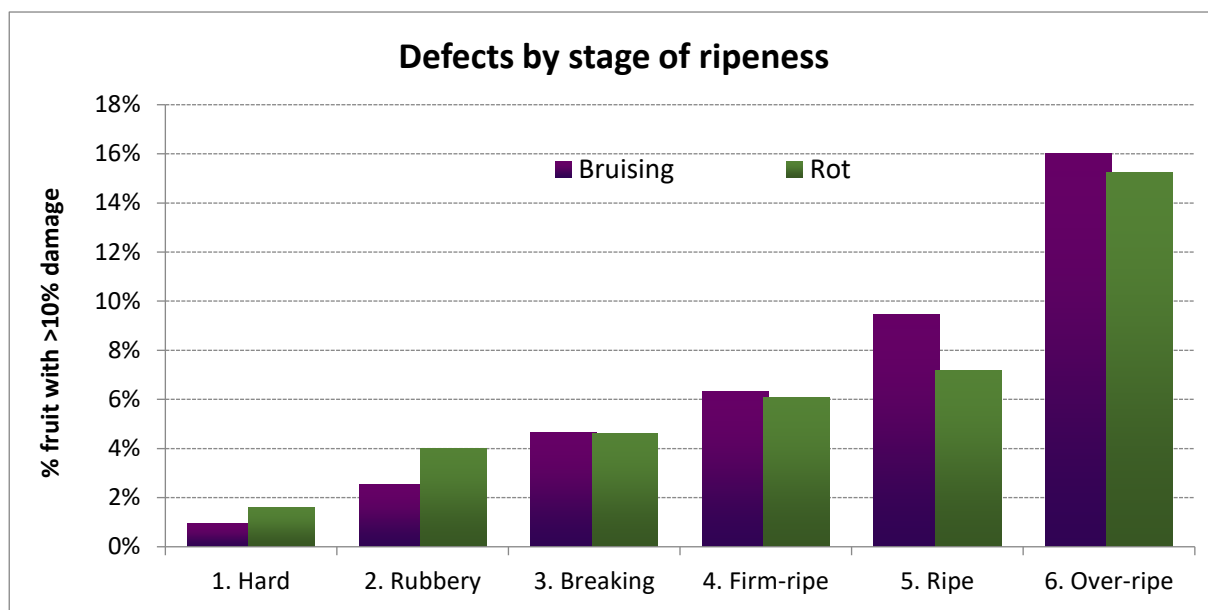


Figure 23. Levels of bruising and rots by stage of ripeness at purchase (Hass and Shepard combined).

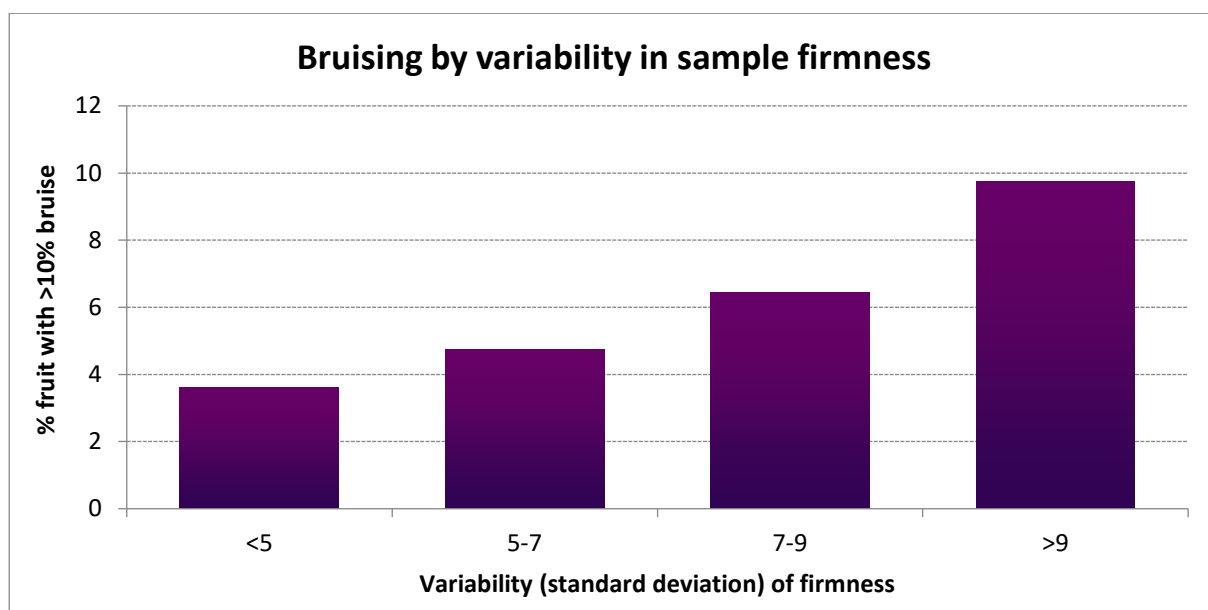


Figure 24. Bruising by variability (standard deviation) in firmness of 10-fruit sample of Hass avocados at purchase.

Quality by retail city

Fruit quality varied slightly between retail cities, most likely due to differences in regions supplying those markets. For example, Perth had the highest quality level overall, but no imported fruit was sampled there. When considering only Australian grown fruit, Perth, Brisbane and Melbourne all had similar quality levels (Figure 25). Sydney quality was slightly lower at 87% for Australian grown fruit, however this is likely to reflect differences in production regions that supply Sydney.

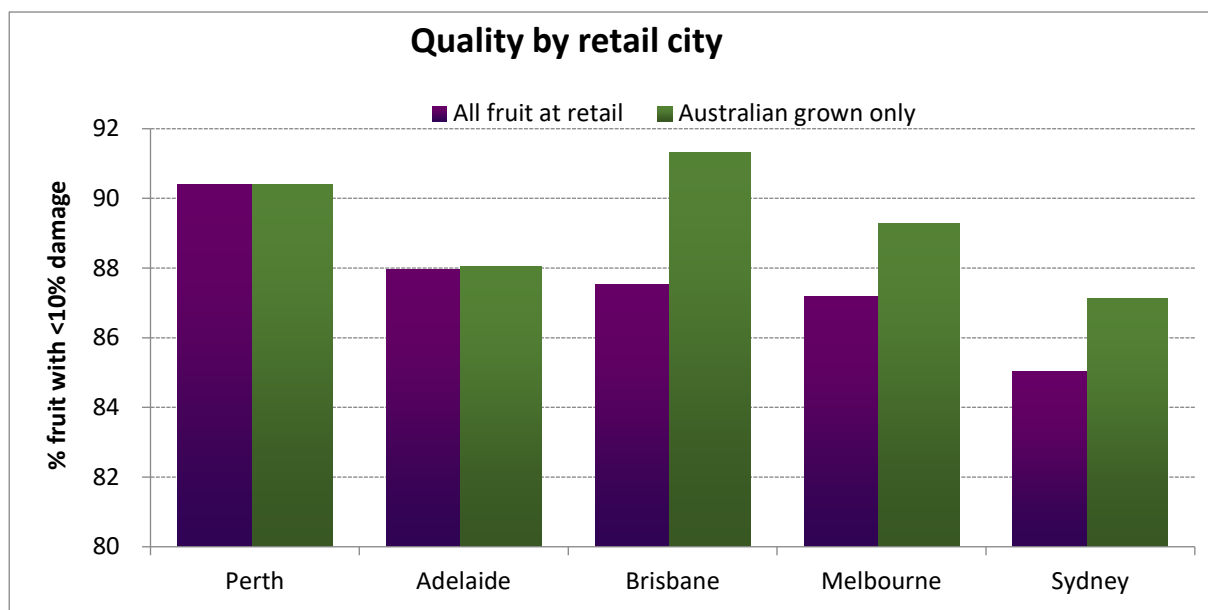


Figure 25. Acceptable fruit by retail city where samples were purchased. Results are broken down by all fruit at retail (Australian grown and imported fruit), and Australian grown only.

Suppliers meeting the acceptable quality standard

Many suppliers (packhouses or marketers) meet the industry target of 90% acceptable fruit, with 33 out of 56 suppliers sampled above this level. A further 18 suppliers were between 80% and 90% acceptable fruit, while five suppliers were below 80% (Figure 26). This suggests that a targeted approach to industry quality improvement would be efficient, focusing more on those who do not meet the industry quality target, and those that are major suppliers. Those that do not meet the industry target make up a mix of supply volumes, with large, medium and small suppliers in that group.

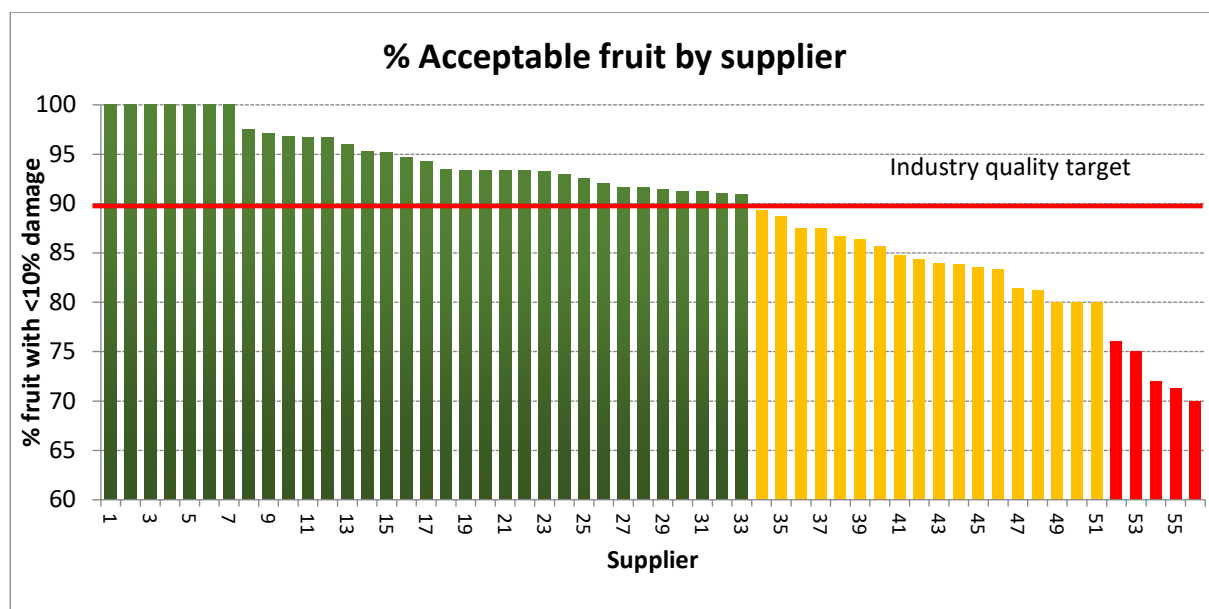


Figure 26. Acceptable fruit of Australian suppliers who had at least three samples collected during the project.

Maturity monitoring

Although maturity was only monitored for a 13-month period in this project, the supply of immature fruit remains an issue. Immature Hass and Shepard fruit were identified at the start of the supply season from samples grown in North Queensland (Figure 27, Figure 29). Immature Hass were identified in February, April and May, and immature Shepard in

February and March (Figure 28, Figure 30).

One year of monitoring is not enough to identify if an improvement has been made since the previous monitoring project conducted from 2007 to 2015 (AV11015). However, in that project, immature fruit was identified from all production regions, whereas it was only identified in North Queensland fruit in AV19003. The levels of immature fruit for North Queensland Shepard in February remained at similar levels to 2007-15 at close to 30% of samples. Also, levels of immature Hass from North Queensland were not dissimilar between the two projects, with immature samples in April at 73% and in May at 34% in 2007-15.

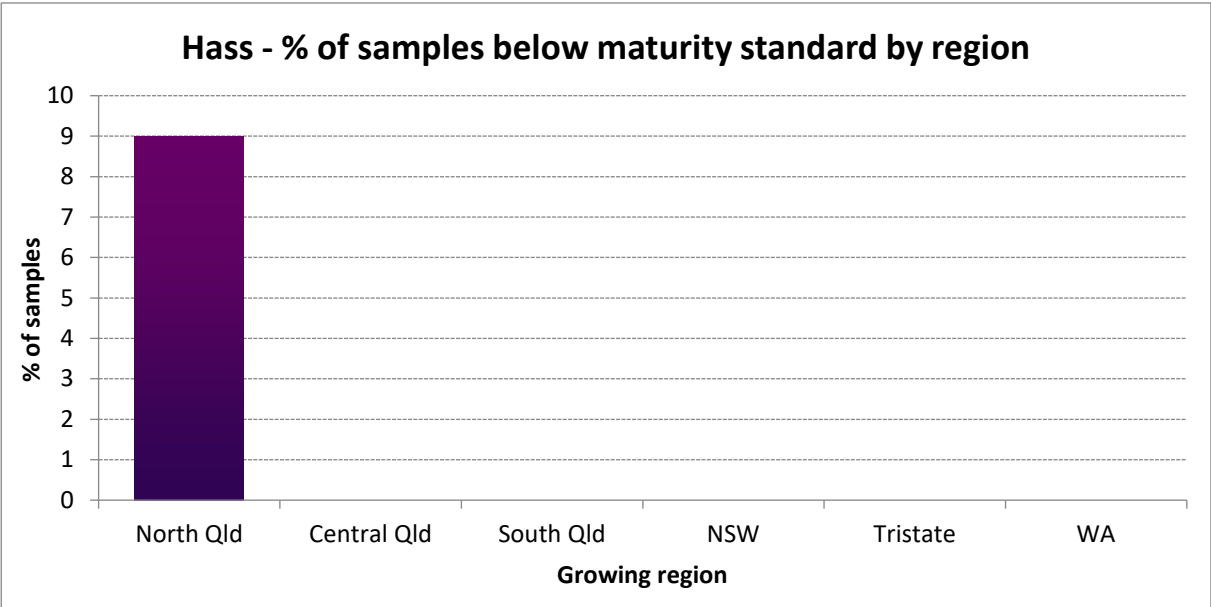


Figure 27. Percentage of Hass samples collected at wholesale from 2022-23, which failed to meet the industry minimum maturity standard of 23% dry matter.

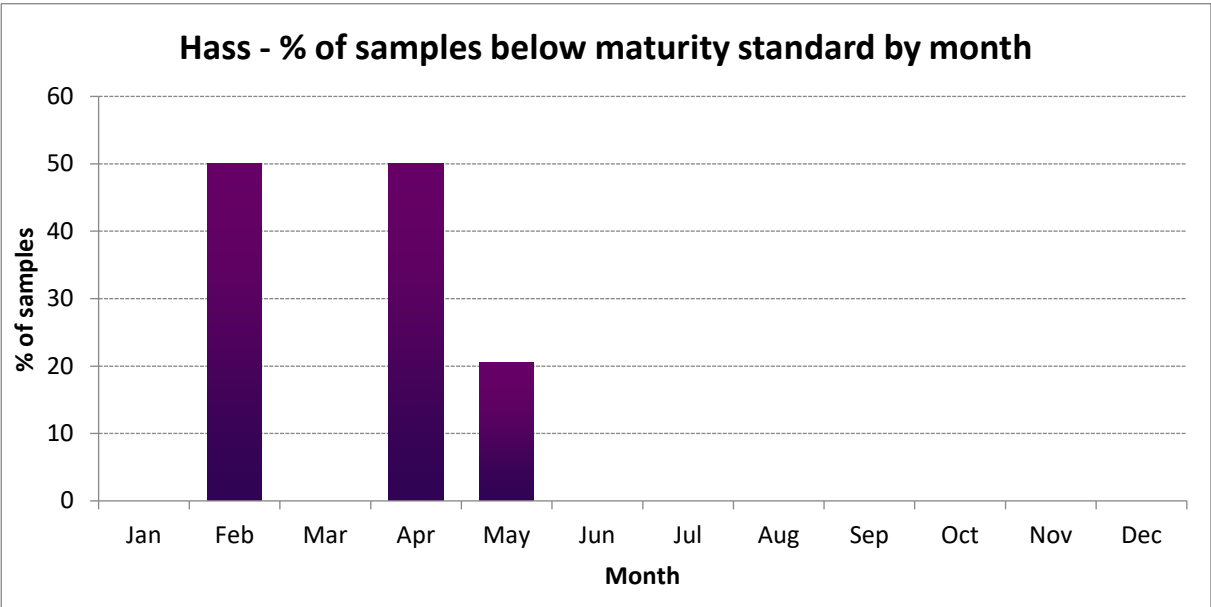


Figure 28. Percentage of Hass samples collected at wholesale from 2022-23, which failed to meet the industry minimum maturity standard of 23% dry matter.

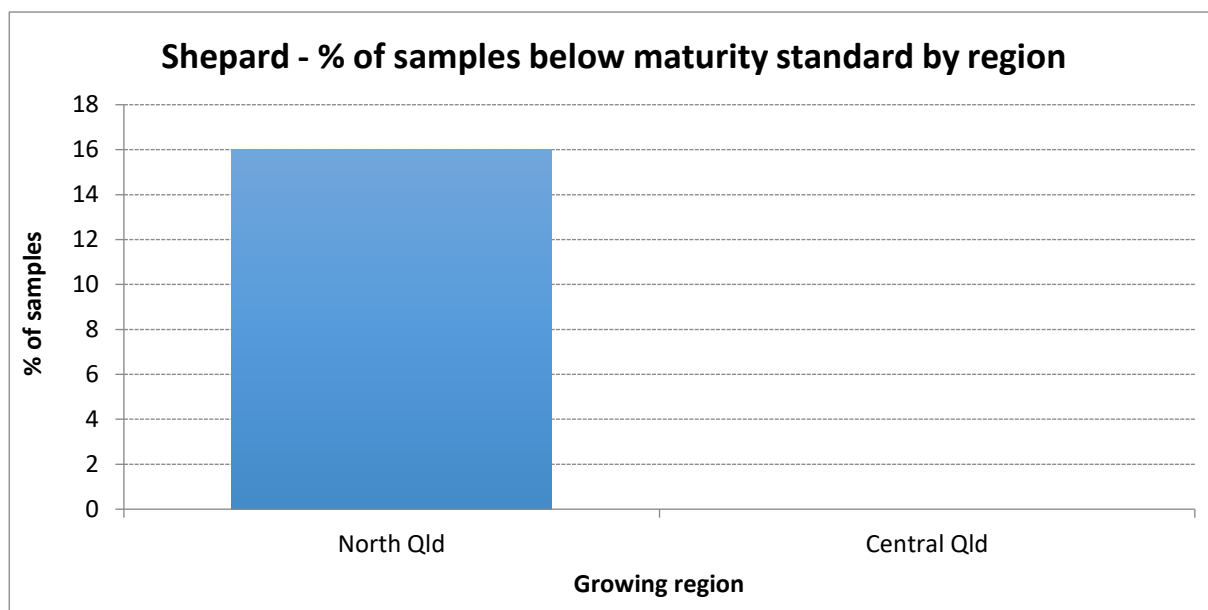


Figure 29. Percentage of Shepard samples collected at wholesale from 2022-23, which failed to meet the industry minimum maturity standard of 21% dry matter.

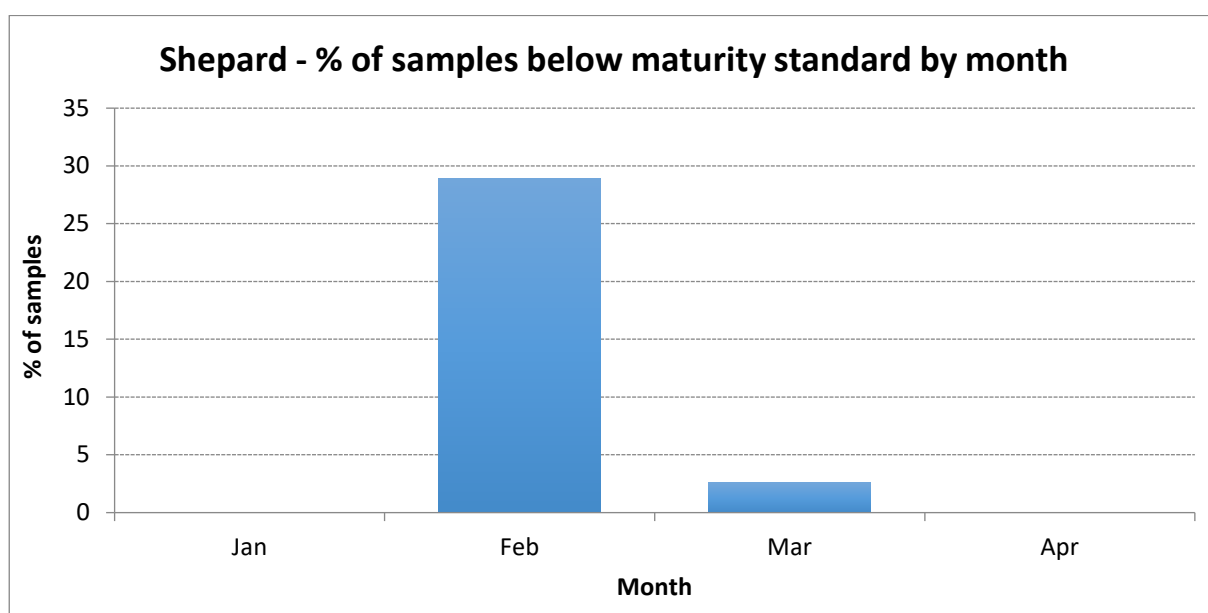


Figure 30. Percentage of Shepard samples collected at wholesale from 2022-23, which failed to meet the industry minimum maturity standard of 21% dry matter.

Outputs

Table 2. Output summary

Output	Description	Detail
Retail quality dataset and reports for suppliers and retailers	Reports on fruit quality provided to retailers and suppliers for each sample of their fruit collected at retail.	All 125 contracted sampling events were conducted (Appendix 6), assessing a total of 1546 samples of ten fruit each, or 15,460 individual fruit over the three year project. PDF reports were emailed to the supplying packhouse, and retailer within a week of sample assessment. The reports were confidential, and examples of the reports are provided in Figure 1 and Figure 3.
Maturity monitoring dataset and reports for suppliers	Report on fruit maturity provided to the supplying packhouse for samples collected at wholesale.	Samples were collected each month between February 2022 and March 2023. Immature fruit were identified during five separate months, so only five out of eight rounds of follow up monitoring were conducted. This provided a total of 22 maturity monitoring events, and a total of 226 samples (10-fruit each) (Appendix 6). PDF reports were emailed to the supplying packhouse within a week of sample collection. The reports were confidential, and an example of the report is provided in Figure 2.
Quarterly retail quality reports for major retailers	Reports presented to Coles, Woolworths and Aldi on a quarterly basis.	Presentations made via an online meeting with major retailer category managers and product technologists, AAL Market Development Manager, and Hort Innovation Marketing Manager. The reports provide a summary of fruit quality for each retailer, and benchmarks them with their deidentified competition. Potential causes of quality issues were identified, and recommendations for improvement provided. The reports were confidential, however an example of a deidentified report is provided in Appendix 7.
Deidentified quality results shared with the wider industry	Monthly industry snapshot Monthly retail snapshot Quality by variety, with long-term averages for Hass and Shepard Maturity monitoring	Industry quality results (retailer and supplier deidentified) were uploaded to the AAL BPR each month. Each report consists of up to 6 charts or graphics, for the use of growers, packers, wholesalers, ripeners, retailers and industry consultants. These include: • quality by production region, retail city, variety and retailer • fruit defect levels by retailer • fruit age by month • stages of ripeness at retail • quality of Australian vs imported fruit • layers of fruit on displays • quality over time • fruit maturity by production region Login access is required to access the pages via the BPR, and there is a full archive of results: https://avocado.org.au/best-practice-resource/retail/retail-quality/ and https://avocado.org.au/bpr-articles/maturity-monitoring-results/
Regional forum and industry event presentations	Presentations on quality results were made at face-to-face and online industry forums. This	<i>Completed:</i> • Crows Nest, South Queensland – 24/3/21 • Mildura, Victoria - 5/5/21

Output	Description	Detail
	provided a breakdown of quality results by production region, as well as a national update.	• Avocado quality update webinar – 12/5/21 • Avo Connections, Brisbane – 7/6/21 • Perth wholesale forum – 25/6/21 • AvoGrow webinar – 12/8/21 • Brisbane wholesale forum – 18/10/21 • Avocado wholesale quality webinar – 20/10/21 • Avo Connections, Brisbane – 6/6/22 <i>Not completed at time of reporting:</i> • World Avocado Congress, Auckland – 3/4/23 • Avo Connections, Adelaide – 5/6/23
Article in FreshPlaza e-newsletter	The article explains the project, and initial findings.	Published 6/9/21: https://www.freshplaza.com/article/9352480/australian-project-monitoring-avocado-quality-to-ensure-it-is-meeting-consumer-expectations/
<i>Talking Avocados</i> articles	Retail quality and maturity monitoring results and data insights for industry stakeholders	Ten contributions to <i>Talking Avocados</i> are attached in Appendix 8, with an additional article to be published in the Autumn 2023 edition.
Video interview	The video provides an overview of the project and some key findings for growers.	https://youtu.be/wVltdqjHlbg Video produced in February 2023 by the AV21004 project, and distributed to industry by AAL.
Ad hoc analysis of quality results for industry and retailers	Analysis of seasonal quality issues was provided for industry and retailers as requested.	Examples of issues and analysis provided includes: • Fruit too firm at retail – analysis of stages of ripeness for retailers – May 2021 • Shepard fruit too firm at retail – analysis of stages of ripeness for retailers - March 2022 • NZ fruit quality issues – analysis of NZ fruit versus Australian fruit quality for retailers – December 2022 • Long supply season in WA, leading to potentially overmature fruit – analysis of levels of rots over the WA season provided to suppliers – December 2021 to February 2022 These analyses remain confidential as they identify major retailers, and/or suppliers.
PRG meetings held	A project reference group met biannually, or as needed	PRG meetings were held on these dates: 28 February 2020, 7 July 2020, 1 December 2020, 24 May 2021, 24 January 2022, 30 January 2023.

Outcomes

Table 3. Outcome summary

Outcome	Alignment to fund outcome, strategy and KPI	Description	Evidence
Continuous feedback mechanism allowing suppliers and retailers to identify quality problems	Outcome 2: Industry supply, productivity and sustainability. Strategy 6: Apply a systems approach to improving quality of Australian avocados throughout the supply chain. KPI: Evidence of increased product quality management across avocado supply chains.	Most of Australia's major avocado packhouses and marketers received quality assessments and reporting on their fruit, with 97 packhouses assessed. All three major retailers had near-weekly feedback on quality in their stores, as did a selection of independent retailers. Quality issues were identified by retailers and suppliers.	The project has increased supplier and retailer awareness of fruit quality issues. Of the suppliers surveyed, 83% said they are now more aware of their fruit quality issues. Independent retailers used quality feedback to identify quality issues in their stores, with 80% of those surveyed more aware of their fruit quality issues, and using the reports as a quality control tool. All major retailers were presented with quality issues and opportunities for improvement at quarterly meetings, including: a lack of ripe fruit on display, higher levels of bruising on loose fruit displays, and increased levels of rots.
Industry and AV18000 staff will be fully aware of quality issues in each major region, to further direct project activities	As above	As a result of data sharing with the AV18000 project, industry presentations, and monthly quality updates on the AAL BPR, industry and AV18000 staff are more aware of quality issues in each region. The AV21005, project has requested use of retail quality results to help guide their project activities and identify less robust fruit. The AV18000 project was able to use the AV19003 dataset to verify the representativeness of their sampling program in each of the key growing regions.	It is estimated that staff from most avocado packhouses in Australia have viewed the deidentified industry quality data provided on the AAL BPR. In total, 2101 views, and 1440 unique page views were made over 2.5 years. This included up to 437 unique views on a single page. Further details are provided in Appendix 9. From suppliers surveyed, 79% said they are now more aware of fruit quality by production region. Growers used results from the project to help guide decision making through the season. E.g., in Dec. 2021, a WA packhouse was interested to gauge if fruit quality was declining through the season, to help guide a decision to shorten their season to reduce the risk of quality issues late in the season. Another major WA packhouse found the reporting useful to better identify variability in quality between their grower suppliers. They requested additional samples be collected to assist them with this further.
Suppliers and retailers make	As above	Based on feedback from this project, the major	Out of the suppliers surveyed, 58% said they have made practice changes,

Outcome	Alignment to fund outcome, strategy and KPI	Description	Evidence
changes that help improve the quality of avocados at retail		retailers have all made practice changes which will help improve the quality and demand for avocados. Category managers were able to use the retail quality data to help justify changes in their businesses. Furthermore, the retail monitoring was used to measure changes which had been made, and check if quality had improved. Packhouses have also made practice changes, or followed up on quality issues with their growers, and others in the supply chain who handle their fruit.	or conducted follow up activity based on quality feedback received. Feedback following a wholesale quality webinar was that 88% of attendees were likely to make changes to aspects of their business as a result of attending the webinar. Independent retailers used the quality feedback to discuss issues with their suppliers, with some changing suppliers if quality was consistently poor. An IGA store made changes to their stock rotation and handling practices in response to issues of overripe fruit and high levels of bruising. Major retailers used evidence from quality monitoring to make changes across their store networks, including: • Shifting from loose fruit displays to tray displays following data showing lower levels of bruising in fruit displayed in trays • Adjustments to supplier firmness specifications in response to a lack of ripe fruit in stores • Adjustments to firmness and fruit age specs. in response to data showing high levels of rots in NZ fruit (December 2022)
Objective measure of how well the industry is tracking on their mission to improve avocado quality	As above	The avocado industry has an objective measure of avocado quality over time. Three years of retail quality data, and one year of maturity data can be compared with quality previously reported in AV11015.	Results provided in this final report, <i>Talking Avocados</i> articles, industry presentations, and on the AAL BPR will be used by the avocado industry to assess the SIP outcome 2.
	As above	Quality of avocados have improved over the duration of the project	Although variable between years, the data shows a slight improvement in quality over the 3 years of the project. The project is likely to have contributed towards this improvement, along with other causes.

Monitoring and evaluation

Table 4. Key Evaluation Questions

Key Evaluation Question	Project performance	Continuous improvement opportunities
To what extent has the project achieved its expected outcomes?	As outlined in the outcomes section, the project has met or exceeded all expected outcomes.	Awareness of issues by growing region could be improved further by presenting results at more regional forums.
How relevant was the project to the needs of intended beneficiaries?	Supplier survey results suggest the project was highly relevant, as 58% of respondents made practice changes or follow up actions based on quality feedback received. Major retailers also made changes to their businesses based on the quality feedback.	Smaller suppliers are less likely to be sampled at retail, and may have only received 1 report per year, which is unlikely to meet their needs. If fruit are not displayed in trays, then traceability is limited to the packhouse or brand on the fruit label. This means the quality assessment cannot always be linked to a grower. Improved traceability on fruit labels would help with this.
How well have intended beneficiaries been engaged in the project?	A wide range of delivery methods was used to engage with beneficiaries. These included: • Reports emailed directly to 97 suppliers, 4 major retailers, and 19 independent retailers • Reports provided on the AAL BPR, and promoted via the e-newsletter were viewed 2101 times • Meetings with major retailers • Face-to-face presentations and webinars for industry • Video • Magazine articles • Other engagement through AAL staff, including the AAL Market Development Manager, and Industry Development Manager From the supplier survey, 80% of suppliers had viewed some of the project outputs.	Integrating the retail quality monitoring project with the supply chain monitoring (AV18000), as detailed in the AV22011 Request for Proposal, will allow for more efficient and improved engagement with suppliers.
What efforts did the project make to improve efficiency?	Use of the Konect app for data collection made for more efficient sampling and data management. Additionally, semi-automated reporting in Power BI allowed for rapid and efficient feedback to suppliers and retailers.	There is potential to further automate the reporting process, by better integrating assessment images into the report. We have identified a potential 20% improvement in efficiency for assessments if a visual defect

	Efficiencies of sampling, assessments and report creation increased over the course of the project as staff became more experienced in these processes.	assessment method is used, rather than weighing individual defects. Avocado retail quality monitoring could be combined with retail monitoring for other industries, to improve efficiencies for instore sampling.
--	---	---

Quotes from the end-of-project survey

The following are quotes from the end-of-project survey which support the continuation of the project, and provide further evidence of project outcomes and impact:

“The avocado quality feedback report is a great tool which assists our business with their Avocado QC practices, merchandising practices and provides valuable supplier feedback. This report assists with improving the customer’s avocado experience” – Category Manager, major retailer

“This project has been well managed with some great data, it would be great to see it continue” – Category Manager, major retailer

“Used the evidence provided to improve operational issues across the store network” – Category Manager, major retailer

“Keep it going. The information is very useful as a grower/packer but also for the industry it is important to keep quality monitoring up to date” – Queensland grower/packer

“Keep it going. Provides valuable feedback to industry” Tristate grower/packer

“I think it (the reporting) has been done well and the dashboard style reports are easy to view and use” – Queensland grower/packer

“Re bruising and rots, this feedback is very valuable. Again, it’s great seeing a sample of actual ripe eating quality from instore” – Queensland grower/packer

As a result of quality feedback: **“Offered some handling techniques to independent retailers. Looked at our supply chain when issues have arisen. Made customers aware of quality”** – Marketer

Recommendations

General recommendations:

1. The industry should continue monitoring avocado quality at retail, along with rapid feedback, which has excellent support for continuation by retailers and suppliers
2. Continue maturity monitoring during months when immature fruit is likely to be supplied. Feedback needs to be more rapid, so that if a grower's fruit fails to meet the maturity standard, they can hold off harvesting until further testing is done. A near-infrared (NIR) device like the Felix could be used to provide instant measurements, rather than using the oven drying method
3. Maturity monitoring feedback could be provided to the buyer (market agent) of the fruit, to help increase adherence to the industry standards

Retail:

4. Work with independent retailers to improve quality, given that quality of independents was consistently below all three major retailers
5. Focus future quality improvement work on bruising, which remains the largest quality defect for Hass
6. Encourage the following practices, which this project demonstrates can reduce bruising:
 - Shift from loose fruit displays to tray displays
 - Supply and display uniformly ripe fruit
 - Minimise time between harvest and retail sale
7. Continue to benchmark retailers against their de-identified competition to help drive quality improvement
8. Identify the optimum fruit firmness for retail display of Hass avocados, which balances the need to maximise sales, but also maintain quality - softer fruit are more likely to have bruises and rots, however consumers want to purchase fruit which are ripe and ready to eat
9. Allow for some flexibility in sampling in future quality monitoring projects to provide additional quality testing capacity when major retailers trial practice changes. Identifying quality improvements from retail trials can help category managers get the support needed to have changes adopted across their store network

Grower and packhouse quality improvement work should focus more on:

10. Growing regions with lower quality levels, such as NSW, North Queensland, and South Queensland
11. The minority of suppliers who have fruit quality below the 90% industry target
12. Hass, rather than Shepard, given that the quality of Shepard avocados is already well above the 90% industry quality target

Refereed scientific publications

None to report

References

Applied Horticultural Research (2018). Australian avocado supply chain best practice guide. Hort Innovation.

Gamble, J., Harker, F. R., Jaeger, S. R., White, A., Bava, C., Beresford, M., ... & Woolf, A. (2010). The impact of dry matter, ripeness and internal defects on consumer perceptions of avocado quality and intentions to purchase. *Postharvest Biology and Technology*, 57(1), 35-43.

Goldwater, A. (2018). Avocado retail sampling. Final report AV18006. Hort Innovation.

Hort Innovation (2022). Avocado Strategic Investment Plan 2022-2026.

Joyce, D. (2018). Supply chain quality improvement – technologies and practices to reduce bruising. Final report AV15009. Hort Innovation.

Kantar (2022). Introducing the Domestic Growth Framework – Australian Market Report.

Rogers, G. (2018). Supply chain quality improvement – Retailer point of purchase improvements. Final report AV15011. Hort Innovation.

Tyas, J. (2016). Avocado industry fruit quality benchmarking. Final Report AV11015. Hort Innovation.

Intellectual property

No project IP or commercialisation to report

Acknowledgements

The project team gratefully acknowledges the contributions of the following groups:

- Avocados Australia– project guidance, communications support, and distribution of reports to industry stakeholders
- Project reference group members for their input and guidance throughout the project
- Major and independent retailers who participated in the project
- Growers, packers and marketers who provided feedback to help improve the usefulness of outputs
- Fruit samplers and assessors

Appendices

Appendix 1. Retail sampling and fruit assessment protocol.

Appendix 2. Maturity monitoring protocol.

Appendix 3. Retail quality and maturity monitoring record forms

Appendix 4. End of project survey

Appendix 5. Defects by growing region

Appendix 6. Retail quality and maturity monitoring samples collected

Appendix 7. Major retailer quality reporting template

Appendix 8. *Talking Avocados* articles

Appendix 9. User views of online reports

AV19003 Retail sampling protocol v.8

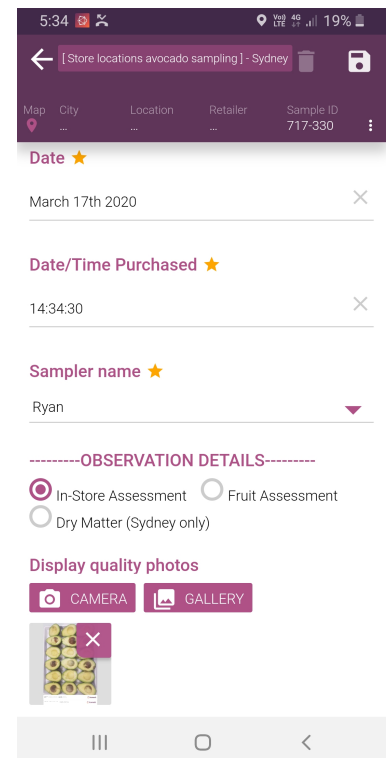
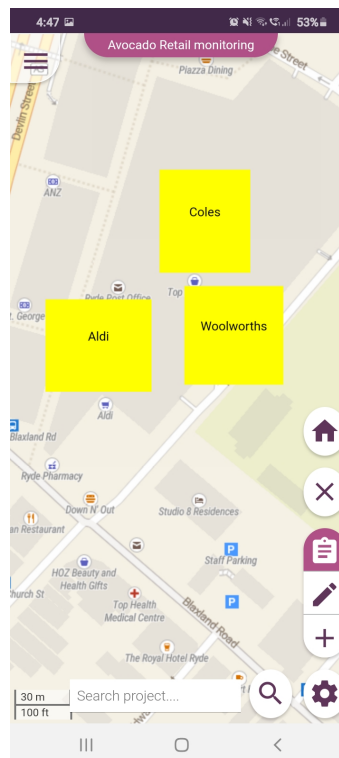
1. Store sampling

Sampling route and timing:

- Maintain the same route, and order of store collection each time
- Where possible, sample on the same day of the week each round
- It is suggested to sample on a Tuesday or Wednesday, so that fruit is ripe for assessing before the weekend

Before entering store:

- Login to Konect App
- Click the '+' sign to start a new survey
 - Note, if you are continuing with an existing survey, then find the Sample ID in the list, and click on that survey
- Select a Sample ID label from the labels provided and enter the Sample ID code
- Check that the store name and location listed matches the store which you are sampling from
- Enter the following information:
 - **Date/time purchased**
 - **Sampler name**
- **Observation details** – ensure that 'In-store assessment' is selected.



Inside the store:

- Locate the main (largest) avocado display in the store
- Select only Hass or Shepard avocados (Shepard replaces Hass from March-May)
 - If there are both Hass and Shepard available, then only collect the dominant variety on display
 - If Shepard is available, then check signage/packaging labels, as there are other green skin varieties which may look similar
- **Display quality photos:**
 - Click 'camera' and take a photo of the sample ID number label
 - Then do the same again and take a photo of the entire avocado display
- **Is fruit sorted by ripeness:**

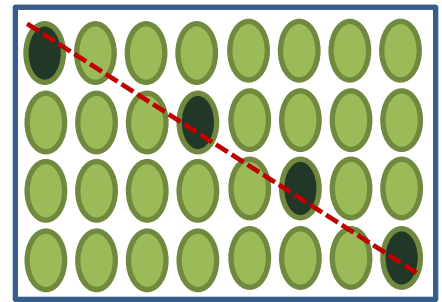
- Tap 'Yes' if fruit are purposely segregated by ripe and unripe (e.g. one side ripe, one side unripe)
- Record the average **number of fruit layers** that fruit are stacked on top of each other
- **Percentage of ready to eat fruit** on the entire display
 - By hand feel, estimate the percentage of ripe (ready to eat) fruit on the entire display – ready to eat means fruit which can be eaten that day. For reference, ready to eat is any fruit with firmness below 60 on the durometer
- Record the **price per fruit**
 - If on multi-buy special, then input the sale price per fruit (e.g. 2 for \$4 = \$2/fruit)

Identify a SINGLE batch of fruit to sample from and record supplier details:

- Identify the dominant supplier on the display
 - However if you have already collected fruit from that supplier during the day, then select from another supplier – i.e. try and collect fruit from as many different suppliers through the day
- If taken fruit from a tray, then it is important to ensure that the brand name on the fruit label matches that of the tray which you select fruit from
 - If it doesn't match, then only record the packhouse/supplier name from the fruit label
- **Packhouse**
 - Identify the packhouse name (if available on the tray), or the supplier number or brand name, then:
 - Select the packhouse name from the dropdown list
 - If the packhouse name is not in the list, or you are entering a brand name or supplier number from the fruit label, then select '**Other**' and record the name/number
 - If packhouse name is not known then select 'unknown'
- **Grower**
 - If grower details are available on the tray label, then note these under 'grower'
- **Pack date**
 - Record the pack date if available on the tray label – not the best before date!
 - This date will always be at least 1 week earlier, so always check that the pack date is logical
- **Fruit sticker barcode**
 - Scan the fruit label if it has a barcode, by tapping on the scan icon on the right of the field
 - If your phone cannot scan the barcode, then just ensure you take a photo of the fruit label in the photos section further down
- **Fruit size**
 - Select the fruit size if available on the tray label
 - If unavailable, select 'not in tray'
- **Variety**
 - Select either Hass or Shepard
- **Country of Origin**
 - Select either Australia , New Zealand Or Chile
- **Sample taken from**
 - Select 'loose display', or 'tray on display'

Select the sample from the display:

- Loose fruit on display
 - Randomly select 10 fruit in a diagonal line across the display, taking from near the front to near the back of the display
- Fruit in a tray
 - Randomly select 10 fruit in total from three trays (of the same batch), in a diagonal line across each tray
- Do not select fruit that is obviously damaged or rotten and a consumer would be unlikely to purchase
- Collect 10 pieces (one sample) of fruit only per store
 - All 10 fruit should be from the same brand/supplier/batch/fruit label
- **Fruit and tray label photos**
 - Take a photo up close of the batch of fruit on display which you have sampled from – e.g. a tray of fruit, or 20 fruit on loose display
 - Take a photo of the tray label if available
 - Take a photo of the fruit label up close
- **External quality**
 - Select any major external quality issue (only if >20% of fruit are affected)
 - If 'other', record in notes field
 - If there are no problems, then select 'No issues'
- **In-store notes**
 - Please note any issues/comments if needed

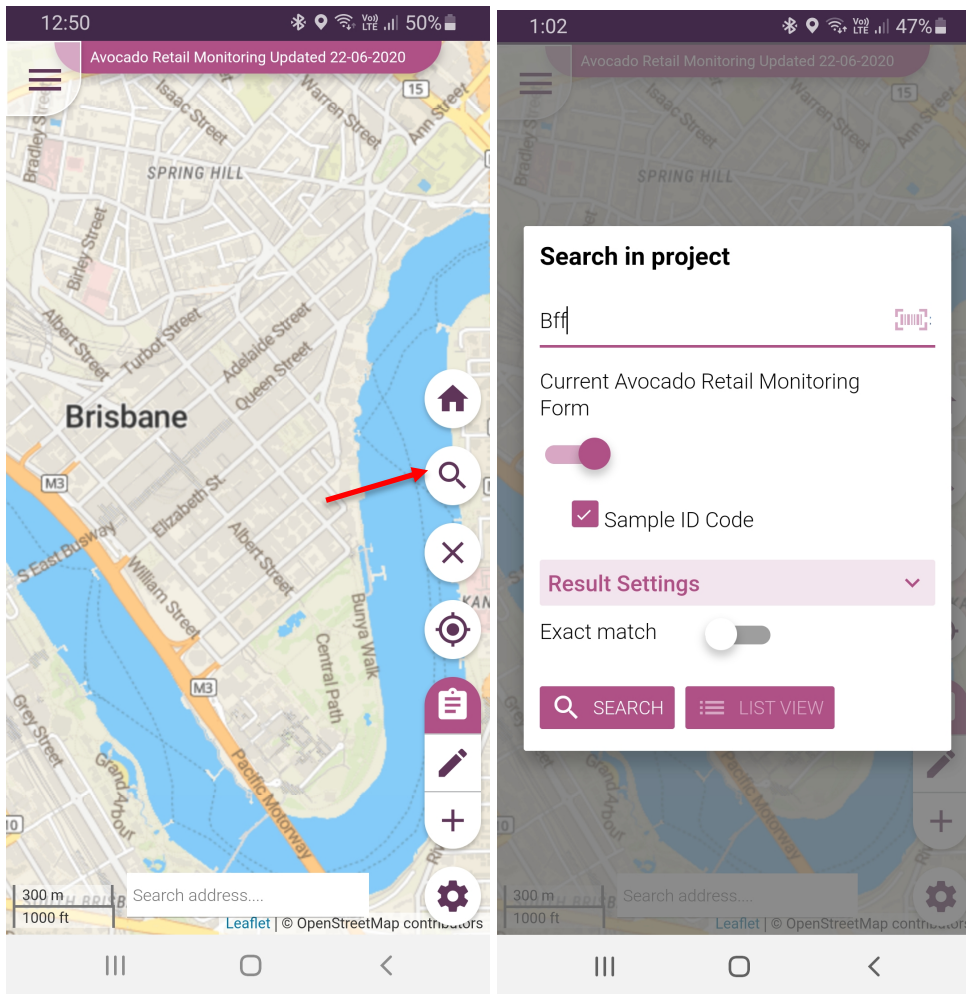


Finishing up in-store:

- All fruit should be placed carefully into an avocado tray, along with the barcode label
- Pay at checkout and collect copy of receipt
- Return fruit to vehicle
- Keep trays of fruit wrapped in insulation blankets, and where possible, avoid parking in full sun, especially on hot days

Return fruit to office/lab and take firmness measurements:

- Transfer fruit immediately from the car to an air-conditioned or cool, shaded place. This should be between 19-23°C.
- On the same day as collecting the fruit, assess fruit firmness of all samples using the durometer
- Ensure all 10 fruit are placed in order, and labels 1-10 are written on the tray liner underneath each fruit
- Log back in to the Konect App
- On the map screen, click the search button on the right side, and search for the Sample ID – that should redirect you back to the survey form for that sample



- Scroll to bottom of survey form
- Check durometer calibration:
 - Place glass dish (facing up) on a solid surface, ideally a hard bench or floor
 - Check calibration by taking 10 readings in the base of the glass dish
 - Also check that a reading of 0.0 is achieved when no pressure is applied
 - If the average of 10 readings on the glass dish is >3 units out from 100, then please calibrate by:
 - Check that durometer tip is screwed on tight
 - Place glass dish (facing up) on a solid surface, ideally a hard bench or floor
 - Press the durometer into the base of the glass dish and hold durometer pressed down
 - When a steady reading is reached, press 'cal' button on the durometer
 - Check calibration again, by repeating the 10 readings in the glass dish
- Under 'Firmness at Purchase (Fruit 1)', enter average firmness of fruit 1, using durometer as follows:
 - Turn on durometer
 - Click 'N-AVE', and press until it shows 'No.2' (average of 2 readings)
 - Press 'MAX' so it shows 'MAX' in top right of screen
 - Hold fruit on a table, and gently press durometer onto equator of the fruit, until it beeps
 - Press 'ZERO'
 - Repeat a second reading on the opposite side of the fruit, until you hear a beep

- An average of the two readings will now show up on the screen, which can be entered into Konect for each fruit
- Zero again to repeat on the remaining 9/10 fruit
- Ensure that the order of fruit (1-10) is retained
 - It might be worth keeping together some trays with fruit numbers (1-10) labelled on the tray liner
- Click 'Sync with Cloud'

2. Assessing internal quality

When to assess fruit:

- Hold fruit at room temperature (19-23°C) for at least 24hrs (from time of sampling) before checking firmness
- After 24hrs, check average firmness of 10 fruit using durometer (refer to firmness measurement instructions in previous section)
- Once average firmness reading of the sample of 10 fruit reaches 45 or less (or will fall below 45 before next assessment day), and 24hours has passed from time of sampling, fruit can be assessed

Assessing internal fruit quality:

- Login to Konect App
- Go to the map, and search the Sample ID Code for the sample you are about to assess
- Once you are in the sample form, scroll down to 'OBSERVATION DETAILS' and select 'Fruit Assessment'
- Keeping the fruit in order (1-10), cut all fruit in half, and take the half without the seed and lay out on the A3 laminated card for a photo along with the sample ID code label
- Take photos under 'Internal Fruit quality photos':
 - One photo of all fruit on the white background, with the sample ID label (see example below)
 - Extra photos of all fruit with body rots -quarter the fruit, peel back the skin, and take a photo of the skin and flesh together for each fruit, along with a number on a plastic card which identifies which fruit it is
- Assess each fruit, one at a time:
 - Cut into quarters, and remove skin
 - Separate, weigh and record:
 - Good flesh (no issues)
 - Rotten flesh
 - Select cause of rotten flesh
 - Bruised flesh
 - Other defect (e.g. vascular browning, flesh discolouration)
 - Select cause of 'other defect'
 - If 'other', then please specify
- Scroll back up in the app to 'Fruit number', and select the next number, and repeat the internal assessment on all 10 fruit
- **Tap save** on the top right of the screen once all 10 fruit have been assessed,

- If you have any comments/issues to add for the fruit assessments, then enter those at the bottom of the form.
- Use the Avocado Fruit Quality Problem Solver to help identify defects present
- Once all assessments are complete for the day, click 'Sync with the Cloud'

Maturity monitoring at wholesale – sampling protocol v1

1. Fruit sampling at wholesale markets

Avocado dry matter will be monitored at the Sydney wholesale markets to determine the proportion of immature fruit on the market. This market is Australia's largest market for avocados, has a diverse supply base and is likely to be the most representative market in Australia.

Maturity monitoring cannot be achieved at the point of retail along with the remainder of the project's sampling, as dry matter needs to be assessed on hard-green fruit, as close to the time of harvest as possible – this is best achieved at a wholesale market.

Sixteen trays of fruit will be sampled on a monthly basis, from a range of wholesale agents on the trading floor of the Sydney Wholesale Market. An additional eight rounds of follow up samples will be collected over the course of the monitoring program. These will be used following collection of a number of immature samples, or where results are disputed by the supplier. Eight samples will be collected at each follow up round, made up of suppliers whose results are close to or clearly below the minimum standard.

Fruit will be collected from as many different suppliers as possible, from a range of growing regions, including those early in their supply season, when fruit is more likely to be immature. Previous work (AV11015) shows that fruit is most likely to be harvested while immature as growing regions commence harvest as follows:

- a. Jan/Feb – North QLD (Shep)
- b. March/April – Central QLD (Shep)
- c. April/May – North QLD, Central QLD (Hass)
- d. May/June – Central NSW, South QLD, Tamborine/Northern Rivers, Sunshine Coast (Hass)
- e. July-Dec– Western Aus, Tri-State/NT (Hass)

Fruit will only be collected at the hard-green stage of ripeness, in order to provide a sample which closely resembles that sampled by a grower in the orchard.

Collect a mix of premium and class 1 samples where possible.

Only Australian grown Hass and Shepard fruit will be purchased.

Trays of fruit will be purchased, rather than bulk boxes, and the fruit size will be of an average size from the consignment available.

Purchase and tray details will be recorded as follows: market agent; packhouse; grower; growing region, pack date; batch number; variety; size of fruit; date sampled; and date purchased.

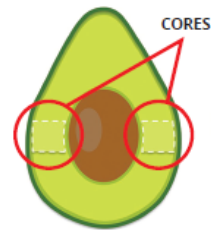
Collect fruit from as many different growers as possible. Note that this may mean purchasing multiple trays from an individual packhouse, where growers differ on the labels. Avoid purchasing multiple trays from the same grower.

Photographs will be taken of the tray and fruit labels, as well as the fruit in the tray.

2. Dry matter assessment

After purchase, fruit will be transported immediately to the AHR laboratory, and dry matter cores taken that same day. This will involve:

- Randomly selecting 10 fruit from each tray (10 fruit shown to be statistically significant in AV11015)
- Recording the average firmness of the 10-fruit using a Turoi durometer
- Two cores of flesh are removed from the equator of each fruit (see image to the right) using a 16mm corer – take one core from the dorsal side, and one from the ventral side
- The skin and seed coat are removed from the flesh cores
- Each core is cut in half
- Empty foil dish is weighed
- Flesh cores are placed in the foil dish and weighed using a calibrated balance, with 2 decimal places
- Steps 1-5 are repeated for all 10 fruit
- Flesh cores are dried in a 60°C dehydrator
- Flesh cores are weighed, returned to the dehydrator, and reweighed until there is no change in weight on further drying (usually 3 days)
- Calculating % DM of each individual fruit, as well as the average of the 10-fruit sample



Percentage dry matter is calculated as:

$\% \text{ DM} = \text{sample dry weight} / \text{sample fresh weight} \times 100$

Record forms

Retail sampling

2:56 [Store Locations Update] - Melbourne

Map Sample ID Code Retailer Purchase Date Sampler Name

CURRENT AVOCADO RETAIL RELATED ITEMS

Link record to parent

✓ Linked to 'Melbourne' from dataset Store Locations Update.

Copied values summary

Sample ID Code ★

City

Melbourne

Location

Waverley Gardens Shopping Centre

Retailer

Purchase Date

Sampler Name

-----OBSERVATION DETAILS-----

☒ In-Store Assessment ☐ Fruit Assessment

☐ Dry Matter (Sydney only)

Sample ID number photo and display quality photos

CAMERA GALLERY

Is fruit sorted by ripeness?

☒ No ☐ Yes

Average number of fruit layers

< >

Percentage of fruit ready-to-eat

< >

Price per fruit

< >

Packhouse

Unknown

Grower

Pack Date

Best Before Date

Fruit sticker brand

Fruit Size

14

Variety

☒ Hass ☐ Shepard

☐ Other (Do not purchase)

Country of Origin

Australia

New Zealand

Chile

Unsure

Sample taken from

☒ Loose display ☐ Tray (single layer)

☐ Tray back of store/not handled

Fruit, Fruit Label and Tray Label Photos

CAMERA GALLERY

External quality (if >20% fruit affected)

No Issues

External quality notes

In-store notes

Internal fruit quality photos

CAMERA GALLERY

Fruit Number

< 1 >

Firmness at purchase (Fruit 1)

Fruit assessment

1:24 [Store Locations Update] - Melbourne

Map Sample ID Code Retailer Purchase Date Sampler Name

CURRENT AVOCADO RETAIL RELATED ITEMS

Link record to parent

✓ Linked to 'Melbourne' from dataset Store Locations Update.

Copied values summary

Sample ID Code ★

City

Melbourne

Location

Waverley Gardens Shopping Centre

Retailer

Purchase Date

Sampler Name

-----OBSERVATION DETAILS-----

☐ In-Store Assessment ☒ Fruit Assessment

☐ Dry Matter (Sydney only)

Sample ID number photo and display quality photos

CAMERA GALLERY

Fruit, Fruit Label and Tray Label Photos

CAMERA GALLERY

Assessment Date

Internal fruit quality photos

CAMERA GALLERY

Fruit Number

< 1 >

Is there damaged flesh to record? (Fruit 1)

☒ Yes ☐ No

Flesh weight good (Fruit 1)

Flesh weight bruise (Fruit 1)

Flesh weight body-rot (Fruit 1)

Flesh weight stem-end-rot (Fruit 1)

Flesh weight vascular browning (Fruit 1)

Flesh weight flesh discolouration (Fruit 1)

Flesh weight other defect (Fruit 1)

Fruit assessment comments (For entire sampling session)

Maturity monitoring

1:24

[City Locations] - Sydney

Map Sample ID Code Observation details

RELATED ITEMS DRY MATTER MONITORING

Link record to parent

✓ Linked to 'Sydney' from dataset City Locations.

Sample ID Code

Observation details

☒ Collection ☐ Assessment

Purchase date

Sampler name

Market agent

Variety

☒ Hass ☐ Shepard
☐ Other (Do not purchase)

Is it Australian grown (only collect Australian fruit)

☒ Yes ☐ No

Packhouse

Unknown

Grower

Growing region

Unallocated

Pack date

Batch number/ID

Size

14

Fruit grade

☒ Premium ☐ Class 1 ☐ Class 2

Tray label

CAMERA

GALLERY

Fruit label

CAMERA

GALLERY

Fruit in the tray

CAMERA

GALLERY

1:25

[City Locations] - Sydney

Map Sample ID Code Observation details

RELATED ITEMS DRY MATTER MONITORING

Link record to parent

✓ Linked to 'Sydney' from dataset City Locations.

Sample ID Code

Observation details

☐ Collection ☒ Assessment

Durometer firmness (average of 10 fruit)

< >

Date cores removed

Fruit 1 dry matter

Fruit 2 dry matter

Fruit 3 dry matter

Fruit 4 dry matter

Fruit 5 dry matter

Fruit 6 dry matter

Fruit 7 dry matter

Fruit 8 dry matter

Fruit 9 dry matter

Fruit 10 dry matter



Avocado Retail Quality Monitoring Survey

This survey has been designed to help assess the AV19003 Monitoring Avocado Quality at Retail Project (<https://ahr.com.au/avocado>) which has provided feedback to suppliers and retailers on fruit quality over the past 3 years.

Your input is important, and the survey will only take 2-5 minutes.

Your answers will remain confidential.

1. Contact information

Name (optional)

Business name
(optional)

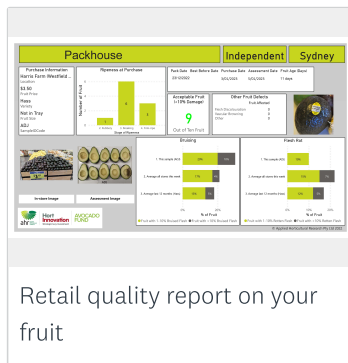
2. In which avocado growing region are you based?

- | | |
|--|---|
| ☐ North Queensland | ☐ Tristate |
| ☐ Central Queensland | ☐ Western Australia |
| ☐ South Queensland | ☐ Other |
| ☐ New South Wales | |

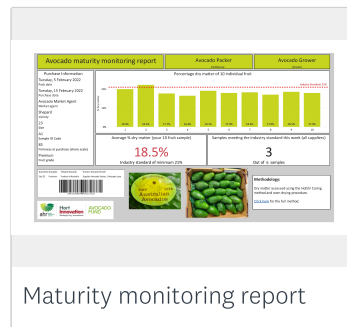
* 3. Which group best describes your role at work?

- ☐ Grower or farm owner/employee
- ☐ Packhouse owner/employee
- ☐ Other

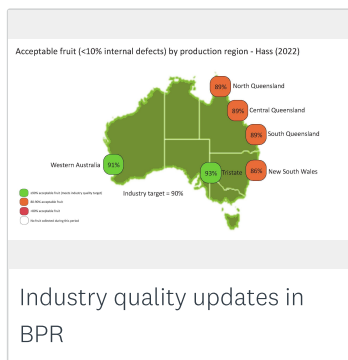
* 4. Have you received or accessed any of the following quality feedback from the project? (click all that apply)



Retail quality report on your fruit



Maturity monitoring report



Industry quality updates in BPR

☐ None of the above

* 5. As a result of feedback provided, are you more aware of your fruit quality at retail, and quality by production region?

	No	Somewhat	Yes
More aware of: your fruit quality	☐	☐	☐
More aware of: fruit quality by production region	☐	☐	☐

* 6. Have you actioned any follow up, or practice changes based on the quality feedback received? Or have you requested changes from supply chain stakeholders who handle your fruit?

- ☐ Yes
- ☐ No

If so, please list these below:

7. What further information or assistance would improve the quality monitoring and feedback provided by this project?

8. Please provide any other comments

Hass defects by growing region (2021-23)

	% fruit with >10% damage				
Growing region	Bruising	Body rot	Stem-end rot	Vasc. browning	Flesh disc.
North Qld	7.8%	2.2%	0.5%	2.5%	1.2%
Central Qld	6.3%	2.9%	0.1%	0.8%	1.5%
South Qld	7.4%	2.8%	0.4%	2.4%	3.1%
NSW	12.1%	3.9%	1.6%	1.3%	1.6%
Tristate	4.1%	1.6%	0.7%	1.2%	2.7%
WA	4.0%	2.5%	0.8%	1.2%	0.9%

Shepard defects by growing region (2021-23)

	% fruit with >10% damage				
Growing region	Bruising	Body rot	Stem-end rot	Vasc. browning	Flesh disc.
North Qld	0.60%	0.44%	0.71%	0.27%	0.77%
Central Qld	0.79%	0.00%	0.26%	0.00%	0.26%

Avocado samples collected at retail from May 2020 to March 2023

Event number	Sampling date	City	No.10 fruit samples collected
1	19/05/2020	Sydney	16
2	26/05/2020	Sydney	6
3	28/05/2020	Brisbane	9
4	2/06/2020	Perth	10
5	9/06/2020	Melbourne	13
6	23/06/2020	Sydney	17
7	2/07/2020	Brisbane	11
8	7/07/2020	Melbourne	12
9	21/07/2020	Perth	10
10	28/07/2020	Sydney	17
11	11/08/2020	Sydney	17
12	20/08/2020	Brisbane	11
13	25/08/2020	Sydney	18
14	1/09/2020	Perth	10
15	8/09/2020	Sydney	16
16	17/09/2020	Brisbane	11
17	22/09/2020	Sydney	18
18	29/09/2020	Perth	10
19	13/10/2020	Sydney	18
20	20/10/2020	Perth	9
21	29/10/2020	Brisbane	11
22	2/11/2020	Melbourne	12
23	10/11/2020	Adelaide	10
24	17/11/2020	Sydney	18
25	24/11/2020	Perth	10
26	30/11/2020	Melbourne	13
27	10/12/2020	Brisbane	10
28	4/01/2021	Melbourne	13
29	12/01/2021	Perth	10
30	18/01/2021	Sydney	16
31	25/01/2021	Melbourne	12
32	4/02/2021	Brisbane	10
33	9/02/2021	Sydney	16
34	16/02/2021	Adelaide	10
35	22/02/2021	Melbourne	12
36	2/03/2021	Sydney	15
37	11/03/2021	Brisbane	11
38	16/03/2021	Perth	10
39	23/03/2021	Melbourne	13
40	6/04/2021	Sydney	16
41	15/04/2021	Brisbane	11

Event number	Sampling date	City	No.10 fruit samples collected
42	20/04/2021	Melbourne	12
43	4/05/2021	Perth	9
44	10/05/2021	Sydney	16
45	20/05/2021	Brisbane	11
46	10/06/2021	Brisbane	11
47	15/06/2021	Sydney	16
48	28/06/2021	Melbourne	12
49	6/07/2021	Perth	10
50	12/07/2021	Adelaide	10
51	2/08/2021	Melbourne	11
52	23/08/2021	Brisbane	11
53	24/08/2021	Perth	10
54	7/09/2021	Perth	10
55	28/09/2021	Perth	10
56	11/10/2021	Brisbane	11
57	11/10/2021	Sydney	16
58	12/10/2021	Perth	10
59	25/10/2021	Melbourne	11
60	1/11/2021	Sydney	11
61	8/11/2021	Sydney	9
62	16/11/2021	Perth	10
63	22/11/2021	Melbourne	11
64	30/11/2021	Sydney	14
65	6/12/2021	Brisbane	11
66	11/12/2021	Adelaide	9
67	14/12/2021	Melbourne	12
68	4/01/2022	Sydney	16
69	11/01/2022	Brisbane	11
70	11/01/2022	Perth	10
71	24/01/2022	Sydney	14
72	31/01/2022	Melbourne	11
73	22/02/2022	Sydney	14
74	28/02/2022	Melbourne	12
75	7/03/2022	Sydney	15
76	14/03/2022	Brisbane	11
77	22/03/2022	Perth	10
78	28/03/2022	Melbourne	14
79	4/04/2022	Sydney	14
80	11/04/2022	Sydney	16
81	19/04/2022	Brisbane	11
82	26/04/2022	Melbourne	13
83	3/05/2022	Perth	10
84	9/05/2022	Sydney	15

Event number	Sampling date	City	No.10 fruit samples collected
85	16/05/2022	Sydney	15
86	17/05/2022	Brisbane	11
87	30/05/2022	Melbourne	13
88	31/05/2022	Perth	10
89	6/06/2022	Brisbane	10
90	14/06/2022	Perth	10
91	14/06/2022	Sydney	15
92	27/06/2022	Melbourne	13
93	11/07/2022	Brisbane	11
94	12/07/2022	Perth	10
95	18/07/2022	Sydney	9
96	26/07/2022	Melbourne	13
97	1/08/2022	Sydney	13
98	8/08/2022	Brisbane	11
99	16/08/2022	Perth	10
100	22/08/2022	Sydney	16
101	29/08/2022	Melbourne	13
102	5/09/2022	Sydney	16
103	12/09/2022	Brisbane	11
104	26/09/2022	Melbourne	13
105	4/10/2022	Sydney	16
106	11/10/2022	Perth	10
107	17/10/2022	Sydney	16
108	24/10/2022	Adelaide	10
109	24/10/2022	Melbourne	13
110	31/10/2022	Brisbane	11
111	14/11/2022	Brisbane	11
112	15/11/2022	Perth	10
113	21/11/2022	Sydney	16
114	29/11/2022	Melbourne	13
115	5/12/2022	Sydney	15
116	12/12/2022	Melbourne	13
117	3/01/2023	Sydney	15
118	10/01/2023	Perth	10
119	16/01/2023	Sydney	16
120	23/01/2023	Brisbane	11
121	6/02/2023	Sydney	13
122	20/02/2023	Sydney	16
123	28/02/2023	Melbourne	11
124	6/03/2023	Melbourne	13
125	7/03/2023	Sydney	15

Total **1,546** **10-fruit samples**
15,460 **individual fruit**

Maturity monitoring samples collected from the Sydney markets between February 2022 and March 2023.

Event number	Sampling date	No. trays collected
1	8/02/2022	6
2	15/02/2022	(no fruit available) 0
3	21/02/2022	9
4	8/03/2022	14
5	22/03/2022	12
6	5/04/2022	16
7	26/04/2022	2
8	3/05/2022	3
9	10/05/2022	14
10	30/05/2022	17
11	21/06/2022	14
12	11/07/2022	14
13	8/08/2022	16
14	6/09/2022	13
15	10/10/2022	11
16	31/10/2022	9
17	12/12/2022	9
18	24/01/2023	6
19	8/02/2023	9
20	13/02/2023	8
21	21/02/2023	9
22	8/03/2023	15

Total 226



Retailer 'A' avocado quality monitoring results July 2021 – October 2021

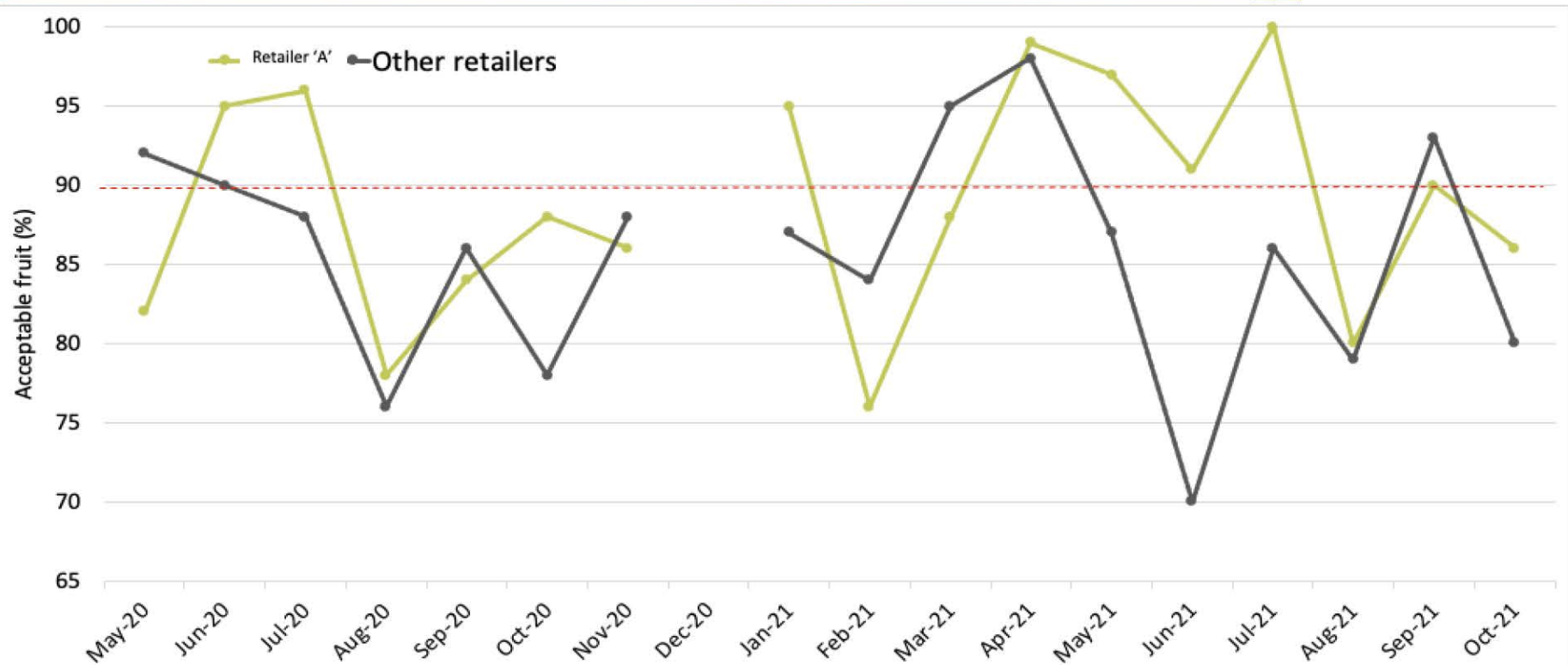


Method



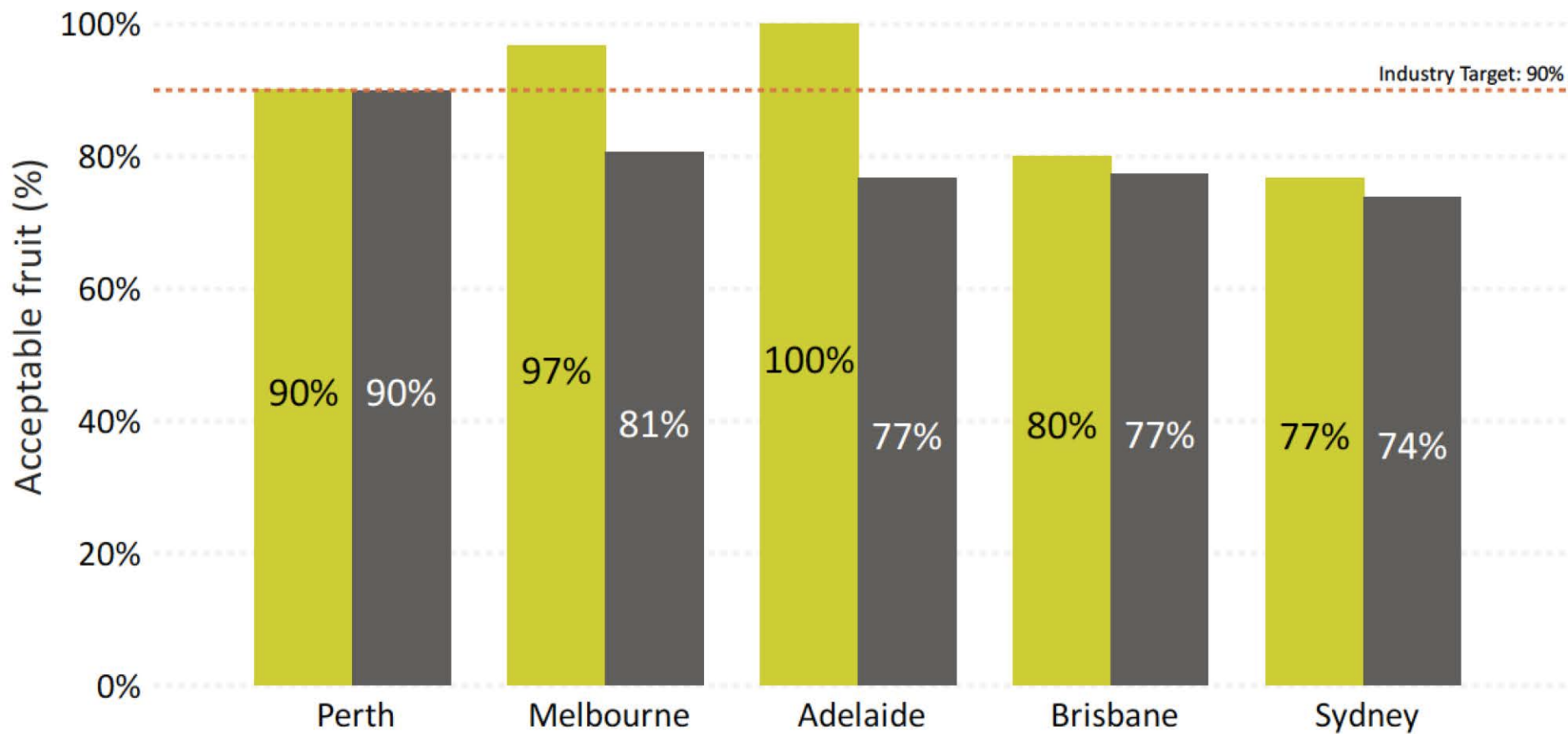
- Sampling in Sydney, Brisbane, Melbourne, Perth, and Adelaide
- A sample of 10 fruit are randomly selected from the display, all from a single supplier/brand
- Assessment of display, and tray label details recorded
- Firmness at purchase: fruit returned to laboratory, and on the same day, firmness measurements taken using a Turoi durometer
- Fruit held for at least 24hrs from time of purchase, or longer until the average of the 10 fruit reaches stage 5 ripe
- Fruit halved and photographed
- Fruit quartered, skin removed and assessed for rots, bruising, vascular browning, and flesh discolouration
- Damaged and non-damaged flesh weighed, and percentage damage is calculated

Acceptable fruit by month



Acceptable fruit by city - Jul '21 - Oct '21

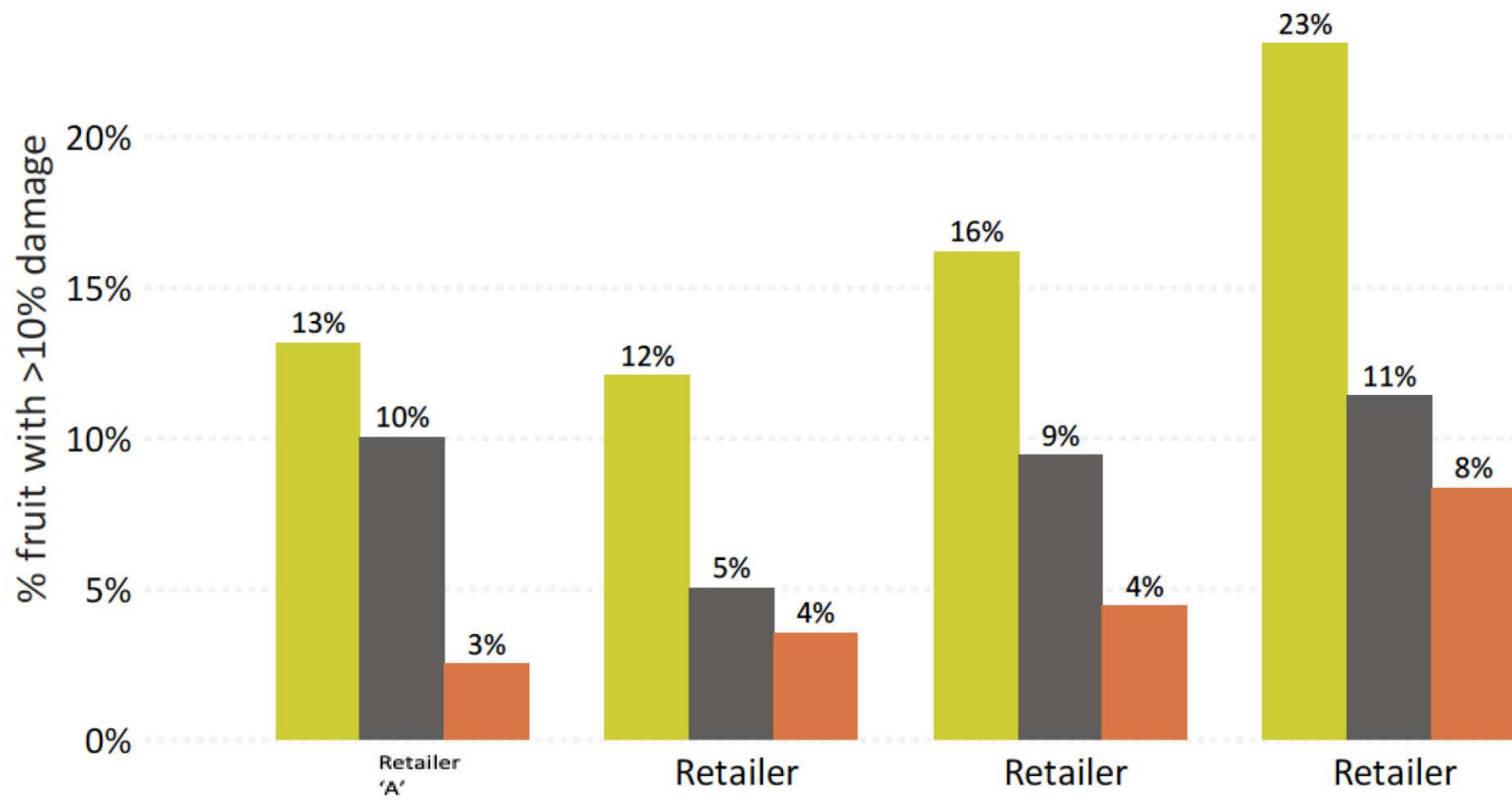
● Retailer 'A' ● b) Other retailers





Major defects by retailer - Jul '21 - Oct '21

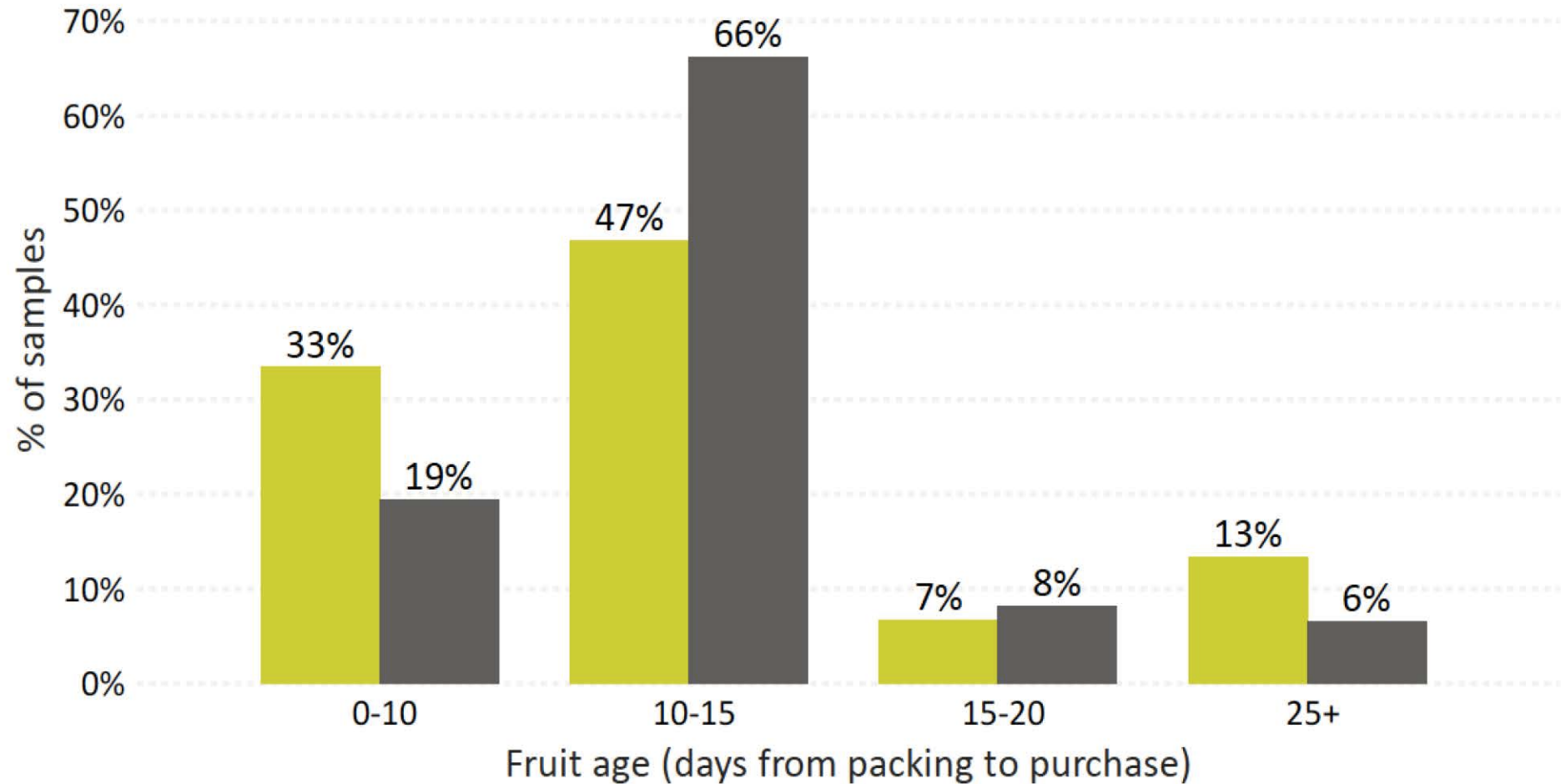
● Total unacceptable fruit ● Bruising ● Rots



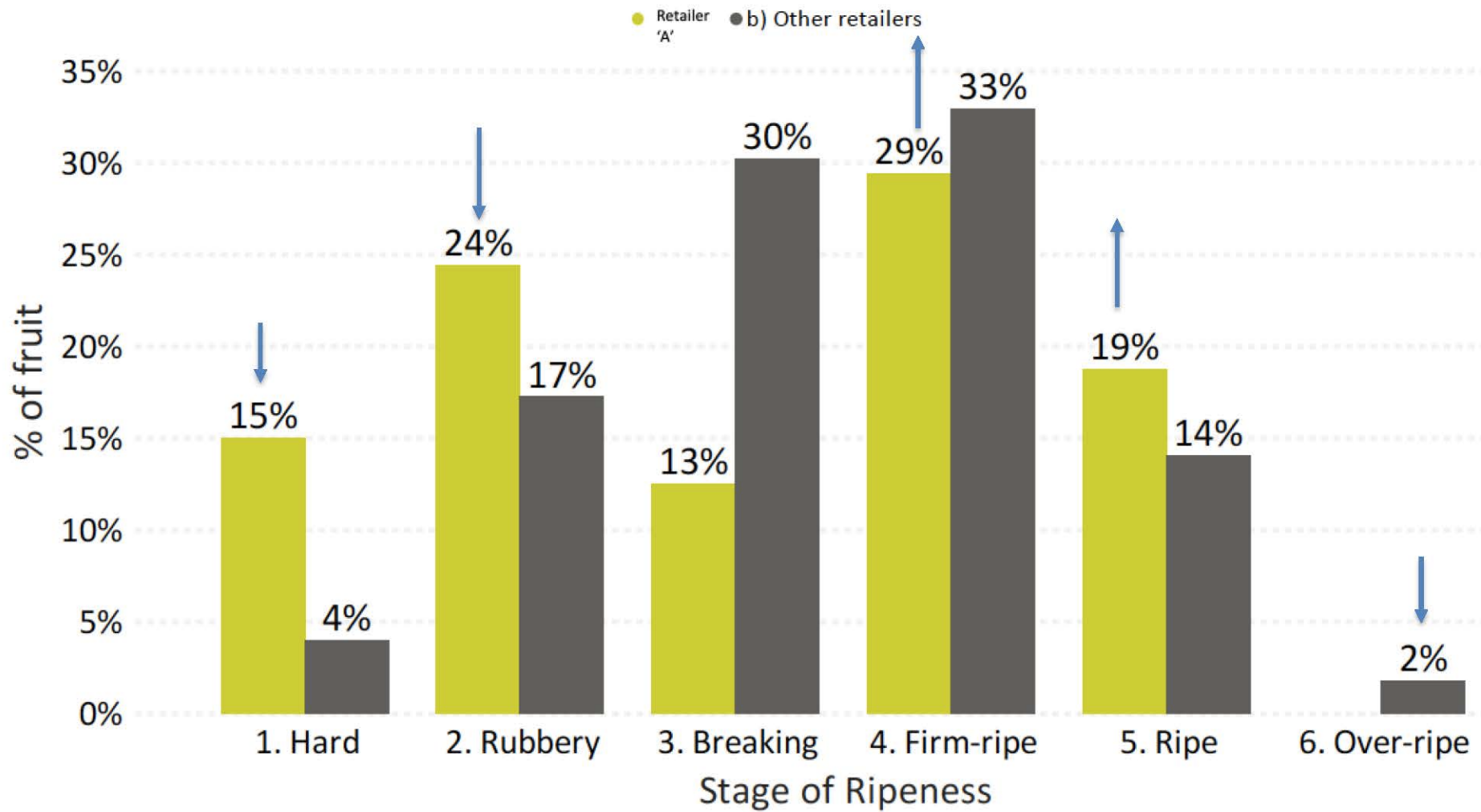


Fruit age at purchase - Jul '21 - Oct '21

Retailer
a) 'A' b) Other retailers



Ripeness stage at purchase - Jul '21 - Oct '21



Fruit quality by store May 2020 – Oct 2021

Store	Acceptable fruit (%) □	Bruising (% fruit with >10% bruise)	Rots (% fruit with >10% rot)	Fruit age (avg days from packing to retail)	Fruit layers on display	Ripeness at purchase (avg stage)
Acacia Ridge	97%	2%	2%	17	1	3.3
Westfield Teatree	93%	0%	7%	19	1	3.6
Top Ryde	92%	6%	1%	15	1	2.7
Dandenong Plaza	92%	5%	3%	12	1	3.3
Cannington	91%	4%	5%	13	1	4.4
Waverley Gardens	91%	3%	7%	14	1	3.0
Bondi Junction	85%	9%	6%	14	3	2.6
Westfield Carindale	82%	9%	7%	20	1	4.0
Roselands Shopping	79%	10%	7%	16	1	2.6
Average	88%	6%	5%	15	1	3.2

Acknowledgement

**Hort
Innovation**
Strategic levy investment

**AVOCADO
FUND**

This project has been funded by Hort Innovation using the avocado research and development levy and funds from the Australian Government. For more information on the fund and strategic levy investment visit horticulture.com.au



RESEARCH AND DEVELOPMENT

Monitoring avocado quality in retail

Adam Goldwater, Applied Horticultural Research

Australian avocado production and consumption continues to climb year on year, but what does this mean for stakeholders? For a fresh produce category to grow, consumers need confidence and positive experiences of fruit purchases that meet their expectations.

Fruit quality is one of the biggest issues currently facing the avocado industry. Domestic consumption of avocados needs to increase significantly during the next four to five years. Why? To meet increasing supply based on current plantings.

At the same time, imports of avocados have been increasing (from New Zealand), and Chile now has access to the Australian market. Customer satisfaction with Australian avocados is therefore critical to increase sales.

Surveys of avocado quality undertaken by Avocados Australia from 2011 to 2015 found 20-25% of fruit in stores had unacceptable levels of bruising, internal rots, or other disorders. Poor fruit quality reduces consumer satisfaction and sales. The avocado industry continues investing to improve fruit quality, and this project will help measure the effectiveness of those investments.

During the next three years, Applied Horticultural Research (AHR) will be funded via the Hort Innovation Avocado Fund to measure avocado fruit quality nationally at supermarkets, independent fruit stores and speciality retailers.

What to expect from the project

Regular assessments are planned for retailers in Sydney, Melbourne, Brisbane, Perth and Adelaide (at the same stores each time to reduce variability). The timing of sample collections will be staggered so that the industry receives feedback from at least one location nearly every week throughout the year, capturing change of supply regions.

Hass and Shepard avocados will be purchased from retail displays, as presented to consumers. The quality of store displays will be assessed, and fruit supplier details, including pack-date will be recorded. Fruit samples will then be returned to the laboratory for assessment of firmness, dry matter, bruising, rots and other internal defects.

Wherever possible, sampling will include as many different packhouses as can be sourced from the targeted retailers on each sampling event.

INTERMERCATO GRAPPLES 
High performance grabs, grapples and rotators for Forestry, Transport, Construction and Recycling



Selective limb removal pruning shears

Cameron Moir
(Sales and Support)
0417 669 707

1300 88 21 61
sales@grapples.com.au
www.grapples.com.au

Stakeholder benefits

Rapid feedback to growers, packers, retailers and marketing groups will provide real-time reports on fruit quality at retail. This continuous feedback mechanism will enable problems to be addressed to help improve the quality of avocados.

Reports will be tailored to specific stakeholder groups, and where possible, results will be confidentially benchmarked against other suppliers, growers and retailers, providing a ranking for the season.

The project will provide an objective measure of how well the industry is tracking on their mission to improve the consumer eating experience of avocados.

Where to find results

Sampling will commence once COVID-19 related restrictions are lifted, and non-essential work activities can resume.

Regular communication and updates with de-identified results will appear via the Avocados Australia website. Keep an eye out for ongoing findings from the project in *Talking Avocados* magazine, as well as *Guacamole* newsletter.

Confidential reports will be emailed to specific stakeholder groups.

AHR will participate in extension field days and industry events, presenting findings with a strong focus on specific regional issues.

More information

Adam Goldwater, Applied Horticultural Research (AHR), 0466 080 693 or adam.goldwater@ahr.com.au.

Acknowledgement

The *Monitoring avocado quality in retail* (AV19003) project has been funded by Hort Innovation, using the avocado research and development levy, and contributions from the Australian Government.

**Hort
Innovation**
Strategic levy investment

**AVOCADO
FUND**





agrisilica

SILICON FERTILISER

the stress relief nutrient

You are losing Yield before you see it.



What's your Soil's Plant Available Silica levels?

- May increase nutrient uptake & reduces nutrient losses from leaching
- May increase crop performance in dry & saline conditions
- May increase crops cell wall strength & stimulate plant health
- Improves structure of soil
- Reduces the toxic effect of excess soil aluminium, chlorides & cadmium
- Approved for use in Organic Agriculture
- Available in a 2-5mm granule. Blendable with other granular fertilisers

0438 954 500
vic@agripower.com.au
www.agripower.com.au
Contact us for Trial Data Results, Sales & more information.

NEWS

— General News —

Retail avocado quality monitoring: first results

By Adam Goldwater, AHR

The project team for AV19003 has now been sampling and assessing avocados from retail stores in Brisbane, Sydney, Melbourne and Perth for nearly five months.

A total of 2,060 (206 x 10-fruit samples) fruit were assessed as of the end of September 2020, covering 32 Australian suppliers of Hass avocados and purchased from 51 different retail stores.

Many Australian suppliers will now be familiar with the snapshot quality reports which have been emailed out to them the week following sample collection. A similar report (without supplier details) is provided to retailers, and reports for the wider industry have now been added to the Best Practice Resource, in the Retail section (avocado.org.au/bpr/).

Industry close to the target

The good news is that the industry met, or was very close to meeting, their target of 90% acceptable fruit in three out of the five months the project has been running (Figure 1). Unfortunately, quality slipped in August and September. This was a time when retail prices rose, and supply began to shift

from Northern New South Wales, Central Queensland and Southern Queensland to the Tristate, Western Australia and New Zealand.

Bruising accounted for the majority of the decline in acceptable fruit in August 2020. This could be an indirect effect of increased prices, as customers squeezed more fruit searching for that perfect, precious avocado.

Improvements have been made since 2015

The last avocado retail quality monitoring project (AV11015) finished up in 2015. The project concluded that from 2012 to 2015 the average percentage of acceptable Hass avocados (less than 10% internal defects at retail) was 79%. This meant that consumers were dissatisfied with quality of at least one avocado for every five they purchased – hardly a way to encourage sales.

The industry set a target of halving this level of unacceptable fruit, reducing it to no more than 10%. To achieve this, the industry has invested significantly in improving management of production, harvesting, packing, cooling and transporting, including the current Hort Innovation project, *Implementing best practice of avocado fruit management and handling practices from farm to ripening* (AV18000).

This raises the question, “have these investments in quality improvement paid off?”

The good news is that the average percentage of acceptable fruit rose to 86% for the five months to September 2020. While this is promising, it will be good to see the more complete results after 12 months of monitoring, in order to cover all growing regions and times of year.

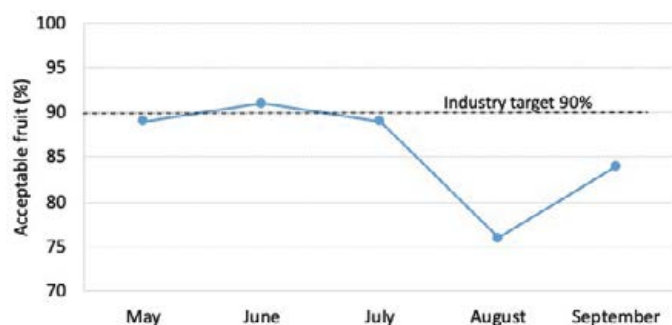


Figure 1. Percentage acceptable fruit (less than 10% internal defects) at retail for Australian grown Hass avocados from May 2020 to September 2020.

Most suppliers meeting target

Initial project findings suggest that many suppliers are following best practice guidelines, meeting or exceeding the industry target of 90% acceptable fruit. However, three suppliers were well below that target. This is what reduced the overall industry average to 86% acceptable fruit (Figure 2).

Those three suppliers were from different growing regions, so issues with fruit quality do not relate to local growing conditions. The results could be due to any issues from production right through to the retail shelf. For example, it could be that these fruits are staying in the supply chain too long, or they are not being correctly ripened or stored at the correct temperature. This project is closely aligned with AV18000, which is providing support to supply chain members to make improvements.

Bruising remains the major issue

As found previously, bruising remains the main quality problem at retail. From July to September 2020, more than half of the unacceptable fruit were bruised, while flesh rots (body rots and stem-end rots combined) accounted for 29% of unacceptable fruit (Figure 3).

The level of bruising measured in recent months is similar to that reported between 2012 and 2015 (AV11015). It is most likely that much of this is happening at retail.

Previous projects have demonstrated that consumers squeeze more fruit if avocados are \$4.99 compared to when they are \$2.99. They will also squeeze more fruit if consistently ripe fruit are not available. Through this project, major retailers are being sent regular reports on fruit quality in their stores, and are using these to improve the practices within their control, to help reduce bruising and other defects.

The main reason we are seeing an improvement in acceptable fruit this year compared to 2012-15 is the reduction in rots

and vascular browning. This could be a result of better pre and post-harvest disease management, as well as cool chain control. It will be interesting to see if this trend continues going forward.

Work to do

In summary, the results so far indicate that most avocado supply chain members are doing a good job, and that quality has improved since 2015. However, there is still work to do, particularly in terms of understanding the high level of damage observed within a relatively small number of supply chains.

More detailed and regularly updated industry quality reports are available in the Avocados Australia Best Practice Resource in the Retail section, under Retail Quality.

So what happens to results from here?

Results will be updated monthly on the Avocados Australia website for industry to understand how quality is tracking across growing regions and retailers to empower adoption of industry best practice throughout the supply chain. Details on how to access and understand data will be communicated via industry channels. Additionally, results will be reviewed with major retailers and Avocados Australia to support improvements at retail point of sale.

More information

For further details, please contact Adam Goldwater at Applied Horticultural Research (AHR) on 0466 080 693 or adam.goldwater@ahr.com.au.

Once you are logged into the Best Practice Resource, you can find the monthly retail quality reports in the Retail section of the BPR: avocado.org.au/bpr/.

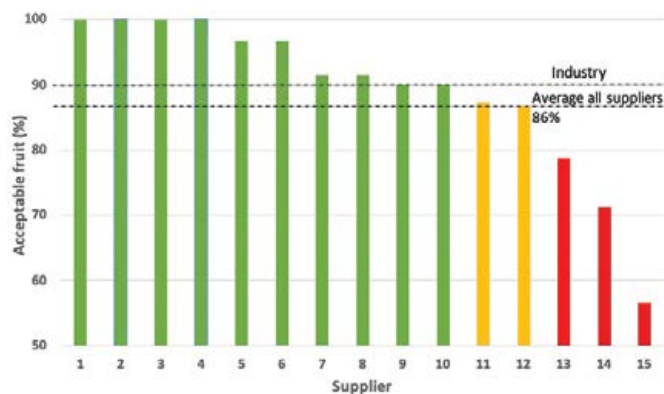


Figure 2. Percentage acceptable fruit (less than 10% internal defects) from Australian suppliers during May 2020 to September 2020. Based on 165 lots of 10-fruit samples collected at retail in Brisbane, Sydney, Melbourne and Perth; numbers of samples vary across suppliers.

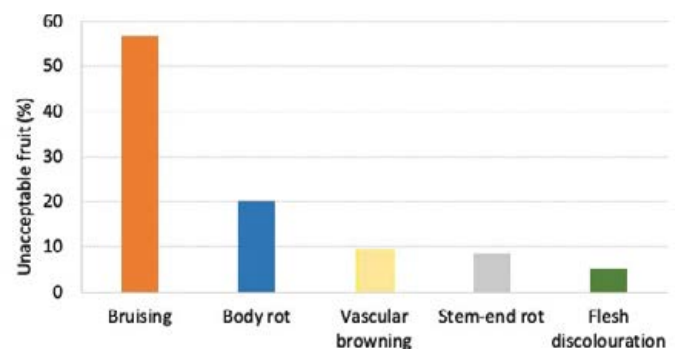


Figure 3. Reason fruit was unacceptable (more than 10% of flesh damaged at retail) in Australian supplied Hass avocados purchased between May and September 2020.

Acknowledgement

The *Monitoring avocado quality in retail* (AV19003) project has been funded by Hort Innovation, using the avocado research and development levy, and contributions from the Australian Government.



AVOCADO
FUND

The *Monitoring avocado quality in retail* (AV19003) project is conducting regular assessments at supermarkets, independent and specialty retailers in Sydney, Melbourne, Brisbane, Perth and Adelaide over three years – providing some 600 separate quality assessments each year. Passing on quality information on specific batches of fruit to packhouses is intended to help businesses identify improvement opportunities and help address any inefficiencies or issues in their operations. De-identified data from the sampling is also being analysed to monitor industry performance on the whole.

In each city, trained retail staff visit a range of major and independent retail stores within a day. Where multiple avocados are present within the store, they identify the largest display and record information such as price, display method and number of layers of fruit stacked on the display. Ten fruit are selected from a single supplier/batch based on the fruit label. Where fruit is taken from a tray that matches the fruit label supplier/brand, the tray label details are recorded. Fruit are selected randomly using a transect approach across a loose display, or randomly from three separate trays, depending on the method of display.

Fruit are purchased, and placed in avocados trays, and transported back to the laboratory. On the same day, firmness measurements are taken using the Turodurometer (two readings per fruit) to provide an indication of firmness of fruit at purchase.

Fruit are then held at ambient temperatures for 24 hours from the time of purchase, or once the average of the 10-fruit samples reaches stage 5 ripe. The sample is then ready for assessment, and fruit are halved and photographed. The fruit is quartered, skin removed, and defects including flesh rots, bruising, vascular browning and flesh discolouration identified. The percentage damage in each fruit is then calculated by separating and weighing each type of damage, as well as good flesh.

Nutrient-Rich Compost



**Organically certified
and Freshcare compliant.**

- Grassdale Fertilisers' state-of-the-art operation produces nutrient-rich, manure-based compost.
- Rich in humic acid and labile carbon.
- Screened for ease of handling and composted aerobically to stabilise and improve nutrient availability.

**Grassdale
FERTILISERS**

Contact Brad Smith on 0419 757 203
or brad@grassdalefert.com.au

www.grassdalefert.com.au

2006106

Monitoring avocado quality at retail – data mining

Adam Goldwater, *Applied Horticultural Research*

The project team for AV19003 has now been sampling and assessing avocados from retail stores since May 2020. More than 300 store visits have resulted in the purchase of 3,280 avocados. After measuring initial firmness, these have been ripened, halved, photographed, peeled and then the amount of rotten/bruised/discoloured flesh scooped and weighed.

What this means is that we are accumulating a rich and detailed wonderland of data.

Although still short of the one-year mark, we can already start to see some really interesting relationships between the various factors that affect quality at retail. The monthly reports can be found in the Retail module of the BPR: avocado.org.au/bpr/.

Avocados don't get better with age

It is well established that fruit are more likely to develop rots as storage time from harvest increases. However, our assessments have found a link that is tenuous at best (Figure 1). Adding a trendline to the data indicates that rots and disorders such as flesh discolouration and vascular browning tend to increase once fruit is more than 25 days old. But, there are exceptions; some 30-day-old samples were completely clean, while others that were less than 15 days old had 30% of fruit with major defects. For example, although it generally takes 24 to 27 days for imported New Zealand fruit to reach retail shelves, many were just as good as local fruit.

What this likely shows is that how WELL fruit is grown and stored is just as important as how LONG it has been stored.

But they do get better with maturity

Approximately 13% of the 1,550 Hass avocados tested for maturity contained less than the minimum 23% dry matter. One of the findings from AV15009 (D. Joyce et al., 2018) was that less mature fruit are more susceptible to bruising. While variability in our data means differences are not statistically significant, there is a trend to increased bruising in batches of fruit with less than 25% dry matter.

Bruising – the big issue

Interestingly, the amount of fruit on the display had one of the biggest impacts on bruising; major bruising (>10% flesh) nearly doubled when fruit was more than two layers deep on the display, compared to when it was one or two layers deep. This may reflect increased “rummaging” by customers, or poor fruit rotation on an overloaded display. Certainly, this is something for retailers to consider!

Another finding from a previous project (AV15011) was that consumers squeeze

up to twice as many fruit if it is hard to find one at the ripeness they want.

Our data so far supports this, in that there does appear to be an increase in bruising when fruit are displayed at a firmer stage of ripeness (durometer >70) or ready to eat (durometer <50) compared to those displayed firm-ripe (durometer 50-60). Fruit that are already soft when displayed are clearly more susceptible to bruising damage. Hard fruit may be more bruised due to customers trying to find the ripeness stage they want, as well as the increased time between purchase and assessment while we wait for the fruit to ripen.

In search of a perfect avocado

Another interesting finding is that rots and disorders vary in fruit from different growing regions. This is hardly surprising given the range of different climates where avocados are grown, as well as the abnormal weather encountered over the last 12 months.

During February and March of 2020,

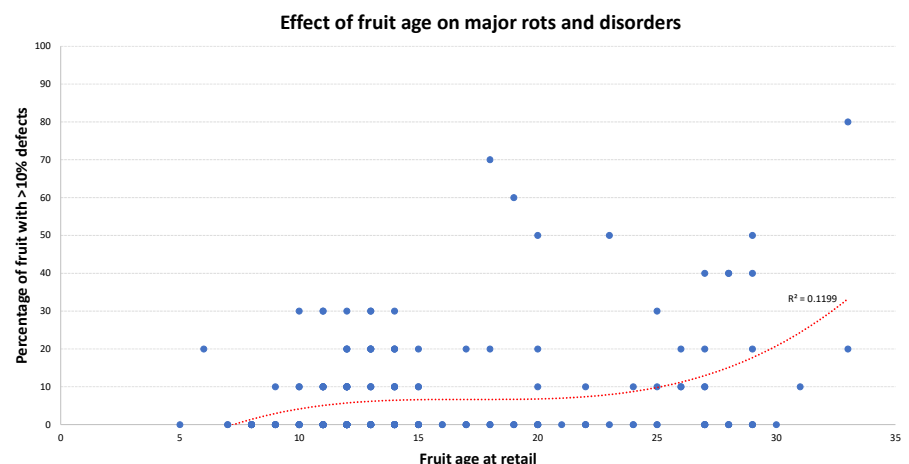


Figure 1. The effect of fruit age at retail on the percentage of fruit with a major rot, flesh discolouration, or vascular browning (>10% of flesh affected) when ripe. Each symbol is a batch of ten fruit; red line indicates a trend line plotted to the data ($R^2=0.12$).

growing regions of NSW experienced extreme heavy rains, while New Zealand not only had a wet winter, but also significant rain during November. This is likely to relate to the higher proportion of fruit with body or stem-end rots from these regions compared to the drier climates of Tristate and Western Australia. While North Queensland also had high rainfall from January to March, this was not unusual, however, and it appears that rots were well managed.

Vascular browning and discoloured flesh were highly variable. While a high percentage of fruit from South Queensland and Tristate had these disorders, this was based on a limited number of samples (13 and 12 respectively), of which two samples were almost completely unacceptable. This variability is demonstrated by the large error bars attached to this data (Figure 4, on page 19). Further sampling will help establish whether this is an “outlier” result or reflects a real issue within these growing regions.

Although the project has not yet had its first birthday, a treasure trove of data has already been collected. As we continue to assess and analyse, we will gain further insights into factors affecting fruit quality, including fruit age, maturity and regional variation. It will also guide ways to optimise displays so as to reduce fruit damage. In conclusion, Watch this Space – *more coming soon...*

More information

For further details, please contact Adam Goldwater at Applied Horticultural Research (AHR) on 0466 080 693 or adam.goldwater@ahr.com.au.

Once you are logged into the Best Practice Resource, you can find the monthly retail quality reports in the Retail module of the BPR: avocado.org.au/bpr/.

Acknowledgement

The *Monitoring avocado quality in retail* (AV19003) project has been funded by Hort Innovation, using the avocado research and development levy, and contributions from the Australian Government.

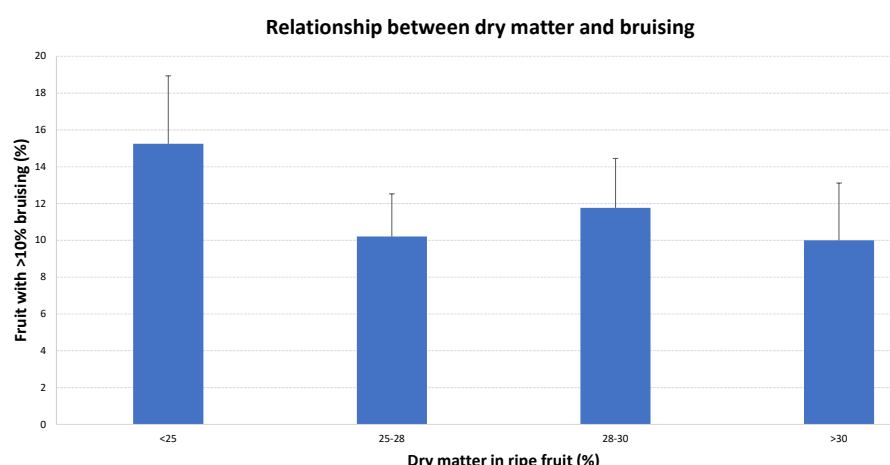


Figure 2. Relationship between average dry matter/batch of 10 fruit and percentage of fruit with major bruising. Bars indicate the standard error of each mean value.

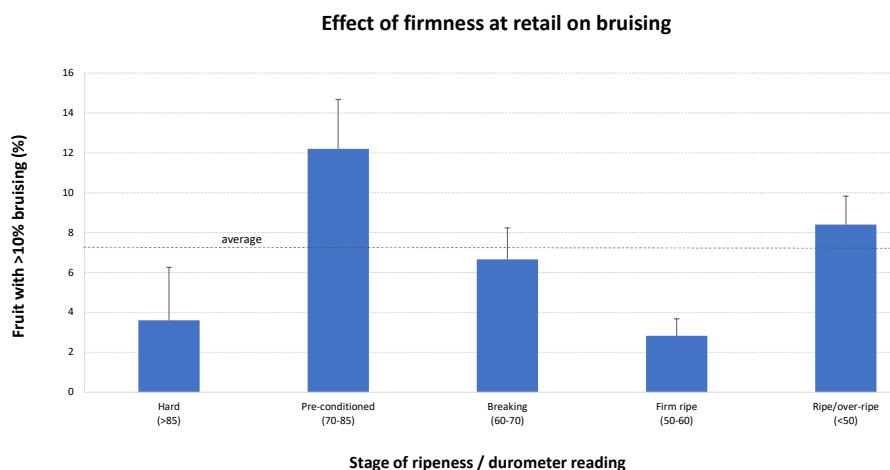
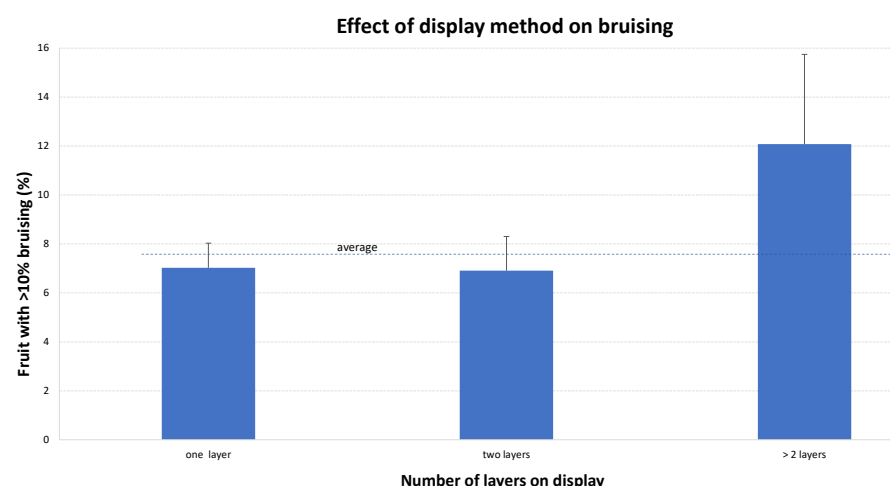


Figure 3. Effect of display method (left) and firmness at purchase (right) on the percentage of fruit with >10% bruising. Bars indicate the standard error of each mean value.

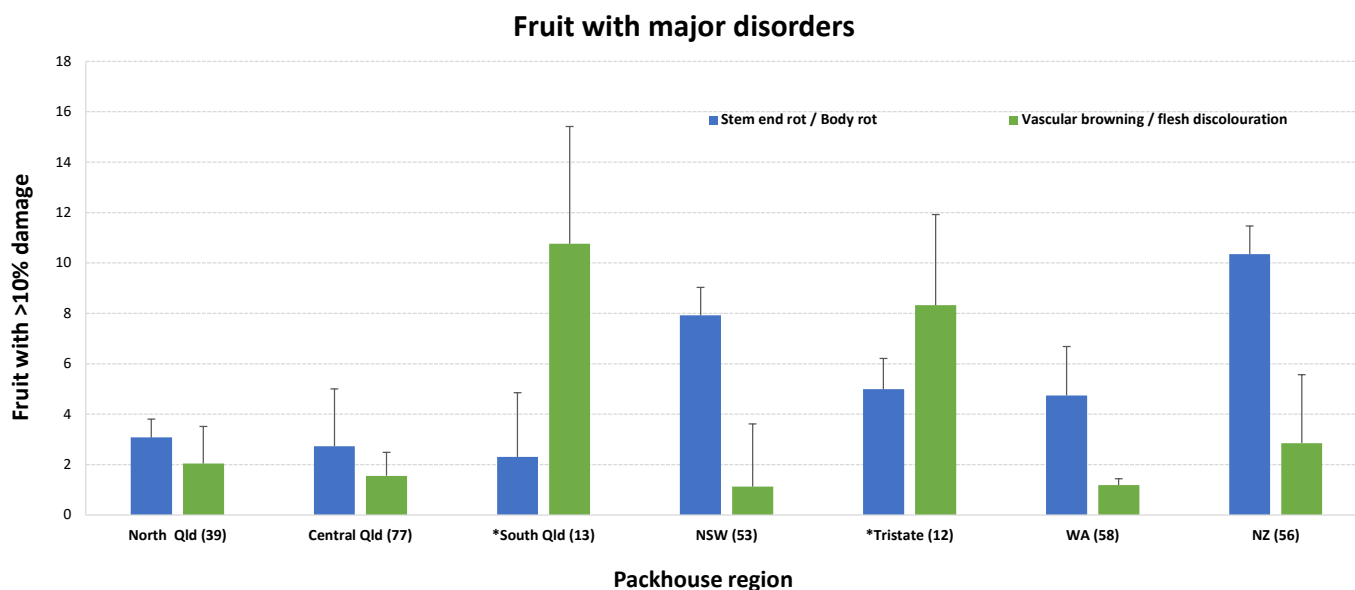


Figure 4. Average percentage of fruit with more than 10% of flesh affected by a stem end or body rot, or vascular browning/discoloured flesh. Bars indicate the standard error of each mean value. Numbers in brackets indicates the number of 10-fruit samples collected for each growing region. *South Qld and Tristate averages are based on a limited number of samples.

**Hort
Innovation**
Strategic levy investment

**AVOCADO
FUND**

We are your PREFERRED link to Sydney's local and country grocers, providores, the famous Paddy's Markets and export.

With 18 years experience we market all varieties of Australian Avocados all year round.

Communication is key, we provide quick returns and payments

We specialise in providing fruit specifically ripened to our customers needs.

Phil's Preferred Fruit Pty Ltd
Stand 202 - 203 C Shed
Sydney Markets
E: info@preferredfruit.com.au
M: 0416 229 505
P: (02) 9763 2399
F: (02) 9325 6009

WE ARE PREFERRED FRUIT.

@PREFERREDFRUIT
 @PREFERRED_FRUIT

Durometer firmness measurements result in minimal bruising

Adam Goldwater, Applied Horticultural Research

Avocados are easily bruised when ripe, and the retail quality monitoring team take a number of steps to avoid any damage to fruit after retail purchase. Firstly, handling is minimised by carefully placing the fruit into avocado trays when purchased, and fruit are kept in those trays until the time of assessment.

Fruit firmness measurements are made on the day of purchase using a Turoi durometer (Figure 1). Although this is a non-destructive measurement, flesh could potentially be damaged when the small durometer tip is pressed into the fruit. After firmness measurement, fruit are held at ambient for a minimum of 24 hours from purchase, or until they reach stage 5 ripe, allowing enough time for any bruising to develop. To be sure that bruising measured in the project is not caused by the durometer measurements, a small trial was conducted to check what damage, if any, the durometer causes.

Forty fruit from a single supplier were purchased at retail. Half of the fruit were assessed with the durometer, and fruit skin marked where the readings were taken. No firmness measurements were made on the remaining half of the fruit. All fruit were held at ambient for 48 hours before cutting along the firmness assessment sites to check for bruising.

When fruit were cut open, very minor bruising was recorded from approximately 40% of the firmness measurement sites. In most cases, the amount of bruised flesh caused by the durometer was so little (less than 0.5g) it would account for less than 0.5% of total flesh weight and would not be recorded in the normal sampling process. This was far less than the level of bruising identified in some fruit which had not had firmness measurements, presumably the result of handling at retail (Figure 2).

Approximately 20% of more than 3,000 fruit sampled in 2020 had no bruising at all, while bruises that are present may be on any part of the fruit, not just the equator.

This further suggests that firmness measurements are not causing significant flesh bruising. Nonetheless, the sampling team regularly monitor for damage caused by the durometer, particularly in soft or lower dry matter fruit that are more susceptible to bruising.

Although the durometer can cause very slight flesh damage, it is the best option we currently have for a 'non-destructive' objective measure of firmness. Firmness measurements provide the retailers with an indication of fruit firmness in their stores and allows for correlations of fruit firmness with internal quality. The major retailers agree that this information is useful, and both the major retailers and project reference group support the continuation of these firmness measurements.

Acknowledgement

The *Monitoring avocado quality in retail* (AV19003) project has been funded by Hort Innovation, using the avocado research and development levy, and contributions from the Australian Government.

**Hort
Innovation**
Strategic levy investment

**AVOCADO
FUND**



Figure 1. Measuring fruit firmness with a Turoi durometer.



Figure 2. Minimal flesh bruising was evident 48 hours after durometer firmness measurements were made (left), whereas severe bruising was found in fruit which had not had any firmness measurements (right), likely the result of handling at retail.

Hass results from the 2020-21 season

Adam Goldwater, Applied Horticultural Research

The avocado retail quality monitoring project (AV19003) has now covered a full season of Hass, from May 2020 to February 2021. Results are positive, with industry making progress towards meeting the target of 90% acceptable fruit (fruit with less than 10% flesh damage).

For the first time since retail quality monitoring commenced (AV11015), acceptable Hass fruit quality reached 86% (May 2020 to February 2021), up from 72% acceptable in 2008 (Figure 1). While this is a great result, it will be necessary to see this trend continue into 2021 and 2022 before we can conclude that an improvement has been made.

Where have the quality improvements been made?

Since 2008/15, improvements have been made in bruising, body rots, and flesh discolouration (Figure 2). Stem end rot and vascular browning levels are similar. We only have one season of data so far in AV19003, and while defect levels are likely to vary considerably between years, these early results suggest that investments in production, supply chain and retail improvements have been successful. Although bruising levels have declined slightly, bruising remains the most significant contributor to damaged fruit at retail.

Quality by country of origin

Quality of Australian Hass avocados narrowly exceeded that of imported fruit (Figure 3). There has been considerable interest and concern about quality of imported fruit, especially since Chile began export of Hass avocados to Australia in 2020. Quality of Chilean fruit was not too dissimilar to Australian fruit, with 84% of Chilean fruit acceptable, compared to 87% of Australian fruit. New Zealand fruit quality was similar to that of Chilean, at 83.5%. This was surprising given

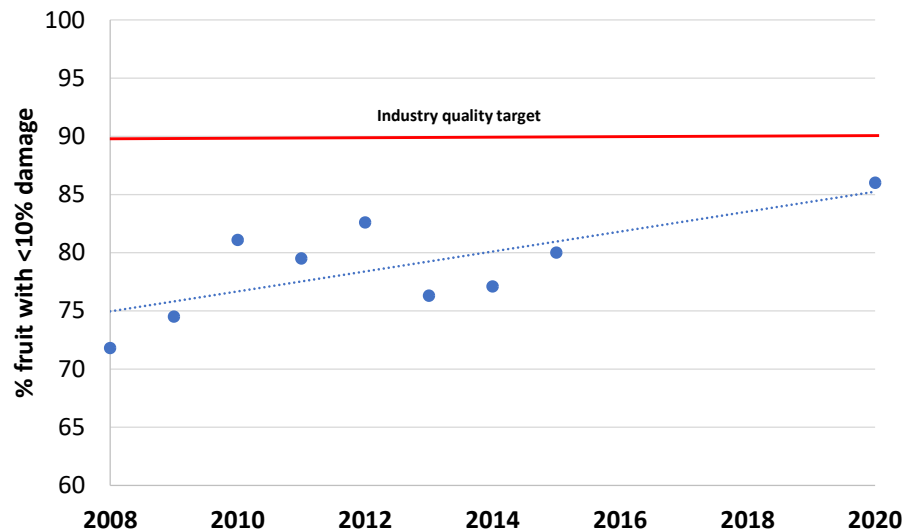


Figure 1. Percentage acceptable Hass fruit in Australian retail stores from 2008 to 2020 (Australian and imported fruit). Datapoints from 2008 to 2015 are from project AV11015, and 2020 data from AV19003.

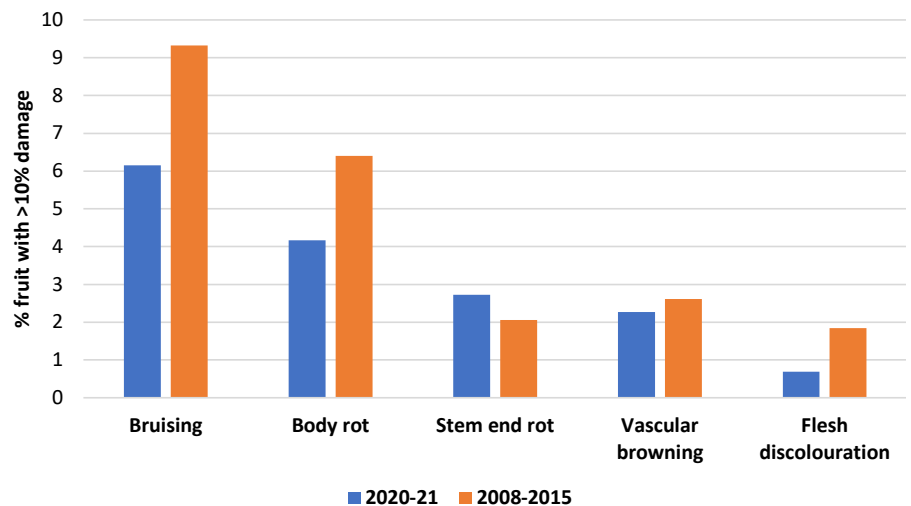


Figure 2. Types of defects causing unacceptable Hass avocados at retail (Australian and imported fruit). Blue columns are May 2020–February 2021 data from AV19003, while orange columns show average data during 2008 to 2015 from AV11015 (Avocados Australia).

that some Chilean fruit we assessed was packed at least 40 days prior to purchase at retail. This result reiterates the importance of the Australian industry's continued focus on quality improvement, in order to remain the preferred supplier over imported product.

Quality by growing region

Western Australia took out the prize for best Hass avocado quality for 2020/21 with 93% of fruit acceptable to consumers. Not far behind was North Queensland, also exceeding the industry target of 90%. Central Queensland and Tristate were not far off the 90% target, while results from South Queensland and New South Wales were below 80% acceptable fruit (Figure 4). Note that the small sample sizes for South Queensland and Tristate (13 and 12 respectively), as this means that results for those two regions may not be representative. More samples will be collected later this year, which will help indicate whether or not these results are an aberration.

The major differences in quality between regions suggests that future investments to improve quality may be best directed at particular production regions, rather than a national approach.

Shepard quality assessments are well underway, so look out for results in the next issue of *Talking Avocados*.

More information

For further details, please contact project leader Adam Goldwater at Applied Horticultural Research (AHR) on 0466 080 693 or adam.goldwater@ahr.com.au.

For up-to-date retail quality data, and more in-depth analysis, log into the Avocados Australia Best Practice Resource at avocado.org.au/bpr/, go to the 'Retail' tab, and select 'Retail Quality'.

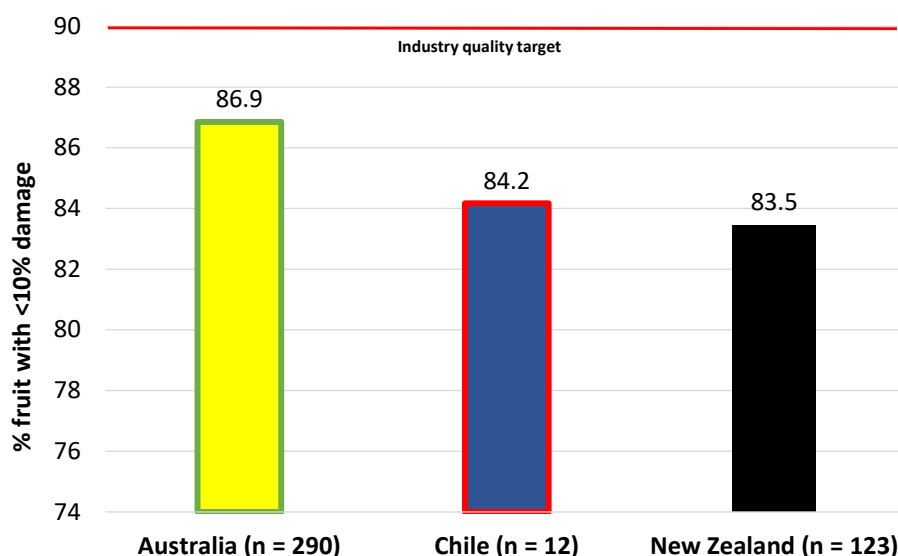


Figure 3. Percentage acceptable Hass fruit by country of origin in Australian retail stores during May 2020 to February 2021 (n is the number of 10-fruit samples collected).

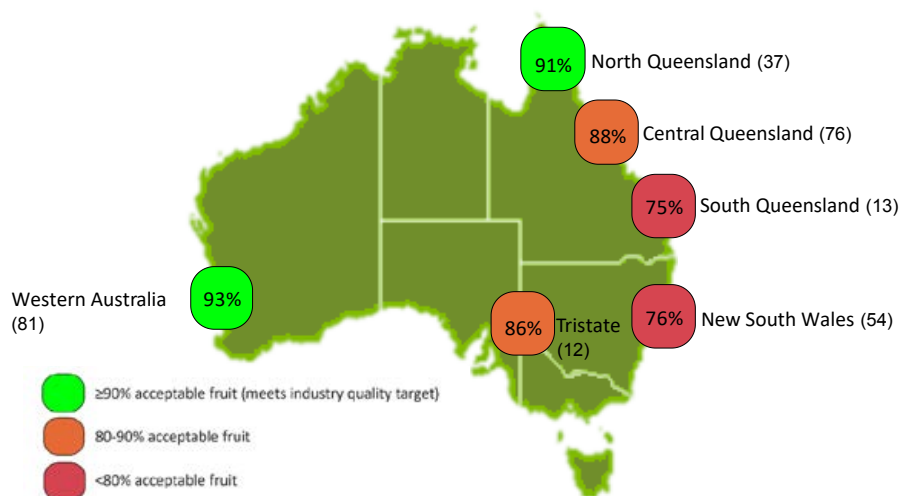


Figure 4. Percentage acceptable Australian Hass avocados by production region during May 2020 to February 2021. Numbers in brackets after each region name are the number of 10-fruit samples collected in the project.

Acknowledgement

The *Monitoring avocado quality in retail* (AV19003) project has been funded by Hort Innovation, using the avocado research and development levy, and contributions from the Australian Government.

**Hort
Innovation**
Strategic levy investment

**AVOCADO
FUND**

Exceptional Shepard quality followed by a challenging start to Hass season

Adam Goldwater, Applied Horticultural Research

Shepard quality at retail was excellent this year. Overall, 97% of Shepard fruit was deemed acceptable to consumers (<10% internal defects) from February to May.

This result was well above the industry's 90% acceptable fruit target, and sure to please consumers and encourage repeat purchases.

Shepard quality was similar out of both North and Central Queensland growing regions, with 97% and 98% acceptable fruit respectively. Overall, flesh defects were minimal, with bruising and stem-end rot the key issues, albeit at low levels (Figure 2).

These results are based on a total of 92 (920 fruit) Shepard samples collected between February and May 2021 from major and independent retail shelves in Brisbane, Sydney, Melbourne, Adelaide and Perth.

The exceptional Shepard quality was likely aided by the rapid flow of fruit through the supply chain, with an average of 14 days from packing to display at retail. It is widely recognised that as the time between harvest and ripening increases, so does the risk of rots and internal disorders in the ripened

fruit. In the Shepard samples collected this season, only 7% exceeded best practice of 21 days from packing to display at retail.

Hass quality – May-June 2021

Unfortunately, as of July, fruit quality has been in decline since monitoring of the Queensland Hass season began in May. Acceptable fruit quality started off at 85% in May, declining to 72% in June. June was the lowest quality level recorded for any month in the past year. Quality was consistently poor (71-76% acceptable) in all three retail markets sampled in June, including Brisbane, Sydney and Melbourne.

In June, bruising was the largest contributor to fruit damage, at 13.6% of fruit, up from the 12-month average of 6.3%. Additionally, body rots, vascular browning and flesh discolouration all increased significantly from the 12-month average (Figure 3).

Fruit age and quality

An increase in defects including body rots, vascular browning and flesh discolouration could be related to older fruit at retail in June. Fruit age of Australian Hass at retail has increased to 16 days from packing in June compared to 13 days based on the 12-month average. On average this is the oldest Australian Hass fruit that we have sampled during the past 12 months.

The more time in the system from packing to retail, the greater the risk of rots and storage defects. This is clearly demonstrated through data collected to date in this project, where the level of fruit with major rots increases consistently as fruit age increases (Figure 4). For example, fruit that was 15-20 days old had 4.3% major rots, whereas that level of rots almost doubled to 8.2% when fruit age increased to 20-25 days.

Although the large volumes of fruit this season are a challenge, moving fruit through the supply chain as quickly as possible can help improve fruit quality.



Figure 1. A typically flawless sample of Shepard purchased from retail during February to May 2021.

Potential causes of increased bruising

The increase in bruising is concerning. Previous research (AV12009) suggests that the predominant cause of avocado flesh bruising is from handling by produce staff and consumers at retail point of sale. The recent increase in bruising could be due to an increase in handling of fruit at retail, although this has not been assessed in the project.

There are also factors which increase fruit susceptibility to bruising. These include earlier maturity fruit (lower % dry matter), fruit softening, and increasing fruit age (AV10019). In June, it took an average of 3 days extra for fruit to reach the point of retail, compared to the 12-month average for Australian Hass. Furthermore, fruit purchased in June was likely to be early to mid-maturity. Therefore, both fruit age and maturity could have contributed to increased bruise susceptibility in June.

More information

As the Hass season continues, we hope to see quality lift, returning to the industry target of 90% acceptable fruit. For up-to-date retail quality data, and more in-depth analysis, visit the Avocados Australia Best Practice Resource at avocado.org.au/bpr/, go to the 'Retail' tab, and select 'Retail Quality'.

For further details, contact project leader Adam Goldwater at Applied Horticultural Research (AHR) on 0466 080 693 or adam.goldwater@ahr.com.au.

Acknowledgement

The *Monitoring avocado quality in retail* (AV19003) project has been funded by Hort Innovation, using the avocado research and development levy, and contributions from the Australian Government.

**Hort
Innovation**
Strategic levy investment

**AVOCADO
FUND**

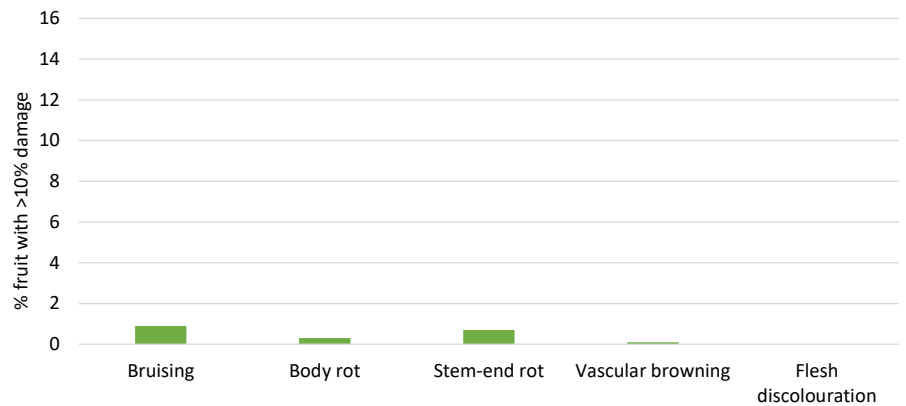


Figure 2. Types of defects causing unacceptable Shepard avocados at retail: February to May 2021.

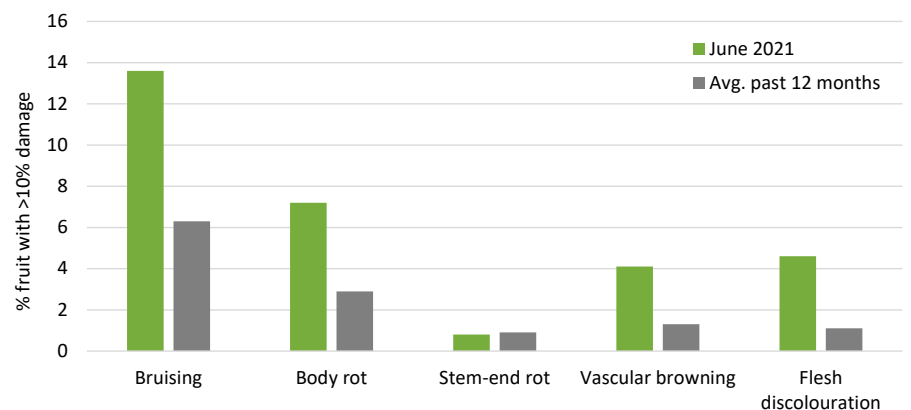


Figure 3. Defects causing unacceptable Hass avocados at retail in June 2021 (green columns) compared with 12-month average (grey columns).

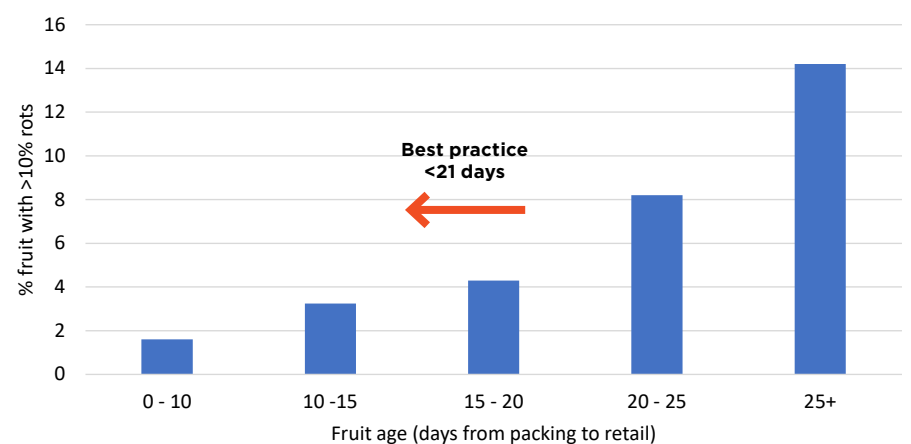


Figure 4. Effect of fruit age on flesh rots: as days from packing to retail increases, so too does the level of fruit with rots >10% of flesh. Data based on 560 samples (5,600 fruit) of Hass and Shepard collected from May 2020 to May 2021 in AV19003.

Monitoring avocado quality at retail: fruit quality declines as supply increases December 2021

Adam Goldwater, Applied Horticultural Research (AHR)

Fruit quality at retail declined from September to November 2021. Acceptable quality levels slipped from 92.5% in September to 81% in November, with higher levels of bruising and rots contributing to this. A comparison with the same period in 2020 shows September fruit quality was higher in 2021, while lower in both October and November 2021.

In recent months, retail sampling has associated some poor-quality fruit as 'old' fruit, exceeding 20 days from packing to purchase at retail. Issues with this fruit has included higher levels of rots, and storage defects such as flesh discolouration and vascular browning.

It is well established that fruit age has a major impact on quality, where older fruit is more susceptible to rots, flesh discolouration and vascular browning. Data collected in this project clearly demonstrates this. All supply chain members play a role in good fruit age management, and can use this to help improve fruit quality at retail. For example, reducing fruit age from 20-25 days down to 15-20 days could half the level of fruit with major rots.

We hope to see a lift in quality through the remainder of Hass supply this summer, as we saw during the 2020-21 summer. To achieve this, the key focus needs to be on moving fruit through the supply chain as quickly as possible.

Better fruit quality at major retailers

Fruit quality at major retailers in most major cities was consistently higher than at the independents. Between May 2020 and November 2021, an average of 17.5% of fruit at independent retailers was unacceptable, compared to 11-14%

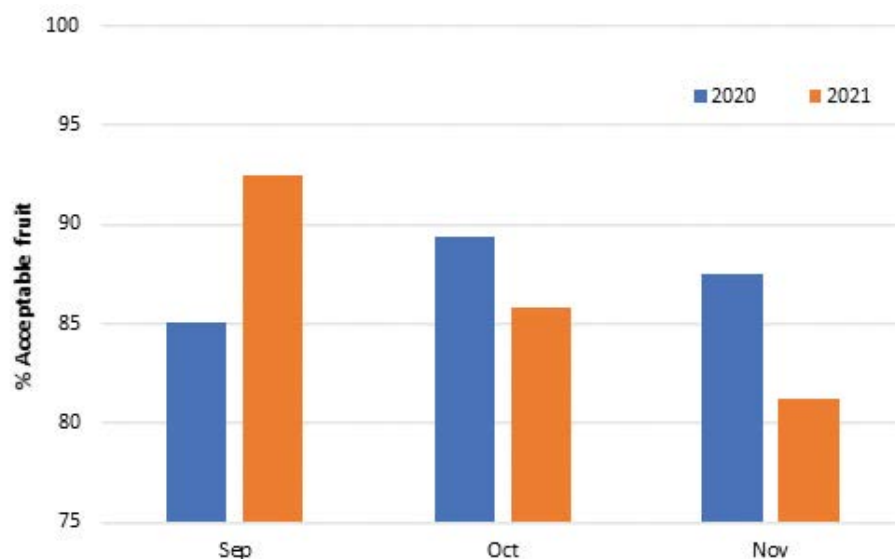


Figure 1. Level of acceptable Australian grown avocados (Hass only) at retail during September to November 2020 and 2021. Fruit are considered acceptable to the consumer if less than 10% of the flesh is damaged.

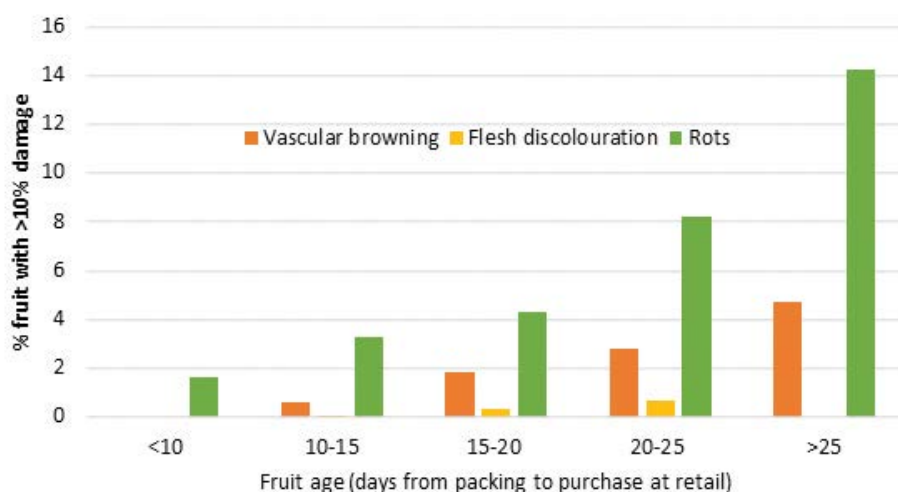


Figure 3. Internal damage increases with fruit age, particularly once fruit age exceeds 20 days from packing to purchase at retail. Data collected from AV19003 during May 2020 to November 2021.



Figure 3. Flesh discolouration, vascular browning and rots both increase in prevalence and severity with fruit age.

at the three major retailers.

This difference in quality does not appear to be due to one defect alone, but rather slightly higher levels of rots, bruising, vascular browning, and flesh discolouration. This could be the result of poorer handling practices in the independent retailer supply chains, including management of fruit age and temperature.

Previous studies have shown that levels of avocado bruising are higher at independent retailers compared with major supermarkets (AV12009). This could be related to different display practices at independent stores which may increase fruit handling. For example, fruit is usually taken out of the tray at independent stores and displayed loose, rather than being left in the tray.

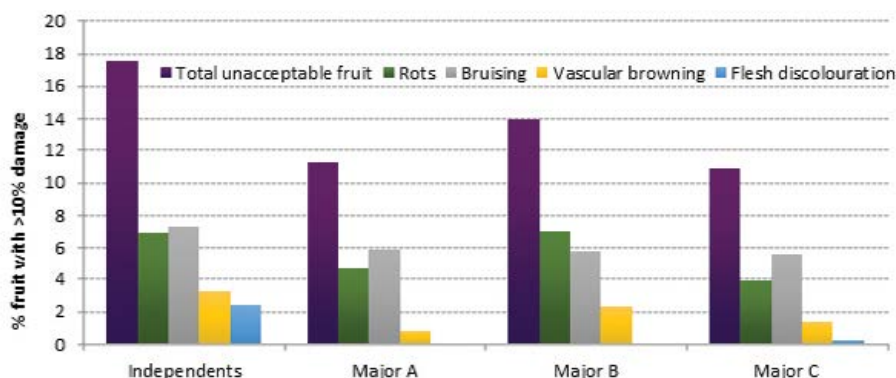


Figure 4. Internal avocado damage levels at independent and major supermarkets (de-identified) in Australia from May 2020 – November 2021.

We have also seen a trend for larger fruit displays in some independent stores, which may increase consumer handling and time that fruit is left on display.

Industry investment in quality improvement at the point of retail has tended to focus more on the major supermarkets. This is not surprising given that this is where the majority of fruit is sold, and that there are efficiencies in working with a chain of stores, rather than individuals. However this could be a contributing factor to the poorer quality levels at independent stores, and creates an opportunity for future quality improvement for the avocado industry.

Further information

For up-to-date retail quality data, and more in-depth analysis, visit the Avocados Australia Best Practice Resource, go to the 'Retail' tab, and select 'Retail Quality'.

For further details, please contact the project leader:

Adam Goldwater
Applied Horticultural Research (AHR)
0466 080 693
adam.goldwater@ahr.com.au

Acknowledgement:

This project has been funded by Hort Innovation, using the Avocado research and development levy and contributions from the Australian Government. Hort Innovation is the grower-owned, not-for-profit research and development corporation for Australian horticulture.

**Hort
Innovation**
Strategic levy investment

**AVOCADO
FUND**

Pollination services



Australian owned and operated family beekeeping business offers pollination services in South East Queensland and New South Wales Northern Rivers region.

For more information please contact owner Ugis Lauberts
mobile phone 0408239329
email bitis@live.com

Maturity monitoring commences at Sydney central markets

By Adam Goldwater, Applied Horticultural Research

Avocado maturity (% dry matter) has a strong influence on the sensory acceptability, ripening characteristics and incidence of rots and disorders of avocados. Poor consumer eating experiences that result from immature fruit reduce the likelihood of repeat purchases, as well as prolonging the time between purchases. For this reason, it is important to minimize the amount of immature fruit in the market.

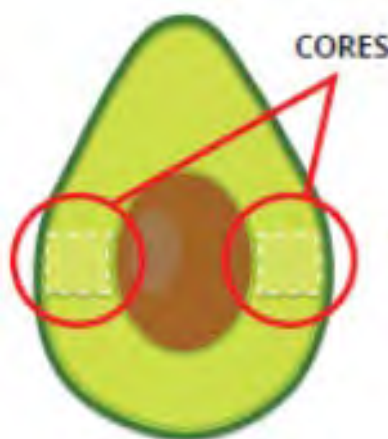
Previous industry monitoring (AV11015) found that immature fruit was often supplied at the start of the season in most growing regions. That work was completed in 2015, with no industry-wide monitoring of maturity since then. As part of the retail quality monitoring project (AV19003), maturity monitoring at the Sydney Central Market has re-commenced, with samples collected twice monthly.

Methodology

Trays of hard-green avocados are randomly purchased from market agents at the Sydney Wholesale Market. Where possible, the fruit size selected is an average size from the consignment available. One tray of fruit is purchased per supplier/batch, and tray label details are recorded.

Fruit is transported immediately back to the AHR laboratory and processed on the day of purchase. A 10-fruit sample is randomly selected from the tray. Average firmness of the 10 fruit is measured using a Turoni durometer. Cores are then taken using the Hofshi Coring method:

1. Two cores of flesh are removed from the equator of each fruit (see image to the right) using a 16mm corer



2. The skin and seed coat are removed from the flesh cores
3. Each core is cut in half
4. Empty foil dish is weighed
5. Flesh cores are placed in the foil dish and weighed using a calibrated balance, with 2 decimal places
6. Steps 1-5 are repeated for all 10 fruit
7. Flesh cores are dried in a 60°C dehydrator
8. Flesh cores are weighed, returned to the dehydrator, and reweighed until there is no change in weight on further drying (usually 3 days)

Percentage dry matter is calculated as:

$$\% \text{ DM} = \frac{\text{sample dry weight}}{\text{sample fresh weight}} \times 100$$

Supplier reporting

Maturity results are reported confidentially back to the supplying packhouse within 1 week of purchase. The report is a one page summary and includes purchase information; percentage dry matter of all 10 fruit; average dry matter; a summary of all samples for the week; and tray and fruit label photos.

Maturity monitoring results

On average, 1 in 5 samples collected at the start of the 2022 Shepard season were below the industry minimum maturity standard of 21% (Shepard) dry matter. As of 17 March 2022, a total of 6 out of 27 samples collected fell below 21%, with two samples sitting between 18-19%.

Although a limited sample number to date, this level of immature fruit is an improvement on the average from 2007-2015 when almost 30% of North Queensland Shepard samples fell below the minimum standard in February (AV11015). The project will continue to monitor the level of immature fruit in the Australian market, to determine if improvements have been made since the last industry-wide monitoring finished in 2015.

Retail quality update

Australian grown Hass fruit quality at retail declined through spring 2021, with acceptable fruit levels slipping from 93% to 81% during September to November. Quality consistently improved for the following three months, peaking at 95% in February 2022. Despite this great finish to the Hass season, acceptable fruit quality through most of the 2020-21 season was below the Australian industry target of 90% acceptable fruit. Promisingly, the quality of Australian grown Hass consistently outperformed that of imported fruit each month.

Initial results from the start of the Shepard season show excellent quality in March 2022, with acceptable fruit levels of 98%. This is in line with Shepard quality levels recorded in March 2021.



Figure 1. An example of a supplier maturity monitoring report (not real data).

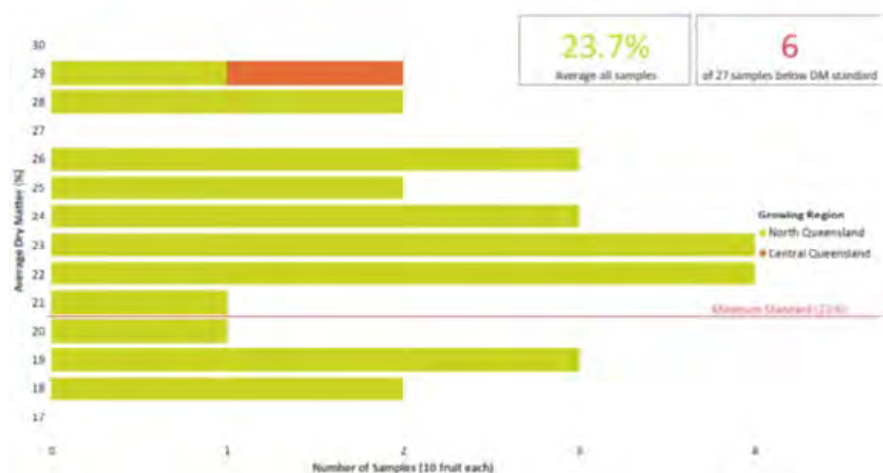


Figure 2. Average Shephard dry matter content by growing region – samples collected at Sydney Wholesale Market from 8 February to 8 March 2022.



Figure 3. Level of acceptable Australian grown avocados (Hass only) at retail during 2021-2022. Fruit are considered acceptable to the consumer if less than 10% of the flesh is damaged.

Further information

For up-to-date retail quality data, and more in-depth analysis, visit the Avocados Australia Best Practice Resource, go to the 'Retail' tab, and select 'Retail Quality'.

Maturity monitoring results are available on the Best Practice Resource under the 'Packhouse' tab, followed by 'Maturity'.

For further details, please contact the project leader:

Adam Goldwater
 Applied Horticultural Research (AHR)
 0466 080 693
adam.goldwater@ahr.com.au

Acknowledgements

The *Monitoring avocado quality in retail* (AV19003) project has been funded by Hort Innovation, using the avocado research and development levy and contributions from the Australian Government. Hort Innovation is the grower-owned, not-for-profit research and development corporation for Australian horticulture.

Hort Innovation
 Strategic levy investment

AVOCADO FUND

RESEARCH AND DEVELOPMENT

Avocado quality update - September 2022

By Adam Goldwater, Applied Horticultural Research

Exceptional Shepard fruit quality

The 2022 Shepard season wrapped up with superb quality throughout March to May. Acceptable fruit quality levels exceeded 95% in March and April, climbing to 98% in May (Figure 1). Flesh rots were the most common defect, albeit at low levels. There was a notable quality improvement in May 2022 compared to May 2021.

Early Shepard supply was too firm

Anecdotal reports in March suggested that Shepard fruit were too firm on retail shelves. There was concern that a lack of ripe fruit may slow retail sales. The retail quality monitoring project was able to confirm a shift towards display of unripe fruit, particularly at one of the three major retailers. Analysis of firmness in that retailer's stores showed that 64% of fruit on their shelves were at stages 1 or 2 (Figure 2), whereas best practice is to merchandise fruit at stages 3-5. The retailer used that information to adjust their firmness specifications and help increase the supply of ripe fruit.

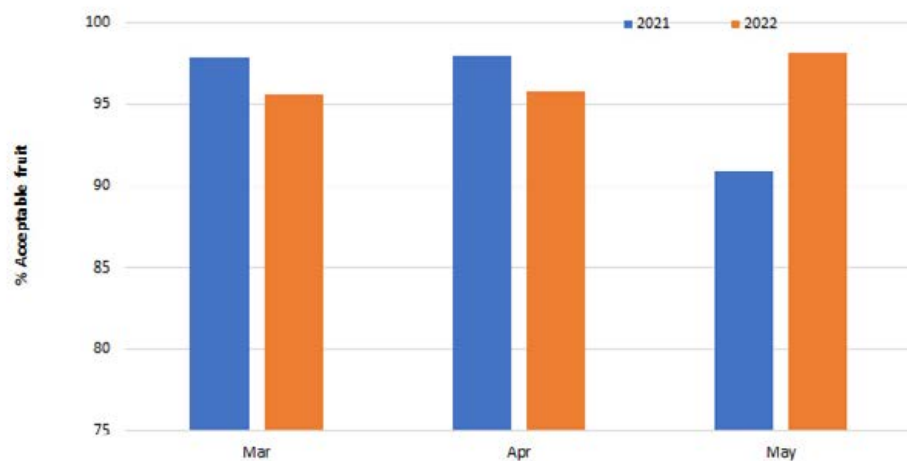


Figure 1. Level of acceptable Shepard avocados at retail in 2021 and 2022. Fruit are considered acceptable to the consumer if less than 10% of the flesh is damaged.

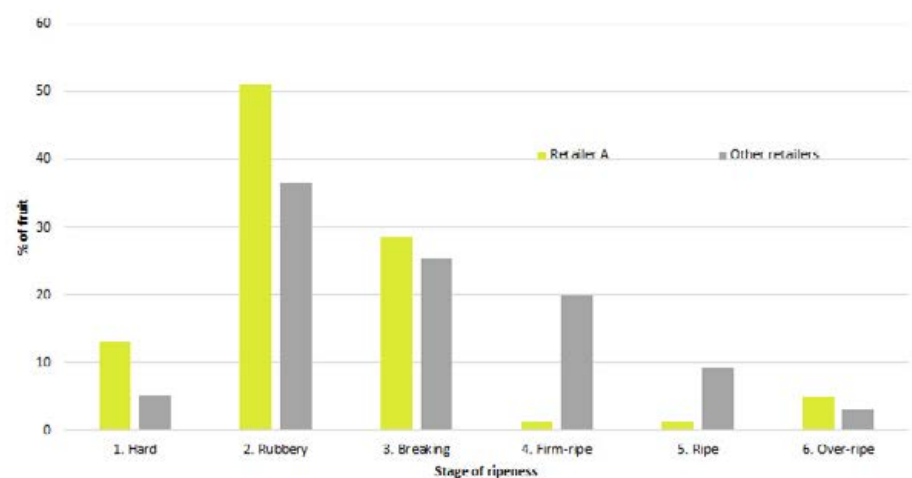


Figure 2. Shepard stages of ripeness at retail in March 2022 at one of the major retailers (Retailer A) compared with the other major retailers and a sample of independents (Other retailers).

Hass season started well, then quality slipped

Quality for the start of the 2022 Queensland Hass season was generally very good, exceeding the industry target of 90% acceptable fruit in both May and June, and an improvement on 2020 and 2021 (Figure 3). However, quality slipped in July and August, with a notable increase in bruising, and storage disorders such as flesh discolouration and vascular browning.

Lower levels of bruising in fruit displayed in trays

Retail quality data is actively used to help retailers make improvements, particularly to help reduce bruising. With two years of sampling now complete, the project has a rich dataset (more than 12,000 fruit). We identified a difference in the quality of fruit sampled from loose versus tray displays. On average, 5.6% of fruit displayed in a tray were bruised (more than 10% of total flesh), compared to 7.5% of fruit on loose displays, which had two or more layers of fruit.

It is logical that displaying fruit in trays can reduce bruising, given that ripe fruit, which are highly susceptible to bruising, are often tipped rather than hand-stacked onto loose displays. Additionally, consumers are less likely to rummage through tray displays, as fruit are well presented and in a single layer.

The benefits of using tray displays were presented to the major retailers, who are interested in the results, and acknowledged a preference to move entirely to tray displays.

Maturity monitoring results

Maturity monitoring commenced at the Sydney Wholesale Markets in February 2022, and results were positive for Shepard, with only 11% of samples collected below the minimum maturity standard of 21% dry matter. Most of the immature samples were collected in February (Figure 5). In comparison, previous work found 16.5% of Shepard samples collected between 2007 and 2015 were below the minimum dry matter standard (AV11015 data).

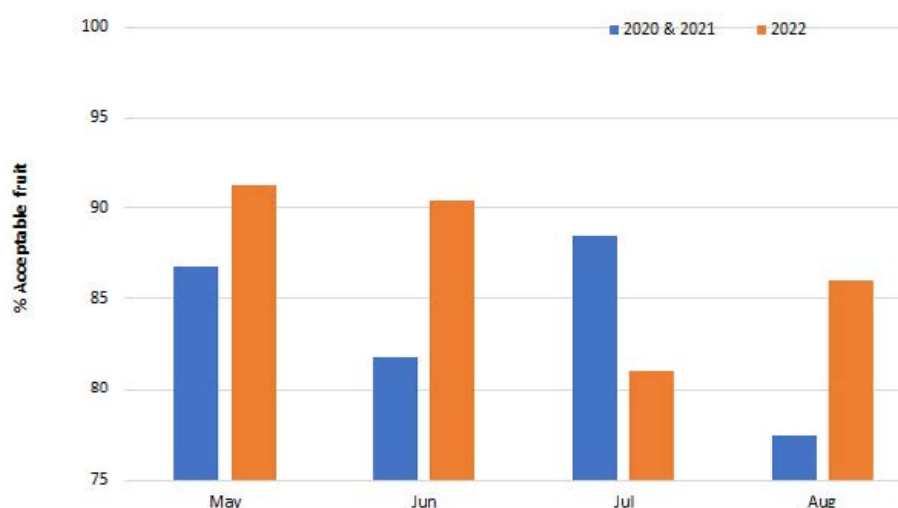


Figure 3. Level of acceptable Hass avocados at retail for May to August 2020-2021 versus 2022. Fruit are considered acceptable to the consumer if less than 10% of the flesh is damaged.



Figure 4. Fruit from tray displays (top) has a lower incidence of bruising compared to fruit displayed on loose displays (bottom).

RESEARCH AND DEVELOPMENT

Avocado retail quality update

By Adam Goldwater, *Applied Horticultural Research*

Australian Hass fruit quality improved throughout spring, lifting from 86% acceptable fruit in August, to 94% in November. However, as imported fruit entered the retail market in September, the overall level of fruit quality declined (Australian and imported), reaching a low of 78% acceptable fruit in December, due to significant levels of rots in imported fruit. This is unfortunate for Australian suppliers, given that a consumer's intent to repeat purchase avocados is negatively affected by poor quality, regardless of the country of origin.

Bruises and rots – how can severity of damage affect overall retail quality?

To maximise sales, the Australian avocado industry's quality goal is for all fruit to have no more than 10% internal flesh damage. To progress towards that target, it is useful to understand how severe the current damage is, and whether adoption of new pre and postharvest practices can realistically reduce internal damage to within the 10% target.

Bruising is the most prevalent internal quality issue for Australian grown Hass, with 21% of fruit sampled at retail over the past 2.5 years damaged by bruising. However, the size, or severity of bruising is important, given that a bruise which affects less than 10% of the total flesh is less likely to deter consumers from repeat purchase. Retail quality monitoring has identified 7%

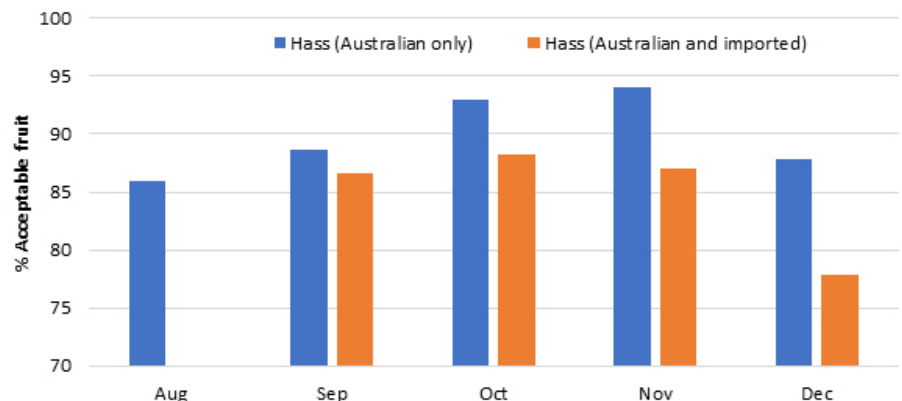


Figure 1. Level of acceptable Hass avocados at retail during August to December 2022. Fruit are considered acceptable to the consumer if less than 10% of the flesh is damaged.



Figure 2. Bruise severity (% of damaged flesh) of samples of Australian grown Shepard and Hass avocados collected at retail between May 2020 and November 2022.

of Hass with bruising that exceeds 10% of the flesh. Of these, roughly half sit in the 10-20% bruise severity category (Figure 2).

If the industry can reduce bruise severity, even slightly, then many of the

bruises in the 10-20% severity category would shift to below the 10% level. This could halve the level of Hass which are unacceptable to consumers because of bruising. Simple practices to reduce bruise severity include reducing the size and number of impacts during

handling by store staff and consumers, refrigerating ripe fruit, reducing time in the system from harvest to retail, and harvesting fruit with higher dry matter levels.

Flesh rots affect 13% of Shepard and 16% of Australian Hass avocados at retail. Fortunately, the majority of these rots only affect a small volume of flesh, where only 3.5% of Shepard and Australian grown Hass avocados have rots which affect more than 10% of the total flesh. As good as this sounds, there is a risk that changes to inferior pre and postharvest practices could increase the severity of rots, resulting in more rots exceeding the 10% damage level. For example, more time in storage could double rot severity, resulting in rots in the 5 to 10% severity category shifting to 10 to 20%, almost doubling the level of rotten fruit considered unacceptable to consumers (Figure 3).

Maturity monitoring results

Maturity monitoring at the Sydney Markets continues, and since June, no immature samples of Hass were identified (Figure 4). The average dry matter through this period was 31.5% from samples grown in Central and South Queensland, NSW, Tristate and WA.

Although typically a period where there are fewer issues with immature fruit on the market, previous monitoring from 2007 to 2015 (AV11015) identified immature fruit from NSW, Tristate and WA during this period.

This result is consistent with the improvement in compliance with maturity standards seen earlier this year, where there was a lower proportion of immature Hass and Shepard fruit in the market during February to July 2022, compared with the same period over 2007 to 2015.

More information

For up-to-date retail quality data, and more in-depth analysis, visit the Avocados Australia Best Practice Resource at avocado.org.au/bpr/, go to the 'Retail' tab, and select 'Retail Quality'.

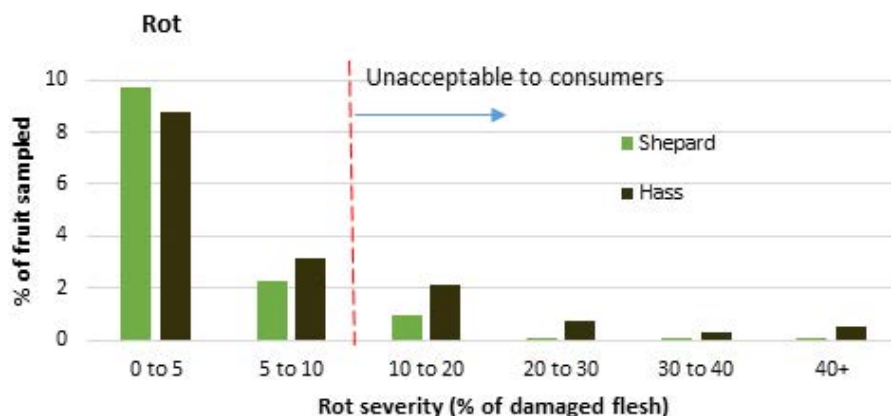


Figure 3. Rot severity (% of damaged flesh) of samples of Australian grown Shepard and Hass avocados collected at retail between May 2020 and November 2022. Results are body and stem-end rots combined.

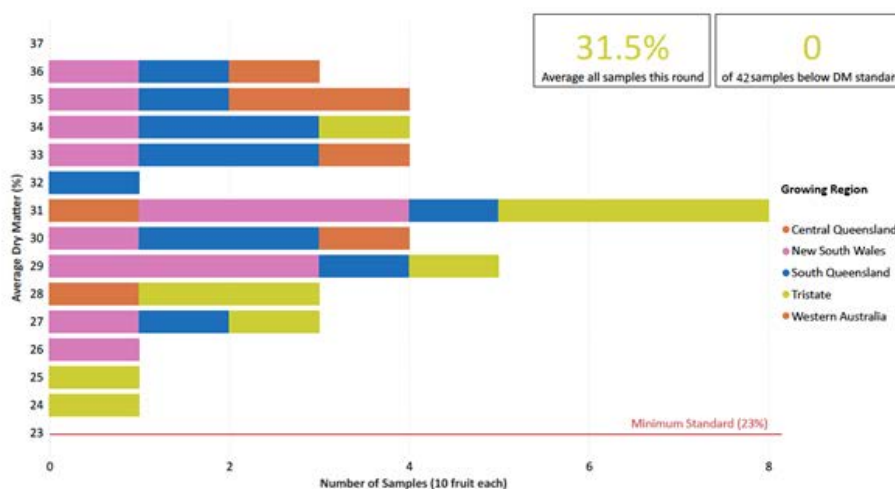


Figure 4. Hass dry matter by growing region from samples collected at Sydney Markets from September to December 2022. All samples met the Hass minimum dry matter standard of 23%.

Maturity monitoring results are available on the Best Practice Resource under the 'Packhouse' tab, followed by 'Maturity'.

For further details, please contact project leader Adam Goldwater at Applied Horticultural Research (AHR) on 0466 080 693 or adam.goldwater@ahr.com.au.

Acknowledgements

The Monitoring avocado quality in retail (AV19003) project has been funded by Hort Innovation, using the avocado research and development levy

and contributions from the Australian Government. Hort Innovation is the grower-owned, not-for-profit research and development corporation for Australian horticulture.

Hort Innovation
Strategic levy investment

AVOCADO FUND

User views of retail quality and maturity monitoring reports hosted on the Avocados Australia Best Practice Resource

Report page	Total page views	Unique page views
Retail quality (2.5 years)		
Industry snapshot	416	272
Retail snapshot	292	206
Hass variety	337	239
Shepard variety	86	68
Retail quality archive	161	83
Retail quality homepage	616	437
Maturity monitoring (12 months)		
Monthly results	164	118
Archive	29	17
Total	2101	1440