

Utilisation of Potato Waste to produce a Vodka Product Suitable for the New Zealand Market

*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 NZ Inc. approached Massey University's School of Food and Nutrition to develop a vodka product from potato waste. To create a successful vodka product, the method of producing the vodka needs to be established along with some product development work to obtain a unique and saleable product. Potatoes NZ Inc. is the industry association representing the interests of New Zealand's potato industry. They are interested in providing a case study in how potato waste can be utilised.

The aim for this project is to design a feasible vodka based product using potato waste. The key objectives were reviewing the vodka production process and identifying traits that make a product successful, conducting market research and conducting vodka production trials.

Two trials were completed one laboratory scale and one pilot scale. Both trials were successful in producing a high yield of ethanol from the potato waste with the average of the two trials being around 90% ethanol by volume. The second trial was successful in producing a vodka product that was able to be bottled and labelled and is technically fit for commercial sale.

The market research conducted comprised of a focus group, an interview with a representation of the hospitality industry and a consumer survey. The focus group was conducted with eight participants. The objective of this focus group was to gather feedback on the choices consumers make when purchasing vodka and their current consumption patterns. From the focus group the key points were that vodka was a popular, versatile drink option and that price was the driving factor behind most purchasing decisions. The industry interview was used to identify the brands and types of vodka being used in various restaurants: from this the main brands were Smirnoff and Stolichnaya, but the brand choice was variable with prices. The consumer survey was conducted to gauge vodka drinkers' consumption habits and their response to the product concept, with the concept at this stage being just a vodka made from potatoes; the survey aimed to develop the concept further to a final product. The key points from the survey were that price was ranked the most important factor when purchasing vodka followed by taste and brand. The respondents were very open to trying new

brands of vodka and were more likely to purchase a product that was produced in New Zealand from local ingredients.

The final formulation of the product was approximately 40% ethanol and 60% RO water with trace amounts of glucose and methanol being present. The process used follows a traditional vodka process. A taste panel was conducted and ranked the vodka from this project highest for taste, smell and the price participants would pay when compared against three vodka products currently on the market. The labelling design was an uncluttered, neutral design, containing all legal requirements. With the design being predominately white which is used to depict the pureness and simplicity of the product, the touches of black and red used to represent sophistication, quality and to catch the consumers eye.

The year one cost for this product if it was to be commercially produced is estimated at about \$1,000,000 including capital. The projected production is 1,000L/ 1,000 bottles produced fortnightly, so the total amount produced will be 26,000 bottles creating a revenue of about \$1,000,000 if the product is priced at \$40. This product has the potential to be successful in market, therefore it is recommended that a full costing, feasibility analysis, business plan and commercialisation plan is developed.

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1. Introduction

a. Background

The New Zealand potato industry currently produces ~100,000T/year of potato waste from the 525,000T/year of potatoes produced. The majority of vodka in the NZ and international market is produced from grain. However, traditionally vodka has been brewed from potato (and other starch sources). The client wishes to develop a vodka from the potato waste. To create a successful vodka product, the method of producing the vodka needs to be established along with some product development work to obtain a unique and saleable product.

Vodka is an alcoholic spirit originating from Eastern Europe. It can be made through the fermentation and distillation of a range of grains and cereals, potatoes, rice and other fermentable foods. It is a clear spirit composed of ethanol and water with a high purity and alcohol content often achieved through multiple distillations. Some vodkas retain or have added, trace flavour and aroma compounds. In NZ vodka requires a minimum alcohol content of 37% ABV with no maximum level set (FSANZ, 2004). Internationally, the accepted minimum varies between 37% and 40% ABV.

b. Aims and Objectives

The aim for this project is to design a feasible vodka based product using potato waste produced current operations of Potatoes NZ Inc.'s members.

The objectives are:

- Complete a literature review on the vodka production process and the traits that makes vodka products successful in market.
- Identify a possible market and consumer profile, and conduct market research to determine what may make a vodka product successful in that market.
- Conduct both a laboratory scale and pilot scale vodka scale trial of vodka production.
- Run a sensory panel comparing vodka produced in the pilot scale trial versus vodka products currently on the market.
- Develop a pilot scale vodka distillation process for fermented potato.
- Prepare product and process specifications for a vodka product that uses potato waste/low quality potatoes as the base ingredient.

c. Constraints

- The project must be completed between the 4th March and the 30th November 2017, with experimental work to be completed by August 15th 2017.
- The main starch source should be potato waste or low grade potatoes.
- Laboratory and pilot-scale work will be limited to process equipment currently available at Massey University.
- Sensory evaluation is subject to ethics approval, as the product contains alcohol.

2. Literature Review

a. Vodka

Vodka is an alcoholic spirit (usually approximately 40% ABV), which originated in Eastern Europe, and is made through the fermentation and distillation of a starch source. The starch source is sometimes potatoes, but today most vodka is based on grain fermentation.

i. History of Vodka

Fermentation to produce alcoholic beverages can be traced back nearly 8,000 years with the earliest evidence being found in 7000- 6600 BC through chemical analysis of a pottery jar from Jiahu, China (Gately, 2008). The alcohol produced was of a low alcohol content percentage $\approx <14\%$ due to it being a result of natural fermentation. The invention of the distiller in Greece 200 AD (Fairley, 2013) allowed for beverages to be produced at a higher alcohol percentage. Distillation technology then spread slowly throughout Europe and Northern Africa. Vodka appears in about the 9th century, with both Russia and Poland claiming to be the first producers (Herlihy, 2012). The first record of a distillery was in the Russian *Vyatka Chronicle* in 1174 (Abou-Ganim & Faulkner, 2013).

Vodka became a popular beverage in Russia and other Eastern Europe countries in the 14th century but was consumed little outside of this geographical area until after the Russian Revolution (1917). The Tsarist Russian government had strictly controlled the production of vodka with heavy taxes and production tariffs in place resulting in a government monopoly of vodka and its production (Pokhlebkin, 1992). Russian producers were responsible for the refining of the vodka product to what it is today, with improvements of the distillation as well as the addition of a filtration step which originally used wood and felt before charcoal was introduced as the common filtration material (Gately, 2008). After the Russian Revolution, the Soviet government significantly reduced the amount of distilleries causing the emigration of several prominent vodka producers (Himeslstein, 2010); introducing vodka across the globe with it rising steadily in popularity to be one of the most consumed beverages in the world.

ii. Composition of Vodka

Non-flavoured vodka products are comprised of only ethanol and water. Different countries have different legislation on the percentage of alcohol required in the product with the amount typically $\approx 40\%$ (ABV). Flavoured vodkas can have a range of other ingredients.

The nutritional panel for a standard shot of vodka is 27g:

Table 1- Nutritional Panel for single serving of vodka. Source: (Conde Nast, 2016)

Nutritional Panel	
Serving Size 27g	Per serving
Calories	64
Total Fat	0g
Saturated Fat	0g
Trans Fat	0g
Sodium	0g
Total Carbohydrates	0g
Dietary Fibre	0g
Sugars	0g
Protein	0g

iii. International Vodka Market

Russia and other vodka belt countries (Russia, Poland, Belarus, Ukraine, the Baltic and Nordic States) consume the most vodka per capita and are also some of the largest producers for export (Stubb, 2006). The ten largest exporters in terms of US\$millions and world percentage is shown in Table 2, New Zealand is ranked 50th in the world exporting only US\$930,000 and contributing to 0.04% of the world total (International Trade Centre, 2016). The top ten brands of vodka in terms of amount sold in 2014 is shown in table 3.

Table 2- Top Vodka Exporters in the World. Source: (International Trade Centre, 2016)

Rank	Exporter	2015 Vodka Exports	% World Total
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1.	Sweden	US\$490 million	22.8%
2.	France	\$442.2 million	20.5%
3.	United Kingdom	\$168.8 million	7.8%
4.	Poland	\$149.8 million	7%
5.	Russia	\$116.1 million	5.4%
6.	Netherlands	\$109.2 million	5.1%
7.	Germany	\$107.9 million	5%
8.	United States	\$80.5 million	3.7%
9.	Latvia	\$72.1 million	3.4%
10.	Finland	\$65.4 million	3%

Table 3- Top 10 Vodka Brands by case amounts. Source: (Eads, 2015)

Rank	Brand	Owned by:	Country of Origin	Case Sales in 2014
1.	Smirnoff	Diageo	France	25,493,000
2.	Absolut	Pernod Ricard	Sweden	11,100,000
3.	Zubrowka	Roust	Poland	5,200,000
4.	Svedka	Constellation	Sweden	4,150,000
5.	Grey Goose	Bacardi Martini	France	3,900,000
6.	Skyy	Campari	USA	3,900,000
7.	Finlandia	Brown-Forman	Finland	3,500,000
8.	Stolichnaya Premium	SPI	Russia	3,400,000
9.	Russian Standard	Roust	Russia	3,100,000
10.	Pinnacle	Beam- Suntory	France	2,457,000

iv. Vodka Production in New Zealand

New Zealand produces several brands of vodka, with the most popular being *42 Below* which is an internationally acclaimed product. The brands play on New Zealand's clean green image; all boasting the purest water in the world as rated by the United Nations World Health Authority. A summary of the New Zealand vodka brands is below:

- **42 Below.** This vodka brand began in a Wellington garage in 1996 by creator Geoff Ross, the company was producing approximately 100 cases per month until 2002 when investors allowed for the expansion of the processing capabilities. By 2004 the company had grown by 2116% and was supplying to countries around the world, *42 Below* was purchased by Bacardi in 2009 for NZ\$138 million. *42 Below* is fermented from NZ GE-free wheat, the fermented product is quadruple distilled to give is a pure smooth mouthfeel and taste (Troy & Ross, 2010).
- **26,000 Vodka.** This vodka brand operates on a much smaller scale, being available at only 5 distributors within NZ and the only international distributor being CITC Rarotonga. The vodka is fermented from GE free grains and is triple distilled before being filtered through quartz beach sand and charcoal with both sourced from the west coast of the South Island. This brand's main selling point is the use of an underground water source that is 26,000 years old, this unique aqua spring is a source of very pure water. (26000 Vodka Ltd , 2016).
- **Broken Shed Vodka.** This vodka product has a whey base (a dairy by-product) and is distilled four times. This product is gluten free. It is sold exclusively in the USA by Broken Shed Imports in Manhasset, NY, with it being found throughout Connecticut and Rhode Island, also found throughout NZ. Broken Shed vodka uses water rated the purest and finest in the world sourced from an aquifer in the Southern Alps near Wanaka. (Broken Shed Distilleries, 2017).
- **Blue Duck.** This vodka is a clear, grain-based product that is distilled 7 times which is unusual as the average is only 4-5 distillations. This produces a very smooth vodka which has a high critic rating. This product is artisan crafted with hand-crafted products produced in a copper reflux pot and uses pure NZ water. (Simply Pure Ltd, 2007)
- **Stil.** Stil vodka has a grain base and is distilled only two times. This product is not a premier vodka and is less expensive than the others on the list. It is not as smooth and palatable, with the lower quality due to only two distillations.

b. Vodka Process

i. Raw Ingredients

Starch Source/Base

Vodka is made from a variety of starch sources or other sugar-rich plant matter (Ermochkine & Iglkowski, 2003), traditionally vodka utilised cereal grains such as wheat, corn or rye as the starch source (Herlihy, 2012), and with potatoes also being adopted once they became widely available in Eastern Europe. Today, vodka is mainly produced from the following:

- Corn
- Sugar beet molasses
- Barley
- Wheat
- Sugarcane molasses
- Potatoes (Ermochkine & Iglkowski, 2003)

Table 4- Examples of international brands and different base sources. Source: (Speciality Drinks Limited (GB), 2016)

Brand	Country	Base
42 Below	New Zealand	GE-free Wheat
Absout	Sweden	Wheat
Adnams	UK	Barley, wheat and oats
Aviv 613	Israel	Grain and Fruit
Belvedere	Poland	Rye
Blue Ice	USA	Potato
Bombara	Australia	Grape
Crystal Head	Canada	Peaches and Corn
Dot AU	Australia	Sugar Cane
Finlandia	Finland	Barley
Hrenovuha	Russia	Horseradish
Kleiner Fiegling	Germany	Fig
Kissui	Japan	Rice

Krupnik	Poland	Grain and Honey
L'Chaim	Israel	Corn
Rain	USA	White Corn
Russian Standard	Russia	Winter Grains
Soplica	Poland	Grain, fruit and nuts
Zoladkowa Gorzka	Poland	Herbs and Fruit

Enzyme

Enzymes are required to break down the starch source to release their fermentable sugars; amylase is the enzyme used to break down the starch (Lee, 1996). High temperature tolerant amylase is required as the mashing step can reach boiling temperatures (100°C) especially in production of potato vodka (Weeks et al., 2008).

Yeast

For the fermentation of ethanol for Vodka products the main yeast used commercially is *Saccharomyces cerevisiae* (Walker et al., 2016). There are a large range of strains used with each strain being most efficient at utilizing a different starch source. Strains that produce the highest ethanol yield for potatoes are *S.cerevisiae* IR-2 (Gao et al., 2012), *S.cerevisiae* var. *bayanus* (Arapoglou et al., 2012) and *S.cerevisiae* NP01 (Watanbe et al., 2010).

Water

Water is an important ingredient in vodka, with the quality of the water having a large impact on the final taste, appearance and stability of the product (Krosnijs, 2013). Ions such as Ca^{2+} , Mg^{2+} , HCO_3^- and SO_4^{2-} can interact with the ethanol in the product and other ingredients found in vodka to form bicarbonates and sulphates which negatively affect both taste and appearance (Yermolaeva, 2002). The water used in vodka production must meet the requirements set by individual countries, for example the water used in Russia must meet the Water Code of the Russian Federation (Federation Council of Russia, 2006). New Zealand does not have specific legislation for vodka production but the water used in the processing must meet the New Zealand Food Safety Authority Code of Practice.

Mashing

In the first stage of vodka production the starch source must be hydrolysed to release the fermentable sugars needed for the fermentation stage. This is done at high temperatures up to 100°C to release the starch from the source i.e. potato or grain. Heat-resistant enzymes are used to increase the rate of reaction (Serna-Salvidar, 2016). After the mashing is completed the contents of the mash container must be cooled (to <40°C) before the addition of the yeasts for fermentation to avoid yeast death (Matus, 2014).

Fermentation

Fermentation is the metabolic process in which a chemical change occurs due to the activities of enzymes secreted by micro-organisms. In vodka fermentation, a yeast converts fermentable sugars to ethanol and carbon dioxide. The liquid exiting the fermentor will have a low alcohol by volume (ABV) value (=5-10%), distillation is required to increase the alcohol percentage and purify the liquid.

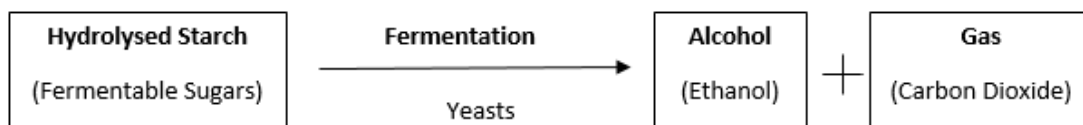


Figure 1- Fermentation process for ethanol production. Source: (Farias et al., 2010)

The ethanol yield from fermentation is dependent on many factors such as temperature, substrate to yeast ratio, pH (Lin, et al., 2012), yeast strain used, condition of yeast cells, amount of yeast, aeration, agitation (Hough et al, 2012), sugar (substrate) concentration, time of fermentation (Sanchez, 2008), presence of inhibitors, bacterial contamination (Bhavbhuti et al. , 2012) and carbon (i.e. starch) source (Yang et al., 2013).

Distillation

Distillation is the separation of a liquid mixture (the fermented mash) by evaporation and condensation of the outgoing vapour, the separation happens due to the different boiling points of components in the mash. The boiling point of pure ethanol is 78°C (Krell, 1982), whereas water has a boiling point of 100°C (both temperatures at atmospheric pressure). In vodka distillation the fermented mash is mainly ethanol and water, but

there are other components present. Some of the extra components are more volatile than ethanol, so are removed with the ethanol. Other components remain in the fermented mash.

Distillation has three separate phases, firstly vaporisation where the phase change gives alcoholic vapours, secondly condensation where the vapours are cooled and collected and thirdly rectification where the vapours are concentrated to remove excess water and other substances (Simon, 2016).

Vodka distillation is completed by two methods, either batch/pot distillation shown in Figure 1 or continuous/column distillation shown in Figure 2.

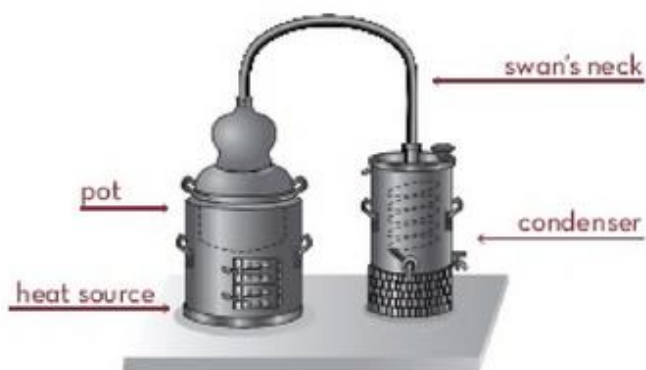


Figure 2- Pot Still for batch fermentation. Source: (Abou-Ganaim, 2013)



Figure 3- Column Still for continuous fermentation. Source: (Abou-Ganaim, 2013)

The pot still is the more labour intensive option with greater skill required to produce a quality product, running one batch will distil to approximately 40% ABV with most vodka brands repeating the process several times to give a purer product with less flavour and a higher alcohol percentage (Smith, 2011). The column still uses an analyser and rectifier cylinder to continually distil the vodka, this processes the mash into a vodka of the desired percentage of alcohol and purity very efficiently (Hocking, 2012). Column stills are more often used in commercial distilleries due to their efficiency and ability to process larger amounts of product (Aylott, 2003).

Dilution

The liquid exiting the distillation columns will have a high percentage of ethanol (approximately 90% or more), with the percentage increasing for each successive distillation (Katzen et. al. , 1999). This alcohol must be diluted with water to give a drinkable product. In NZ and Australia, the *minimum* ABV that the finished product can contain if it is to be marketed as a spirit is 37%; '*A food that is sold as a spirit must be a spirit and contain at least 37% alcohol by volume.*' (FSANZ, 2015). The quality of the water used to dilute affects the quality of the product (Aylott, 2003) especially in the case of water high in ions which will negatively affect the vodka (Krosnijs, 2013).

Filtering

Once diluted, vodka products are filtered to remove any impurities which will have a detrimental effect on the sensory qualities of the vodka (taste, smell and appearance) (LaVilla, 2009). Activated charcoal filters are the most commonly used filters (Tascon, 2012). Activated charcoal is a treated form of carbon that has numerous small, low-volume pores that give the carbon an increased surface area, and this gives more surface area for chemical reactions and adsorption (Roy, 1994). The increased area for adsorption allows for the removal of a greater amount of impurities from the vodka. Multiple filters are used in industry to further filter the product for example NZ brand *42 Below* vodka is claimed to be filtered through activated charcoal filters 42 times (Troy et al. , 2011).

Other materials that can be used are Herkimer diamonds (double-terminated quartz crystals) for the Crystal Head brand, Reyka vodka uses lava rock beds, Loaded Vodka is filtered through coconut husk while some brands such as luxury brand Belvedere use no

filters in their process. Some filters, such as coconut husk might itself impart a flavour to the product. The use of exotic filters may be mostly a marketing/branding exercise. Brands with little or no filtering probably achieve purity through multiple distillations instead.

Flavouring

Traditionally, vodka is drunk without any flavour additives relying on its own “natural smooth flavour”. However, some (especially cheaper) vodkas are not smooth drinking, and would typically be mixed by the consumer with other products. As an alternative flavoured vodka was introduced to disguise and make such crude vodkas more palatable (Owens et al., 2011). Distillation removes the majority of the flavour of the original ingredients (Piggott, 2011), therefore intentional flavours are added during or after filtration (Aylott, 2003).

The first commercial flavoured vodka was released in 1986 by *Absolut*, this was the product *Absolut Pepper* which can be used as a base for a Bloody Mary cocktail and was created due to the popularity of that cocktail (Absolut, 2017). Both natural and synthetic flavourings are used commercially. However large brands such as *Absolut* and *42 Below* only use natural flavouring ingredients (Troy et al., 2010), (Absolut., 2013). The trend for flavoured vodka may be set to decline with the popularity of pure vodka returning (Malandrakis, 2017).

Packaging

Vodka does not require any resting time before being packaged, and is not usually rested in barrels or similar to impart desirable flavours (as other spirits such as whiskey are). Vodka is packaged in a vessel that does not impart flavour such as stainless steel (Wisniewski, 2003), glass or plastic, with plastic packaging becoming more popular as the cost of production and shipping is less. The size, shape and opaqueness of the bottle has no technical effect on the product (sunlight is not an issue with unflavoured vodka) and many companies use distinctive bottle shapes, designs and colours for marketing purposes.

c. What makes a Vodka product successful

i. New Zealand Market

Of the OECD countries New Zealand (NZ) has the eleventh highest consumption of alcohol per capita, consuming 11.2 litres of alcohol yearly per capita compared to the global average of 6.3 litres (World Health Organisation, 2014). In 2016 New Zealanders consumed 44.8 million litres of spirits and spirit based drinks, with vodka being the most popular spirit for woman and third most popular for men (Pherson, 2017). The vodka brands with the biggest market shares in NZ are Smirnoff, Absolut, Stolinchaya and 42 below. Although this vodka product may be exported, analysing why these products are popular in New Zealand, may give some guidance for product development.

ii. Competition Stories

Absolut

Absolut was first produced in Åhus, Sweden in 1879 by Lars Olsson Smith under the name of 'Absolut Rent Branvin' which translates to Absolute Pure Vodka (Lewis, 1996). Smith made use of the new continuous column distillation technique and by the age of 26 he was distributing three quarters of the vodka in Sweden. Smith died in 1913 around the time of the company's demise, it wasn't until 1970 that the brand was revitalised by The Swedish Wine and Spirits Corporation who rebranded and updated the production process. The new owners set to target the USA market; representing 60% of vodka consumed in the western world (Vin & Spirit AB, 2004).

When entering the US market Absolut initially used an American marketing team whose packaging and marketing ideas were not well received and led the Swedish team to instead choose a design which copied the antique medicine bottles which vodka was originally purchased in. The bottle was designed with no labels, revealing the clear product, and the colour blue was decided upon due to its cool, fresh and clean connotations (Francis, 2013). The new improved Absolut product was first produced in April 1979 and exported to the US two months later (Vin & Spirit AB, 2004), during the mid-80's it was introduced across most European, Asian and Pacific countries with it now being the second most produced vodka brand in the world (Eads, 2015).

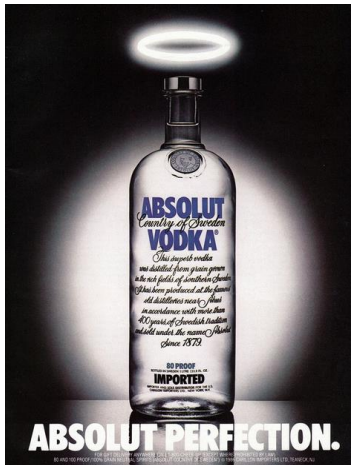
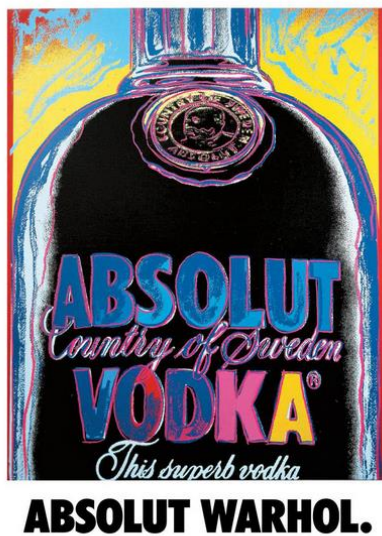


Figure 4- Absolut Vodka Ad from 1980, the original advertisement. Source: (Simonson et al., 1997)

The success of the Absolut product could be due to the use of their distinct bottle shape; the star of their 1,500 advertisements, starting with their original Absolut ad shown in figure 4. Absolut vodka relied on their aesthetics of their bottle and ad campaigns to appeal to the young American market (Simonson et al., 1997). During the 1980's Absolut had several high-profile collaborations. The first being with Andy Warhol in 1986 producing the first Absolut art piece advertisement show in figure 6. Since then collaborations with musicians, artists and designers has kept the brand fresh and interesting with it having continual growth in many markets (Radic, 2013).



Figure 5- Examples of Absolut ads all showing the bottle shape and Absolut words. Source: (Radic, 2013)



Copyright © 1985 The Andy Warhol Foundation for the Visual Arts, Used by V&S Vin & Spirit Assoc. ABSOLUT is a registered trademark of V&S Vin & Spirit Assoc.

Figure 6- Artwork advertisement by Andy Warhol. Source: (Radic, 2013)

42 Below

42 Below is a NZ produced vodka that was first produced in a Wellington garage by Geoff Ross who at the time worked as a marketing executive at Saatchi and Saatchi. Ross got the idea to start producing vodka in NZ after viewing an ad for Skyy Vodka which is made in the USA. Ross thought vodka products should be produced in pure places and as NZ boasts the purest air and water in the world he decided to produce a product here. For several years production was on a small scale producing enough for bars and restaurants in wellington but the product was met with resistance due to the origins of the product. It wasn't until a bottle of 42 below was ranked in the top 2 in the world in a blind tasting in London that the company was able to grow.

42 below struggled to expand internationally due to the insufficient income from NZ sales alone, so they listed on the share market in 2006 and with the capital from the shares expanded production facilities and entered into new markets (Inder, 2006).

Some marketing techniques used by 42 Below were met with heavy resistance. For example, an ad was placed in which they apologised to Sweden about the blind tasting competition listed above, saying their rival in Sweden was the least favourite. Absolut filed a lawsuit claiming then misquoted the results. Absolut won and 42 below replied with the ad in figure 7, which stated '*we are so distressed that we have gone out with*

our own money and placed this new ad in the press to make sure that everyone knew Absolut was not judged the 'least favourite', but that the article actually said, 'No one had kind words to say about Absolut'. The retraction gathered more attention than both the tasting competition, initial advertisement and the lawsuit with the image going viral. Another "negative" media incident for 42 Below was in the USA market with an advert describing the vodka as pure as snow driven from Columbia and illustrated with images of cocaine. The Columbian embassy took great offence but this resulted in a large amount of press for the product (Chug, 2010)

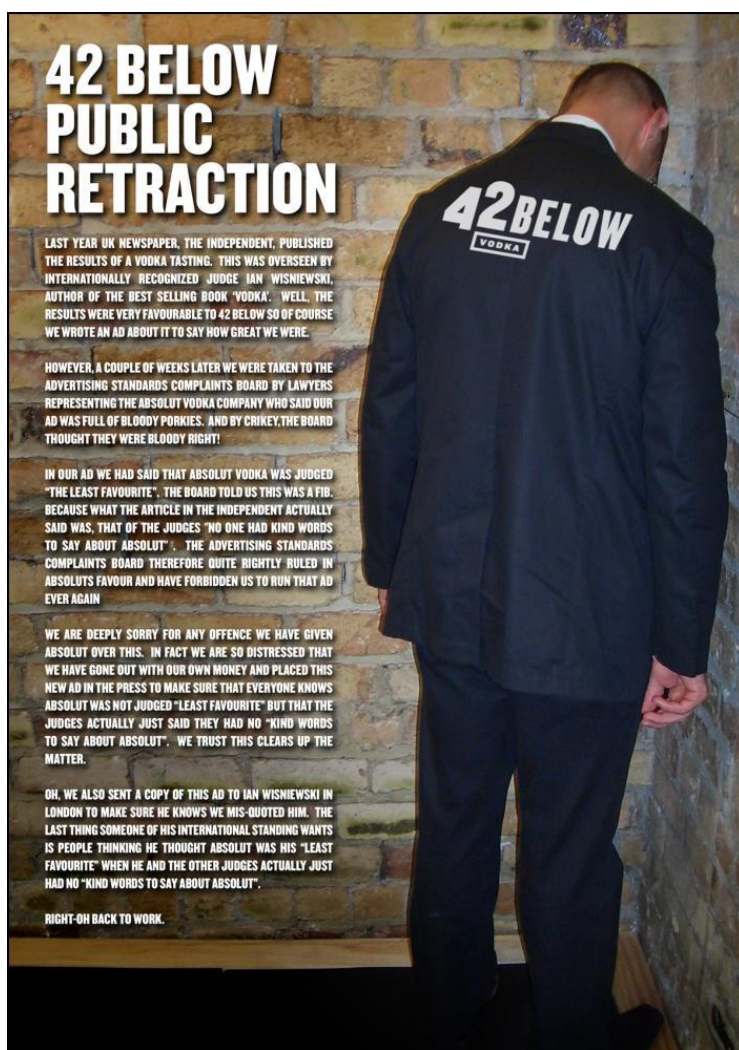


Figure 7 - Retraction Advertisement run by 42 below. Source: (Troy et al., 2010)

Along with the infamous advertisements listed above 42 Below used other forms of marketing. NZ model Kylie Bax was a rep in the American party scene with 42 Below creator's wife commenting that '*Celebrity endorsements is the No1 brand-building vehicle in the American Marketer*' (Chug, 2010). Ross's history in advertisement gave the

company a unique spin on marketing. Its most popular method was tongue-in-cheek ads, which often gathered attention from around the world.

iii. What makes the product successful

When producing a vodka product getting the right marketing mix is essential for making the product a success. The marketing mix is price, place, promotion and product. (Institute of Alcohol Studies, 2016). The price of the product can greatly impact the success of the product. Sold too cheaply, the brand will not get enough returns from sales, which can limit expansion and capital growth. Sold at too high of a price the product may have lower sales and also not appeal to one of the larger alcohol consumer groups of 18-25 year olds (World Health Organisation, 2014). Using price discounts and promotions can be an important marketing method for both retailers and producers, a study conducted by the Alcohol Focus Group in Scotland found that supermarket promotions and discounts caused an increase of 20-25% in Alcohol sales (Institute of Alcohol Studies, 2006).

The promotion of the vodka product includes advertisements, sponsorship, social networking and instore placements. The advertising and promotion of alcoholic beverages must comply with New Zealand Law and the guidelines set in the Code for Advertising and Promotion of Alcohol (Advertising Standards Authority, 2016). Sponsorship by alcohol companies is the second largest source of sponsorship funding in the UK (Institute of Alcohol Studies, 2016). Promotion is most important for new brands entering the market.

Providing a quality vodka product is essential in making a product successful, the vodka itself must be of high quality but the product is inclusive of the brand and packaging. The vodka product itself must be of a high quality for the amount paid, with a more premium taste and flavour being ideal. The design of the bottle is especially essential to attract new consumers, with unique and alluring packaging being important to differentiate it from similar products (Ambrose et al., 2011). It is important for the development of the vodka, that brand name and packaging should be done informed by market research and consumer input to gather information on the target audience, potential marketing strategies and the product consumers want (Duboff, 2000).

d. Conclusion

The vodka production process is well documented and studied due to the product being manufactured commercially for many years. The main process steps are mashing, fermenting, distilling, diluting, fermenting, flavouring and packaging. There are variations within these methods especially when using different starch sources. The key traits of what makes a vodka product successful is effective marketing and producing a quality product. Through looking at case studies of 42 Below and Absolut vodka their main points of differentiation from the market is their alternative marketing methods.

3. Formulation Trials

a. Overall Aim of Formulation Trials

The aim of the formulation trials were to produce a Vodka product using potato waste as the main starch source. To complete this two trials were completed the first was focused on producing ethanol and the second was to do the whole process finishing with a drinkable vodka product.

b. Processing Methods

The processing method used for the formulation trials was based on the standard vodka production method identified in the literature review. The process used was similar in both trials conducted. The exception being that the first trial was not taken to completion, and was stopped after distillation. The processing method was:

- Potatoes were peeled and sliced before being added to a large pot. The potatoes are covered with water and brought to the boil. Heat-stable Alpha-Amylase is added at this stage. The contents were kept simmering for 30 minutes with constant stirring. This is the mashing stage.
- Remove from heat, stir to dissolve and leave to cool to 50°C. Once cooled transfer to the fermentation vessel, adding a set amount of water stirring to combine.
- Once contents in the fermenter bucket have cooled to below 25°C add the *Distiller's Vodka Yeast*, leaving to ferment for 14 days between 15-25°C.
- After fermentation strain the contents from the fermenter with the sediment being removed. The liquid strained is added to a stil.
- The stil used in these experiments is the Turbo 500 Stil. The stil will be run for 2-3 hours with the condensing water having a flow rate of 500ml/minute. It is important that the flow rate of condensing is constant to ensure the correct compounds are distilled, ethanol distils at a temperature of 78°C but if flow rate is too fast it risks toxic methanol being distilled at 64°C.

- For each trial the distillate was collected and tested to determine the amount of alcohol present in the sample after distilling.
- The distillate was then diluted with RO (reverse osmosis) water to a target amount of alcohol ABV%. Activated carbon is added and left to settle before the vodka is filtered through a solid activated carbon cartridge filter.
- Once filtered the product is bottled using 750mL plastic PET bottles.

c. Ingredients

The potatoes used in this experiment were Agria potatoes, this is one of the more common potato types processed by Potatoes NZ. The yeast used in this experiment is Still Spirits *Vodka Distiller's Yeast*, a single culture vodka yeast strain. The ingredients in the packet are Dried Yeast, yeast nutrients, amyloglucosidase enzyme, anti-foaming agent, vitamins and trace minerals. High tolerant Alpha Amylase Enzyme from Still Spirits was used.



Figure 8- From left to right, ingredients used in trials, Agria Potatoes, Vodka Distillers Yeast and Alpha Amylase

d. Analysis Methods

Analysis of the product was necessary to determine the alcohol content of the final product; sensory analysis was also carried out on the product from trial 2. Microbial analysis was not necessary for the final product as the distillation process's high temperatures and the percentage of alcohol present at this stage would inhibit microbial growth in the product.

Two chemical analysis methods were used to determine the alcohol content of the vodka product in the two trials. The analysis methods were Gas Chromatography (GC) and High Performance Liquid Chromatography (HPLC).

In industry three methods can be used to determine the alcohol content of a product; GC, Densitometer and Distillation (AOAC , 2017).

GC operates by detecting the selective adsorption and desorption of volatile components on a stationary phase. The volatiles are transported by inert gases through columns to a detector, for alcohol detection a flame ionisation detector is used (Speeding, 2015). The detector identifies peak profiles that correspond to each compound passing through, these allow for the compounds to be quantified by weight and with a known standard determine the alcohol content of the product can be determined. This method is accurate to 0.05% by volume, the method's sensitivity and speed of test make it a popular industry choice. The densitometer analyses by measuring the different densities of the sample. The distillation method is based on removing and collecting all the alcohol in the sample. The distillate is then diluted into a known amount of distilled water. The alcohol concentration of this solution is able to be determined by measuring the density with a hydrometer. The distillation is one of the cheaper and simpler methods available while having little error.

e. Trial One

i. Aim

The aim of this trial was to establish a method and trial ingredients to be used in the processing of the final product.

ii. Method and Materials

Table 5-Materials and equipment used in Trial 1

Equipment	Ingredients
10L Pot and Lid	320g Agria Potatoes (Peels and Flesh)
Electric Element	1750 L Water
3L Agitated Fermenter	30 g Yeast
Turbo 500 Stil	2 g Alpha-amylase

Method

The method for this trial followed the method in section 3b. The amounts used are shown in table 5. The process was taken through to the distillation stage. At which three Samples were taken from the run and tested in the HPLC to determine the percentage of ethanol and methanol present. The samples were taken at 0-10 minutes, 10-15 minutes and 15-25 minutes.

iii. Results

The amount of methanol and ethanol present in the samples is shown in table 6. Figure 9 shows the first two samples' peaks (pink and black) for methanol and ethanol and 10% standards for methanol and ethanol (blue and red). The raw data results are in appendix 1.

Table 6- HPLC Results for Methanol and Ethanol percentages for samples from Trial 1

Time	Methanol (%)	Ethanol (%)
0-10	1.12	93.30
10-15	0.067	97.95
15-25	0.13	91.71

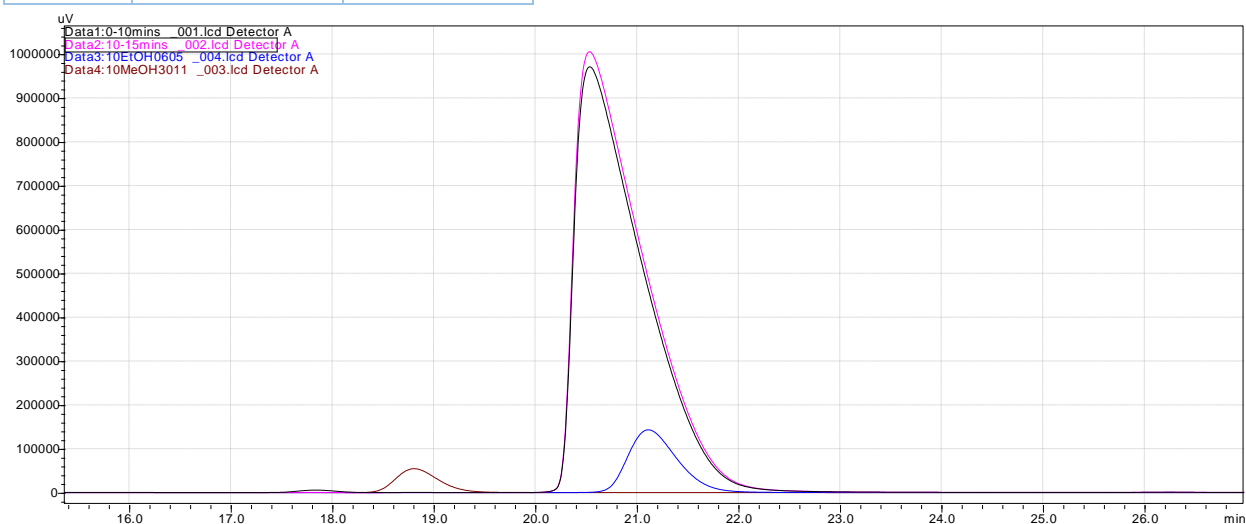


Figure 9- HPLC peaks from Trial 1

These results showed that using the above method and materials, a high yield of ethanol is able to be produced. There was a small amount of methanol present in each sample

but as the maximum tolerable concentration of methanol in drinks is 2% v/v by volume all samples tested were under the legal limits (Paine, 2001).

Due to the high yield results from this experimental trial, the method and materials should be maintained for the second trial.

f. Trial Two

i. Aim

The aim of this trial was to produce a bottled vodka product. This was an advancement on trial one with this trial containing diluting, filtering and bottling steps to give a complete product.

ii. Method and Materials

Table 7- Materials and equipment used in Trial 2

Equipment	Ingredients
30L Pot and Lid	3125g Agria Potatoes (Peels and Flesh)
Electric Element	29.575 L Water
25L Fermenter Bucket	72 g Yeast
Turbo 500 Stil	4 g Alpha-amylase
EZ Filter	

The method for this trial followed the method in section 3b. The amounts used are shown in table 5. Samples were taken from the start, middle and end of the distillation run. These were tested in the HPLC to determine the percentage of ethanol present for the dilution step. The remaining ethanol was diluted with 2575ml of RO water to make the vodka product. The vodka was then filtered through a carbon cartridge EZ filter. Three samples were taken from the filtered product. Once filtered the vodka was bottled in 1l PET bottles. These were then labelled with the label shown in figure 14.

i. Results

The results from samples taken from the end of the fermentation period and throughout the distillation period are shown in Table 8. Figure 10 shows the four samples' peaks,

the sample taken at the end of fermentation in black, start in pink, middle in blue and tail in red. The raw data results are in appendix 1.

Table 8- HPLC Results for Methanol and Ethanol percentages for samples from Trial 2

Sample	Methanol (%)	Ethanol (%)
Fermented	0.59	6.10
Start	0.36	57.92
Middle	0.02	79.53
End	0.01	99.21

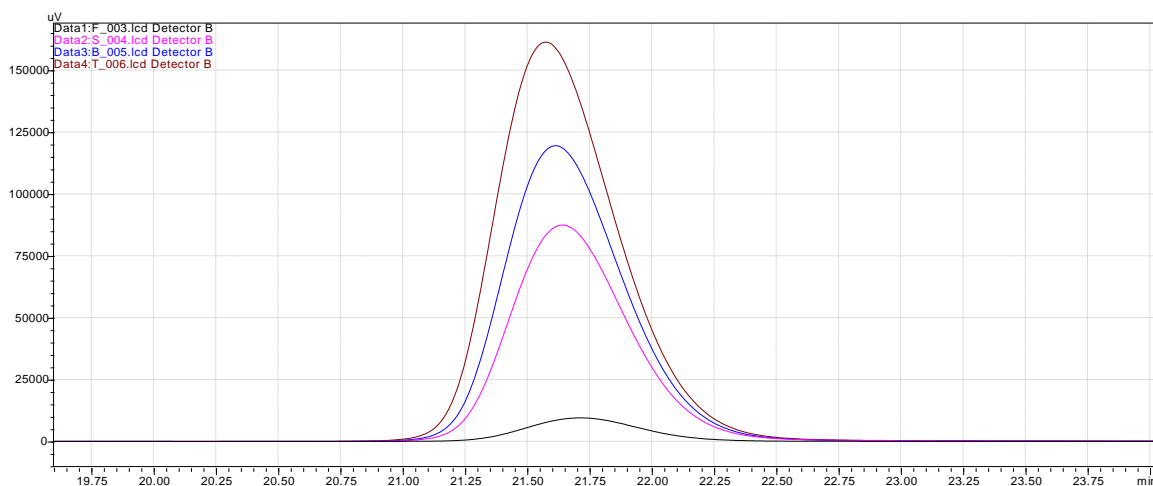


Figure 10- HPLC peak results from Trial 2

The ethanol percentages shown in table 8 were used to calculate the amount of water that needed to be added to dilute the ethanol down to produce a safe to consume vodka product. A simple dilution equation $m_1 \times 1 = m_2 \times 2$ was used to dilute the product down to 30-40%. After the product was diluted and filtered three samples were taken to be tested again for methanol and ethanol percentage.

Table 9- HPLC Results for Methanol and Ethanol percentages from diluted samples

Sample	Methanol (%)	Ethanol (%)
One	0.022	29.96
Two	0.02	29.96
Three	0.021	29.94

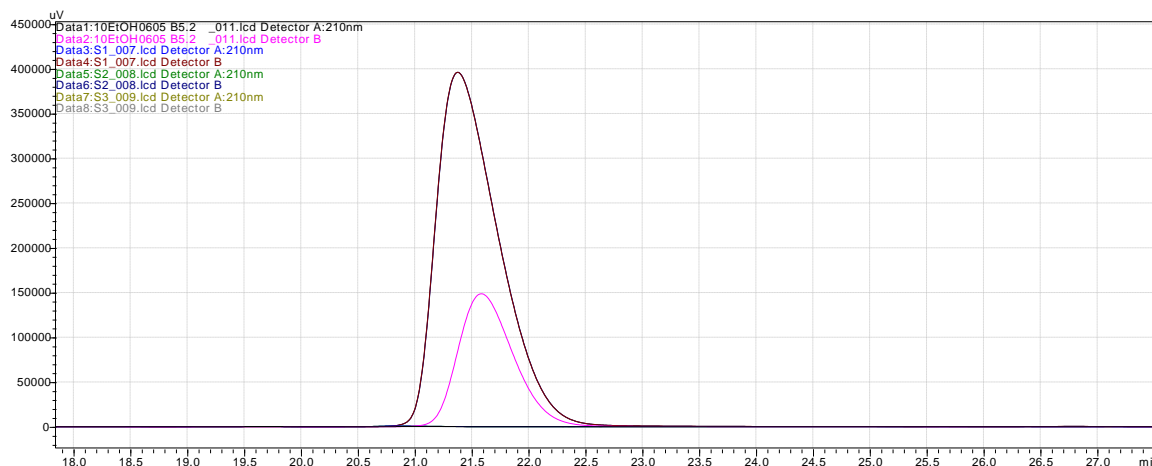


Figure 11-HPLC results for diluted samples in trail 2

The results in Table 9 show that the samples were diluted to have a final ethanol percentage of ~30%. This percentage is lower than ideal as most vodka's on the New Zealand market have percentages between 37- 40%. It is recommended that when diluting the molar concentration be considered as water and ethanol have different molecular weights it makes the dilution more complicated.

b. Conclusions from Trials

The method and materials used in the trials are able to produce a high yield ethanol and when diluted can produce a saleable vodka product.

From the results it can be seen that the head (first 100-200mL) of the distillate must be disposed of due to containing toxic levels of methanol.

When diluting to 40% abv the molar mass of ethanol and water should be considered to give a more accurate dilute result.

4. Market Research

a. Aim of Market Research

The aim of the market research was to investigate the potential for a potato vodka in the New Zealand beverage market and the possible traits that could make the product successful.

To achieve this the following steps were necessary:

- To conduct a focus group
- To investigate how Vodka fits into the hospitality industry
- To conduct a consumer survey

b. Focus Group

i. Aim of Focus Group

The objective of this focus group is to gather feedback on the choices consumers make when purchasing vodka and their current consumption patterns. In order to keep the voice of the consumer relevant to the decision making process a focus group was conducted early on in the project. The focus group consisted of eight females aged between 18-23.

ii. Focus Group Responses

All participants in the focus group consumed alcohol with half consuming it at least weekly and the other on a fortnightly basis. The average consumption per session was between 8-12 standards which is similar to the national average of consumers in that demographic (Health Promotion Agency, 2015). Two of the respondents consumed less at only a couple of drinks. Vodka was the most popular choice of alcoholic drink for the participants with cider being consumed the next most, followed by beer and wine. They most typically consumed alcohol at home or a friend's house, and not often purchasing drinks at restaurants/bars/clubs due to cost. The majority of the participants did not purchase alcoholic beverages when out for dinner/lunch, but those that did, choose to consume wine and cider at these occasions.

The driving factor in choosing alcoholic beverages was price, with the price per standard being the key point. Other influences when purchasing alcohol is where they are

drinking, the taste and the type of alcohol. The participants typically pre-planned the type of product they would purchase before entering the store, but choose the specific product/brand when at the stores where they could compare prices of similar products. All participants were open to trying new products, with recommendations impacting their choice. Although open to trying new products they would only if within their price range, with them more likely to try a range extension product rather than a completely new product or brand.

All of the participants consumed vodka as their first choice of beverage, with half purchasing it as a straight spirit and the other half purchasing ready-to-drink options. When purchasing straight beverages taste was not that important but with RTDs taste was of much more importance. For both options value for money in terms of standard drinks per dollar was the main driving factor. None of the participants gave any thought to ingredients or country of origin of the products, with them not knowing where any of their current products are from. When asked to describe the taste of vodka they described it as having a chemical, unpleasant taste that gave them a burning sensation when consumed. The brands they consumed or knew were Absolut, Smirnoff, 42 Below, Grey Goose, Stil and Kristov.

c. Industry Interview

i. Aim of Industry Interview

The industry interview was conducted with an industry professional with several years experience in the hospitality industry. The interview was used to research the brands and types of vodka being used in various restaurants. The interviewee worked at a mid-priced restaurant in Hamilton which is part of Lawrenson's Group a Bar and Restaurant Association which includes restaurants, pubs, nightclubs and cocktail bars.

ii. Key points from industry interview

- Vodka was the most common spirit purchased, this was in the restaurants, clubs and bars within the group showing the drink was consumed in a range of situations.
- The house spirit at most of the restaurants were either Smirnoff and Stolichnaya with retail prices NZ\$40/1L and NZ\$45/1L respectively, with the brand used as

the house spirit being determined by bulk deals/discounts the group could get when purchasing.

- The clubs that had a younger clientele used NZ Vodka brand as their house spirit, this is not available on the consumer market, with product only available to businesses. This brand had an average price of NZ\$20/1L.
- The premium option across the group was Grey Goose, with it being used by request only due to it retailing for NZ\$70/700mL
- The other key brands stocked are the various 42 Below flavours, the flavoured 42 Below products such as kiwifruit, feijoa and passionfruit are popular cocktail bases.

d. Consumer Survey

i. Aim of Consumer Survey

The consumer survey was conducted to gauge vodka drinkers' consumption habits and their response to the product concept, with the concept at this stage being just a vodka made from potatoes. The survey aimed to help develop the concept further to a final product. The survey consisted of 20 questions with the results being found in appendix 2. There was a total of 50 responses. This survey gathered information similar to the focus group, but aimed to gather from a larger audience with a more diverse demographic.

ii. Participant Demographics

The majority of the respondents for this survey were between 18-22 at 87.27%, the second largest demographic was 23-30 at 10.91%. There was one respondent in the 41 plus age range and none in the 31-40. The ratio of female to male respondents was 3:2, this response in the gender demographic was favourable due to women being more likely to drink ready-to-drink (RTD), wine and spirits options while males are more likely to drink beer as their preferred drinking options (Coleman, 2015). The respondents that were under 18 or did not consume vodka were excluded from the survey.

iii. Consumption Habits

The most common consumption choice was 2-4 times with 50% of the respondents consuming vodka/vodka products at that frequency. Only seven respondents consumed

the product on a weekly basis, with the remaining respondents consuming the product once a month or less. When purchasing vodka straight spirits was the most common method of purchasing with ready-to-drink being purchased slightly less. The most common consumption amount was 7 plus standard drinks per sitting with 45%, this was followed by 5-6 standards drinks at 33%, 3-4 standards drinks at 16% and 1-2 standard drinks being the least common option at 6% of respondents. The respondents most commonly consume Vodka beverages at home, followed by at a pub/club/bar then at an event.

The survey respondents purchased 10 different brands of straight spirits with the most popular brands being Smirnoff, Absolut and 42 Below, with Smirnoff being purchased by 43 of the 50 respondents. The other brands that they purchased were Ivanov, Finlandia, Stil, Crystal Head, Grey Goose, Skyy and New Zealand Vodka. Less than half of the respondents know the raw materials in their vodka products, with those that responded “yes” said the ingredients were a range of starch sources including grain and potatoes. Other ingredients mentioned were dairy waste and sugar.

When purchasing a vodka product, the respondents ranked price as the factor they value the most. Taste was ranked the second most important followed by brand. The ingredients and country of origin both ranked very low in comparison. These responses were very similar to the responses from the focus group with them also valuing price the most and caring little for ingredients and country of origin.

iv. Vodka Product

The following questions were asked to rank on a 0-100 scale. The respondents were very open to trying a new brand of vodka with the average response on the scale being a value of 84. Knowing that the vodka product was to be produced in New Zealand and using local ingredients, the respondents were claimed to be likely to purchase the product with the average response being 72. The vodka developed being produced is to use potatoes as the main starch source. When questioned if using potato as the main starch source would make them more likely to purchase this product the respondents were more likely but only slightly with the average being 55.

The survey found that 77.27% of the respondents would prefer to purchase the product in a 1 litre straight no flavour 37% option. Pre-mixed 330mL Flavoured Bottle was the next most popular at 11.5%, followed by 1 litre bottle flavoured 37% at 7% and pre-mixed 250ml can flavoured at 4.5%.

v. Conclusions from Consumer Survey

Moving forward the key points to take from the survey were:

- That price was ranked the most important factor when purchasing the product followed by taste and brand. Therefore, when producing a product making a cheap option is of high importance.
- That the respondents were very open to the prospect of trying a new brand of vodka as well as being more likely to purchase a product that is produced in New Zealand and made from local ingredients.

5. Final Product

The final product will be a 1 litre unflavoured vodka.

a. Formulation

The formulation of the product is 40% ethanol and 60% RO water. There is trace amounts of Glucose and Methanol present but as less than 0.5% does not have to be part of the formulation or labelled. The toxicity level for methanol is maximum 200mg/dL (Dart & Kostic, 2003), as the product is less than this the product is safe for consumption.

b. Process

i. Process Flow Diagram

The process begins with receiving potato waste. The product should be peeled and sliced if not already. The potato waste is then added into a mashing tank where water and heat-resistant alpha-amylase is added. The tank is heated to 100°C and kept at this temperature for 30 minutes. The tank contents are cooled and transferred to a fermentation vessel where the yeast is added. The fermentation vessel is kept at 20°C for 14 days with light agitation being applied throughout.

The fermented liquid is transferred to a still with the solids in the fermentation vessel being disposed of as waste. Ethanol is distilled at 78°C but as methanol is distilled at a lower temperature the initial distillate (5% of batch) is disposed of for safety reasons. The still is run for 1-4 hours dependent on the input volume. The distillate is then diluted with reverse osmosis water to have a 40% alcohol content. Once diluted the product is put through an activated charcoal filter before being bottled and labelled.

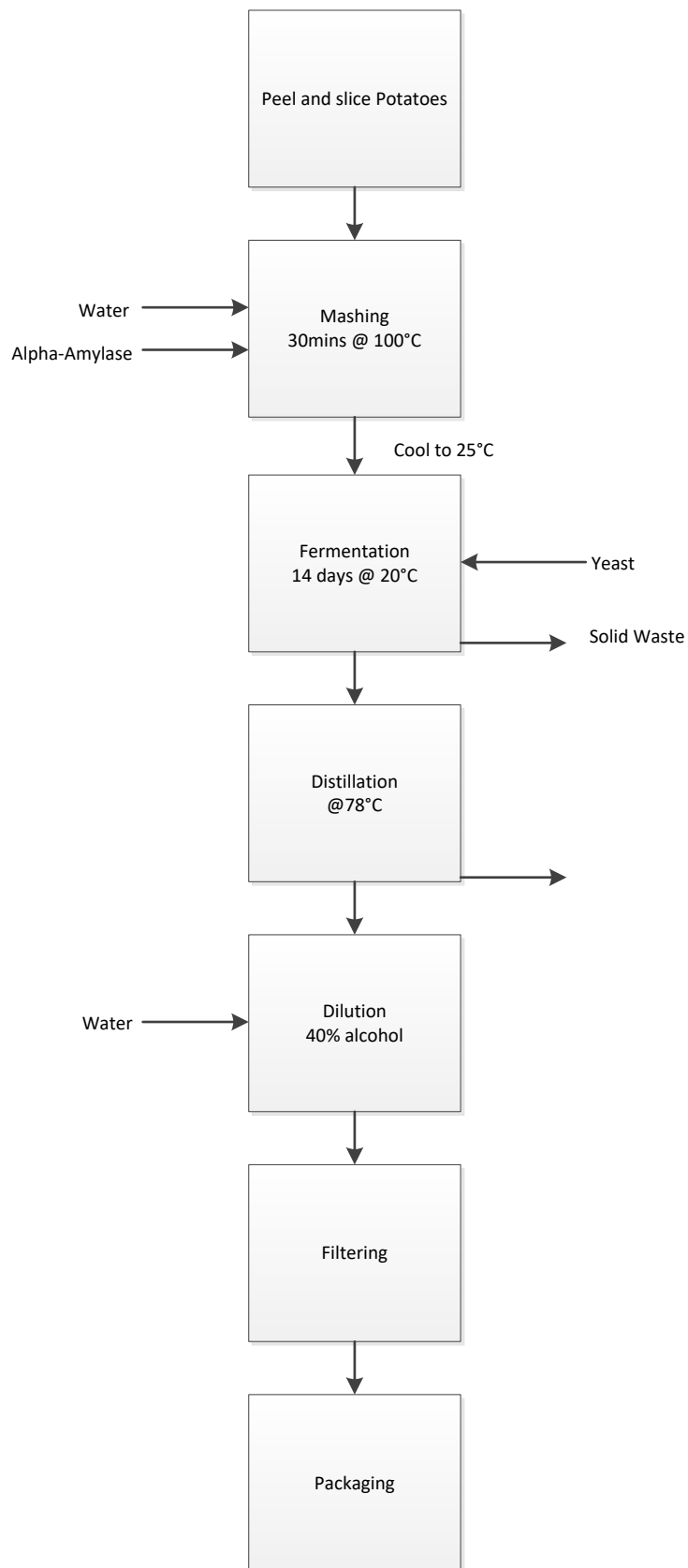


Figure 12- Process Flow Diagram

ii. P & ID

A simplified pipe and instrument diagram has been produced shown in figure 13.

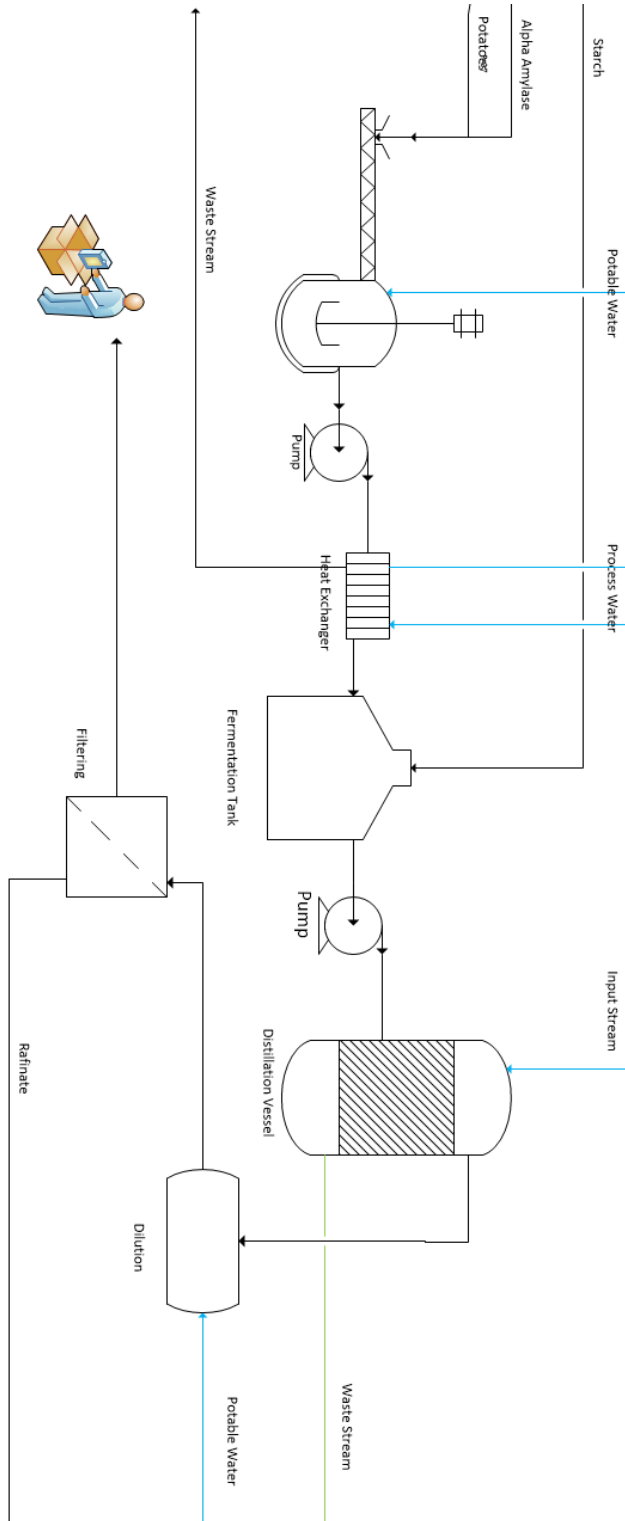


Figure 13- Pipe and instrument diagram of vodka process

c. Taste Panel

i. Aim and Method of Taste Panel

A taste panel was conducted to observe how the Vodka produced in this experiment compares against current products on the market. The three vodka products that were trailed in the taste panel were Grey Goose (\$69.99), Smirnoff (\$34.99) and Kristov (\$12.99). Ethics approval was needed for the taste panel, the project was evaluated as low risked and lodged with ethic committee (25th July 2017).

The taste panel was conducted with eight participants with each trying four unknown vodka beverages. When testing a vodka product, the three senses involved in the tasting are smell, sight and taste. During the taste panel the following procedure for testing was followed by all respondents. The taste panel were also asked to give a price they estimated the four vodka products would retail for. A copy of the form provided taste panel is shown in appendix 3.

Sight - Hold the vodka glass up to the light and look at the liquid's clarity, texture and luminescence. The participants were asked to rate the clarity on a 9-point hedonic scale with opaque and transparent being at the end of the scales.

Smell - Smell the vodka as you briefly swirl it about in your glass. Smell was ranked on how pleasant the smell was ranked from extremely unpleasant to extremely pleasant.

Taste - First taste by sipping, letting the vodka rest on your palate while exhaling through your nose, then swallow. Second, after cleansing your palate (use soda water), try swallowing the rest of the sample, without letting it linger on your palate this time. The taste was ranked using the same hedonic scale as smell between extremely unpleasant to extremely pleasant.

ii. Results from Taste Panel

The results from the taste panel were averaged across the eight participants and ranked from the average scores. The highest price ranking was determined by asking the participants how much they would spend on the vodka they were tasting. The scores from the participants were tabulated and can be found in appendix 4, a summary of the results is shown in table 10.

Sight	Smell	Taste	Highest Price
Kristov	Project Vodka	Project Vodka	Project Vodka
Smirnoff	Kristov	Kristov	Grey Goose
Project Vodka	Grey Goose	Smirnoff	Smirnoff
Grey goose	Smirnoff	Grey goose	Kristov

Table 10- Results from taste panel

The sight attribute for the vodka showed the least variability in scoring by participants, therefore the results for this section are less significant compared to the other results. Grey Goose having the lowest score is surprising due to it being distilled five times compared to the other three samples being distilled once.

For both taste and smell the vodka produced in this product got the highest scores, therefore had the most pleasant taste and smell. This is a positive result showing that the vodka product produced is rated above products currently on the marking. Kristov was ranked second for both of these but due to it having a lower alcohol level of 20% would give the product a weaker flavour and aroma.

The project vodka was also ranked the highest in terms of how much the participants would pay for the product with the average amount being NZ\$39.71/1L, Grey Goose had the second highest average with a value of NZ\$31.71/1L, followed by Smirnoff at NZ\$30/1L and Kristov had the lowest average at NZ\$28.71/1L.

As the project vodka had the highest average for price the participant would pay it could theoretically be priced above Grey Goose on the current market. Due to Grey Goose being deemed as a premium product it is able to have the higher retail price even though it had the lowest ranking for taste, the product is able to retail at the high price due to the brand perception. As the vodka produced in this project would be produced under a new brand, the product would struggle to sell if priced at a similar value to Grey Goose. Therefore, when retailed it is recommended the product be sold at a medium price of between NZ\$35-40.

d. Packaging Design

The market research showed that consumers care little for brand or packaging design. Therefore, when developing a label, the emphasis was on including all information

legally required by Food Standards Australia New Zealand. All beverages containing more than 1.15% alcohol by volume must include a statement of the alcohol content. The alcohol content can be in terms of ethyl alcohol or ethanol, for this product the product contains ethanol at 40%, this is shown on the label in Figure 14. The geographical location of where the Vodka was produced has been included as standard 2.7.5 states: *where a given quality, reputation or other characteristic of the spirit is essentially attributable to its origin in that particular country, locality or region*. As this product is to be produced in New Zealand with New Zealand products the reputation and quality of the product would likely be incorporated into the marketing strategy as was done for other NZ vodka brand 42 below. The production date has been included for traceability reasons but due to Vodka having an indefinite shelf-life a best before or used by date is not required.

For the design of the bottle an uncluttered, neutral design was used. The label is predominately white, this colour was chosen due to it signifying purity and simplicity. The 'pureness' of a vodka is often used as a descriptor of a quality product; therefore, it is important to incorporate that into the packaging design. Black is the other main colour in the design used for all writing and small symbols at the corners. Black represents sophistication and class while giving the perception of increased value and higher quality (Brunazzi, Parisi, & Pereno, 2014). The small amount of red used in the emblem gives a sense of excitement and draws the eye to the product. Vintage designs are a current design trend, with the use of the Jaques family crest ensures the product's design in on trend.

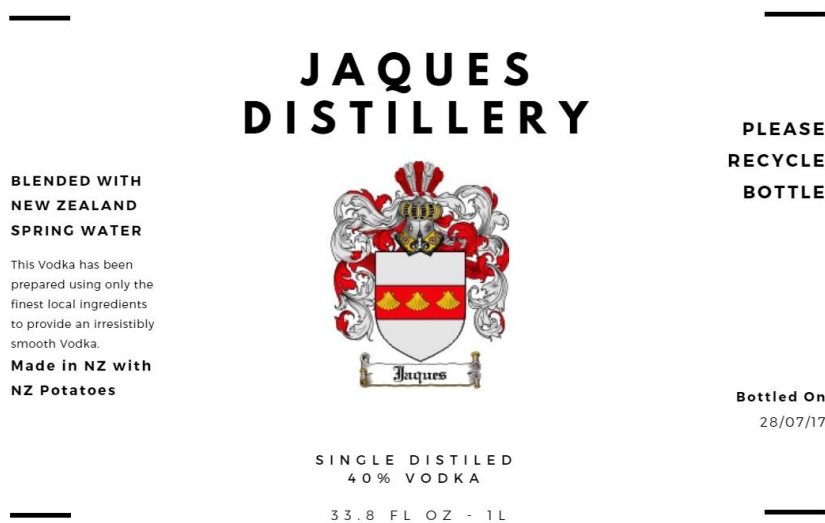


Figure 14- Label design for Vodka product

e. Costing

Table 11- Costing table for year one of product production. Data retrieved from: (Bouman, Jesen, & Wake, 2007)

Cost	Amount
Equipment	
- Mashing Vessel	\$20,000
- Fermentation Tanks	\$20,000
- Stil	\$50,000
-Other equipment	\$450,000
Heating	\$3,640
Raw Materials	\$10,000
Start-up costs	\$250,000
- Business & Financial Plans	
- Packaging Design	
- Prototype Development	
- Market Testing	
- Legal	
Overheads	\$250,000
Total Cost	\$1,053,640

The equipment costing was calculated by using a processing volume of 1m³. As this is a fluid processing plant a Lang factor of 5 was used to calculate all remaining equipment and system costs, this was done by the sum of the main plant items multiplied by the Lang factor is the installed cost of the main plant items, which include minor equipment. Gas heating was used for the stil, the stil requires 140kW per hour to distil 500L (Kovodel,

2017), which takes approximately 5 hours. Therefore, the power required per processing day (1,000L) for heating is 1,400kW, the stil will be run once a fortnight over the year thus having 26 processing days. The price of gas for heating is \$0.10 per Kw/hr.

Overhead costs were added into the costing table; overheads are the expenses associated with running a business. Overhead costs include rent, utilities, insurance, salaries, research and development and other fixed and variable costs associated with running a factory. This cost will be fixed each year from year to year.

i. Feasibility Analysis

The amount of Vodka being produced is 1,000L per batch therefore 1,000 units. There will be a batch produced each fortnight bringing the total amount of product being produced per annum to 26,000 bottles. If each bottle retails for \$40, the revenue generated from this will be \$1,040,000. Due to their being minimal raw material cost after the initial capital cost investment and start-up costs the year to year costs will be low therefore a high return on investment is achievable if product is successful in market.

6. Conclusions and Recommendations

The aim of this project was achieved in the development of a vodka product using potato waste. The vodka product developed was a 1 litre bottle of 40% abv unflavoured vodka.

The production process for this product followed traditional vodka distilling techniques with a simplified process being; preparing of potatoes, mashing, fermenting, distilling, diluting, filtering and packaging. In the trials completed for this project a maximum ethanol yield of 99% was achieved, this was then diluted to 30% which is safe to consume.

The consumer research; focus group, industry personnel interview and consumer survey all gave similar key points. The main driving factor when purchasing alcohol was the price, the taste and brand did have some influence. The respondents in both the focus group and consumer survey were open to trying new brands of vodka and were more likely to purchase a product that is produced in New Zealand made from local ingredients. Price was still the driving force in the hospitality industry with there being variability in brands stocked depending on price and discounts of the product. From the consumer survey 77% of respondents would prefer to purchase the product as a 1 Litre bottle, no flavour with 40% abv.

The vodka product produced in this project was ranked highly against other vodka products currently on the market. When compared against a premium, average and cheap vodka the project product was ranked highest for taste and smell and also had the highest price for the amount the participants would pay for the product.

The total cost for producing this product including capital investment and start-up costs would have a cost of \$1,053,640 for the first year. As a large amount of these costs are one-off capital investment (\$540,000) and start-up costs (250,000) the operating costs from year two onwards would be relatively low. With the current production of 1,000L/ 1,000 bottles produced fortnightly the total amount produced will be 26,000 bottles creating a revenue of \$1,040,000 if the product is priced at \$40.

This vodka product has the potential to be successful in the New Zealand vodka market, to achieve this it is recommended:

- A full costing and feasibility analysis be conducted on opening a distillery and producing this vodka product.
- Investigate whether a multiple distillation process could produce a higher value product.
- A business plan be prepared with the above information be developed to prepare the product for commercialisation.
- A factory scale trial be conducted to observe if the product has any changes when produced on a larger scale.
- A commercialisation plan be prepared with information regarding the distribution method and channels as well as the proposed promotion for the product.
- Ready-to-drink flavoured products could be developed using the ethanol based produced in this process.

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Appendices

8. Appendices

Appendix 1- Raw data from trials

Trial One

0-10					
Methanol	17.842	144418	0	mg/L	0.317
Ethanol	20.538	45266386	0	mg/L	99.388
10-15					
ID#	Name	Ret. Time	Area	Conc.	Unit
1	Methanol	17.831	10889	0	mg/L
2	Ethanol	20.536	47525298	0	mg/L
15-25					
ID#	Name	Ret. Time	Area	Conc.	Unit
1	Ethanol	20.542	44494497	0	mg/L
2	Methanol	18.863	21040	0	mg/L
25-35					
ID#	Name	Ret. Time	Area	Conc.	Unit
1	Ethanol	21.017	8490700	0	mg/L
2	Methanol	No peak is detected.	0	0	mg/L
methanol					
ID#	Name	Ret. Time	Area	Conc.	Unit
1	Ethanol	No peak is detected.	0	0	mg/L
2	Methanol	18.809	1613352	161335.2	mg/L
ethanol					
ID#	Name	Ret. Time	Area	Conc.	Unit
1	Methanol	No peak is detected.	0	0	mg/L
2	Ethanol	21.115	4851781	485178.1	mg/L

Trial Two

Ferment			
Acid H2SO4	24971	Acid H2SO4	24185
Glucose	2176	Glucose	2060
LA	4012	LA	3993
L+LA	9953	L+LA	9711
	67783		68884
	9141		8779

Ethanol	307488	Ethanol	307610
TOTAL	425524		425221
Start			
	9119		11957
Methanol	5635	Methanol	14934
Ethanol	4851624	Ethanol	2922293
TOTAL	2942516		2949184
Body			
Methanol	3465	Methanol	3499
Ethanol	4012427	Ethanol	4017629
TOTAL	4015893		4021128
Tail			
Ethanol	5500923	Ethanol	5503126
	2291		2373
TOTAL	5383214		5005499
10% v Ethanol 060517 B5.2			
Ethanol	5042940	5042394	5049557
TOTAL	5042940	5042394	5049557
10%v Methanol 3011			
Methanol	1560934	1559381	1560148
TOTAL	1560934	1559381	1560148
Sample 1			
Glucose	2007	Glucose	2117
Methanol	3380	Methanol	3351
Ethanol	15113479	Ethanol	15117601
	10022		9879
	8483		8267
	30229		30099
TOTAL	15167601		15171315
Sample 2			
Glucose	2091	Glucose	2236
Methanol	3441	Methanol	3642
Ethanol	15114722	Ethanol	15122524
	9844		10085
	8518		8571
	29919		30848
TOTAL	15168535		15177906
Sample 3			
Glucose	2047	Glucose	2178
Methanol	3242	Methanol	3351
Ethanol	15106104	Ethanol	15116252
	10163		9750
	8318		8727
	30537		30598

TOTAL	15160411		15170855
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Appendix 2- Consumer Survey with Answers

Vodka Products in the NZ Market

Q1. I agree to participate in this study under the set conditions above

Answer Choices	Response Percent
Yes	100.0%
No	0.0%
	Answered
	Skipped

Q2. What is your gender?

Answer Choices	Response Percent
Female	70.0%
Male	28.0%
Other	2.0%
Prefer not to answer	0.0%
	Answered
	Skipped

Q3. What is your age?

Answer Choices	Response Percent
Under 18	0.0%
18-22	86.0%
23-30	12.0%
31-40	0.0%
41 plus	2.0%
Prefer not to answer	0.0%
	Answered
	Skipped

Q4. How often do you consume Vodka or Vodka Products?

Answer Choices	Response Percent
Every day/Almost every day	0.0%
2-4 times a week	2.0%
Once a week	12.0%
2-4 times a month	48.0%
Once a month	16.0%
Less than once a month	20.0%
Never	2.0%
	Answered

Skipped

Q5. When purchasing vodka, in what form do you purchase?

Answer Choices	Response Percent
Straight Spirits	85.71%
RTDs (Cruisers, KGB ,etc)	63.27%
Cocktail	12.24%
Shot	12.24%
Other (please specify)	2.04%
	Answered
	Skipped

Q6. Where would you consume a vodka beverage?

Answer Choices	Response Percent
In a pub/club/bar	57.14%
In a restaurant	20.41%
At an event	61.22%
At home	83.67%
Other (please specify)	2.04%
	Answered
	Skipped

Q7. When drinking Vodka, how much would you consume in each sitting?

Answer Choices	Response Percent
1-2 Standard drink	6.12%
3-4 Standard drinks	16.33%
5-6 Standard drinks	32.65%
7 plus Standard drinks	44.9%
	Answered
	Skipped

Q8. Do you know the raw materials vodka is produced from?

Answer Choices	Response Percent
No	57.45%
Yes, if so please Specify	42.55%
	Answered
	Skipped

Q9. What Vodka Brand do you purchase?

Answer Choices	Response Percent
Smirnoff	89.58%

42 Below	33.33%
Stolichnaya	0.0%
Ivanov	8.33%
Finlandia	4.17%
Stil	20.83%
Absolut	45.83%
Belvedere	0.0%
Crystal head	2.08%
Grey Goose	6.25%
Skyy	6.25%
Other (please specify)	4.17%
	Answered
	Skipped

Q10. What do you value most in a Vodka product?(1=Value most, 5= Value least)

Answer Choices	1
Taste	9
Price	30
Brand	4
Country of Origin	2
Ingredients	3

Q11. How open are you at trying a new vodka brand?

Answer Choices	Average Number
(no label)	86.54167

Q12. How much would you pay for a 1 litre Vodka Bottle with a strength of 37%

Answer Choices	Response Percent
Less than \$30	4.17%
\$31-\$40	89.58%
\$41-\$50	4.17%
\$51-\$60	2.08%
\$61 plus	0.0%
	Answered
	Skipped

Q13. Knowing it is being made in New Zealand and uses local ingredients, does it make you more likely to purchase this product?

Answer Choices (no label)	Average Number 71.80435
------------------------------	----------------------------

Q14. Vodka can be made from various starch sources e.g. grain & potatoes or from sugar. Does using potatoes as the main starch source make you more likely to purchase this product?

Answer Choices (no label)	Average Number 54.76087
------------------------------	----------------------------

Q15. Would you like to give any feedback or recommendations for this product?

Answered	10
Skipped	40

Q16. How would you prefer to purchase this product?

Answer Choices	Response Percent
1 Litre Bottle Straight no flavour 40%	77.27%
1 Litre Bottle Flavoured 40%	6.82%
Pre-mixed 330ml Bottle Flavoured	11.36%
Pre-mixed 250ml Can Flavoured	4.55%
	Answered
	Skipped

Appendix 3- Taste Panel Form

Taste Panel

There are three senses involved in a tasting of vodka: smell, sight and taste.

- **Sight.** Hold the vodka glass up to the light and look at the liquid's clarity, texture and luminescence.
- **Smell.** Smell the vodka as you briefly swirl it about in your glass.
- **Taste.** First taste by sipping, letting the vodka rest on your palate while exhaling through your nose, then swallow. Second, after cleansing your palate (use soda water), try downing the rest of the sample, without letting it linger on your palate this time.

Please taste each sample one at a time and answer their corresponding questions. Once completing the questions for each sample please rank the them on the last page.

Sample 123

Sight:

How do you find the clarity of the sample?

Opaque

Transparent



Smell:

How do you find the smell of the sample?

Extremely unpleasant

Extremely Pleasant



Taste:

How do you find the taste of the sample?

Extremely unpleasant

Extremely Pleasant



Pleasant

How much would you expect this product to retail for:

Sample 621**Sight:***How do you find the clarity of the sample?*

Opaque

Transparent

**Smell:***How do you find the smell of the sample?*

Extremely unpleasant

Extremely Pleasant

**Taste:***How do you find the taste of the sample?*

Extremely unpleasant

Extremely



Pleasant

How much would you expect this product to retail for:

Sample 451

Sight:*How do you find the clarity of the sample?*

Opaque

Transparent

**Smell:***How do you find the smell of the sample?*



Taste:

How do you find the taste of the sample?



Pleasant

How much would you expect this product to retail for:

Sample 897

Sight:

How do you find the clarity of the sample?



Smell:

How do you find the smell of the sample?



Taste:

How do you find the taste of the sample?



Pleasant

How much would you expect this product to retail for:

Ranking

Please rank the samples from the 1-4, with 1 being the one you would pay the most for and 4 being the least.

Rank	Sample
1	
2	
3	
4	

Appendix 4- Taste Panel Results

Sample 123 - Smirnoff				
Participant	Clarity	Smell	Taste	Retail Expectations
1	8.7	3.5	6	40
2	8	6	5	20
3	7	4	4	25
4	9	3	2	30
5	8	3	4	30
6	8	8	6	-
7	9	4.2	5	35
8	8	7	3	30
Average	8.2125	4.8375	4.375	30
Sample 621 - Project				
Clarity	Smell	Taste	Retail Expectations	
8.5	6.5	6.8	70	
7.8	8.2	7.8	40	
7	7	7	35	
9	6	5	38	
8	4	6	40	
8	6	5	-	
9	7	3.5	15	
8	9	7	40	
8.1625	6.7125	6.0125	39.71	
Sample 451 - Kristov				
Participant	Clarity	Smell	Taste	Retail Expectations
1	8.8	5	7	20
2	8	6.3	4.2	15
3	8.9	6	6	40
4	8	5	6	36
5	9	6	8	25
6	8	7	4	-
7	9	5	4.5	25
8	8.5	8.1	8	40
Average	8.525	6.05	5.9625	28.71
Sample 897 - Grey Goose				
Clarity	Smell	Taste	Retail Expectations	
8	7.3	7	60	

7.7	6.3	5.7	30
7	3	5	30
9	3	2	32
8	7	3	20
8	6	6	-
9	4.5	4.5	30
8	6	1	20
8.0875	5.3875	4.275	31.71

Appendix 3 Survey

Vodka Products in the NZ Market

Q1. I agree to participate in this study under the set conditions above

Answer Choices	Response Percent
Yes	100.0%
No	0.0%
	Answered
	Skipped

Q2. What is your gender?

Answer Choices	Response Percent
Female	70.0%
Male	28.0%
Other	2.0%
Prefer not to answer	0.0%
	Answered
	Skipped

Q3. What is your age?

Answer Choices	Response Percent
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2-4 times a month	48.0%
Once a month	16.0%
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Never	2.0%
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Q5. When purchasing vodka, in what form do you purchase?

Answer Choices	Response Percent
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RTDs (Cruisers, KGB ,etc)	63.27%
Cocktail	12.24%
Shot	12.24%
Other (please specify)	2.04%
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Q6. Where would you consume a vodka beverage?

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Answer Choices	Response Percent
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Q8. Do you know the raw materials vodka is produced from?

Answer Choices	Response Percent
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Belvedere	0.0%
Crystal head	2.08%
Grey Goose	6.25%
Skyy	6.25%
Other (please specify)	4.17%
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\$31-\$40	89.58%
\$41-\$50	4.17%
\$51-\$60	2.08%
\$61 plus	0.0%
	Answered
	Skipped

Q13. Knowing it is being made in New Zealand and uses local ingredients, does it make you more likely to purchase this product?

Answer Choices	Average Number
(no label)	71.80435

Q14. Vodka can be made from various starch sources e.g. grain & potatoes or from sugar. Does using potatoes as the main starch source make you more likely to purchase this product?

Answer Choices	Average Number
(no label)	54.76087

Q15. Would you like to give any feedback or recommendations for this product?

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Skipped	40

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1 Litre Bottle Flavoured 40%	6.82%
Pre-mixed 330ml Bottle Flavoured	11.36%
Pre-mixed 250ml Can Flavoured	4.55%
	Answered
	Skipped