DEVELOPMENT OF A FLAVOURING SYSTEM FOR 'HONEY BUTTER' POTATO CHIPS

'A project report presented in partial fulfilment of the requirements of the Bachelor of Food Technology with Honours at Massey University'

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Executive Summary

Potatoes New Zealand Inc. is a New Zealand based company whose primary objective is to represent the interests of the potato industry in New Zealand and have sponsored this project. One of the products created with potatoes is packaged potato chips which currently have a $150m market in New Zealand. This market is growing at 15% annually with an increase in consumer demand for a wider variety of flavours.

A unique flavour of chips that has become a craze in South Korea is the “Honey Butter” variety originally produced by Haitai-Calbee Confectionary Co. This flavour is yet to penetrate the mainstream food distributers in New Zealand and the aim of this project aim was develop a honey butter flavouring system for potato chips to be used industrially. A literature review was carried out to review the current knowledge and findings around development of a flavour system as well as the changes in the potato chip market that led to the commission of this project.

A focus group was first carried out to conduct consumer testing with people familiar with the product. The results from this group were promising with all members enjoying the honey butter chips supplied and being interested in New Zealand version of the product. Next the honey butter flavour was developed. The development of the flavour used a number of suppliers and trials with the final formulation including Manuka honey powder which provided a distinctly New Zealand aspect to the flavour. The number of trials for development was limited by the amount of unflavoured chips available.

The flavour developed was then tested in a sensory panel with Haitai-Calbee’s Honey Butter product. Both products were well liked by the panels with the flavour developed and Haitai-Calbee’s product receiving average overall liking scores of 8.5 and 11.2 respectively on a 15cm line scale. The results showed that there is consumer interest for new potato chip flavours to be released in the New Zealand market.

The final cost of the flavour developed was calculated to be $31.52/kg. While this price is expensive it can be easily decreased with large scale production as the prices are dependent upon the amount ordered. The price can also be decreased by changing the Manuka honey powder to a generic honey powder and/or changing honey flavour to a

cheaper supplier. These options would require reformulating however and would remove the unique selling point of the Manuka Honey. The recommended packaging system for this product is a foil laminate in a vertical form fill and seal machine. If possible a nitrogen flush should be included to remove Oxygen from the package environment and help maintain product quality over a longer period of time.

Recommendations from this project are to investigate the changes on the overall liking for increasing the honey flavour and decreasing the butter flavour in the flavour developed. It is also recommended that if possible the sensory panel be repeated with fresh ingredients and a shelf life evaluation be done on the product.

Acknowledgements

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Table of Contents

List of Figures

List of Tables

1.0 Introduction

Potatoes NZ Inc. is a New Zealand company whose primary objective is to represent the interests of the potato industry in New Zealand have sponsored this project. New Zealand currently produces 525,000 MT of potatoes per year from 10,329 hectares of planted land. From this number 330,000 MT goes to processing with the entire industry being worth $142 million annually (Potatoes New Zealand, 2017). One of the products created from this processing is packaged potato chips. This market is growing at 15% annually with an increase in consumer demand for a wider variety of flavours (Stuff, 2016).

A unique flavour of chips that has become a craze in South Korea is the “Honey Butter” variety originally produced by Haitai-Calbee Confectionary Co. This flavour is yet to penetrate the mainstream food distributers in New Zealand and is only available from specialty Asian food stores. This flavour was an unprecedented success in South Korea receiving much attention and advertising through social media. This flavour has shown great potential and this project was commissioned to develop a honey butter flavouring system for potato chips that can be used industrially. This flavour aims to add significant value to the potato industry in New Zealand.

2.0 Aims, Objectives & Constraints

2.1 Aim:

The aim of this project is to develop a honey butter flavouring system for potato chips that can be used industrially.

2.2 Objectives:

- To conduct a literature review into flavour formulations and Honey Butter chips.
- To obtain and characterise 'honey butter' chips.
- To conduct consumer research using consumers familiar with the product.
- To obtain or make potato chips that can be used for the flavouring system.
- To develop and formulate a 'honey butter' flavour system that can be applied industrially to flavour potato chips.
- To conduct sensory testing with the flavour developed

2.3 Constraints:

- **Time:** The final report of this project must be completed by the 22nd of October.
- **Sensory testing:** The sensory booths and willing participants may not be available when required. The booths can be booked in advance but compensation may be required to entice willing participants.
- **Obtaining Honey Butter Chips:** The Honey butter chips required to be characterized may be not be readily available as they are from South Korea and only sold in specialty stores.
- **Materials:** Unflavoured chips and ingredients will be required for the flavour development part of this project. These will have to be sourced from industry as there are no facilities available at Massey to line produce chips.

3.0 Literature Review

Introduction

This literature review was completed to review the current knowledge and findings around the development of a Honey Butter flavour system for industrial application on potato chips for Potatoes New Zealand. The review investigated the potato industry in New Zealand and the potato chip product along with the changes in the market that led to the commission of this project. A part of this project was to characterise honey butter chips already present in the industry so current analytical and sensory characterisation methods alongside flavour systems and their development were also reviewed. These methods were analysed in terms of the project and how they could be applied to aid in the development of a flavour system. Peer reviewed sources were used where possible however they were not always available for the subjects investigated. When peer reviewed sources were not available multiple sources were consulted to ensure the validity of the provided information.

3.1 The Potato Industry in New Zealand

A potato is a South American herb *Solanum tuberosum,* the plant is widely cultivated for its edible starchy tuber. While the term potato can describe either the herb or the tuber, it will be refined to describing the tuber in this report.

New Zealand currently produces 525,000 MT of potatoes per annum from 10,329 hectares. Potato farms can be found all over the country and the potato industry is currently worth $142 million annually. Potatoes New Zealand Inc. is a trade/industry association and they hold themselves directly responsible for promoting the needs of the potato industry and the value of potatoes and potato products (Potatoes New Zealand Inc., 2017).

3.1.1 Growing Potatoes

Potatoes are grown from seed, a cut piece of potato with an eye in each piece. For a uniform crop the pieces should consistent in size and weight. It is important that the seed piece has been treated for disease and kept clean during planting to prevent infection (Gould, 1999). Prevention of disease is paramount as they have the potential to present serious issues to the user of the infected crop from either serious illness or the production of an inferior product from the diseased potato.

While potatoes are grown in many locations around the world, the culture of each area can be drastically different. This can lead to variations in flavour for potato products produced in different regions. Proper soil testing and fertilizer use can reduce this effect and ensure best results for crop yield and quality (Gould, 1999).

3.1.2 Adding Value to Potato Products

The idea of adding value to products is to enhance or improve the value or worth of the product before offering the product to consumers. This concept is utilized to maximize profitability by creating the highest value possible product from the raw materials available (Investopedia, 2017). One way added value can be achieved is through strong branding; creating the perception that your company's product is worth more than the competitor's products (Williams, 2017). Another method is through the ability to charge more for providing a superior product or service. A combination of these methods should be used by New Zealand Potatoes Inc. to ensure the success of their products

and brands in the potato crisp market both domestically and internationally. The goal of the project is to create a honey butter flavour system to be used industrially and so will be centred around adding value to products through providing a superior product.

3.2 Potato Chips

Potato chips were first created in 1853 in New York by Commodore Cornelius Vanderbilt, the industry grew steadily until hitting a boom post World War One in 1931 in Ohio when the Ohio Chip association was created. By 1937 potato crisps had spread across the United States and the National Potato Chip Institute was formed (Gould, 1999).

Currently potato chips are a popular snack sold across the world with over $5.7b (USD) in sales in the United States in 2016 (Statista, 2016). The industry in New Zealand is a lot smaller at $150m (NZD) but still accounts for one fifth of potato production in the country (Ineson).

3.2.1 Potato Chip Manufacture

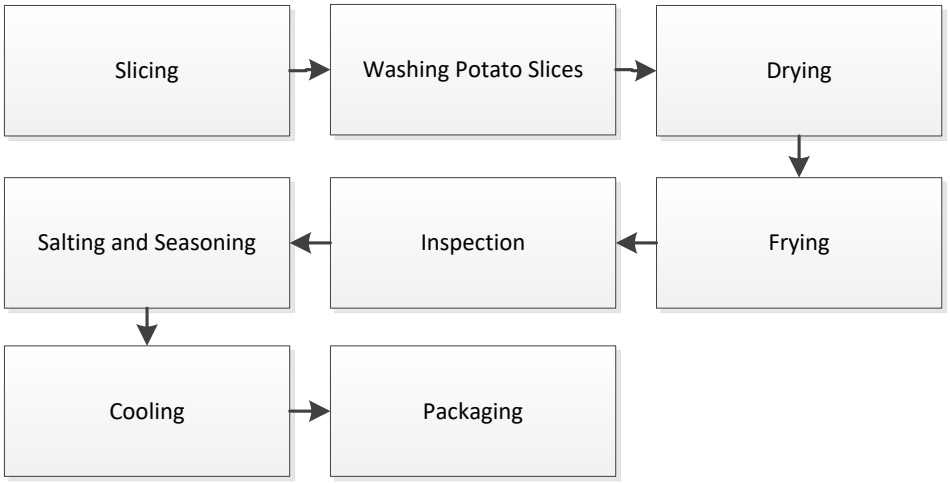

Figure 1: Flow diagram of potato crisp manufacture

The general process for potato chip manufacture is given in Figure 1. Automatic slicing of the potatoes ensures that uniform crisps are produced. This is typically done with a centrifugal slicer where potatoes enter the rotating impeller and are forced against the inner surface of the slicing assembly. As the potatoes pass each knife a slice is produced.

Washing the potato slices prior to frying is optional but it can help to remove loose starch and can improve crispness and colour. If this step is chosen, the slices should be

washed by counter current flow to ensure that clean water is the last on the slices (Gould, 1999).

Drying is done to ensure that excess water is removed prior to frying. This can be achieved through the use of air blades followed by vibration of the slices.

Frying of the potato slices can be done through either a batch or a continuous method. Batch style is commonly referred to as “old fashioned” or “kettle style” this method typically takes longer with 8-10 minutes extra per batch, has a lower temperature and a slightly higher oil content in the chip. The continuous method is the most widely used and can be operated with a variety of heating systems. A variety of oils can be used cook chips and each imparts their own flavours. During frying the water present in the potato slices evaporates and is replaced by oil, if the fat content gets too high the chip can become oily while if it is too low the chip can become less crisp. The amount of fat absorbed by the chips as well as their texture depends upon the type of oil and the frying temperature used (Kita, Lisinska & Golubowska, 2007).

Chips are inspected either electronically or visually following the frying process in order to remove any discoloured burnt or defective crisps (European Snacks Association, 2014). This step is important for ensuring the highest quality product possible reaches the consumer.

Potato chips can be seasoned either dry or wet. For the dry method the chip is coated in salt while the oil on the surface of the chip is still hot to increase adhesion, the typical salt content for crisps is between 1.5% - 2%. If further seasoning is to be used the dry powder is applied with either a tumble drum seasoner or sprinkled on top like the salt. For dry application it is important to consider flow of the seasoning powder and the degree of adhesion. The flow ability can be increased with flow agents which also help to reduce the effect of moisture pickup. Adhesion depends upon the temperature and level of surface oil as well as the particle size and shape so it will be important to consider these factors when designing the flavour system.

For wet application a slurry of seasoning and oil is sprayed directly onto the crisps. This method of application typically takes place in a tumbler also. As the liquid is stored in a holding tank the ingredients used need to resist settling out prior to use, one way to

help to ensure this is through the reduction of particle size in the slurry. An analysis of the facilities New Zealand Potatoes would use to produce the honey butter crisps needs to be undertaken before a decision on the method of flavour application is made.

Potato chips are typically cooled prior to packaging. This helps to eliminate moisture in the bag and improve texture of the product when it reaches the consumer (Gould, 1999).

Packaging of the crisps is typically done on site in a form, fill, seal vertical packager where the bags are inflated to a degree before being sealed to help protect the delicate product. The bags are often filled with an inert gas such as Nitrogen to help prevent oxidation and keep the quality of the product as high as possible.

A chip bag is typically comprised of multiple layers of polymer materials, an example of this is: Biaxially orientated polypropylene on the inside, low-density polypropylene in the middle, another middle layer of (BOPP) and an outer layer of a thermoplastic resin (Polymer Solutions, 2015). These materials help give the packaging strength, flexibility, and provide barriers to UV light, oxygen and water vapour to maintain product quality. The current packaging in use by New Zealand Potatoes manufactures will be investigated to ensure it will be suitable for the flavour system developed.

3.2.2 Changes in the Potato Chip market

The potato crisp market has experienced substantial growth over the years and manufactures in the market are expected to be able to quickly develop new flavours and modify ingredients to meet taste preferences of a variety of consumers (Transparency Market Research, 2017).

Recently the tastes of the $150m a year New Zealand potato chip market has shifted with a growing demand for specialty flavours (Ineson, 2016). Domestic sales of chips have grown 15% over the past three years with potato chips making up one fifth of New Zealand's potato industry. Similarities have been drawn between the chip and the craft beer markets with consumers wanting a lot of choice and a wide variety (Ineson, 2016).

3.2.3 The Honey Butter Flavour Sensation in Korea

In August 2014 Honey Butter chips; a joint venture between Japanese snack company Calbee and Korean Confectionary company, Haitai were released in South Korea (Keelan, 2015). This snack soon became a craze with many stores consistently selling out of the snack product. Haitai-Calbee reported $20.3 million (USD) in sales in January and February in 2015 of Honey Butter chips (Revolvy, 2016). Due to their popularity Honey Butter chips became very difficult to obtain and a snack "black market" was quickly created. This black market was a means for consumers to get a hold of the product through non-typical means such as online auctions often at highly inflated prices (Keelan, 2016). Despite Haitai-Calbee claiming that they were working day and night to meet the market demand their production capabilities were unable to keep up. To meet this gap in the market many competitors started creating their own version of the Honey Butter flavour. Currently one of Haiti's competitors, Nongshim Co.'s owns the top selling potato chip snack with their Honey Mustard Chips (The Korea Herald, 2015).

One theory for the snacks amazing success in Korea is that it removed the preconception that potato chips could not be sweet but rather only spicy or salty (Keelan, 2015). The success of Honey Butter chips shows potential opportunities for other sweet and savoury snack products.

3.3 Flavour Characterisation

To achieve the goal of developing a honey butter flavour system for industrial use, one objective was to characterise the Honey Butter Chips developed by Haitai-Calbee. This was done in order to evaluate the formulation of an already existing successful product in the market place to use as a base for the development of a new flavour system. While the packaging of Haitai-Calbee's product does state most ingredients, there are some translation differences and some components have been made especially for Haitai-Calbee such as "Honey Butter Flavour Seasoning". The results of the characterization investigation should lead to the ingredients used by Haitai-Calbee or effective substitutes to use to begin the formulation of a new flavour system. There are both analytical and sensory method for flavour characterization both of which will be investigated.

3.3.1 Analytical Techniques

The perceived odour of any material is composed of one or more volatile components present in concentrations above the sensitivity threshold (Delahunty, Eyres, & Dufour, 2006). Analytical techniques discussed in this review are aimed to help identify the compounds already used in industry in Honey Butter flavour systems, specially the system used by Haitai-Calbee.

3.3.1.1 Gas Chromatography Mass Spectrometry (GC/MS)

Gas chromatography mass spectrometry is an analytical technique that is made up of a gas chromatograph (GC) connected to a mass spectrometer (MS) (Ochiai, 2012). This technique allows for complex mixtures of chemicals to be separated identified and quantified. For a sample to be analysed it must be sufficiently volatile and thermally stable, because of this some samples require chemical modification prior to analysis. The Honey Butter crisp produced by Haitai-Calbee will require solvent extraction and the extract be subjected to various 'wet chemical' techniques prior to GC/MS analysis (Paul, 2017). This technique outputs a large amount of peaks as shown in Figure 2 and is dependent upon the library of known compounds that the data produced can be compared against. The sample from Haitai-Calbee is unlikely to have any compounds that have not been previously identified. If this is the case however then sensory methods of characterisation will have to be relied upon.

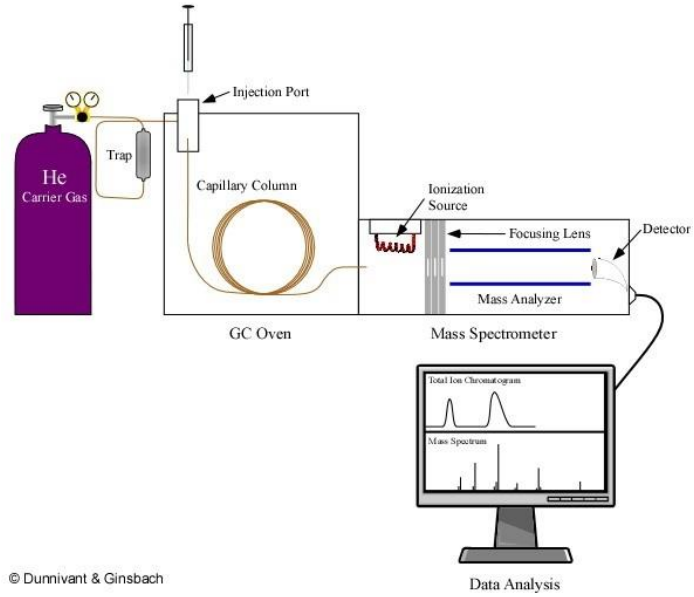

Figure 2: Diagram of a GC/MS system (Dunnivant, 2017)

3.3.1.2 Gas Chromatography-olfactometry

Gas chromatography-olfactometry (GC-O) refers to the use of human assessors as a sensitive and selective detector for odour active compounds. This technique aims to odour activity of volatile chemicals in a sample extract and assign a relative importance to each compound (Delahunty, Eyres, & Dufour, 2006). This technique can be used in addition to GC/MS to help assign sensory descriptions to the compounds detected (Figure 3). This has useful applications for determining which part of each honey butter flavour system is responsible for which aspect of flavour they deliver.

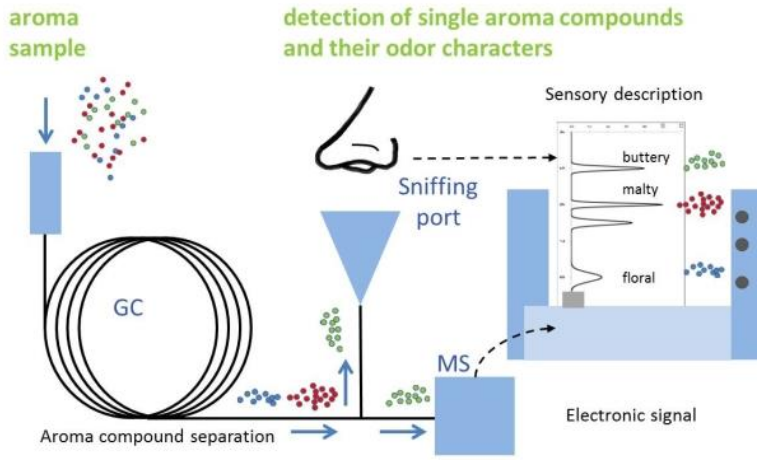

Figure 3: Diagram of a gas chromatography-olfactometry system (FlavoLogic, 2017)

3.3.2 Sensory Techniques

Sensory evaluation is a scientific discipline that concerns the presentation of a stimulus to a subject and then the evaluation of the subject's response (Bills &Mussinan, 1984). While the responses can be translated into a numerical form and statistically analysed, they do come from people which can result in variance and drift especially among untrained panellists.

3.3.2.1 Profile Attribute Analysis

Profile attribute analysis is a qualitative descriptive technique. The vocabulary used to describe the product and the product's evaluation itself are achieved by discussion and agreement among panel members (Ho & Manley, 1993). This technique requires a panel leader to moderate interactions between panellists and lead the group toward a general consensus of opinion. The final product description is indicated by a series of symbols (Ho & Manley, 1993).

3.3.2.2 Descriptive Analysis

Descriptive analysis (DA) provides a quantitative analytical characterisation of aroma taste and mouth feel (Taylor, 2002). The first task for a DA is the development of a vocabulary that will be used to describe the differences between the samples in specific terms. For each study reference samples are provided to define each term and panellists are trained to rate each attribute consistently. Once training is complete the intensity of each term is rated for each product by the panellists. A variation of this test is Free Choice Profiling where the panellists use their own terms to describe the product, (Ho & Manley, 1993; Taylor, 2002) this test can however lead to difficulties in analysis of results.

3.3.2.3 Intensity Rating Tests

Intensity rating tests are used to measure the size and nature of differences in flavours or flavoured products by a panel of trained judges rating a specific attribute (Taylor, 2002). A number of different scales such as category or unstructured line graphs can be used (Figure 4). For investigation such as this project, line or category scales would be ideal as a flavour system is being measured. This test has the application to be used to compare attributes of the new flavour system that will be developed against existing crisp products in the industry.

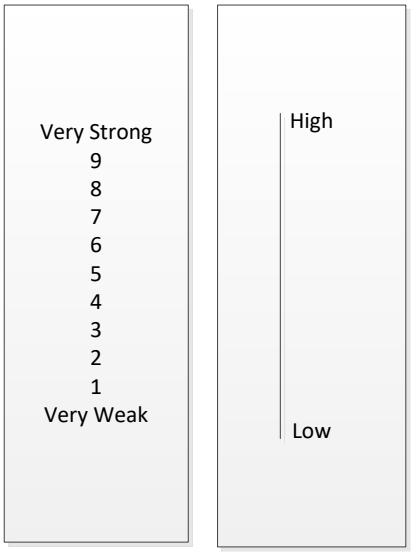

Figure 4: Example of a category scale (left) and an unstructured line scale (right)

3.3.2.4 Difference Tests

Difference tests are conducted to determine whether there are perceptible differences between products. The two most common difference tests are the duo-trio test and the triangle test (Society of Sensory Professionals, 2017). If a difference is found between samples, pair tests can be used to determine which product is higher in a specific attribute (Taylor, 2002). These tests have useful applications for testing the created honey butter flavour against existing systems and obtaining data to support changes in formulation.

3.4 Flavour Systems

The flavour system for this project will refer to a system developed to deliver a honey butter flavour from a crisp base. A number of techniques to develop a flavour system are in use from mixing all the ingredients together at the start or building a flavour one component at a time (Taylor, 2002). Currently the plan for this system is to attempt to make a replication of the Haitai-Calbee's product using ingredients sourced from New Zealand before adjusting it based on sensory and focus group data. The ingredients for this system will be sourced from Flavour House, as this was the supplier chosen by New Zealand Potatoes.

The primary two tastes to be delivered by the flavour system are honey and butter:

Honey is essentially a highly concentrated water solution of two sugars, dextrose and levulose. While the physical characteristics and behaviour of honey is due to its sugars, the flavouring materials are a part of its minor constituents. The flavour and aroma of honey can vary greatly due to the wide range of floral sources that can be used to produce it. The flavour of honey results from the blending of many "notes" consisting of tartness or acidity (White & Doner, 1980). While the level of acids are less than 0.5% of the solids, they account for the flavour and stability of honey against microorganisms.

This indicates that the honey and honey flavour produced in New Zealand could taste quite different from any produced elsewhere. This could account for differences in the produced flavour system from that of Calbee's which is manufactured in Japan. Sensory testing will be undertaken to determine whether the difference is positive or negative.

Butter is a dairy product containing up to 80% fat created from the agitation of cream resulting in an oil in water emulsion. While the butter product is a complex mixture, butter flavour has distinct characterising components; diacetyl and acetoin. These compounds can be obtained through either chemical synthesis or extraction from dairy products (Rose, 2015). Butter flavour has been well defined so matching it to an existing system should present few problems.

3.5 Conclusion

The potato industry in New Zealand was researched to provide background information around the project. While slightly dated Gould's work on potato processing was very informative and provided an overview of the potato industry as a whole.

The rise in popularity of craft chips that led to the commission of this project was also investigated. The Honey Butter chip craze in South Korea was particularly unique and the potential opportunities for other sweet and savoury snack products in the market provided further investigative possibilities for future work.

Taylor's Food Flavour technology was also very useful for description and analysis of food flavour and characterisation methods. Gas chromatography mass spectrometry will be useful in characterising existing honey butter flavour systems while the information on flavour systems and sensory techniques should help with development and testing.

There was some difficulty in finding up to date information on potato crisp industry sales and trends due to many studies requiring payment to be accessed.

4.0 Consumer Testing – Focus Group

4.1 Aim:

The aim of this focus group was to conduct consumer testing on participants familiar with the product.

4.2 Materials and Methods:

Participants found for the focus group were primarily from Asia as this was indicated by the New Zealand Potatoes sponsor as a potential target market and the most likely demographic to find participants already familiar with the product.

Haitai-Calbee's honey butter chips, a kettle BBQ and line produced salt and vinegar chip samples were supplied for the participants to try. Once the participants were seated the project was introduced and consent forms were handed out.

The participants were encouraged to try all the samples and each one was asked what their name was and what they do/study to help break the ice and encourage an open dialogue.

The following list of questions were used to try and structure the focus group. The group was allowed talk after every question and asked more question on any points that they brought up.

Questions:

- Do you currently consume potato crisps?
- How often do you consume potato crisps?
- What are your favourite flavours?
- Thoughts on the Honey Butter Product?
- Have they had it before?
- What part of the flavour do they like the most?
- What words or terms would you use to describe the Honey Butter flavour?
- Would they be interested in seeing a New Zealand version of the flavour?
- Would they expect it to taste the same or would they like a New Zealand spin on the flavour?
- What other flavours would they like to see on the shelves?

4.3 Results

Seven people were found to participate in the focus group.

Table 1: Ethnicity of participants in focus group

Ethnicity	**Number of people**
Chinese	1
NZ European	1
Pilipino	1
Taiwanese	4

Table 2: Questions and Answers for focus group

Questions:	**Answers:**
Do you currently consume potato crisps?	6 yes, 1 sometimes
How often do you consume potato crisps?	2 Daily 4 Once a week 1 Once a month
What are your favourite flavours?	Sour cream, Chicken, Cucumber, Honey mustard, Salt and vinegar, Onion, Spicy Thai, Sweet Chilli, BBQ
Thoughts on the Honey Butter Product?	6 of the 7 liked the flavour Two liked the look of the packaging, the symbols and colours used, thought it looked healthy. One person said that the packaging was very important for sales in Taiwan. Three liked the base chip of the honey butter chips compared to the New Zealand kettle chips used, thought they were less oily and more healthy
Have they had the Honey Butter Chips before?	2 had eaten it before

What part of the flavour do they like the most?	Likes; • Sweet but not too sweet • Not too buttery • Popcorn taste • Savoury taste One person thought not enough flavouring
What was your favourite flavour of chip sample?	Honey Butter 3 people Salt and Vinegar 3 people BBQ 1 people
What was your favourite chip base?	Kettle 3 Line produced 3 Undecided 1
Would they be interested in seeing a New Zealand version of the flavour?	Six of the seven participants would be interested in a New Zealand version of the flavour
What other flavours would they like to see on the shelves?	Kiwi Fruit, Fejoa, garlic, really spicy, seaweed, cheese

4.4 Discussion

The focus group did not follow the exact format of questions that was originally planned and the participants were not able to provide many words or terms to describe the Honey Butter chips. This could be attributed to most of the participants being exchange or international students for whom English was a second language. The suggestion was also raised that a poll be taken to determine the participants favourite flavour and chip base from the samples supplied which was not originally planned.

It was fortunate that six of the seven participants currently consumed potato chips at least once a week as it meant that they would be in the target market of this product. The spread of favourite flavours was varied with many new or non-traditional flavours

such as cucumber, spicy Thai and honey mustard being suggested. This is consistent with the market research conducted in the literature review that consumers are looking for more choice in flavour for their snacks. Six out of the seven participants liked the Honey Butter chips supplied with two having tasted them before. The comments were quite consistent with nearly all the participants enjoying both the sweet and savoury components of the flavour. One participant noted that the taste was similar to popcorn and found it to be enjoyable.

The original objective was a conduct a focus with participants familiar with the product however finding people who had tried them before proved to be difficult and only two could be located. Nearly all of the remaining participants were Asian conforming to the request of the project sponsor. Two participants commented on the packaging, saying that they liked the colours and designs commented that it gave the impression of being healthy. Another person also noted that packaging was very important to sales in Taiwan. The design of any packaging is outside the scope of this project but it is important to note that the target country and user should be considered if this product is to be created and launched overseas.

The poll to determine which flavour and base samples were the favourite were quite even between honey butter (3) and salt and vinegar (3) and line produced (3) and kettle (3). The sample size of seven people is not large enough to draw meaningful results from but at a glance it is promising to note the initial interest in the Honey Butter flavour with six of the seven being interested to try a New Zealand version of the flavour. There also some comments that some people found the kettle variety of chip to be “oily” and “less healthy”.

The final question of the focus group asked the participants what other flavour they would like to see on shelves in the supermarkets. Their responses were; kiwi fruit, fejoa, garlic, really spicy, seaweed and cheese. The responses were a wide variety of both sweet and savoury flavours that show the current trend of interest in new exciting flavours. They also show possibility for future projects or development by chip manufactures both in New Zealand and abroad.

4.5 Conclusion

The focus ran very smoothly with all participants willing to communicate and contribute their ideas. Unfortunately, only two participants had tried honey butter chips before the focus group but all had tried potato chips before and were familiar with the snack. While the sample size was small and only seven people were tested the initial results were good and indicate that many people enjoy the Honey butter flavour and would be willing to try a New Zealand version of the flavour. These results confirm the market research cited in the literature review that there is a large interest in new and exciting flavours in the snack industry. There were also a variety of sweet and savoury flavours suggested by the participants that they would like to see being sold in supermarkets. These flavours could be used as the basis for another student project or anyone in the industry who are looking to expand their product range.

5.0 Flavour Development

The sponsor for this project, Potatoes New Zealand, indicated that they did not wish for the project to try and replicate the Honey Butter chip created by Haitai-Calbee but rather create a flavour that could potentially cater for both the domestic and international market. It was decided that line produced chips would be used as the base for this project. While there is the option to investigate the flavour on kettle chips in the future, for consistency in trials only line produced chips will be tested.

As part of research for this project a factory tour was completed in Auckland at Eta, a New Zealand based chip and snack manufacturer. They provided much useful information around flavour trials and potatoes varieties specific to chip variety. They advised that while some varieties could not be used for kettle all potato varieties could be used for line produced chips. The information learned on the tour also helped the choice to develop a dry powder mix to be used in a drum seasoner rather than a wet flavour spray.

5.1 Aim

The aim of this experiment was to develop a honey butter chip flavour that can be applied industrially to flavour potato chips.

5.2 Method for all trials

A large bag of blank chips was obtained from Eta on the day of the factory tour. They were removed from the line after frying prior to flavouring. These were used in the following method for adding the flavour for trials;

1. Weigh out flavour components to a total of 6% w/w of the chips and blend the flavour components together.
2. Measure 50g of chips (Figure 5) and microwave for 30s, to imitate factory conditions by melting the oil and bringing it to the surface to aid adhesion of the flavour powder
3. Place chips inside an inflated plastic bag
4. Pour the dry flavour ingredients evenly across the chips
5. Twist the top of the plastic bag closed and gently rotate for 30 seconds to imitate a drum seasoner (Figure 6)

Figure 5: Unflavoured chips being weighed prior to seasoning

Figure 6: Chips and flavour powder being mixed in a bag to imitate a drum seasoner

5.3 Trial One Materials

The initial flavour formulation used for trials (Table 3) was given by Hawkins Watts, a flavour house that was contacted for samples. They provided a standard recipe for flavourings that could be tweaked as needed. The recipe below is for 6% w/w on 50g of chips. The weight for salt was aimed to be kept between 1-2% of total product weight.

Table 3: Ingredient weights and suppliers for trial one

Ingredient	Weight (%)	Weight (g)	Supplier
Salt	22	0.675	Countdown Supermarket
Castor Sugar	20	0.6	Countdown Supermarket
Honey Flavour	5	0.15	Hawkins Watts
Butter Flavour	9	0.27	Hawkins Watts
Yeast Powder	7	0.21	Hawkins Watts
Garlic Powder	3	0.09	Davis Trading
Onion Powder	2	0.06	Davis Trading
Citric Acid	1	0.03	Davis Trading
Sweetener	30	0.9	Hawkins Watts
Syloid (Silicon Dioxide)*	0.5	0.015	-
Total	100	3	

*Silicon dioxide is a flowing agent that was not able to be sourced from flavour houses for trials as it is typically supplied pre mixed in flavour powders

5.4 Trial One Results and Discussion

Figure 7: Sample container from trial one

Results from the first trial showed that the flavour addition method resulted in adequate covering and adhesion of flavour powder across the chips. The base flavour recipe worked well however after being tasted it was determined that the honey and butter flavours were not strong enough. At the time of the first trial the honey powder samples had not arrived and a sweetener provided by Hawkins Watts was used in its place. This was not planned but due to time restrictions the trial went ahead to ensure the method would be suitable for all remaining trials.

5.5 Trial Two Materials

It was decided to double the honey and butter flavour weights in the recipe to try and increase the honey and butter flavours. As the total weight of the flavour was to be kept to 6%w/w, the weight for the increased flavours was taken from the castor sugar and salt. By the time of the second trial the dried honey powder samples from GS Foods had arrived. They provided both a honey dew and a Manuka dried honey powder, both of which were tested with the recipe in Table 4.

Table 4: Ingredient weights and suppliers for trial two

Ingredient	**Weight (%)**	**Weight (g)**	**Supplier**
Salt	18.17	0.545	Countdown Supermarket
Castor Sugar	16.00	0.48	Countdown Supermarket
Honey Flavour	10.00	0.3	
Butter Flavour	18.00	0.54	
Yeast Powder	7.00	0.21	
Garlic Powder	3.00	0.09	Davis Trading
Onion Powder	2.00	0.06	Davis Trading
Citric Acid	1.00	0.03	Davis Trading
Honey Powder (honey dew or manuka)	24.33	0.73	GS Foods
Syloid (Silicon Dioxide)	0.50	0.015	-
Total	100	3	

*Silicon dioxide is a flowing agent that was not able to be sourced for trials

5.6 Trial Two Results and Discussion

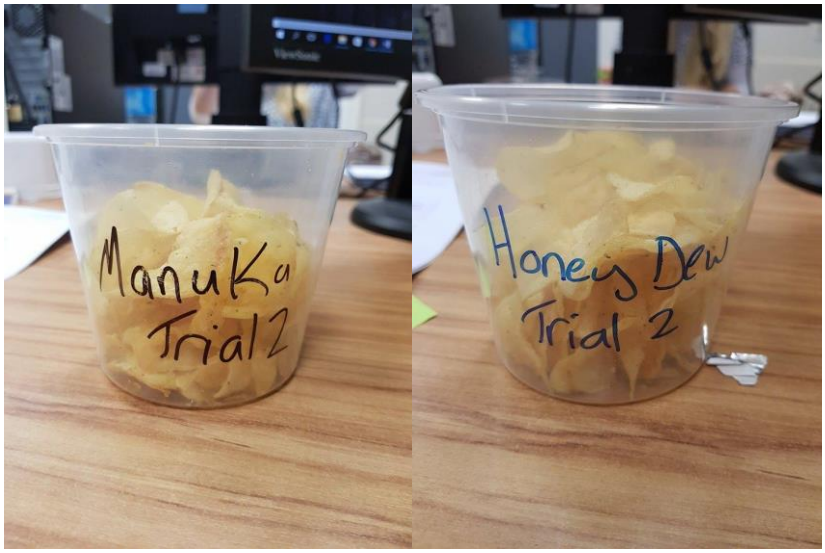

Figure 8: Sample containers for trial 2, Manuka honey powder on left honey dew on right

The honey and butter flavours were much stronger from this recipe however they were still not as strong as wanted. The honey powder in place of the sweetener added a much greater depth of flavour and a New Zealand spin on the formulation due to the unique taste of Honey Dew and Manuka honey. Both samples had potential however after discussion with the project supervisor, the Manuka Honey powder was chosen due to its stronger, more distinct taste.

5.7 Trial Three Materials

Trial three aimed to increase the honey and butter flavour weight further and to test the flavours provided by Sensient flavour house. Sensient provided three samples, one butter and two honey flavours. Both of the Sensient honey flavours were created with the Sensient Butter flavour and the Hawkins Watts flavours was also trialled at triple the flavour weights from trial one using the formulation in Table 5.

Table 5: Ingredient weights and suppliers for trial three

Ingredient	Weight (%)	Weight (g)	Supplier
Salt	16.5	0.495	Countdown Supermarket
Castor Sugar	10	0.3	Countdown Supermarket
Honey Flavour	15	0.45	Sensient/Hawkins Watts
Butter Flavour	27	0.81	Sensient/Hawkins Watts
Yeast Powder	5	0.15	Hawkins Watts
Garlic Powder	3	0.09	Davis Trading
Onion Powder	2	0.06	Davis Trading
Citric Acid	1	0.03	Davis Trading
Manuka Honey Powder	20	0.6	GS Foods
Syloid (Silicon Dioxide)*	0.5	0.015	-
Total	100	3	

*Silicon dioxide is a flowing agent that was not able to be sourced for trials

Figure 9: Trial three samples from left to right, Sensient N8206 honey flavour, Sensient N949 honey flavour, Hawkins Watts Flavours

5.8 Trial Three Results and Discussion

Once the three samples were created they were tasted and compared among University staff. From feedback of the tasters both the honey flavours and butter flavour of the Sensient samples were found to provide a more desirable flavour than the Hawkins Watts flavour samples. From the two honey flavour samples provided by Sensient, N8206 and N9494, the N8206 was a better fit for the flavour profile desired. N8206 is also classed as a natural flavour which would appeal to some consumers if it was included on the label.

5.9 Conclusion

The lab scale method of flavour application proved to be effective for the needs of this project. The original base recipe supplied by Hawkins Watts was a good starting point for flavour development but the honey and butter flavour levels proved to be much lower than the levels desired. Testing multiple flavour varieties was effective for ensuring that the most suitable flavours were selected to be evaluated with a sensory panel. Due to time restrictions on the project a formal panel was not used for the selection of the final flavour combination. Unfortunately, Eta was also unable to provide any more unflavoured chips so only one flavour was taken through to sensory and the number of trials was limited to allow enough chips for sensory samples. The feedback from the informal testing was used to determine the final combination for a more detailed sensory analysis.

6.0 Sensory Analysis of Developed Flavour

6.1 Aim

To conduct sensory testing to determine and compare the overall liking and specific attributes scores of Hatai-Calbee's Honey Butter chip and the Honey Butter chip flavour developed.

6.2 Materials and Methods

The number of flavours developed was narrowed down to one (Table 6) in the flavour development stage of the project. This was done due to limited amount of line produced chips that were available for sensory samples and to decrease the amount of samples that panellists would have to sample. Massey university does not have the equipment necessary to produce this type of potato chip and Eta was unable to provide any more samples.

Five grams of both samples were presented to 50 untrained panellists in white containers with a randomly assigned three-digit code. Haitai-Calbee's product was given the code 117 and the flavour developed was given the code 423. All of the panellists were presented with both white containers at the same time. Half of the panellists received a sensory evaluation from instructing them to taste and evaluate the 117 sample first. The other half of the panellists received a sheet instructing them to taste sample 423 first. The information and consent form as well as the sensory evaluation sheet can be found in appendices 2, 3 and 4. The 50 panellists were found in the Riddet Building at Massy University Manawatu. A range of participants were tried to be used however due to the test taking place on a University campus many panellists were either students or lecturers.

The sample size for this sensory testing was 50 people. This number was indicated to be adequate for the needs of this project by the projects.

A 15cm line scale for the overall liking score was chosen to allow the panellists more options to grade the products than a 9-point scale. The line scale also helped to differentiate scores between the two samples as they were much less likely to be given the same grade by the panellists. On this scale a score of 0 indicated extreme dislike while a score of 15 indicated extreme like for the product. As per standard sensory

practice the panellists were asked for overall liking scores for both samples before they were asked to assess specific attribute levels (Jirangrat, 2017).

Table 6: Ingredients and suppliers for final product formulation

Ingredient	**Weight (%)**	**Weight (g)**	**Supplier**
Salt	16.5	0.495	Countdown Supermarket
Castor Sugar	10	0.3	Countdown Supermarket
Honey Flavour (N8206)	15	0.45	Sensient
Butter Flavour	27	0.81	Sensient
Yeast Powder	5	0.15	Hawkins Watts
Garlic Powder	3	0.09	Davis Trading
Onion Powder	2	0.06	Davis Trading
Citric Acid	1	0.03	Davis Trading
Manuka Honey Powder	20	0.6	GS Foods
Syloid (Silicon Dioxide)*	0.5	0.015	-
Total	100	3	

*Silicon dioxide is a flowing agent that was not able to be sourced for trials

6.3 Results

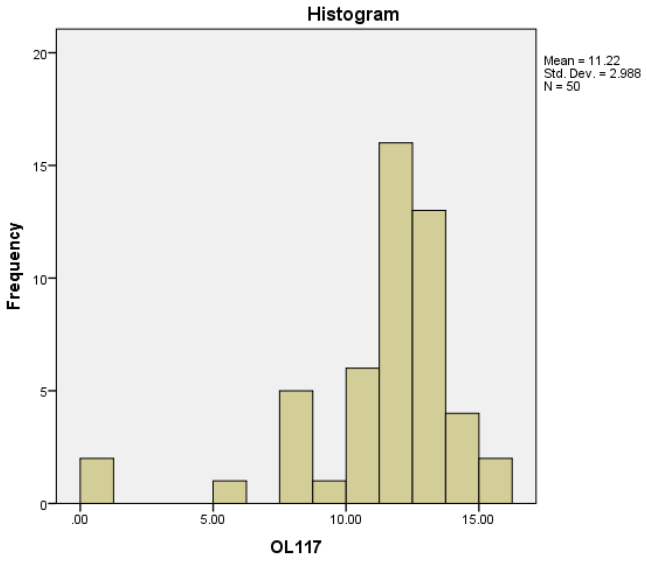

Figure 10: Distribution of overall liking scores for sample 117 (Haitai-Calbee's Product)

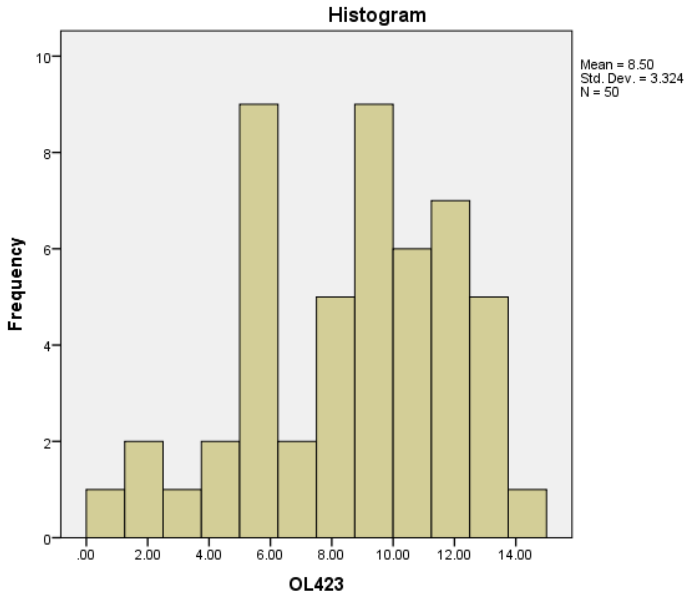

Figure 11: Distribution of overall liking scores for sample 423 (flavour developed)

Figures 9 and 10 show the distribution of overall liking scores for the two products. The average hedonic rating for samples Haitai-Calbee's flavour and the flavour developed were 11.2 and 8.5 respectively. These scores are both above the middle point of 7.5 (neither like nor dislike) on the overall liking scale but before the scores could be analysed further they needed to be tested for normality.

Table 7: Tests for normality of samples liking scores

Tests of Normality

	Shapiro-Wilk		
	Statistic	df	Sig.
OL117	.814	50	.000
OL423	.962	50	.110

a. Lilliefors Significance Correction

The null hypothesis for the Shapiro-Wilk test is that the data is normally distributed and the alternate hypothesis is that the data is not normally distributed. As the p-value for the overall liking score of 117 (Haitai-Calbee's Product) is less than the alpha level specified of 0.05 (Table 7) the null hypothesis can be rejected and the alternate hypothesis that the data is not normally distributed can be accepted. The p-value for the overall liking of sample 423 (the developed flavour) of 0.110 is larger than the alpha value of 0.05 meaning that the null hypothesis can be accepted and the data is normally distributed.

Because the same panellists were used to judge both samples the two data sets are related. As the two data sets are related and one is not normally distributed the Wilcoxon rank test was chosen to test the relationship between the overall liking scores for both samples (Laerd Statistics, 2017). The null hypothesis for the Wilcoxon rank test is that the average overall liking score for samples 423 and 117 are not significantly different. The p-value for this test was 0.000 (Appendix 6). This was lower than the set alpha value of 0.05 meaning that the null hypothesis can be rejected and the alternate hypothesis of the samples average overall liking scores being significantly different can be accepted. Therefore, it is concluded that the panel preferred the Haitai-Calbee's product significantly more than the developed flavour.

A t-test was also used on the overall liking data for the flavour developed (423) which can only be done if the data is normally distributed (Wilkinson & Jirangrat, 2017). This was done to test the hypothesis that the mean overall liking score was greater than the middle point on the scale of 7.5. The null hypothesis for this test is that the average overall liking value is not significantly different than 7.5. The p-value from the t test was 0.038 (Appendix 6). This was lower than the set alpha level of 0.05 meaning the null

hypothesis can be rejected and the alternate hypothesis of the mean overall liking score being significantly larger than 7.5 can be accepted.

The overall liking and just about right scales used were able to be linked in a penalty analysis to provide a better understanding between attribute skews and overall liking. A penalty analysis is useful for identifying an improvement direction based on the sensory results as well as what consumers like or dislike about a product from a sensory perspective. A summary table of the penalty analysis can be found in Appendix 6. The two bars in Figure 12 represent the attributes of honey and butter flavour in the product developed and how they were perceived by the panel, whether they were “too much”, “just about right”, or “too little”.

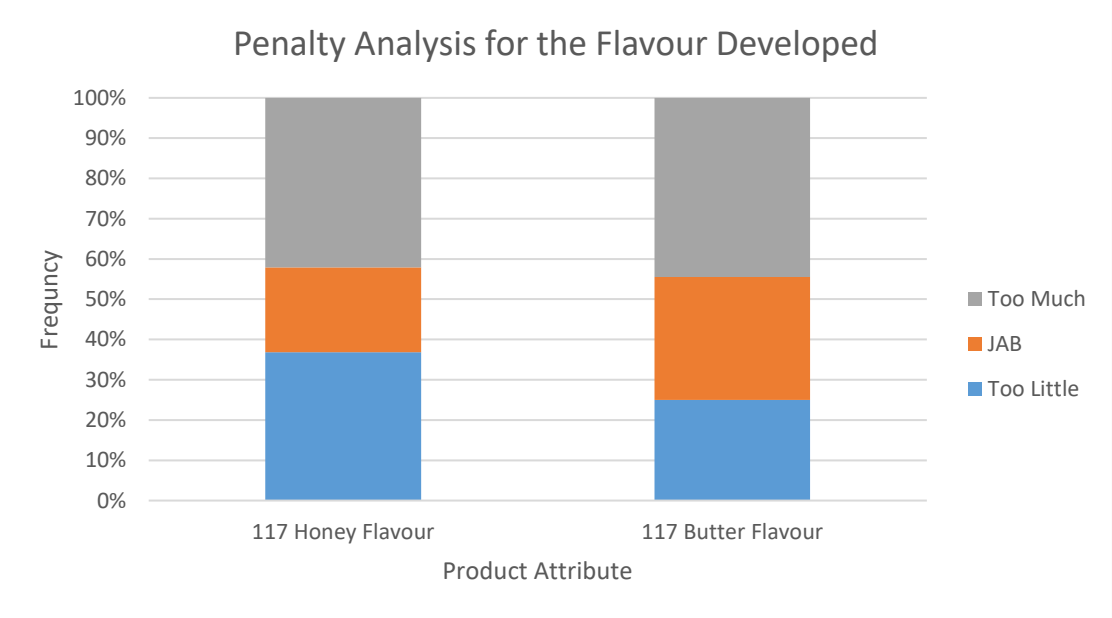

Figure 12:Penalty analysis for sample 423 (flavour developed)

6.4 Discussion

This Wilcoxon Rank test shows that the Hatai-Calbee product had an average overall liking score that was significantly higher than the flavour developed. This is consistent with the results as 37 of the 50 panellists scored the Haitai-Calbee product higher on the liking scale than one developed. While this is not the exact desired outcome it is very promising for the project and the development of new flavours in New Zealand as both products were well received and liked by the panellists. Many panellists asked where they would be able to purchase the product and enjoyed the tasting session. The average overall rating scores for both products were also affected by a few panellists

who extremely disliked both products. This does show an accurate sample of the overall population as this product will be extremely disliked by some due to its intense flavour and that potato chips are considered by some people to be unhealthy. A screening process is recommended to be considered if the sensory panel is to be repeated to remove these people and focus on consumers that would consume this style of product

The t-test conducted shows that the flavour developed was liked significantly above the middle point on the liking scale. This shows that while the flavour developed has room for improvement it does have positive feedback from consumers. It is also important to note that the panel had only 50 people and many of the panellists were University students or lecturers. It should also be noted that the final sensory day was conducted a month after final trials. While all ingredients were food safe, there was a loss of intensity of flavour as well clumping observed from the Manuka honey powder. The clumping from the Manuka powder led to difficulties in achieving even distribution of flavour powder across the chips. There was also a slight change to the taste of the butter flavour from the development trials to the sensory panel.

From the penalty analysis conducted the flavour developed received the highest penalty scores for each attribute of 1.700 for too much butter flavour and 0.962 for too little honey flavour. Therefore, it is recommended that in further trials that the levels of honey flavour be increased slightly and the levels of butter flavour decreased slightly. This method of data analysis is useful for providing for improvement direction but is limited when it comes to the magnitude by which the attribute needs to be changed (Jirangrat, 2017). As the product received high penalty scores (Figure 12) for both too little and too much on both flavour attributes it shows that different panellists rate the product differently, some want more flavour and some want less. These scores may have been impacted by the order in which the panellist tasted the product, many commented that they found the Haitai-Calbee product to be very intense and would be interested in seeing a middle ground between the two flavours.

6.5 Conclusion

Both products were well liked by the panellists as shown by the average overall liking scores being 11.2 and 8.5 for the Haitai-Calbee and flavour developed respectively. This is promising for Potatoes New Zealand looking to release new flavours into the market as both variations of flavour were received well by the panel. However, it should be noted that the panel was limited by its size of 50 people and its demographic. The susceptibility of the ingredient used in the flavour developed to storage conditions needs to be careful monitored and further trials around this are recommended. In particular, the Manuka honey powder is prone to clumping, leading to uneven flavour distribution across the chips. If this flavour is taken further by New Zealand Potatoes, it is recommended that a larger scale sensory panel be done with fresh ingredients as well as potential changes to the honey and butter flavour levels indicated by the penalty analysis with increased honey flavour and decreased butter flavour. Screening of panellists should also be considered as the intense flavour can be very disliked leading to a large impact on average overall liking scores.

7.0 Product specifications

Table 8: Breakdown of Ingredients, Suppliers and Weights for Flavour Developed

Ingredient	**Weight (%)**	**Product Code**	**Supplier**
Salt	16.5	n/a	Countdown Supermarket
Castor Sugar	10	n/a	Countdown Supermarket
Honey Flavour N8206	15	963625	Sensient
Butter Flavour XF1590	27	967021	Sensient
Yeast Powder	5	SPRINGALYS D200/8-PW	Hawkins Watts
Garlic Powder	3	GARPOW	Davis Trading
Onion Powder	2	ONIONPWD500	Davis Trading
Citric Acid	1	n/a	Davis Trading
Manuka Honey Powder	20	H291	GS Foods
Syloid (Silicon Dioxide)	0.5	n/a	-
Total	100		

The breakdown of ingredients by suppliers, weight and product code is shown in Table 8. If this product is taken to large scale production, then bulk suppliers for salt and castor sugar are recommended. These components are unlikely are to change properties depending on supplier. While the sensory properties of the garlic powder onion powder and citric acid might change slightly on the supplier the impact on the overall product is likely to be minimal. If suppliers for these components are changed then retesting of the product is recommended. The sensory effects of the honey flavour, butter flavour, yeast powder and Manuka honey powder are very dependent upon the suppliers chosen. If any are needed to be changed then reformulation is recommended complete with sensory panels as the taste of the overall product will change significantly.

8.0 Costing Analysis

Table 9: Cost Breakdown of Flavour Developed

Ingredient	**Price per kg ($NZD)**	**Weight (kg)**	**Price ($NZD)**	**Price retrieved from**
Salt	0.70	0.165	0.1155	Amalgamated Food Distributors Ltd
Castor Sugar	2.50	0.100	0.25	Countdown Supermarket
Honey Flavour	82.95	0.150	12.44	Sensient
Butter Flavour	22.57	0.270	6.0939	Sensient
Yeast Powder	20.00	0.050	1.00	Hawkins Watts
Garlic Powder	6.33	0.030	0.1899	Gilmours
Onion Powder	16.90	0.020	0.338	Davis Trading
Citric Acid	8.00	0.010	0.08	Eco freaks
Manuka Honey Powder	55.00	0.200	11.00	GS Foods
Syloid (Silicon Dioxide)	2.50	0.005	0.0125	NZ Chemical Suppliers Database
Total		1000	31.52	

The Haitai-Calbee product is sold at around $4 per 120g bag in Korea and for much larger amounts on auction sites around the world (Amazon, 2017). This leads to a minimum selling price of $33.33/kg of product which has 60g of flavour. 60g of the flavour developed will cost $1.89 which can be easily decreased depending on the buying power of the manufacturer. While a portion of the $33.33/kg will go to retailers, distributors, manufacturing costs and overheads the highest possible price for the flavour developed will be only 5.67% of the value of Haitai-Calbee's product. It is unlikely that the flavour developed will have the same level of success as the Korean product, but it can still be sold at a premium price especially with the inclusion of Manuka honey powder.

The breakdown for the costs of each component of the flavour developed can be found in Table 9 where the total price per kilogram of flavour powder is $31.52 NZD. This is a high price for a flavour powder as personnel at Eta snack manufactures indicated that they purchase flavour powders at around $4 - $8NZD per kilogram. This price was calculated at the rates that were available to the public and can be decreased easily depending on the size of the order.

The highest cost ingredients in the formulation developed are the honey flavour and Manuka Honey powder with prices of $82.95/kg and $55.00/kg respectively. If there is a need to reduce the cost of the formulation price, then these ingredients should be investigated first.

The Manuka honey powder created problems in the sensory tests due to its clumping and vulnerability to oxygen, but it does provide a unique New Zealand aspect to the flavour. Spray dried Honey Dew powder is slightly cheaper at $48/kg but this is still quite expensive for a snack flavour component. Other generic spray dried honey powder options exist in the market at around $10/kg depending upon the amount purchased (My Spicer, 2017). The Honey flavour N8206 was the most suitable of those tested and if this is desired to be changed to a cheaper alternative then reformulation is recommended.

The remaining components in the ingredients list form a very small part of the overall cost with the exception of the butter flavour contributing $6.09/kg. If the Honey flavour and powder levels are decreased the other component levels can be raised to reach the 6%w/w of flavour to chip ratio. The salt level in this formulation is 0.93% of the overall weight of the product. This is slightly below the recommended level of 1-2% so if reformulation is done this should be increased first. It also has the advantage of being the cheapest ingredient at $0.70/kg.

9.0 Recommended Packaging system

The method of packaging recommended for the flavoured chips is a vertical form, fill, and seal machine. The bag material is supplied in a roll which is formed into a tube before being filled with a pre weighed amount of chips from above. The machine seals the open end of the tube which simultaneously cuts the bag from the tube and seals the bottom of the next bag. These machines can also be modified to include a Nitrogen flush of the bag. This addition of Nitrogen flushing is more expensive but is recommended to be included if the manufacturer has the capability. The Nitrogen flush removes oxygen from the atmosphere inside the package which help to maintain product quality over a longer period of time. This is particularly important with the Honey Butter flavour due to its susceptibility to oxidation. A full shelf life evaluation is recommended to be done on the product prior to its release, with and without the Nitrogen flush to observe its effects on the product quality.

The packaging material used needs to be an excellent moisture barrier as potato chips first start to deteriorate by absorbing moisture. A foil laminate is recommended; orientated polypropylene, low density polyethylene, foil, low density polyethylene, high density polyethylene and ethylene-vinyl acetate. These materials help give the packaging strength flexibility and maintain product quality with a water vapour transfer rate of 0mL m^{-2} day^{-1} and an oxygen transfer rate of 0mL m^{-2} day^{-1} (Robertson, 2017). The combination also acts as a great barrier to moisture, oils and gases and the outer layer provides puncture resistance and an easily printable surface.

10.0 Conclusion and Recommendations

The aim of this project was achieved and a honey butter flavour system for industrial application to flavour potato chips was developed. For the focus group conducted it was difficult to find people who were familiar with the honey butter chip product but all participants were familiar with potato chip snacks. The results from this group were promising with all members enjoying the honey butter chips supplied and being interested in New Zealand version of the product.

The development of the honey butter flavour used a number of flavours and the final formulation included Manuka honey powder which provided a distinctly New Zealand aspect to the flavour that can be used as a unique selling point in overseas markets. The number of trials for development was limited by the amount of unflavoured chips available due to Eta being unable to provide more after the factory tour.

The flavour developed was tested in a sensory panel with Haitai-Calbee's Honey Butter product that provided inspiration for this project. Both products were well liked by the panels with 37/50 of the panellists liking Hatai-Calbee's product more than the flavour developed. The average overall liking scores were tested with a Wilcoxon Rank test and it was determined that Haitai's Calbee's product had an average overall liking that was significantly higher than the product developed. This shows that there is the consumer interest present for new potato chip flavours to be released in the New Zealand market. The penalty analysis conducted on the flavour developed indicated that the butter flavour should be decreased and the honey flavour increased. The sensory panel however did only use 50 people and there were some problems with the Manuka honey flavour clumping and losing some flavour after storage. The butter flavour was also noted to change flavour slightly between flavour development and sensory testing.

The final cost of the flavour developed was calculated to be $31.52/kg. While this price is expensive it still has the potential to generate considerable revenue for a manufacturer. It can also easily be decreased by a manufacturer with a higher purchasing power enquiring into prices as many are dependent upon the amount ordered. The price can also be decreased by changing the Manuka honey powder to a generic honey powder and/or changing honey flavour to a cheaper supplier. These

options would require reformulating however and would remove the unique selling point of the Manuka Honey.

The recommended packaging system for this product is a foil laminate in a vertical form fill and seal machine. If possible a nitrogen flush should be included to remove Oxygen from the package environment and help maintain product quality over a longer period of time.

Recommendations from this project are to investigate the changes on the overall liking for increasing the honey flavour and decreasing the butter flavour in the flavour developed. It is also recommended that if possible the sensory panel be repeated with fresh ingredients and a shelf life evaluation be done on the product.

Other new and exciting flavours that combine sweet and savoury tastes like the Honey Butter flavour that has had so much success be investigated by Potatoes New Zealand to add value to the potato industry in New Zealand.

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Appendix 1: Information Sheet and Consent Form for Focus Group

Information Sheet

Title of Work: Development of a Honey Butter Flavour System

Researchers Name:	Quinn McKay	Supervisors Name:	Michael Parker
Contact Details:	Quinndillon4@gmail.com	Contact Details:	M.E.Parker@massey.ac.nz

Welcome to the Honey Butter focus group. I am a 4th year food technology student from Massey University. My Individual assignment this year is to develop a Honey Butter flavour system for crisps.

It is important for me to determine what appeals to consumers and what they would purchase in order to develop the optimal flavour system. You were chosen to participate today because you are considered to be an ideal consumer or buyer of the product. Today we will discuss current chip products on the market, what appeals to you about them and the changes you would make to them.

During the session, you will taste few samples that may contain the following components that can be harmful or cause allergic reactions with certain groups of people. You will be excluded from taking part if you are allergic, or may be adversely affected by any of the following: (delete those not contained in the foods in question)

• Fish and Fish derivatives

• Milk and milk derivatives

For the purposes of this study, I will need to audio record this session. All information obtained during this session will be kept confidential and in accordance with the Human Ethics code of Massey University.

Your participation in this study will take a maximum of 1.5 hours.

“This project has been reviewed and approved by the Massey University Human Ethics Committee: Southern A, HEC Application 13/05. If you have any concerns about the ethics of this research, please contact, Dr Brian Finch Chair, Massey University Human Ethics Committee: Southern A telephone 06 350 5799 x 2541, email humanethicsoutha@massey.ac.nz.”

Thank you for your participation,

If you have any questions about this work, please contact one of the people indicated above.

Consent Form

Title of Work: Development of a Honey Butter Flavour System

CONSENT FORM

THIS CONSENT FORM WILL BE HELD FOR 12 MONTHS FROM DATE OF SIGNING (For minors aged 8-15 consent form is to be signed by a parent or guardian)

The information collected in this study will be used to complete an assignment in partial fulfilment of the Bachelor of Technology in Food Technology. Non-participation will not affect your academic performance (delete if not using students) No data linked to an individual's identity will be collected. You are under no obligation to accept this invitation. If you decide to participate, please read below statement and sign:

• I have read and understood the Information Sheet and have had the details of the study explained to me. My questions have been answered to my satisfaction, and I understand that I may ask further questions at any time.

• I agree to voluntarily participate in this study under the conditions set out in the Information Sheet.

• I understand I have the right to withdraw from the study at any time and to decline to answer any particular questions.

• I have advised and discussed with the Researcher any potentially relevant cultural, religious or ethical beliefs that may prevent me from consuming the Foods under consideration.

• I agree to be videotaped, but understand that I have the right to ask for the tape to be turned off at any time during the study.

Age:
……..

Gender:
……..

Occupation:
……

Ethnicity:
……..

Participants Signature: ..... Date:
.....

Full Name – printed:
.....

Appendix 2: Information Sheet and consent form for sensory panel

Information Sheet

Development of a flavouring system for 'honey butter' chips

Researchers Name:	Quinn McKay	Supervisors Name:	Michael Parker
Contact Details:	Quinndillon4@gmail.com	Contact Details:	M.E.Parker@massey.ac.nz

Welcome to the Honey Butter crisp focus group. I am a 4th year food technology student from Massey University. One of my assignments this year is to develop a flavouring system for 'honey butter' potato chips.

It is important for me to determine what appeals to consumers and what they would purchase to develop the optimal flavouring system. You were chosen to participate today because you are considered to be an ideal consumer or buyer of the honey butter crisp product.

During the session, you will taste few samples that may contain the following components that can be harmful or cause allergic reactions with certain groups of people. You will be excluded from taking part if you are allergic, or may be adversely affected by any of the following:

- Milk and milk derivatives

Your participation in this study will take a maximum of 30 minutes.

"This project has been reviewed and approved by the Massey University Human Ethics Committee: Southern A, HEC Application 13/05. If you have any concerns about the ethics of this research, please contact, Dr Brian Finch Chair, Massey University Human Ethics Committee: Southern A telephone 06 350 5799 x 2541, email humanethicsoutha@massey.ac.nz."

Thank you for your participation,

If you have any questions about this work, please contact one of the people indicated above.

Consent Form

Development of a flavouring system for 'honey butter' chips

CONSENT FORM

THIS CONSENT FORM WILL BE HELD FOR 12 MONTHS FROM DATE OF SIGNING (For minors aged 8-15 consent form is to be signed by a parent or guardian)

The information collected in this study will be used to complete an assignment in partial fulfilment of the Bachelor of Technology in Food Technology. Non-participation will not affect your academic performance. No data linked to an individual's identity will be collected. You are under no obligation to accept this invitation. If you decide to participate, please read below statement and sign:

• I have read and understood the Information Sheet and have had the details of the study explained to me. My questions have been answered to my satisfaction, and I understand that I may ask further questions at any time.

• I agree to voluntarily participate in this study under the conditions set out in the Information Sheet.

• I understand I have the right to withdraw from the study at any time and to decline to answer any particular questions.

• I have advised and discussed with the Researcher any potentially relevant cultural, religious or ethical beliefs that may prevent me from consuming the Foods under consideration.

• I agree to be videotaped, but understand that I have the right to ask for the tape to be turned off at any time during the study.

Participants Signature: ..... Date: .....

Full Name – printed:
.....

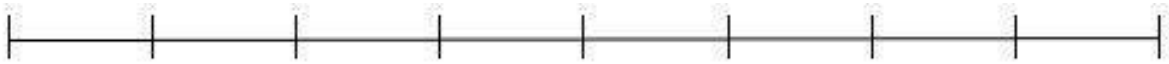
Appendix 3: Sensory evaluation form with sample 123 first

Sensory Testing for Honey Butter Crisp Flavour

Please taste sample 123 before answering question 1 then taste sample 423 before answering question 2. Please use the water provided to cleanse your palate between samples if needed.

1. What is your overall liking of the flavour of sample 123? (Please place a mark along the scale that corresponds to your answer)

Dislike extremely | Neither Like nor Dislike | Like Extremely



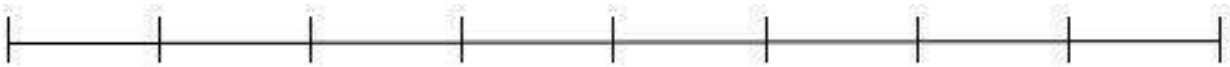
2. What is your overall liking of the flavour of sample 423? (Please place a mark along the scale that corresponds to your answer)

Dislike extremely | Neither Like nor Dislike | Like Extremely

Sensory Testing for Honey Butter Crisp Flavour

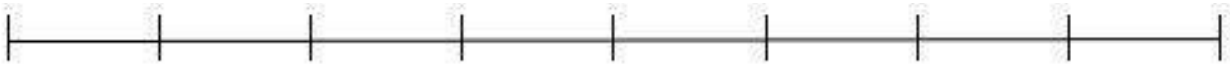
1. How would you rate the intensity of the honey flavour of sample 117? (Please place a mark along the scale that corresponds to your answer)

Much too weak | A little too weak | Just about right | A little too strong | Much too strong



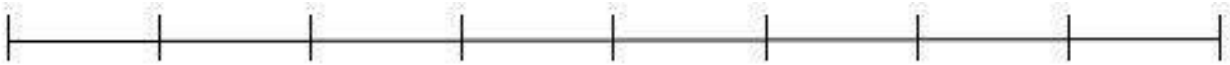
2. How would you rate the intensity of the butter flavour of sample 117? (Please place a mark along the scale that corresponds to your answer)

Much too weak | A little too weak | Just about right | A little too strong | Much too strong



3. How would you rate the intensity of the honey flavour of sample 423? (Please place a mark along the scale that corresponds to your answer)

Much too weak | A little too weak | Just about right | A little too strong | Much too strong



4. How would you rate the intensity of the butter flavour of sample 423? (Please place a mark along the scale that corresponds to your answer)

Much too weak | A little too weak | Just about right | A little too strong | Much too strong

5. Do you have any comments on the Manuka characteristics of sample 117?

Do you have any additional comments to make about either of these samples?

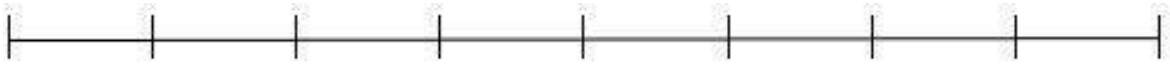
Appendix 4: Sensory evaluation form with sample 423 first

Sensory Testing for Honey Butter Crisp Flavour

Please taste sample 423 before answering question 1 then taste sample 117 before answering question 2. Please use the water provided to cleanse your palate between samples if needed.

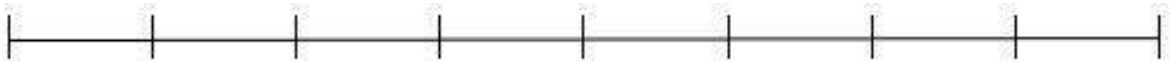
3. What is your overall liking of the flavour of sample 423? (Please place a mark along the scale that corresponds to your answer)

Dislike extremely | Neither Like nor Dislike | Like Extremely



4. What is your overall liking of the flavour of sample 117? (Please place a mark along the scale that corresponds to your answer)

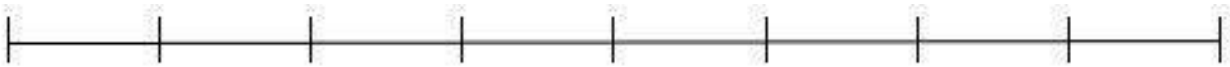
Dislike extremely | Neither Like nor Dislike | Like Extremely



Sensory Testing for Honey Butter Crisp Flavour

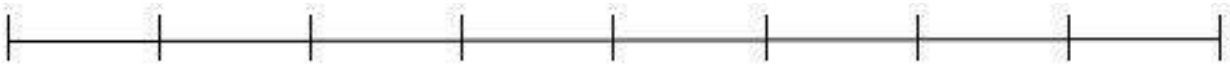
6. How would you rate the intensity of the honey flavour of sample 423? (Please place a mark along the scale that corresponds to your answer)

Much too weak	A little too weak	Just about right	A little too strong	Much too strong



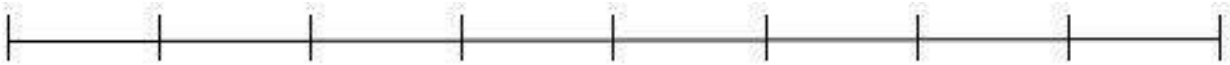
7. How would you rate the intensity of the butter flavour of sample 423? (Please place a mark along the scale that corresponds to your answer)

Much too weak	A little too weak	Just about right	A little too strong	Much too strong



8. How would you rate the intensity of the honey flavour of sample 117? (Please place a mark along the scale that corresponds to your answer)

Much too weak	A little too weak	Just about right	A little too strong	Much too strong



9. How would you rate the intensity of the butter flavour of sample 117? (Please place a mark along the scale that corresponds to your answer)

Much too weak	A little too weak	Just about right	A little too strong	Much too strong

10. Do you have any comments on the Manuka characteristics of sample 117?

Do you have any additional comments to make about either of these samples?

Appendix 5: Raw Data from Sensory Panel

Table 10: Raw data from sensory panel

	Overall liking		Honey Flavour		Butter Flavour	
Participant	117	423	117	423	117	423
1	13.3	3.8	5	1	4	8
2	11.3	3.7	5	3	5	6
3	13.2	9.4	5	3	5	3
4	11.3	7.5	5	3	3	4
5	13.2	11.3	3	4	5	3
6	15	11.3	5	4	6	8
7	14	11.3	5.25	3.9	5	4.8
8	15	11.3	5	2	5	5
9	7.9	11	6	5	5	6
10	0	5.6	9	5	6	3
11	8.3	10.5	5	5.25	5.8	6.4
12	1.1	10.2	3.5	5	8.5	4
13	11.3	13.2	5	4	5	5
14	8.5	6.4	5.8	3.5	5	2.6
15	12.3	10.4	5	3	4.5	5
16	10.7	7.5	5	3.6	5	4
17	12.1	6.5	5.7	2.8	4.8	2.8
18	10.3	5.6	5.4	2.4	4.4	5.4
19	10.5	12.3	5.5	5.3	5	5.6
20	5.6	13.2	3	5	4	4

21	12.5	5.2	4.6	2.6	3.2	7.8
22	7.5	1.8	5	8	6.6	5.5
23	10.8	4.9	5.6	3.6	6.3	6.4
24	11.8	6.2	5.3	6.3	6.1	3.8
25	13.2	9.6	6	4	5	5
26	7.5	10.2	6	3.3	4.3	5
27	11.3	7.5	5	2	6	2
28	11.3	13.2	7	4	7	5
29	11.3	7.5	5	3	4	3
30	10.4	9.6	5.2	4.4	5.3	5
31	13.8	9.5	5	3	5	3
32	13.2	9.4	5	3.8	5	3
33	13.6	8.9	4	4.4	5	1.6
34	10.2	0	5	8	5.7	7
35	11.4	1.8	6.1	3.2	5.8	5.9
36	11.8	6.2	5	4	6	3
37	11.3	5.6	5	4	7	6
38	11.8	9.4	5	3.6	6.5	6.4
39	11.3	5.6	5	3	5.3	7
40	13.2	7.5	6	6	6	2
41	13.2	13.4	5	3	6	5
42	13.2	5.6	5	7	6.3	2
43	12.6	10.2	5	3	6	5
44	13	11.3	6.4	4.4	5.5	3.6

45	14.8	11.3	8.5	3	5	4.3
46	13.2	5.6	5	3	5	3
47	14	14	6	3.8	6.9	5
48	9.4	9.3	3	6	5	4
49	12.4	9.4	3	3	5	7
50	11.3	13.4	5	4	7	5

Appendix 6: Processed Data from Sensory Panel

Table 11: Summary table for data processing of sensory results

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
OL117	50	100.0%	0	0.0%	50	100.0%
OL423	50	100.0%	0	0.0%	50	100.0%

Descriptives

			Statistic	Std. Error
OL117	Mean		11.2240	.42251
	95% Confidence Interval for Mean	Lower Bound	10.3749	
		Upper Bound	12.0731	
	5% Trimmed Mean		11.5533	
	Median		11.6000	
	Variance		8.926	
	Std. Deviation		2.98756	
	Minimum		.00	
	Maximum		15.00	
	Range		15.00	
	Interquartile Range		2.72	
	Skewness		-2.003	.337
	Kurtosis		5.190	.662
OL423	Mean		8.5020	.47011
	95% Confidence Interval for Mean	Lower Bound	7.5573	
		Upper Bound	9.4467	
	5% Trimmed Mean		8.6289	
	Median		9.4000	
	Variance		11.050	
	Std. Deviation		3.32421	
	Minimum		.00	
	Maximum		14.00	
	Range		14.00	

	Interquartile Range	5.70	
	Skewness	-.438	.337
	Kurtosis	-.304	.662

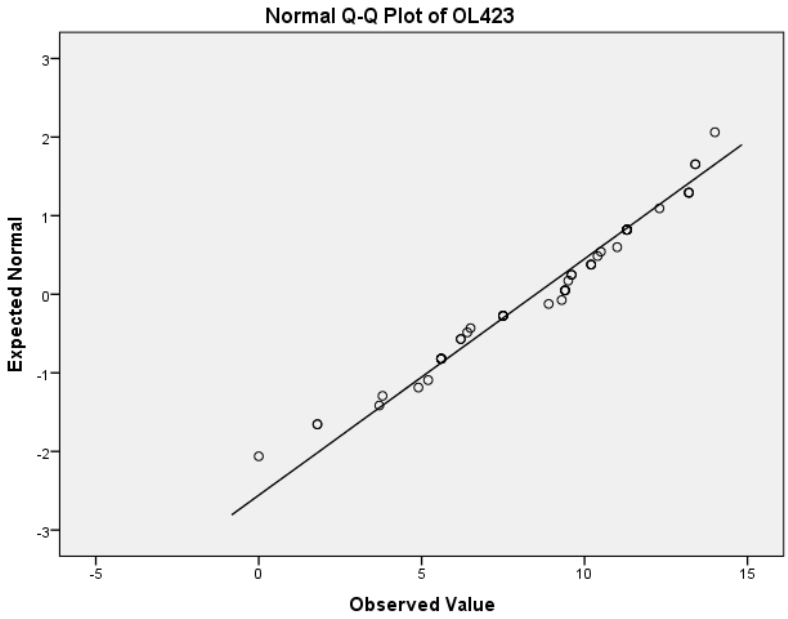


Figure 13: Normal Q-Q plot for sample 423, the flavour developed

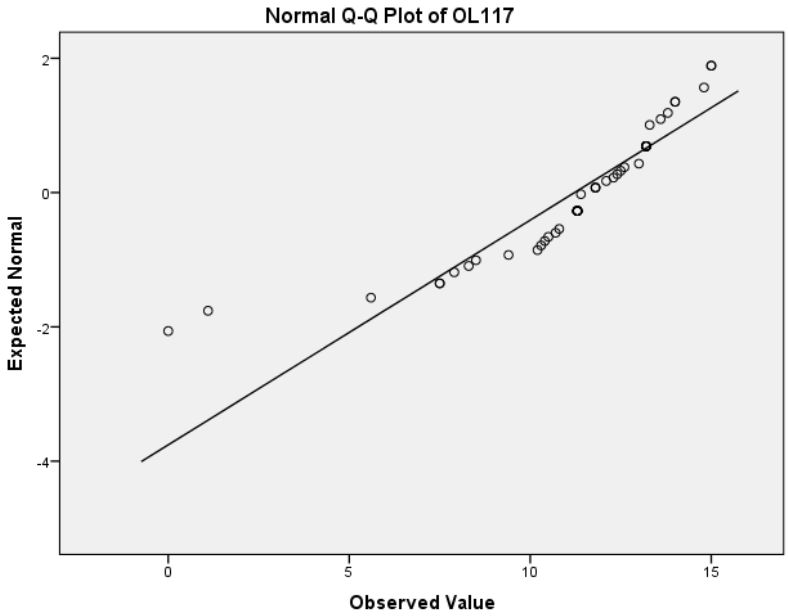


Figure 14: Normal Q-Q plot for sample 117, Haitai-Calbee's Flavour

Wilcoxon Signed Ranks Test

Table 12: Wilcoxon Ranks Test results run on both samples

Ranks

		N	Mean Rank	Sum of Ranks
OL423 - OL117	Negative Ranks	38[a]	26.95	1024.00
	Positive Ranks	11[b]	18.27	201.00
	Ties	1[c]		
	Total	50		

a. OL423 < OL117

b. OL423 > OL117

c. OL423 = OL117

Test Statistics[a]

	OL423 - OL117
Z	-4.095[b]
Asymp. Sig. (2-tailed)	.000

a. Wilcoxon Signed Ranks Test

b. Based on positive ranks.

Table 13: t-test results from flavour developed

One-Sample Statistics

	N	Mean	Std. Deviation	Std. Error Mean
OL423	50	8.5020	3.32421	.47011

One-Sample Test

	Test Value = 7.5					
					95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean Difference	Lower	Upper
OL423	2.131	49	.038	1.00200	.0573	1.9467

Table 14: Summary table for penalty analysis on sample 117 and 423

Variable	Level	Frequencies	%	Sum(OL)	Mean(OL)	Mean Drops	Penalty score
117 Honey Flavour	Too little	7	14	67.8	9.69	2.26	0.3167
	JAR	25	50	298.7	11.95		
	Too much	18	36	194.7	10.82	1.13	0.4073
117 Butter Flavour	Too little	9	18	96.2	10.69	1.49	0.2680
	JAR	18	36	219.2	12.18		
	Too much	23	46	245.8	10.69	1.49	0.6858
423 Honey Flavour	Too little	38	76	331.9	8.73	1.27	0.9620
	JAR	4	8	40	10.00		
	Too much	8	16	53.2	6.65	3.35	0.5360
423 Butter Flavour	Too little	23	46	194.7	8.47	3.22	1.4796
	JAR	11	22	128.5	11.68		
	Too much	16	32	101.9	6.37	5.31	1.7002

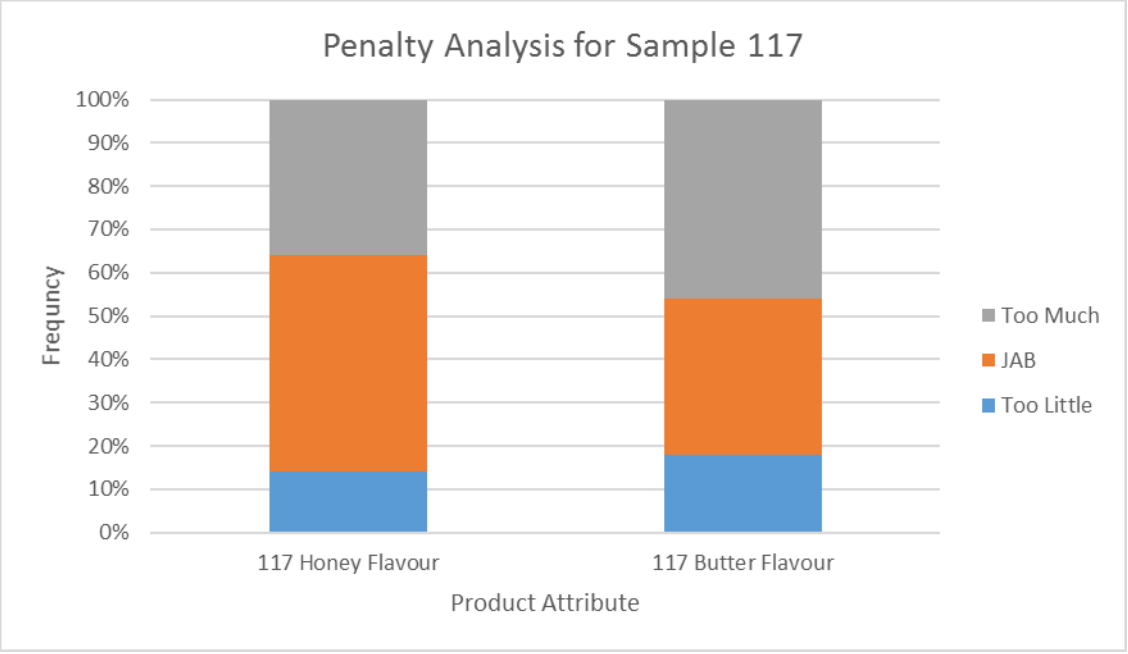


Figure 15: Penalty analysis for sample 117, Haitai-Calbee's Product