Low-alcohol fermented products and their perception by female consumers

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Title: **Low-alcohol fermented products and their perception by female consumers**

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Introduction: Alcohol consumption is present in many cultures, but there has been an increase in demand for low-alcohol (<1.1% ABV) fermented products in various countries and this trend is making its way to Canada. However, the perception of these products by their potential consumers is not well studied. The further development of low-alcohol beverages may offer the products with improved sensory characteristics and added value. Therefore, a shift in consumption from full-alcohol to low-alcohol products may reduce the health and socio-economic burdens associated with alcohol consumption and provide new opportunities to use these beverages in innovative ways. The current study was conducted with females who expressed interest in low-alcohol products.
Objectives: This study consists of two parts. The objective of the first part was to explore the female consumer perception and attitudes towards low-alcohol products, and explore the consumer liking of a few low-alcohol and dealcoholized products currently on the market in Nova Scotia (NS). The objective of the second part of the study was to investigate sensory properties of the existing low-alcohol products and compare them with their full-alcohol counterparts. The hypothesis of the study was that females may be more likely to consume low-alcohol products if there are added flavours, or sweetness to help offset any negative sensory properties that may occur during dealcoholization, such as blandness or a low aromatic profile.
Methods: 16 females (41± 22y) completed the Alcohol Preference Questionnaire and participated in two focus groups aimed at exploring consumer perception and attitudes towards low-alcohol products. Another 52 females (39.5 +/- 7.4y) have performed a taste panel testing of four low-alcohol and dealcoholized beer samples: Pale Lager (4.0% ABV), Citrus Lager (2.4% ABV), Non-Alcoholic Pale Lager (0.0% ABV), and Non-Alcoholic Citrus Lager (0.0% ABV).
Results: The results obtained from the focus group data revealed the preference of female consumers for sweet, fruity, aromatic flavour and high carbonation in low-alcohol beer products. The necessary attributes demanded by female participants also include sweetness, aromatics, and citrus notes, and the negative characteristics would be an aftertaste, wateriness, and blandness. There was a significant effect of beer type on overall liking (P=0.0002). Post hoc comparisons indicate that the Pale Lager, Citrus Lager, and Non-Alcoholic Citrus Lager were all significantly liked more overall than the Non-Alcoholic Pale Lager.
Conclusions and Implications: These findings support the hypothesis that females may be more likely to consume low-alcohol products if there are added flavours in order to help offset any negative sensory properties. Through this study, attributes that drive liking and disliking were explored, and these findings may be utilized in the future for creating conceptually new or innovative beverages with low-alcohol content.

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Acronyms

ABV: Alcohol by volume

ANOVA: Analysis of variance

CA: Correspondence Analysis

CATA: Check-All-That-Apply

CVD: Cardiovascular disease

HSD: Honest Significant Difference

NS: Nova Scotia

PARW: Partially alcohol-reduced wines

PCoA: Principal Coordinate Analysis

Chapter 1: Introduction

Alcohol-free beer and low-alcohol beer has had an increased market share due to the global trend for healthier lifestyles (Liguori et al., 2015). It has been observed that in the last 10 years low, or non-alcoholic beer has a larger growth volume compared to stout, dark beer, and lagers (Liguori et al., 2015; Euromonitor International 2013). However, it has been difficult switching consumers to low or non-alcoholic alternatives, like dealcoholized wine, because consumers think these products do not taste like their full alcohol versions (Meillon et al., 2010). Alcohol contributes sensory properties like weight, residual sweetness, and flavour, and once the alcohol is removed it can have sensory consequences on a product (Erten & Campbell, 2001; Ross & Weller, 2008).

This study will investigate the perceptions of female participants towards low-alcohol wine and beer, and to explore what sensory properties can be approved on to increase the taste and consumer liking of the products.

Chapter 2: Literature Review

Fermented Foods and Beverages

Fermented food and beverages are readily available all over the world, and can comprise up to 40% of the human diet in certain areas (Borresen et al., 2012). Fermentation is a metabolic process that occurs when carbohydrates are partially, or completely oxidized by microorganisms and their enzymes (Kabak & Dobson, 2011). Fermentation extends shelf life for certain products, and is crucial for the manufacturing processes of alcoholic beverages, vinegars, cured meats, and certain cheese (Blandino et al., 2003). The four major fermentation processes and examples of products developed from these processes are in Table 1.

Table 1. The four major fermentation processes and their products. Adapted from Blandino et al. (2003)

Fermentation Process	Products
Alcohol (via yeasts)	Ethanol (Beer, wines)
Lactic acid (via lactic acid bacteria)	Fermented milks and cereals
Acetic Acid (via *Acetobactor* species)	Vinegar
Alkali	Soy sauce

Fermentations can occur either naturally via native microorganisms (a.k.a. spontaneous fermentation), or intentionally by adding microorganisms to result in inoculated fermentation (such as in alcoholic beverages). Grains such as rice, wheat, corn, sorghum, and other grains are fermented worldwide to gain different fermented foods and beverages (Blandino et al., 2003). The grains and subsequent fermented products are shown in Table 2.

Table 2. Grain and subsequent fermented products. (Blandino et al., 2003)

Grain	Fermented Products
Rice	Idli, Dosa, Dhokla
Wheat	Soy sauce, Kishk, Tarhana
Corn	Ogi, Kenkey, Pozol
Sorghum	Injera, Kisra
Cereal-based	Beer, Sake, Bouza, Chicha, Mahewa, Boza

Before refrigeration, or chemical preservatives, fermentation was the only means for preserving and storing foods (Borresen et al., 2012). Traditionally, fermented foods were made on a smaller scale before the industrial revolution, but now require large-scale processes to keep up with consumer demand, and this has brought about new-patented technology (Borresen et al., 2012). One patented improvement (US6046022) is fermenting red rice with at least one *Monascus* strain, and using these products as dietary supplements to help treat and prevent CVD, diabetes, and hypertension (Borresen et al., 2012). Another improvement is using wild yeasts and acid-producing bacteria in a multi-step fermentation, which creates sour beers or kombucha tea (Borresen et al., 2012).

Kombucha is a fermented tea beverage that is made by using a colony of yeasts and acetic acid-producing bacteria (Borresen et al., 2012). The bacteria converts the alcohols produced by the yeasts into acetic acid, and results in a non-alcoholic beverage (Borresen et al., 2012).

Wine

In Canada, a beverage containing 1.1% ABV or more is considered an alcoholic beverage, and anything less than 1.1% ABV is considered a "low-alcohol" beverage (CFIA, 2014; IARD, 2015). In Europe and Turkey, beverages containing more than 1.2% ABV are considered an alcoholic beverage, and in New Zealand and Australia anything above 1.15% ABV is considered an alcoholic beverage (IARD, 2015).

Wine that has been dealcoholized to less than 1.1% alcohol by volume (ABV) is considered a 'Dealcoholized wine,' but if the alcohol content isn't dealcoholized to less than 1.1% must be labeled "Partially Dealcoholized Wine" (CIFA, 2014). Any ingredient that is added to the dealcoholized wine must be labeled on the bottle in the ingredient list section, but if it was added prior to dealcoholization it does not have to be declared on the label (CFIA, 2014).

According to the UK Food Standards Agency (FSA), wine is at a minimum of 9% ABV, and anything lower than 9% ABV has to be labeled accordingly (Charles, 2010). Low-alcohol wine contains 0.5-1.2% ABV, and anything above 1.2% ABV, but below 5.5% ABV is considered a reduced-alcohol wine (Erten & Campbell, 2001). According to the Canadian Food Inspection Agency (CFIA) wine that is 9% ABV or less may use the term "Light."

Beer

The terms "extra light" and "light" are two examples of common names used for beer based on the alcohol content (CFIA, 2014). According to the *Food and Drug Regulations* (FDR), a beer that contains 0.4% alcohol can be labeled "0.4% Alcohol

Beer," but there are no requirements for the use of a common name at this percentage of alcohol (CFIA, 2014). "Low-alcohol" can be used for a beer with less than 1.1% alcohol since anything less than 1.1% ABV is considered low-alcohol in Canada (CFIA, 2014). The common names of beer based on their ABV percentage are listed in Table 3.

Table 3: Common names for beer based on their % of ABV (CFIA, 2014)

% of ABV	Qualified Common Name or Common Name
1.1 to 2.5	Extra Light Beer, Extra Light Ale, Extra Light Stout, and Extra Light Porter
2.6 to 4.0	Light Beer, Light Ale, Light Stout, Light Porter
4.1 to 5.5	Beer, Ale, Stout, Porter
5.6 to 8.5	Strong Beer, Strong Ale, Strong Stout, Strong Porter, Malt Liqueur
8.6 or more	Extra Strong Beer, Extra Strong Ale, Extra Strong Stout, Extra Strong Porter, Strong Malt Liqueur

Nutritional Properties of Fermented Products

Fermentation increases the concentration of dietary vitamins and essential amino acids in a product, and as a result changes its sensory properties and functional qualities (Blandino et al., 2003; Kabak & Dobson, 2011). For instance, after lactic fermentation,

sorghum was found to have increased levels of niacin, thiamin, riboflavin, and increased protein quality (Kazanas & Fields, 2006).

One method of enriching nutrients is through starter cultures or multi-step processes like malo-lactic fermentation, which are sustainable and food safe for consumption (Borresen et al., 2012). Enriching protein, amino acids, and vitamins in fermented food products may prevent nutrient deficiencies in certain populations, enhance the digestibility of certain foods, and may act as functional food products (Borresen et al., 2012; Kabak & Dobson, 2011). A list of fermented products and their added nutritional value or health benefits are listed in Table 4.

Table 4: Fermented products and their advantages

Fermented Product	Added Nutrients or Health Benefits
Fermented Milk Products (i.e. yogurt)	● Reduces cholesterol, and improves mineral absorption ● Increases: lactic acid, galactose, free amino acids, fatty acids, and B vitamins ● Reduces risk of CVD
Fermented Tea	● Antimicrobial activity ● Increases vitamins, and reduces caffeine content ● Prevents and treats CVD, diabetes, cancer, and gastrointestinal infection
Fermented Soy (e.g. miso, soy sauce, etc.)	● Prevents age-related and hormone-related diseases ● Prevents and treats inflammatory diseases or health disorders (cancer, infection, autoimmunity, and asthma).
Fermented Rice	● Contains unsaturated fatty acids, sterols, and B-complex vitamins. ● Reduces cholesterol, type II diabetes, CVD ● Prevents cancer

Adapted from Borreson et al. (2012), and Kabak and Dobson (2011).

Health Benefits Associated with Moderate Alcohol Consumption

In observational studies moderate alcohol consumption may prevent, or protect against cardiovascular disease (CVD) and other diseases (Chikritzhs et al., 2015; Fekjaer, 2013). The J-shaped alcohol curve and the "French Paradox" are patterns, or anomalies that occur in observational studies. Excessive alcohol consumption is associated with increased mortality risk, and moderate alcohol consumption has been theorized to provide potential protective effects against disease (Renaud et al., 1999; Plunk et al., 2014). Studies have found the J-shaped alcohol pattern reoccurring when observing this association, but to date there is no plausible biological mechanism that can pinpoint the answer (Fekjaer, 2013; Chikritzhs et al., 2015). However, there are reasons to doubt the protective benefits of alcohol in these studies. A lack of dose-response relationships, confounding variables between non-drinkers and drinkers (such as lifestyle factors), and lack of biological mechanisms are just a few reasons to doubt the health benefits of moderate alcohol consumption (Naimi et al., 2005; Fekjaer, 2013).

In a randomized trial it was observed that the 'Mediterranean diet' was beneficial for reducing the risk of CVD for high-risk persons due to olive oil and nuts, and not solely from the moderate wine consumption of the participants (Estruch et al., 2013; Chikritzhs et al., 2015). This evidence reveals that the "French Paradox" and the J-shaped alcohol curve may not be due to only moderate wine consumption, but also a synergy of variables (Chikritzhs et al., 2015). Many researchers suggest that protective effects of moderate alcohol consumption on diseases, like CVD, may be due to confounding variables and should be interpreted with caution (Naimi et al., 2005; Chikritzhs et al., 2015).

In a prospective cohort study in France, a sample of middle aged men (n=36,250) was selected in order to evaluate the association between health risk and alcohol consumption (i.e. beer and wine) (Renaud et al., 1999). Main results were: moderate intake of both wine and beer was associated with lower risk for CVD; intake of daily wine had a stronger inverse association with risk of CVD (Renaud et al., 1999). The authors suggest that both wine and beer moderate consumption reduced the risk of CVD in French middle-aged men.

In a cross-sectional study in France, a J-shaped relationship was found between total alcohol consumption and waist-to-hip ratio (WHR) in both men and women (Lukasiewicz et al., 2003). The researchers found that women and men who consumed less than 100 g per day of wine had a lower WHR than non-drinkers and heavy drinkers. They also found that spirits consumption was positively associated with BMI, and that there was no relationship between beer consumption and BMI and WHR (Lukasiewicz et al., 2003).

Currently, there is no data on the health risks or chronic conditions of low-alcohol consumption. Heavy or excessive alcohol consumption has been proven to be a leading health hazard in certain populations and countries and should never be encouraged due to being more harmful than beneficial (Naimi et al., 2005; Plunk et al., 2014). For instance, in a recent cohort study by Karami et al (2014) increasing alcohol consumption was associated with reduced renal cell carcinoma (RCC) risk compared to non-drinkers regardless of sex or alcoholic beverage type. Also, another study observed an inverse association between alcohol intake and risk of chronic kidney disease (CKD) in both men and women (Kusek, 2015). The hazard ratios for CKD decreased as self-reported alcohol

consumption increased: 0.95 for occasional, 0.84 for light, 0.77 for moderate, and 0.69 for heavy (Kusek, 2015). Both of these studies may be interpreted as to having an association with increasing alcohol consumption to gain potential health benefits, but it should never be encouraged to increasing alcohol consumption to gain potential health benefits due to harmful consequences associated with increased alcohol consumption.

Specific Fermented Alcohol Products and Their Effects on Human Health

Red Wine

Resveratrol has been aptly studied in red wine for the last decade, and has a variety of purported biological activities, such as protecting against several diseases (Rotches-Ribalta et al., 2012). The potential health benefits of resveratrol are due to its "anti-inflammatory, antioxidant, and antitumorgenic properties" in vitro" (Naugler et al., 2007, p. 117). Essentially, this phytochemical prevents oxidative stress in cells and it is theorized to prevent certain ailments such as certain cancers, ischemic heart disease, and inflammation (Naugler et al., 2007).

Resveratrol has low bioavailability, and is rapidly metabolized after oral ingestion, but in a recent study it was found that resveratrol metabolite concentration significantly increased in urine over long-term consumption in both interventions (one with red wine, and with dealcoholized red wine) (Rotches-Ribalta et al., 2012). This provides evidence that the health benefits of red wine can also be present in dealcoholized red wine, and resveratrol bioavailability is not influenced by alcohol presence.

Dealcoholized Wines

In a randomized crossover controlled clinical trial conducted with 67 male participants with either diabetes mellitus or ≥3 risk factors for cardiovascular disease, it was reported that dealcoholized red wine decreased systolic and diastolic blood pressure (BP) while increasing plasma nitric oxide concentration (Chiva-Blanch et al., 2012). Red wine had similar effects, but the findings were non-significant. The researchers concluded that the health benefits of red wine were due to the polyphenols and not to alcohol, and that moderate alcohol consumption does not affect BP in high cardiovascular risk subjects. Therefore, dealcoholized red wines have a similar nutrient profile as full alcoholic red wines.

Beer

Beer contains phenolic compounds (i.e. phenolic acids, flavonoids, proanthocyanidins, tannins, etc.) that are responsible for delaying oxidation (Zhao et al., 2010). Phenolic profiles in barley vary across varieties of beer, and are changed during the malting process (Zhao et al., 2010). Fermentation changes the nutrient profile of certain grains as well, such as sorghum was found to have increased levels of niacin, thiamin, riboflavin, and increased protein quality after lactic fermentation (Kazanas & Fields, 2006).

Alcohol-Free Beer

Low-alcohol and non-alcoholic beer contains vitamins, minerals, soluble fibres, and antioxidants just like alcoholic beer (Ligouri et al., 2015). The only significant

differences between low-alcohol and full alcohol beers besides alcohol content are the loss of esters, volatile compounds, and aldehydes during the dealcoholization processes (Ligouri et al., 2015). However, polyphenols are present in the beer, or wine regardless of being dealcoholized (Chiva-Blanch et al., 2012).

One study found that hops have a sedative effect, and improved sleep quality of a group of female nurses (n=17) after drinking non-alcoholic beer for two weeks (Franco et al., 2012). Full strength or low-alcohol beer would not have the same effect on sleep quality since alcohol interferes with cardiovascular relaxation (Franco et al., 2012; Pietila et al., 2018).

Non-alcoholic beer and alcoholic beer both go through the same fermentation steps (Mangindaan et al., 2018). The only difference is that after fermentation is completed the non-alcoholic beer goes through further processing: dealcoholization. The next step is to remove the alcohol by either membrane-based processes, or thermal methods (Muller et al., 2017).

Evaporation and distillation are both heat treatment processes that remove alcohol, but these methods can be detrimental on the flavor and aroma of the beer because these characteristics are easier to thermally degrade (Mangidaan et al., 2018). Characteristics that are harder to remove by the heating process are bitterness and maltiness, and these traits are still detected by the consumer once the alcohol has been removed (Missbach et al., 2017).

Membrane-based processes are reverse osmosis, dialysis, osmotic distillation, and pervaporation (Muller et al., 2017). These methods use milder temperatures to remove the

alcohol, and have minimal impacts on flavour and nutrient changes unlike traditional thermal methods (Mangidaan et al., 2018).

Sensory Properties of Alcohol Products

Alcohol, a.k.a ethanol, has sensory properties that may be difficult to mimic in low-alcohol products: mild fragrance, mouth-feel, weight, flavour, and residual sweetness and flavour (Erten & Campbell, 2001; Ross & Weller, 2008). There is a synergy in an alcoholic beverage, and when one variable is lacking or in low concentration it can have sensory consequences. For instance, low-alcohol wine may be perceived as thinner, lighter, or sweeter than regular alcohol wine due to the removal of ethanol (Ross & Weller, 2008; Erten & Campbell, 2001).

Sensory Evaluation of Wine

Wine contains polyphenols (i.e. anthocyanins and tannins) that are responsible for colour intensity, polysaccharides that affect the aroma, and glycerol that contributes to the flavour intensity and mouth feel (Lorrain et al., 2013). Winemaking processes, such as certain fermentation or aging, also contributes to red wine by providing volatile compounds like esters that contribute to the volatility (i.e. fruity aromas) to the wine (Lorrain et al., 2013).

Meillon et al (2010) studied the impact of partially alcohol-reduced wines (PARW) on liking, perceived complexity and sensations. The Australian Syrah red wine was originally 13.4%, but was partially dealcoholized by reverse osmosis to ABV levels of 11.5%, 9.5%, and 7.9% (two at this ABV; one had 8.44 g sugar added). The full-

strength alcohol wine was perceived as the most complex, the 7.9% ABV without added sugar was considered the most astringent, and the 7.9% ABV wine with added sugar was preferred over the 7.9% ABV wine without added sugar (less of a bitter aftertaste). The researchers also observed that there was a correlation between consumers liking PARW and the number of wine bottles in their cellars. For instance, consumers who had fewer than 20 bottles in their cellars were more likely to like the PARW.

In terms of taste, the higher the ABV the more complex the red wines are due to the effects of alcohol on temporality of sensations (masks bitter sensations, aromas linger longer in the mouth and nasal cavity, etc.). Information on the health benefits of partially dealcoholized wines may influence the likability of PARW, and this would be beneficial through PARW tastings with the public. The researchers concluded that the results were not uniform in terms of liking PARW, but taste and information on PARW influenced overall liking of PARW.

Sensory Evaluation of Beer

The sensory properties of beer are: bitterness, turbidity, foam stability, O_2 and CO_2 (which affects aroma and flavour), alcohol content, colour, pH, and polyphenols (Liguori et al., 2015). During dealcoholization some of these properties can be lost in the process leading to a loss of volatile compounds, less body, and a low aromatic profile of the beer (Ligouri et al., 2015). In a recent study, researchers used osmotic distillation (via stripping agents) to dealcoholize beer, and found that there was no difference between pH, colour, bitterness, and polyphenol content (Ligouri et al., 2015). The only sensory disadvantages found were traces of oxygenation (lead to increased turbidity), and a

reduction of CO_2 (lead to a loss of foam) (Ligouri et al., 2015). Regardless, in terms of nutrient profile dealcoholized, or low-alcohol beer will have similar phenolic profiles to full alcoholic beers (Ligouri et al., 2015).

During the dealcoholization process there is a loss of fruity aromas and flavour with the removal of ethanol, and other compounds are left behind and no longer subdued (Mangidaan et al., 2018). In a study by Missbach et al. (2017) both the sensation for malty flavour, and bitterness were present in alcohol-free beers, but there were also problematic off-flavours that were detected as well. Two of the biggest sensory concerns for non-alcoholic beers are a lack of fruity aroma, and a strong worty flavour (Perpète & Collin, 1999). Once ethanol is removed other flavours intensify, like maltose, or a worty flavour, which is caused by 3-methylthiopropionaldehyde (Blanco et al., 2014; Perpète & Collin, 1999).

Bioactive Compounds Isolated from Fermented Alcohol Products and Their Innovative Use

Polyphenols

Polyphenols are found in many plants, and their purpose is to help the plants defend against ultraviolet radiation or pathogens (Manach et al., 2004). Polyphenols are classified into groups (by their number of phenol rings and by binding elements): phenolic acids, flavonoids, stilbenes, and lignans (Appendix 1) (Manach et al., 2004). Polyphenols are characterized by their antioxidant activity, and *in vitro* have been shown to act as radical scavengers (Flamino et al., 2009).

Flavonols

Flavonols are the most common flavonoids in foods, mainly in the form of quercetin or kaempferol, and accumulate on the outside of the fruit because they are stimulated by light (Manach et al., 2004). Variance in flavonols concentration in fruit (same piece of fruit, or even from the same tree) depends on the exposure to sunlight, and even on the size of fruit (Manach et al., 2004). The skin to fruit ratio can also play a part in variance of flavonols concentration. For example, a bigger grape would have less flavonols than a smaller grape because of this ratio (biosynthesis is stimulated by light). Red wine contains between 2 and 30 mg flavonols per liter, which works out to be between 0.2 and 3 mg per serving (Manach et al., 2004).

Flavanols

Flavanols can be either in a monomer form or in a polymer form. The monomer form is known as catechins, and are not glycosylated in foods like flavonols (Manch et al., 2004). Polymers of catechins, are known as proanthocyanidins or as condensed tannins, are responsible for the astringency of fruits and beverages like grapes, apples, tea, wine, and beer (Manach et al., 2004). The tannins are reduced when they are polymerized during maturation and ripening of the fruit. Red wine contains between 80 and 300 mg of flavanols per Litre, or between 8 and 30 mg per serving.

Anthocyanins

Anthocyanins are pigments in the epidermal tissues of flowers and fruit, and are resistant to light, pH, and oxidation when in the aglycone (anthocyanidins) form (Manach

et al., 2004). Anthocyanins are stabilized by binding to other flavonoids, and this creates co-pigmentations in the flowers and fruit. Red wine contains between 200 and 350 mg anthocyanins per Litre (20-35 mg per serving), and become more complex as the wine matures (Flamino et al., 2013).

Stilbenes

Stilbenes are found in minute amounts in a few edible plant species, but have desired biological activities when consumed by humans: anticancer, antioxidant, anti-inflammatory, and cardioprotective (Flamino et al., 2013). Stilbenes are considered phytoalexins since they have antifungal activity, and are induced by stress (Bavaresco, 2003). Resveratrol is the primary stilbene found in *Polygonum cuspidatum* (Ratnasooriya et al., 2010), and one of the main stilbenes associated with health benefits of red wine consumption.

Resveratrol

Resveratrol (3,5,4'-trihydroxy-trans-stilbene) is a natural polyphenol found in grapes, peanuts, berries, and in red wine (Burns et al., 2002; Ratnasooriya et al., 2010). Resveratrol has two isomers: *cis*- and *trans*-isomers. Both are present in red wine due to being on the outside of grape skins, which are then used in the winemaking process, but only the *trans*-isomer is biologically active in humans (Naugler et al., 2007). This phytochemical is present on the surface of red and white grapes, but since it is not ideal to use the skins for white winemaking it is present in only red wines.

Trans-resveratrol decreases as the grape ripens to maturity, and this may be why Pinot Noir from warmer climates contains higher resveratrol compared to other grapes, which is usually harvested earlier than other varieties (Naulger et al., 2007; Goldberg et al., 1995). Other variations in resveratrol concentration among wine (even from the same varietal) may be due to climatic conditions, differences in viticultural practices (i.e. organic versus herbicide use), or winemaking practices (Naugler et al., 2007).

Enhancing Flavonoids

A few studies were able to increase biosynthesis of flavonols, such as anthocyanin, by treating the wine grapes with methyl jasmonate (MeJ) (+131% increase in one year), or with benzothiadiazole (BTH) (+56% increase after two years) (Flamino et al., 2013). Other hormones, such as ethylene or salycilic acid, and chitosan were also shown to increase anthocyanin biosynthesis in grapes (Flamino et al., 2013).

Choosing wine grapes that have higher colour intensities may also enhance anthocyanins in functional wine beverages (Ratnasooriya et al., 2010). In a study of Nova Scotia wine grapes the only polyphenols detected in the juice were anthocyanins, meaning there may be a correlation between the colour of the skin and the concentration of anythocyanins present in the juice (Ratnasooriya et al., 2010).

Enhancing Resveratrol

Certain techniques may increase resveratrol concentration in red wines such as, longer macerations and higher pressure during pressing of the skins (Naugler et al., 2007). Also, harvesting before the grapes are too ripe may also increase *trans*- resveratrol

concentrations. Antioxidants are positively correlated with phenolic content of grapes (Kalt et al., 1999a), and it is shown that only 30% of polyphenols are present after being pressed for wine, which leaves 70% behind in the pomace (Pinelo et al., 2005; Ratnasooriya et al., 2010). It may be ideal to utilize the pomace in the winemaking process in order to extract more of the polyphenols that are left behind after the grape pressing. Another theory of obtaining *trans*-resveratrol in juice is to heat the mash prior to pressing, and this may exert polyphenols from the skin into the juice (Ratnasooriya et al., 2010).

Winemaking processes may also be altered in order to enhance resveratrol in red wine. Glycoside levels drop while monomer levels rise, and this occurs during winemaking (i.e. alcohol, and malolactic fermentation) (Bavaresco, 2001). However, sulfites (SO2) may have to be re-added (since it is removed in distillation) in order to maintain the concentration of antioxidants since it acts like a preservative (Belisario-Sanchez et al., 2009).

Consumption of Alcohol Products with Lowered Alcohol Content

Alcohol-free Beer in the Global Market

Alcohol-free beer (less than 0.5 % ABV in Europe, and less than 0.05 % ABV in UK) and low-alcohol beer (no more than 1.2% ABV) has had an increased market share due to the global trend for healthier lifestyles (Liguori et al., 2015). According to the Euromonitor International (2013) low or non-alcoholic beer has a larger growth volume between 2007-2017 compared to stout, dark beer, and lagers. Spain consumes the most non-alcoholic beer followed by Nigeria, Iran, and Germany (Euromonitor, 2013). Also,

this report takes into account over 80 different countries including Canada, and this data reveals that Americans consumes more non-alcoholic beer than Canadians. These statistics indicate that there is an increased market share for non-alcoholic and low-alcohol beer, and the market share and production continue to grow annually as there is a global trend for a healthier lifestyle (Euromonitor, 2013; Mangidaan et al., 2018).

Consumption Patterns and Health

Men are more likely to drink heavily than women, and less likely to be lifelong abstainers, or quit drinking (Wilsnack et al., 2009). However, women absorb and metabolize alcohol differently than men, and this can have dire consequences on their health (Frezza et al., 1990). Women have less body water, and studies have shown that this contributes to higher blood alcohol concentrations than a man who has drank the equivalent amount (Wilsnack et al., 2009). Women have lower gastric alcohol dehydrogenase activity, and this also contributes to higher blood alcohol levels and higher risks of alcohol induced liver disease (Frezza et al., 1990). Women are more at risk for the toxic effects of alcohol on the liver even though men consume more quantities, and more often (Guy & Peters, 2013).

Chapter 3: Objectives and Hypothesis

Hypothesis

Female consumers are more likely to consume low-alcohol products if there are added flavours (such as grapefruit) to help offset the negative sensory properties that are associated with low-alcohol products or caused during the dealcoholization process.

Objectives

1. To explore the female consumer perception and attitudes of low-alcohol fermented products.
2. To explore consumer liking of low-alcohol and dealcoholized products currently on the market in Nova Scotia.
3. Investigate the sensory properties of the existing low-alcohol and dealcoholized products and compare them their full-alcohol counterparts.

Chapter 4: Materials and Methods

Focus Group Introduction

The market of low-alcohol and dealcoholized products is limited in Nova Scotia even though the consumer demand for these products are on the rise in other places of the world (Liguori et al., 2015). Low-alcohol beverage consumption is desirable for a number of reasons, such as health reasons, and it may be valuable to explore the local consumer demand for new innovative functional products in Nova Scotia. The first part of the study was designed to explore the attributes Canadian consumers expect from low-alcohol fermented products, and to gain insight into the perception of potential functional ingredients that may be used in enhancing low-alcohol fermented products. A focus group was chosen for the first part of the study because they are used to learn about specific populations or groups and may help develop ways to reach a specific target audience more effectively (Morgan, 1996).

Study Design

This first part of this study consisted of creating focus group questions, and then validating these questions with a sample population. Dr. McSweeney's class (n=25, age 19-22) of Acadia University assisted in validating these questions on November 30th, 2016. Testing questions orally prior to using them in a focus group provides insight into the wording and understanding of the questions, and allows the researcher to change or delete redundant questions (Kreuger, 1988). The input collected was used to revise the questions for the focus group, improve the flow of the questions by deleting redundant

questions, and aided in exploring attitudes and opinions towards low-alcohol products (Kreuger, 1988; Fern, 1982).

Recruitment and Inclusion Criteria

The first focus group protocol was approved by MSVU REB and Acadia REB, and was held at Acadia University on April 11th, 2016. Participants were recruited in the Annapolis Valley via email and in person, and the eligibility criteria were persons 19 years of age or older, and who consume or would consider consuming low-alcohol products. Individuals who did not consume alcohol were not included in the study due to the effect it may have had on the study outcomes. Participants filled out an Alcohol Preference Questionnaire (Appendix C), and indicated on the form if they would be interested in participating in a focus group at a later date. Sixteen participants were contacted to be a part of the focus group, seven confirmed that they could participate, and five women between the ages of 20 and 63 years of age met on April 11th at Acadia University.

The study was advertised to both males and females, however only females responded. In other studies females have been reported to be more likely to quit drinking alcohol, or be lifetime abstainers, and these reasons may be why only females applied to participate in the study (Wilsnack et al., 2009).

Participants and Sample Size

Focus groups may consist of five participants, but are normally between six and 12 participants (Fern, 1982). The participants may have been acquaintances because the

Wolfville community is quite small containing slightly more than four thousand residents according to Statistics Canada, 2017, but having smaller groups of four to six may have made the participants more comfortable (Morgan, 1996), and more open to share their daily lives and opinions (Holbrook and Jackson, 1996). However, the optimal sample size for idea generation in market research is eight participants (Fern, 1982), therefore, the possibility of follow up interviews were discussed after the focus group commenced.

The participants were given an information sheet and consent form outlining the study on the day they filled out the Demographic Questionnaire (Appendix E) and the Alcohol Preference Questionnaire (Appendix F). The participants were also given another consent form on the day of the focus group as well. After the forms were signed and collected the audio recording device was turned on, and a student volunteer transcribed the meeting notes during the session. Pseudonyms were used instead of participants' real names to help protect their identities. Once the focus group was completed, the recorded audio was transcribed. Perceived barriers or disadvantages that were identified are listed in Table 5, and perceived benefits or advantages that were identified are listed in Table 6.

Second Focus Group

The first focus group consisted of five participants, and the information collected redirected the research to include a second focus group and a sensory evaluation trial (Appendix G). The decision to do another focus group rather than individual interviewing is because focus groups may obtain different and a wider range of information that can be collected from an individual basis (Fern, 1982). To build on the data collected from the

first group having a sensory evaluation trial prior to the focus group gave an opportunity to discuss and evaluate a few low-alcohol products currently on the market.

The second focus group were recruited via email to Dr. McSweeney's database of trained consumers (Centre for the Sensory Research of Food mailing list), and females were the target audience since the first focus group consisted of all females.

Tested Beer Samples

The samples used for the second focus group and the sensory evaluation trial consisted of two non-alcoholic beers, and two alcoholic beers. Samples were selected from a similar brand, Budweiser, because of their availability at local stores. Three products were chosen from Budweiser: Bud Light (Pale Lager at 4.3% ABV; UPC 018200531682), Bud Light Radler (Citrus Lager at 2.4% ABV; Article 1025076), and Prohibition Brew (Non-Alcoholic Pale Lager at 0.0% ABV; UPC 20971436). The only non-alcoholic citrus lager available at the local grocery store was the Grolsch Radler (Non-Alcoholic Citrus Lager at 0.0% ABV; UPC 87167412). The samples were numbered with a random 3-digit codes, and not identified to the participants until the end of the session. Each sample was approximately 50 ml and served in 21.5 cl ISO wine glasses, and was poured 10 minutes before the participants arrived (to help prevent the loss of carbonation, and to keep the product at 4°C). Water and crackers were provided to panelists and they were asked to cleanse their palate between samples.

Each participant was given a consent form to sign and hand in prior to the beer samples (Appendix A). Each participant was given four samples of beer, a preliminary questionnaire (Appendix C), a glass of water, and a few crackers when they arrived. The

participants were asked to taste the samples in the order outlined on the sheet, and asked to write what they liked and disliked about each sample. The form (Appendix C) was a tool that the participants could refer to during the focus group questions, and were collected after the focus group finished the session.

Study Design of the Sensory Evaluation Trial

The second focus group (n=11) assisted in creating keywords that were used as attributes to describe beer, such as watery, citrus, bland, and aromatic (Table 7). These attributes helped develop terminology for use in two parts of the study: acceptability testing (overall, flavour, texture, and appearance), and for the Check-All-That-Apply (CATA) question.

Acceptability and Check-All-That-Apply (CATA)

To obtain an understanding of liking of the different beer types (non-alcoholic, vs. alcoholic) acceptance testing in conjunction with a CATA question was conducted. The CATA question is routinely used in sensory studies because it assists with finding an association between attributes and the products, and the impacts of attributes on consumer liking (Sourial et al., 2010). The trial was held at the Acadia Centre for Sensory Research of Food in individual testing booths. Prior to starting the experiment, a consent form and information form with details about the test, and the ingredients in the beer, were given to each participant (Appendix B).

Recruitment, Inclusion Criteria, and Compensation

Recruiting occurred via email to Dr. McSweeney's database of consumers, and also via a campus wide email list. To be a part of the study participants had to like beer, be at least 19 years of age, and not allergic to grapefruit or any other ingredients used in the study. The participants were mainly female staff and students of Acadia University, and female community members of Wolfville, NS. All participants were given a $10 gift card for their time.

Sample Presentation and Testing Environment

The samples that were used for the second focus group were also used for the sensory evaluation trial: Pale Lager (4.3% ABV), Citrus Lager (2.4%), Non-Alcoholic Pale Lager (0.0%), and Non-Alcoholic Citrus Lager (0.0% ABV). The samples were randomly assigned a 3-digit code, and presented to each participant at the same time. Approximately 50 ml of each beer was put into glass 21.5 cl ISO wine glasses and served at 4°C. Water and crackers were given to the participants to clean their palates between each sample. Using the Compusense Cloud software (Compusense, Guelph, Ontario, Canada) the participants completed the CATA and acceptability questions for each sample.

Participants were asked to first indicate how much they liked each sample in terms of flavour, texture, appearance and overall liking using a 9-point hedonic liking scale (Appendix D) (Jones et al., 1955). The scale ranged from 1 "Dislike Extremely to 9 "Like Extremely." Following the 9-point hedonic scale, the panelists were asked to complete a CATA question. The participants were asked "check" or click all of the

attributes they perceived in each sample. The attributes listed in the CATA question were from Table 7 (determined during the second focus group), and from a literature review (Missbach et al., 2017; Guinard et al., 1998).

Statistical Analysis

The hedonic values obtained from the consumer trial were analyzed using one-way analysis of variance (ANOVA) with Tukey Honest Significant difference (HSD) as the post hoc test. The ANOVA and Tukey HSD were calculated using the XLSTAT® software (Version 2015.6, New York, NY) in Microsoft Excel™. All statistics were at a 95% significance level. A penalty analysis was used to analyze the CATA and hedonic overall liking scores in order to determine the mean impact of each attribute on overall liking (Ares et al., 2014).

For the CATA test, the terms and number of mentions used by the participants to describe the beer samples were placed in a contingency table. A Cochran's Q test was used to identify significant differences among the beer samples for each attribute. The principal coordinate analysis (PCoA) was applied to correlation coefficients in the contingency table, and the results were displayed in a two dimensional map.

Correspondence Analysis (CA) was conducted on the CATA data because it aids in the study of finding the association between two variables, and similarities between the categories of each variable (Sourial et al., 2010; Ares et al., 2014). CA was used to find the association between attributes and beer samples, and the impact of attributes on consumer liking. From this information a two dimensional map was created.

Chapter 5: Results

First Focus Group

The first focus group (n=5) identified perceived barriers and benefits of low-alcohol products, and there were more advantages than disadvantages to consuming these products (Table 6). The main concerns or negative aspects for consuming these products were social and taste related (Table 5).

Second Focus Group

Prior to the second focus group the female participants (n=11) had a chance to sample four low-alcohol products, and fill out a questionnaire (Appendix C). The written feedback collected on the forms was in depth, and provided insight into the participants' perceptions of the four products. Six comments were made on the cloudiness of the Non-Alcoholic Citrus Lager and Citrus Lager, and four comments were made on the clearness of the Pale Lager and Non-Alcoholic Pale Lager. By doing a word count: taste was mentioned 27 times, sweetness was mentioned 12 times, grapefruit was mentioned 10 times, bitterness was mentioned 9 times, citrus notes were mentioned 8 times, aroma was mentioned 5 times, and hoppy was mentioned 4 times.

In the second focus group (n=11) the female participants provided oral feedback on each sample based on taste, appearance, flavour, and overall liking (Table 7). The Pale Lager and Non-Alcoholic Pale Lager were described as: watery, bland, thin, and having an aftertaste. The Non-Alcoholic Citrus Lager and Citrus Lager were described as: juicy, citrusy, and cloudy. The Pale Lager and Non-Alcoholic Pale Lager were both clear, and the participants found this to be an advantage. The participants voted on the products, and

only 18% liked the Pale Lager, 36% liked the Non-Alcoholic Citrus Lager, none of the participants liked the Non-Alcoholic Pale Lager, and 45% liked the Citrus Lager.

Sensory Evaluation Trial

Acceptance Testing

Liking of Appearance

There was a significant effect of beer type on liking of appearance (P=0.0001). Post hoc comparisons reveal that the Pale Lager, and the Non-Alcoholic Pale Lager were significantly liked more than the citrus-flavoured samples (Table 10). The Citrus Lager had the lowest mean liking score in this category (M=4.3, SD=1.7), and the Non-Alcoholic Citrus Lager (M=6.1, SD=1.6) had the second lowest score.

Liking of Texture

There was a significant effect of beer type on liking of texture (P=0.002). Post hoc comparisons indicate that the Citrus Lager and the Pale Lager were liked significantly more than the Non-Alcoholic Pale Lager (Table 10).

Liking of Flavour

There was a significant effect of beer type on liking of flavour (P=0.002). Post hoc comparisons indicate that there was a significant difference in flavour between the Non-Alcoholic Citrus Lager, and the Non-Alcoholic Pale Lager (Table 10).

Overall Liking

There was a significant effect of beer type on overall liking (P=0.0002). Post hoc comparisons indicate that the Non-Alcoholic Pale Lager was liked significantly less than the other beer samples (Table 10).

Check-All-That-Apply

When completing the CATA test, the participants checked between 1 to 22 terms to describe the beer samples. The attributes and the number of times they were mentioned are listed in Table 11. The most frequently used terms are: sweet, low carbonation, fruity, citrus, and thin. The least mentioned terms were: bland, nutty, grainy, malty, thick, and hoppy.

Correspondence Analysis (CA) was conducted on CATA counts. Figure 1 displays the associations between the four beer samples, and consumers' descriptions. The first two dimensions on the map explained 96.39% of the experimental data variability (Figure 1). This biplot displays the samples into four main quadrants on the first and second dimensions. The Pale Lager was located in the first quadrant, and was associated with watery, thin, clear, grainy, aftertaste, and low carbonation attributes. The Non-Alcoholic Pale Lager is located in the fourth quadrant, and was associated with bland, bitter, malty, nutty, hoppy, and yeasty. The Citrus Lager is located in the third quadrant, and associated with the citrus, cloudy, sharp and sour attributes. The Non-Alcoholic Citrus Lager is located in the second quadrant, and is associated with the sweet, fruity, aromatic, and high carbonation attributes.

Figure 2 displays the attributes that affect overall liking, and the relationships between the attributes. Aromatic, fruity and citrus positively affect overall liking. Since

blandness, and wateriness are on the opposite side of the origin to overall liking it indicates that these attributes have a negative impact overall liking (Ares et al., 2014).

Figure 3 displays the attributes that had the most significant mean effect on liking and disliking of the four beer samples. Sweet, aromatic, and citrus attributes positively impacted overall liking of a beer sample. The attributes that caused the participants to dislike a beer sample were aftertaste, wateriness, and blandness.

Table 5: Perceived barriers or disadvantages of low-alcohol products, as identified by focus group #1

Taste ● **"The removal of alcohol may take away the mouth-feel or burn."**
Social ● **"No buzz."** ● **"The relaxation effect will not be present."**

Table 6: Perceived benefits or advantages of low-alcohol products, as identified by focus group #1

Accessibility

- **Available to people under the age of majority**
- **Available at the grocery store**

Taste

- **May be sweeter than other regular alcoholic products**
- **May taste like fruit juice**
- **Easier to drink than a full alcohol product**

Health and Safety

- Healthier attitudes towards drinking (may create healthier drinking habits)
- People on medications can drink them
- People who need to wean off alcohol can drink them
- Pregnant women can drink them
- Designated drivers can drink them
- Nutrients should still be the same
- Less calories

Price

- Low-alcohol products should be cheaper since they contain no alcohol
- Seniors or people on a budget can afford them

Table 7. Feedback and attributes on samples collected orally from focus group #2

Sample 432 (Pale Lager)

- **Not a lot of flavour. Hoppy taste, but watery**
- **Good appearance, but usually prefer a darker beer**
- **Not too fizzy**
- **Lacking taste**
- **Light body**
- **Bitter aftertaste**
- **2/11 people liked it overall**

Sample 593 (Non-Alcoholic Citrus Lager)

- **Juicy**
- **Citrus flavour**
- **Similar to ginger ale, but less sweet**
- **Not hoppy**
- **Similar to a lemonade**
- **No alcohol flavour**
- **A bit cloudy**
- **6/11 people would buy it, and 9/11 people would drink if given**
- **Tastes artificial**
- **No structure or body**
- **4/11 people liked it overall**

Sample 679 (Non-Alcoholic Pale Lager)

- **Soapy after taste**
- **Smells disgusting**
- **Watery**
- **Thin**
- **Flat (no bubbles)**
- **No flavour**
- **Fruity, wheaty flavour**
- **Well balanced**
- **Is similar to a non-alcoholic product that you can buy at a supermarket**
- **No one would buy it**
- **If given at someone's house 2/11 people would drink it out of politeness**
- **Comes from a can (tastes metallic)**
- **Nothing special**
- **Really generic**
- **0/11 people liked it**

Sample 204 (Citrus Lager)

- **Grapefruit taste**
- **Sharp and bitter**
- **Citrus aroma (smells like grapefruit juice)**
- **Cloudy appearance (looks unfiltered)**
- **7/11 people would buy it**
- **3/11 would buy it during the summer months**
- **Described as a breakfast beer, and could drink like a mimosa**
- **5/11 people liked it overall**

Table 8. Feedback collected on samples from questionnaire (Appendix C)
Focus Group #2

Sample 432 (Pale Lager 4.3% ABV)

- **"I find sample 432 to have little substance. Tastes very light and almost watery. On a hot day it would be thirst quenching, but there is very little flavour."**
- **"Watery taste. Very carbonated. The strange sparkle is distracting. No bitter or hoppy flavour. No flavour."**
- **"Like the slight hoppy flavour. Dislike the wateriness."**
- **"Light. Not strong aftertaste."**
- **"I like that the beer has a lighter flavour. I do not like very bold beers. However, I think it is a little too light. I feel like I am almost drinking water."**
- **"It's very light, not hoppy at all. Wheat flavours are nice. I think there could be more body to the beer, it's a good base and easy drinking beer, but it does feel like it's missing some flavour."**
- **"Light and smooth. Watery. Not hoppy, which I like. Refreshing and quenches thirst. A little bland and weak though."**
- **"Like: light. No bitterness. I can envision using it to make a cocktail (i.e. radler). No aftertaste. The more I drink it, the more I like it. Dislike: normal beer aroma."**
- **"I liked the colour, aroma and appearance, but found the taste watery."**
- **"Light in colour and very clear. Not too strong in flavour. Not too fizzy. Tastes as it should."**

Sample 593 (Non-Alcoholic Citrus Lager 0.0% ABV)

- **"I like the feel of this beer on the back of the throat. I like its effervescence. I like the citrusy flavour ad sweetness. To me, this is a perfect summer beer for sipping on the back deck. Not a beer for winter."**
- **"Nice grapefruit sparkle. Leaves an acidic taste. Too sweet for me. Interesting."**
- **"I like it if it was ginger ale, but as a beer it doesn't make it. I would never purchase this if I wanted a beer flavour."**

- **"Sweet. Light. Carbonated?"**
- **"I like that it has more carbonation and it is very smooth. I love citrus, so I appreciate the citrus notes in this beer."**
- **"I like the citrus flavour and the lack of hoppiness. Unfortunately, I think it tastes more like a cooler and not like a beer. Very delicious though! I also like that in comparison to sample 204 it has more clarity even though it is still slightly cloudy."**
- **"Yum, delicious. Great flavour. Nice citrus taste, doesn't really taste like beer. Taste more like a fruit juice. Something different, which is nice. Light and refreshing. Not sure if I could drink a lot of it though, might get sickly."**
- **"Like: love the lemon aroma. Sweet. I don't drink much beer at home. But this I would absolutely drink. Doesn't taste like beer. Refreshing. Light. No aftertaste. Zero bitterness. Nothing I dislike."**
- **"I liked the colour, aroma, fizziness, clarity and fruity taste. There wasn't anything I disliked."**
- **"Smells like a fruit juice – something has been mixed in. Slightly cloudy. Tastes like pear or a weak juice. Not much fizz. Dissatisfying."**

Sample 679 (Non-Alcoholic Pale Lager 0.0% ABV)

- **"To me, this beer didn't have a great deal of flavour, but what flavour it had I didn't care for. It seemed almost soapy in aftertaste."**
- **"No flavour, uninteresting. So following sharpness, but not a satisfying or interesting drink. Nice clear look…"**
- **"Has a beer flavour – mild alcohol – but prefer 432."**
- **"More bitter. Not as sweet. Heavier."**
- **"I enjoy the taste, but think it's really light, almost watered down. Too smooth, little carbonation."**
- **"I like that there are fruity notes, but also subtle wheat and hops. This beer is very well balanced for such a light beer. It also has a clear, pleasant appearance. It is a bit sweet for my taste, but I have nothing bad to say about this sample."**
- **"It's okay pretty plain, not much flavour. A little "burpy." Light and**

refreshing, but tastes watery."

- **"Like: mild flavour. Light. No bitterness. No aftertaste. Dislike: too mild for cocktails. Nothing stood out to make me choose it over another product."**
- **"It's bitter and the smell is off putting. Otherwise, colour and fizziness, clarity is okay. I didn't like the taste at all."**
- **"Nice colour and clarity. Tastes thin and diluted. Virtually no fizz, but can pick up hops a bit. Not satisfying."**

Sample 204 (Citrus Lager 2.4% ABV)

- **"I liked the texture and feel of the beer in my throat. I liked the citrus nature and preferred that this beer wasn't as sweet as the other citrusy beer (593)."**
- **"I would like it better if it was clear. Strong grapefruit flavour. More acidic. Less sweet. Finishes nicely."**
- **"I like the grapefruit flavour – not sweet. Not crazy about the cloudiness."**
- **"Sweet. Fruity. Light and bubbly. Similar to a radler? Probably my favourite."**
- **"Love the citrus flavour and the fact that it is stronger than the other samples."**
- **"I like the bitter grapefruit taste, it's got a nice body, full flavours. I think the appearance would affect my decision to buy it though, it's extremely cloudy."**
- **"Strong grapefruit taste. Tastes like a juice. Bitter, but smooth. Sweet, wouldn't be able to drink a lot of it. Acidic."**
- **"Love the grapefruit aroma. The grapefruit flavour not too sweet. Refreshing. No bitterness. Has the sourness of grapefruit."**
- **"The taste was okay, but I thought had too much grapefruit flavour. I dislike the cloudiness."**
- **"This bears no resemblance to beer. It's a taste I've had before – oh yes, it does have tonic mixed in with it, or grapefruit. Cloudy."**

Table 9. Participant demographics of sensory trial

Texture and Appearance Liking Tests ● n=52 ● **Average age 39.5 +/- 7.4**
Overall liking, Flavour, and CATA Tests ● n=68 (combined with the paper ballots from Appendix C) ● **Average age 42.3 +/- 10.1**
Overall population age for all tests: 40.8 +/- 8.2.

Table 10. Mean scores for appearance, flavour, texture and overall liking

	Liking of Appearance	Liking of Texture	Liking of Flavour	Overall Liking
Non-Alcoholic Citrus Lager (0.0% ABV)				
Mean	6.1b[1,2,3]	6.9a	6.7a[4]	6.8a
SD	1.6	1.6	2.0	2.0
Citrus Lager (2.4% ABV)				
Mean	4.3c	6.2ab	6.1ab	6.2a
SD	2.1	1.7	2.2	2.1
Pale Lager (4.0% ABV)				
Mean	7.5a	6.8a	6.0ab	6.1a
SD	1.5	1.7	1.6	1.6
Non-Alcoholic Pale Lager (0.0% ABV)				
Mean	7.3a	5.6b	5.4b	5.3b
SD	1.7	1.8	2.02	2.1

[1] n=52

[2] Data input on a 9-point hedonic scale (1=dislike extremely, 5= neither like or dislike, 9=like extremely)

[3] Means in a same column with the same letter are not significantly different ($p \geq 0.05$)

[4] n=68

Table 11. Terms and number of mentions used by consumers to describe the beer samples

Category	Number of mentions	Frequency (%)
Sweet	92	36.5%
Bitter	42	16.7%
Bland	22	8.7%
Nutty	3	1.2%
Grainy	10	3.9%
Malty	18	7.1%
Watery	57	22.6%
Clear	56	22.2%
Cloudy	48	19.0%
Aromatic	55	21.8%
Citrus	89	35.3%
Sour	34	13.5%
Thin	67	26.6%
Thick	6	2.4%
Hoppy	19	7.5%
Sharp	32	12.7%
Aftertaste	60	23.8%
Low carbonation	87	34.5%
High carbonation	59	23.4%
Fruity	79	31.4%
No aftertaste	32	12.7%

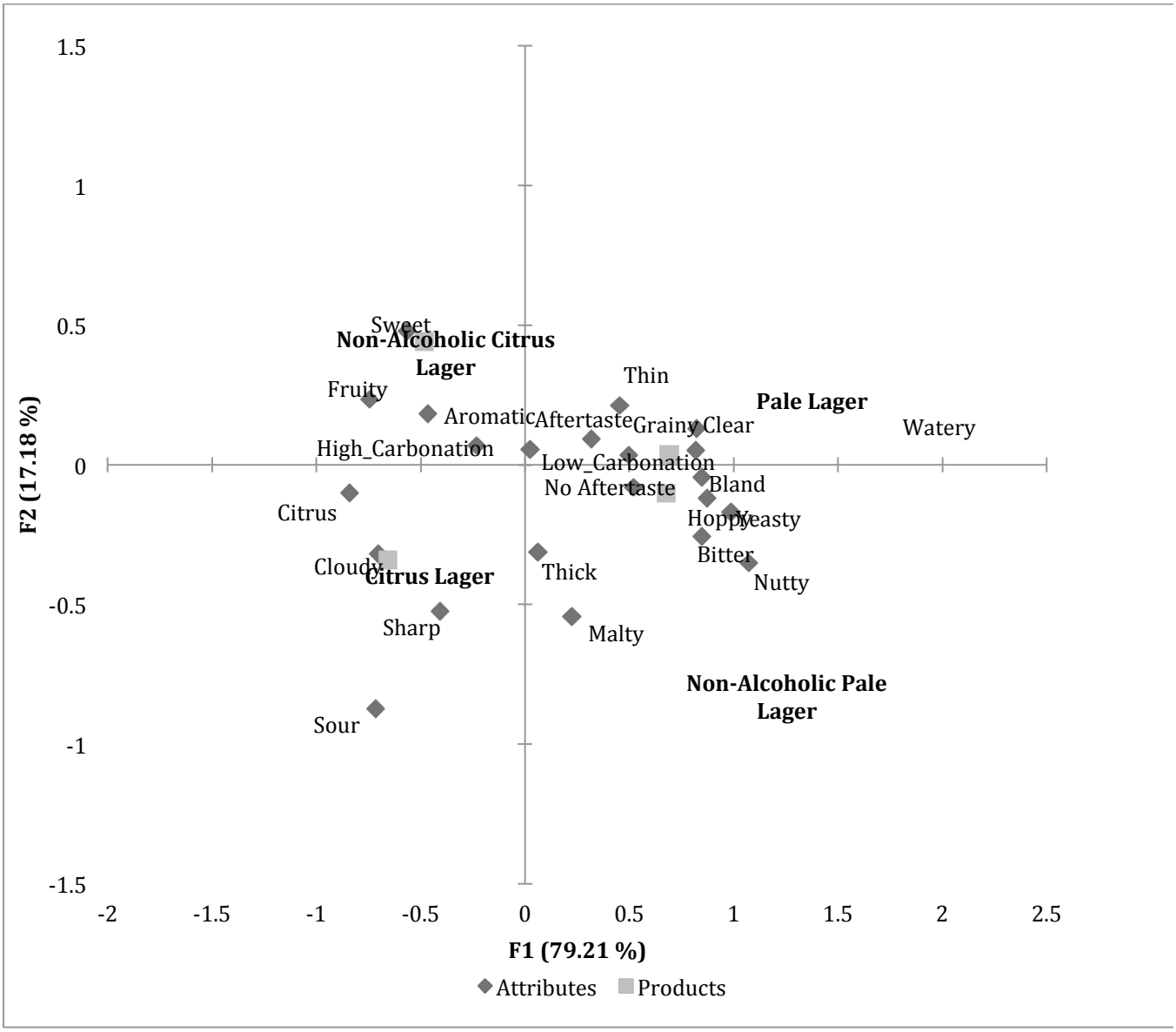

Figure 1. Biplot representation of the four beer samples and consumers' descriptions on the first two dimensions of correspondence analysis.

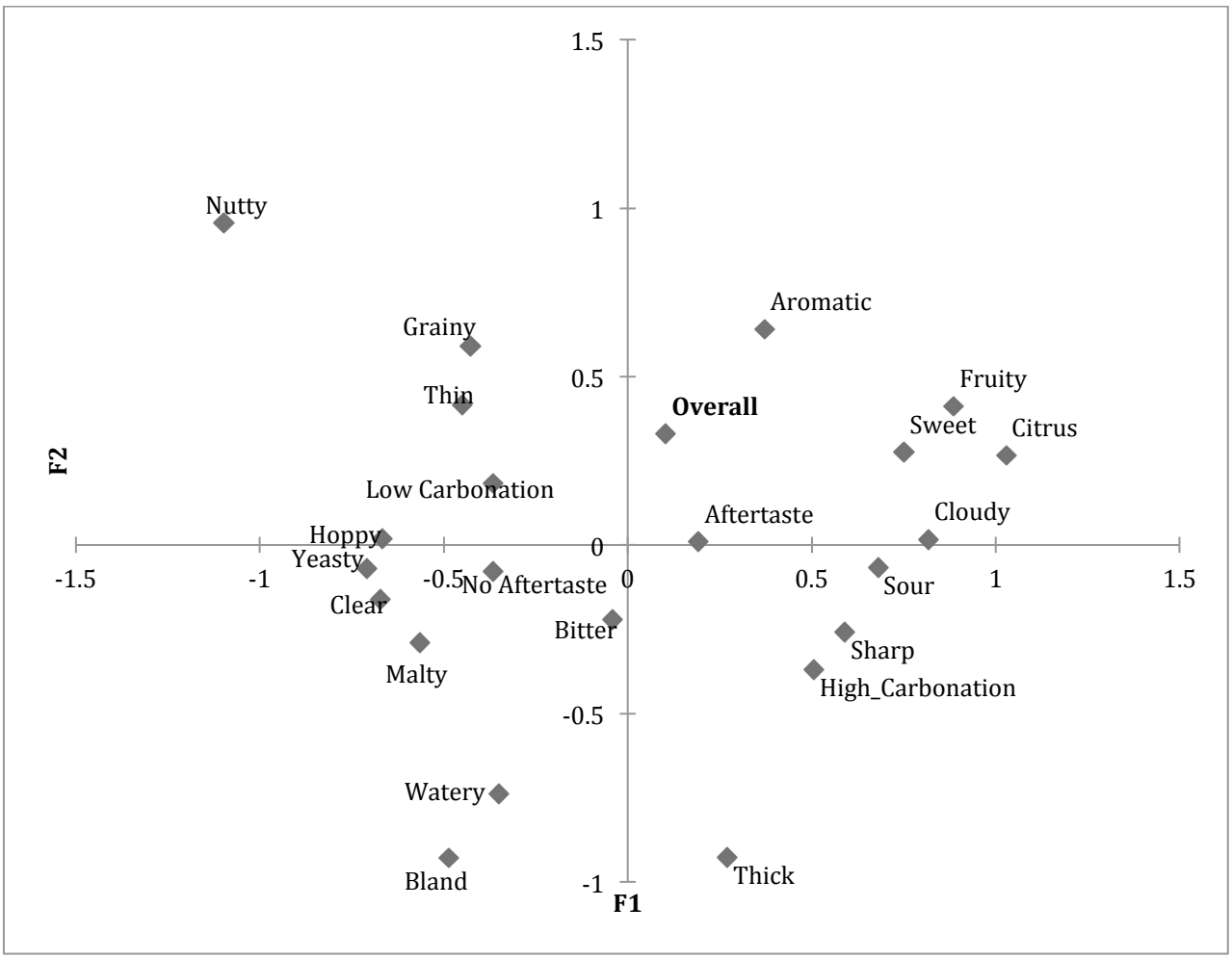

Figure 2. Biplot representation of the four beer samples and the sensory terms used to describe them, on the first two dimensions of the correspondence analysis of CATA counts considering overall liking scores as supplementary variables.

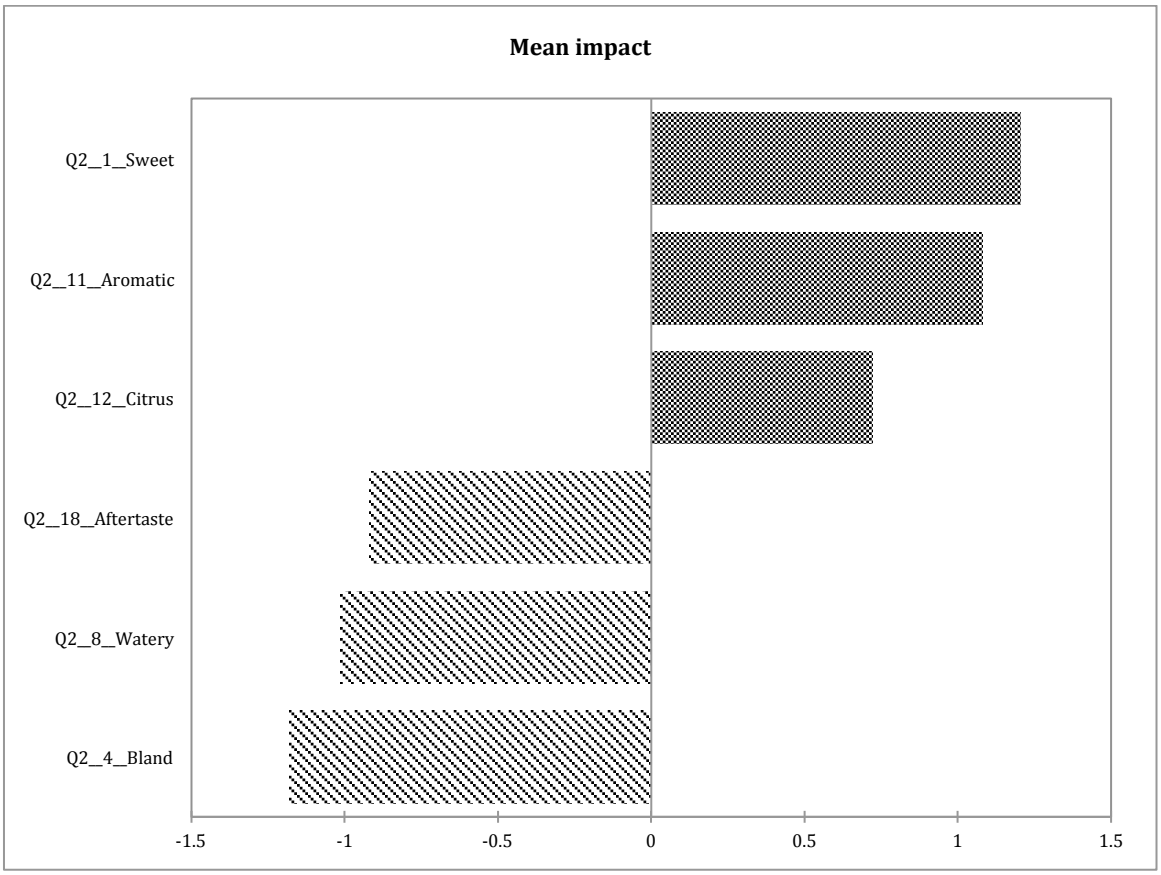

Figure 3. Bar graph representation of attributes with a significant mean impact on liking and disliking of the four beer samples.

Chapter 6: Discussion

Focus Groups

A perceived barrier or disadvantage of low-alcohol products that was a concern for some participants was the effect on taste. The participants (n=5) thought that the mouthfeel, or burn would no longer be present in the product (Table 5), and this would be a potential negative aspect that would have to be overcome. This perception is one of the main reasons why it is difficult for consumers to switch to low or non-alcoholic alternatives (Meilon et al., 2010). The participants were worried that low-alcohol products would be sour, thin, and watery versions of their full alcohol versions. Alcohol does provide weight, residual sweetness, and flavour to the product, and once the alcohol is removed or lightened there may be sensory consequences on a product (Erten & Campbell, 2001; Ross & Weller, 2008).

There were many perceived benefits or advantages of low-alcohol products, and taste was mentioned again (as shown in Table 6). The participants thought that a positive aspect of low-alcohol products would be to taste like fruit juice, and may be sweeter than full alcohol versions. Sweetness prevents bitter or sour tastes, and this may be one reason why the participants saw sweetness as an advantage to a low-alcohol product (Meillon et al., 2010). Besides taste, the focus group thought of health, safety, accessibility, and affordability benefits that a low-alcohol product would provide. Educating consumers on the health, safety and other benefits of low-alcohol products may influence the likability of them (Meillon et al., 2010). There were more pros than cons for low-alcohol products, as identified by the first focus group, but taste was a major concern. Therefore, it is

imperative that low-alcohol products maintain sensory attributes associated with alcoholic beverages, or they will not fulfill market needs (Ratnasooriya et al., 2010).

Sensory Evaluation Trials

Sensory Evaluation Trial Background

Pairing focus groups and surveys are a way of combining qualitative and quantitative methods, but may result in opposing data if not completed properly (Morgan, 1996). However, it can be common to use the survey as the primary method, and use the focus group as a secondary method of information (Morgan, 1996; Goss 1996). The focus group can provide preliminary information, such as providing background information on participants' opinions, and may help generating hypotheses (Morgan, 1996; Goss, 1996; Holbrook & Jackson, 1996).

According to Holbrook and Jackson (1996) if the focus group topic is related to the health field it may complement survey-based research because the data can be used to pilot surveys, or help understand particular beliefs in sample populations. These are the reasons why sensory evaluation trials were included in this study.

Liking Acceptance

Liking of Appearance

Both the Non-Alcoholic Pale Lager and Pale Lager were clear products, while the Non-Alcoholic Citrus Lager and Citrus Lager were both cloudy products. The clear samples each had a mean hedonic score between 7.3 and 7.4 (Table 10), which means these samples were "moderately liked" in terms of appearance (Appendix D). The Non-

Alcoholic Citrus Lager had a mean hedonic score of 6, and the Citrus Lager had a mean hedonic score of 4, which translates to "liking slightly", and "neither like or dislike" in terms of appearance (Appendix D). The data collected from the focus groups also found that cloudiness was a negative barrier or disadvantage to an alcohol product (Table 8). Consumers expect lagers and filtered beer to be clear or haze free, and when these products are cloudy it is seen as a quality issue (Aron & Shellhammer, 2010).

According to Anderson (1973) when a consumer's expectation of a product is not met it is negatively perceived and valued. A consumer has past beliefs and knowledge of a product, and when these expectations are not consistent within a product it will not be accepted (Anderson, 1973). Product information via marketing, or direct sales aids in educating the consumer, and helps improve their evaluation or perception of a product (Anderson, 1973). Product information on cloudiness may increase consumer liking of appearance, and may aid in product acceptance.

Liking of Texture

Both the Non-Alcoholic Citrus Lager and Pale Lager were liked significantly more than the Non-Alcoholic Pale Lager in terms of texture. By looking at the 9-point hedonic scale both the Non-Alcoholic Citrus Lager and Pale Lager would fall in the "liked slightly" category compared to the Non-Alcoholic Pale Lager fell into the "neither liked, nor disliked" category (Appendix D).

According to Sherman (1975) a consumer evaluates texture of liquids by evaluating the viscosity of a product three ways: visual conditions, mouthfeel conditions, and stirring conditions. The Pale Lager contained alcohol, and this would have given

more weight and texture to the sample (Erten & Campbell, 2001; Ross & Weller, 2008). The Non-Alcoholic Citrus Lager contained locust bean gum, which is used a thickener, stabilizer and gelling agent in the food industry (Barak & Mudgil, 2014). The Non-Alcoholic Citrus Lager was perceived as having more texture, and the mouthfeel more pleasant since the locust bean gum added weight and masked any thinness or wateriness usually associated with non-alcoholic beers (Barak & Mudgil, 2014; Erten & Campbell, 2001; Ross & Weller, 2008).

Texture is related to flavour intensity, and when a product is bland or watery the texture is very important in a product (Sherman, 1975). In the second focus group the Non-Alcoholic Pale Lager was perceived as thin, watery, bland, and having low carbonation (Table 7). These perceptions indicate the reasons why this sample scored the lowest in this category.

Liking of Flavour

In terms of flavour the most significant effect was between the Non-Alcoholic Citrus Lager, and Non-Alcoholic Pale Lager. The second focus group found that the Non-Alcoholic Pale Lager was watery and bland, and none of the participants would drink this product (Table 7). Flavour is perceived through taste, smell, and the trigeminal sensation of food (Smith & Margolskee, 2001). There is a strong link between taste and pleasure, and when there are no stimuli (salty, bitter, sweet, or sour) the chemical and physical reactions of eating do not occur (Smith & Margolskee, 2001). Blandness, wateriness, and lack of viscosity are perceived as negative attributes because they create the sense of displeasure (Smith & Margolskee, 2001).

The Non-Alcoholic Citrus Lager had citrus notes, which added aroma and taste, and locust bean gum, which improved the tactile sensation of the product. These positive attributes would have created a more pleasurable experience for the consumer, and therefore, perceived as more flavourful than the Non-Alcoholic Pale Lager. Added citrus, and texture covered up any negative attributes that were left behind from the dealcoholization process (Meillon et al., 2010; Barak & Mudgil, 2014), and this may be why this product was more liked than the Non-Alcoholic Pale Lager.

Overall Liking

The texture, appearance, and flavour sensory attributes all contribute to a product's acceptance by a consumer (Sherman, 1975). The Non-Alcoholic Pale Lager met consumer's expectations in terms of appearance, but the flavour or texture was not acceptable to consumers (Table 10). The Pale Lager, Citrus Lager, and Non-Alcoholic Citrus Lager were liked significantly more than the Non-Alcoholic Pale Lager due to these reasons. The Non-Alcoholic Pale Lager had the lowest mean score translating to the sample being "neither liked or disliked" by the panelists, and this was explored further by the CATA results.

Check-All-That-Apply

Principal Coordinate Analysis

The principal coordinate analysis (PCoA) was applied to correlation coefficients, and the results were displayed in the two dimensional map (Figure 2). In Figure 3 overall liking is associated with aromatic, fruity and sweet, and negatively associated with bland, watery, and bitter. This indicates that consumers like beers that are aromatic, fruity and

sweet, and according to the symmetric plot Non-Alcoholic Citrus Lager was the most associated with these attributes (Figure 1).

Correspondence Analysis

According to Figure 1 and the consumers in this trial a beer should be: sweet, fruity, and aromatic. A beer should also not be relatively too citrusy, cloudy, sharp, sour, thick, bland, or malty. The Non-Alcoholic Citrus Lager is associated closely with consumers' preferences since it was perceived as sweet, fruity and aromatic (Figure 1). The Citrus Lager was perceived as citrusy, cloudy, sharp and sour so it was not liked as much as the Non-Alcoholic Citrus Lager (Figure 1). The Pale Lager and Non-Alcoholic Pale Lager did not perceive many of the sensory attributes that drive liking since neither was perceived as fruity, sweet, or aromatic. The focus group participants found the Non-Alcoholic Pale Lager to be thin, watery, and bitter, which are some of the negative attributes that were described as the "must not haves" (Figure 3).

Penalty Analysis

A penalty analysis was used to analyze the CATA data in order to determine the mean impact of each attribute on overall liking. This method is a way to discover which attributes drive liking and is usually used to increase consumer liking (Ares et al., 2014). The results show which attributes are "must haves" to improve consumer liking, and "must not haves" that affect consumer liking (Ares et al., 2014). The mean impact chart (Figure 3) shows the attributes that significantly impacted consumer liking. The attributes with the darker shading are the "must have" attributes that drive consumer liking, and the

lighter shaded attributes are the ones that negatively impact consumer liking of a product. The must haves for beer are sweet, aromatic, and citrus, and the must not haves aftertaste, watery, and bland (Figure 3). Sweetness had the greatest positive influence on consumer liking (increased liking by 1.3 points on the 9-point hedonic scale), and blandness was the greatest negative influence on consumer liking of a product (decreased liking by 1.3 points on the 9-point hedonic scale). Since there is a strong link between taste and pleasure an ideal beer would be aromatic, have a pleasant taste, and satisfy the tactile sensation (Smith & Margolskee, 2001). Flavour is perceived through these three sensations, and when they are all positive sensations they create a pleasurable experience for a consumer and would drive liking of a product (Smith & Margolskee, 2001).

Summary

According to these results, the sweetness of the Non-Alcoholic Citrus Lager along with the aromatic and citrus notes influenced consumer liking of this product. The blandness, wateriness, and aftertaste of the Non-Alcoholic Pale Lager perceived by the consumers was not acceptable. Areas of improvement would be to have a higher level of carbonation on the Non-Alcoholic Pale Lager, and to have an added flavour or sweetness to help mask the negative texture profile of this product.

Chapter 7: Implications for Future Research

Functional foods may be a new promising approach to help reduce the risk or reducing the effects of chronic disease, such as CVD (Health Canada, 2002). According to Health Canada (2002) a functional food is "consumed as a part of a usual diet, and is demonstrated to have physiological benefits and/or reduce the risk of chronic disease beyond basic nutritional functions." There has been an increase in the demand for functional beverages in North America for perceived health benefits such as antioxidants, and it was observed that from 2002 to 2007 the market demand for these products increased 14% (Ratnasooriya et al., 2010; Mintel, 2007). Therefore, creating functional benefits of our everyday foods may increase nutritional impacts, and aid in preventing or mitigating risk factors for certain chronic diseases.

Future research should include adding functional food product samples in the sensory evaluation (such as products with added vitamins and dietary fiber) to see if they impact consumer liking or disliking of low-alcohol products. The implications of this research may create new functional beverages for the market, and be a part of a healthy diet.

Conclusion

An objective of this research was to explore the consumer perception of low-alcohol fermented products and the potentials for new products with added values. In both the second focus group and both consumer sensory trials the Non-Alcoholic Citrus Lager was liked significantly more than the Non-Alcoholic Pale Lager.

The hypothesis that females were more likely to consume low-alcohol products if there were added flavours (such a grapefruit) because it would offset the negative sensory properties that are associated with low-alcohol products is supported by this research. The sweetness, aroma, and flavour of the Non-Alcoholic Citrus Lager (0.0% ABV) along with the fact that it was not perceived as watery or bland was more appealing to consumers in this trial than the Non-Alcoholic Pale Lager (0.0% ABV). However, cloudiness of this product was a negative aspect, and this may need to be addressed in order to increase likability.

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Appendix A: Consent Form

Project title: Consumer evaluation of different beer styles

A sensory evaluation project conducted by:

- Matthew McSweeney, Acadia University Centre for Sensory Research of Food (Principal Investigator)
- Janine Radul, Applied Human Nutrition, Mount Saint Vincent University (Collaborator)
- Bohdan Luhovyy, Applied Human Nutrition, Mount Saint Vincent University (Collaborator)

This project is a part of Janine Radul's Master's project at Mount Saint Vincent University.

Study intent

You are being asked to participate as panelists in a sensory study of different beer styles. The purpose of this study is to evaluate the flavours, aromas and mouthfeel of different beer styles. This consent form is intended to help you understand exactly what we are asking of you so that you may decide whether you want to participate in the study. Please read the form carefully and ask any questions you like before deciding to participate. **Your participation is completely voluntary and you are free to withdraw from the testing at any time, without penalty.**

The procedure

If you volunteer to participate in this study, we would ask you to do the following:

Focus Group:

You will be presented with 4 samples of beer (50ml per sample). In a group setting, you will be asked to taste and identify what sensory attributes (taste, aroma, mouthfeel and appearance) you perceive in the beer. You will then be asked to describe your ideal beer, discuss what attributes you like and dislike about beer and finally what attributes drive your purchase of beer.

Confidentiality and use of data.

Confidentiality will be respected. Each participant is given a code number for use in the study. Data files and all personal information that could identify you, such as name and address is confidential and held separately in a locked file at Acadia University.

Risks

If you have any allergies or sensitivities to wheat, barley, hops, alcohol or unsalted soda crackers you should not participate in this study.

Ingredients:

Water, yeast, hops, water, barley, corn, rice, wheat, malt extract, hop extract, natural aromas and flavours, sugar, lemon juice, orange juice, grapefruit juice, locust bean gum, maltodextrin.

Crackers and water will be used as palate cleansers.

Thank you gift for participating
To thank you for your time all participants will be compensated a $10 gift card to a local establishment.

Agreement and signature

I, _____, agree to participate in the study described above.
(Please print name)

I have read this consent form and understand the risks and the information provided. All my questions have been answered to my satisfaction. I understand that participation is voluntary and that I may withdraw at any time without penalty. Consenting to participate does not waive any rights that I have to legal recourse in the event of research related harm. I understand that the consumption of alcohol by pregnant women has been shown to have substantial negative effects on the fetus. I understand that if I am driving, I will take a breathalyzer test upon conclusion of the trial and will remain at the facility until my blood alcohol concentration is below 0.05%. I understand that I have 30 days following my participation to withdraw my responses, after which it will be no longer possible.

I voluntarily consent to participate in this study.

_____ Date: _____
(Signature of Participant)

Please indicate your e-mail address if you wish to be contacted at the completion of the study to reveal the results of the study.

E-mail: _____

For additional information contact Matt McSweeney, Acadia University Centre for Sensory Research of Food, 902-585-1230, matthew.mcsweeney@acadiau.ca. This study has been reviewed and approved by Acadia University's Research Ethics Board. For more information, contact Dr. Stephen Maitzen, Chair, Research Ethics Board, 902-585-1498 or smaitzen@acadiau.ca

_____(Signature of Researcher)

Appendix B: Consent Form for Consumer Trial

Project title: Consumer evaluation of different beer styles

A sensory evaluation project conducted by:

- Matthew McSweeney, Acadia University Centre for Sensory Research of Food (Principal Investigator)
- Janine Radul, Applied Human Nutrition, Mount Saint Vincent University (Collaborator)
- Bohdan Luhovyy, Applied Human Nutrition, Mount Saint Vincent University (Collaborator)

This project is a part of Janine Radul's Master's project at Mount Saint Vincent University.

Study intent

You are being asked to participate as panelists in a sensory study of different beer styles. The purpose of this study is to evaluate the flavours, aromas and mouthfeels of different beer styles. This consent form is intended to help you understand exactly what we are asking of you so that you may decide whether you want to participate in the study. Please read the form carefully and ask any questions you like before deciding to participate. **Your participation is completely voluntary and you are free to withdraw from the testing at any time, without penalty.**

The procedure

If you volunteer to participate in this study, we would ask you to do the following:

Acceptance Testing:

If you volunteer to participate in this study, we would ask you to do the following things: You will be asked to evaluate 4 different beers (ingredients below; 4 samples of 50 ml). This will take approximately 15 minutes. You will be asked to evaluate the appearance, texture and flavour of the samples and answer questions about how much you like or dislike them. You will also be asked to check off the attributes on the computer which correspond to each product. Additionally, you will be asked to fill an exit questionnaire about your eating habits and demographics.

Confidentiality and use of data.

Confidentiality will be respected. Each participant is given a code number for use in the study. Data files and all personal information that could identify you, such as name and address is confidential and held separately in a locked file at Acadia University.

Risks: **If you have any allergies or sensitivities to wheat, barley, hops, alcohol or unsalted soda crackers you should not participate in this study.**

Ingredients:
Water, yeast, hops, water, barley, corn, rice, wheat, malt extract, hop extract, natural aromas and flavours, sugar, lemon juice, orange juice, grapefruit juice, locust bean gum, maltodextrin.

Crackers and water will be used as palate cleansers.

Thank you gift for participating
To thank you for your time all participants will be compensated a $10 gift card to a local establishment.

Agreement and signature

I, _____, agree to participate in the study described above. (Please print name)

I have read this consent form and understand the risks and the information provided. All my questions have been answered to my satisfaction. I understand that participation is voluntary and that I may withdraw at any time without penalty. Consenting to participate does not waive any rights that I have to legal recourse in the event of research related harm. I understand that the consumption of alcohol by pregnant women has been shown to have substantial negative effects on the fetus. I understand that if I am driving, I will take a breathalyzer test upon conclusion of the trial and will remain at the facility until my blood alcohol concentration is below 0.05%. I understand that I have 30 days following my participation to withdraw my responses, after which it will be no longer possible.

I voluntarily consent to participate in this study.

_____ Date: _____
(Signature of Participant)

Please indicate your e-mail address if you wish to be contacted at the completion of the study to reveal the results of the study.

E-mail: _____

For additional information contact Matt McSweeney, Acadia University Centre for Sensory Research of Food, 902-585-1230, matthew.mcsweeney@acadiau.ca. This study has been reviewed and approved by Acadia University's Research Ethics Board For more information, contact Dr. Stephen Maitzen, Chair, Research Ethics Board, 902-585-1498 or smaitzen@acadiau.ca

_____(Signature of Researcher)

Appendix C: Focus Group Questions

Date:

1. Please eat sample 457 and record your overall liking on the scale below.

Dislike Extremely	Dislike Very Much	Dislike Moderately	Dislike Slightly	Neither Like or Dislike	Like Slightly	Like Moderately	Like Very Much	Like Extremely

2. Please eat sample 457 and record your liking of the flavour on the scale below.

Dislike Extremely	Dislike Very Much	Dislike Moderately	Dislike Slightly	Neither Like or Dislike	Like Slightly	Like Moderately	Like Very Much	Like Extremely

4. Please write what you like and dislike about sample 457:_____

5. Please eat sample 201 and record your overall liking on the scale below.

Dislike Extremely	Dislike Very Much	Dislike Moderately	Dislike Slightly	Neither Like or Dislike	Like Slightly	Like Moderately	Like Very Much	Like Extremely

6. Please eat sample 201 and record your liking of the flavour on the scale below.

Dislike Extremely	Dislike Very Much	Dislike Moderately	Dislike Slightly	Neither Like or Dislike	Like Slightly	Like Moderately	Like Very Much	Like Extremely

8. Please write what you like and dislike about sample 201: _____

9. Please eat sample 194 and record your overall liking on the scale below.

Dislike Extremely	Dislike Very Much	Dislike Moderately	Dislike Slightly	Neither Like or Dislike	Like Slightly	Like Moderately	Like Very Much	Like Extremely

10. Please eat sample 194 and record your liking of the flavour on the scale below.

Dislike Extremely	Dislike Very Much	Dislike Moderately	Dislike Slightly	Neither Like or Dislike	Like Slightly	Like Moderately	Like Very Much	Like Extremely

11. Please write what you like and dislike about sample 194:

12. Please eat sample 805 and record your overall liking on the scale below.

Dislike Extremely	Dislike Very Much	Dislike Moderately	Dislike Slightly	Neither Like or Dislike	Like Slightly	Like Moderately	Like Very Much	Like Extremely

13. Please eat sample 805 and record your liking of the flavour on the scale below.

Dislike Extremely	Dislike Very Much	Dislike Moderately	Dislike Slightly	Neither Like or Dislike	Like Slightly	Like Moderately	Like Very Much	Like Extremely

14. Please write what you like and dislike about sample 805:

Thank you very much!

Appendix D: Hedonic Scale

Please eat sample _____ and record your liking of the flavour on the scale below.

Dislike Extremely	Dislike Very Much	Dislike Moderately	Dislike Slightly	Neither Like or Dislike	Like Slightly	Like Moderately	Like Very Much	Like Extremely

Appendix E : Demographic Questionnaire

Age:_____

Sex: _____

Level of education (*circle the highest that you currently obtained):*

a) *High School*
b) *College or Trade School*
c) *University (baccalaureate)*
d) *University (graduate or post-graduate)*
e) *Currently a student*

Do you drink alcohol? Yes/No

What is your favourite alcoholic beverage? _____

Would you say that 50% of your alcohol intake was this beverage? Yes/No

Would you consider drinking a low-alcohol version of this beverage if it tasted the same as the original? Yes/No

Are you interested in being contacted for further study participation? Yes/No

Appendix F: Alcohol Preference Questionnaire

1. How often do you usually drink alcohol? *(Please circle one)*
    a. Never
    b. Less than once a month
    c. Less than once a week
    d. 1-2 days a week
    e. 3-4 days a week
    f. 5-6 days a week
    g. Everyday

2. On a day when you drink alcohol, how many drinks do you usually have? *(Please circle one)*
    a. 1-2
    b. 3-4
    c. 5-8
    d. 9+
    e. I never drink alcohol.

3. Over the last 12 months, how often do you drink the following: *(Please circle one)*
    a. Beer (low-alcohol; 1.1% alcohol by volume or lower)
        i. Once a month
        ii. A few times a month
        iii. A few times a week
        iv. Once a day
        v. I never drink beer.

    b. Beer (full strength; 4% alcohol by volume or higher)
        i. Once a month
        ii. A few times a month

iii. A few times a week
iv. Once a day
v. I never drink beer.

c. Red wine
i. Once a month
ii. A few times a month
iii. A few times a week
iv. Once a day
v. I never drink red wine.

d. White wine (including sparkling wines)
i. Once a month
ii. A few times a month
iii. A few times a week
iv. Once a day
v. I never drink white wine.

e. Fortified wines, port, sherry, etc.
i. Once a month
ii. A few times a month
iii. A few times a week
iv. Once a day
v. I never drink fortified wines, port, sherry, etc.

f. Spirits, liqueurs, etc.
i. Once a month
ii. A few times a month
iii. A few times a week
iv. Once a day
v. I never drink spirits, liqueurs, etc.

4. Over the last 12 months, on a day that you were drinking, please indicate how many glasses of the following that you consumed:

    a. In total how many glasses of beer did you usually drink? *(Please circle one)*
        i. 1-3
        ii. 4-6
        iii. 8-10
        iv. I never drink beer.

    b. In total how many glasses of wine did you usually drink? *(Please circle one)*
        i. 1-3
        ii. 4-6
        iii. 8-10
        iv. I never drink wine.

    c. In total how many glasses of spirits did you usually drink? *(Please circle one)*
        i. 1-3
        ii. 4-6
        iii. 8-10
        iv. I never drink spirits.

    d. In total how many glasses of **other types of alcohol** did you usually drink? *(Please circle one, and indicate at the bottom what other type of alcohol it is that you drink)*
        i. 1-3
        ii. 4-6
        iii. 8-10
        iv. What is this other type of alcohol that you drink? _____

Appendix G: Flow Chart of Study Design