

# **Shepard Avocado Maturity Consumer Sensory Research**

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The New Zealand Institute for Plant and Food  
Research Ltd

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## **AV09026**

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## 'Shepard' Avocado Maturity Consumer Sensory Research

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**The New Zealand Institute for Plant & Food Research  
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The aim of this project was to determine, in more detail than available from existing research, the level of fruit quality that negatively impacts on consumer purchasing behaviour.

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Date: 31 May 2010

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# Media Summary

Dry matter content (DM) of avocados represents the amount of carbohydrates and nutrients that have been transported from the tree into the fruit. The longer the avocado remains on the tree, the higher the dry matter, and consequently, %DM is used by growers to decide when avocados are ready to harvest. In the current study, 112 consumers tasted 'Shepard', a variety of avocado that can be harvested early in the season. The avocados were collected from a range of locations in Northern Queensland in order to ensure that fruit of varying maturity (%DM) were available for tasting at the same time. Consumers' liking of flavour increased progressively as the DM content of avocados increased from 18% to 23% but then reached a plateau, where further increases in DM did not result in corresponding increases in liking. The immature (lower DM) avocados were frequently described as having 'bland/tasteless' or 'watery' flavour as well as being less liked than other avocados. Following tasting, consumers were asked about their experience with avocados and the extent that a quality guarantee offering to refund or replace damaged fruit might increase purchasing. Consumers continued to report a high incidence and severity of damage in the avocados they purchased for consumption at home. The study indicated that consumers' willingness to buy avocados increased as a consequence of the quality guarantee.

# Technical Summary

This research project addresses two questions for the Australian avocado industry:

1. To determine the minimum maturity, as measured by % dry matter (DM), that produces 'Shepard' avocados that are of acceptable eating quality to Australian consumers
2. To assess the potential impact on consumers of the introduction of a quality guarantee by industry.

Research was undertaken in Brisbane using 112 consumers from the target demographic for Avocados Australia Ltd, and recruited on the basis that a third fell into each of the categories of 'high frequency', 'medium' and 'occasional' eaters of avocados. The 'Shepard' avocados were sourced from a wide range of locations in Northern Queensland (Atherton Tablelands) in order to ensure DM levels varied from about 18% to about 32%. All fruit were successfully ripened and sorted into four distinct DM bands (~19.5%, ~22.6%, ~25.3% and ~28.5% DM) of similar firmness.

Consumers' liking of flavour increased progressively as the DM content of avocados increased from 18% to 23%, but then reached a plateau, where further increases in DM did not result in corresponding increases in liking. The lowest DM treatment contained immature fruit, which were frequently described as having 'bland/tasteless' or 'watery' flavour. These immature avocados (~19.5% DM) were significantly less liked than both the early maturity (~22.6% DM) and late maturity (~28.5% DM) avocados, which were not significantly different from each other. The mean liking score for avocados harvested at middle stage of maturity (~25.3% DM) was between the scores received by immature and late maturity avocados and not significantly different from the scores for either treatment.

Research on the potential impact of a quality guarantee involved collecting consumer responses and opinions on external defects and internal damage (e.g. bruising) that can be found in avocados, and considering how these barriers to purchase/consumption may be mitigated through the provision of an industry guarantee for internal quality (refund or replacement of damaged fruit). It was found that purchase intention declined dramatically as a result of any external defects being present on the fruit (e.g. ridging, spotting and tree rub) and consumers reported high incidences and severity of damage to the flesh in the fruit that they purchased. Consumers' overwhelming response was that provision of a quality guarantee would increase their intention to purchase fruit, but few would return avocados for refunds or replacement because of the inconvenience.

The recommendations are (in brief):

1. Immature 'Shepard' avocados (DM less than 23%) should be excluded from the marketplace to optimise consumer flavour preferences. There is no advantage of imposing a DM standard higher than 23% because no further increase in consumer preference for 'Shepard' avocados was observed beyond this %DM.
2. Consumers indicated that a quality guarantee would increase the likelihood that they would purchase avocados. Many consumers indicated that although they would be encouraged to buy avocados, they probably would not return damaged avocados because of the perceived inconvenience of keeping docketts and having to return to the store. The value of the guarantee would therefore be that industry is demonstrating the confidence they have in their own product. However, it would be easy to lose this level of consumer trust if it were not possible to deliver damage-free avocados. Furthermore,

an additional risk to any guarantee programme is evident in the high level of self reporting on the incidence and severity of damaged flesh in avocados prepared in the home. It is not clear whether this damage resulted from events in the industry supply chain, occurred as a result of mishandling in the home, or was incurred during transit from the store to the home.

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# 1 Introduction

In June 2007, research was completed by HortResearch (now known as The New Zealand Institute for Plant & Food Research Ltd) to determine the minimum maturity measurement (as measured by % Dry Matter, DM) for 'Hass' avocados that makes them acceptable eating quality to Australian consumers. The HAL project was called AV06025: Avocado Australia Ltd Sensory Research (Harker et al. 2007).

Research was undertaken in Brisbane using 107 consumers from the target demographic, and recruited on the basis that one third met the categories of 'high frequency', 'medium' and 'occasional' eaters of avocados. The 'Hass' avocados were sourced from a wide range of locations (South East, Tablelands, Bundaberg and Atherton localities within Queensland, and WA) in order to ensure DM levels varied from about 17% to about 44%. Consumers tasted avocados from all these 'maturity' categories.

Consumers showed a progressive increase in liking and intent to buy avocados as the DM content increased. Consumers were unsure if they would purchase an avocado with a DM of 20% but indicated they would probably buy (~80% chance) the avocados with 38% DM. Consumer acceptance of the quality of avocados was relatively high at about 90–95%, but declined significantly to 70% if the DM was lower than 22%.

One of the recommendations made at the conclusion of this work was to set a minimum maturity standard between 22% DM and 28% DM to ensure an appropriate competitive advantage in the marketplace. This reflects the approximately linear increase in liking and purchase intent that occurs as DM increases from 22% to 28%. Thus, improvements in DM in this % region have the potential to stimulate consumer demand and consequently increase prices or increase volume of sales. This recommendation was, however, qualified by the further recommendation that the decision on where to set a minimum would require additional information to establish the desired competitive positioning of the Australian avocado industry.

Based on the results of this work and taking into consideration the subsequent recommendations, the avocado industry has publicly recommended a new maturity standard of 23% DM for 'Hass' avocados at time of harvesting.

'Hass' avocados are the main commercial variety of avocado marketed in Australia, making up approximately 80% of fruit marketed. In the months of February through April, however, there are very few 'Hass' fruit available and 'Shepard' avocados sourced from Northern and Central Queensland are marketed during this period. Retail quality surveys conducted by Avocados Australia and evidence collected through discussions with Australian avocado marketers has told us that consumers experience quality issues with 'Shepard' avocados and it is believed that this is at least in part due to the marketing of immature fruit. Because of varietal differences, it is not possible simply to apply the recommendations from the research data related to 'Hass' avocados and the consumer-preferred DM percentage to 'Shepard'. The aim of this project was therefore to determine the minimum maturity measurement as measured by % dry matter that produces 'Shepard' avocados that are of acceptable eating quality to Australian consumers, using a similar process to that which was used in determining these criteria for 'Hass' avocados in 2007.

## 2 Materials and methods

### 2.1 Fruit sources

Avocados were harvested from various locations around Northern Queensland (Atherton Tablelands) on the assumption that they would provide the range of maturity required for the trial (Table 1). Fruit were harvested straight into trays and airfreighted to the postharvest laboratory of Agri-Science Queensland (Department of Employment, Economic Development and Innovation) at the Maroochy Research Station (MRS) at Nambour within 24 h of harvest.

Table 1. Sources of 'Shepard' avocado fruit used for a consumer study in Brisbane, including harvest date (in 2010) and number of fruit harvested.

Grower/farm	Date harvested	Number of fruit
Blundell	9 March	40
Collins	8 March	40
Joubert	8 March	120
Kleyn	9 March	80
Kochi	8 March	250
Lavers	9 March	140
Walkamin Research Station	8 March	100
Westwood Farm	8 March	120
Willbi	9 March	120

### 2.2 Fruit assessments

#### 2.2.1 Sorting for Dry Matter (~Maturity)

Avocados were numbered on arrival at MRS to allow individual fruit to be tracked from the start of DM testing to consumption by individual consumers. Each fruit was assessed for DM within two days of arrival using the Hofshi plugger to remove a core of tissue from the fruit equator (Arpaia et al. 2001). Skin and seed coat were removed from the core, and the cores halved and dried to constant weight at 65°C. Fruit were placed in a cold room at 5°C until the DM results were obtained (about 2–3 days). Fruit were then sorted into four DM categories, ensuring that there were at least 150 fruit in each category (Table 2).

Table 2. Dry matter (DM) categories and number of 'Shepard' avocado fruit used for a consumer study in Brisbane.

DM category	Targeted DM	Number of fruit
Immature	18-21%	154
Early	21.5-24%	175
Mid	24.5-27%	215
Late	>27.5%	284

### 2.2.2 Ripening Treatments

To provide ripe fruit over the three days of tasting and to account for the expected different ripening times of fruit with differing maturities, the fruit were divided into two groups and ripened under different conditions. One group was placed under ethylene (10  $\mu\text{L/L}$  in a constant flow through system) for two days at 19°C. Fruit was then transferred to a cold room and held at 19°C for one day, then at 15°C until reaching the 'firm ripe' stage (hand firmness of 4, see next section). The other group was held at 16°C (without ethylene) until firm ripe. Fruit from both groups were then held at 5°C until the consumer testing.

### 2.2.3 Selection of fruit for consumer evaluations

One day before the start of consumer taste testing, all avocados were transported by car to the Queensland Primary Industries and Fisheries Sensory facility (19 Hercules Street, Hamilton, Brisbane). Use of a 5°C coolstore and 20°C allowed avocado ripeness to be manipulated within the period of consumer taste testing.

All fruit needed to be sorted for ripeness before presentation to consumers for tasting. This was done initially by hand assessment of fruit firmness by one expert (A.W.), who has over 18 years' experience in assessing the postharvest condition of avocados. Hand firmness evaluations were based on relationships between hand assessment and instrumental texture measurements established in earlier studies (White et al. 1999), and modified for the current study. On several occasions hand-based ripeness assessments for fruit served to consumers for tasting were confirmed by using a hand-held Effegi penetrometer (Effegi, Alphonsine, Italy) with an 11-mm diameter Effegi probe (Harker et al. 1996). Avocados were sorted to be within a narrow firmness range from 4.5 to 5.5 hand firmness (White et al. 2005).

Before each consumer panel, fruit from each of the four DM bands were cut into half and the seed removed. As there are large spatial differences in DM within a 'Hass' avocado (Schroeder 1985), the top (proximal) and bottom (distal) ends of each half were removed. The remaining mid pericarp section, which is less variable in DM, was then cut in half longitudinally (~2 cm wide by 3–4 cm high) and the skin removed. Care was taken to avoid the area of the fruit where the core was removed for DM assessment, and only fruit free of bruising and rots were used. Flesh from a single fruit was shared between a minimum of two panellists.

Samples of avocado flesh were placed into clear plastic cups, which were labelled with 3-digit codes that represented the respective fruit treatment. Details of the condition (DM and firmness) of individual fruit could be related to responses of an individual consumer.

The process of selecting appropriate avocados, and preparing the fruit to serve to consumers took the team of two (A.W. & B.S.) about 1 to 1.5 hours for each consumer tasting session (~10 consumers / session).

## 2.3 Consumers

One hundred and twelve consumers from the greater Brisbane area were recruited by international recruitment agency IPSOS under the instructions of Innovative Food Technologies (IFT), DEEDI. Recruitment criteria were developed in reference to the populations targeted in Avocados Australia sales promotions. Consumers were primarily between the ages of 20-40 years, were solely or jointly responsible for the majority of their household's grocery shopping, and had purchased avocados in the last three months. Recruitment of consumers was also

based on frequency of avocado consumption. It was the intention of recruiters to include an even spread of respondents from three consumption levels:

1. High frequency consumers (one or more avocados each week)
2. Medium frequency consumers (about one avocado each fortnight)
3. Occasional consumers (about one avocado each month).

The demographic profile of consumers who participated in the study is presented in Table 3.

Table 3. Demographic profile of consumers (N = 112).

Factor	Demographic	Percentage
Gender	Female	64%
	Male	36%
Age	20-24	14%
	25-29	26%
	30-34	23%
	35-39	23%
	40-44	7%
	45+	7%
Main purchaser for household	Yes	90%
	No	10%
Frequency of avocado consumption	One or more each week	50%
	One each fortnight	35%
	One each month	13%
	One or two each 3 months	2%
Income	less than \$20 000	5%
	\$20 000 to \$34 999	10%
	\$35 000 to \$54 999	17%
	\$55 000 to \$74 999	20%
	\$75 000 to \$99 999	23%
	\$100 000 to \$119 999	5%
\$120 000 or more	20%	
Hours of work	Full time - 30 h or more	45%
	Part time - less than 30 h	29%
	Not in paid employment	26%

## 2.4 Consumer testing facility

Consumer evaluations of avocados were undertaken in standard sensory evaluation facilities, located at the IFT Hamilton Laboratory site (19 Hercules Street, Hamilton, Qld, 4007). The sensory laboratory included 12 individual tasting booths (Figure 1), an adjacent food preparation laboratory and a conference room. Samples of avocado were passed through a hatch in the tasting booths to each consumer.



Figure 1. Facilities used for consumer study.

## 2.5 Questions on taste of avocado

This study consisted of consumers completing a series of tasks involving taste testing and the completion of a questionnaire. A small pilot study of eight consumers was first undertaken in New Zealand to determine any problems in the study design before the large-scale research. The tasks given to consumers were broken into three stages: (1) assessment of consumers' opinions after tasting avocados harvested at differing maturity (as determined by DM content) and their list of relevant flavour descriptors, (2) an assessment of the importance of external appearance relative to flesh quality and (3) an assessment of the extent that consumer choice of avocado would be affected by a guarantee of internal quality. Only the first task involved tasting of avocado. In each of these stages, a range of questions was asked. Consumers were briefed on the details of questionnaires and the tasks they were being asked to undertake, and were encouraged to ask questions if they were at any time unsure what was needed.

### 2.5.1 Tasting of avocados with different DM content

Consumers tasted fruit (as described above) from each of the four DM categories. Each consumer was provided with an A3 answer sheet as shown in Figure 2, and asked to indicate how much they liked each sample using a hedonic scale:

- Like extremely
- Like very much
- Like moderately
- Like slightly
- Neither like nor dislike
- Dislike slightly
- Dislike moderately
- Dislike very much
- Dislike extremely

To control for presentation order effect, the order in which fruit from different DM categories were tasted varied across consumers. The order in which fruit were tasted was according to a

randomised complete block statistical design that accounted for order and carryover effects. The consumers were asked to taste the fruit using the following instructions:

**“Part 1: How much do you like the avocado?”**

- Taste the samples in the order at the top of your scoring sheet from left to right (checking 3 digit codes on the samples match the 3 digit codes on the scoring sheet).
- Place each container of fruit in the position that represents how much you like its taste. After that, you may go back and re-taste each avocado. You can change the position of the containers as you progressively taste and re-taste all the avocados.
- When you are certain of your decisions, and the relative liking for all the fruit, **mark the boxes with a tick.**

*Only when you have completed Part 1 should you proceed to Part 2a and the questions about acceptability and purchase intentions.*

**Part 2a: Acceptability and purchase intent.**

- Taste the samples in the order that appears at the top of your scoring sheet. After tasting each sample, answer the questions on acceptability and purchase intention at the bottom of the page by ticking the appropriate boxes.

**Part 2b: Register on computer, enter your scores and describe the avocado.**

- Register your number on the computer
- Enter your scores for each sample on the computer. Start with your first sample, on the left of your scoring sheet, entering your scores one sample at a time.
- When you get to the question “Which of the words below would you use to describe the eating experience (flavour, taste or texture) of this avocado sample?”, please go back and taste the remaining piece of avocado and select the words on the screen that best describe your sample.

*Please ask if you have any questions or are unsure what to do.”*

Consumers were provided with water crackers (Arnott’s Original, Arnott’s Biscuits Ltd, Homebush, NSW) and filtered water as palette cleansers between tastings. Once the consumers had indicated how much they liked the fruit, they were asked to re-taste each fruit and answer two supplemental questions, as follows:

1. “Is the quality of the fruit (identified by 3-digit code) acceptable or unacceptable?” (Yes/No)

2. “During the year avocados generally vary in price between \$0.99 and \$2.99 for an average sized fruit”. If you knew that the next avocado you bought was going to taste like fruit (identified by 3-digit code) and had a price of \$1.99 would you buy it?”

The consumers responded by ticking a multi-choice answer:

- Definitely will buy (90 to 100% chance)
- Probably will buy (70 to 89% chance)
- Possibly will buy (50 to 69% chance)
- Possibly will not buy (30 to 49% chance)
- Probably will not buy (10 to 29% chance)
- Definitely will not buy (0 to 9% chance)



Figure 2. Forms and fruit sample containers used for tasting avocados of differing dry matter (DM).

After transferring the results collected on A3 sheets into Compusense® (a computer programme designed to collect sensory data), the participants were asked to fill in another screen on which they ticked multi-choice options for flavour descriptors relevant to the avocados. The flavour descriptors were:

- Nutty
- Tasteless/bland
- Chemical/metallic
- Bitter
- Soft
- Firm
- Mushy
- Rubbery
- Rich
- Smooth
- Creamy
- Oily
- Typical avocado flavour
- Rancid
- Buttery
- Off-flavour
- Watery
- Dry
- Herbaceous/Herby
- Other

## 2.6 The importance of external appearance relative to flesh quality

Avocados Australia Ltd has been considering the possibility of developing a quality guarantee as a mechanism to create enhance sales to consumers and create additional value for Industry. Speculation was that a guarantee relating to internal quality would lessen the requirements for cosmetically perfect fruit. Before pursuing the issues relating to the guarantee, it was deemed necessary to understand more about the relative importance of external appearance and internal quality. Research was undertaken as a survey in which consumers were presented with images representing different types and levels of internal and external defects.

### 2.6.1 Images

The external defects were selected to represent a range of cosmetic problems that typically affect commercial production: ridging, skin spotting and tree rub (White et al. 2009). The image of a ripe 'Hass' Avocado with a colour rating of about 4 (White et al. 2009) was modified so that the same image was available with no defect, ridging, skin spotting and tree rub symptoms. Original images were obtained from 'The International Avocado Quality Manual' (White et al.

2009) and were manipulated using Photoshop® CS3. The Photoshop cloning tool was used to transfer the cosmetic defects from an original avocado photograph onto the newly created image. Care was taken in selecting appropriate areas of original images in order to ensure that the final image was as realistic as possible. The images were then exported to MS Word 2003, where they were inserted into the questionnaire booklet. The word document was printed on a colour photocopier (model DocuColor 5065, Fuji Xerox Co. Ltd, Japan). Examples of the images are shown in Figure 3.

The images of problems of internal quality were those used in the earlier study (Harker et al. 2007). The images show different levels of bruising of internal flesh and were chosen because bruising is one of the most frequent causes of poor internal quality reported to be experienced by consumers (Harker et al. 2007). Examples of the images are provided in Figure 4.

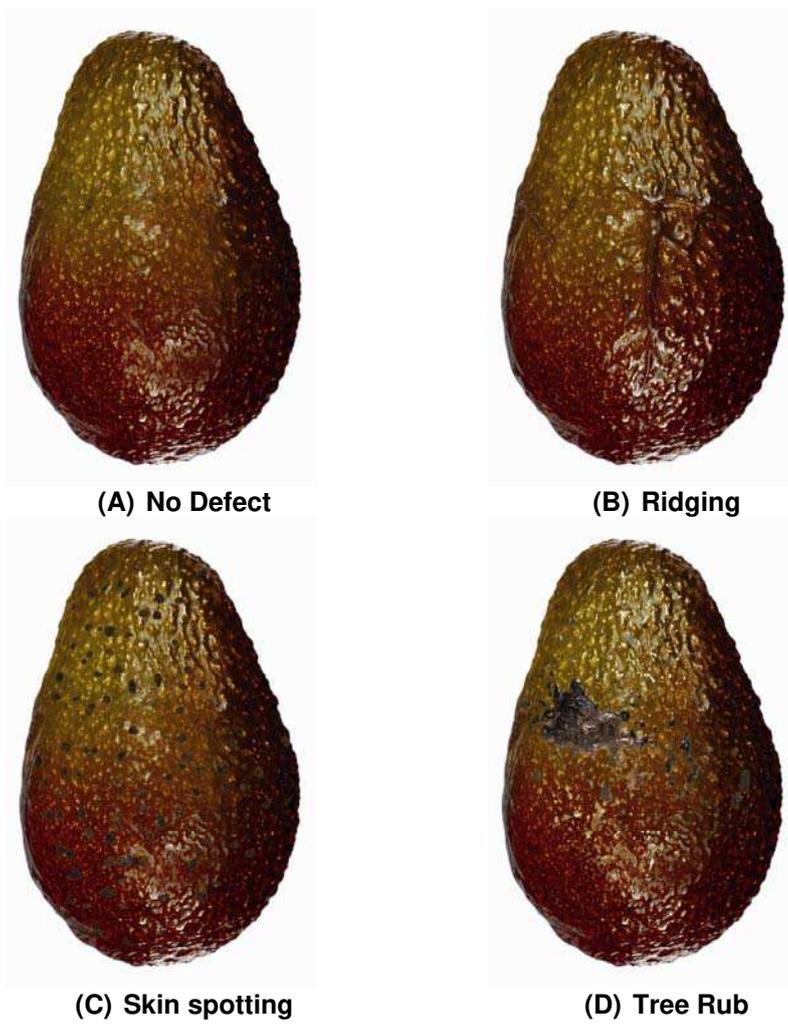


Figure 3. Images used as examples of cosmetic defects of avocado.



Figure 4. Images used as examples of internal flesh damage to avocado.

## 2.6.2 Questionnaire

The first question asked consumers to indicate their willingness to purchase avocados with different cosmetic defects (as shown in Figure 3):

*Imagine that you have gone shopping and are considering buying an avocado to eat within the next two days. Please indicate your intention to buy each of the avocados below?*

The consumers responded by ticking a multi-choice answer:

- Definitely will buy (90 to 100% chance)
- Probably will buy (70 to 89% chance)
- Possibly will buy (50 to 69% chance)
- Possibly will not buy (30 to 49% chance)
- Probably will not buy (10 to 29% chance)
- Definitely will not buy (0 to 9% chance).

The participants were then asked a series of questions that allowed us to understand more about consumers' past experiences, as well as information on how each consumer stored and used avocados in the home. This also served as a prompt to get consumers thinking more about these issues themselves. The participants were shown the images of internal damage (Figure 4) with the following text:

*These images show avocados that have been cut open. The image on the left is of an undamaged avocado and the image on the right shows the type of internal damage sometimes seen.*

They were asked about their experiences with quality of avocados in the home:

*How often do you purchase an avocado and have to discard some of the flesh because it is damaged?*

- Every time that I buy an avocado
- 3 out of 5 times that I buy an avocado
- 1 out of 5 times that I buy an avocado
- 1 out of 10 times that I buy an avocado
- Never

The consumers were also asked how severe the symptoms were:

*How much of the avocado do you usually have to discard?*

- 50% of the avocado
- 33% of the avocado
- 25% of the avocado
- 10% of the avocado
- 0% of the avocado

For consistency, these multi-choice answers are the same scales as were used in the previous study on flesh damage (Harker et al. 2007).

Consumers were asked how they ate and where they stored their avocados:

*How do you eat your avocados? Please tick all the boxes that are relevant to you.*

- As a spread
- On bread
- On crackers
- As an ingredient in a salad
- Cut in half with a filling
- As a dip / guacamole
- With nachos
- With other Mexican foods
- With risotto and/or pasta
- Other (please describe):
- With baked potatoes
- As a topping on a casserole
- With sushi
- In a prawn cocktail
- With soup
- For a baby
- On a platter
- I would eat it as a fruit on its own

*Where do you keep your avocados in your home? Please tick all the boxes that are relevant to you.*

- In a fruit bowl that is in clear view
- Somewhere other than a fruit bowl but still in clear view
- In a fruit bowl but out of sight (for example in a cupboard)
- In the refrigerator
- Somewhere other than a fruit bowl or the fridge that is out of sight
- Other (please describe)

Finally participants were asked how important it was to them that their avocados were free of cosmetic defects and free of internal damage as well as the relative importance of these two factors.

*How important is it that there are no marks, blemishes or imperfections on the outside of your avocados?*

*How important is it that there are no portions of the avocado that you need to throw away?*

Responses to both questions were collected on the following scale:

- Extremely important
- Definitely important
- Generally important
- Somewhat important
- Only slightly important
- Not at all important

Finally, participants were asked:

*How important is external appearance relative to internal quality of the avocados you buy?*

External appearance is	definitely <u>more</u> important	than internal quality
	generally <u>more</u> important	
	only slightly <u>more</u> important	
	equally important	
	only slightly <u>less</u> important	
	generally <u>less</u> important	
	definitely <u>less</u> important	

## 2.7 A guarantee for internal flesh quality

Participants were asked for their views on the use of a quality guarantee for avocados in a series of questions.

The first question was as follows:

*Imagine that you have gone shopping and are considering buying an avocado to eat within the next two days. The avocados that you see in the store have the following guarantee:*

### **Premium Avocados**

**Quality Guarantee – if one of these avocados is returned within 3 days of purchase with internal damage we will either replace the avocado or return 100% of the price you paid.**

*How would this guarantee affect your decision to buy an avocado?*

Responses were collected using the following scale:

- Definitely more likely
- Probably more likely
- Possibly more likely
- Neither more or less likely
- Possibly less likely
- Probably less likely
- Definitely less likely

Consumers were then asked to provide an open-ended comment on the guarantee:

*Please could you describe how you feel about this type of guarantee? How useful will it be to you personally? (Please write in the box below).*

The participants were then offered a series of options relating to the extent / magnitude of the guarantee according to the following scenario:

*Imagine that you have gone shopping and are considering buying an avocado to eat within the next two days. All the avocados cost \$1.99 each. The avocados that you see have four different options for guarantees. For each of the guarantees below, please circle the number that best expresses your intention to buy the avocado?*

The stated guarantees were:

*Premium Avocados – if one of these avocados is returned within 3 days of purchase with internal damage we will:*

1. **either replace the avocado or return 100% of the price you paid.**
2. **replace it with 2 new avocados.**
3. **give you 150% of your money back.**
4. **replace it with 2 new avocados or give you 150% of your money back.**

The responses each guarantee were collected using a horizontal presentation of a 9-category scale, anchored at the extremes with 'definitely less likely to buy' (score = 1) and 'definitely more likely to buy' (score = 9).

Finally, consumers undertook a task in which they indicated their intention to purchase avocados represented in a range of scenarios relating to price, guarantee and cosmetic defect. The task was akin to a choice task and participants were given the opportunity to score the scenarios (images of avocados with related information on guarantee and price) relative to each other by providing all scenarios on a single A3 sheet of paper. A 2 x 2 x 2 design was used – 2 levels of cosmetic defect (no defect v. defect), 2 levels of price (\$1.99 v. \$2.49) and 2 levels of guarantee (no guarantee v. guarantee). The guarantee statement was the standard wording: *Quality Guarantee – if one of these avocados is returned within 3 days of purchase with internal damage we will either replace the avocado or return 100% of the price you paid.* Participants were asked:

*Imagine that you have gone shopping and are considering buying an avocado to eat within the next two days. Please indicate your intention to buy each of the avocados below?*

The responses were collected using the following multi-choice scale:

- Definitely will buy (90 to 100% chance)
- Probably will buy (70 to 89% chance)
- Possibly will buy (50 to 69% chance)
- Possibly will not buy (30 to 49% chance)
- Probably will not buy (10 to 29% chance)
- Definitely will not buy (0 to 9% chance)

### 3 Results and Discussion

#### 3.1 Consumer preferences for avocados with differing DM content

It was important to demonstrate that avocados used in this study represent distinct DM categories before we could place any level of reliance on the consumer responses that were collected. The process of sorting avocados into different DM categories was very successful. All categories were significantly different from each other ( $F_{3,444} = 1854, P < 0.001$  and all 6 pairwise comparisons using Fisher's protected LSD were significantly different,  $\alpha < 0.05$ ). The median DM for each category was 19.5%, 22.6%, 25.3% and 28.5% for 'immature', 'early', 'mid' and 'late' maturity categories respectively (Figure 4A). The process of allocating avocados to individual consumers ensured no overlap in DM categories for any set of four avocados tasted by an individual consumer. This was confirmed by plots of differences in DM values between adjacent DM categories provided to individual consumers (Figure 4B). With the exception of 3 outliers, there were no pairs of fruit with negative differences in DM values (i.e. no fruit from a higher DM category that were actually lower in DM) and no fruit that had no (zero) difference between DM categories. Rather, the average DM difference going from 'immature' to 'early', from 'early' to 'mid' and from 'mid' to 'late' maturities were 2.9%, 3.0% and 3.7%, respectively. All the avocados that were presented to consumers fell within a narrow band of firmness (ripeness) values (4.5 to 5.5) and there was no significant difference between treatments according to the Pearson's Chi-squared test ( $\chi^2 = 6.1, df = 3, P = 0.11$ ). The mean firmness by hand assessment was 5.2, where 5 indicates that the whole fruit deforms with moderate hand pressure (Figure 5).

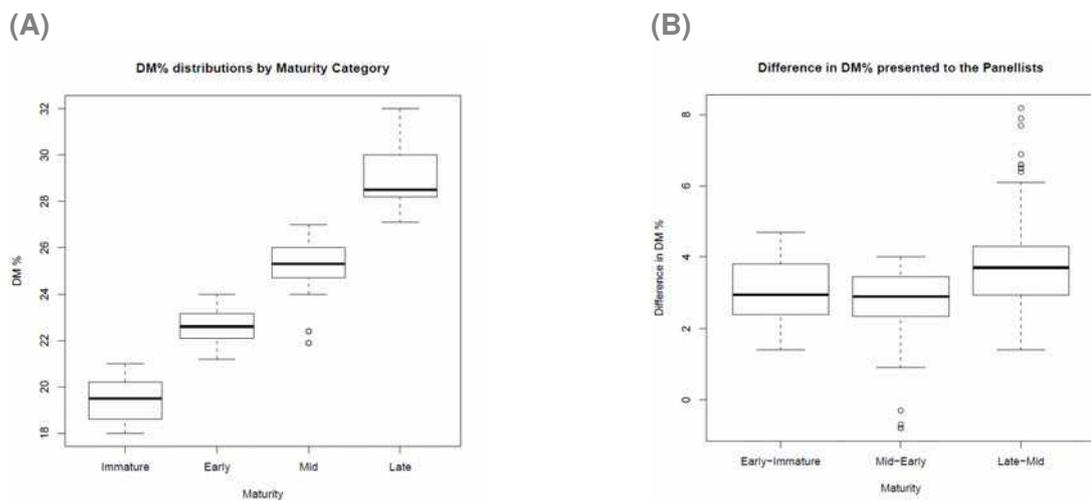


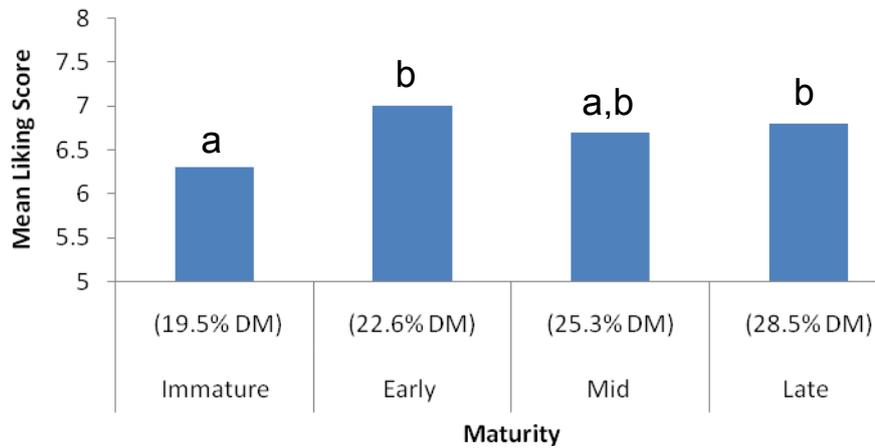
Figure 4. The distribution of dry matter (DM) content in individual avocados from each DM category (A), and the difference in DM between pairs of avocados from adjacent DM categories that were presented to individual consumers (B). Graphs are box plots in which the median is represented by the thick black horizontal line; the region between the upper and lower quartiles (square box) contains 50% of the data; 99% of the data lie between the horizontal lines that are connected by a vertical line; and the outlying data points are unfilled circles.

The consumers were asked to taste avocados of differing DM content and indicate their absolute liking of each fruit, and to pay attention to the relative patterns of liking between these different avocados. We consider this as critical baseline information because this task is not cognitively challenging and consumers usually know exactly what they like and dislike (e.g. Harker et al. 2005, 2008). For example, it is increasingly well recognised that while consumers are good at identifying when something is wrong with a food (i.e. they dislike it), they will struggle to identify or explain what sensory attributes they disliked. In the current study, there was a significant increase in consumer liking for avocados as the fruit DM category increased ( $F_{3,333} = 3.14$ ,  $P = 0.026$  and pairwise comparisons (calculated using Fisher's protected LSD) indicated that immature avocados were significantly less liked than early or late maturity fruit ( $\alpha = 0.05$ ), but not significantly differently from mid maturity fruit. Avocados harvested at early, mid and late stages of maturity did not evoke any significant differences in liking scores. The relationship between maturity stage and consumer liking is most easily seen in Figure 6. The mean liking scores increased from 6.3 (~like slightly) to 7.0 (like moderately) as avocados progressed from immature (19.5% DM) to early (22.6% DM) stages of maturity and, except for a slight dip for mid maturity fruit (25.3% DM), remained at close to scores of 'like moderately' for all subsequent increases in maturity up to late maturity avocados (29% DM).

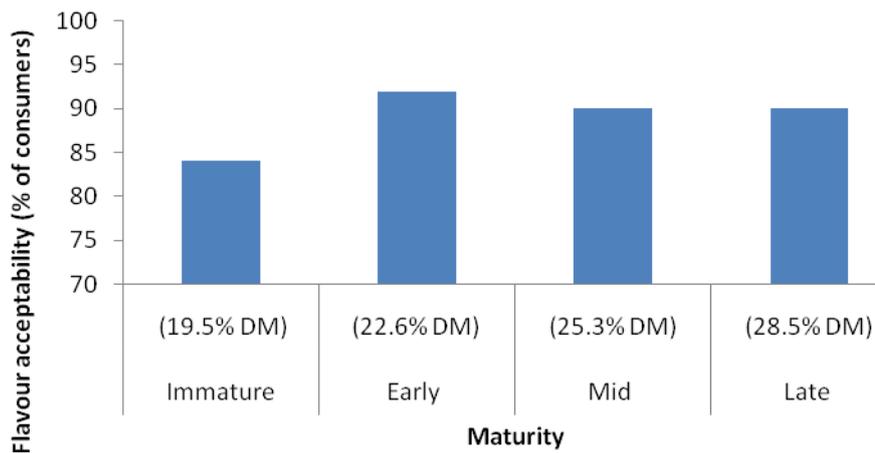
For the supplementary question (Was the quality of the fruit acceptable or unacceptable?), the acceptability of fruit in all DM categories was relatively high, and even the lowest DM avocados ('immature' = 19.5% DM) were considered acceptable by 84% of consumers (Figure 6). Maturity categories had no significant influence on acceptability of avocados ( $F=1.38$ ,  $df = 3, 333$ ,  $P = 0.248$ ), with the percentage of consumers rating the avocados as having acceptable flavour being 84% for immature (19.5% DM), 92% for early (22.6% DM), 90% for both mid (25.3% DM) and late (29% DM) maturity treatments (Figure 6).

There was no significant increases in consumers' intention to purchase avocados at the stated price of \$1.99 for each stepwise increase in DM band (Friedman's statistic adjusted for ties = 4.28, 3 df,  $P = 0.23$ , using chi-square approximation, Figure 6). Furthermore, analysis using Wilcoxon Matched-Pairs Test confirmed that there were no differences in purchase intention between all DM/maturity categories (Figure 6).

### (A) Liking



### (B) Acceptability



### (C) Purchase intent

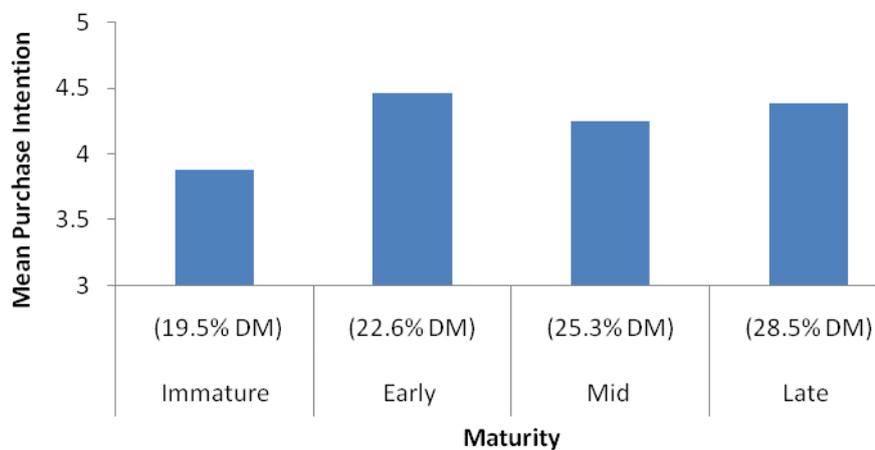


Figure 6. Consumer scores for acceptability, liking and purchase intent for avocados from the different dry matter (DM) categories. Bars with different letters are significantly different from one another (see text).

Examination of consumer liking for the maturity categories shown in Figure 6 suggests an increase in liking as maturity increases from immature to early stages, followed by a plateau. This relationship was confirmed in Figure 7 where the curve (Loess smoother) was generated using all individual consumers' responses and the points represent mean liking as was calculated for discrete bands of DM (Note that the scatter plot produces a grid pattern because of the categorical nature of the data). Figure 7 shows that liking increased in an approximately linear fashion up to about 23% DM, after which further increases in DM resulted in a slight dip, followed by a regaining of liking.

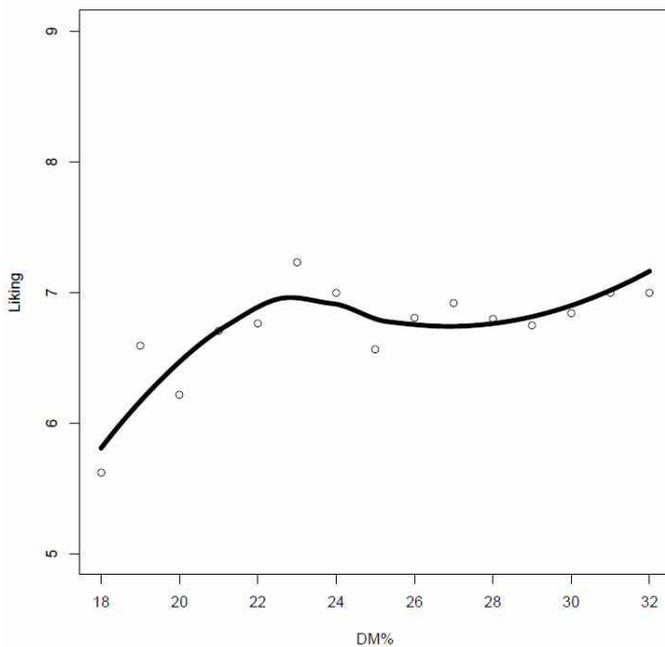


Figure 7. Relationship between dry matter (DM) of avocados and consumers' purchase intentions.

There were some concerns that the late maturity treatment had inherently poor quality, which was apparent as a high proportion of fruit that needed to be discarded because of flesh greying symptoms. While all avocados provided to consumer were visually free of this problem, this does not necessarily mean that apparently unaffected fruit are not expressing incipient symptoms that might manifest as poorer flavour. For this reason, we were concerned that the average liking score for the late maturity treatment might reflect a dichotomy in consumer responses, such that some consumers really disliked the fruit and others receiving less affected fruit really liked it. In order to assess if this was a problem, we examined the distribution of liking scores for all maturity treatments (Figure 8). The data suggest that variability in liking scores associated with the late maturity treatment was no different to that associated with avocados harvested at early or mid maturity treatments. Notably the immature avocados had the lowest mean liking scores and the tightest distribution of liking scores (Figure 8).

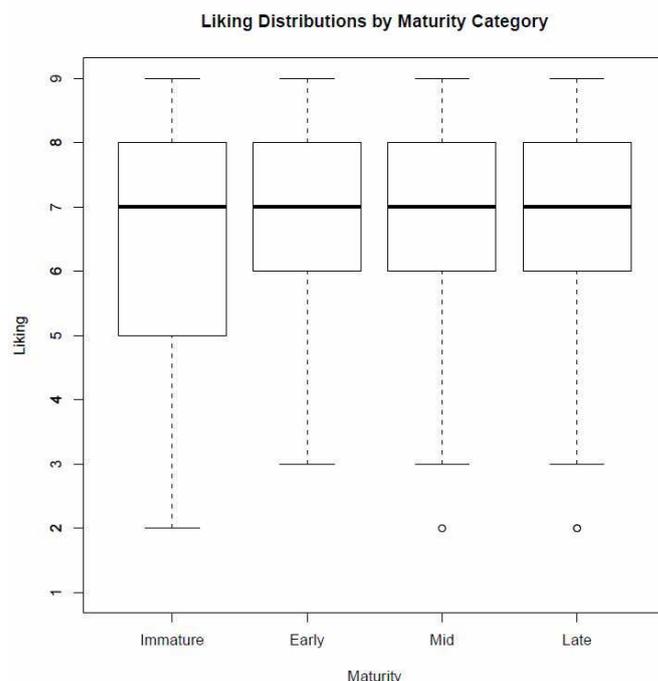


Figure 8. The distribution of consumer liking scores for avocados from each maturity category. Graphs are box plots in which the median is represented by the thick black horizontal line; the region between the upper and lower quartiles (square box) contains 50% of the data; 99% of the data lie between the horizontal lines that are connected by a vertical line; and the outlying data points are unfilled circles.

### 3.2 Flavour descriptors used by consumers

Texture attributes 'soft', 'smooth' and 'creamy' were most frequently used to describe the avocados and flavour attribute 'typical avocado' was only ranked fourth (Figure 9). However, flavour attributes 'buttery', 'nutty', 'rich' and 'tasteless/bland' all were ranked above the next most frequently used texture attribute, which was 'firm' (Figure 9). Thus, the most frequently used positive descriptors were (in order of frequency of use): soft, smooth, creamy, typical avocado flavour, nutty, buttery and rich.

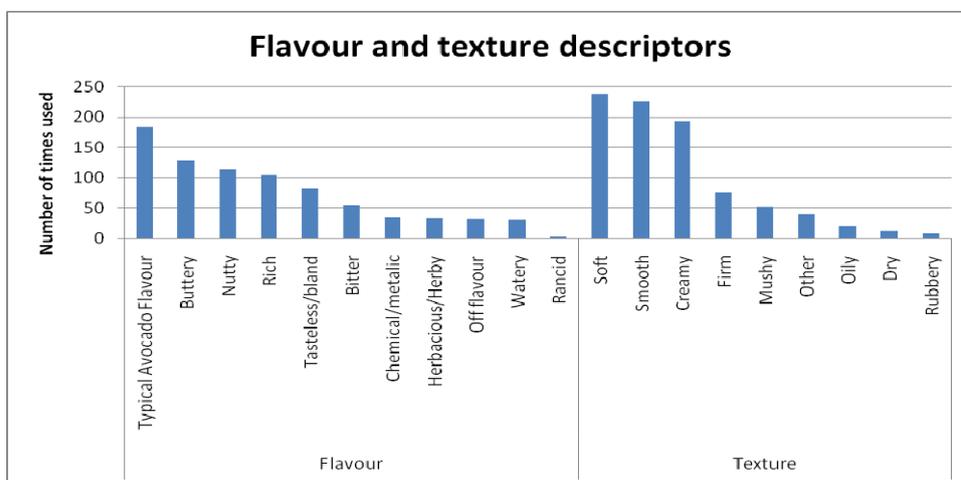


Figure 9. Number of times flavour descriptors were used in the avocado study.

The type of descriptors identified by consumers as being relevant for each of the avocados they tasted varied between maturity treatments. Notably, the descriptors ‘tasteless/bland’ and ‘watery’ were more frequently associated with immature avocados (Figure 10). Over 30% of consumer described immature avocados as ‘tasteless/bland’ and over 16% of consumers described the same immature fruit as ‘watery’. In both cases, the use of descriptors was significantly higher in immature than in other maturity treatments according the Wald test (for ‘tasteless/bland’  $P = 0.003$ ; for ‘watery’  $P < 0.001$ ). The high percentages of consumers using these negative descriptors reinforces that low DM avocados were providing an inferior flavour experience.

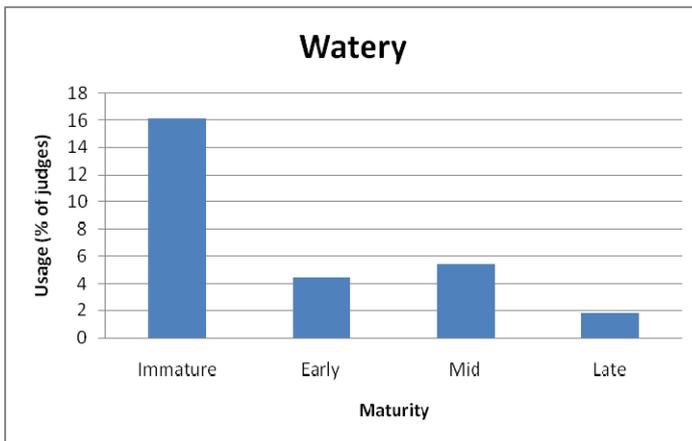


Figure 10. The frequency with which consumers described the flavour of avocados from various maturity treatments as being ‘tasteless/bland’ or ‘watery’.

The frequency with which consumers identified avocados as delivering positive flavour attributes such as ‘creamy’, ‘buttery’, ‘smooth’, and ‘rich’ showed a trend of increasing use of the descriptors with advancing harvest maturity (Figure 11). While none of these trends was statistically significant, the increasing use of the descriptor ‘creamy’ was almost significant ( $P = 0.056$ ; Wald test). The most preferred treatment (i.e. ‘early’) was identified as having the highest frequency of consumers describing its flavour as ‘nutty’, ‘typical avocado’ and ‘oily’ and the lowest percentage of consumers identifying it as being ‘mushy’, but again none of these was statistically significant (Figure 12). Distributions of descriptor use are provided for all descriptors in Appendix 1.

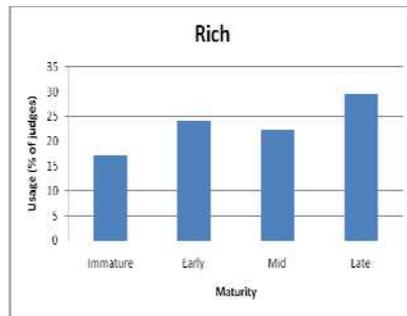
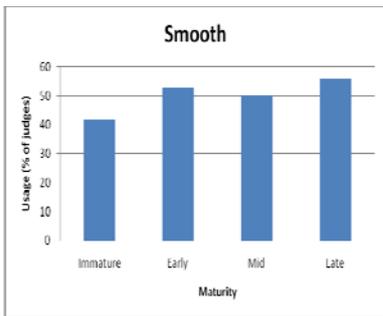
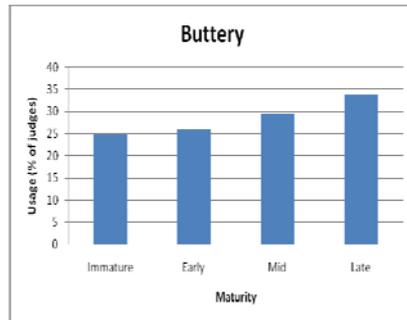
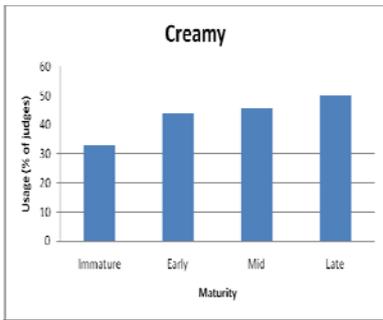


Figure 11. Avocado descriptors that increases in frequency of usage with advancing maturity.

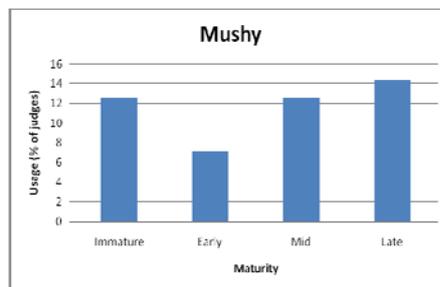
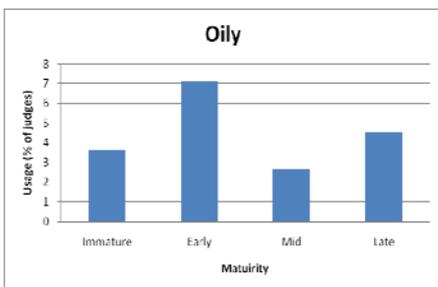
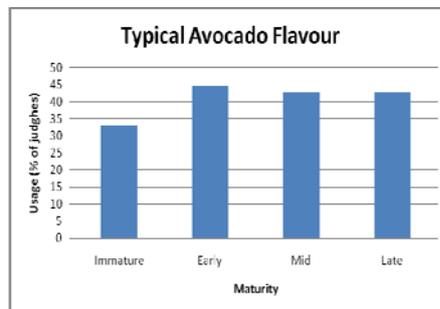
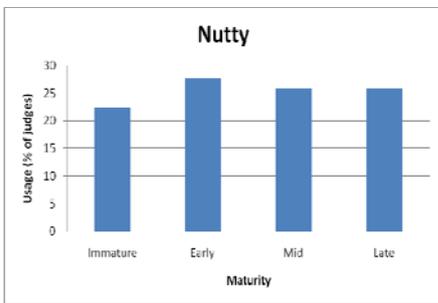


Figure 12. Avocado descriptors that are most/least frequently used to describe early maturity avocados.

### 3.3 Interpretation and implications of DM study

The objective of this part of the study was:

**To determine the minimum maturity measurement as measured by % Dry Matter that produces 'Shepard' avocados which are of acceptable eating quality to Australian consumers.**

The immature avocado treatment (mean DM = 19.5%; treatment DM range = 18% to 21%) was significantly less liked by Australian consumers than early or late maturity fruit. This was confirmed by the higher frequency with which consumers used the descriptors 'tasteless/bland' and watery to describe the flavour of these immature avocados. A more precise assessment of the influence of DM on consumer liking was possible by plotting the curve for liking against DM content for individual avocados. This plot (Figure 7) indicated a steady increase in liking as DM increased from 18% to 23% DM. However, there was no further increase in consumer liking with subsequent increases in DM over 23%. Based on these data, we recommend a minimum DM level of 23% be applied to 'Shepard' avocados to ensure maximum flavour acceptability for Australian consumers.

### 3.4 External defects and internal damage in avocados

#### 3.4.1 Consumer purchase intention

Consumers' intention to purchase avocados was greatly influenced by the presence of external defects. All defects (none v. ridging v. spotting v. tree rub) evoked responses from consumers that were statistically different according to analysis of variance ( $P < 0.001$ ) with all pairwise comparisons being significant ( $\alpha = 0.05$ ). The effect of defects on purchase intention is best demonstrated by proportion of consumers indicating that they would definitely buy avocados from each of the treatments (Figure 13). Seventy percent of consumers indicated that they would definitely buy the avocado when shown an image of a perfect fruit, but fewer than 15%, 5%, and 2% of consumers responded this way when shown images of fruit with the external defects such as ridging, spotting and tree rub, respectively (Figure 13). There was a tendency for ridging to be more acceptable to consumers than spotting, which in turn was more acceptable than tree rub. But clearly, the presence of any external defect dramatically reduced purchase intention.

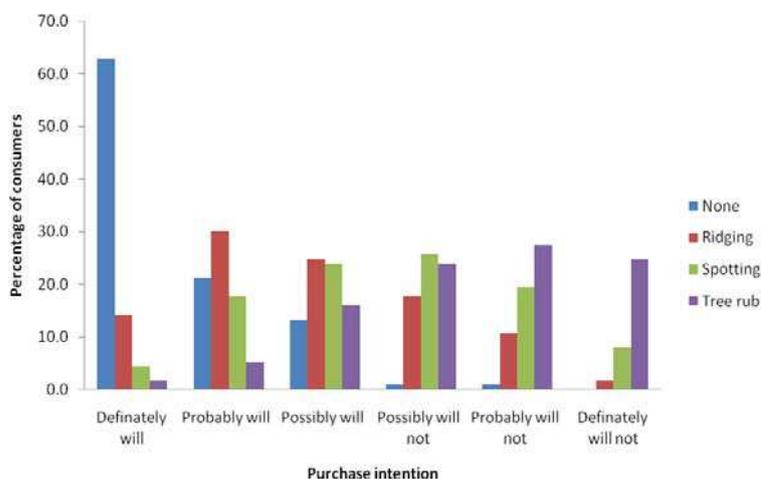


Figure 13. Influence of avocado cosmetic defects on consumer purchase intentions.

### 3.4.2 Frequency with which consumers report damaged avocados

Eighty-two percent of consumers reported that three or more out of every five avocados that they usually purchase has some internal damage (Figure 14a) and 58% of consumers indicated that they usually need to discard a quarter or more of the flesh of damaged avocados (Figure 14b). These percentages for incidence and severity of damage are higher than those obtained during the 2009 retail survey of 16 outlets (four major cities) where 59.5% of fruit was found to have some internal flesh damage, but only 25.4% of fruit had symptoms where 10% or more of the flesh had been damaged (Embry, personal communication). This suggests that substantial damage may occur during transit from the retailer to the home, in the home, or that consumers are sensitised to the issue of fruit damage and are overestimating the actual number of occasions that they find damaged fruit. If it is one of the former explanations, then we highlight that this may represent a significant risk should industry implement a guarantee for fruit quality.

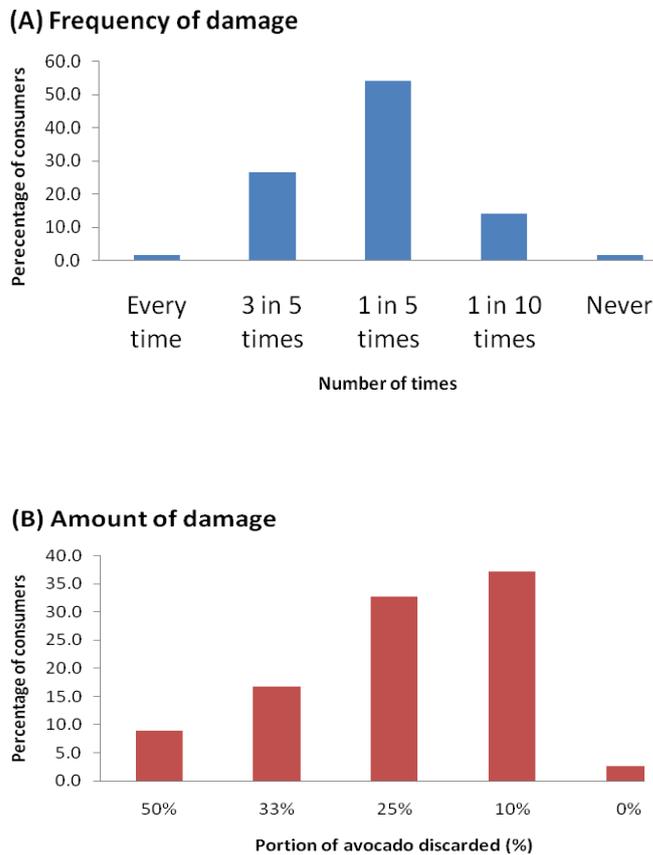


Figure 14. Self-reporting of incidence (a) and severity (b) of damaged avocados by consumers.

### 3.4.3 Consumer uses of avocado and where they store their avocados

These questions were used to start consumers thinking about the ways in which they used avocados and whereabouts in the home they stored their avocados, as prompts to their requirements of the fruit. It is clear that consumers are largely using their avocados as a spread or ingredient in meals rather than as a whole fruit eaten on its own (Table 4). Consumers were storing their avocados in the refrigerator (81%) as well as in view of visitors (70%) (Table 5). The most likely explanation for both options having high response rates is that consumers store fruit in different locations according to the ripeness of the avocado and the length of time the consumer wants to keep the fruit.

Table 4. Ways in which consumers use or eat avocados (values represent % of consumers).

Use	%	Use	%	Use	%
As a spread	81.4	With nachos	69.0	In a prawn cocktail	17.7
On bread	80.5	With other Mexican	45.1	With soup	1.8
On crackers	56.6	With risotto and/or	10.6	For a baby	15.9
As an ingredient in a	90.3	With baked potatoes	10.6	On a platter	26.5
Cut in half with a filling	8.0	As a topping on a	4.4	I would eat it as a fruit	23.9
As a dip / guacamole	79.6	With sushi	62.8	Other	4.4

Table 5. Storage options in the home (values represent % of avocado consumers).

Location	%	Location	%	Location	%
In a fruit bowl that is in clear view	52.2	In a fruit bowl but out of sight (for example in a cupboard)	1.8	Somewhere other than a fruit bowl or the fridge that is out of sight	0.9
Somewhere other than a fruit bowl but still in clear view	17.7	In the refrigerator	81.4	Other	1.8

### 3.4.4 Relative importance of cosmetic defects and internal damage

The presence of damaged flesh in avocados was considered to be a greater problem for consumers than cosmetic defects. This was the case immaterial whether the questions were asked individually (e.g. *How important is it that there are no marks, blemishes or imperfections on the outside of your avocados?* or *How important is it that there are no portions of the avocado that you need to throw away?*) or together (e.g. *How important is external appearance relative to internal quality of the avocados you buy?*) (Figure 15). Notably, 60% of consumers indicated that external appearance was less important than internal quality, 17% thought they were of equal importance and 22% considered external appearance to be more important than internal quality (Figure 15b).

This is perhaps not surprising given that consumers were asked a series of questions that made them think about past quality experiences in the lead up to the question on relative importance of cosmetic defects and internal damage. However, it is important to consider the earlier unprompted result on the effect of cosmetic defects (ridging, spotting and tree rub) on purchase intention – willingness to buy avocados declined dramatically for fruit with cosmetic defects (Figure 13).

We believe more research is needed to understand the trade-offs between external appearance and internal quality, should this become a core component of any guarantee or pricing strategy.

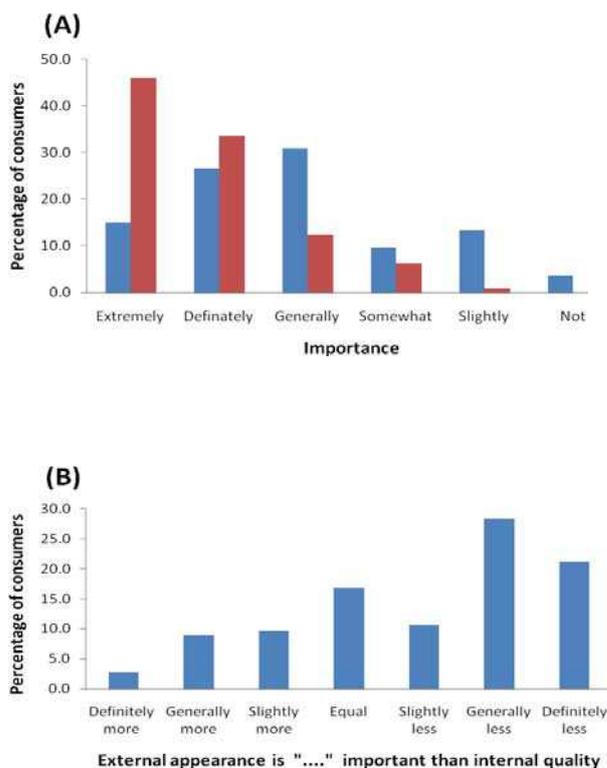


Figure 15. The importance of avocado external defects (blue bars) and internal quality (absence of damage, red bars) to consumers when asked as individual questions (A) and the associated rating of relative importance (B).

### 3.5 Consumer responses to a guarantee for internal quality

Internal quality in this part of the study was defined as absence of internal damage. Consumers all responded positively to the quality guarantee, with 60% of consumers indicating that they would definitely be more willing to buy a fruit with a guarantee (Figure 16). Only 9% of consumers indicated that the guarantee would not alter their willingness to buy the avocados and no consumer indicated that they were less likely to purchase fruit as a result of the guarantee (Figure 16).

The reasons that consumers were responding this way were apparent from their responses to the open-ended question: ‘How would this guarantee affect your decision to buy an avocado?’ Responses were predominantly positive (n=84), with neutral responses (n=12) relating to consumers not being currently worried by quality of avocados and comments that the guarantee would only be useful if shops were at a convenient location. Negative responses were mainly that it would be difficult/annoying to return avocados (n=4) or that consumers thought that prices would be higher as a result of the guarantee (n=3). There was also a theme relating to how believable such a guarantee would be (n=9). Many consumers specifically indicated that the value of the guarantee was not so much related to the need to replace damaged fruit, but more to the confidence that industry had that the product was defect free. A number of consumers specifically commented on that industry would be showing confidence in their own product (n=8), with a substantial number of consumers indicating that, even though they approved of the guarantee and would buy more avocados, they probably wouldn’t return their avocados if they were damaged (n=34), because of the inconvenience of going back to the shop and the need to keep receipts. Two consumers commented on their bad experiences when trying to return products to retailers. A small minority of consumers specifically commented that they would return their fruit (n=6). Table 6 presents a summary of comments with examples, and the full list of comments are provided in Appendix 2.

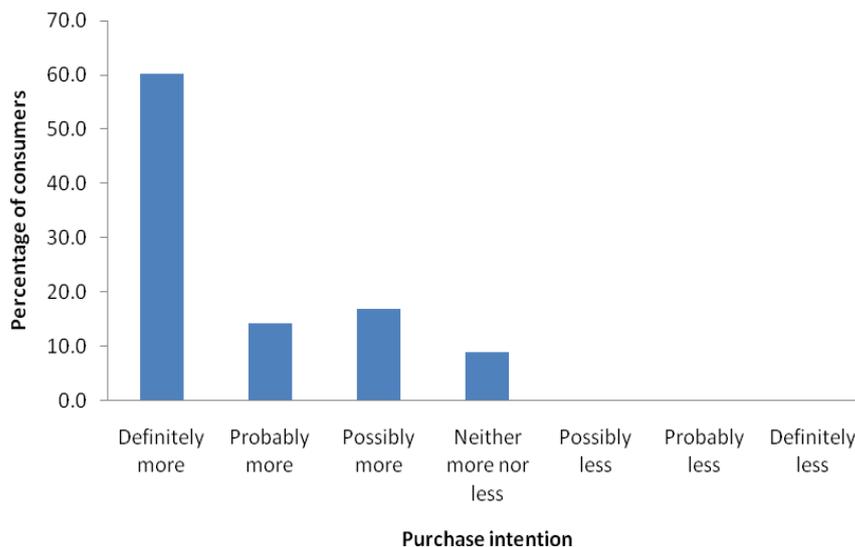


Figure 16. Influence of guarantee on consumer intention to purchase avocados.

Table 6. Analysis of consumer comments on guarantee. Number of comments are greater than the number of consumers, as many consumers provided multiple comments.

Theme	Number of comments	Examples
Positive	84	<ul style="list-style-type: none"> <li>• <i>This guarantee makes me feel more confident on the internal quality of the avocado.</i></li> <li>• <i>Very useful, I would probably buy a lot more if I could be guaranteed there was no internal damage or money back.</i></li> </ul>
Neutral	12	<ul style="list-style-type: none"> <li>• <i>A good idea but probably of no use to me, I haven't had too many bad avocados.</i></li> <li>• <i>Would only be useful if shop was only a short distance from home.</i></li> </ul>
Negative	4	<ul style="list-style-type: none"> <li>• <i>It is good if they are charging lots for the avocado (\$3-\$4) but you still have to go back to the shop which is annoying.</i></li> </ul>
Concerns on price	3	<ul style="list-style-type: none"> <li>• <i>I would hope that it did not drive the price of avocados up!</i></li> <li>• <i>I'd worry about the cost of maintaining this guarantee (it's probably [to] be passed on to the consumer)</i></li> </ul>
Believability	9	<ul style="list-style-type: none"> <li>• <i>That sounds too good to be true!</i></li> <li>• <i>How can you guarantee that of a natural product? It would make me wonder how it's been grown, stored, altered.</i></li> <li>• <i>Going back to get another dodgy avocado would not be satisfactory.</i></li> </ul>
Reassurance by industry	14	<ul style="list-style-type: none"> <li>• <i>Would make me feel confident with the grower and the store and elevate my perception of them.</i></li> <li>• <i>It creates confidence as a purchaser - Implies the grower/retailer cares about the quality of product.</i></li> </ul>
Would not return fruit	34	<ul style="list-style-type: none"> <li>• <i>Not sure if I'd go through the bother and hassle - keeping receipts, lining up for a refund, etc.</i></li> <li>• <i>The reality is that I would be unlikely to return the product due to time and inconvenience.</i></li> </ul>
Definitely return fruit	6	<ul style="list-style-type: none"> <li>• <i>I would certainly return the avocado if necessary.</i></li> <li>• <i>I would return if damaged.</i></li> </ul>
Experience of returning products	3	<ul style="list-style-type: none"> <li>• <i>However, it is embarrassing having to return to the store as sometimes the store people do not like to return even when a product states that you can return it if unsatisfied.</i></li> </ul>

As the scale or value of the guarantee increased, consumers became increasingly willing to purchase the avocados (Figure 17). All levels of guarantee evoked statistically significant differences in consumer response ( $P \leq 0.01$ ) with the exception of the '150% refund' and 'replace with 2 avocados' (Friedman's test followed by Wilcoxon matched pairs tests). For example, consumer responses became increasingly favourable as guarantee increases from replace or reimburse to replace with two new avocados, to 150% refund, to replace with two avocados or refund 150% of price (Figure 17). Essentially these data suggest that consumers were responding to their judgment of the value of the offer/guarantee and also to increased options of how to implement the guarantee. One might speculate that the decision to receive a refund or a replacement may reflect the original reason the fruit was purchased, e.g. to use when entertaining/a special occasion versus everyday use.

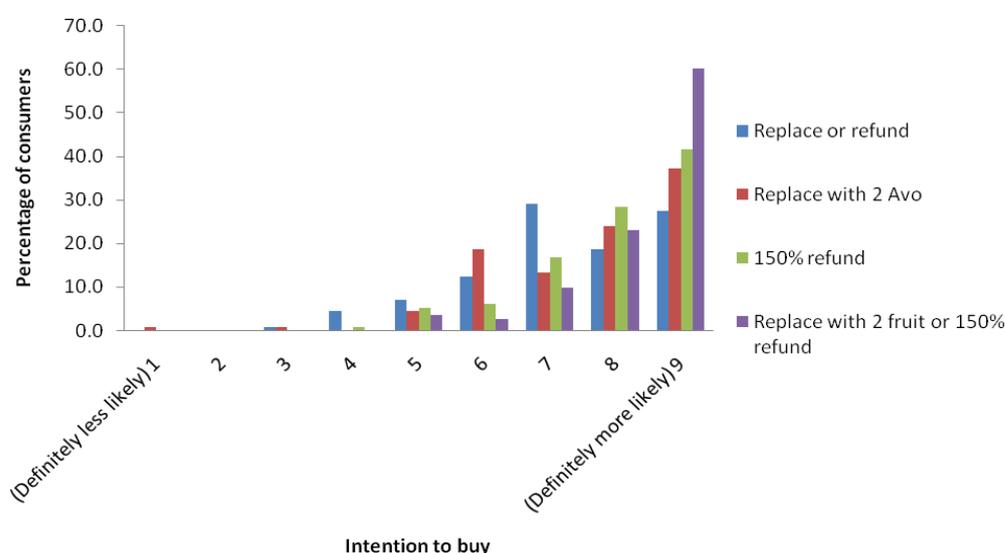


Figure 17. Influence of different magnitudes of guarantee for replacement or refund incentives on consumer intention to purchase avocados.

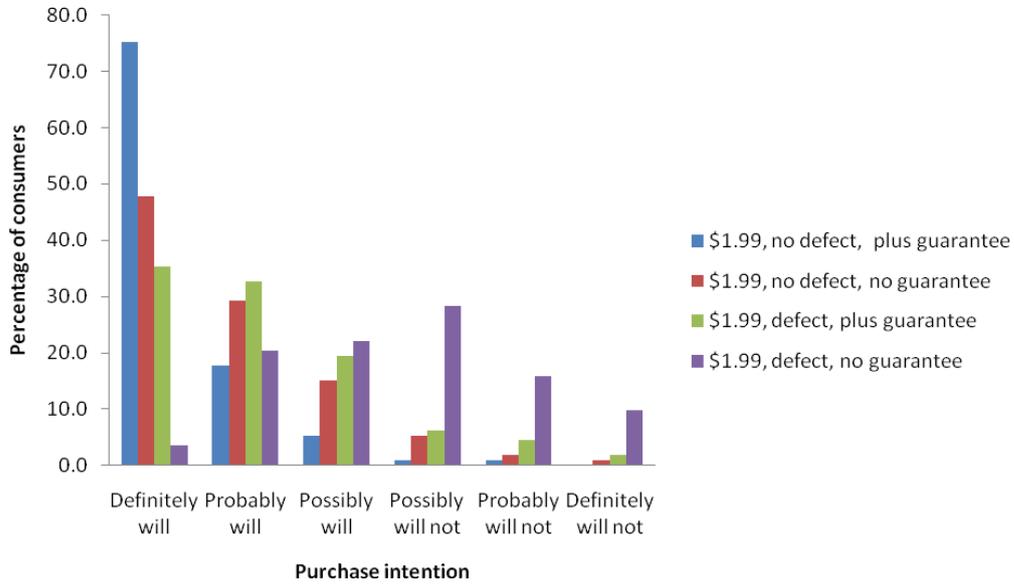
### 3.6 Influence of cosmetic defects, price and guarantees on consumer willingness to purchase avocados

Consumers were asked to indicate their purchase intentions for a series of eight scenarios where external defects (present/absent), price (\$1.99/\$2.49) and guarantee (present/absent) were systematically altered. All factors (defect, price and guarantee) had a significant influence of consumer purchase intentions ( $P < 0.001$ ) with a significant interaction ( $P < 0.001$ ) between presence or absence of defect and price. Recall that a third of consumers assessed scenarios based on each of the external defects (ridging, spotting and tree rub), respectively. Statistical analysis of individual defects produced similar results to the combined analysis (described above), with the exception that the interaction between presence or absence of defect and price was not significant for ridging. Given the similarity of data collected and the low numbers of participants associated with analysis of individual defects, all further discussion relates to the combined analysis (Figure 18).

The price point at which avocados were sold had a dramatic influence on purchase intention. For this reason, along with presentation of options for purchase scenarios in two rows (top row

at \$1.99 price point and bottom row at \$2.49 price point), we have presented separate graphs showing the influence of defects and guarantee on purchase intention (Figure 18). It is not unexpected consumers were most willing to purchase avocados without external defects and a guarantee and were least willing to purchase avocados with an external skin defect and no guarantee (Figure 18a, b). However, purchase intentions for avocados without external damage but no guarantee and avocados with an external defect but covered by a guarantee for internal damage were similar (Figure 18a, b). The relative importance of the guarantee seemed to differ for these two treatments depending on price point. Consumers seemed relatively more interested in an avocado that had a guarantee (even if there was an external defect) at the higher price point (Figure 18b) than at the lower price point (Figure 18a).

**(A) Price point = \$1.99**



**(B) Price point = \$2.49**

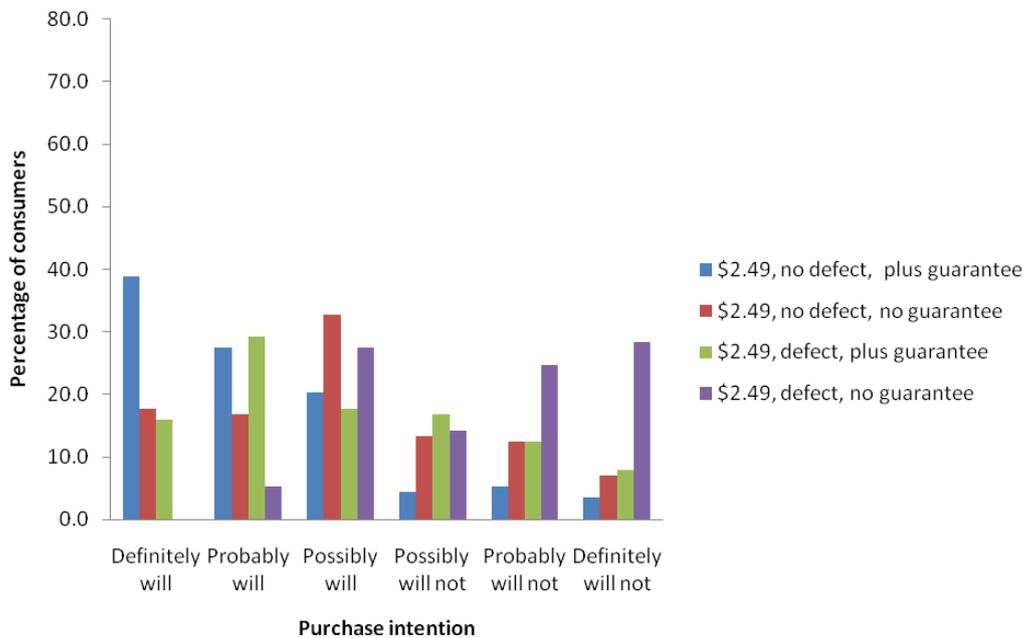


Figure 18. Consumer purchase intentions for avocados with and without external defects and with and without guarantee for internal quality (absence of flesh damage) at price points of \$1.99 (A) and \$2.49 (B) per fruit.

### 3.7 Interpretation and implications of study on external defects, internal damage and the value of a quality guarantee

The intention of this component of the study was to gather baseline information to inform current and future discussions within industry over the possibility/risk of implementing a quality guarantee. An obvious risk to such a programme apparent from the current data is the high level of self reporting on the incidence and severity of damaged flesh in avocados eaten in the home. It is not clear whether this damage is the result of industry supply chain, occurred as a result of mishandling in the home, or during transit from the store to the home.

Consumers clearly saw value in the provision of a guarantee and most indicated that such a guarantee would increase the likelihood with which they would purchase avocados. Many consumers indicated that although they would be encouraged to buy avocados, they probably would not return damaged avocados because of perceived inconvenience of keeping docketts and having to return to the store. We would speculate that the value of the guarantee would therefore be that industry is demonstrating the confidence they have in their own product. However, it would be easy to lose this level of consumer trust if it were not possible to deliver damage-free avocados. Indeed, a number of consumers were expressing scepticism that such a guarantee was possible and not just '*a marketing gimmick*'.

An area of interest to Avocados Australia Ltd was the option to alleviate the need to discard fruit with external cosmetic defects by providing a guarantee of the internal quality (absence of flesh damage). The data in the current study confirmed that consumer choice of fruit is strongly influenced by the external appearance, even though they realise that internal quality is more important. There was some evidence of a equitable trade-off between external damage and presence of a guarantee such that avocados with external defects but with a quality guarantee were perceived to be of similar value as fruit with a perfect skin but no guarantee. However, the overwhelming result was that a guarantee would increase willingness to purchase all avocados and opportunities associated with fruit without external defects are perhaps greater than for those avocados with external defects.

## 4 Conclusions

### 4.1 Maturity

The frequency with which consumers described immature avocados as having a bland/tasteless or watery flavour was significantly higher than for other maturity treatments. This poorer flavour experience is one of the reasons that consumer liking for immature avocados was significantly lower than for either early or late maturity avocados. More detailed analysis indicated that consumer liking of avocados increased progressively as the DM content increased from 18% to 23%. The data suggest that consumers will perceive an improvement in avocado quality as the DM standard is set at a higher level within this range. However, there is no benefit to industry in setting a maturity standard higher than 23% DM, since there was no significant improvement in consumer liking of avocados from the higher maturity treatments.

### 4.2 Quality guarantee

Consumers responded positively to the suggestion that industry might guarantee the internal quality of avocados. The advantage of such a guarantee was seen as the reassurance that consumers gained from industry's own confidence in the product and many consumers indicated that they probably wouldn't use the guarantee to return damaged avocados for replacement or reimbursement. There are two obvious risks identified in the current study that industry would need to assess before implementing any guarantee. Firstly, if the value of the guarantee is associated with reassuring consumers that industry can be trusted to deliver damage-free avocados, then one would need to be certain that industry could achieve this – otherwise consumer trust would be lost and the guarantee devalued. The second risk is apparent in the high reporting of damaged avocados in consumers' homes, which suggests that significant damage occurs from handling of avocados by consumers after purchase. Industry would need to consider how they would address this issue and its impact on their guarantee without damaging relationships with consumers.

## 5 References

Arpaia ML, Boreham D, Hofshi R 2001. Development of a new method for measuring minimum maturity of avocados. *Californian. Avocado Society 2001 Yearbook* 85: 153-178.

Harker FR, Amos RL, White A, Petley MB, Wohlers M 2008. Flavor differences in heterogeneous foods can be detected using repeated measures of consumer preferences. *Journal of Sensory Studies* 23: 52-64.

Harker FR, Jaeger SR, Hofman P, Bava C, Thompson M, Stubbings B, White A, Wohlers M, Heffer M, Lund C, Woolf A 2007. Australian consumers' perceptions and preferences for 'Hass' Avocado. Report to Horticulture Australia Ltd, Project AV06025. HortResearch Client Report No. 21796. 53 pp.

Harker FR, Maindonald JH, Jackson PJ 1996. Penetrometer measurement of apple and kiwifruit firmness: operator and instrument differences. *Journal of the American Society of Horticultural Science* 121(5): 927-936.

Harker FR, Norquay C, Amos R, Jackman R, Gunson A, Williams M 2005. The use and misuse of discrimination tests for assessing the sensory properties of fruit and vegetables. *Postharvest Biology and Technology* 38: 195-201.

Hofman P, Ledger S. 2001. Reducing avocado defects at retail level – Avocare. Department of Primary Industries, Queensland. 33pp.

Johnston J, Requejo-Jackman C, White A, Woolf A 2006. Avocado maturity: a review of harvest indices and the relationship with postharvest quality. Report to Avocados Australia and Horticulture Australia. HortResearch Client Report Number 20621.

Schroeder 1985. *California Avocado Society Yearbook*, 69: 137-143.

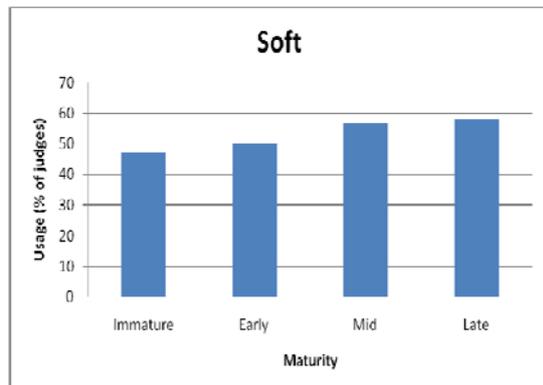
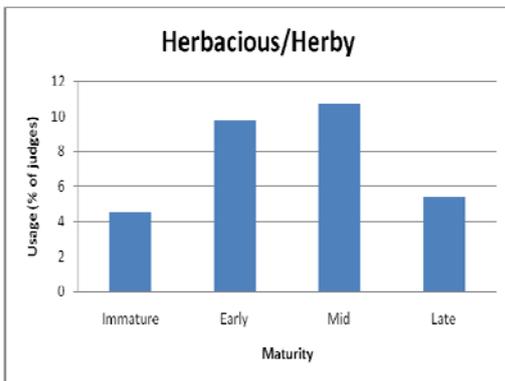
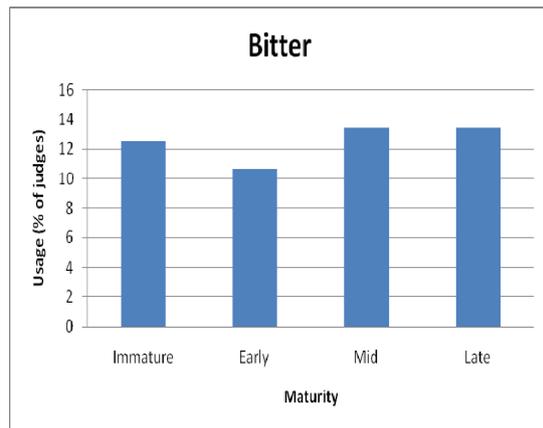
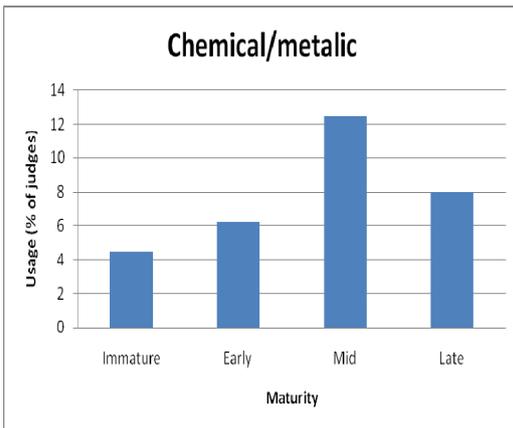
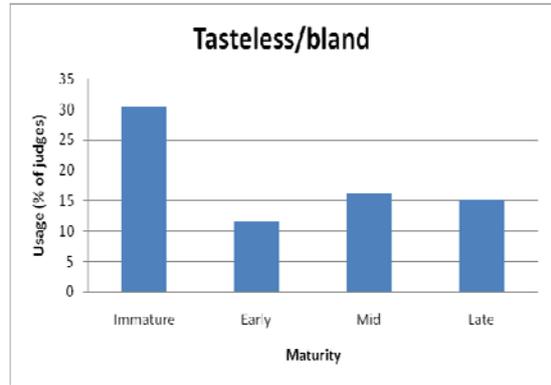
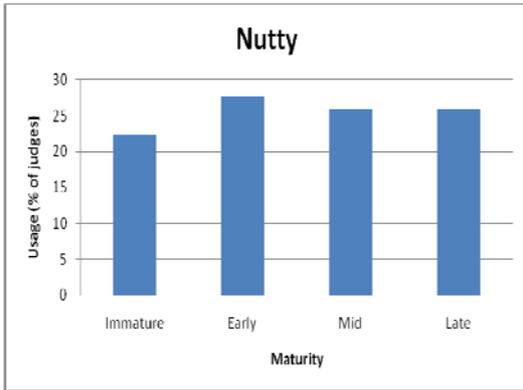
White A, Woolf AB, Harker FR, Davy MW 1999. Measuring avocado firmness: assessment of various methods. In: *World Avocado Congress IV Proceedings*, Uruapan, Mexico, October, pp. 389-392 (Revisita Chapingo Serie Horticultura 5 Num. Especial).

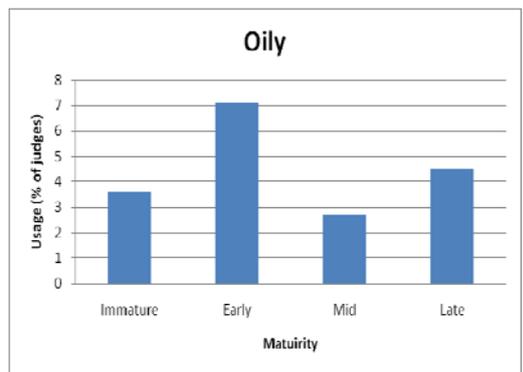
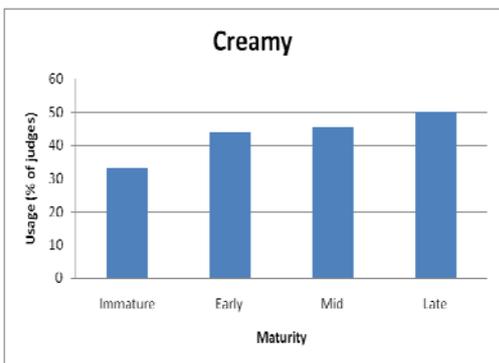
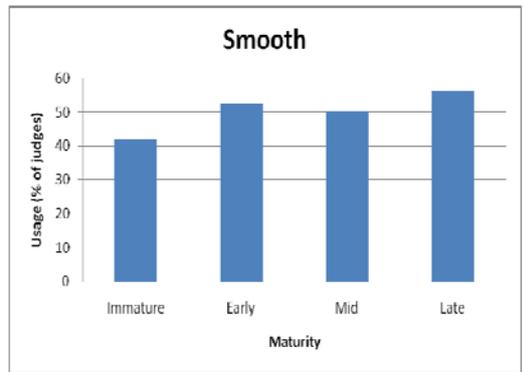
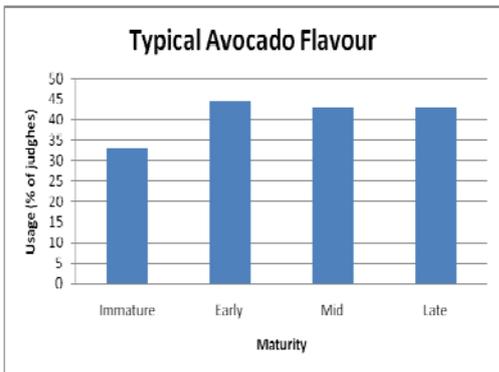
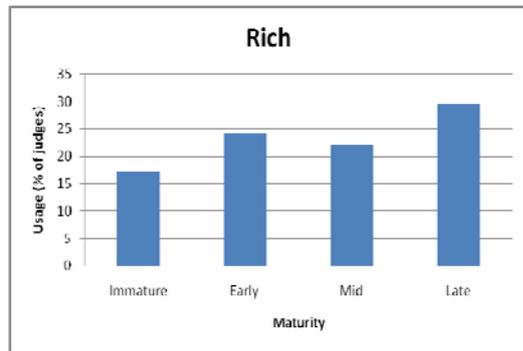
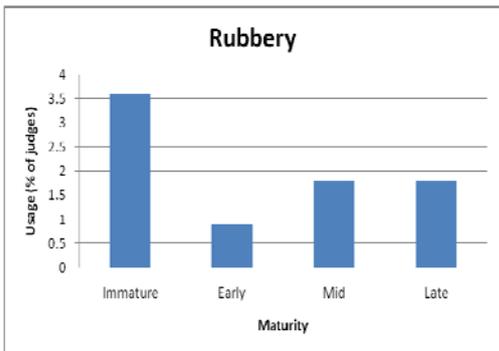
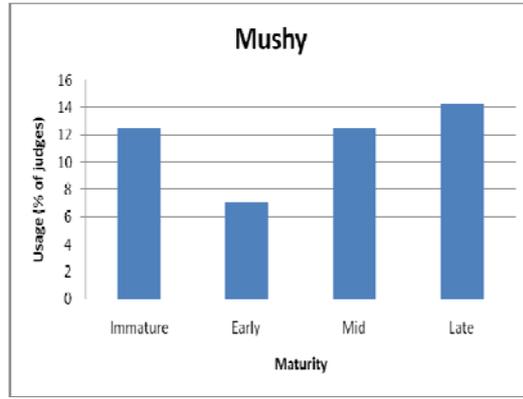
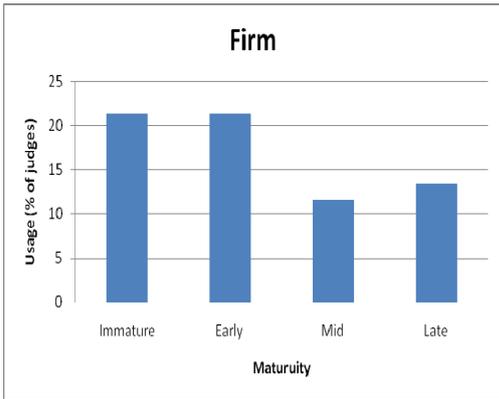
White A, Woolf A, Hofman P, Arpaia ML 2005. The international avocado quality manual. The Horticultural and Food Research Institute of New Zealand Ltd, Auckland, New Zealand. 72 pp.

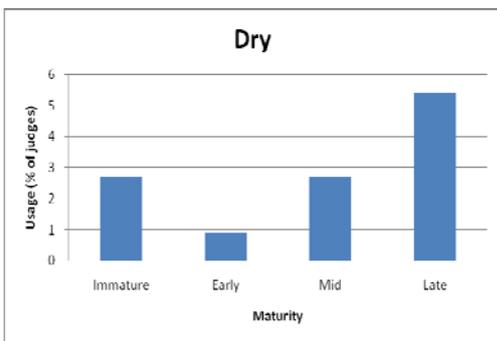
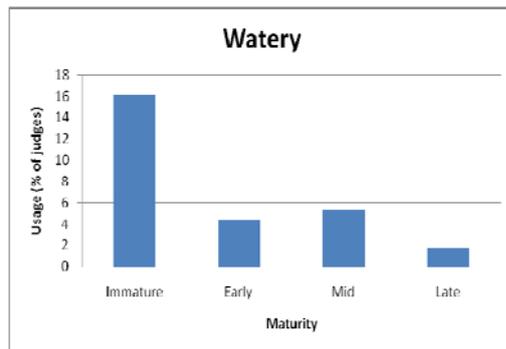
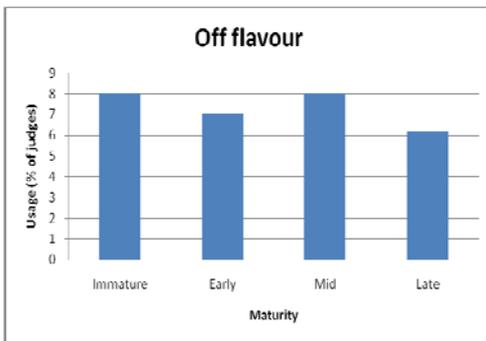
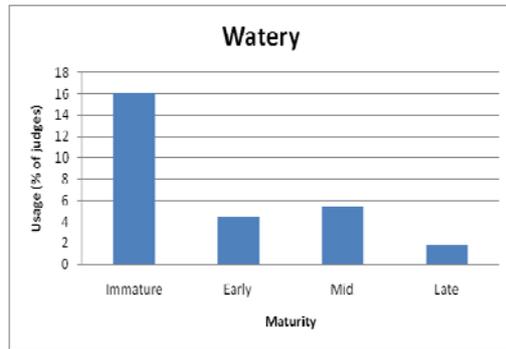
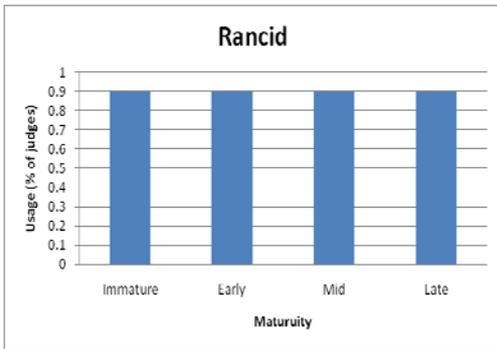
White A, Woolf A, Hofman P, Arpaia ML 2009. The international avocado quality manual. The New Zealand Institute for Plant & Food Research Ltd, Auckland, New Zealand. 70 pp.

# 6 Appendices

## 6.1 Appendix 1 – Frequency of descriptor use







## 6.2 Appendix 2 – Consumer responses to open-ended question: “How would this guarantee affect your decision to buy an avocado?”

It is a useful guarantee, but only if I can be bothered to return to the store to get the refund!
I do not usually have bad luck with avocados and buy them with reference to when I will eat them. So unless I had a very unlucky avo, it does not mean much.
It would depend how far away from home I was. It would be useful if there was a supply of that guarantee in most shops.
I would want to buy avocados more as I'm guaranteed a 'good' avocado. It just seem like a waste (financially and food-wise) when I buy an avocado and some of it goes to waste because it is damaged.
It's a good thing but I probably wouldn't bother over an avocado. I like them most of the time.
This guarantee makes me feel more confident on the internal quality of the avocado.
That sounds too good to be true! But this statement definitely encourages me to buy avocado on the spot when I see it. But some concerns like I'm too busy and I wouldn't care for a few dollars and I wouldn't come back with opened avocado to a shop to show to a nice lady. I'd be ashamed a little. But such a guarantee on quality of avocados would impress me!
Yes, it would be useful in a way that you as a buyer would get total satisfaction out of the product. That way the ...stays happy and has fresh avocados.
I think it seems like a bit of overkill - I would hope that it did not drive the price of avocados up! That being said, I would be much more confident that I would be purchasing a premium avocado first time, as I'd assume the store would not wish to waste money.
It is from a shop I frequent then it would be extremely useful
This is assurance to stay within the brand as it guarantees the quality of the product.
Would find this guarantee useful and would certainly return the avocado if necessary, however purchase would still be determined primarily by price.
If I have the time to return the avocado I would as it has a guarantee on it.
Depends on the location of the store claiming it. Is it convenient to return the avo if damaged.
Very useful, I would probably buy a lot more if I could be guaranteed there was no internal damage or money back.
Excellent guarantee, waste of money purchasing an avocado that is internally damaged.
I think it is fantastic. I love avocados but get sick of buying them with internal damage.
It is a good idea for avocados, I am always getting so-so fruit.
I would wonder how this type of guarantee could be made (not sure how internal damage appears). Also, if only 10% of avocado was damaged, I probably wouldn't bother to return it for a refund. So all in all, I like the idea but it's probably not that useful to me.
Great idea, should apply to all fruit. Nothing worse than paying for what you think is good fruit only to bite or cut open and find it no good.
This is a great concept. It appeals to me because I regularly eat avocados. Although I am not too fussed if they are damaged, quality reassurance is always a good thing when purchasing a product.
Would only be useful if shop was only a short distance from home.
Less worries about the quality from the look of the outside.
Not very useful, who would bother going all the way back to the store to get their \$2 back? Although if they're offering it their avocados must be good.
Absolutely perfect. Can be a bit of a gamble buying avocados. This greatly reduces the risk.
I think it's great to give consumers a guarantee - especially at the times when avocados are quite expensive. It's really disappointing to cut into a discoloured or damaged avocado.
Ensure that I get a better quality fruit - it would mean the store would probably stock better quality if they are willing to guarantee it.
It is always good to know if there is a guarantee on anything you buy. It makes you feel secure that you're getting good quality - and if not - you can replace it. I tend not to have a problem picking damaged avocados, but it's always nice to have.
it's tasty.
Because you don't normally get a guarantee with fruit and veg it's a hit and miss thing. I would definitely buy if this was in place. Think it's a great idea.

Probably would not use all the time but would provide use with more confidence in buying.
Avocados are so expensive in Brisbane so it is really important that you get to eat all of what you pay for. So I would very much like to see this kind of guarantee.
I would feel it is safe to buy because I am always disappointed and feel ripped off when I have to discard a lot of the avocado as soon as I open it. However, it is embarrassing having to return to the store as sometimes the store people do not like to return even when a product states that you can return it if unsatisfied.
This is a fantastic guarantee. It would be useful for all types of fruit!
The guarantee sounds great but I'd worry about the cost of maintaining this guarantee (it's probably be passed on to the consumer) and the amount of wastage of avocados. There's already too much wasting of food at supermarkets.
I would only buy these ones if they had this guarantee.
As I usually shop or pick things up every 2-3 days the time line works well. Not sure if I'd go through the bother and hassle - keeping receipts, lining up for a refund, etc.
Would make me feel confident with the grower and the store and elevate my perception of them. Would be excellent to know I can exchange avocado. Make me feel confident of the quality of the product. It would be something I tell other people.
It would be great because I usually buy with the intention of using in the next couple of days. At least you know what you're getting is good, and if it's not you can return it so you would feel better about buying.
I like the idea but the reality is that I would be unlikely to return the product due to time and inconvenience. It would make me feel more confident in buying avocados when they're expensive.
I would definitely be more inclined to purchase avocados with this guarantee. Although it would only be handy if I am going back to that shop, as I don't like making special trips to return inferior goods.
A good idea but probably of no use to me, I haven't had too many bad avocados.
Would be great if fruit is being used for entertaining or special occasions - but in normal circumstances I probably couldn't be bothered to return one if it was damaged.
If there are no more chemicals used to produce it then I have a good feeling.
Yes, because if I pay for a quality fruit, I expect quality fruit.
Being on a budget it's hard to spend the money to find out that you're not getting what you pay for, but if I had this guarantee I'd buy avocados more often knowing I had this guarantee.
It may urge me to purchase it at the time because of the guarantee, however, if I got home and the avocado was damaged, I probably wouldn't bother taking it back, due to the effort involved. So it may only work initially (once or twice) but then after that not so much.
How can you guarantee that of a natural product? It would make me wonder how it's been grown, stored, altered?
Makes you feel more comfortable trying a new type of avocado. If I know the brand I'd be ok to just buy it because I know the usual taste, quality and internal appearance.
It would be a waste of time returning 1 or 2 avocados.
Don't know whether I would bother actually returning it if it was damaged but would make me feel more confident to purchase it possibly!
This guarantee is important, as sometimes when purchasing fruit it's very unlikely you're able to see the inside of the fruit and often when purchasing fruit there are a lot of damage and you do end up throwing away.
Highly desirable!
It will give me the assurance that my money is well spent.
If the place of purchase is handy this sort of guarantee would certainly make me feel more inclined to buy avocados.
Avocados usually have some kind of damage because they are so delicate, so this guarantee would be good to have as a back-up.
It would be useful because you know that if it's not quality then you haven't wasted your money.
Unlikely to claim on it as it is a lot of time to go back to store to return/swap avocado. Bit of a gimmick. I would return if damaged.
If this was possible it would make a big difference to the choice of avocado I would buy as I am always throwing them away because they are bad inside!
I will feel more confident while purchasing and paying the price of avocado knowing that I will get the quality that I want. Price is not the main factor in my purchase of avocado and I will be very happy if I

can get a quality guarantee.
Very useful, as I don't like to waste money.
It sound like a good idea, but to me seems like a bit of a hassle to have to go back. I would probably just use it and not bother returning the fruit.
Personally wouldn't make much difference as it is not efficient for me to go back to the shop to request my money back.
Money-back guarantees are a hassle when returning a product. I would usually not bother to return something. However, it does show confidence in a product, hopefully meaning the product is worth it.
This would be great and this means I can buy what I need and not need to buy slightly more in case some parts to be thrown out.
It is good if they are charging lots for the avocado (\$3-\$4) but you still have to go back to the shop which is annoying.
it's a kind of reassurance of top quality which is not always possible in a fruit. As this would be different it would make sure that if the avocado was internally damaged I would go for replacements hence always quality avocado to eat.
It is useful to me as I would intend on buying another avocado anyway and so I would return it for a better one.
I think it sounds good in theory, however, I would think that there would be some people who would take advantage of the systems and not be honest. I also am not sure how helpful it would be if you needed to use same day - would you got to the effort of returning?
The guarantee would make me more inclined to purchase this type of avocado. However, even if it did have internal damage, I probably wouldn't return it due to inconvenience.
It's always important to have value for money. You don't want to be discarding food if it's not necessary. The guarantee makes sure that I would have value for money. For me it's quite a good idea.
As a busy mum I don't have the time to go back to the store and return items even if I get my money back. I would be disappointed if the avocado was no good but wouldn't go back to the store.
Knowing that the internal fruit is guaranteed to be without damage is a great way to encourage more sales and I would be likely to buy with this guarantee.
Reassuring. Definitely useful as with the cost of avocados you do feel ripped off if it's damaged or unusable.
I do enjoy eating avocados but they can sometimes be a little over priced. I use it more as an alternative to butter or margarine, The guarantee will ensure that I know my money is not going to waste if I am not pleased with the product.
If buying from a smaller store like an IGA where they are good on refunds I would definitely be reassured by it. If it were at woolworths I would be more apprehensive as they are bad with refunds and it makes you feel embarrassed.
It creates confidence as a purchaser - Implies the grower/retailer cares about the quality of product.
Would rather a guarantee that the quality is perfect. Going back to get another dodgy avocado would not be satisfactory.
Very useful if no significant price increase. Would not affect decision to purchase an avocado, just the decision on which one.
It's reassuring to back the quality of the product with a guarantee however, it would have to be really bad for me to return the product.
Don't think I would like it because some shops may put the damaged ones back on the shelf.
Useful enough as I can let retailers/producers know of the quality they are producing and how to fix it in the future. Also, guarantees my money back on expensive fruits such as avocados.
I like the idea but honestly couldn't be bothered taking it back for a refund within any length of time. It makes me hope that there will be less problems though.
I would go for it. But it's not very attractive as I can't go to the shop just to return the avocados. I shall go only if I have any other work near/in the shop.
This is an excellent guarantee, because you can't always tell from the outside if there is some brown inside. I buy a lot of avocados and occasionally have to throw some away which is disappointing.
I would not find it important as we have a busy lifestyle so taking the avocado back - we probably wouldn't be bothered. We would probably continue to buy them without the above guarantee as much as normal (ie without the guarantee). I also think the 'offer' could be construed as an indication of poor quality.
That's generally a great idea for both buying (customers) and sellers as the guarantee would impress the customers in getting the items confidently. And not many customers would return them if there is any minor damage in it as he is well aware about the quality promise.

It would be advantageous to me as a consumer as there is nothing more disappointing than having to throw away large portions of the fruit.
This is a great guarantee as you are not left with damaged fruit that you have to throw away. As I use avocados regularly this would be extremely useful to me.
It would save a lot of wasted money when you buy them and can't use them.
It would be nice to be able to ensure that I get the most from an avocado as they are usually a luxury item in our household. I am very disappointed when avocado is waste.
This guarantee would be good as I am often disappointed with the avocados I get once home. It is a hassle to have to return them though.
I would love to be guaranteed that there is good quality fruit available. Considering the cost of avocado, it is quite annoying having to throw out so much of it.
It would be an encouraging factor for me to buy avocados more often.
This would be extremely useful and allow me to choose fruit that are riper than I would normally purchase.
It might influence me to think about buying the fruit. But I would still believe in my own opinion about the fruit.
The guarantee would give me confidence about the quality of the avocado and encourage me to purchase it. However, if I did buy an avocado with internal damage, it would be unlikely that I returned the avocado due to inconvenience.
Only useful if it is convenient to return to that store. Cost of petrol v's cost of avocado.
I wouldn't take any notice of it, even if the avocado I bought did have internal damage.
Happy as I know that I would buy a quality avocado
I would probably consider it just as a marketing gimmick. To return an avocado would mean finding time from work (in full-time employment), driving to the shop (not environmentally friendly if sole aim of trip) and making sure I kept the shopping docket (as proof of purchase).
If the outside seems to be fine but the inside is terrible, at least you can get it replaced/refunded.
I think the guarantee is fantastic and would be inclined to buy avocados more often without the worry of losing money on bad produce.
It may be very useful depending on whether it is (avocado) to be used for guests or for me. If for me, very useful as I can take back at my leisure not really useful if I'm preparing dinner for guests. Generally good idea.
Not convenient to return 1 avocado.
Scepticism as to conditions attached - How must it be kept after purchase? But initial promise must be honoured. Useful because no-one wants to buy an avocado to find it is bad inside, especially if it is for a salad.
This would increase my interest if it was to a premium price.
It seems a little "Tacky" but generally speaking if I knew I could return a damaged avocado, I would be far more likely to buy more.
I would feel extremely satisfied and will definitely buy from the seller. Price will not be an issue.
This is a good guarantee, because you can't always judge the internal condition. So if I bought an avocado that had a good external condition but was internally damaged, I could exchange it for a better/different one instead of throwing it away and wasting money. This would be useful to me as I have a tight budget and don't like wasting food.
A guarantee like this would be more beneficial especially to consumers - when the store you bought it from would mean that they would have to handle the avocado more delicately which is where most bruises probably come from.
I really like this type of guarantee - I hate throwing away parts of avocados because of damage. This would be very useful to me.