Platinum Peach Project

Report on Grower Chain and Consumer Design of Experiments (DOEs)

Prepared for: Sarah Marshall and Adrian Huisman
Ontario Tender Fruit Producers' Marketing Board

Prepared by: Value Chain Management Centre
George Morris Centre
225-150 Research Lane
Guelph, Ontario
N1G 4T2
Contact: Martin Gooch
Telephone: 519-822-3929 ext 216
Fax: 519-837-8721
Contact email: martin@georgemorris.org

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1 Purpose

The purpose of this project is to assist Ontario's tender fruit industry in developing the capabilities required to readily adapt to a rapidly changing business environment. This can only be achieved through improving quality management practices along the entire value chain – from orchard to retail store. These activities ultimately determine the value of Ontario tender fruit from consumers' perspectives. It seeks to achieve this through better understanding consumer priorities and enable stakeholders to capture premium prices for distinctly high quality fruit, aimed at specific consumer segment. It also aims to provide insights that can lead to an increase in the quality and consistency of Ontario fruit supplied across the overall peach category. Loblaw Companies Limited (LCL) is the first Canadian retailer to work with Ontario suppliers to market distinctly high quality tender fruit at premium prices, in the form of the platinum peach.

The project is based on the concept of value chain management, which describes the purposeful decision by businesses that comprise a value chain to improve their profitability through developing the processes and capabilities required to create consumer-recognized value. This is achieved through developing close, mutually compatible relationships, which enables the opportunity to combine resources to achieve objectives that would otherwise not be possible. While the concept is straightforward, it requires leadership, vision, proactive sharing of information and effective governance.

The statement "the quality of your fruit determines your position in the market" is very true, particularly when consumers view produce as a destination category that has a marked influence on their purchasing behaviour. With a view of supporting the Ontario tender fruit industry in a move toward a premium peach, similar in size and quality to a California peach, in 2010, LCL established criteria for a *platinum peach* and agreed to buy 7,000 cases per week of fruit that met the following four specifications:

- >2 7/8 inch diameter
- High degree of redness/blush
- Brix >11%
- Pressure > 5 to 10 psi

The project will result in greater opportunities for Ontario's tender fruit industry to exploit new and emerging market opportunities, in Canada and internationally. This is of critical importance, given that peach production is due to increase by 40% by 2012 and new markets are required to ensure that this increase in production does not result in a saturated local market – with resulting price implications. Improving the quality and marketability of Ontario-produced fruit will enable producers, marketers and retailers to capture greater value

from their operations. It will also enable Ontario's tender fruit industry to reduce the hundreds of trailer-loads of peaches that have often been imported into Ontario and the rest of Canada during the local growing season.

1.1 Project Objectives

The project has five key objectives:

1. Increase the management capabilities of key stakeholders operating in Ontario's tender fruit industry, particularly for peaches and nectarines;
2. Develop the processes required to deliver the right quality of fruit in the right way to target consumers;
3. By so doing:
    a. increase the value of Ontario-grown tender fruit within the markets to which it is currently supplied;
    b. increase Ontario tender fruit producers' long-term competitiveness and profitability;
    c. strengthen the wider industry's long-term competiveness and profitability; and
    d. enable Ontario's tender fruit industry to develop new markets, both in Canada and internationally;
4. Test the willingness of target segments of the consumer population to pay a premium for Ontario-grown peaches and nectarines that possess distinct high-quality attributes; and
5. Reduce the volume of imported tender fruit that currently enters the Ontario and Canadian markets.

Achieving these objectives will enable Ontario's tender fruit industry to reposition itself as a competitive force in the minds of retailers and consumers. Retailers will be able to handle and merchandize Ontario fruit to the best of their abilities. Consumers will choose and value Ontario tender fruit ahead of the myriad alternative fruits available.

2 Project Activities

The Project's activities are designed to determine:

- The impact management practices have on fruit quality and consumer satisfaction;
- The extent to which pressure, brix and temperature change throughout the value chain, and potential drivers of any change; and
- The optimum pressure and brix at picking; and pressure, brix and pulp temperature at packing for delivering the best consumer taste experience.

2.1 Research

The research took three forms. The first was a 'Production' experiment to establish which of the factors derived from a visit to California have the greatest effect on yields and peach qualities: foil, summer pruning and leaf thinning. This work included:

- A fact-finding mission to California, to acquire first-hand insights into the production, marketing, category management and research practices of businesses considered to be at the leading edge of supplier practices worldwide
- A Consumer Design of Experiment (DOE), to determine the effects of pressure, brix and temperature on consumer satisfaction with platinum-grade peaches.

Two results of two related research activities, conducted in conjunction with the CAAP funding project, were also undertaken:

- Orchard Design of Experiment (DOE), to evaluate the effect on yields of foil, summer pruning, and leave thinning
- In-store interviews, to establish the relative importance of specific factors on driving peach consumers' purchasing behaviours.

A subsequent visit to Chile provided further insights into how Ontario's tender fruit industry could increase its competitiveness, through implementing approaches and processes that have proven successful elsewhere.

2.2 Varieties

Six (6) varieties of peaches have been selected for the platinum project. The suitability of each variety for inclusion in the platinum project will be evaluated going forward after the participants have reflected on the results of the Orchard DOE, Chain DOE, and the consumer research.

Variety	**Usual harvest date**
Garnet Beauty	Jul 27 - 30
Red Haven	Aug 10 - 16
Coralstar	Aug 16 - 23
Allstar	Aug 26 - Sep 4
Harrow Beauty	Aug 27 - Sep 4
Glowingstar	Sep 7 - 13

3 Summary of Findings from International Fact-Finding Visits

Presented below is a summary of the two international fact-finding visits.

3.1 California

With insights from the Californian visit providing the basis of the Orchard DOE, more detailed insights from the visit are contained in a separate report: Increasing the Competitiveness of Ontario's Tender Fruit Industry: Report on Research Visit to California).

Fifteen to 20 years ago, the California fruit industry focused on size, colour and the ability to ship around the world. Taste and eating quality were of secondary importance. Standard practice involved harvesting into 950lb totes and hydro-cooling the fruit prior to packing. Today, neither of these activities continues. Hydro-cooling has been found to discolour the fruit and, importantly, grower/packers realized that by focusing on price first, they were creating negative outcomes, adversarial relationships and dissatisfied consumers. Flavour, as perceived by the end consumer, is now the key priority. This, along with improved shelf life, is managed through objective process control.

Communications through the chain are also well managed. In the past, it was common for suppliers to only visit with their main retailers immediately before the season, and as necessary, during the season to secure a spot market order and relay the order back to the company. Communication with customers only occurred when an issue occurred; for instance, if the customer wanted to change an order or the supplier had more volume they wanted to sell. Today, grower/packers carefully select the retailers they wish to work with and manage these accounts more closely. For example: visits to the retailers occur two to three times over the year; programs are developed well in advance of the season; and managers are in constant communication across different functions of the chain.

The overall size of the California industry is much larger than Ontario's. Just one of the operators visited during the two-day trip produces more volume in conventional produce than the entire Ontario industry. In addition, some businesses also produce a substantial amount of organic product. While this enables large independent farms to create economies of scale that are not possible in Ontario, it is not the primary reason for their success.

Due to their size, some businesses in California are also able to fund and manage their own research facilities for developing new varieties. The aim of this is to ensure that they only plant the best tasting new varieties. These businesses source breeding stock through relationships with nurseries in almost 30 countries and strongly believe their future is defined by their ability to develop capabilities to supply specific products to specific markets. By

focusing on being able to provide specific products for specific markets (i.e. early, mid-season or late), growers have been able to expand their businesses and extend their seasons. All of the companies visited in California have also paid attention and adapted to market trends such as retail consolidation and increased consumer discernment. Therefore, all of the businesses carefully select the varieties they grow and do so for well-researched reasons relating to consumer satisfaction.

Some producers also grow additional products, such as berries, citrus, kiwi, peppers, broccoli, corn, apples and pears. One company in particular not only grows produce through the California season but also buys and sells produce internationally on behalf of its major customer. The company negotiates supply, prices and programs from numerous farms located in various countries. By consolidating supply through central shipping points and using cross docking, this operator provides its major customer with greater control over quality, as well as access to progressive international suppliers. It has also improved communication throughout the chain.

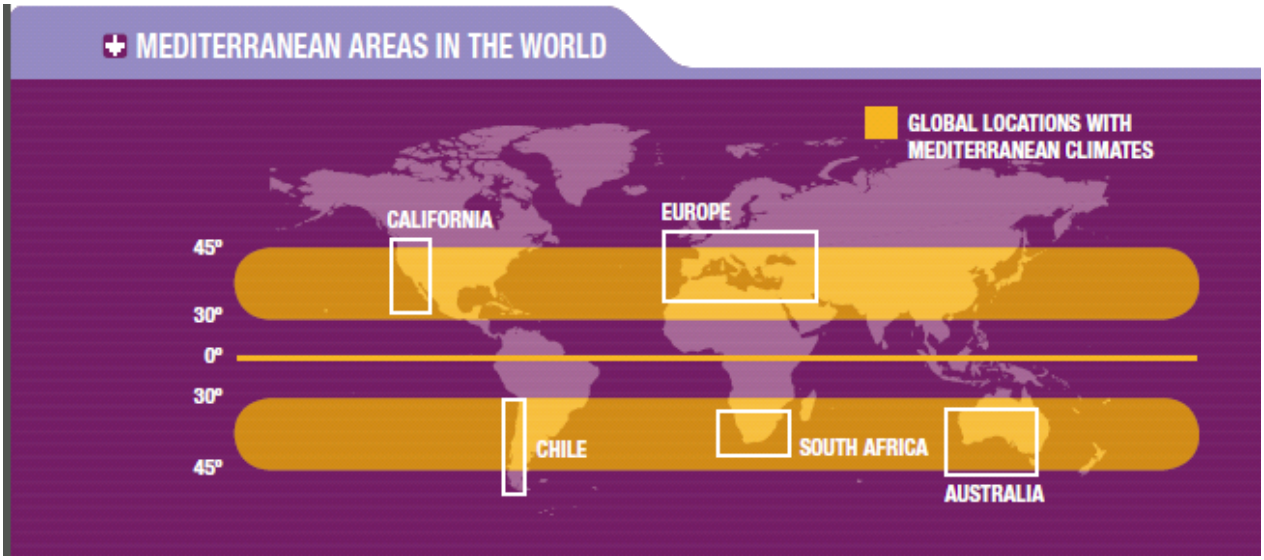
Although the season is longer and the volume is larger in California compared to Ontario, the conclusion is that it is not the weather, cost of labour or size of operation that has made the industry competitive. Rather, it is their attention to detail and implementation of processes that result in consistently high quality fruit through enforcing accountability throughout the chain. As one manager stated, "Volume is key to achieving efficiency, but effectiveness is key to remaining competitive and connected".

3.2 Chile

Chile is a leading fruit exporter from the Southern Hemisphere, supplying both local and worldwide markets. Fruit is the third most important sector within the national economy. As such, it is considered vital as an important provider of employment and investment.

Chile's fruit production is counter-seasonal to the main tender fruit consuming markets of the Northern hemisphere. The country's north-south orientation enables Chile to produce peaches from November through to March. Its Mediterranean type climate is unique. As shown below in Figure 3-1, only a small number of countries worldwide enjoy similar climates, which translate into excellent opportunities for fruit production.

Figure 3-1 Global Locations That Experience A Mediterranean Climate



Statistics regarding the Chilean peach and nectarine industry compared to global production and exporting are presented below in Figures 3-2 and 3-3. Worldwide, in 2010 – 2011 Chile accounted for just 1.1% of peach and nectarine production, yet 20.4% of peach and nectarine exports.

Figure 3-2 Global Production of Fresh Peaches and Nectarines (2010-2011)

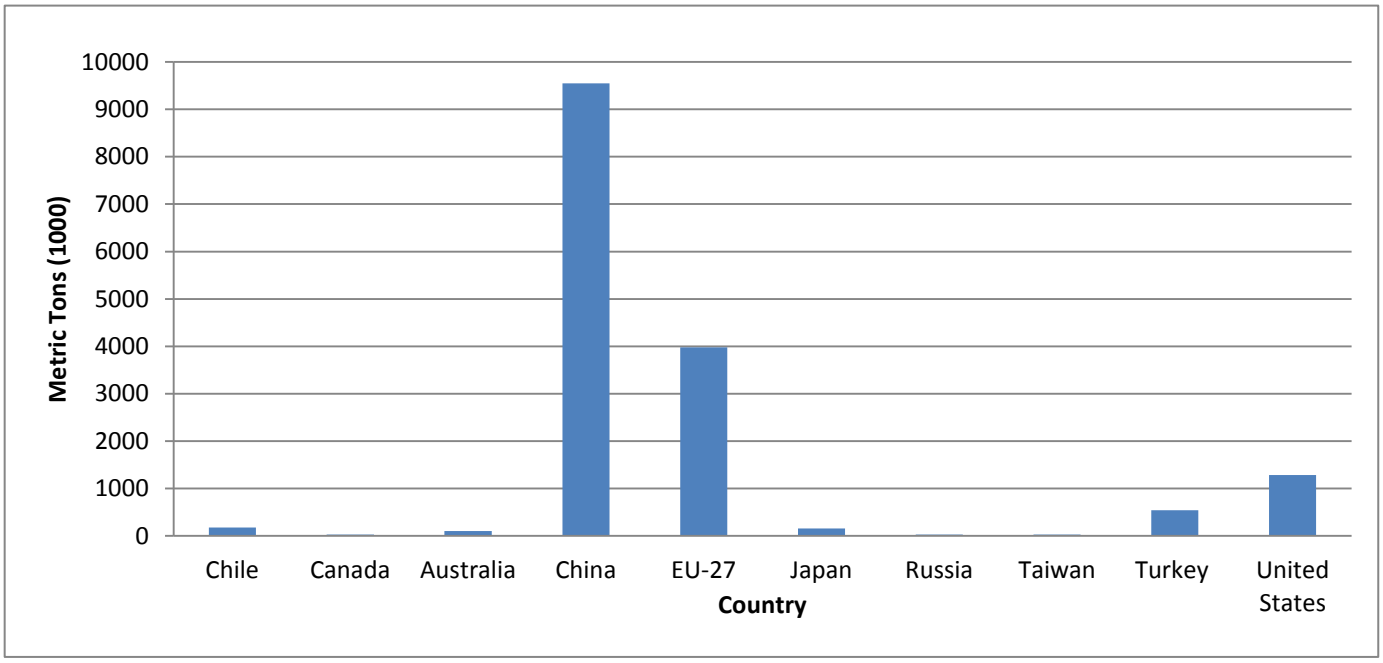
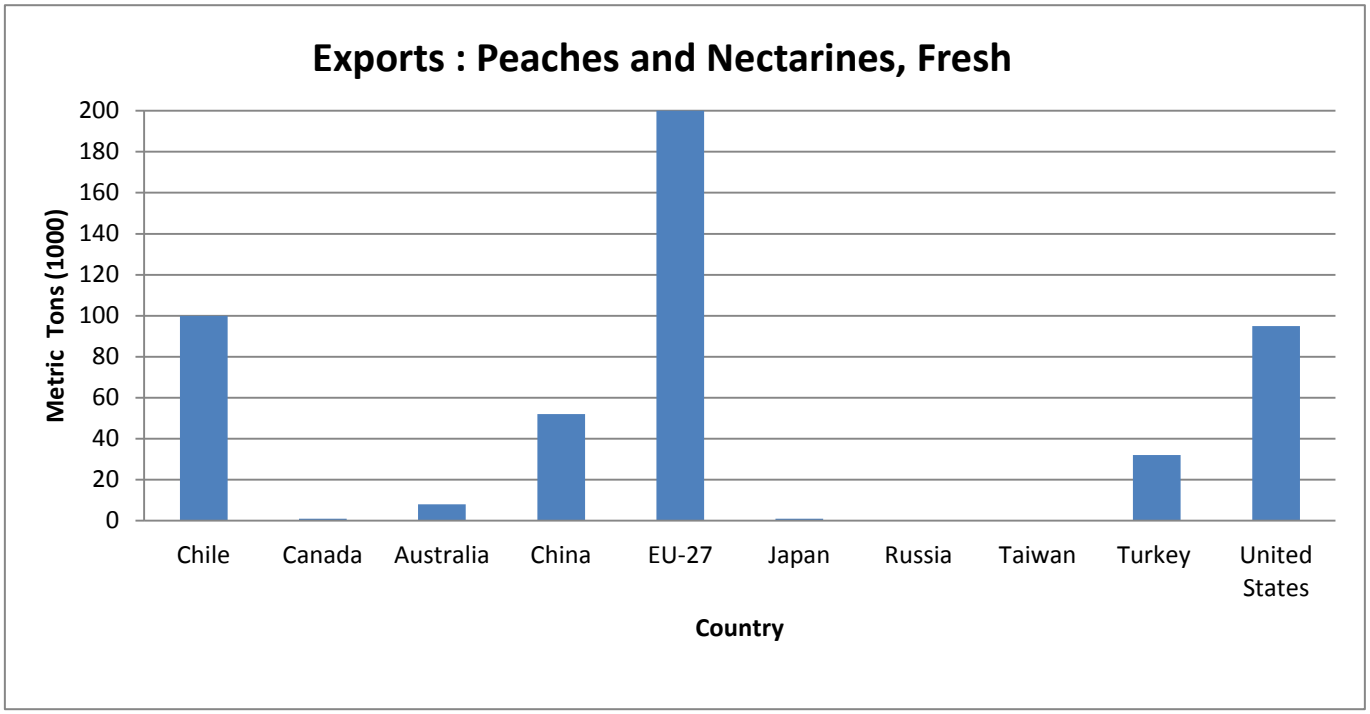
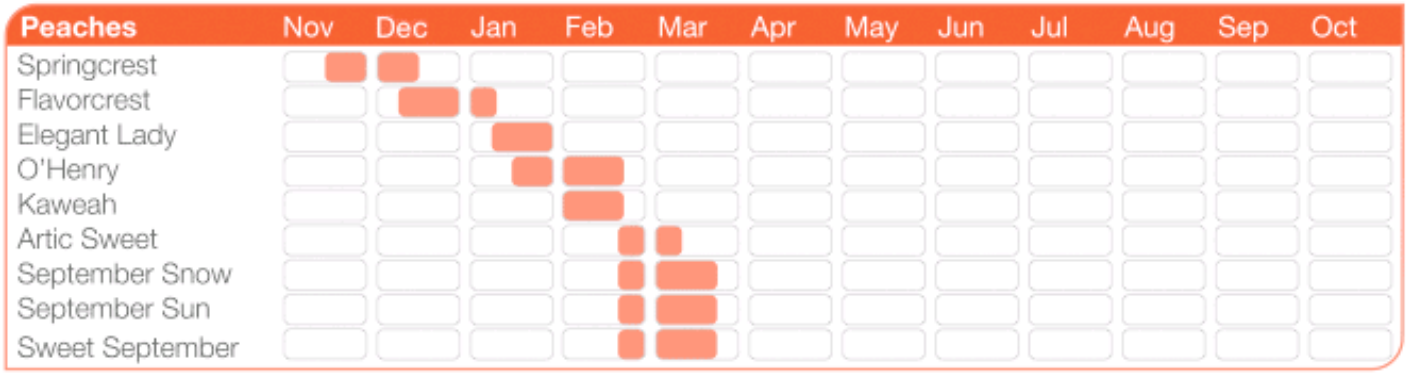


Figure 3-3 Global Exports of Fresh Peaches and Nectarines, Fresh (2010-2011)



Chile's primary export markets include the United States, Canada, Europe and China. Chilean producers have been progressive in adapting to new varieties to satisfy target markets and extend the season of production. Shown below in Figure 3-4 are the types of peach varieties grown in Chile and the approximate harvesting date by variety.

Figure 3-4 Peach Variety and Harvesting Period



That the exportation of fruit is critical to the Chilean economy has been the primary driver of Chile developing the processes, systems and capabilities required to compete in an increasingly competitive and international industry. It has also led to the development of an

industry culture focused on developing the business, research and infrastructure required to compete in a rapidly changing industry.

A focus on exporting to increasingly demanding markets led the Chilean fruit industry to become quality driven. The companies who focused on volume rather than quality have largely ceased operating. A primary reason for this is being because, in seeking to remain viable through handling an ever greater volume of fruit, companies began accepting rejections as part of their normal business model. This led to a downward spiral, often due to the sending of lower grade fruit, resulting in higher shrinkage and repacking costs, and lower profit margins.

The success of the Chilean industry partly stems from industry leaders tending to be highly educated. The majority of large scale commercial producers have attended university, often studying engineering in particular. This education and experience has led them to acquire critical thinking skills and a broad perspective of the determinants of business success. It also results in them possessing a detailed understanding of processes and their execution, along with the need to monitor processes scientifically to continually improve performance.

Leading businesses have also succeeded through establishing season-long marketing programs and developing the capabilities required to build close mutually-beneficial relationships with retailers. Adopting this approach enabled them to establish a more stable (if sometimes lower) source of revenue than operating on the open spot market. Like a stock investor, leading companies often balance their financial risk through committing perhaps 70-80% of their crop to pre-arranged programs while supplying the remainder to the open market – in the hope of securing higher prices whenever the opportunities arise.

Developing closer, more constructive relationships with retailers has provided suppliers with detailed market insights. This has translated into opportunities to better innovate in terms of variety, product, packaging or process. It has also enabled Chile to pilot new marketing arrangements and constantly monitor the effectiveness of new approaches; and access the economic resources required to undertake new initiatives and constantly innovate in relation to changing market demands. Possessing unique insights into consumer purchasing behavior also enabled Chilean fruit producers and marketers to further strengthen their competitive position by proactively reacting to the drivers of retailers' business decisions.

The ability to constantly innovate in relation to market demands also stems from Chilean exporters having developed the ability to constantly share information between multiple links along the value chain and monitor the impact of management decisions. This helps them maintain product excellence, which is extremely important given that quality is a major deal breaker for exports.

Over recent years the Chinese market has become known as willing to pay high prices for good quality fruit. However the Chinese market also pays drastically lower prices than other markets for fruit of lesser quality. This has further driven the need for Chilean exporters to strategically manage financial risk through strategically determining which fruit is exported to specific markets. Hence, a historical desire to pay the lowest price possible for fruit has led to lower quality generally being sent to the United States and Canada.

4 Orchard DOE

This and subsequent sections only include data from the 2010 season. The purpose of the Orchard DOE was to establish, through experimentation, which of the factors derived from the visit to California have the greatest effect on yields and quality of Ontario-grown peaches. The factors researched were reflective foil, summer pruning and leave thinning.

Each grower set aside an "X" acre area of trees, homogeneous in variety and age. Each DOE was comprised of eight distinct blocks, all of the same variety. The specifications used to evaluate the performance of each block reflected Loblaw's specifications for 'regular' and 'platinum' peaches.

Records were maintained of the fruit harvested and graded from each of the eight blocks.

	Foil		No Foil	
Thinned Leaves	1. No Prune	2. Prune	3. Prune	4. No Prune
No Thinned Leaves	5. No Prune	6. Prune	7. Prune	8. No Prune

Therefore, the eight experimental blocks comprised:

1. Thinned leaves, no summer pruning, foil
2. Thinned leaves, summer pruning, foil
3. Thinned leaves, summer pruning, no foil
4. Thinned leaves, no summer pruning, no foil
5. No thinned leaves, no summer pruning, foil
6. No thinned leaves, summer pruning, foil
7. No thinned leaves, summer pruning, no foil
8. No thinned leaves, no summer pruning, no foil

The DOEs involved two growers/packers: Lepp Farms Inc/Shoreline Packers and Andrewes Limited. Each selected a small block of trees to conduct the experiment. A high level overview of findings is provided below.

- Screening the DOE results indicated that all three variables may positively impact the size and colour of the fruit as well as pressure and brix. However, the analysis was not statistically significant enough to justify major investments at the moment. Rather, it suggests that a series of more robust DOEs is required.
- Specifics as to how each variable affected the outcome by grade of fruit are shown for both growers in the following tables.

Andrewes	Foil	Leaf pluck	Summer prune
Total packed	Negative effect	Positive effect	Positive effect
Bulk	Negative effect	Positive effect	No effect
3 Litre baskets	Not applicable	Not applicable	Not applicable
Plastic container	Negative effect	Positive effect	Negative effect
Platinum peach	*Positive effect*	*Positive effect*	*Positive effect*
Average pressure	Negative effect	Negative effect	No effect
Average Brix	*Positive effect*	*Positive effect*	*Positive effect*

Lepp/Shoreline	Foil	Leaf pluck	Summer prune
Total packed	No effect	Positive effect	Negative effect
Bulk	Negative effect	Negative effect	Negative effect
3 Litre baskets	Negative effect	Negative effect	Positive effect
Plastic container	*Positive effect*	*Positive effect*	Negative effect
Platinum peach	*Positive effect*	*Positive effect*	*No effect*
Average pressure	No effect	Positive effect	Positive effect
Average Brix	No effect	Positive effect	No effect

To determine economic feasibility of the three options, the following calculation assumed that if labour is $12/hr, foil is $180 for 4,000 feet, and it takes three minutes to prune one tree and six minutes to leaf pluck, then the cost to fully treat one tree is $2.24. ($0.44 foil, $0.60 prune and $1.20 to pluck).

- If the tree yields one case of platinum (~25) peaches at a $3 premium, then the gross margin is $0.75 per tree.
- If the tree yields 2 cases then the margin is $3.75/tree.

Based on these figures, it must be concluded that whatever effect leaf plucking has on the production of platinum peaches, it is likely not financially viable to pursue.

5 Chain Design of Experiment (DOE)

The purpose of the Chain DOE was to assess the impact of individual links along the chain and the performance of the chain overall on three factors that were deemed important as indicators of fruit quality, and therefore consumer satisfaction. These were pressure, brix and temperature. The results would also enable informed assessments to be made of the impact of the chain's operations on the chosen varieties, the expectation being that the research results would enable the researchers to make informed recommendations on how the chain's overall performance could be improved.

The DOE was set up so that designated shipments of platinum peaches could be monitored as they traveled the full length of the value chain prior to consumer evaluation.

All peaches in this DOE had to meet criteria for a platinum peach - more than 2 7/8 inches in diameter and within a specified degree of colour (redness). As mentioned above, the two growers/packers involved in the experiment were Lepp Farms Inc/Shoreline Packers and Andrewes Limited. The variety of peach was not considered as a factor in the experiment.

The DOE involved the three stated factors at two levels; therefore, a 2^3, 8 run, full factorial experiment. This means that all factors were tested independently of each other.

The DOE array was as follows:

Packer	**Run #**	**Y_1, Pressure**	**Y_2, Brix**	**Y_3, Temperature**
Andrewes	Run 1	5 LOW	11 LOW	COLD
Andrewes	Run 2	9 HIGH	13 HIGH	COLD
Andrewes	Run 3	5 LOW	13 HIGH	COLD
Andrewes	Run 4	9 HIGH	11 LOW	COLD
Shoreline	Run 5	5 LOW	11 LOW	HOT/COLD
Shoreline	Run 6	9 HIGH	13 HIGH	HOT/COLD
Shoreline	Run 7	5 LOW	13 HIGH	HOT/COLD
Shoreline	Run 8	9 HIGH	11 LOW	HOT/COLD

The DOE lots were determined after packing. A Vineland Growers Co-op (VGC) intern measured and tracked the pressure and brix of five peaches per lot. The intern determined which lot the sample represented and labelled it 1 to 8 as appropriate. Each experimental lot was labelled to flag that a tray of 40 peaches was destined for Vineland Research Innovation Centre (VRIC). The intention was to have three lots from each DOE run (1 thru 8) such that 24 trays of peaches would be tested at VRIC.

It was determined that the preferred point of determining the pressure and brix values and therefore the DOE run was immediately after packing. We did not, however, feel it was appropriate to experiment with peach temperatures to the extent that we might intentionally hold peaches in the kill zone (36 to 46 degrees F). Instead, we established that Andrewes and Shoreline have different packing procedures and chose the two pack/cooling methods as the temperature parameters.

Specifically at Andrewes, peaches were placed directly into cold store as received, then brought out a day or so later for packing - before potentially going back into cold store until required. Alternatively, Shoreline hot-packed and sent their fruit to Vineland Growers Co-op's Virgil facility where there is a new 'cool wall'. This cool wall is designed to pull cold air through skids of packed fruit, quickly reducing pulp temperature.

Figure 5-1 Skid of Peaches at the 'Cool Wall' in VGC's Virgil Facility

Figure 5-2 DOE ID tracker label

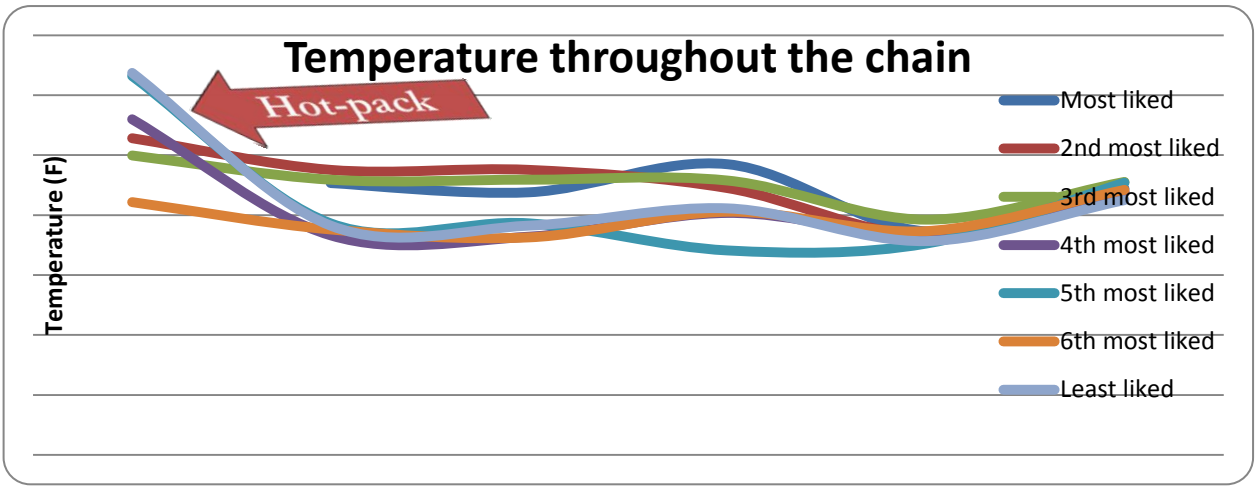
5.1 Results

The first week VRIC was able to collect DOE lots of peaches from designated Loblaw and Zehrs stores. Thereafter, however, DOE shipments were collected at LCL's Distribution Centre (DC) due to difficulties in tracking and segregation. Given the relatively small number of DOE shipments, the findings should be considered directional rather than statistically significant.

Figure 5-3 shows the differences in the median temperature of individual pieces of fruit that are cold versus hot-packed, as they move along the value chain, and their relative appeal to the consumer panel. The initial temperature is taken at the point of packing. This would be

after being refrigerated for a day or longer (in the case of cold-pack), and on the same day as harvesting in the case of hot-pack. As can be seen, in all but one case, cold-packed fruit remains considerably warmer than hot-packed fruit through to being ready for dispatch from the LCL DC.

Figure 5-3 Median Temperatures of Cold vs. Hot-Packed Fruit



Shown below in Figure 5-4 are details on the individual shipments referenced in the key to Figure 5-3. As with the key, they are listed in the order that the sensory panel ranked their eating quality.

Figure 5-4 Details on Shipments Reported Above

Shipments tracked through the chain and relative consumer preference
Most liked (Redhaven from Andrewes - 5.2/7)
2nd most liked (Coralstar from Shoreline - 5.13/7)
3rd most liked (Redhaven from Andrewes - 5.03/7)
4th most liked (Redhaven from Andrewes - 5/7)
5th most liked (Coralstar from Shoreline - 4.69/7)
6th most liked (Redhaven from Andrewes - 4.39/7)
Least liked (Glowingstar from Shoreline - 4.25/7)

Figure 5-5 shows the median temperature of hot-packed vs. cold-packed shipments *(not individual pieces of fruit)* as they pass along the value chain. Data confirm that hot packing could be a more effective means of cooling fruit and ensuring that its temperature remains

below (or close to below) the kill zone - which leads to rapid breakdown and a subsequent loss of fruit.

Figure 5-5 Median Temperature of Shipments, Hot vs. Cold-Packed Peaches

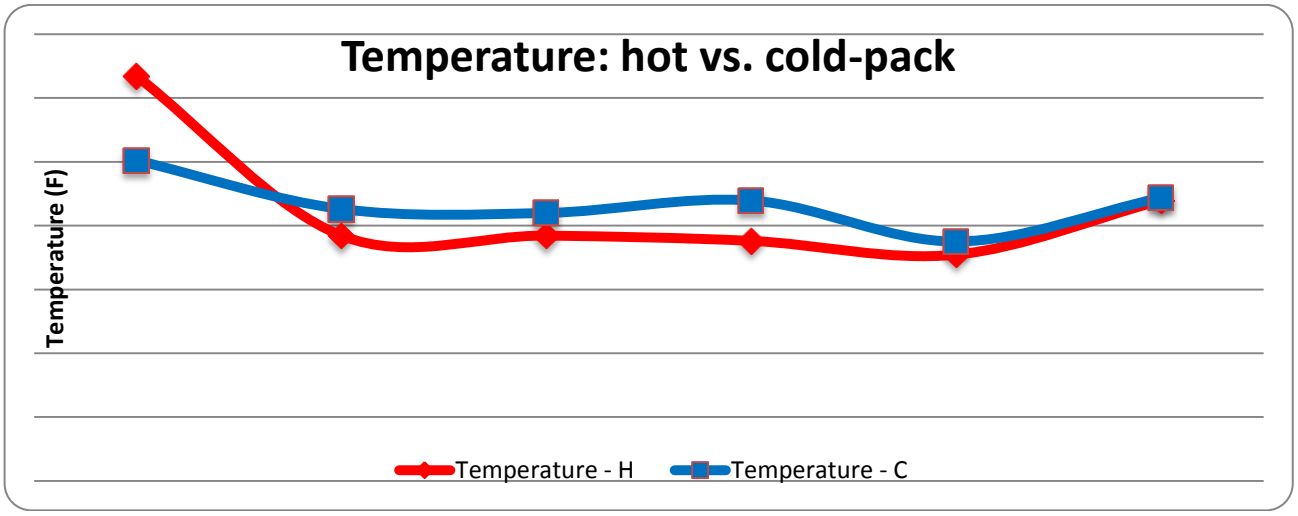


Figure 5-6 shows that median brix measurements vary more in shipments of hot-packed versus cold-packed fruit. It is not known whether this reduction in brix within shipments of hot-packed fruit is an anomaly caused by the rapid cooling.

Figure 5-6 Median Brix, Hot vs. Cold-packed Peaches

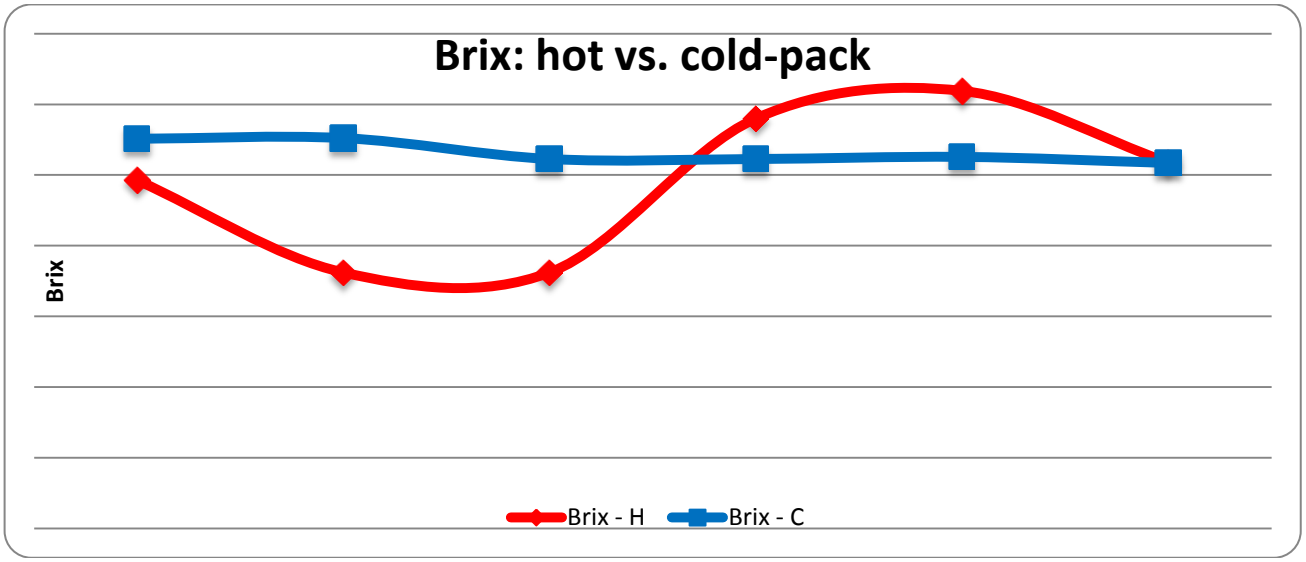
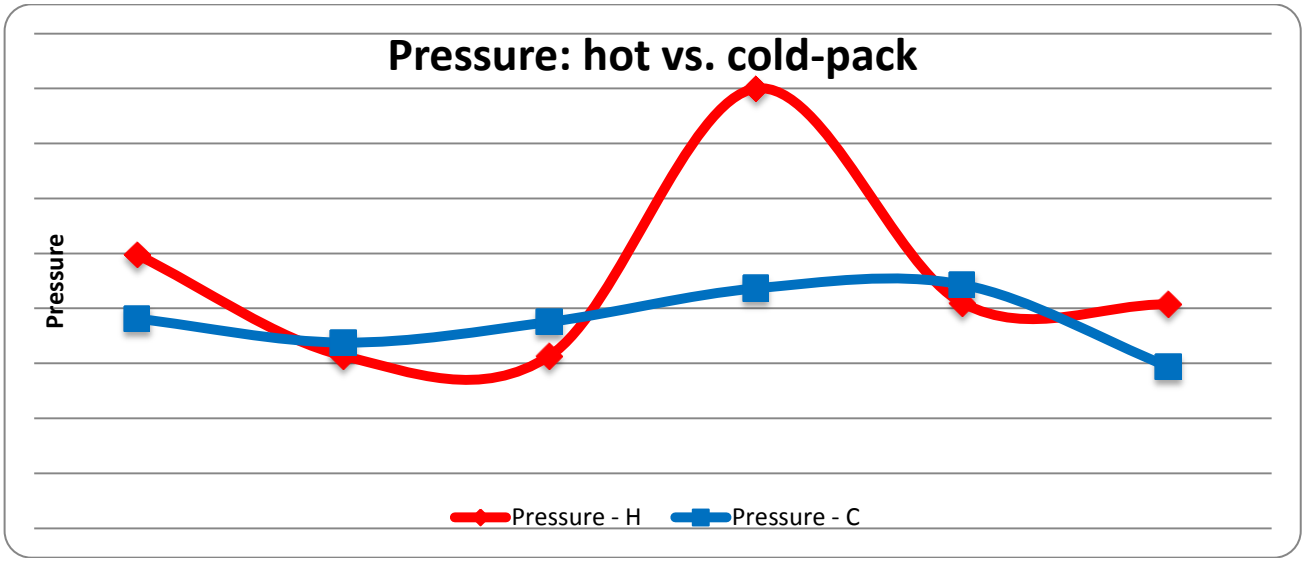


Figure 5-7 shows the median pressure measurements of shipments of cold-packed versus hot-packed fruit. It is not known whether the sudden increase in pressure in shipments of

hot-packed versus cold-packed fruit at the time of receipt at LCL's DC is due to differences in pressure between fruit contained within the shipments, or whether it is a testing error.

Figure 5-7 Median Pressure, Hot vs. Cold-packed Peaches



6 Consumer Research

6.1 In-store Research

In addition to the consumer research conducted by VRIC, in-store interviews were conducted in four LCL stores. To get a sense of the perceived value that Ontario consumers place on peach attributes, 1,000+ peach consumers were interviewed in Loblaw stores over two weeks during August 2010. Presented in a separate case study, **'INDUSTRY COLLABORATION TO IMPROVE THE QUALITY OF ONTARIO'S PEACHES AND CAPTURE GREATER VALUE FROM THE MARKET'**, the findings are statistically significant and illustrate that the peach market is segmented.

High level findings from the research include the following:

- The market comprises four general groups of consumers, who are distinct regarding income, education and household unit size.
- Visual cues related to evaluating quality unequivocally have the greatest influence on consumers' purchasing decisions.
- Attributes associated with eating experience are of slightly lesser, though still critical, importance in motivating consumers to purchase Ontario peaches.
- Price is of moderate importance in motivating consumers to purchase Ontario peaches. The relative importance of price to other factors fluctuates in relation to consumers' propensity to purchase peaches as individual fruit or packaged.
- Compared to visual cues and eating quality, most consumers place less value on whether peaches are grown in Ontario, or tree ripened.
- Consumers who say they strongly support local are less likely to be in the top 25% of purchasers of Ontario peaches, by volume.

6.2 VRIC Consumer Testing

Research methods

On receiving masters of fruit from each of the DOEs, the Vineland Research and Innovation Centre (VRIC) recorded the DOE number. As can be seen in Figure 6-1, at least one run was completed of every DOE configuration. In total, 14 DOE shipments were received by VRIC and subjected to three separate tests: destructive, consumer and sensory. Each test, described in more detail in the Appendix, was designed to provide a different perspective.

Figure 6-1 Number of each DOE 'run' received by VRIC

DOE run number	Number of lots received by VRIC
1	1
2	2
3	1
4	2
5	2
6	2
7	3
8	1

6.3 Destructive Tests

Ten peaches were subjected to testing of temperature, pressure, brix and acidity, each being a destructive test. Three peaches from each DOE lot were sampled, making a total of 45 peaches. The average temperature was 43.75, Standard deviation was 1.13 and the range was 41.8 to 46.7. All units were measured in degrees Fahrenheit.

6.4 Sensory Tests

Ten peaches were subject to sensory testing by VRIC expert panel of sensory testing. Attributes included:

- Sweetness
- Acidity
- Bitterness
- Astringency
- Flavor
- Green Flavor
- Crispness
- Chewiness
- Firmness
- Juiciness
- Fuzz
- Smoothness

Ratings were recorded on a 100 point scale where 10 = weak and 90 = strong.

6.5 Consumer Tests

The remaining peaches were submitted to a VRIC consumer panel recruited from LCL consumer panels in the St Catherine's and Hamilton area. Each consumer tester rated each peach sampled on a 7 point hedonic scale where 1 = strongly dislike and 7 = strongly like.

6.6 Alignment with DOE Parameters

The weakness of using a small sample of fruit to characterize an entire skid of fruit is that the sample does not necessarily reflect the characteristics of the entire shipment. Figure 6-2 shows, however, that the results of pressure and brix tests compared with the intended values for each DOE lot generally have a good alignment, even after a number of days in the value chain.

Figure 6-2 Comparison of Each DOE Run's Base Values vs. Tested Values

DOE Run	DOE Settings		VRIC Tests		Differences	
	Press	Brix	Ave P	Ave B	Press	Brix
1	5.0	11.0	4.7	6.9	0.4	0.3
2	9.0	13.0	7.0	9.7	3.4	3.3
2	9.0	13.0	6.2	9.4	-0.8	1.3
3	5.0	13.0	5.9	8.0	-2.9	3.3
4	9.0	11.0	6.3	8.8	5.0	0.4
4	9.0	11.0	6.2	8.7	-1.1	-1.2
4	9.0	11.0	6.7	8.9	2.9	-0.4
5	5.0	11.0	5.7	7.2	-0.9	0.2
5	5.0	11.0	5.6	7.2	-3.9	2.2
6	9.0	13.0	7.9	10.0	1.6	1.1
6	9.0	13.0	7.7	9.9	1.2	1.1
7	5.0	13.0	6.4	8.1	3.4	0.2
7	5.0	13.0	6.6	8.2	3.0	2.6
7	5.0	13.0	6.3	8.1	3.6	1.7
8	9.0	11.0	8.0	9.3	1.7	0.0

7 DOE Analysis

7.1 Chain DOE results

Figures 7-1, 7-2 and 7-3 show examples of the measured fluctuation in the pressure, brix, and temperature of three specific shipments of peaches as they passed along the value chain. They are titled according to the relative ranking provided by the VRIC consumer panel; as listed in Figure 5-4 *(in section 5)*.

Figure 7-1 DOE Producing Fruit Ranked Highest by VRIC Consumer Panel

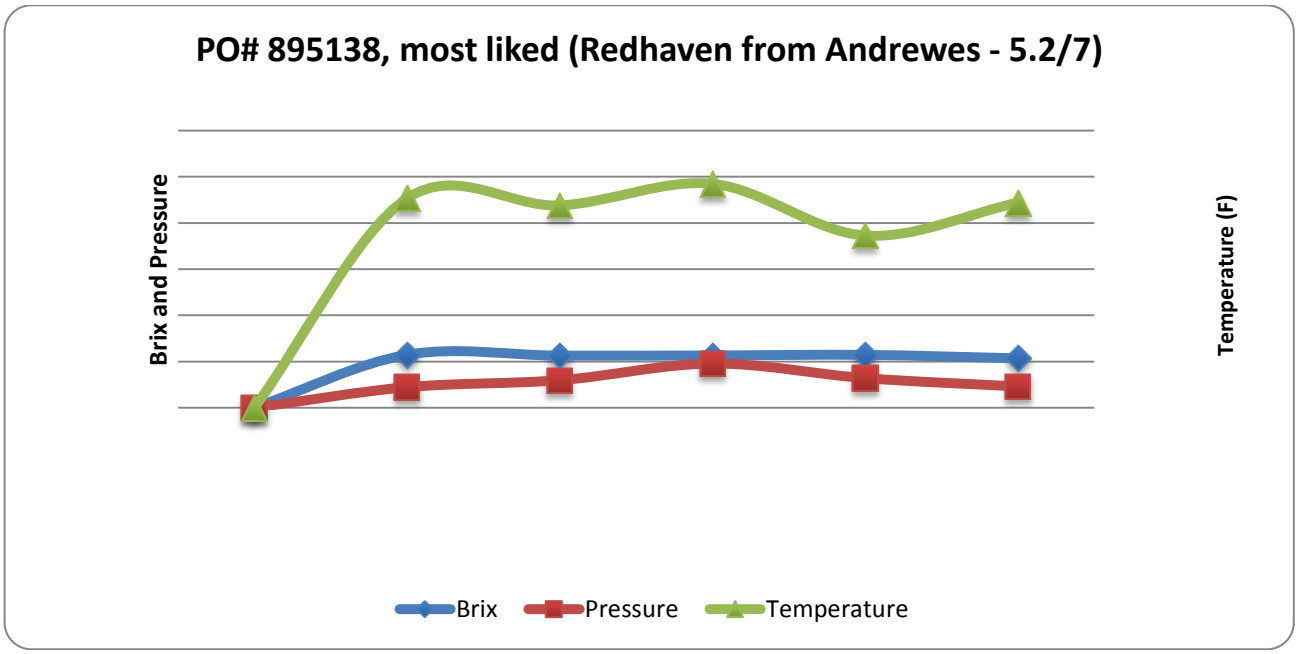


Figure 7-2 DOE Producing Fruit Ranked Second Highest by VRIC Consumer Panel

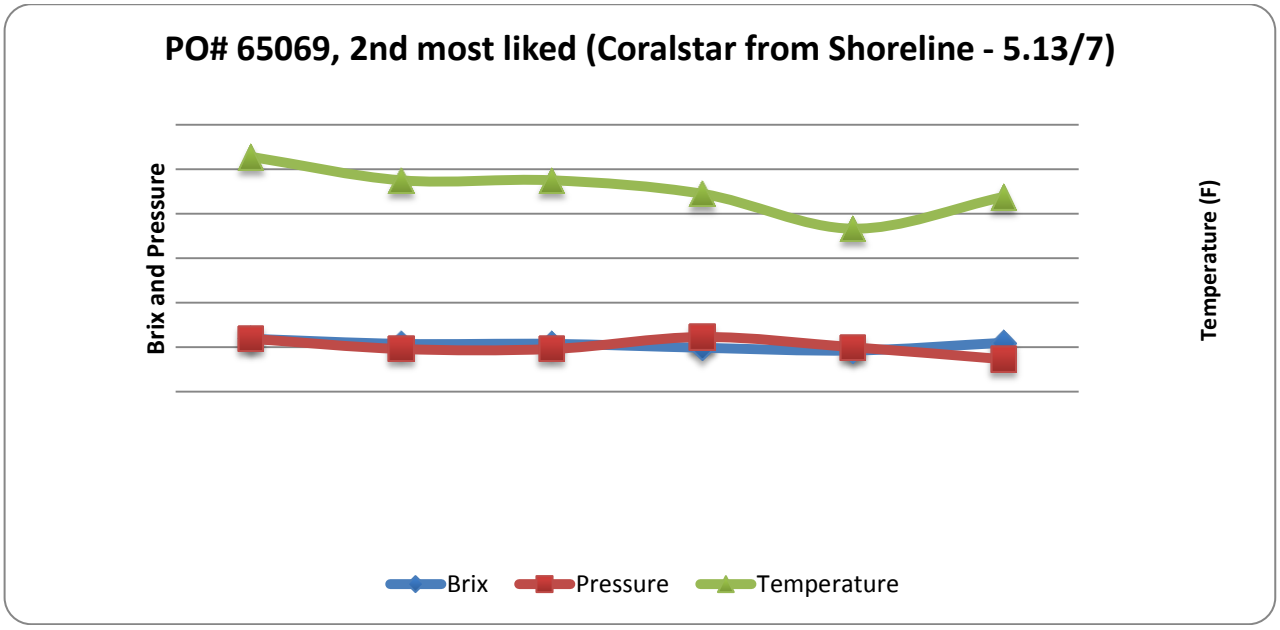
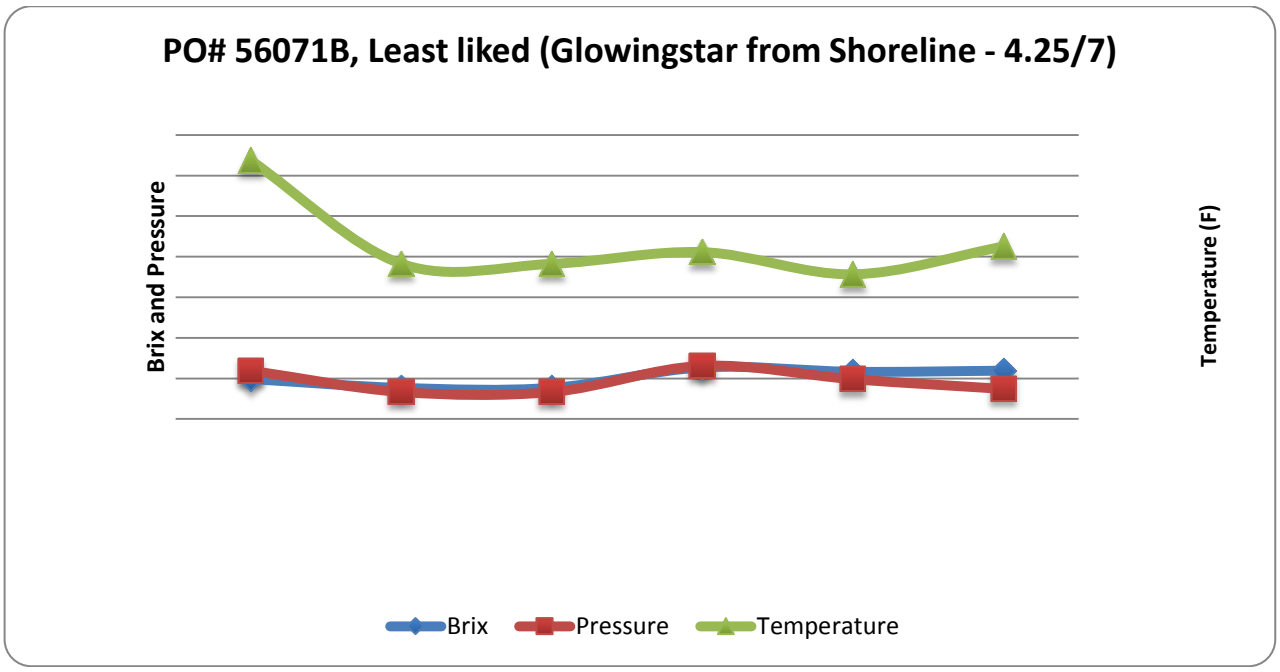


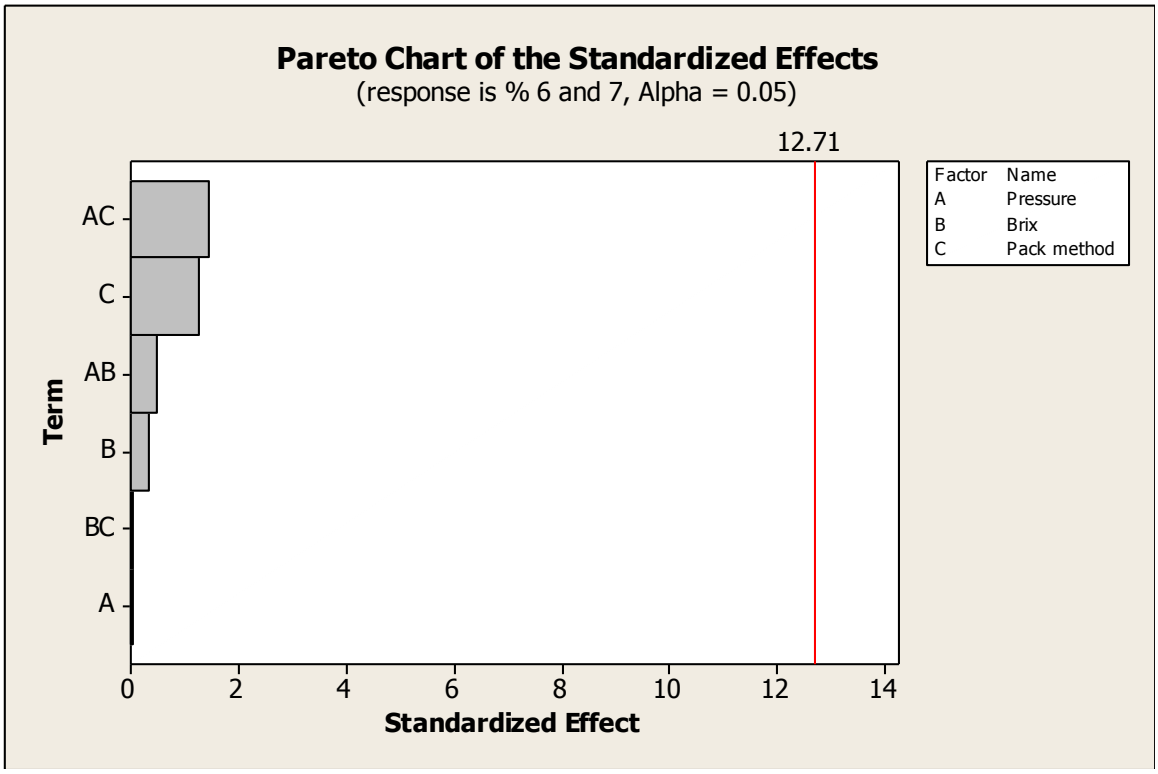
Figure 7-3 DOE Producing Fruit Ranked Lowest (least Liked) by VRIC Consumer Panel



7.2 Consumer/Taste Tests

The above ranking was achieved through the consumer tests conducted by VRIC. Two sets of consumer research were undertaken by VRIC. The first analysis focused on the hedonic 7-point scale as rated by consumers. This is ordinal data so it was necessary to track the median rather than mean and standard deviation. The medians were extremely close (4.5 to 6) and as such revealed that no differences exist between experimental runs. Runs that scored a 6 and 7 as well as runs that scored 5, 6 and 7 were analyzed and the findings are presented below.

Figure 7-4 Standardized Effects of Pressure, Brix and Pack Method on Runs that Scored 6 and 7

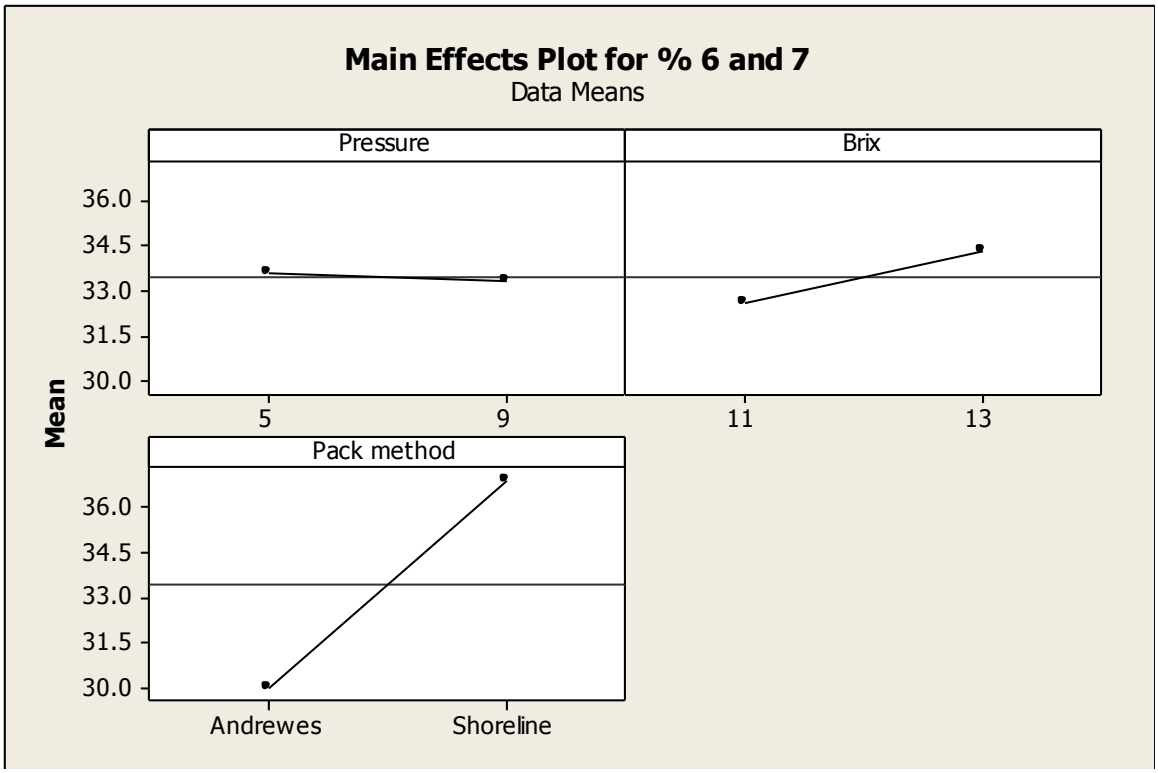


Comments on statistical significance

In order to have statistical significance, a single factor or two-factor interaction (bar) must extend beyond the vertical red line. We can see in the chart above that no factors (pressure, brix or pack method) impacted the experiments results in any significant way. However, they do provide an indication of what may happen should a more robust experiment or larger sample be taken, perhaps next year.

Therefore, Figure 7-5 should not present a conflict between the indications from the main effects plots that follow. What we conclude is that the factors appear to have an effect but are of low statistical significance and we are therefore unable to recommend with certainty that a specific factor will deliver the desired result.

Figure 7-5 Main Effects of Pressure, Brix and Pack Method on Consumer Satisfaction (Ranked 6 or 7)



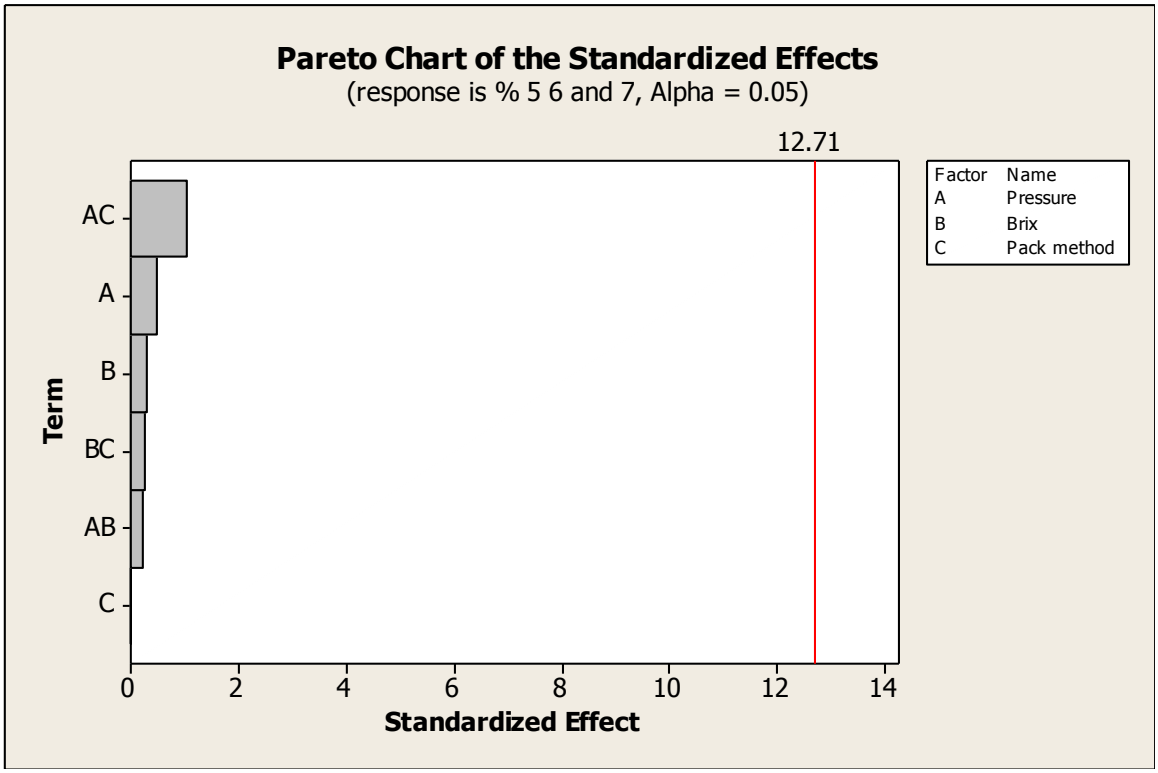
Main effects plot interpretation

The horizontal line is the grand average for the experiment. Each dot is the average effect for the stated factor. The units are in proportion or percentage.

Figure 7-5 shows that the factor with the greatest effect is the packer. Clearly, a higher proportion of 6 and 7 ratings indicates a higher proportion of consumer satisfaction and is therefore better. Shoreline was found to receive a higher percentage of 6 and 7 scores among consumers. Pressure and brix were found to have little effect. This analysis does not take into account the variety packed.

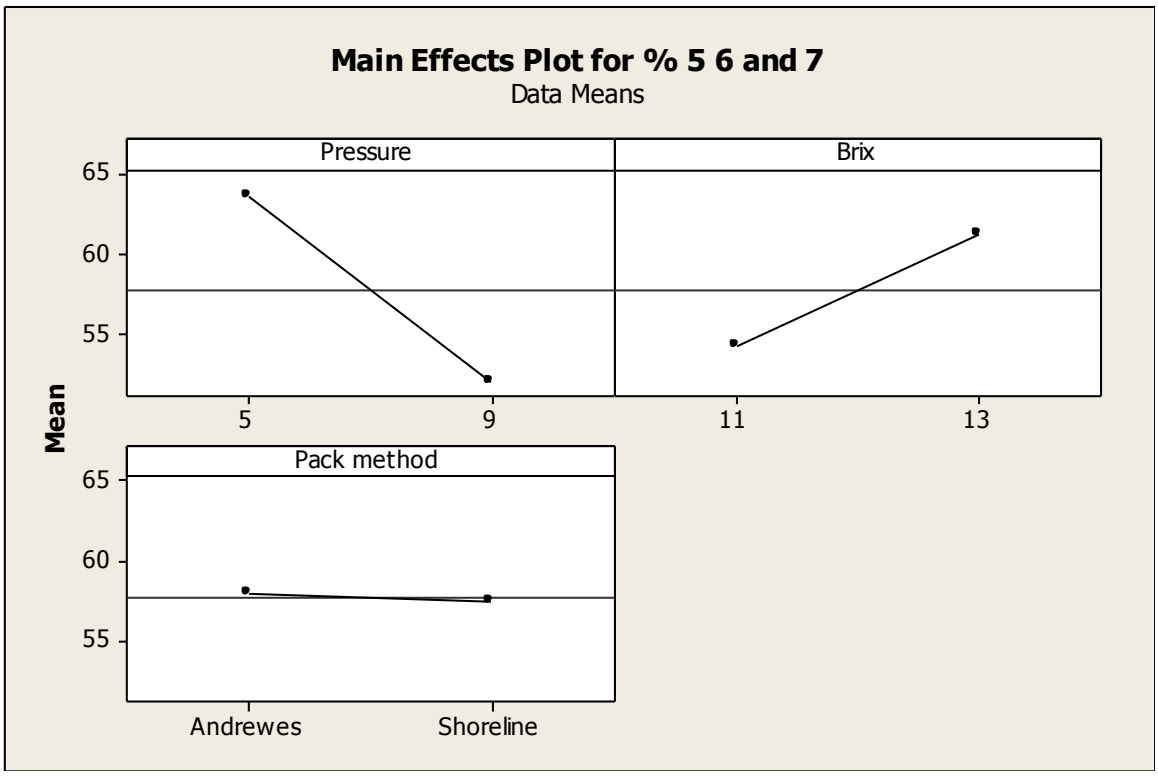
The following consider lots that were rated at 5, 6 or 7.

Figure 7-6 Standardized Effects of Pressure, Brix and Pack Method, Runs that Scored 5, 6 and 7



This also indicates that no one factor or two-factor interaction has statistical significance.

Figure 7-7 Main Effects of Pressure, Brix and Pack Method on Consumer Satisfaction (Ranked 5, 6 or 7)



Unlike the previous example, we see in Figure 7-7 that the packer has no impact on consumer satisfaction. Rather, low pressure and high brix were found to increase the proportion of consumer satisfaction scores at 5, 6 and 7.

Shown in Figure 7-8 is the extent of the effect that brix, pressure, or packing method appear to have on the hedonic scale afforded to specific DOEs.

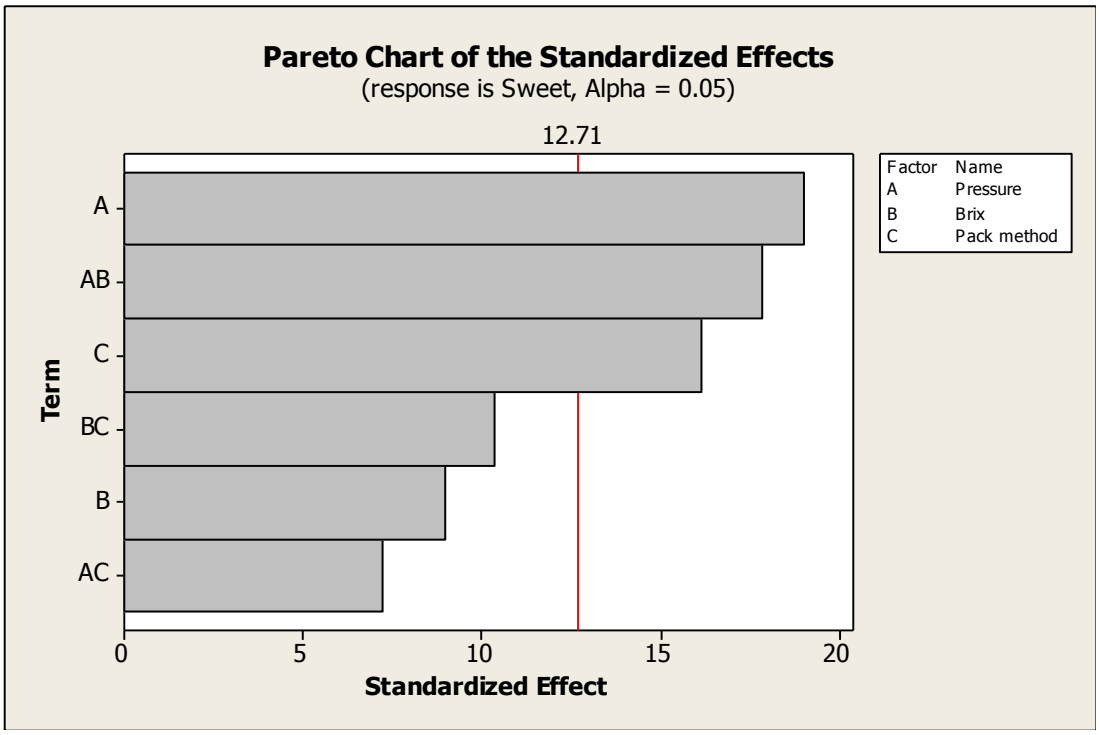
Figure 7-8 Hedonic Scores Afforded to Specific DOEs

Response Attribute	Pressure (psi)	Brix (%)	Packer/Pack Method
Proportion at 6 and 7 on hedonic scale	No effect	13	Shoreline
Proportion at 5, 6 and 7 on hedonic scale	5	13	No effect
Sweetness	5	13	Andrewes
Juiciness	5	No effect	Andrewes
Flavour	5	13	Andrewes

7.3 Sensory Tests

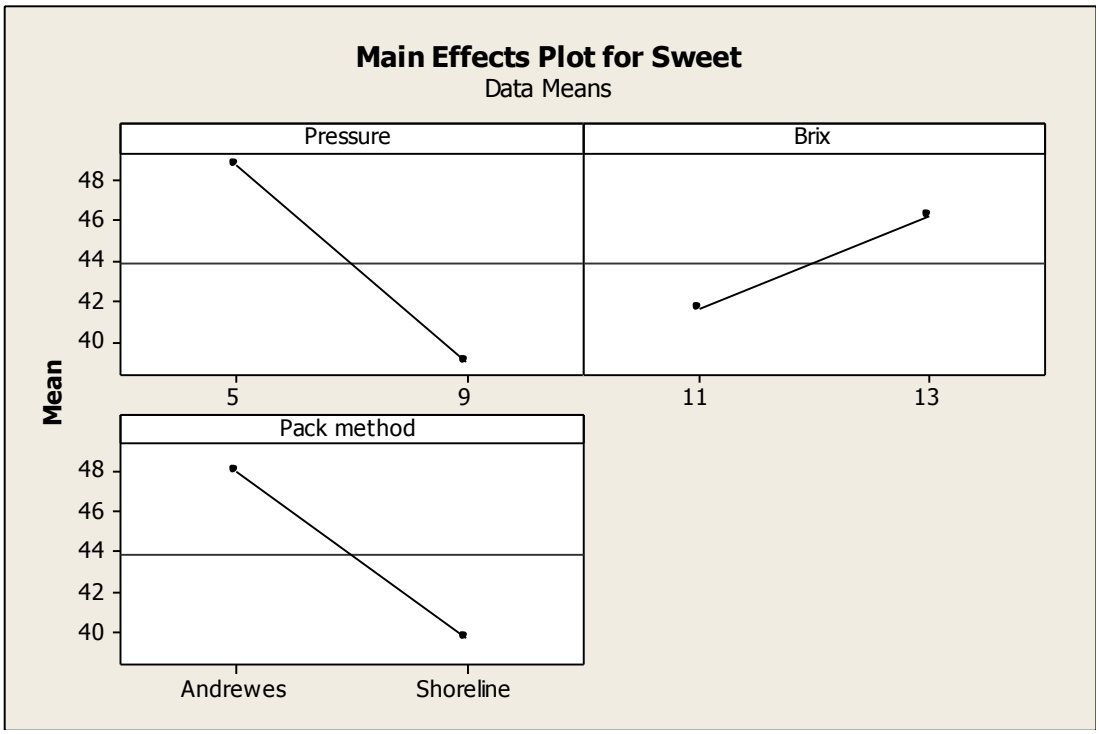
The next analysis is focused on the expert sensory panel scoring for sweetness, juiciness and flavour. These attributes were selected because consumer research conducted by VCMC on behalf of LCL indicated they were the most important attributes for a premium peach from consumers' perspectives.

Figure 7-9 Standardized Effects of Pressure, Brix and Pack Method on Sweetness



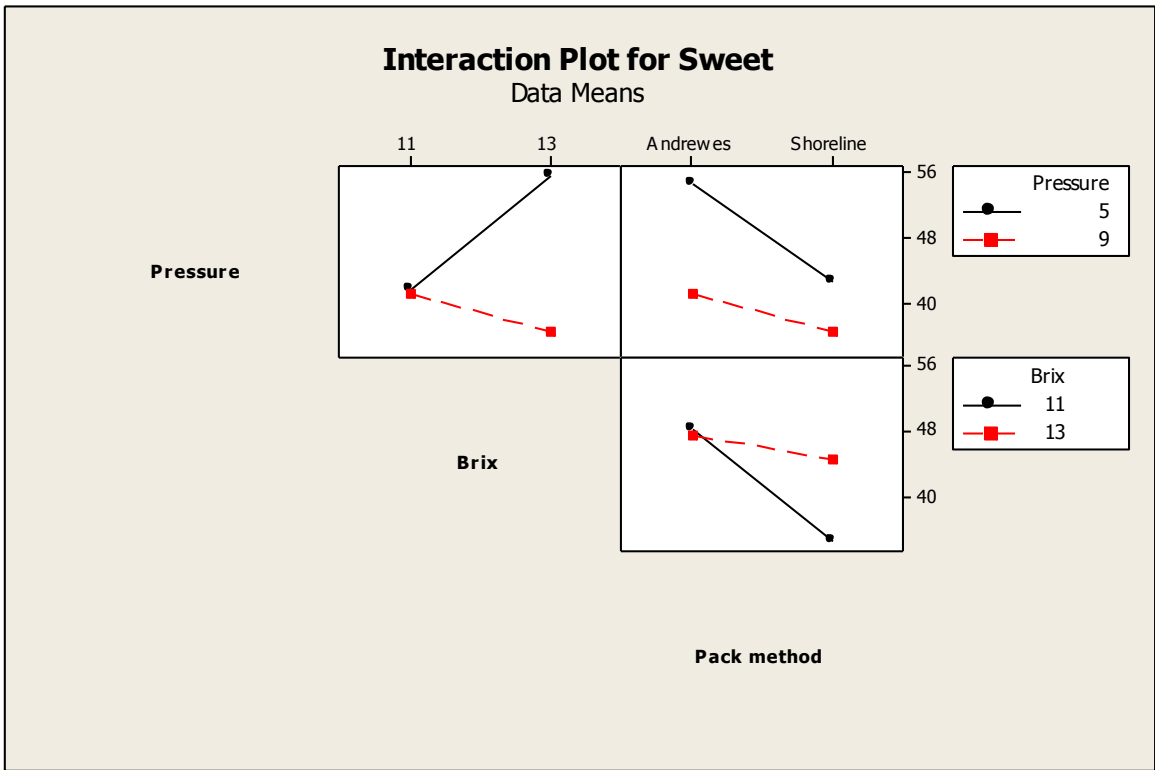
In Figure 7-10 below, we can see that pressure, pack method, and the interaction of pressure and brix have statistical significance on sweetness.

Figure 7-10 Main Effects of Pressure, Brix and Packer on Sweetness



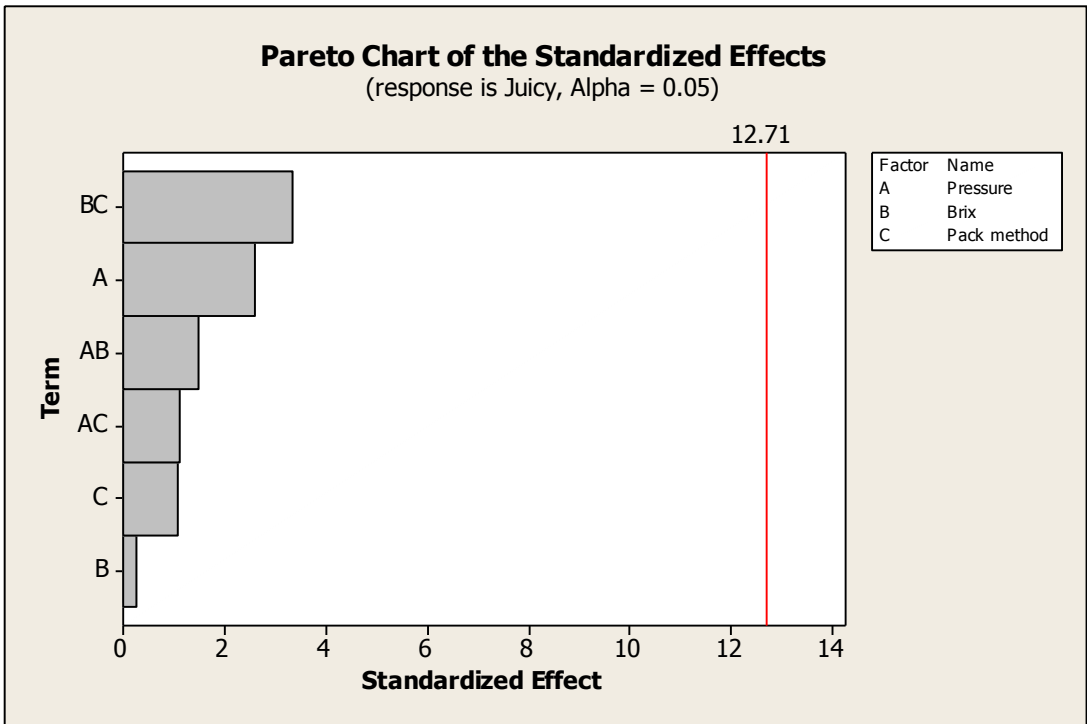
Low pressure, high brix and fruit from Andrewes deliver increased sweetness. From the results presented in Figures 7-11, 7-12 and 7-13, the pack/cool method requires further investigation. The fruit from Shoreline may have been 'put to sleep' by the cool wall so maturing ceased, whereas the fruit packed by Andrewes may have continued to mature through the supply chain. If this is the case, those packing through Shoreline and VGC cool wall may need to rethink their criteria for "ready to pick". Again, the variety picked and pack method are not included in this analysis.

Figure 7-11 Interaction Tables for Sweetness, by Packer



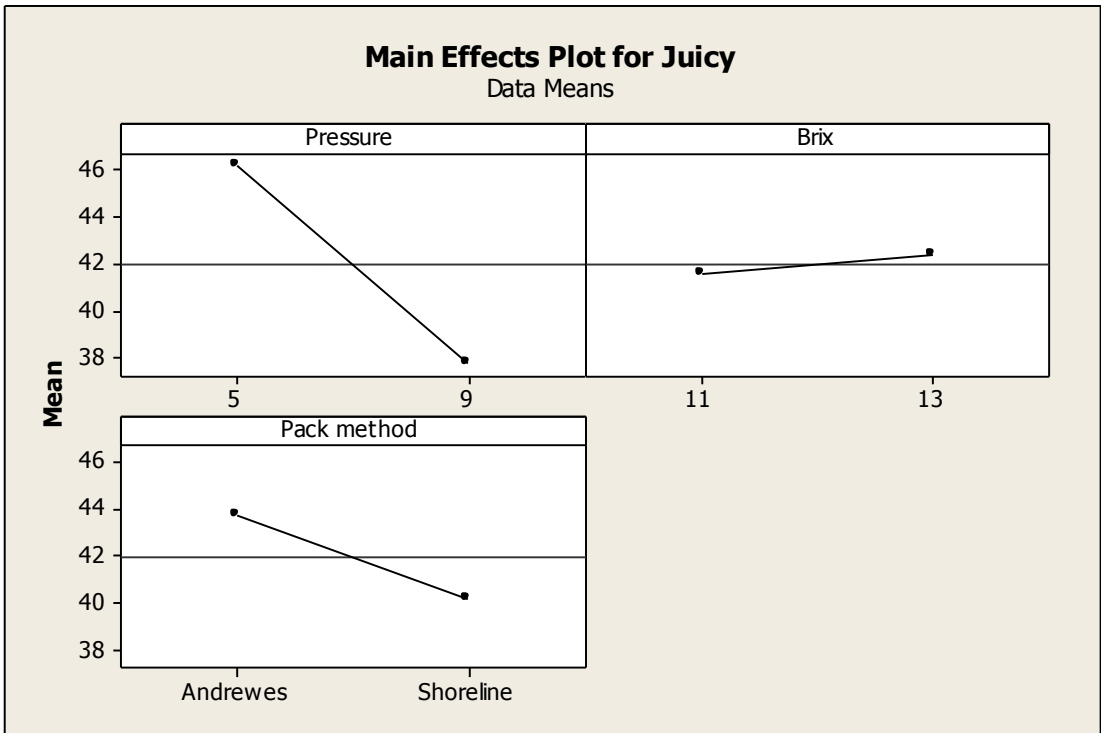
The results show that high brix and low pressure is better from the standpoint of satisfying consumers' expectations of sweetness, an important element of overall eating quality. Whereas Andrewes' fruit can achieve consumer satisfaction with a brix of 11 or 13, to get the same result from the test panel, Shoreline must provide brix of 13 to get close to the same sweetness result.

Figure 7-12 Standardized Effects of Pressure, Brix and Pack Method on Juiciness



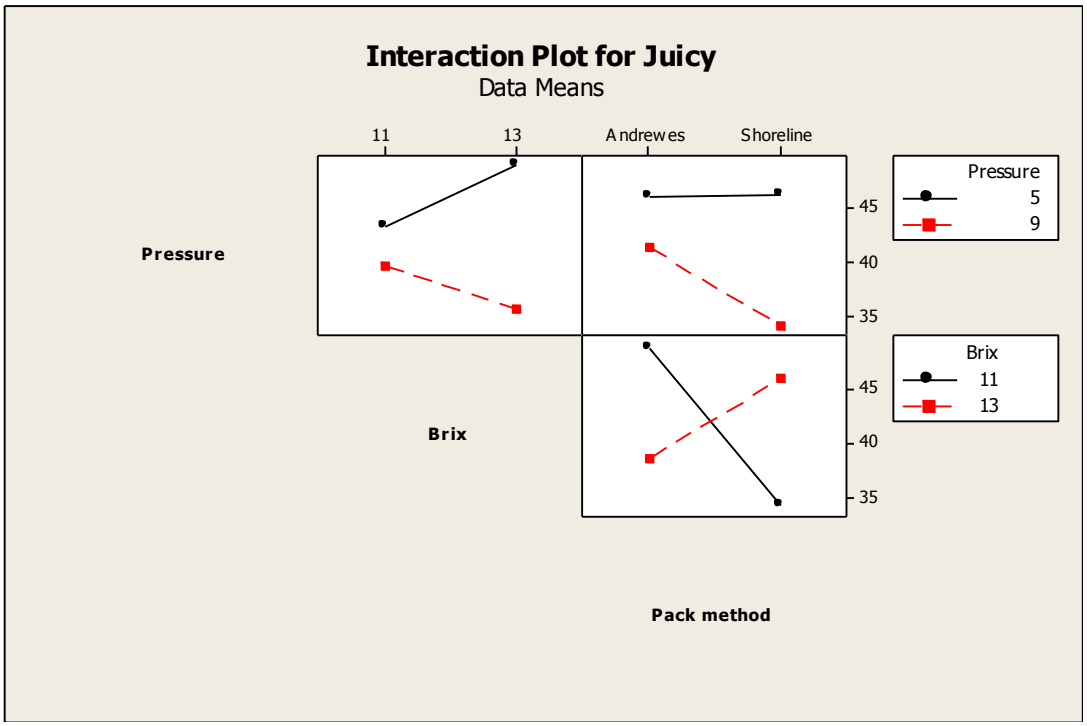
The above results show that no factor or 2-way interaction has a statistically significant on perceived juiciness.

Figure 7-13 Main Effects of Pressure, Brix and Packer on Juiciness



The overall results indicate that lower pressure has the greatest impact on increasing consumers' perceptions of juiciness. Brix has minimal impact. As can be seen below in Figure 7-14, from the standpoint of the consumer panel, Andrewes shipped more juicy peaches then Shoreline.

Figure 7-14 Interaction Tables for Juiciness, by Packer



The above results indicate that Shoreline brix 13 is closest to Andrewes brix 11.

The following results compare packing method and packer/shipper with consumers' perceptions and satisfaction with flavour.

Figure 7-15 Standardized Effects of Pressure, Brix and Pack Method on Flavour

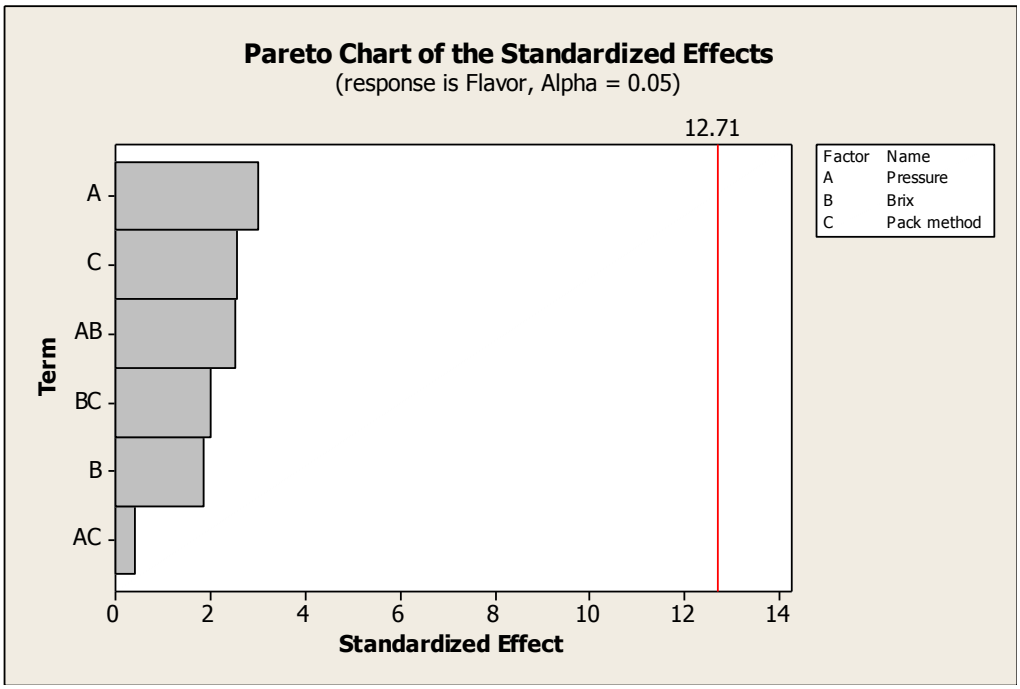
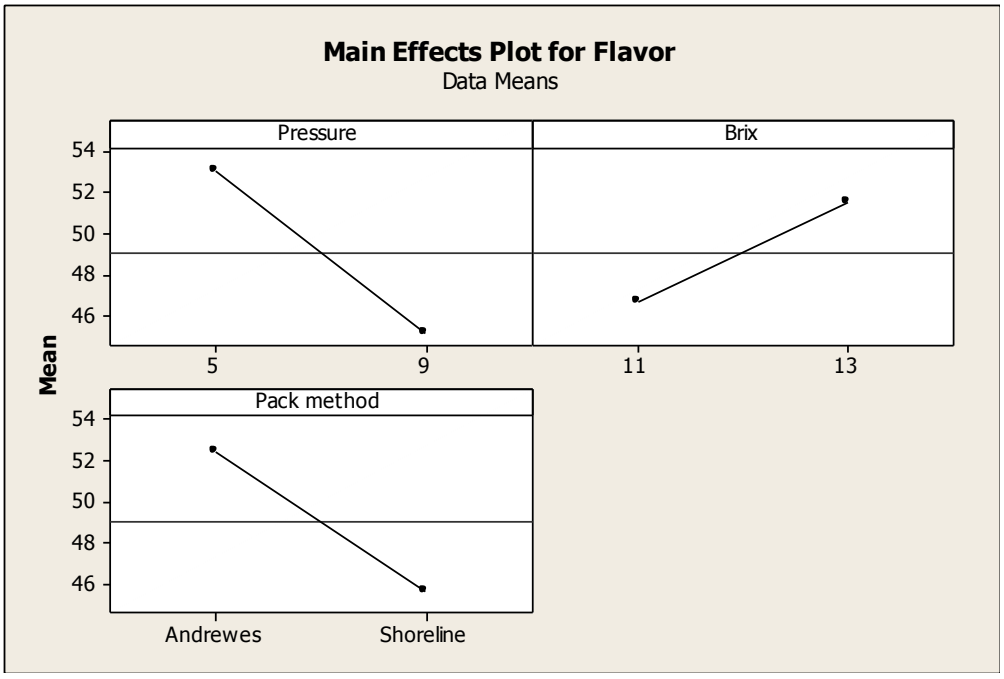


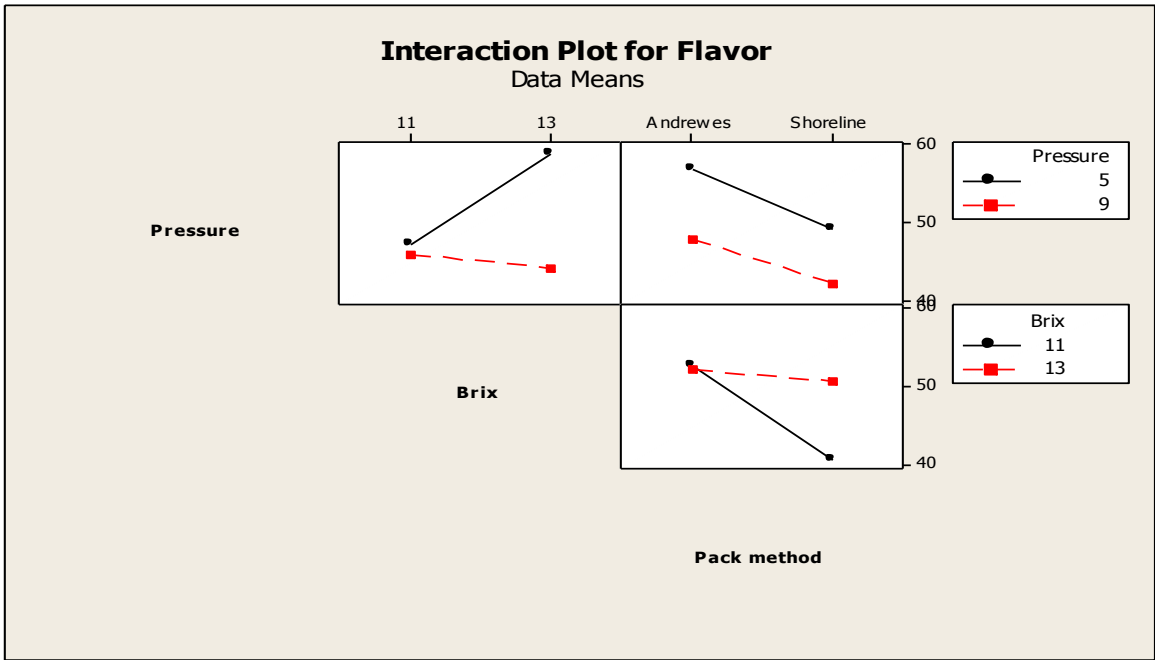
Figure 7-15 shows that no individual factor, nor 2-way interaction of factors, has a statistically significant impact on flavour. That said, Figure 7-16 shows that low pressure and higher brix are associated with consumers' satisfaction with flavour.

Figure 7-16 Main Effects of Pressure, Brix and Packer on Flavour



The relative impacts of factors described in Figures 7-14, 7-15 and 7-16, are summarized below in Figure 7-17. As can be seen, peaches from Andrewes with low pressure and high brix achieved a better flavour score in the sensory panel tests.

Figure 7-17 Interaction Tables for Flavour, by Packer



8 Summary

The research findings show that eating and visual quality have a direct effect on consumer satisfaction and the value they equate to peaches. They also show that:

- Quality, not volume, has the most impact on businesses' long-term profitability;
- Developing the capabilities to cost-effectively produce, distribute and market consistently high quality fruit is critical to the success of any business;
    - Canada trails California and Chile in the extent to which its producers and marketers have developed the capabilities required to achieve these outcomes;
- Visual cues have greatest influence on consumers' purchasing decisions;
- A relationship exists between peach pressure/softness and consumer satisfaction;
- A slightly lesser relationship exists between brix and eating quality;
- Reflective foil, summer pruning, and leaf thinning offer opportunities to enhance the attributes to which consumers equate the greatest value; and
- Hot packing, followed by forced air cooling, appears likely to be an effective way of maintaining quality through the chain (and potentially extending shelf-life);
    - Though, as it reduces respiration and therefore the ripening process after harvest, using this approach is likely to require changes to how/when peaches are harvested.

Appendix: VRIC SENSORY EVALUATION REPORT (2010): Platinum Peach Project

Objectives

The overall objective of the project was to determine the impact of pressure, brix, and pulp temperature levels (as well as factors such as acid levels) on peach sensory properties and consumers' overall eating experiences. The peaches were selected according to the Design of Experiments (DOE) provided by the Value Chain Management Centre/George Morris Centre. For this project, the Vineland Research and Innovation Centre committed to the following:

- Conduct instrumental (scientific) analyses on peaches sampled at the retail store
- Describe sensory properties and differences on the same sample lot using descriptive analysis with a trained sensory panel
- Determine consumer overall liking on the same sample lot using hedonic tests

Methodology

Products

The peaches were sourced on the Thursday morning of each testing week from different locations. Product information is outlined in Table 1. The tests were conducted between August 13th, 2010 and September 12th, 2010. Please note that tests were not conducted the second week due to lack of samples available for that purpose. In addition, some peach samples were evaluated although they were not part of the Platinum DoE project. In that case samples were supplied by a Zehrs store.

Table 1: List of Peaches (DOEs and 'Zehrs' samples)

Week #	Sample type	DoE Code	Source	Number of peaches received	Date of reception
Week1	DOE	Lot 1	Store 562 Fortinos (Hamilton)	2 trays of 35 peaches each	August 12th, 2010
		Lot 4 (1)		2 trays of 35 peaches each	
		Lot 5 (1)	Store 536 Zehrs (St Catharines)	2 trays of 35 peaches each	
		Lot 7 (1)		2 trays of 35 peaches each	
Week 2	No Samples				
Week 3	DOE	Lot 2 (1)	Loblaws' DC (Cambridge)	1 tray of 42	August 26th, 2010
		Lot 3		1 tray of 42	
		Lot 5 (2)		1 tray of 42 peaches	
		Lot 6 (1)		1 tray of 42	
		Lot 8		1 tray of 42	
	'Zehrs sample'	Zehrs Tuesday (1)	Store 536 Zehrs (St Catharines)	1 tray of 42	
		Zehrs Wednesday (1)		1 tray of 42	
Week 4	DOE	Lot 2 (2)	Loblaws' DC (Cambridge)	1 tray of 42	September 3rd, 2010
		Lot 6 (2)		1 tray of 36 (6 peaches were missing)	
	'Zehrs sample'	Zehrs Tuesday (2)	Store 536 Zehrs (St Catharines)	1 tray of 42	
		Zehrs Wednesday (2)		1 tray of 42	
Week 5	DOE	Lot 4 (2)*	Vineland Coop	2 trays of 42	September 12th, 2010
		Lot 7 (2)*		2 trays of 42	
	'Zehrs sample'	Zehrs Tuesday (3)	Store 536 Zehrs (St Catharines)	1 tray of 42	
		Zehrs Wednesday (3)		1 tray of 42	

*Due to visual differences, we chose to treat the two trays as different products, which is the reason that there are two samples per DOE Lot for Week 5 (Lot 4(2)-Box 1, Lot 4(2)-Box 2, Lot 7(2)-Box 1, Lot 7(2)-Box 2).

For instrumental analyses, 10 peaches were held in cold storage at 4 degrees. For sensory evaluation (consumer tests and trained panel), the others peaches were stored at room temperature 24 hours a day until the day of testing.

Instrumental Analyses

The methods for the Determination of Temperature, Flesh Firmness, °Brix, and Titratable Acidity are presented below:

Temperature

A digital probe thermometer was used to measure the flesh temperature of peaches immediately prior to other analyses. The probe was inserted into the shoulder of the peach, penetrating the flesh by about 3cm. Once the temperature displayed on the thermometer stabilized, it was recorded. Temperature values were determined using a Traceable Thermometer from Fisher Scientific (Ottawa, Ontario, Canada) and were recorded in °F.

Flesh Firmness

The flesh firmness of the peaches was measured twice per peach – once on each cheek. A very thin slice was removed from the centre of each cheek of the peach to remove the skin and expose the flesh. The flesh firmness was determined through a Magness-Taylor test. A rounded-tip probe, 5/16" in diameter, penetrated the peach flesh by 5/16". The maximum force required to penetrate the fruit by this distance was recorded, and used as a measure of fruit firmness. The Magness-Taylor test was performed using a TA XT Plus Texture Analyzer (Texture Technologies Corp., Robbinsville, New Jersey, USA/Stable Micro Systems, Godalming, Surrey, UK) equipped with a probe of 5/16" diameter. The flesh firmness was recorded as an average, per peach, in pounds (lbs) force.

°Brix

After the flesh firmness was determined, the °Brix of the peach was measured using a refractometer. A wedge from each cheek of the peach was cut out with a clean knife. Each wedge was squeezed over the lens of the refractometer, separately, until a couple of drops of juice covered the lens. The refractometer measures the refractive index of the liquid, and reports the values as °Brix. °Brix was measured twice per peach using a digital refractometer, the PR-101α, from ATAGO USA Inc (Bellevue, Washington, USA). The °Brix was reported as an average per peach.

NB – Many of the peaches for this project were too firm to squeeze juice out of manually. As a result, for most of the peaches, the °Brix was determined after juicing – see below. These measurements were also done in duplicate, and reported as an average.

Titratable Acidity

Titratable acidity was determined by titrating a known volume of peach juice with a standardized alkaline solution.

Peach juice was attained by juicing the peach with a household juicer. The peach skin was removed using a sharp knife, and the flesh was cut away from the stone. The flesh was juiced using Jack LaLanne's Power Juicer Elite purchased at Canadian Tire (Welland, Ontario, Canada).

The peach juice was centrifuged to settle any remaining pulp, and a 10ml aliquot of the juice was transferred to a beaker. 50ml of water were added to the beaker along with a stir bar. The solution was titrated, while stirring, with standardized 0.1N sodium hydroxide solution. The pH was monitored throughout the titration, with an Accumet Basic AB15 pH meter from Fisher Scientific (Ottawa, Ontario, Canada), and the juice solution was titrated to an endpoint of 8.10 pH units.

Titrations were performed in duplicate per peach to ensure precision and confidence in data. Titratable acidity was reported as an average, per peach, as grams of malic acid per 100ml peach juice.

Descriptive Analysis

Panelists

Eleven members of the Vineland trained sensory panel (9 females, 2 males) participated in this study. For each session, there were nine panelists. Seven panelists participated in all the four measurement sessions. Panelists were divided in two groups according to their availability: some panelists came every Thursday evening and the others came every Friday morning. Panelists were compensated $12/hr.

Training

Panelists were asked to rate the perceived intensity of attributes generated during training sessions. The list of all attributes is presented in Table 2. Please note that four training sessions (1.5 hour each) were run before the first week of measurement for introducing the project and generating the attributes. Also, during the measurement weeks, others training sessions were run every Wednesdays (2 groups: morning and evening) to re-calibrate the panelists.

Table 2: List of the Peaches' Attributes and Definitions

Taste and Sensation				
Descriptor	**Definition**			
Sour	The taste stimulated by acids, such as citric, malic, phosphoric, etc. *Examples: Lemon, Vinegar...*			
Sweet	The taste stimulated by sucrose and other sugars, such as fructose, glucose, etc., and by other sweet substances such as saccharin, aspartame, etc. *Examples: Candies, Soda...*			
Bitter	The taste stimulated by substances such as quinine, caffeine, and hop bitters. *Examples: Coffee, Endive…*			
Astringent	*The complex of sensations due to shrinking, drawing, or puckering of the epithelium as a result of exposure to substances such as alums or tannins. It is not a taste since it is not only perceived on the tongue. It is a mouth feeling and you have no more saliva in the mouth. You have to water your mouth to remove this feeling.* *Examples: Red wine, Cranberry juice...*			
Flavour				
Flavour Descriptor	**Definition**		**Least anchor**	**Most anchor**
Peach				
Green	Peach which the flavour is not existent.		Very ripe peach	Unripe peach
Texture				
Descriptor	**Definition**	**Least anchor**	**Most anchor**	**Where? Skin, Flesh or Both.**
Firm	The force required to compress between tongue and palate.	Raspberry	Carrot	Both
Crisp	Breaks apart in single step. Higher frequency sound. Force of fracture when biting-sound produced in initial bite.	Banana	Celery	Both
Juicy	Amount of liquid released when chewing.	Dried Apricot	Watermelon	Flesh
Chewy	Time and number of chewing movements needed to rind the sample prior to swallowing.	Raspberry Banana	Dried Apricot	Both
Fuzzy	The feeling of the outside skin on the tongue, lips and palate.	Nectarine	Peach	Skin
Smooth	Feeling on flesh on the tongue. Anchors: Fibrous to Smooth.	Celery	Avocado	Flesh

Samples

The peach samples were presented one by one. For each sample, panelists received two wedges (with the skin) from the eight-wedged peaches in three-digit-coded 2 oz plastic cups. The peaches were rinsed with cool, filtered water 30 minutes prior to evaluation. Peaches wedges were prepared at time of presentation and cut with a knife in eight similar wedges to be immediately distributed to the panelists.

Evaluation

Panel sessions were conducted in the Sensory Evaluation Laboratory at Vineland, equipped with 10 individual booths designed according to international standards. The panelists were instructed to taste the sample and to rate their perceptions on 15 cm intensity line scales, and anchored from 'weak' to 'intense'. Two replicates of measurement were conducted in the same session. A break of 20 minutes was made between the two replicates to avoid sensory fatigue. Samples were presented using a Williams Latin Square design, minimizing the first position and carry over effects.

Data Collection

Data were collected using the sensory software EyeQuestion (Logic 8, the Netherlands).

Consumer Tests

Consumers Screening and Recruitment

Consumers were recruited from the Vineland Consumer Database, the Internet and newspaper advertisements. Advertisements were posted in the following newspapers: St. Catharines Standard, Niagara Falls Review, and Welland Tribune on the weekends of July 30 and 31 and August 20 and 21. Those who showed interest in participating in the study were contacted via email and phone to fill out an online questionnaire regarding their grocery shopping habits, food allergies and sensitivities, and availability. Subjects were also asked to provide contact information in order to be scheduled for participation in the study. If the subjects met the predetermined participating criteria (no known food allergies, primary household grocery shopper and peach consumer), they were invited to participate in the study. Subjects were informed that they would be compensated $10/hr, and were expected to attend at least 3 of 5 available sessions. If they attended 4 sessions out of 5 sessions available, they received a $15 gift card as a bonus, and if they attended all 5 sessions, they received a $30 gift card as a bonus.

Subjects Attendance

The number of participants per week is listed in Table 3.

Table 3: Number of Participants Per Week

Week	Week 1	Week 3	Week 4	Week 5
Total	32	40	32	36
Male	11	12	12	13
Female	21	28	20	23

- Number of subjects who attended a total of 4 sessions: 20
- Number of subjects who attended a total of 3 sessions: 12
- Number of subjects who attended a total of 2 sessions: 7
- Number of subjects who attended a total of 1 session: 9

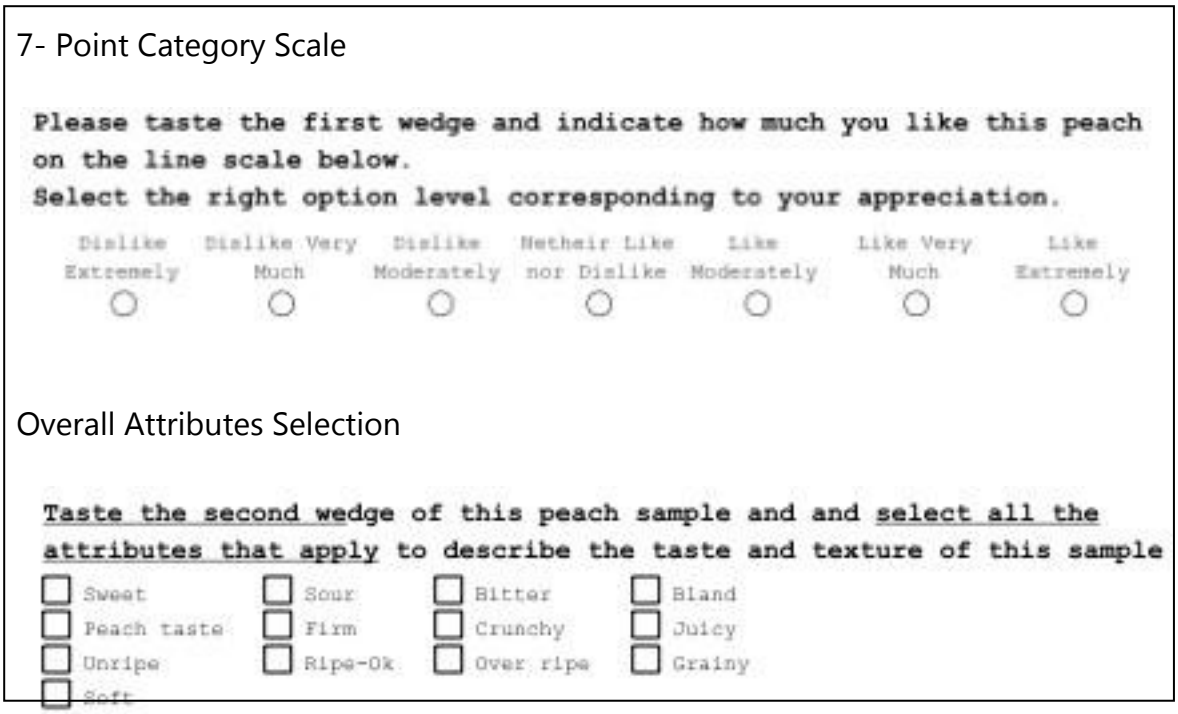
Samples

Peach samples were taken out of cool storage (4 °C) and stored at room temperature 24 hours prior to the testing. Each sample was assigned a random 3-digit code. Samples were washed and sliced into eight wedges immediately before serving. Two wedges of each sample were served in 2 oz plastic cup. The order of the presentation was balanced using a William Latin Square design. One sample was served at a time.

Evaluation

Sample evaluations were conducted on Fridays in Rittenhouse Hall on the Vineland Research and Innovation Centre campus. On the scheduled testing day, subjects were asked to sign in upon arrival. They were given an oral explanation of the experiment purpose, compensation and procedure. Each subject was given a paper copy of the questionnaire and a subject identification number. They were asked to evaluate one sample at a time. For each sample, subjects were asked to taste the first wedge of the sample to rate their hedonic liking on a 7-point category scale, then taste the second sample wedge and select all the attributes that best described the sample overall. The listed attributes were sweet, sour, bitter, bland, peach taste, firm, crunchy, juicy, unripe, ripe (ok), over-ripe, grainy and soft. Figure 1 provides an example of the questionnaire which consumers had to fill out. It was recommended that subjects clean their palates with provided water and take a 2-minutes break between samples. Subjects were compensated upon completion of each tasting session. The same procedure was followed for four weeks.

Figure 1: Example of Consumer Questionnaire



Data Collection

Data were collected by scanning all the paper questionnaires and by using the sensory software EyeQuestion (Logic 8, the Netherlands).