

Understanding and utilization of flavour parameters in stone fruit

Varietal selection in conjunction with consumer preferences to increase stone fruit consumption in Australia



A report for

By Jason Size

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Executive Summary

Evaluation of stone fruit for the fresh market can be very subjective in nature. The aim of the scholar was to identify easier and more coherent ways to evaluate the multitude of varieties of stone fruit that come through the breeding system to help growers make more accurate choice on varietal selections for their orchards whilst also understanding current market demand and supply forces internationally. This will also help marketers and retailers understand the various consumer preferences that are current and help growers choose varieties that help increase sales and ultimately consumption of stone fruit in Australia. During the scholar's travels it was evident that flavour is clearly an individual perception and preference but there are various methods that could help streamline and clearly identify varieties with particular traits that are more consumer acceptable.

Basic methods such as simple evaluation data points leading on to principal component analysis (PCA) grouping linked to consumer testing can all be utilized in the stone fruit industry resulting in an overall benefit to the entire supply and demand chain. Importantly, post-harvest effects on fruit, whether it is within the supply chain or variety specific, is often not looked at in the detail that it may need to be in the future.

Currently in Australia we have under consumption of stone fruit. Some may call this oversupply in a small market but it is more a case of us hearing all too often "the customer is constantly complaining of a bad eating piece of fruit"; this comes from the supermarket level to the average person on the street at a farmers market.

Looking at markets overseas, there appears to be a move towards looking to different aspects of flavour and delivering more to the consumer at both a local level, supporting the "grow local, eat local" concept as well as utilizing particular branding strategies to improve sales.

It was also recognized that there are clear consumer preferences in taste, texture and maturity. The challenge is to see how the market can or will adapt to those needs at all levels.

The conclusions reached are to look more closely at post-harvest influences on the end eating quality of stone fruit and also move to potential utilization of a discriminatory analysis grouping plan in conjunction with consistent regional evaluation data to categorize stone

fruit with more clearly defined profiles that are consumer acceptable. The inclusion of other objective measurements like acid to enhance or improve the data set within current evaluations is also another aspect for consideration.

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Foreword



I have been a stone fruit grower for more than 20 years. Recently, I have also taken on the role of an evaluator within the Quality Fruit Marketing Pty Ltd (QFM) group where I have endeavoured to provide quality fruit and advice to all that require it.

The aim from the outset of my growing career was to grow the best fruit possible. This was indeed a huge statement considering all that goes into producing 'quality' fruit.

Not only are we faced with a knowledge constraint for utilizing good irrigation practices, fertiliser regimes and best practice production methods to get 'quality' fruit to the market, but we are also faced with Australia's harsh seasonal conditions as well as general business constraints.

Let us look at the word 'quality' that we use all too often in marketing our fruit. The word as described by Merriam-Webster dictionary (2014):

Definition of QUALITY

2 a: degree of excellence: grade

b: superiority in kind

In a book called 'The peach; botany, production and uses' by Desmond Layne and Daniele Bassi the word "quality" is defined;

'Fruit Quality is a concept encompassing sensory properties (appearance, texture, taste and aroma), nutritive value, mechanical properties, safety and defects. Together, these attributes give the fruit a degree of excellence and economic value'

Layne and Bassi go on to explore other meanings to explain that the economic relevance of the various quality traits is largely variable. (Layne & Bassi, 2008)

For my part, I would also add further to those definitions, including the words "ensuring that fruit is sound and free of defects, pest or disease and presented in a way which highlights the natural aspects of the fruit to make it look appealing or superior."

A definition of type is generally contained in all quality assurance procedures that growers and packing sheds use as well as specifications outlined by retail customers.

In my role of evaluating fruit, the tendency is to measure other parameters that are deemed to be also part of the 'quality' of the fruit, these include but are not limited to; size, sugar (brix), taste, flavour, texture, appearance, colour and so on.

Putting aside, but not forgetting, all parameters, the description and measurement of flavour is the main focus of my report and how it interacts with consumers, growers and breeders.

My role over the last few years has been to evaluate new varieties of stone fruit to ensure that they perform adequately in the region of the Riverland, South Australia.

Within this time the question of flavour has been identified as somewhat lacking in an industry which should pride itself on delivering to the consumer what he/she wants consistently. The pursuit of understanding 'flavour' as some type of measurement was deemed to be integral to my evaluation performance. This was also coupled with the fact that there was consistent pressure on me to provide reliable data to industry and my fellow growers.

I had already been made aware of an Australian report done on behalf of the Summer Fruit Industry which showed high sugar and riper, softer fruit was preferred more by consumers. Delivering riper fruit to the consumer is problematic from the grower perspective, as in most cases orchards and packing sheds are not equipped at this stage to be able to manage effectively the more mature fruit that the consumer wants. I looked at a number of other studies that have been done in the last 10 years from California. California is one of the largest suppliers of fresh peaches and nectarines to the rest of the United States.

On my travels I spent quite a bit of time in the United States visiting breeders, fellow evaluators and nurserymen. I visited California three times in the space of 13 months to try and gauge the extent of the season and understand the 2013 and 2014 season's overall performance for the growers.

In August 2013, I visited a breeder in Israel called Ben-Dor Fruits, plus three breeders in France and a retailer in the United Kingdom (UK). I also visited intellectual property managers in South Africa and supply category managers in London in June, 2014.

I want to thank Woolworths Australia for sponsoring me and allowing me to study a topic that I am deeply involved in.

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- My business partners and associates who continued to support me over my journey.
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Abbreviations

AIGN – Associated International Group of Nurseries

ANFIC – Australian Nurseries Fruit Improvement Company

CTIFL – Centre Technique Interprofessionel des Fruits et Legumes

DPS – Direct Produce Supplies

INRA – National Institute for Agricultural Research

LDA – Linear discriminant analysis

PCR- Principal component analysis

QFM – Quality Fruit Marketing

RSSC – Ripe Soluble Solids Concentration

RTA – Ripe Titratable Acidity

SARDI – South Australian Research and Development Industries

SF – Summer Fruit

SF 10021 – Summer Fruit Project number 10021

SSC – Soluble Solids Concentration- measured as Brix

TA – Titratable Acidity

Texas A & M – Texas Agricultural and Machinery University

U K – United Kingdom

USDA – United States Department of Agriculture

Objectives

The objectives of the study are primarily to understand:

- Various stone fruit breeders' views on flavour in their breeding programmes. What makes them choose a variety's profile over another and how.
- Retailers or marketers view on increasing or maintaining sales.
- The role of consumer surveys, sensory testing and their implications
- The use of flavour measurement techniques and fruit evaluations
- What does the grower do in the future and what is the nursery connection?

Chapter 1- Introduction

Growers in Australia face an enormous number of varieties available for them to plant from various nurseries. There are many nurseries providing multiple numbers of different selections for them to choose. For example www.factree.com.au, www.oleanurseries.com.au, www.littletreecompany.com.au, www.mossmontnurseries.com.au.

Growers are also facing high supply issues with lower returns in the current market environment for a normal season. Seasons do fluctuate in terms of overall quantity supplied, but a low supply year, due to climatic conditions, is generally not normal. A seasonal scenario of high supply, limited demand, is often due to consumer dissatisfaction with current offerings of the fruit on the market.

There have been some projects commenced at industry level to measure this and try and look at measures to reduce the current dissatisfaction level. The 2012/13 Industry advisory committee annual report refers to project SF11000 in improving consistency in stone fruit and also project SF 12003, where an experimental orchard is being established to investigate irrigation and tree density on various fruit in order to achieve better fruit for the consumer (Summer fruit advisory committee, 2013). Another project, SF10021, highlighted consumer testing that indicated that high Soluble Solids Concentration (SSC) and softer fruit gained an overall approval rating by consumers (Jones et al, 2012).

The aim of every grower is to remain viable within their industry. In order to do this in the stone fruit industry they need to consistently maintain their sales revenue. It stands to reason that if the sales revenue falls, then so potentially does the ability to remain viable. The question remains; how to increase sales when overall consumption rates are falling? One way is to increase production capacity and gain economic efficiencies. The other point is to understand and quantify reasons for low sales and take appropriate measures to rectify the problem. If low sales are caused primarily by low consumer satisfaction then there is a need to address the issues and fix it.

By looking at the consumer tests along with an understanding of the breeders, nursery, retail and grower experiences around the world then we may attempt to rectify the issues being experienced in the Australian stone fruit Industry. The eventual aim is to identify ways to increase the ability to provide consumers with fruit that provides a good eating experience as well as wanting to go back and repeat the purchase.

Chapter 2 - Understanding the breeder's aims

Stone Fruit Breeders

Travel in 2013 and 2014 to North America, Israel, France, Canada, South Africa and the UK was undertaken to meet with breeders, researchers and growers of stone fruit.

All breeders interviewed have their own defined taste of what they were trying to achieve. Some had many different profiles to fit their customers' demands, but in general they had an overall perception of the ideal, albeit in most cases this was of a subjective nature and based on their own palate (Size, 2014).

- Professor David Byrne, Texas A & M, has a good appreciation of breeding flavourful fruit but highlighted the need for other parameters to have a higher ranking as objectives. These included yield, colour, chilling requirement, and size. Flavour as well as texture was dependant on his experience in selecting lines which ate better or the same as the varieties currently available. (Byrne, 2013)
- Dr Jose Chaparro, Florida University, is focused on breeding low-chill varieties of peach (and some nectarine) in the Florida region. His main focus is on the chill requirements for that particular State with an emphasis on yield, size and flavour. Flavour again was benchmarked against his experienced palate. (Chaparro, 2013)
- Glen Bradford, B & Q Genetics, Le Grand California, is focussing more on sugar as the benchmark, with flavour being determined by himself and his son-in-law Jon Quisenberry. He is guided by the grower/packer organisations that are licenced to use his program. They give Glen and Jon feedback on the lines that they breed and make adjustments along the way. Most of the material sampled while at Glen's was low acid with high Soluble Solids Concentration. (Bradford, 2013)

- Terry Bacon of Sun World, in Bakersfield, California, has started to include other parameters that help him determine overall flavour of his peaches, nectarines, plums and apricots. He includes juiciness, texture, aroma, sugar and acid in his evaluations to help describe flavour. It is these parameters that allow him to decide whether a variety is flavourful. Again most of these parameters are based on the benchmarks that he has developed. (Bacon, 2013)
- John Slaughter of Burchell Nursery in Clovis, California, seems to be more inclined to have fruit with more acid in the profile. Although he has a suite of profiles he breeds he has a focus on post-harvest responses and what part production practices, rootstocks and nutrition have on his fruit. (Burchell, 2013)
- Floyd Zaiger, Leith Gardner of Zaiger Genetics, Modesto, California, constantly looks to have a wide range of fruit types and tastes available in the program. On any given day when you visit their weekly showcases, you will find apricots, plums, interspecific plums and nectarines, apriums, pubescence plums, cherries and white and yellow fleshed peaches and nectarines, all with different tastes which could satisfy any consumer. These breeders have their own views on what they think growers and consumers would want in the product that they provide but are also guided by growers as well. (Zaiger, 2013)
- Joseph (Seffi) Ben-Dor of Ben-Dor fruits, Israel, is a grower who started breeding fruit to provide a more consistent line of fruit for his orchard and packing shed. He has now demand for his lines of fruit from retailers in the UK. (Ben-Dor, 2013)
- Alexandre Bouche, AC Fruits, is guided by the owners of the program who seem to want more sub-acid peaches. His opinion is guided towards sub-acid for peaches with more of a balanced taste in the nectarines. However there were some peaches and nectarines that when tasted seemed to have a low acid profile. (Bouche, 2013)

- INRA, Guy Clauzel, apricot breeder gave me his breeding order of preference and fruit taste was third on the list after disease and pest resistance, fertility before taste. (Clauzel, 2013)
- Laurence and Arsene Maillard were adamant that acid played an important part in the flavour profile of the fruit. They had previously been ridiculed for going down the low acid, high sugar line but now they have been sought out by Waitrose to use Maillard's brand 'Regalines' in their marketing plan. (Maillard, 2013)
- Craig Ledbetter, USDA, was the first to indicate to me that maybe consumption rates are falling not because of poor quality fruit but an increase in other available options. He is one that is working with some acid values to give more meaningful data to his varieties whether they are apricots or grapes. (Ledbetter, 2013)
- Darren Graetz of the South Australian Research and Development Institute (SARDI) uses his palate as a base for taste, texture and juiciness, but also backs it up with post-harvest work to see how the material behaves in and out of storage. (Graetz, 2014)
- Dr Ksenija Gasic of Clemson University of South Carolina, utilized general palate analysis but is heavily involved in the RosBreed program to map the genetic structure of the peach. Evidence from the genes that they have isolated is helping them get closer to knowing fully what to look for genetically when screening out new hybrids down the track. For example, they can eliminate low blush, certain diseases, acidity levels and some levels of sweetness compounds. (Gasic, 2014)
- Dr Chunxian Chen, of Byron Georgia, has recently taken over from Dr Okie at the Georgia USDA Byron department, is slowly just starting to adapt his palate to what his growers are requiring him to look for in terms of quality parameters in his and Dr Okies hybrids. (Chen, 2014)

In conclusion, most breeders visited, rarely indicated that they use any scientific form of measurement of flavour or taste. Most is from a subjective but experienced palate basis. One breeder has indicated a specific number for acid in relation to 'high SSC' but again utilizing, more often than not, a palate approach. A couple of other breeders have indicated that acid is important for flavour but generally do not do too much testing for it.

Most breeders have made constant changes in their breeding programs to give their customer the fruit that they desire. The move to sub-acid or low acid nectarines and peaches from a more traditional acid base is one instance where this has occurred (Crisosto et al, 2005).

It should also be noted that the breeders within a public breeding program are often more ready than not to use consumer sensory data as validation or verification of their fruit for acceptance.

Dr Amy Bowen of the Vineland Research and Innovation Centre near Niagara in Canada indicated potential work they may do for the current peach breeder at Vineland to verify that some of the newer lines are consumer acceptable. Dr Bowen has done a lot of work to profile volatile aroma compounds in apples to group specific traits within apples that certain consumer demographics desire. (Amyotte, et.al., 2014)

Chapter 3 – Retailers and marketers

Retailers

A conversation with Waitrose, a significant retailer in the U K, suggested that they have very defined views on a flavour target. They have spent a lot of time looking at various breeders around the world to end up settling on a program to utilize the 'Regaline' brand of Laurance and Arsene Maillard, ARGO Selections Fruit. Their aim is to use this brand to provide a consistent line of peaches and nectarines to their consumers at a premium price, involving less work than they currently undertake with Ripe and ready.

Ripe and ready has been used predominately in the United States to provide a more mature piece of stone fruit to the consumer to increase consumption rates. The Ripe and ready process is the forced ripening of stone fruit after harvest, as part of the post-harvest supply chain cycle, which introduces an additional cost compared to stone fruit harvested at a certain maturity, usually at a firmer pressure, and then straight to the consumer. The Ripe and ready program in the UK involves consumers taking the fruit home and ripening it themselves. This takes the product's quality out of the control of the grower and retailer and onto consumers, who may not be educated enough to correctly follow through the ripening process. Utilizing a line of stone fruit that is already of a consistent quality in terms of flavour will avoid all those issues raised above.

Other flavour quality specifications utilized and employed by Waitrose is a brix standard or minimum level. In June 2014, Waitrose showed that, from data the previous season, there was an increase in sales or a positive reaction to the Regaline program, albeit on limited supply (Northcroft, 2014).

In meetings with retailers in London during June 2014, it was clearly demonstrated that by putting a 'local' feel to the product like a Union Jack, demand increased dramatically for the product (Size, 2014).

In Australia, Coles Supermarket has its own specifications of quality, including; brix, pressure, colour, appearance, defect levels, pest and disease. In discussions with Coles in recent years there has been an increased emphasis on achieving better fruit to increase their sales revenue. Access to these specifications is limited unless you are a supplier.

Marketers

Family Tree Farms were interviewed in April, 2013, beginning with Eric Wuhl at their research and development centre and then with their sales Manager Don Goforth. Family Tree Farms, through Eric Wuhl, has focused on putting varieties on trial to evaluate their performance. Main criteria are flavour, size and yield. Eric puts many varieties on display for tasting with the sales team and customers of Family Tree Farms. With this knowledge plus his own, they select varieties for the business's owners to plant. The view of the sales department is that every customer is not just a sale but a partner in a business that is selling flavour to the consumer (Wuhl, 2013).

The business also looks at newer type fruit and develops unique selling points to make sales. It was interesting to note a YouTube clip which showed Rick Jackson and some of his young nieces cutting up a flat type peach and cooking it in the microwave to show what can be done with this type of fruit. Anyone can look at this by searching online for Family Tree Farms' Peach Pie in a Minute (<https://www.youtube.com/watch?v=8awi07Ml1pA>). It is this approach that they feel has been the success of the business. They are constantly looking for new varieties, looking at the agronomical aspects of growing the fruit and letting their customers taste the fruit for feedback.

Giumarra is a business that grows, packs and markets its own fruit. It has recently taken on board an agreement to have an exclusive license to manage a breeding program of stone fruit from France. (Krause, 2013)

Ben-Dor Fruits is not only a breeder but a grower and packer of stone fruit. They have utilized their knowledge of growing and selling the fruit to breed the varieties with the

flavour that suits their climate but also their customer demands. They have consistently seen demand from their UK customers and growers in Chile and South America for their fruit.

Marketers are keen to grow lines of stone fruit that meet their customers demand. They have recognized the demand for good flavoured fruit and have taken steps that seem appropriate to manage it. Travels to the UK in June 2014 indicated that retailers are not able to supply consistent product to the consumer. Meetings with UK retailers and suppliers continue to highlight concerns over the variability in the individual varieties within the stone fruit category.

Chapter 4 – The consumer

Reports that have been made in recent years suggest that consumers of stone fruit in Australia are generally dissatisfied with the fruit that they eat. (Jones et al, 2012)

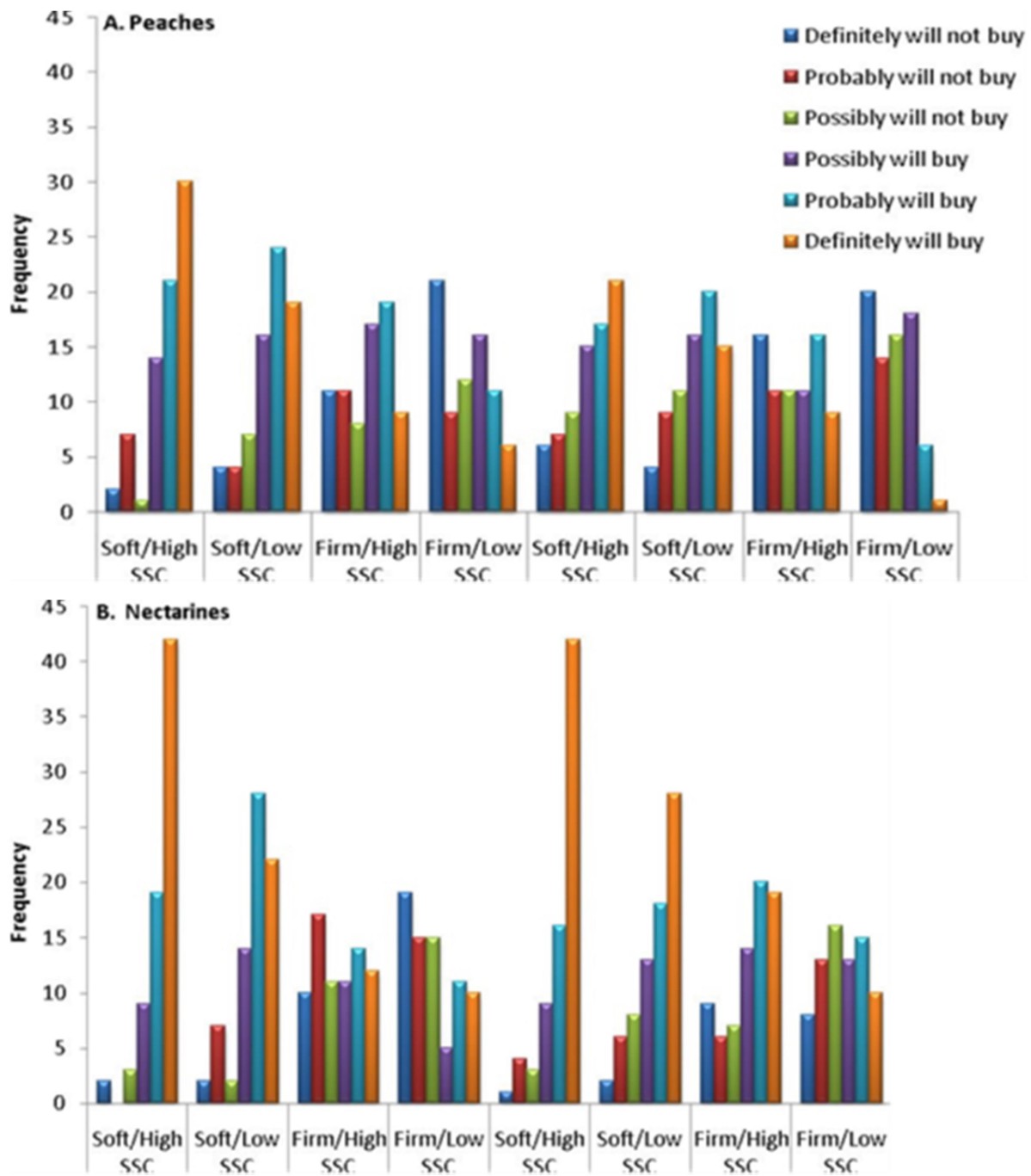
This is also pertinent in other world areas such as California and the United Kingdom. For example, a report abstract "How do we increase Peach Consumption" describes the fact that levels of peach consumption is declining and suggests reasons for this and possible remedies (Cristosto, 2002). The main issue is the variability within the number of varieties available at retail level. Varieties within the stone fruit category change regularly during a season and so does the variability. There is a need to qualify this and determine consumer likes and dislikes with the use of surveys and sensory tests (Jones, et al, 2012).

Consumer sensory tests:

Recent Australian tests have shown domestic consumers prefer yellow fleshed, low-acid nectarines and yellow fleshed, high-acid peaches, both with high sweetness. In project SF 10021 the following points were observed:

"The main driver of consumer liking, acceptance and purchase intent for the target peach and nectarine cultivars was fruit firmness, with consumers providing significantly higher scores for soft fruit than firm fruit, irrespective of acid content or SSC. In most instances, acid (as determined using high - and low-acid cultivars) had little effect on consumer scores if the fruit were soft. With peaches, even if fruit were firm, acid content tended not to influence consumer scores significantly. However, low-acid, firm nectarines achieved significantly higher consumer scores than high-acid, firm nectarines from the same SSC band. Consumers scored fruit from the high SSC bands higher than fruit from the low SSC band, and the effect of high SSC was more evident in firm fruit." (Jones et al, 2012).

Figure 1: Consumer purchase intent for peaches (A.) (n=75), and nectarines (B.)(n=75) presented as frequencies of each category on the purchase intent scale



(Source: Jones et al, 2012)

French tests have shown a high consumer acceptance for high sugar and low acid fruit as shown in an extract from a presentation to the author by Christian Hilaire at CTIFL in 2013. This presentation was based on a report called 'Peaches and Nectarines: Perception of

distributors and consumers' by Danielle Scandella and Catherine Roty of CTIFL. (Scandella, 2010)

Figure 2- Definition of French consumer segmentation survey: sub acid, balanced, acid type

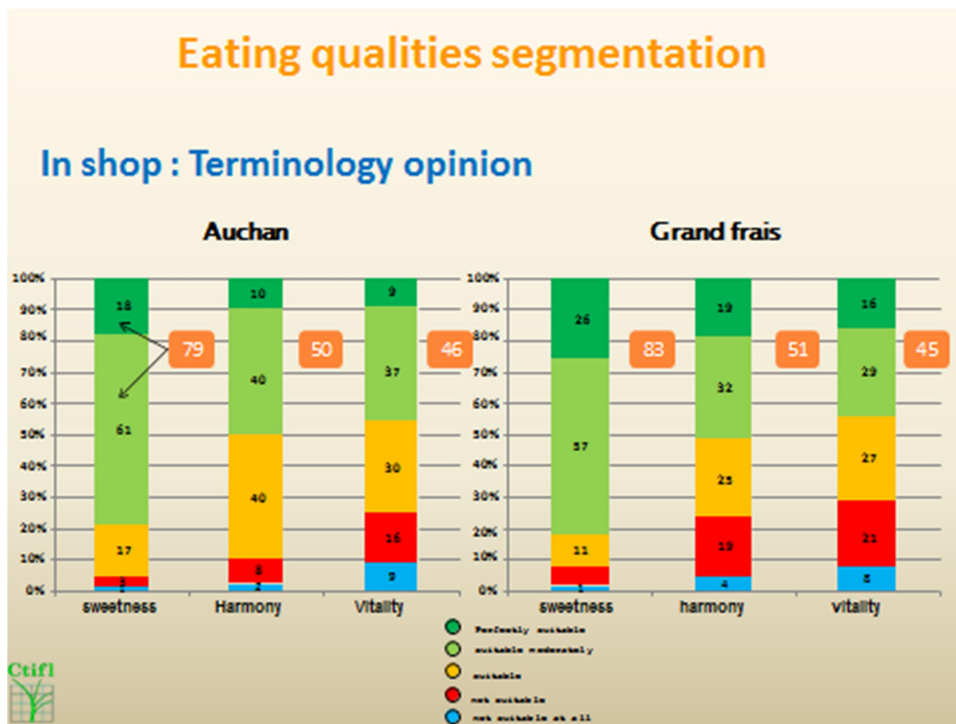


(Source: Hilaire 2012)

Figure 2 above provides the descriptors of the segmentation trial. Three categories of acid profiles were segmented in store by categorizing them as either, sub-acid or sweet flavour, balanced flavour and thirdly, acid flavour. Douce indicates sub acid or sweet flavour. Harmonie indicates a balanced flavour and vitality is the descriptive word for acid type fruits.

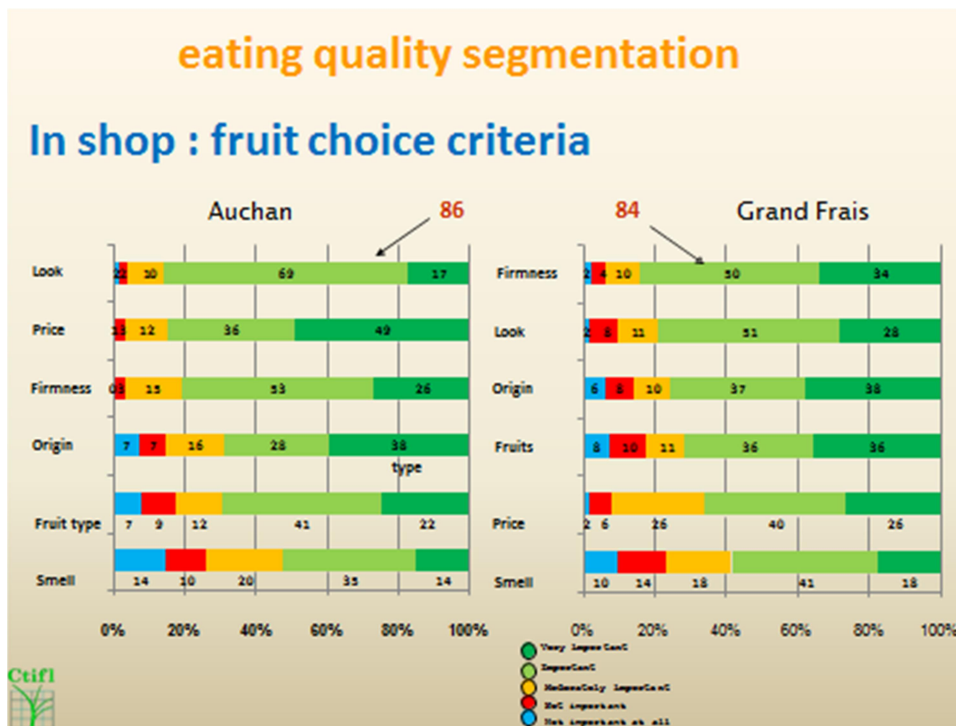
The graph (figure 3) looks at the two stores that the trial was conducted in. Auchan is best described as a middle class store with moderate quality standards. The price point is at the mid-range point of average purchase price in France. Grand frais on the other hand is best described as a high quality, high priced store. In this graph it can be seen that at Auchan, 79% of customers preferred Sweet flavoured or sub acid type fruit and at Grand frais, 83% preferred the same indicating a strong preference in this study of consumers leaning more towards a sweet flavoured fruit or sub acid type.

Figure 3- Graphs showing large percentage preferred sub acid-balanced type.



(Source: Hilaire 2012)

Figure 4: Looking at the bigger consumer picture.



(Source: Hilaire 2012)

The graph above (Figure 4) attempts to highlight the varying degrees of consumer fruit choice criteria. It can be seen above that 84-86% of consumers still purchase on look with price being the next largest factor. Fruit type and aroma is last. This is a crucial part of the discussion in understanding consumer behaviour as it has been demonstrated with the high preference ratings of sweet flavoured or sub acid fruit is still being dominated by consumers reliance on appearance and price to guide their purchasing decision.

Research from California

Californian tests have shown consumer acceptance is related to Ripe Soluble Solids Concentration (RSSC) and/or Ripe Titratable Acidity (RTA) but it varies with cultivar. Based on this work, different companies can select a quality index based on a minimum RSSC within a RTA range for a tested cultivar according to the percentage of consumers that the companies would like to satisfy. Stone fruit quality surveys (since 1994) show that most of these cultivars produced fruit that exceed these proposed minimum quality indexes. The use of adequate cultural practices and the careful determination of the harvest date should be applied properly to assure that the majority of fruit would exceed these minimum quality indexes (Crisosto, Crisosto & Bowerman, 2005).

In 1997 a sensory test was done on organoleptic values for stone fruit and it was determined that in order to create reliable organoleptic cultivar groups, the cultivar's potential quality attributes should be defined and RSSC or other quality attribute limits within each group should be established. Several techniques such as crop load adjustments, irrigation and others can be used to modify SSC but each cultivar has a limited SSC and/or RTA range (Crisosto et al, 1997).

In addition, another Californian report stated further:

“Our recent “in store” consumer tests carried out using ‘Honey Kist’, a low acid, yellow flesh nectarine (balanced group), ‘Elegant Lady’, a high acid, yellow flesh peach (peach flavour group), and ‘Spring Bright’, a high acid, yellow flesh peach (tart group) indicated that these

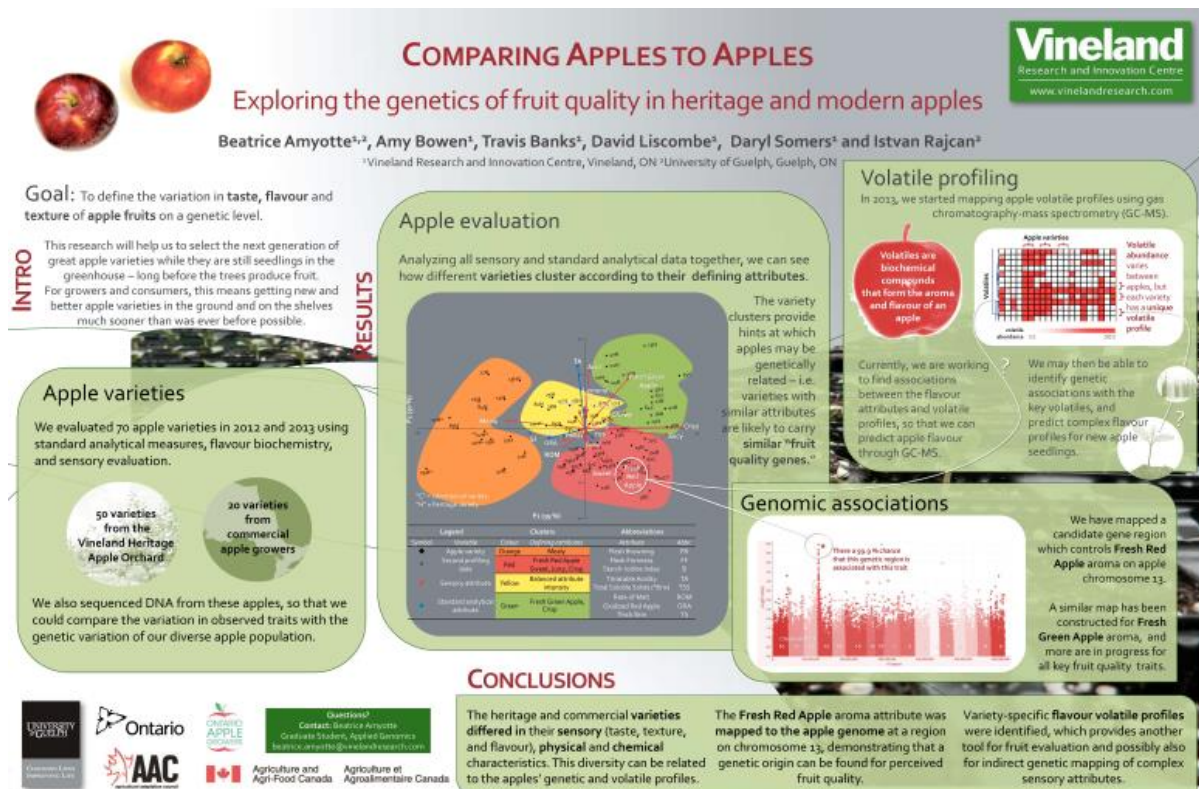
cultivars have high consumer acceptance when fruit are above specific RSSC levels regardless of acidity or the proposed organoleptic group.”

“According to these results, we recommend that cultivars should be classified in organoleptic groups and development of a minimum quality index should be attempted within each organoleptic group rather than proposing a generic minimum quality index based on RSSC. This organoleptic cultivar classification will help to match ethnic preferences and enhance the current promotion and marketing programs. Future work should be pursued to describe the chemical attribute requirements for each organoleptic group to propose a minimum quality index. Furthermore, representative cultivars from each organoleptic group could be used to describe biochemical compounds related to the perception of their sensory attributes. After identification of these compounds, a candidate gene approach can be used to develop marker(s) to establish an early breeding (seedling) program screening for high quality fruit. After that, the relationship between trained panel data and consumer acceptance with an emphasis on ethnic preferences for these proposed organoleptic groups should be investigated.” (Crisosto et al, 2005).

Research from Canada, Vineland

Limited work has been done in regards to looking at flavour parameters that influence consumer behaviour. Most study work has been done on other parameters like point of origin impacts on sales behaviour. There has been work done in apples to identify grouping of certain taste characteristics that define a certain consumer preference, crunchy, juicy, red and so on. There is the ability to link volatile aromatic compounds within this characteristic grouping and hence then group new varieties (Bowen, 2014).

Figure 5: Exploring the genetics of fruit quality in heritage and modern apples.



(Source: Amyotte et al, 2014)

Although the above poster is quite complex, its aim is to show the work in grouping 'apple types' using various techniques. The future aim as described by Dr Amy Bowen is to overlay consumer data over the top of the apple evaluations combined with volatile profiling to select out varieties for growers in the future.

Research from University of Florida

There was a demonstrated collaboration between departments to verify the breeder's fruit with consumer sensory testing. Mercy Olmstead, who is the stone fruit extension person, liaise's with both the breeder, university consumer sensory department, university marketing department and growers (Olmstead, 2013).

Further research

Wil Sumner, Director of Food and Agriculture Testing Services on behalf of Scientific Certification Solutions (SGS) documented in 2011.

“Some retailers have begun to add flavour parameters to their quality specifications, such as minimum brix (sweetness) or pressure. These parameters do not fully capture the factors that influence consumer acceptability”.

Also;

“Using Sensory Science to Define Flavour

- Objective method to determine flavour components in food
- Method uses flavour panels in conjunction with chemical/physical testing.
- Provides basis for analysing consumer acceptability and establishing minimum flavour specifications” (Sumner & Ha, 2011)

It has been shown that consumer’s preference in eating quality depends on many factors which affect the decision to purchase, including labelling, price, maturity, and sweetness. The amount of acid does not seem to matter as long as the sugar content is high in comparison. Most breeders will state that you need a certain percentage of acid to prevent fruit from developing ‘off’ flavours when over ripe. Sub acid types of peaches and nectarines have a tendency to develop these ‘off’ flavours and hence there has been a trend currently in some breeders to move away from sub-acid to more low-acid type of fruit.

Regardless of this, there is a clear need for more consumer testing done in a wide distribution area to determine all factors in deciding a purchase decision. Wording of this survey work is critical in delivering a reliable and understandable result. In truth it may not only be the fact there is just some variability in flavour and taste profiles in the market place but also depend on factors as simple as price point, economic circumstances and other choices available. Again Dr Amy Bowen from Vineland clearly stated that wording of consumer surveys are critical to determine any measured success of a result.

At this point there is a need for a mention of the ‘buy local’ idea. In April, 2013, there was a clearly demonstrated view that there was a move from more conventional marketing to ‘farmers markets’. At Adams County Nursery there were many farms visited that were in

some cases scaling down their farming operations to smaller plots of land and making more money at the same time (Baugher, 2013).

In the United Kingdom, especially with retailers in London, there was a consistent message of the capacity to capture that 'local' demand by putting a Union Jack on British produce.

Chapter 5 – Measurements of flavour

Current evaluations

As described in previous chapters, measurements of flavour have been limited to a subjective measure by the tester.

Desmond Layne, at Clemson University, North Carolina developed a website to help educate not only growers but also consumers on peaches

(<http://www.clemson.edu/extension/peach/>). *“Whether you are a professional or backyard peach grower or simply a peach lover, "Everything about Peaches" provides both technical and popular information to quench your peach appetite.”* (Layne, 2013).

He also provides technical notes on varieties. The Description of the O’Henry peach in 2012 is; slight tips, slight suture bulge, red around pit, excellent very sweet taste, good sugar and acid. There are scores given out of eight for most attributes, including brix, but not flavour and acid levels– (<http://www.clemson.edu/hort/peach/index.php?p=181&e=3976>).

It should be noted that evaluations are carried out at multiple locations to show regional differences.

Mossmont Nurseries deal with the following breeders;

- Burchell Nursery, California
- Sun world, California
- SARDI, South Australia

They provide a Compact Disc (CD) on Burchell varieties to customers wishing to order varieties from him. There are descriptions of the varieties including data from Griffith evaluations plus an e-mail service during the growing season to advise growers of particular varieties performance.

Australian Nurseries Fruit Improvement Company Ltd (ANFIC) is a group of nurseries in Australia which operate under the Associated International Group of Nurseries (AIGN)

network. AIGN is a group of worldwide nurseries that work together to promote innovative products that they deal with.

ANFIC works with a wide range of partners around the world and is proud to promote its relationship with its international partners. As an organisation they have produced some evaluations from the main site in Bathurst. Currently this site has moved and evaluations from a new area are commencing.

Graham's Factree produce data on their varieties from overseas breeders on their website. They are also involved in a Horticulture Australia Limited (HAL) funded grant to provide evaluations on a more regional scale. Under the grant primary sites are set for each nursery category, mainly apples, cherries and stone fruit. Evaluations are made at the primary sites and listed on the website and within an annual report for growers to view. Throughout Australia there are also secondary sites established where they can choose from the primary site evaluations to plant trees in their area. Once the secondary site trees are established, evaluations are also done by selected growers and placed onto the website and in an annual report.

This is a way to ensure that climate variability is measured against a variety's performance. A typical score would be made out of 10 against yield, taste (acid, low acid or sub acid), appearance and an overall performance score. Evaluations can be seen at <http://evaluations.factree.com.au/Evaluations.aspx>.

Currently the main breeder that is handled in Australia by Graham's Factree is Zaiger Genetics from Modesto, California.

An evaluator has many tools to utilize and measure the performance of the varieties that he/she tests.

Appearance or shape is generally descriptive with many types of shapes widely known. For example, globose, teardrop, heart shape and many more descriptive terms. Sizing is done with a simple measure measurement tool, along with sugar.

There is potential for Linear Discriminatory Analysis (*LDA*) work to be done to set a base point for current profiles that are grown and sold. By utilizing data sets from evaluations it can be plotted on a graph the likelihood or how closely related different types of fruit are. There will be a need to collect a large quantity of fruit for each type. A relative quantity of data per variety of each group type to be able to plot the range as a group. Once these are plotted then you can match new varieties up against the known set of types to see where the new varieties lie in relation to them.

It is a long process involving large data sets to work with, but it will define a type of fruit which may not only be suitable for any set consumer base, but will also fit within an individual grower's parameters in planting.

The issue with many varieties can be the variability within a variety. In recent evaluations for the last seven (7) years, fruit have been found with up to ten brix units difference in a variety of a 12 fruit sample. There has also been found up to four brix units difference by taking two sugar measurements on a single piece of fruit but on opposite sides.

Figure 6: Evaluation from the 2013/14 stone fruit season in the Riverland, South Australia, on an early yellow fleshed nectarine.

mm	Kg/cm ² brix	
70	6	12.6
66	6.5	10.7
68	6.5	10.6
69	5.4	13.9
69	5.1	11.2
68	5.6	13.9
73	5.6	12.3
78	5	11.8
68	6	12
64	1	14.4

(Source: Jason Size, QFM variety evaluator, Riverland South Australia)

The above table shows in each row a set of measurements from a single piece of fruit, within a sample base of ten (10) fruit.

Clearly there is a reasonable variation in sugar (brix) to pressure. Generally it is accepted that if the pressure, measured in Kgs/cm², is too high then the sugar content is low. Although this is not necessarily true in the sense that in this example a 5.1 kg/cm² fruit measured at only 11.2 brix and a 5.4 kg/cm² fruit measured 13.9 brix. it must be noted that this differential may be minimised by using grading technology to grade out by pressure or sugar. For this sample it seems there is an optimum pressure of 5.4 kg/cm² to achieve the highest sugars, but only if we discount the pressure of 1 kg/cm² received on one fruit which would be considered overripe.

Figurer 7: White nectarine

mm	Kg/cm ² brix	
73	3.6	16.9
69	3.8	9.3
68	3.2	18.8
67	4.5	9.9
70	5	14.5
66	5	9.4
66	4.6	12.5
67	4.8	13.1
67	4	11.6
65	4.9	11.5

(Source: Jason Size QFM variety evaluator, Riverland, South Australia)

Again each row is a set of measurements from a single piece of fruit, with a sample base of ten (10) fruit.

Here again there is a large variation on pressures and sugar. It is not as clear that the higher the pressure the lower the sugars. It can be seen here that in some cases the lower the pressure does not automatically correspond with a higher sugar reading. It is no wonder there is negative feedback from the consumer if they too are getting this amount of variation

when they purchase their fruit. A piece of fruit at 16 brix is a lot nicer to eat than a piece of fruit that is 10 brix.

There is also an issue of acidity level in fruit. Depending on the level of acid may determine the level of consumer satisfaction as identified in a French store survey in 2012- see Figure 2 above.

There has been some considerable work done on standardising evaluation recording by American public institutions.

RosBreed researchers on behalf of the RosBreed program in the United States have produced a document to try and document the process of an evaluation standard. The main researchers have developed a manual on evaluation criteria including:

Bloom time & type

- Leaf gland type
- Maturity date
- Crop load rating
- Yield rating
- Fruit

–type & fuzz

–size, fruit tip

–Base colour

–Flesh colour

–Freestone/clingstone

–Firmness by FTA or penetrometer

–pH and TA

–SSC (°Brix)

–Flesh browning, texture and bleeding

–Enzymatic browning and phenolic levels

- Pit (size -weight)

- Split pit & pit fragments

The manual has considerable detail on how to capture data to a certain standard that can be utilized by fellow professionals (Gasic et al, 2010).

Chapter 6 – What does the grower do?

Role of the nursery

The nursery quite often plays an important part for the grower in helping to decide on what to plant. It is expensive and time consuming for growers to evaluate the new varieties of stone fruit that come into Australia on their own properties.

There is enormous value in testing or trialling new varieties of stone fruit in the individual growers regions as there are a number of climate issues that affect stone fruit in a number of ways. These factors include; chill, disease and pest pressure, temperature variations that affect bud development and formation, soil & rainfall to name just a few.

Nurseries are starting to be more involved in either evaluating varieties themselves or helping growers establish evaluation sites for testing. Normally these trial trees are free for the grower to test. An example of a nursery participating in a form of evaluation is Little Tree Company in Katanga, New South Wales, listing variety information data on a facebook platform: <https://www.facebook.com/pages/Little-Tree-Company/1374798629415774>.

Grower risk-taking

There are quite a few growers who will travel overseas to view varieties from other countries and make a planting decision based on what is either being planted overseas or from a viewing of fruit and/or fruit trees.

There is a concern that if you plant varieties coming into Australia for the first time without an evaluation period in Australia or in the region it is being planted then you can have potential problems. For example, pointy fruit because the variety requires a higher chill requirement, split stones due to soil and climatic event as well as lower yields than expected. An evaluation site established in the Riverland of South Australia was set up to try and avoid the mistake of planting varieties that do not perform to expectations in that area. It is a

longer process, but the growers involved are more confident when they eventually order trees that the fruit, yield and all other quality parameters are consistent with their market specifications. The flip side is that the group may not be the first to plant that variety in Australia and other growers will have a competitive advantage by planting it straight out of quarantine and making a premium in the market place over other varieties.

This is an approach that does have its merit. One repeated comment from Dave Wilson Nursery was that the market advantage of being first is worth taking the risk. Having two out of five introductions succeed will generate more return to cover the three out of five that do not (McHaley, 2013). This can be a valid point and it is ultimately up to the grower to take that risk.

However in South Africa, growers are more conservative and will generally evaluate first as they tend to have a similar length of time, like Australia, to get new varieties in from other countries. A comment from one intellectual property manager and grower was that he would rather look at a new variety in their conditions before planting large quantities. They have seen climatic effects on overseas varieties that would warrant this testing (Du Plessis, 2014).

Are evaluations good enough?

Currently a few growers evaluate varieties to get an indication of how a variety performs in their location. Most growers do not and rely on others to provide information. This is fine if the variety tested is tested in the grower's own region or locale. Most evaluation data will provide enough to get an insight on its performance, quality and flavour. The constraint is that it is relative to the area where the variety was tested.

What about acid?

The question about acid relates to comments made by some breeders on a variety's performance post-harvest. There is enough evidence and statements made to suggest a

fruit's eating quality post-harvest can be related to the acid level in the fruit. It has been shown that some varieties that are higher in acid come out of cold storage with a more acceptable eating quality than those of lesser acid. The author would be hesitant to suggest that it all revolves around acid, but it has been a constant remark made to the author whilst travelling.

Recommendations

- More work may need to be done on recognizing acid levels in certain types of fruit so that a reference of some sort can be distinguished from a general evaluation point of view. Once these are made and a link is made between what consumers prefer in a profile, then select more quantifiable lines that fit those parameters.
- Advanced work on volatile aroma profiling as well as genetically identifying these as a consumer preference point is worth considering in the future at a scientific level.
- More work needs to be done on post-harvest capabilities before varieties are released on the commercial level. Perhaps collaboration with research centres like Vineland in Canada along with genetic mapping will help enable Australian growers or evaluators to identify varieties with greater post-harvest ability without the need for long term testing and trialling.
- There needs to be more recognition between fruit quality at all stages of its movement through the supply chain to reduce poor consumer reaction. Overseas reports have demonstrated not only cool store issues but also harvest issues affect the performance of varieties.
- The use of LDA at a more advanced level to at least place certain profiles in distinct groups for future development of new varieties is advantageous. However the main hurdle will be segregation of the types at retail level. The use of volatile aroma compounds within this LDA is crucial once it is determined which volatiles are preferred within the consumer base.
- Equally it is important to establish through consumer testing a weighting of all factors that influence the consumers purchasing behaviour.

It must be emphasised that it was clear in the last stages of this study that there needs to be a continued attempt at better understanding varieties post-harvest. The benchmarking to understanding the performance of varieties in the retail chain needs to continue to measure a variety's performance. Poor performance in terms of storage and eating abilities may lead to varieties being removed from the category, which would ultimately be beneficial for the consumer and demand in the future.

There is a need for more evaluation of varieties' acid levels and storage/post-harvest capabilities. A closer scientific look at aromatic compounds and sugar levels overlaid with consumer data to help group particular traits would be beneficial long term.

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Plain English Compendium Summary

Project Title:	Understanding and utilization of flavour parameters in stone fruit
Nuffield Australia Project No.:	1313
Scholar:	Jason Size
Organisation:	Bookpurnong Fruits
Phone:	0885824097
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Email:	jasonsize@bigpond.com
Objectives	<ul style="list-style-type: none"> • To understand various stone fruit breeders' views on flavour in their breeding programmes. What makes them choose a various profile over another? • To understand retailers or marketers view on increasing or maintaining sales and understanding the role of consumer surveys and sensory testing. • Looking at flavour measurement techniques and fruit evaluations as well as determining the grower's and nurseries role in testing new fruit varieties.
Background	Evaluator for a marketing and grower group in the Riverland of South Australia with an objective of providing objective information back to my business and the organisations that provide the varieties to test.
Research	Nuffield Scholarship study tour to various countries and businesses, and eight years of evaluation services to Quality Fruit Marketing
Outcomes	<ul style="list-style-type: none"> • Evaluators should use acid testing as a criteria in order to be more objective in determining the fruit profile type as a consumer preference. • The industry should consider the potential of international volatile aroma compound research and its possible use in future Australian consumer surveys. • The industry should undertake post-harvest trials on current and future varieties for long term flavour performance. • The industry needs to continue with ongoing work on consumer purchasing behaviour studies.
Implications	Possible future industry/scientific research in Linear Discriminatory Analysis or volatile aroma profiling and or grouping.
Publications	Nil