SENSORY PROFILE VARIATION OF POMEGRANATE SEEDS AND POMEGRANATE JUICE – TEA BEVERAGES FLAVOR AND ACCEPTANCE

by

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Abstract

Pomegranate fruits have grown in popularity due to their known beneficial health properties. The objectives of this study were to: 1) determine if flavor differences existed among and within fruits, 2) understand appropriate numbers of replications needed for products that are naturally variable, and 3) compare individual and consensus scores for descriptive sensory analysis over 10 replications of the same product to determine whether differences are found between the methods.

Three different sections of the pomegranate fruit were individually evaluated (top, middle and bottom) to determine if flavor differences existed among the fruit sections. Furthermore, the number of repetitions needed in order to obtain small differences in a descriptive panel was calculated. Results showed that pomegranate fruits have natural variation of flavor in the different sections, as well as differences among fruits of the same cultivar. The number of repetitions increased as the differences that wanted to be detected became smaller, and they decreased, as these differences increased.

After each sections of fruit were individually evaluated, the panel discussed results and set consensus scores for each attribute. Analysis on mean individual scores and consensus data, along with Principal Component Analysis (PCA) showed that both, individual and consensus methods, provided the same reliable and reproducible information. However, this was evaluated using highly trained panelists.

Besides pomegranate juice (PJ), green tea (GT) is one of the most consumed beverages in the world, and has the highest polyphenol content of all teas. Six PJ and GT blends were prepared at different ratios: 90-10, 80-20, 70-30, 60-40, 50-50, 40-60 vol/vol. Lipton GT and Wonderful pomegranates were used to prepare the samples. The objectives of this study were to:

1) determine sensory differences in the samples, 2) consumer acceptance before and after antioxidant information of the samples was provided, and 3) determine their total phenolic content (TPC).

Results showed that samples with lower PJ were higher in attributes intensities for Green, and Tea like flavor, while attributes like Berry, Cranberry, Cherry and Sweetness were lower. Consumers liked samples higher in PJ, and sample 40-60 was the least liked. However, overall liking of all samples increased when antioxidant information was given. TPC results showed that pure PJ had the highest content, and as it was mixed with GT, TPC was the sum of the individual percentages of each component. Addition of claims in beverage labels might be a good strategy for consumers to purchase these type of products high in antioxidant content.

Table of Contents

List of Figures

List of Tables

Chapter 1 - Literature Review

Pomegranate Fruit, juice and products

Pomegranate Fruit (*Punica Granatum*) is believed to be originally from Turkey, and then disseminated to other countries like Israel, India, Spain, Egypt, South America and the United States (Siddiq *et al.* 2012; Carbonell Barrachina *et al.* 2011) among other countries.

Pomegranates have increased in popularity because of their beneficial health properties (Ismail *et al.* 2012). These properties are mainly caused by the presence of polyphenols: punicalagins, ellagic and gallic acids (Qu *et al.* 2012; Akhtar *et al.* 2015). These phenolic compounds can be found in not only the seeds, but also in the rind and membranes of the fruit, which are non-edible parts (Gil *et al.* 2000; Vazquez- Araujo *et al.* 2011). Orgil and others (2014) studied antioxidant activity and phenolic content of the seeds and non-edible parts of the fruit, as well as the bark, roots and fruitless parts of the tree finding that the highest phenolics were found in the non-edible parts of the fruit, and even higher in other analyzed sections of the tree.

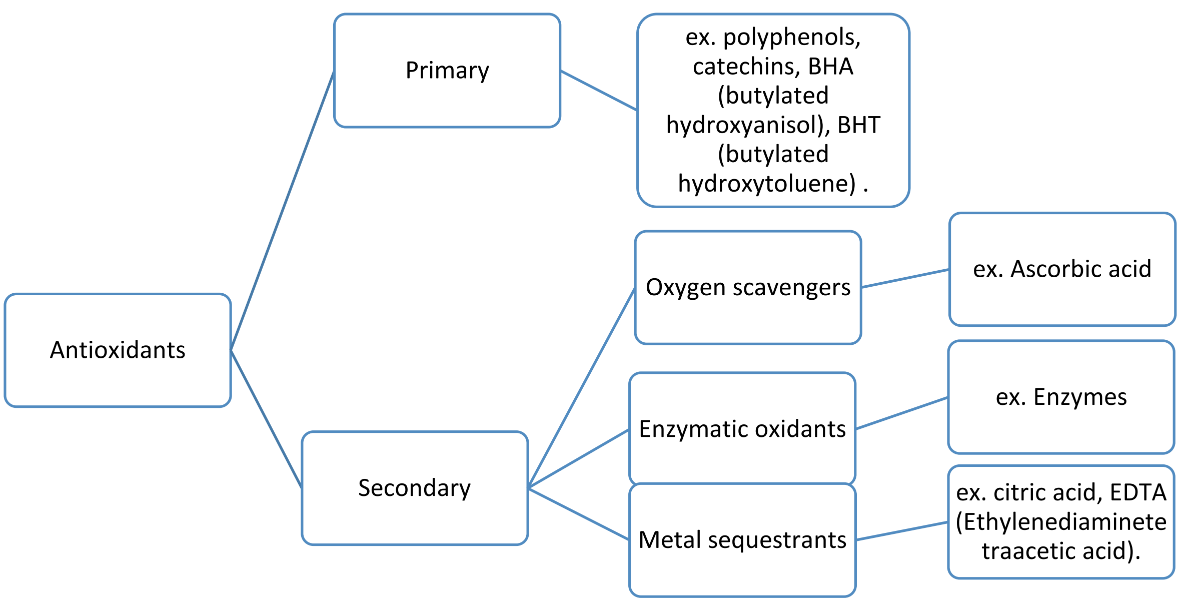
Several studies have been found that use pomegranate by-products, and use them in different ways, in order to make the products more nutritious with higher antioxidant content. Emami and others (2015) replaced part of the grains for pomegranate seed pulp for goat feeding, Verardo and others (2014) determined the lipidic composition of the seeds remaining after juice production for future use of the oil, and Goula and others (2015) reported a process for obtaining oil and phenolics from the waste peel and seeds and then spray drying that product in order to obtain capsules for future use.

Antioxidants are substances that delay or inhibit oxidation. In foods, antioxidants prevent rancidity and development of off flavors. Antioxidants can be primary (compounds that scavenge free radicals, like polyphenols), secondary (scavenging of free radicals is not direct). Among the secondary antioxidants, these can be oxygen scavengers , sequestrants of metals (that are catalyst for the oxidation reaction) and enzymatic oxidants (remove species that easily oxidate) (Pokorny *et al.* 2001; Kocchar *et al.* 1990) (Figure 1-1).

The antioxidant properties and phenolic content of different available commercial juices was compared, finding that PJ was the juice with the most antioxidant activity, followed in descending order by: red wine, concord grape, blueberry, black cherry, acai, cranberry, orange and apple juices, and green, white and black iced teas (Seeram *et al.* 2008).

Besides antioxidants from natural sources like those found in fruits and vegetables, there are several antioxidants that have been synthesized like butylated hydroxytoluene (BHT) or butylated hydroxyanisol (BHA) that have been widely used in the food industry (Sahidy *et al.* 2010).

Figure 1-1 – Different types of Antioxidants



Pomegranates and Health

In the beverage industry, healthy drinks have grown in popularity over the last years. This growth has been even larger than convenience products, meaning that healthy drinks are being sold worldwide, with a different focus on products depending on the country or region. Latin America has grown in powder drinks, fruit juices in India, and North America with functional waters (Van Der Schraelen, 2011).

Pomegranate juice, seed oil, peel and peel extracts have been studied for their beneficial health related properties, mainly derived from the radical scavenging properties. Cancer prevention, anti-inflammatory effects, and antioxidant properties are the major ones (Lansky and Newman 2007; Ismail *et al.* 2012; Orgil *et al.* 2014; Aslam *et al.* 2006), while other properties were also reported, like protection against cardiovascular disease (Aviram *et al.* 2012), and skin repair (Aslam *et al.* 2006). In a study by Tzulker and others (2007) it was found that antioxidant activity correlated positively with total polyphenol content and anthocyanins, and that Total phenolic content is dependent on the growing season and cultivar (Radunić *et al.* 2015).

Pomegranate Sensory Research

Descriptive

Vazquez-Araujo and others (2014) studied differences among 20 pomegranate cultivars and classified them according to their descriptive sensory attributes into different possible uses of the cultivars. For consumption of the fresh raw fruit, the desirable attributes are large size, intense color of both skin and seeds, high sweetness and relatively soft hardness of seeds. Fruits destined for juice production, the desired attributes are harder seeds, and more sour taste characteristics.

Koppel and Chambers (2010) developed a lexicon to describe pomegranate juices (PJ) sensory characteristics. A total of 33 commercially available PJ were evaluated through descriptive sensory analysis, using a modified flavor profile. Thirty-four attributes were defined and references were given for each one. Pomegranate juice has been described as sweet and sour, with presence of berry, fruity, cherry, cranberry, woody and floral attributes. Other attributes can be present, such as beet, carrot, brown spices and musty/earthy.

This lexicon has been used as reference for further studies of PJ (Lawless *et al.* 2013; Vázquez-Araújo *et al.* 2011; Vázquez-Araújo *et al.* 2014; Koppel *et al.* 2014).

Preservation processes of PJ have been studied by Koppel and others (2014). Specifically, how these processes affected the flavor and aroma of PJ. Frozen, pasteurized and dehydrated PJ were analyzed by a descriptive panel. It was found that the preservation methods on the whole were not significantly different from each other for many flavor attributes, but dehydrated and reconstituted juice showed fermented and brown spice attributes, absent in the other two samples. These processes also changed the total phenolic content (TPC) of the samples, with the reconstituted juice the lowest in TPC, decreased by the process of dehydration.

Cadwallader and others (2010) studied the aroma components of fresh and stored PJ and no changes were found in floral, fruity, earthy, sweet, sour and astringent attributes. A lower intensity was found in the stored juice for green aroma. The authors also performed gas chromatography-olfactometry (GCO) analysis, finding 23 odorants that correlated with those found by the descriptive panel.

Vázquez-Araujo and others (2011) studied how sensory and physicochemical properties changed in PJ with the addition of albedo and carpellar membrane at different percentages, in a total of 5 different homogenates. The authors found that physicochemical properties did not change significantly across samples, however, samples lower in albedo homogenate were sweeter, and higher in sweet overall, while samples with higher albedo were more metallic, bitter and pulpy. Those last samples were also significantly higher in TPC.

Kirshenbaum and others (2015) conducted a study to compare sensory and nutritional properties of pomegranate juice produced with seeds only, and juice obtained by pressing the whole fruits. The study found that, as previous studies suggested, the TPC was higher in juices pressed from whole fruits. Descriptive sensory analysis showed that juice attributes were similar for both juices, but the juice obtained by pressing only arils was less astringent and had less red wine flavor. Consumer tests showed that juice from whole fruits was significantly less liked. Such studies are of high interest for the juice industry if juices with higher antioxidant content need to be developed, and help the industry determine what factors need to be taken into account that will further affect the sensory profile and acceptance of the samples.

Consumer research

Pomegranates and PJ have been included in several foods, dressings, and alcoholic beverages (Singh & Singh, 2004) and non-food products (Daswani, 2007). Since there is growing interest in pomegranate and pomegranate products consumption, conducting consumer research allows understanding of perception of consumers towards pomegranate products, product preferences, as well as acceptance and development of optimal juice blends.

Vázquez-Araújo and others (2010) studied PJ and blueberry, blackberry, and raspberry blends, finding that the most liked juice were those with PJ and blueberries. Juices with PJ and more than 10% of blackberries were perceived as too dark for consumers, however, these samples were the highest samples in TPC. The authors also found that consumers looked for taste liking and positive health aspects when purchasing food items.

Anderson and others (2014) conducted consumer research on frozen, pasteurized and dehydrated Pomegranate Juices. Results showed that there were no significant differences in overall liking between the samples. However, four consumer clusters were found: one cluster did not like any of the samples more than the others; the second cluster disliked the pasteurized juice, while the two remaining clusters disliked the frozen sample, and the dehydrated juice respectively. These results showed that consumers disliked samples that had undergone a heating process more than the fresh frozen sample.

Lawless and others (2013) determined the optimal blend of PJ, black cherry, and concord grape based on consumer research. The mixtures used were pure pomegranate, pure black cherry, and pure concord grape. Blends were prepared with 50-50% black cherry - concord grape, 50-50 % concord grape- pomegranates, 50-50 % black cherry- pomegranate, and 33-33-33 % pomegranate-black cherry and concord grape juice. One hundred consumers of pomegranates, cherry and grape juices were recruited for the study and evaluated all the samples. The overall liking of the samples and just about right questions were asked related to the juice attributes. Results showed that 100% juices were rated as “too much” for several attributes like astringency, bitterness, sourness and too little sweetness. Sample of 33% of each juice, showed four attributes that were not balanced, but this mixture showed to be the highest in phenolic content and more balanced than 100% concord and black cherry, suggesting that blends of juices are more appropriate for consumers than 100% single source juices.

Green Tea

Green tea (GT) is a plant originally from China (*Camellia sinensis*) (Sharangi, 2009) and is a popular beverage widely consumed worldwide (Bruno *et al.* 2014; Yang *et al.* 2013; Khan *et al.* 2007). Unlike other tea varieties, GT has low processing compared to black or oolong teas. Immediately after harvesting green tea goes through a moisture elimination process, also called withering, and then a steaming process where the enzymes are deactivated, inhibiting further oxidation, or fermentation of the leaves (Bruno *et al.* 2014). This process allows catechins to remain functional (Sharangi, 2009). Catechins are the main antioxidant components of green tea, from the flavonoid family (Graham, 1992). Other tea varieties, oolong and black tea, undergo partial or full fermentation processes where enzymes, oxidation and polymerization transform catechins into other compounds called thearubigins (Graham, 1992).

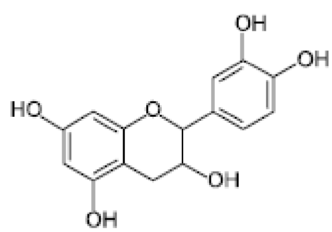


Figure 1-2 Chemical structure of a catechin.

Four main catechins are present in Green Tea (Figure 1-2): EGCG (- epigallocatechin gallate), EGC (- epigallocatechin), ECG (- epicatechin gallate), and EC (- epicatechin), with the first, EGCG is found in higher proportion than the rest. (Khan *et al.* 2007). Yang and others (2013) found that the phenolic content is related to Antioxidant activity positively.

Catechins are astringent, soluble in aqueous solutions and colorless, which makes them of great interest for their application in other products, such as antioxidants in foods like meat products and oils, water oil emulsions, and beverages to increase product shelf life. However, pH and temperature must be taken into account because catechins are unstable in alkaline pH and high temperatures (Graham, 1992; Senanayake, 2013; Zhu *et al.* 1997; Vuong *et al.* 2011; Chen *et al.* 2001). GT has also been included in many existing products, and other nonfood products, like personal care items (Gianeti *et al.* 2013).

Green Tea Sensory Analysis Research

Descriptive Analysis

Lee and Chambers (2007) developed a Lexicon using more than 100 green tea samples from 9 different countries. Descriptive sensory analysis was used to develop the lexicon that contained 31 flavor attributes to describe Green teas. Green/ brown flavors were described using different vegetable references: beany, asparagus, green beans, parsley, brussel sprouts and spinach. Fruity and floral attributes such floral, fruity, citrus and fermented were found. Except for bitter and astringency that were found in all samples in varying intensities, some attributes like citrus, straw-like and seaweed were found only in some tea samples.

Lee and others (2013) compared the tea flavors of different countries using the previously developed lexicon. Samples from China, India, Japan, Kenya, Korea, Sri Lanka, Taiwan, Tanzania and Vietnam with different processing methods (steaming, roasting, baking, crushing, etc.) were used. The results showed that brown, green attributes and astringency were found in 75% of the samples. Some other attributes like brussels sprout, fermented, citrus, animalic, grain, medicinal, or mint were found in less than 10% of samples, indicating characteristic flavor attributes of specific samples. It was found that roasted teas had more brown flavors, while the steamed samples showed more green flavors. Price of teas also was taken into account, but it was found that there was no effect of price on the flavor of the samples.

Lee and others (2009) determined the sensory characteristics of decaffeinated GT. Three different decaffeinated GT (60%, 35 % and 10%) and a regular GT sample were used for the analysis and the samples were evaluated using Sensory Descriptive Analysis by 8 trained panelists. Samples were brewed using 13g of loose leaves, and 1 liter of water at 70 °C. Attributes found were: yellowness, turbidity, bitterness, floral, grassy, fermented tea, roasted grain, dried straw, alcohol, chestnut shell, metallic, astringent and burnt leaf. Samples 60 and 35% were found more metallic, burnt leaf, alcohol and fermented tea than the regular GT. The regular GT was found higher than the decaffeinated samples for the rest of the attributes, showing that the decaffeination process reduced the intensity of several attributes.

Green Tea Consumer Research

Consumer and Descriptive analysis studies have been previously performed on Green Tea, to have a better understanding of consumer data and drivers of liking. Lee and Chambers (2010a) examined consumer acceptability in 6 samples from the most common exporters of green tea in the USA (China, Japan and Korea). A loose leaf and tea bags from each country were chosen. Loose leaf teas (six grams) were brewed for 2 minutes at 70 °C in porcelain tea pots, while tea bags were brewed in 240 ml of water at the same temperature (one cup of water) and dunked 10 times before removed and pressed against a spoon. The consumer test showed that USA consumers preferred teas brewed in tea bags, instead of those brewed with loose leafs. This might be due to the lower intensities in flavor and bitterness. Attributes like animalic, spinach, astringency and bitterness were negatively correlated with overall liking of the samples. The authors suggested that the positive correlation is more complicated to explain, since more samples with different flavor profiles are needed to determine drivers of liking of USA consumers towards green teas.

Consumer liking of Green Teas, probably depends somewhat on familiarity of flavors, and frequency consumption. Lee and Chambers (2010b) studied consumer acceptance of different GT samples in: Korea, where green tea consumption is common, Thailand, where green tea is usually drunk cold, and the USA, which was not yet accustomed to the beverage, since black tea was far more popular than green tea. It was found that liking of the samples varied among countries. Koreans preferred samples with more green and vegetative notes, while Americans and Thai participants preferred more brown, fruity and less intense green flavors. Eight consumer clusters were found in Korea and US with some similarities among them (like drinking frequency), while Thai consumers remained as a single cluster.

Effect of Information on Consumer Liking, and Consumer Attitudes.

Many factors influence the liking of foods, such as association of foods with stimuli, rewards or effects of nutrients can affect the liking of foods (Mela, 2001). Khilberg and others (2005) studied the effect of health, the origin of flour and information on amaranth in order to study neophobic reactions on the liking of four formulations of bread. The results showed that there was an increase in liking due to providing health information, and that the less liked samples were the ones where the liking increased the most.

Schouteten and others (2015) studied the effect of health labels (low in salt, light, and light and low in salt) using the same cheese sample for all the different health labels. It was found that these claims on the labels affected the response of consumers. Expected liking of the health labeled samples was significantly lower compared to the control cheese (simply labeled as cheese). The authors reported that light could have a meaning of “light taste” for consumers, as well as an association of light foods with less flavor.

Tuorila and others (1994), studied the effect of sensory and cognitive information on the enhancement of liking of novel and familiar foods. The study was conducted with participants from Finland and USA with different levels of food nephobia. They were presented with a familiar food and a novel product and divided into three groups: no information about the products was provided, for the second group the names of the products were given, and the third group received the ingredients and descriptions of the products. Results showed that when information of the product was provided, for both novel and familiar foods, the acceptance of the products was augmented. Also, neophobic and neophilic groups gave higher ratings of liking of the products when information was available.

Consumers interest for healthier diets and nutrition has increased in the USA (Childs and Poryzees, 1997). Verbeke, 2006 found that females and older participants had higher acceptance towards functional foods, and that loss of good product characteristics was accepted if that meant an increase in the health benefit of the product. However, Levis and Chambers (1996) found the opposite effect when studying potato chips. The same potato chips scored considerably higher for acceptance when they were simply labeled as potato chips than when they were labeled as “low sodium” potato chips and tested with the same consumers. This difference could be related to the type of product, the actual group of consumers, or changes in consumer behavior over the time between studies.

Roininen and others 1999 developed a questionnaire to study health and taste factors of consumers in relation to their food choices. In order to construct the questionnaire, the statements were developed and taken from previous studies. The Health category consisted in factors like General Health Interest, Light product Interest and Natural Product Interest. The Taste category factors consisted in Cravings for sweet foods, Using food as reward, and Pleasure. Each section had different set of statements that were tested with consumers using a 7 point likert scale, along with a questionnaire on food pairs in order to relate health attitudes with the food choices of consumers.

The Food Choice Questionnaire (Steptoe, Pollard, & Wardle, 1995), Eating Motivation Survey (Renner *et al.* 2012) among other questionnaires developed, are tools of great interest given that it allows to group consumers following their attitudinal behaviors and to achieve specific product development

Beverage Blends, Soft Drinks and Juices

A beverage review (Food Engineering and Ingredients, 2011) revealed that consumers are interested in beverages other than soft drinks, and looking for low calories and healthy beverages such as smoothies and fruit juices that consumers could have for breakfast, and that are convenient to drink on the go.

Awe and others (2013) developed drinks with cocoa (extracted with cold and hot water), hibiscus flower extract and ginger. The aim of these blends was to obtain a beverage with high antioxidant properties and with available products from Nigeria. Hot extracted cocoa beverages had higher antioxidants than the cold ones, and ginger did not increase the antioxidant properties, however, it contributed to the aroma and taste of the mixtures. Further studies with consumers of these blends are needed to determine the proportions of each component that will be more accepted by consumers.

González-Molina *et al.* (2009) developed a PJ and lemon beverage, aiming to obtain a product high in polyphenols. They used different ratios of the juices, exploiting the advantages that lemon juice provides such as: antioxidant to prevent discoloration of PJ, vitamin C, and high TPC. Determination of phenolic showed that the TPC were the sum of the individual components of the juice blend, and that vitamin C content increased as the samples were higher in lemon juice content.

Descriptive Sensory Evaluation Methods

Descriptive Sensory evaluation can be achieved using different methods. Flavor Profile allows the description of attributes using a consensus technique. It was developed around 1940 by Sjostrom, Cairncross and Caul (Lawless and Heymann, 2010). In the first part of this method, the panelists evaluate the samples individually and give scores to attribute intensity, and in the second part, the panel leader will lead the discussion to achieve one common agreed score of the attribute. Flavor profile allows evaluating flavor, aftertaste, order of appearance and amplitude of food products. The panelist must be first screened and highly trained in the evaluation of products, the procedure and the technique of evaluation. Orientation sessions allow the panelists to familiarize with the product, as well as choosing references for the attributes found in the samples if needed. The methods uses various scales, but commonly is used with a 0-15 point scale with 0.5-point increments (Rosales and Suwonsichon, 2015; Sanchez and Chambers, 2015).

When a panel is trained in Descriptive Sensory Analysis, the results across different panels should provide the same data (Heymann, 1994). The use of the method, and the data collection for either individual evaluations or consensus scores has been studied in order to determine if these were comparable.

Syarief and others (1985) compared mean and consensus scores of Flavor and Texture profiles of different food products. Consensus scores, and individual mean scores were calculated in order to compare the data. Coefficient of Variation (CV) and Principal Component Analysis (PCA) were performed to analyze results. Results indicated that the mean scores of individual evaluations were better than consensus scores determined by discussion of the group of panelists. This was concluded because the CV were smaller for individual mean score data, than CV obtained from consensus data, and PCA plots showed that the total variance was explained higher in mean individual data than consensus.

However, Lotong and others (2002) compared results for various orange juice samples in two large studies conducted by independent researchers, one using a consensus method and the other using individual scoring by panelists. Because the tests were conducted independently and compared only post hoc neither the samples nor the attributes were the same although overlaps did exist in both. Thus, the authors in the study used multivariate techniques to compare the results of the two studies to determine if the conclusions of the two studies would be similar. Conclusions were that similar results could be drawn showing the same relationships in the orange juice category regardless of which procedure was used, even accounting for the fact that the panels were from two different laboratories. The authors attributed this to the fact that both panels were highly trained and familiar with the procedures they used for testing.

Research Objectives

Previous research has shown the increased interest of consumers for not only healthy, but also convenient and good tasting beverages. Both Pomegranates and Green Tea have been studied for their antioxidant content and health related properties that its consumption provides, and also, the importance of the cultivar flavor and textural characteristics that will define its final use. No literature has focused on differences within Pomegranate Fruits flavor and texture, a comparison of Individual and Consensus scores in Descriptive Sensory Evaluation of Pomegranates, or PJ and GT beverage blends.

This objectives of this research were:

1) evaluation of individual pomegranate fruits in order to explore the range of differences within fruits and locations within the fruits to help in determining appropriate numbers of replications needed for products that are naturally variable,

2) compare individual and consensus scores for descriptive sensory analysis with the same panel over 10 replications of the same product to determine whether differences are found between the two methods and

3) develop PJ/GT samples and determine the sensory profiles of the blends, the total phenolic content of the samples, and whether additional information would have an effect on consumer acceptance scores.

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Chapter 2 - How many replications is enough? A case study of natural variation in a fruit

Abstract

The number of replications is always of concern in sensory studies, but often is considered to be a function of the sensory panel. However, in the case of many naturally occurring products such as meat, vegetables, and fruits, it is common to expect variation from sample to sample which impacts the number of replications. Thus, the objective of this study was to measure empirically the typical variation in a single set of the "same" samples and to calculate the necessary number of replications needed in order to detect small and large differences in descriptive analysis scores. A highly trained panel tested pomegranates, a product the panel was quite familiar with and that typically is tested using individual pieces of the product that produces variation within the product (arils with an individual fruit), location within the fruit (flower end, middle, stem end), and among samples of the same product (individual fruits of the same variety).
Results showed that even for products with expected natural variation, only a few replications are needed if the detection of differences is approximately 6.6% of the scale when the panel is highly trained and variation is low. However, if quite small differences of 1.3% of the scale are needed to be found or variation is high, the number of replications becomes impossibly high (>25-50). Of course, the final decision on how many replications actually are needed in a descriptive sensory project is determined by the objectives of the project, the desired sensitivity to be achieved, and the available resources.

PRACTICAL APPLICATIONS

When conducting descriptive sensory panels, scientists typically want to detect small differences and the number of repetitions needed may be very large depending on the training of the panel and the type of products being tested. Thus, there must be a compromise between the number of repetitions that will provide significant differences of a very small nature and the resources available to run as many experiments as needed. This information can be of use to researchers for determining the number of replications to run descriptive tests on other products with other panels once they know the existing variation for key attributes.

Keywords: Sensory, Descriptive, Replications, Pomegranate, Variability.

Introduction

Descriptive Sensory Analysis has been found to be a powerful tool allowing determination of product profiles, quality control, and shelf life, among other applications to solving problems in the food industry (Lawless & Heymann, 2010). It is required that the panelists in a descriptive sensory panel, are trained to be consistent with the results and give reproducible data through evaluation sessions (Lawless & Heymann, 2010).

As defined by Meilgaard, Civille and Carr (1999) the experimental error is the natural variation of the product under study. Measuring different experimental units within a single “treatment” will give an understanding of the normal differences that occur among the same product or process variation. These measurements form the replications of the study. Increasing the number of replications will result in a more sensitive test, and, in theory, smaller differences can be detected (Piggot, 1998).

Good sensory practices based on information such as the number of replications, the number of judges (Heymann *et al.* 2012; Chambers *et al.* 1981), panelist training and experience of the panel (Labbe *et al.* 2004; Chambers *et al.* 2004; Otremba *et al.* 2000; Chambers and Smith, 1993; Chambers *et al.* 1981), and having a panel that provides reliable and reproducible data

(Lotong *et al.* 2001), are important in order to decrease the variance error (Lawless & Heymann, 2010). In addition, the type of product and its variability will affect the structure of the testing. For example, Basker (1977) suggested that large differences among products could be determined with a panel of one person and Cliff and Heymann (1991) showed that in some instances little training was required in order to detect differences in obvious attributes. Labbe *et al.* (2004) commented that the product is key to the number of replications that are used in a study with some tests requiring as few as one replication, while others may require many more.

Braghieri *et al.* (2012) identified meat as one of the products that contains considerable natural variation and suggested that more panel training, better sensory standards, and more replications would be needed to conduct studies on meat. Otremba *et al.* (2000) used 18 replications in a meat study to ensure that enough replications had been conducted to sufficiently account for variability in samples in order to make appropriate comparisons between two panels of different levels of training. Those authors found that more training resulted in less variable data, although with such a large number of replications both panels were able to find similar differences.

Fruits have natural variation of nutrients while the fruit is developing and reaching its mature state (Yativ *et al.* 2010), and accumulate metabolites in different parts of the fruit (Wang *et al.* 2016). Therefore, not all fruits from the same cultivar might have the same attribute intensities. Pomegranate fruits have three possible sources of variation: different fruits, the aril location within fruit (stem, middle and blossom end and the individual arils). Only the first two sources of variation (fruit, location), can be controlled for because it is impossible to divide an aril into multiple experimental units.

Pomegranate fruits are grown for different uses, such as juice production, syrup and jellies (Singh and Singh, 2004), manufacturing of dehydrated seeds for use in salads and curries (Thakur *et al.* 2010), and for consumption of fresh arils (Palma *et al.* 2015). In addition, various studies have been conducted reporting beneficial properties of Pomegranate fruits, juice and also from the non-edible parts (Vázquez-Araújo *et al.* 2011), for having high level of antioxidants, anti-inflammatory, and cancer preventive effects (Ismail *et al.* 2012, Orgil *et al.* 2014, Verardo *et al.* 2014). Popularity and consumption of the fruit has also increased over the last few years (Fuhrman, 2008). Given the different uses that pomegranate fruits can have after harvest, it is important to know the sensory profile of the Wonderful cultivar, which is one of the most popular cultivars grown worldwide and the most popular cultivar grown and sold in the USA. (California Rare Fruit Growers, 1997, Qu *et al.* 2012). The Wonderful cultivar has been found to be more sour than sweet and with hard seeds (Vázquez-Araújo *et al.* 2014) which makes it suitable for juice production.

Because the fruit is sold in multiple forms and the individual arils are eaten fresh, this fruit becomes an ideal surrogate for a test of variation with a single fruit cultivar and an empirical test of many replications might be needed to determine differences at a given level of significance using a highly trained, experienced panel.

Thus, the objectives of this study were to 1) determine sensory variation among and Wonderful pomegranate fruits and arils and 2) determine the number of replications needed to find significant differences among products at various levels of intensity differences in an analysis of variance assuming variation as noted in this experiment.

Materials and Methods

Sample preparation

Fresh pomegranates from the United States of the Wonderful variety grown in California (POM Wonderful, LLC, Del Rey, CA, USA) were purchased from a local grocery shop at Manhattan, KS. Ten fruits similar in size were selected for evaluation. Each fruit was cut in three portions: stem end, middle, and blossom end. The sections were cut stem end 1cm from the center toward the stem end, and the blossom end cut 1cm from the center toward the blossom end. The remainder 2 cm section was the middle (Figure 2-1).

Seeds were taken out from each section manually, mixed gently to ensure randomization, weighed and divided equally for each panelist in 96 ml plastic cups. The number of arils served was between 10 and 15 for each panelist. The different sections within a fruit were served randomly, and two fruits were evaluated each day.

Samples were served at 5 °C in random order and were coded with three digit codes.

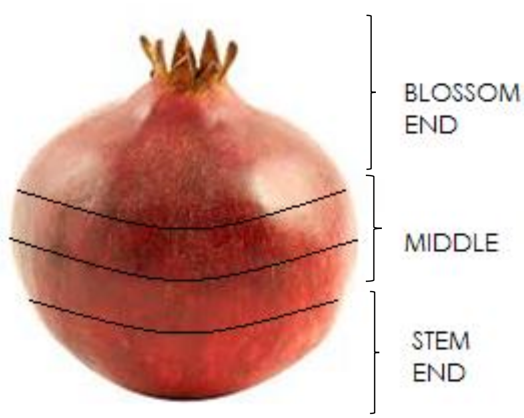

Figure 2-1 - Pomegranate sections obtained from each fruit: blossom end, middle and stem end.

Panelists

Six highly trained panelists (five women and one male, age range 40-70 years) from the Kansas State University Sensory Analysis Center with over 120 hours of training as a sensory panel, an additional 20+ hr. of training on pomegranates, and over 1000 hours of experience evaluated each part of the 10 fruits, for a total of 30 samples, in five 1.5-hour sessions using a pomegranate juice lexicon based on one developed by Koppel and Chambers (2010). Textural attributes were taken from Vazquez-Araujo *et al.* (2014).

A total of 17 attributes were evaluated on the ballot including flavor, and seed characteristics. Each sample (section of the fruit) was evaluated individually by each panelist for the full ballot. A scale from 0 = none to 15 = extremely with 0.5 increments was used for evaluation.

Panelists had a break every two samples evaluated, and were provided with unsalted crackers, deionized water and cubed mozzarella cheese to clean their palates between samples and avoid carryover effects.

Data Analysis

Analysis of Variance (ANOVA) was performed to test differences between sections of the fruit and between fruits ($p \leq 0.05$) and Fisher's protected Least Significant differences (LSD) was performed ($p \leq 0.05$) to determine differences between attributes evaluated. Sources of variation were Fruit and Location as fixed effects and Panelist as random.

Data analysis was performed using XLSTAT (Addinsoft, New York, NY, USA) statistical software.

Number of repetitions was determined using Equation 1 (from Gacula, 1993 and Lawless and Heymann, 2010)

Equation 1

$$N = \frac{\left(Z_{\alpha} + Z_{\beta}\right)^2 S^2}{(M_1 - M_2)^2}$$

Where:

N: The number of replications needed in an experiment.

S: standard deviation

Z_α and Z_β: Z scores associated with Type I and Type II errors.

$M_1 - M_2$: Minimal difference wanting to be detected.

The variables in the equation, standard deviation, replications (or sample size), the desired difference to be detected, and Type I and II errors, are interacting variables, therefore knowing any three of them will determine the fourth parameter (Lawless & Heymann, 2010). Type I and Type II errors are set beforehand, selecting α and β parameters (calculations were tested at $\alpha = 0.05$ and $\beta = 0.1$ and 0.2 meaning a test power of 90 and 80%), the standard deviation was calculated from the data set. The differences $M_1 - M_2$ were the variables that were tested in the equation (detection of significant differences of 0.2, 0.5, 0.75 and 1 point) in order to be able to know the value of needed repetitions.

Results and Discussion

Variability among fruits and locations within fruits

The comparison among individual fruits of the Wonderful pomegranate cultivar showed that eight attributes were found to significantly differ among the fruits: berry, cherry, grape, floral, fruity, sweet, salt and bitter (Table 2-1). This suggests that a single individual fruit is not a good representation of the overall cultivar showing the necessity of replication. It also suggests that individual fruits exhibit some level inconsistency in approximately half the attributes tested when purchased at retail indicating that consumers will get a variable product. This variability may or may not be a problem. It has been shown that consumers can detect small differences in the textural quality of apples from day to day (Harker *et al.* 2002), yet this does not appear to have a major impact on the purchase of apples. However, Casals *et al.* (2011) suggests that when sensory variability within cultivars (land races) of vegetables such as tomatoes overwhelms differences between cultivars this promotes dissatisfaction among consumers because it reduces the unique qualities of the cultivars and the product can lose its appeal.

Vázquez-Araújo *et al*. (2014) studied sensory characteristics of Spanish pomegranates and found mostly similar flavor attributes as those found in this study, with a few additional attributes in that study and some intensities that were slightly higher or lower. The hardness of the seeds is an important characteristic of pomegranates, because it determines the use of the fruit (Melgarejo, 2011; Singh and Singh, 2004). In this study, seed hardness did not vary either among individual fruits nor among locations within fruits. That consistency is key given that the Wonderful cultivar has been found suitable for juice production in previous studies given that it has been reported to have harder seeds than some other cultivars (Vázquez-Araújo *et al.* 2014; Alcaraz – Mármol *et al.* 2015).

Few differences were found among arils from different sections of the same fruit (Table 2-2) and when differences were found they were inconsistent across individual fruits. That suggests that no particular location effect within a fruit (i.e. blossom, middle, or stem end) was noted in this study and that arils are generally similar within a fruit. This is important to note when testing products with natural variability because some products may vary more in one location than another.

Determination of the number of replications needed to detect differences.

Taking into account that differences were found among fruits, and inconsistently within fruit locations, the product obviously has existing variation due to the nature of the product. This variation must be dealt with in the design of the experiment randomizing samples, and more importantly by repeating the experiment under the same conditions, that is testing replicates of the experimental units. Replications are executed in order to estimate the variation in the samples (Piggot, 1986) and to provide a more precise determination of the various types of experimental error.

In descriptive sensory analysis, the researcher generally wants to be able to detect small differences in samples, both qualitative (which attributes are different) and quantitative (by giving an intensity to each attribute) (Meilgaard, Civille, Carr, 1999). According to Gacula, 1993 and Lawless and Heymann, 2010 the number of observations is crucial when collecting data in sensory experiments. That is true both because it is important to capture the true nature of the product and to produce the necessary power in the statistical test. Higher numbers of products and replications produce more degrees of freedom, and when the experiment is properly conducted, that produces greater power in an analysis of variance.

Greater natural variation in products requires a larger number of replications both to get a better sense of the true nature of the product (e.g. a true mean for an attribute) and to produce the appropriate power to find differences when variability is inherent). Table 2-3 shows the number of replications needed for each attribute given its variability in this study when various values of Z_α and Z_β parameters were set at different levels in order to have different examples of possible Type I and Type II errors.

Naturally, as the size of the difference that one needs to find gets smaller the number of replications increases dramatically. For differences of 1.0 on the 15-point scale (6.6% of scale) the number of replications is surprising low (1-2 replications usually) and differences of 0.75 (5% of the scale) requires only 2-4 replications. Needing to find a difference of 0.5 on the scale

(3.3%) requires a jump to 5-8 replications and requiring a panel find a difference of only 0.2 of a point on the scale for a product with this level of variation would require replications exceeding the realm of most logic based on resources (>25-50). That would mean running a costly project, since a lot of sample and time will be needed. According to Meilgaard, Civille and Carr (1999) this decision is a compromise between the desired sensitivity to be accomplished and the researcher resources.

It must be noted that this is an empirical test, meaning that it uses actual data and calculates based on a specific data set that used a specific product (pomegranate) and a specific highly trained panel. Given that training and product both impact the variability in a data set, this information is merely illustrative and is useful as an example, not as a guide for all products and panels. What is apparent in Table 2-4 is that the mean number of replications needed is fairly low (2-4) when using many of the common parameters that are used by sensory scientists ($p<0.05$, $\beta= 10\%$, and differences on the scale of 5%-10% or higher). When those parameters become tighter, the number of replications will need to increase substantially. In some cases, where attributes have high variability (e.g. astringency in this test) the number of replications to achieve a significant difference may never reach the level where small differences can be determined. For attributes such as this, it needs to be determined if the panel needs further training or if the inherent individual physiological variability in the panelists is such that the variability in scores is unlikely to be decreased.

One factor that cannot be specifically determined from this test, but should be noted is that if the level of training is a factor in the low variability produced in this study as might be expected from prior literature, the cost of that training may be offset over time either a) by the ability to reduce the number of replications thus reducing cost per test or b) improving discrimination among samples (i.e. finding smaller differences with the same number of replications) which could result in better information and improved products, services, information, or research.

Conclusions

Sensory descriptive analysis of Wonderful pomegranates showed variation in flavor among fruits, and in limited cases among arils from different locations within the fruit. Attributes such as berry, cherry, grape, floral, fruity, sweet, salt and bitter were found to be different among fruits. These differences may be attributed to different growing and environmental conditions, but clearly show that variation can occur even within the same batch of retail sample.

For such products, the number of replications needed in order to determine whether differences exist in attribute scores at the levels needed for decision making depend on several factors: the parameters set before the test is run, such as Type I and Type II errors, the standard deviation of the data set, and the desired significant differences that want to be detected. This study shows that for a highly trained panel even products that exhibit high variability from sample to sample, such as fruits, can be tested using only a few replications if the level of difference that is important to the researcher is 5-10% of the scale and the panel is able to provide reproducible scores for key attributes. When larger numbers of replications are needed, a balance between the desired parameters, and the practical differences wanted will need to be set in order to find the best way to approach a descriptive sensory study that makes it both useful and manageable given the resources available.

Table 2-1- Mean intensity scores for Fruits attributes. Means with different subscripts were significantly different ($p<0.05$) using Fisher´s LSD test.

	Berry	Cranberry	**Cherry**	**Grape**	**Floral**	**Fruity**	Beet	Musty/ Earthy	Woody	**Sweet**	**Salt**	Sour	**Bitter**	Astringent	Toothetch	Peel Firmness	Seed Hardness
F1	2.50 bc	2.27	1.75 de	1.77 c	1.83 d	2.33 d	1.75	1.75	2.03	2.11 b	1.61 d	2.25	2.56 a	2.17	1.44	1.89	2.72
F2	2.80 a	2.50	2.00 bc	1.83 bc	2.14 ab	2.50 abc	1.75	1.81	2.08	2.08 b	1.72 bcd	2.28	2.56 a	2.17	1.58	1.81	2.42
F3	2.58 bc	2.30	1.69 e	1.86 bc	1.92 cd	2.42 bcd	1.50	1.89	2.03	2.11 b	1.72 bcd	2.39	2.47 ab	2.28	1.42	1.81	2.44
F4	2.47 bc	2.22	1.94 cd	1.75 c	2.03 bcd	2.33 d	1.97	2.03	2.17	2.14 b	1.67 cd	2.28	2.50 ab	2.42	1.56	1.89	2.44
F5	2.47 bc	2.47	1.89 cde	1.83 bc	2.00 bcd	2.42 bcd	1.75	1.81	2.00	2.14 b	1.75 bcd	2.25	2.53 ab	2.25	1.31	1.94	2.44
F6	2.41 c	2.27	2.03 bc	1.94 bc	2.11 abc	2.53 ab	1.75	1.97	2.17	2.14 b	1.86 abc	2.33	2.42 abc	2.17	1.42	1.75	2.47
F7	2.52 bc	2.19	2.25 a	2.03 b	2.25 a	2.50 abc	1.61	1.83	1.94	2.42 a	1.89ab	2.08	2.33 abc	2.11	1.19	1.75	2.58
F8	2.47 bc	2.28	2.08 abc	1.86 bc	2.08 abc	2.39 bcd	1.67	1.94	2.11	2.25 ab	1.81 abcd	2.25	2.19 c	2.08	1.28	1.83	2.61
F9	2.44 c	2.28	2.06 abc	1.86 bc	1.94 bcd	2.36 cd	1.78	2.03	2.08	2.08 b	1.92 ab	2.19	2.31 bc	2.11	1.31	1.78	2.64
F10	2.69 ab	2.33	2.19 ab	2.31 a	2.28 a	2.62 a	1.67	2.02	2.17	2.27 ab	1.99 a	2.30	2.41 abc	2.12	1.39	1.89	2.53
p-value	**0.01**	0.09	**< 0.0001**	**< 0.0001**	**< 0.001**	**0.005**	0.11	0.14	0.06	**0.007**	**0.024**	0.29	**0.037**	0.20	0.12	0.58	0.11

Table 2-2– Mean Intensity scores on a scale from 0 to 15 for Pomegranate sections. Means with different subscripts were significantly different ($p<0.05$) using Fisher´s LSD test

		Berry	Cranberry	Cherry	Grape	Floral	Fruity	Beet	Musty/Earthy	Woody	Sweet	Salt	Sour	Bitter	Astringent	Toothetch	Peel Firmness	Seed Hardness
F1	BLOSSOM	2.50	2.50	1.75	1.92	1.67	2.25	1.75	**1.92 a**	2.00	2.00	1.75	2.25	2.67	2.17	1.42	2.17	2.58
	MIDDLE	2.33	2.33	1.75	1.75	2.00	2.33	1.83	**1.92 a**	2.00	2.33	1.58	2.17	2.33	2.33	1.58	1.83	2.58
	STEM END	2.67	2.00	1.75	1.67	1.83	2.42	1.67	**1.42 b**	2.08	2.00	1.50	2.33	2.67	2.00	1.33	1.67	3.00
F2	BLOSSOM	3.00	**2.50 ab**	2.00	1.92	2.33	2.58	1.92	1.92	2.08	2.08	1.92	2.33	2.58	2.17	1.42	**1.92 a**	2.58
	MIDDLE	2.75	**2.33 b**	2.00	1.67	2.00	2.50	1.75	2.08	2.00	1.92	1.58	2.33	2.42	2.25	1.75	**1.50 b**	2.25
	STEM END	2.67	**2.67 a**	2.00	1.92	2.08	2.42	1.58	1.42	2.17	2.25	1.67	2.17	2.67	2.08	1.58	**2.00 a**	2.42
F3	BLOSSOM	2.67	2.42	1.92	2.00	2.08	2.58	**1.83 a**	2.17	2.08	2.08	1.83	2.25	2.58	2.25	1.58	1.83	2.50
	MIDDLE	2.50	2.25	1.75	1.75	1.83	2.33	**1.67 a**	1.67	2.00	2.33	1.67	2.42	2.42	2.42	1.42	1.83	2.42
	STEM END	2.58	2.25	1.42	1.83	1.83	2.33	**1.00 b**	1.83	2.00	1.92	1.67	2.50	2.42	2.17	1.25	1.75	2.42
F4	BLOSSOM	2.42	2.25	1.92	1.75	2.00	2.25	**1.75 b**	**1.750 b**	2.08	2.17	1.58	2.33	2.50	2.50	1.58	1.83	2.50
	MIDDLE	2.50	2.17	2.00	1.83	2.00	2.33	**2.00 ab**	**2.167 a**	2.25	2.17	1.67	2.25	2.58	2.42	1.42	1.83	2.25
	STEM END	2.50	2.25	1.92	1.67	2.08	2.42	**2.17 a**	**2.167 a**	2.17	2.08	1.75	2.25	2.42	2.33	1.67	2.00	2.58
F5	BLOSSOM	2.42	2.42	**2.17 a**	**1.92 a**	**2.17 a**	2.50	1.75	1.75	2.08	**2.25 a**	1.75	2.17	2.50	2.25	1.42	1.92	2.33
	MIDDLE	2.50	2.58	**1.75 b**	**2.00 a**	**2.00 ab**	2.33	1.92	2.00	2.08	**2.25 a**	1.92	2.33	2.67	2.42	1.50	2.00	2.67
	STEM END	2.50	2.42	**1.75 b**	**1.58 b**	**1.83 b**	2.42	1.58	1.67	1.83	**1.917 b**	1.58	2.25	2.42	2.08	1.00	1.92	2.33
F6	BLOSSOM	2.33	2.33	2.08	1.92	2.08	2.50	1.83	2.00	**2.00 b**	2.08	1.83	2.42	**2.17 b**	**2.08 b**	1.33	1.83	2.42
	MIDDLE	2.58	2.17	1.92	1.92	2.08	2.58	1.75	1.92	**2.17 ab**	2.08	1.83	2.33	**2.42 ab**	**2.33 a**	1.50	1.67	2.50
	STEM END	2.33	2.33	2.08	2.00	2.17	2.50	1.67	2.00	**2.33 a**	2.25	1.92	2.25	**2.67 a**	**2.08 b**	1.42	1.75	2.50
F7	BLOSSOM	2.67	2.33	**2.42 a**	2.08	2.33	2.67	1.58	1.92	**2.08 a**	2.50	1.92	2.25	2.42	2.00	1.25	1.75	2.58
	MIDDLE	2.33	2.17	**2.42 a**	1.92	2.25	2.42	1.50	1.83	**1.83 ab**	2.33	1.83	1.92	2.33	2.08	1.08	1.75	2.58
	STEM END	2.58	2.08	**1.92 b**	2.08	2.17	2.42	1.75	1.75	**1.92 b**	2.42	1.92	2.08	2.25	2.25	1.25	1.75	2.58
F8	BLOSSOM	2.42	2.33	2.17	1.83	2.08	2.42	1.75	1.83	2.00	**2.25 ab**	1.92	2.42	2.33	2.17	1.17	1.92	2.50
	MIDDLE	2.50	2.42	2.25	1.92	2.17	2.50	1.67	2.00	2.17	**2.42 a**	1.83	2.25	2.17	2.08	1.33	1.83	2.67
	STEM END	2.50	2.08	1.83	1.83	2.00	2.25	1.58	2.00	2.17	**2.08 b**	1.67	2.08	2.08	2.00	1.33	1.75	2.67
F9	BLOSSOM	**2.33 b**	2.17	2.17	1.83	1.83	2.33	1.75	1.92	2.00	1.92	1.92	2.17	2.42	2.08	1.17	1.58	**2.58 b**
	MIDDLE	**2.58 a**	2.50	2.00	1.92	2.00	2.42	1.83	2.08	2.17	2.33	1.92	2.25	2.25	2.25	1.58	1.83	**2.50 b**
	STEM END	**2.42 ab**	2.17	2.00	1.83	2.00	2.33	1.75	2.08	2.08	2.00	1.92	2.17	2.25	2.00	1.17	1.92	**2.83 a**
F10	BLOSSOM	2.80	2.40	2.20	2.40	2.30	2.60	1.70	2.00	2.30	2.40	2.10	2.50	2.40	2.10	1.30	1.90	2.50
	MIDDLE	2.70	2.40	2.00	2.30	2.30	2.60	1.60	2.00	2.10	2.10	2.00	2.30	2.50	2.10	1.10	1.80	2.50
	STEM END	2.70	2.20	2.20	2.20	2.40	2.60	1.60	2.00	2.10	2.30	2.00	2.20	2.40	2.20	1.60	1.90	2.70

Table 2-3– Number of repetitions needed to detect differences of certain size, using different parameters.

	Berry	Cranberry	Cherry	Grape	Floral	Fruity	Beet	Musty/ Earthy	Woody	Sweet	Salt	Sour	Bitter	Astringent	Toothetch	Peel Firmness	Seed Hardness
β= 10% α=0.05																	
Differences to be detected																	
0.2	57	38	52	39	38	23	66	63	25	41	50	35	47	45	209	36	60
0.5	9	6	8	6	6	4	11	10	4	7	8	6	8	7	33	6	10
0.75	4	3	4	3	3	2	5	4	2	3	4	3	3	3	15	3	4
1	2	2	2	2	2	1	3	3	1	2	2	1	2	2	8	1	2
β= 20% α=0.05																	
Differences to be detected																	
0.2	46	30	42	32	31	19	54	51	20	33	41	28	38	36	168	29	48
0.5	7	5	7	5	5	3	9	8	3	5	6	5	6	6	27	5	8
0.75	3	2	3	2	2	1	4	4	1	2	3	2	3	3	12	2	3
1	2	1	2	1	1	1	2	2	1	1	2	1	2	1	7	1	2

Table 2-4– Mean number of repetitions needed to detect differences of certain size, using different parameters.

Difference	Number of replications β= 10% and α=0.05	Number of replications β= 20% and α=0.05
0.2	54	44
0.5	9	7
0.75	4	3
1.0	2	2

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Chapter 3 - Consensus and Individual Scoring methods produce similar information on products

Abstract

Descriptive sensory evaluation methods have different advantages and disadvantages that makes the researcher question which method to use, and whether they give the same results. While individual evaluation might avoid the effect of a strong personality of the panel leader and biasing effect of other participants, consensus methods allow panelists to discuss and improve their discrimination abilities.

The objective of this study was to determine if individual and consensus scoring methods would lead to similar results if using the same products, pomegranate fruits of the wonderful variety, and the same highly trained panel.

Statistical analysis showed that some significant differences were found in the two methods; however, when comparing both methods only one attribute was found to be significantly different. As illustrated by the Principal Component Analysis (PCA) map, samples from consensus evaluation were in close proximity to the same samples using individually scored data. Results indicate that when using a highly trained panel that either descriptive method, consensus or individual scoring, can be used to obtain similar results.

PRACTICAL APPLICATIONS

Results in the study suggest that highly trained panels will provide similar information when using either Individual or Consensus scoring methods. This information is of value for sensory professionals that are training panelists for descriptive evaluations, as well as providing information on the equity of the use of both methods for descriptive sensory evaluation.

Introduction

Descriptive Analysis is an objective sensory method, which allows collecting information of products through the use of the senses (Heymann, 1994) and is accomplished using different methods and hybrid methods used to describe both quantitative and qualitative characteristics of products (Civille and Oftedal, 2012). Flavor profile, Quantitative Descriptive Analysis, Texture Profile and Sensory Spectrum ® are the major methods that have been widely used to record sensory characteristics of products. Some methods use individual data collection of the panel, while others, the panel as a group, and through discussion achieve agreed consensus scores (Sanchez and Chambers, 2015).

Foster *et al*. (1955) found that the responses of panelists were influenced by other participant's responses when evaluation of products was held in a round table situation. It was found that the first response in the group influenced the upcoming answers of the rest of the panelists.

However, Caul (1957) explained in the Profile Method of Flavor Analysis, that group table situations are good in order to encourage panelists in their discrimination abilities, and help to improve their confidence towards evaluation.

Meilgaard, Civille and Carr (1999) reported as a disadvantage of the Flavor Profile, which is a consensus method, the possibility of responses being dominated by a strong personality of the panel leader.

Syarief *et al*. (1985) compared data from panels using consensus scores and means of individual scores for different products using Flavor and Texture profiles. Data were analyzed using Analysis of Variance (ANOVA) and the Coefficient of Variance (CV) was used as a way of measuring precision of the methods. Principal Component Analysis (PCA) was also performed and the Cumulative proportion of variance accounted for (CPVAF) was used to measure how well the factors explained the variance of the variables. Results showed that the mean of individual scores was a superior method given that the results obtained of CV and CPVAF were found to be higher than those obtained for consensus scores. However, Lotong *et al.* (2001) conducted descriptive analysis with orange juices in two independent panels. One of the panels conducted consensus evaluation, while the other scored the samples individually. The lexicons developed for evaluating the samples were similar, and flavor characteristics were comparable in both panels. PCA was performed, and similar sensory spaces were found for both the samples and their attributes. The authors concluded that if the panels are highly trained, they are able to provide reproducible and reliable information, regardless of the method. Martin *et al.* (2000) found similar results regarding the training of the panels when using descriptive analysis, providing comparable data when the panelists of both panels had the same training level.

The objective of this study was to determine if data obtained through consensus evaluation gave similar data to that obtained from individual scoring of products. Panelists evaluated Wonderful Pomegranate arils individually, and once finished, discussion was led by the Panel leader in order to reach consensus for the full ballot of attributes.

Materials and Methods

Sample preparation

Fresh pomegranate fruits grown in Del Rey, California (Pom Wonderful, LLC, Del Rey, CA, USA) were purchased from a local grocery store (Manhattan, KS, USA). Fruits were washed and kept refrigerated at 5°C until used.

Ten pomegranate fruits were selected for their similar size. The day of the evaluation, three portions were cut from each fruit: stem end, middle, and blossom end. The center of the fruit was measured, and then one centimeter from each side of the center was used to divide the top and the bottom sections (Figure 3-1).

Each section of the fruits was deseeded manually and gently mixed. Arils form each section were weighed and divided in equal parts for each panelist. Approximately 10 to 15 arils were served in 96 ml lidded plastic cups. Arils were kept refrigerated at 5 °C until served. Each section of the fruit was served in random order as an individual sample, using 3 digit random codes.

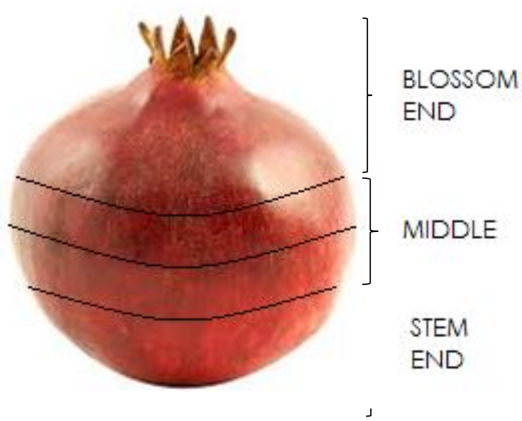

Figure 3-1 – Pomegranate sections obtained from each fruit: blossom end, middle and stem end.

Panelists

Six panelists from the Sensory Analysis Center at Manhattan, Kansas, with over 1000 hours of experience of sensory evaluation, and more than 20 hours of experience evaluating pomegranate fruits and pomegranate juice, evaluated the samples (Koppel and Chambers, 2010; Vázquez-Araújo *et al.* 2011; Koppel *et al*. 2014; Anderson *et al.* 2015).

Orientation and Evaluation

Panelists received 2 days of orientation, of 1.5 hour sessions each day in evaluating pomegranate seeds. At the beginning of orientation, panelists were given the flavor lexicon developed by Koppel and Chambers (2010) and the texture attributes from a study from Vázquez-Araújo *et al*. (2014) for pomegranate seeds. Panelists were asked to determine if any attributes needed to be deleted, added, or changed for this study.

Evaluation was completed in 5 days, and 2 fruits (three sections of the fruit, a total of 6 samples per day) were evaluated in each 1.5-hour session. Fruit sections were served in a random order. In a first stage, panelists evaluated a sample individually for the full ballot using a 15-point scale with 0.5 point increments. After individual scoring, the panel leader led a group discussion in order to set consensus scores for the complete ballot for the same sample. This procedure was repeated for all samples.

Each session had a 10-minute break, and deionized water, unsalted crackers and mozzarella cheese were provided for palate cleansing between sample evaluations.

Data Analysis

Analysis of Variance was performed using SAS v.9.2 (SAS Institute, Inc. Cary, NC, USA) for consensus data and means of individual scores using location and fruit as fixed effects, and panelist as random in the individual dataset. Least Square means was determined using Fisher's Least significant difference (LSD) at a level of significance of 0.05.

Both data sets were run together using SAS v.9.2 (SAS Institute, Inc. Cary, NC, USA), and ANOVA was performed with Fisher's LSD to determine differences between the methods. Sources of variation were fruit, location and method as fixed effects.

Averages across panelist and locations were calculated for the individual data, and averages across locations for the consensus data, resulting in the same set of data for each method. Principal Component Analysis (PCA) was mapped using XLStat (Addinsoft, New York, NY, USA) to visualize how close the same fruit mapped from individual data, was to the fruit mapped from consensus data.

Results and Discussion

Few differences were detected when comparing results from both methods in Wonderful pomegranate seeds.

For the consensus method, three attributes, berry, bitter and floral were found significantly different between fruits, and astringent was found to be of marginal significance (Table 3-1).

The individual method results showed that five attributes; berry, cherry, grape, salt and fruity were found significantly different, and the attribute bitter was found marginally significant (Table 3-2). Both methods found berry and bitter attributes significant, but the individual method had four more significant attributes: cherry, grape, salt and fruity.

However, when looking at the results from the different locations of the fruit for each method, only the attribute cherry was found to be marginally significantly different in the blossom end, middle and stem end of pomegranates for the Individual method, while no significant differences were found for the consensus method. This shows similar results for both methods (Table 3-3).

Results from the analysis of data compared by method, showed no major differences in attributes, except for the attribute Fruity that was found to be significantly different between Individual and Consensus methods. Scores values were similar for the two sensory methods, and standard deviations were lower than 0.3 for all the attributes evaluated for both methods (Table 3-4).

In order to further visualize results, Principal Components Analysis (PCA) was used to visualize the relationship between attributes and samples (Figure 3-2). PCA was mapped for individual data scores averaged across panelists, fruit and location, and consensus scores averaged across fruit and locations. PCA maps allowed displaying differences between fruits for both methods, and attributes. The first two principal components accounted for 45% of the total variability.

When examining Consensus and Individual pairs for each fruit, it was found that consensus and individual data for Fruits 4, 5, 6, 8 and 10 appeared to be similar to each other since they are grouped close one another. Together with the results from ANOVA statistics, it shows that there were no major differences between the two used methods for collecting data. Paired fruits for individual and consensus methods, for fruits 1, 2, 3, 7 and 9 positioned further apart. This difference can also be explained by the natural variation of flavor in fruits. The map showed that there was an existing natural variation among and within fruits since pairs of fruits are positioned differently on the map. Fruits 7 and 10 were more floral and grape, fruit 4 can be described by more beet and astringent flavors, and fruit 2 was more berry and cranberry than fruit 8 that had harder seeds. This variation in fruits can be due to the fruit itself, or the part of the fruit from where the arils were extracted, regardless of the method for data collection (Chapter 1 – How many replications is enough? A case of natural variation in a fruit).

Another source of variation in results could be that the use of different methods provided different results. However, results from ANOVA statistics, show that there was only one marginal significant difference for Fruity when the methods were compared. In addition, by looking at the PCA plot, samples are located in the same basic area of the map.

These results suggest that if the descriptive panel is highly trained, both procedures are good in providing reliable data (Lotong, 2001) and trained to be consistent and give reproducible results (Lawless & Heymann, 2010). Depending on the needs and objectives of the project, the researcher can make the decision on which method is more suitable to use (Civille & Oftedal 2012).

Conclusions

Statistical analysis and PCA show that few differences were found in both methods and that fruits were positioned visually similar in the map, therefore results show that both methods give similar results, but it is of major importance to work with a highly trained panel in order to obtain these outcomes. The decision to use either method, will depend upon the objective of the project, the technique and the samples to evaluate.

Table 3-1 - Mean Intensity scores for Pomegranate Fruits determined using Consensus data. Means with different subscripts were significantly different (p<0.05) using Fisher´s LSD test. Attributes with an asterisk (*) were found of marginal significance.

Consensus data	**Berry**	Cranberry	Cherry	Grape	Beet	Musty/ Earthy	Woody	Sweet	Salt	Sour	**Bitter**	**Astringent ***	Toothetch	Peel Firmness	Seed Hardness	**Floral**	**Fruity**
F1	2.67 bc	2.33	1.67	2.00	1.83	1.83	2.00	2.17	1.67	2.33	2.33 b	2.00 c	1.50	1.83	2.50	2.00 c	2.50
F2	3.17 a	2.50	2.00	1.83	1.83	1.83	2.00	2.17	1.67	2.33	2.67 a	2.17 bc	1.50	1.67	2.50	2.17 bc	2.50
F3	2.83 ab	2.50	1.83	1.67	1.67	2.00	2.00	2.00	1.67	2.33	2.50 ab	2.33 ab	1.50	1.67	2.50	2.00 c	2.50
F4	2.50 bc	2.17	1.83	1.83	2.00	2.17	2.33	2.00	1.67	2.33	2.50 ab	2.50 a	1.33	1.83	2.50	2.00 c	2.50
F5	2.50 bc	2.50	1.83	1.83	1.83	2.00	2.00	2.33	1.83	2.00	2.50 ab	2.17 bc	1.50	2.00	2.50	2.00 c	2.50
F6	2.33 c	2.33	2.00	2.00	1.67	2.00	2.17	2.00	2.00	2.50	2.33 b	2.17 bc	1.33	1.83	2.50	2.00 c	2.50
F7	2.67 bc	2.33	2.33	2.00	1.50	1.83	2.00	2.50	2.00	2.00	2.50 ab	2.00 c	1.50	1.67	2.50	2.33 ba	2.50
F8	2.50 bc	2.50	2.00	1.83	1.67	1.83	2.00	2.33	1.67	2.17	2.00 c	2.00 c	1.50	2.00	2.67	2.00 c	2.50
F9	2.50 bc	2.33	2.00	1.83	1.50	2.00	2.00	2.17	2.00	2.17	2.50 ab	2.17 bc	1.50	1.83	2.50	2.00 c	2.50
F10	2.67 bc	2.33	2.00	2.33	1.50	2.00	2.17	2.33	2.00	2.33	2.50 ab	2.00 c	1.33	1.83	2.50	2.50 a	2.50
SD	0.29	0.22	0.24	0.27	0.25	0.24	0.17	0.25	0.25	0.25	0.22	0.23	0.15	0.25	0.09	0.20	0.00
p-value	**0.023**	0.642	0.079	0.129	0.121	0.832	0.163	0.165	0.192	0.317	**0.006**	**0.059 ***	0.639	0.619	0.474	**0.001**	----

Table 3-2 - Mean Intensity scores for Pomegranate Fruits determined using Individual data. Means with different subscripts were significantly different (p<0.05) using Fisher´s LSD test. Attributes with an asterisk (*) were found of marginal significance.

Individual data	**Berry**	Cranberry	**Cherry**	**Grape**	Beet	Musty/ Earthy	Woody	Sweet	**Salt**	Sour	**Bitter ***	Astringent	Toothetch	Peel Firmness	Seed Hardness	Floral	**Fruity**
F1	2.50 c	2.28	1.75 cd	1.78 c	1.75	1.75	2.03	2.11	1.61 f	2.25	2.56 ab	2.17	1.44	1.89	2.72	1.83	2.33 d
F2	2.89 a	2.56	2.17 ab	1.78 c	1.67	2.11	2.08	1.94	1.69 def	2.50	2.58 a	1.92	1.67	1.81	2.33	1.97	2.50 abc
F3	2.58 bc	2.31	1.69 d	1.86 bc	1.50	1.89	2.03	2.11	1.72 cdef	2.39	2.47 abc	2.28	1.42	1.81	2.44	1.92	2.42 bcd
F4	2.47 c	2.22	1.94 bcd	1.75 c	1.97	2.03	2.17	2.14	1.67 ef	2.28	2.50 abc	2.42	1.56	1.89	2.44	2.03	2.33 d
F5	2.47 c	2.47	1.89 bcd	1.83 bc	1.75	1.81	2.00	2.14	1.75 cdef	2.25	2.53 abc	2.25	1.31	1.94	2.44	2.00	2.42 bcd
F6	2.42 c	2.28	2.03 abc	1.94 bc	1.75	1.97	2.17	2.14	1.86 bcd	2.33	2.42 abcd	2.17	1.42	1.75	2.47	2.11	2.53 ab
F7	2.53 bc	2.19	2.25 a	2.03 b	1.61	1.83	1.94	2.42	1.89 abc	2.08	2.33 bcd	2.11	1.19	1.75	2.58	2.25	2.50 abc
F8	2.47 c	2.28	2.08 ab	1.86 bc	1.67	1.94	2.11	2.25	1.81 bcde	2.25	2.19 d	2.08	1.28	1.83	2.61	2.08	2.39 bcd
F9	2.44 c	2.28	2.06 ab	1.86 bc	1.78	2.03	2.08	2.08	1.92 ab	2.19	2.31 cd	2.11	1.31	1.78	2.64	1.94	2.36 cd
F10	2.73 ab	2.33	2.13 ab	2.30 a	1.63	2.00	2.17	2.27	2.03 a	2.33	2.43 abc	2.13	1.33	1.87	2.57	2.33	2.60 a
SD	0.18	0.16	0.24	0.19	0.20	0.12	0.20	0.27	0.12	0.20	0.16	0.18	0.16	0.19	0.21	0.13	0.18
p- value	**0.006**	0.084	**0.017**	**0.002**	0.281	0.892	0.234	0.382	**0.039**	0.359	**0.054***	0.131	0.199	0.755	0.181	0.063	**0.036**

Table 3-3 – Mean Intensity scores for the different sections of pomegranate fruits for the Individual and Consensus methods. Means with different subscripts were significantly different (p<0.05) using Fisher´s LSD test.

Individual

	Berry	Cranberry	**Cherry ***	Grape	Beet	Musty/ Earthy	Woody	Sweet	Salt	Sour	Bitter	Astringent	Toothetch	Peel Firmness	Seed Hardness	Floral	Fruity
Blossom	2.55	2.36	**2.08 a**	1.95	1.76	1.92	2.07	2.17	1.85	2.31	2.45	217	1.36	1.86	2.51	2.08	2.46
Middle	2.55	2.35	**2.03 ba**	1.88	1.72	2.06	2.07	2.18	1.77	2.32	2.41	219	1.45	1.78	2.46	2.01	2.43
Stem end	2.54	2.24	**1.88 b**	1.86	1.63	1.83	2.08	2.12	1.76	2.23	2.42	2.11	1.36	1.84	2.60	2.03	2.41
p-value	0.982	0.116	**0.057***	0.237	0.322	0.254	0.956	0.773	0.155	0.460	0.792	0.601	0.509	0.472	0.173	0.634	0.426

Consensus

	Berry	Cranberry	Cherry	Grape	Beet	Musty/ Earthy	Woody	Sweet	Salt	Sour	Bitter	Astringent	Toothetch	Peel Firmness	Seed Hardness	Floral	Fruity
Blossom	2.65	2.40	2.00	2.00	1.75	2.00	2.00	2.2	1.85	2.3	2.4	2.15	1.40	1.70	2.50	2.1	2.50
Middle	2.60	2.45	1.95	1.95	1.75	1.95	2.10	2.25	1.75	2.2	2.4	2.25	1.45	1.95	2.50	2.1	2.50
Stem end	2.65	2.30	1.90	1.80	1.60	1.90	2.10	2.15	1.85	2.25	2.5	2.05	1.50	1.80	2.55	2.1	2.50
p-value	0.859	0.327	0.573	0.157	0.236	0.709	0.276	0.632	0.537	0.674	0.276	0.080	0.387	0.087	0.387	1.000	----

Table 3-4 Mean Intensity scores for Individual and Consensus methods. Means with different subscripts were significantly different ($p<0.05$) using Fisher´s LSD test

	Berry	Cranberry	Cherry	Grape	Floral	**Fruity**	Beet	Musty/ Earthy	Woody	Sweet	Salt	Sour	Bitter	Astringent	Toothetch	Peel Firmness	Seed Hardness
Consensus	2.63	2.38	1.95	1.92	2.10	**2.50 a**	1.70	1.95	2.07	2.20	1.82	2.25	2.43	2.15	1.45	1.82	2.52
Individual	2.55	2.32	2.00	1.90	2.05	**2.44 b**	1.71	1.94	2.08	2.16	1.80	2.29	2.43	2.16	1.39	1.83	2.53
p- value	0.082	0.196	0.208	0.656	0.213	**0.003**	0.643	0.883	0.562	0.534	0.641	0.344	0.867	0.608	0.268	0.742	0.699

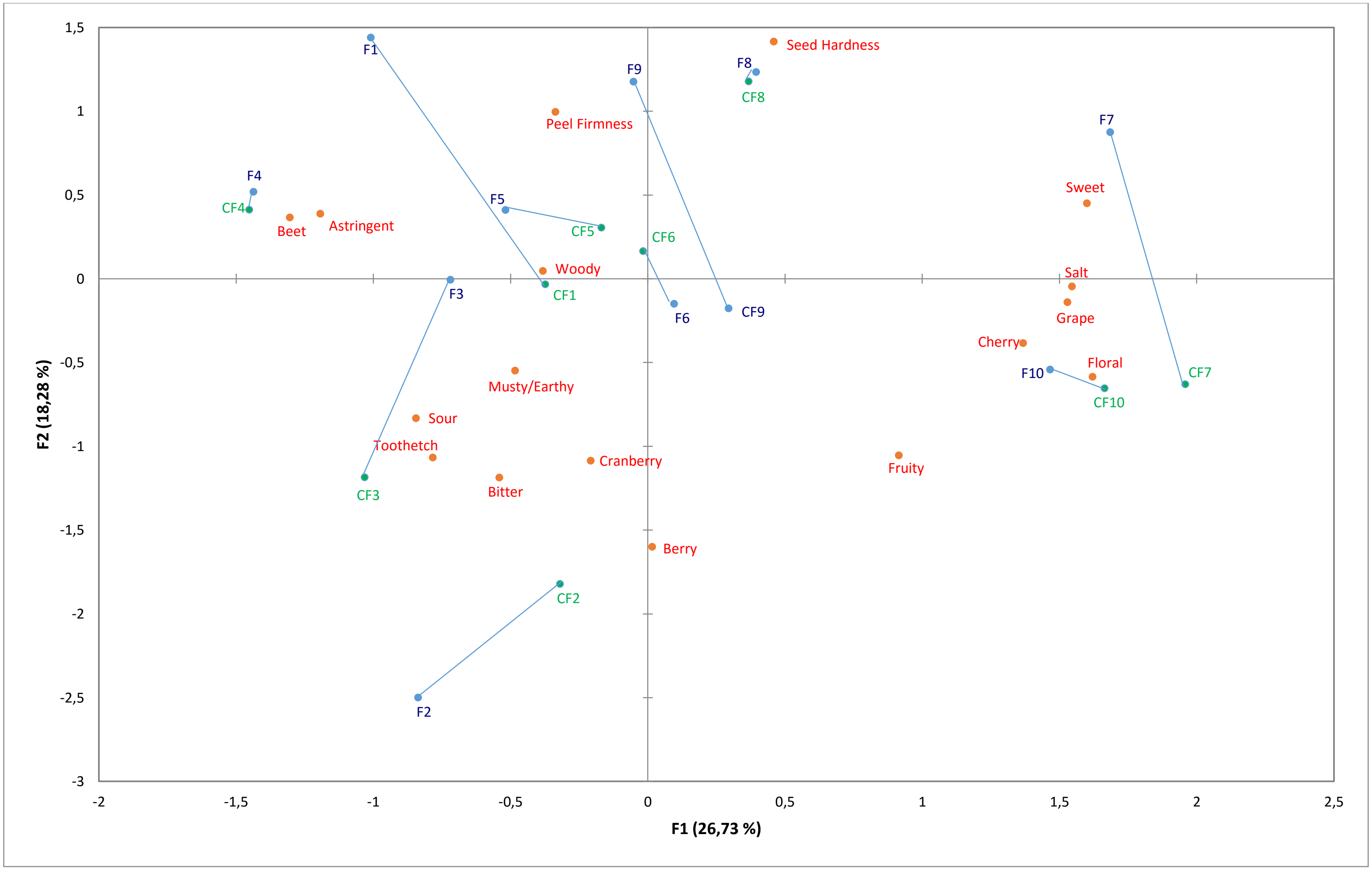

Figure 3-2– Principal Component Analysis (PCA) of the trained panel evaluators for Individual and Consensus scores. F1 to F10 represent averaged individual scores. CF1 to CF10 represent averaged consensus scores.

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Chapter 4 - Pomegranate Juice and Green Tea blends: Effect of Added Information to Consumer Acceptance

Abstract

Pomegranate Juice and Pomegranate products as well as Green Tea flavored products have increased in popularity for their known beneficial health properties. Consumers look for healthier beverages, and rely on labels, claims and product packaging when choosing a product. The objectives of this study were to determine 1) the sensory profiles of pomegranate juice and green tea blends, 2) the acceptance of the blends, 3) whether additional information would have an effect on consumer acceptance scores, and 4) total phenolic content of the samples.

Six Pomegranate Juice (PJ) and Green Tea blends (GT) prepared at different ratios (90-10, 80-20, 70-30, 60-40, 50-50 and 40-60) were evaluated by a descriptive panel in order to explore sensory differences and flavor characteristics. A consumer panel of 100 participants evaluated the samples in overall liking before and after beneficial health information of the samples was provided. The consumers rated fruity flavor, tea flavor, sweetness, sourness and color using Just About Right scales, and responded a series of health and taste factor questions, according to the Health and Taste Attitudes scale.

Descriptive analysis results showed differences in flavor. Blends higher in tea concentration showed higher Green and GT-like and lower in berry, beet, floral, sweetness, and cherry flavors. Significant differences were found in liking of the samples. Overall liking scores of all samples increased after information was provided to the consumers. The highest sample in PJ and lowest in GT blend was liked the most. Further, determination of Total Phenolic Content (TPC) showed that phenolic content of the blends was the sum of TPC of the individual beverages, and that as the samples increased in PJ these contained higher TPC content.

The present study information may be of interest for the beverage industries, providing information of consumer liking of beverage blends, and how the information of health related claims affects the acceptance of beverages.

Introduction

Pomegranate Juice (PJ) has been reported to be the beverage with one of the highest antioxidant and phenolic contents. The antioxidant content in PJ is higher than other fruits, black, green and white tea and red wines (Seeram *et al.* 2008). Due to this high phenolic content several beneficial health related properties have been reported, such as cancer prevention, anti-inflammatory, antioxidant and antibacterial properties, as well as facilitator of skin repair (Kim *et al.* 2002; Aslam *et al.* 2006; Naz *et al.* 2007; Panichayupakaranant *et al.* 2010). Pomegranate popularity has increased, along with consumption of healthy beverages in the world (Fuhrman, 2008).

Previous studies have reported the influence of information on liking and purchase intent of several products, as well as consumer attitudes towards healthy food choices.
Coleman *et al.* (2014) studied liking, emotional response and purchase intent on prebiotic enriched breads and the impact of claims through a consumer test with identical samples with different claims. Two clusters were found: Cluster 1 was not acceptant of claims, and their purchase intent diminished when products presented claims, while Cluster 2 was the opposite, and besides being more acceptant, their purchase intent increased if the product presented claims. Overall liking of the samples did not change when claim information was presented. However, consumers stated that many of the claims were not easy to understand, and questioned the truthiness of the claims.

Liem *et al.* (2012) studied how labels affected taste perception of different formulations of reduced sodium soups. Participants rated the expected saltiness before tasting and the liking of the samples. They were able to add salt after tasting if desired. The findings of the study showed that samples with labels stating a salt reduction were negatively received and increased the difference between the expected and the actual saltiness of the product. As a result, salt expectation and liking were low, therefore consumers tended to add more salt to the samples.

Zandstra *et al.* (2001) reported the influence of Health and Taste attitudes on the consumption on low and high fat foods through a questionnaire on food frequency. Findings showed that participants with higher scores in a General Health interest scale consumed less fatty foods and ate more vegetables and fruits that those with lower scores. On the other hand, participants with high scores in the Light food products section, consumed vegetables and fruits as well as low fat dairy products.

Consumer attitudes and additional product-related information are important factors to consider because they will determine the acceptance of food products, and the final decision of product purchase.

Previous studies have focused on Consumer Research, Descriptive and Total Phenolic Content (TPC) of Pomegranates, and Green Tea (GT) separately and mixed with other fruit juices, but no research has been found combining these two beverages. Koppel and Chambers, 2010 developed a lexicon to describe the flavor of Pomegranate Juice (PJ). Lee and Chambers (2007) established a lexicon for Green Tea, and further descriptive sensory studies have described GT flavor of samples from different countries (Lee *et al.* 2013).

Several consumer studies have been conducted to understand the liking of PJ (Koppel *et al.* 2014 b; Carbonell-Barrachina *et al.* 2011) and GT samples, in the US and across countries

(Lee *et al.* 2010; Lee *et al.* 2009; Lee and Chambers 2010 a, b). Lee *et al.* (2010) found that from several green tea samples from different countries, Lipton green tea, characterized for having green, brown, straw like and bitter flavor characteristics was among the liked samples for USA consumers. However, the mean overall liking score for this sample was 5.69 on a 9-point hedonic scale.

Previous studies have been found, where PJ is mixed with other fruit juices like black cherry and concord grapes (Lawless *et al.* 2013), lemon juice (González-Molina *et al.* 2009), and berries juice (Vázquez-Araújo *et al.* 2010) with the objective of obtaining blends with high antioxidant content, but no studies were found involving PJ and GT mixes.

Studies determining the TPC and antioxidant content of PJ in the juice fraction obtained through different processes (Tzulker *et al.* 2007; Tezcan *et al.* 2009; Vázquez-Araújo *et al.* 2011; Gil *et al.* 2000; Koppel *et al.* 2014a) found that juices pressed with the rind, membrane and non-edible parts of the fruit had more TPC than those obtained from pressing only the fruit seeds. The objectives of the present study were to determine 1) the sensory profiles of pomegranate juice and green tea blends, 2) the acceptance of the blends, 3) whether additional information would have an effect on consumer acceptance scores, and 4) total phenolic content of the samples.

Materials and Methods

Sample Preparation

Fresh Wonderful Pomegranates from Del Rey, California (Pom Wonderful, LLC, Del Rey, CA, USA) were selected, washed and squeezed using a manual fruit juicer (Jupiter Commercial Juice Press, Focus Foodservice, LLC Lincolnshire, IL, USA). Fruits were cut in halves, and squeezed with the rind. They were later filtered using white basket paper coffee filters (Mellita USA Inc., Clearwater FL, USA) to remove parts of remaining membrane and albedo. Afterwards, they were frozen at -26˚C in a Standex BCF93558-0DX6 blast freezer (Standex, Salem, NH, USA) for 45 minutes in 946 ml. Ziploc bags (SC Johnson, Racine, WI, USA), stored at -18°C, and reserved until used.

Pomegranate Juice (PJ) stored bags were thawed two days prior evaluation, and one day before preparation of the samples, and allowed to cool overnight until used.

Lipton Green tea (Unilever, Englewood Cliffs, NJ, USA) was purchased from a local grocery store at Manhattan, KS. Tea was prepared according to package instructions for Quart Iced Tea: four tea bags were brewed in 473 ml of boiling water for 1 and half minutes. After brewing, 710 grams of ice cubes were added and allowed to melt completely. Samples were prepared at the following juice- green tea (GT) ratios: 90-10, 80-20, 70-30, 60-40, 50-50, 40-60 vol/vol. the day before and refrigerated at 5 °C.

Sensory Evaluation

Descriptive Analysis

Sample Preparation

Half hour prior panel evaluation, 30 ml of each sample were poured in 96 ml Styrofoam lidded cups, with random 4 digit codes. More sample was available for tasting if requested.

Panelists

Six highly trained panelists from the Kansas State University Sensory Analysis Center evaluated the 6 samples in triplicates in three 1.5 hour sessions using as reference the definition attributes and references from a Pomegranate Juice Lexicon developed by Koppel and Chambers (2010) and a Green Tea Lexicon developed by Lee and Chambers (2007).

Panelists had previous experience evaluating different beverages, including PJ.

Orientation and Evaluation

During the orientation sessions, panelists were presented with the six samples and determined the attributes and references to be used. The final ballot was composed of 21 attributes (Table 4-1, Appendix C -). The attributes Pomegranate ID, and Green Tea like were added by the panel during the orientation sessions.

Samples were evaluated individually using a scale ranging from 0 to 15 with 0.5-point increments. Samples were evaluated in triplicates and 6 samples were evaluated in each session. Unsalted crackers, deionized water and cubed mozzarella cheese were used to clean their palates between samples. Additionally, 10-minute breaks were given after every two samples in order to clean panelist's palates and avoid carryover effect.

Table 4-1 - Definition and Reference Attributes for evaluation of PJ-GT blends.		
Attribute	**Definition**	**Reference**
Pomegranate ID	The sour, sweet, fruity aromatic that may be somewhat dark, musty, earthy, with an astringent mouthfeel. These aromatics are reminiscent of a combination of fruits that may or may not include concord grape, cranberries, blackberries, raspberries, cherries, currants etc. There are also a vegetable note of beets and carrots.	Fresh pomegranate juice diluted (1:1) = 3.5 Preparation: Dilute fresh pomegranate Juice 1(juice): 1(water). Serve in 1oz cup.
Green Tea – like	A somewhat green, dusty, dried plant leaf aromatic associated with green tea.	Lipton Green tea. Preparation: Brew tea following instructions for preparing ice tea.
Berry	The sweet, sour, sometimes dark aromatics associated with a variety of berries such as blackberries, cherries, currants, raspberries etc., excluding cranberries.	Blackwell Red Currant Jelly = 8.5
Cranberry	The sweet, fruity, slightly sour and sharp aromatics commonly associated with cranberries.	Old Orchard's Frozen Cranberry diluted (1:1) = 3.5 Ocean Spray Dried cranberries = 9.0 Preparation: Reconstitute Cranberry Concentrate according to instructions on the can. Dilute the reconstituted cranberry juice 1(juice):1(water)
Cherry	The sour, fruity, slightly bitter aromatics commonly associated with cherries.	RW Knudsen Cherry Juice diluted (1:2) = 4.0 Preparation: Dilute the cherry juice 1(juice):2(water), serve in 1oz cup.

Grape	The sweet, brown, fruity, musty aromatics commonly associated with grapes.	Welch's Concord Grape Juice diluted (1:1) = 5.0 Welch's White Grape Juice diluted (1:1) = 5.0 Dilute grape juices 1(juice): 1 (water), serve in 1 oz. cup
Floral	An aromatic blend of a variety of fruits, excluding citrus, cranberry and concord grape. May include apples, pears, white grapes etc.	Welch's White Grape Juice diluted (1:1) = 5.0 Dilute grape juice 1(juice): 1 (water)
Fruity	An aromatic blend of a variety of fruits, excluding citrus, cranberry and concord grape. May include apples, pears, white grapes etc.	Welch's white grape juice diluted (1:1) = 5.0 Dilute grape juice 1(juice): 1 (water)
Beet	The damp, musty/earthy, slightly sweet aromatics commonly associated with beets	Diluted Kroger Canned Beet juice (1:2) = 4.0 Preparation: Drain juice from beets. Dilute beet juice 1 (juice): 2 (water).
Green	Sharp, slightly pungent aromatics associated with green plant/vegetable matter, such as asparagus, Brussels sprouts, celery, green beans, parsley, spinach, etc.	Fresh Parsley water= 9.0 (flavor) Preparation: Weigh 25 g. of fresh parsley, rinse, chop, and add 300 ml of water. Let it sit for 15 minutes. Filter and serve the liquid part.
Musty/Earthy	Humus-like aromatics that may or may not include damp soil, decaying vegetation, or cellar-like characteristics.	Raw potatoes = 3.0 (aroma). Diluted Kroger canned beet juice (1:2) =7.0 (aroma). Preparation: Cut potato into slices, place in medium size snifter. Cover. Drain juice from beets, dilute beet juice 1(juice):2(water) Pour half cup in medium snifter, cover
Sweet	The fundamental taste factor associated with a sucrose solution.	2% Sucrose Solution = 2.0 4% Sucrose Solution = 4.0

Sweet Overall	The perception of the combination of sweet taste, sweet aromatics, caramelized, brown sugar, honey, and maple	3% C&H Golden Brown Sugar solution = 4.0
Woody	The aromatics associated with dry freshly cut wood.	Diamond Shelled Walnuts = 4.0
Salt	Fundamental taste factor of which sodium chloride is typical.	0.20% NaCl Solution = 2.5 0.25% NaCl Solution = 3.5
Sour	A fundamental taste factor of which citric acid in water is typical.	0.025% Citric Acid Solution = 2.5 0.050% Citric Acid Solution = 3.5 0.080% Citric Acid Solution = 5.0
Bitter	The fundamental taste factor of which caffeine or quinine is typical.	0.010% Caffeine Solution = 2.0 0.020% Caffeine Solution = 3.5 0.035% Caffeine Solution = 5.0
Metallic	The impression of slightly oxidized metal, such as iron, copper and silver spoons.	0.10% Potassium Chloride solution = 1.5
Astringent	The dry puckering mouthfeel associated with an alum solution.	0.05 % Alum Solution = 2.5 0.1 % Alum Solution = 5.0
Toothetch	A sensation of abrasion and drying of the surface of the teeth.	Welch's Concord Grape Juice diluted (1:1) = 5.0 Dilute concord grape juice 1(water):1(juice) and serve in 1 oz. cups
Color Intensity	The intensity of strength of the color from light to dark.	Pantone Color Bridge coated 7640 = 6.0 Pantone Color Bridge coated 7641 = 8.0 Pantone Color Bridge coated 7642= 10.0

Consumer Research

Sample Preparation

Samples were prepared as detailed in the Descriptive Analysis sample preparation. Half hour prior panel evaluation, 30 ml of each sample were poured in 96 ml Styrofoam lidded cups, with 4 digit codes and placed in refrigeration until served at 5 ±1 °C.

Consumers

Consumers were recruited from the Sensory Analysis Center database (Manhattan, KS, USA) to participate in an evaluation of a beverages study. Consumers were recruited, screened and scheduled using RedJade software (RedJade ®, Redwood Shores, CA, USA). A total of 100 consumers participated in the study (66% women, and 34% men) and satisfied the requirements in the screener: no pregnant or nursing women, over 18 years of age, no allergies or dietary restrictions, consumed Juice, Iced Tea or Juice-Tea beverages at least once a week, and were willing to try Pomegranate- Green tea flavor in a beverage (Appendix D -).

Consumers received a confirmation e-mail that they had qualified for the study and a reminder e-mail the day before the test.

Test Design and Evaluation

RedJade software (RedJade ®, Redwood Shores, CA, USA) was used to design the test, questionnaires and collect data.

Samples were presented monadically, and the serving order was randomized to appear in each of the six possible positions. Unsalted crackers and purified water were provided for consumer's palate cleansing.

The test was carried out in a period of 5 days, with 2 or 3 sessions per day. A total of 100 consumers participated in the study, attending to 1 of the scheduled sessions.

At the beginning of the test, consumers were presented with a consent form with general information of the test and participation in the study. Contact information for further questions was provided, and an electronically signature was collected.

Following, general demographic questions were presented (age, gender, income), followed by sample evaluation. Samples were served monadically, participants were asked to taste the samples and answer the presented questionnaire. Re tasting of the samples was allowed as many times as necessary (Appendix D - , Appendix E -).

Consumers were asked about the Overall liking of the samples on a 9-point hedonic scale, followed by questions about the Fruity Flavor, Tea Flavor, Sourness, Sweetness and Color of the samples, rating on a 5 point Just about right scale (from too little, to too much). After the last sample was presented, consumers were given general information on antioxidants and the Overall liking of the sample was asked again. *("Antioxidants are substances that protect cells from the damage caused by free radicals. Free radicals may play a part in cancer, heart disease, stroke, and other diseases of aging. (from www.cancer.gov). Antioxidants are found in several nuts, vegetables and fruits such as Pomegranates, and herbs such as green tea. After reading this information on the beverage you just tasted, please indicate: How much do you LIKE or DISLIKE this sample OVERALL?")* (Appendix F -

A Similar approach has been used by Lawless *et al.* (2013) who studied the effect of providing beneficial health related statements and reevaluation of the acceptance of black cherry, concord grape and pomegranate juice blends.

After the completion of sample evaluation, participants were asked a series of attitudinal questions based on studies conducted by Roininen *et al.* (2001) and Roininen *et al.* (1999) on health and taste factors of consumers. These questions were categorized in "General Health Interest", "Light Product Interest", "Natural product interest", "Craving for sweet foods", "Using food as a reward" and "Pleasure". The statements were answered using a 7-point Likert scale from dislike extremely to like extremely (Appendix G -

Total Phenolic Content Determination

Samples

Pomegranate Juice and Green tea blends were prepared following the steps in the Descriptive Analysis section the day prior determination and kept refrigerated at 5 °C until used. Pomegranate Juice and Green Tea samples were also measured.

Experimental determination

Total Phenolic Content (TPC) was determined using a modified spectrophotometric Folin – Ciocalteu method (Araujo *et al.* 2010; Tezcan *et al.* 2009; Koppel *et al.* 2014).
Three milliliters (3 ml) of each sample were extracted with 3 ml of 95:5 Methanol (Sigma Aldrich, St. Louis, MO, USA): HCl (Sigma Aldrich, St. Louis, MO, USA) and left for one hour in the dark. Samples were centrifuged at 3000 rpm for 15 minutes at 18 °C. The sample was resuspended with 3 ml of 95:5 Methanol: HCl and centrifuged again under the same conditions. Both supernatants were collected since some sediment was present in the juice samples, and made up to 25 ml with double distilled water. 20 microliters were diluted with 1.58 ml of distilled water, 100 microliters of Folin Denis reagent (Sigma Aldrich, St. Louis, MO, USA) and

300 microliters of a saturated sodium carbonate (Fisher Chemical, New Jersey, USA) solution and measured at 750 nm in a spectrophotometer (Thermo Scientific GENESYS 10S, Thermo Electron Scientific Instruments LLC, Madison, WI, USA). A Gallic Acid (Acros Organics, New Jersey, USA) standard curve was prepared following the same procedure as the samples. Measurements were run in triplicates.

Data Analysis

Analysis of Variance (ANOVA) was performed to examine differences in descriptive attributes of the different samples for PJ-GT at a 5% level of significance. Post-hoc means comparison using Fisher's LSD at 5% level of significance was performed to find differences in the samples.

Consumer data was analyzed using ANOVA, in order to explore differences in overall liking scores and Penalty Analysis was used to analyze Just About Right data.

Agglomerative Hierarchical Cluster Analysis (AHC) was conducted to cluster consumers into different groups, and ANOVA was run for each cluster. Post-hoc means comparison using Fisher's LSD at 5% level of significance was performed to find differences in the clusters. Preference Mapping was run using both consumer and descriptive data in order to determine the drivers of liking of the samples.

Attitudinal questions were separated using the median, in low and high subgroups (Sabbe *et al.* 2009). Percentages were calculated, and ANOVA was performed for each Health and Taste categories. Post-hoc means comparison using Fisher's LSD at 5% level of significance was performed to find differences in the samples for each category. Analysis of overall liking after information was given to participants was not analyzed since there was not sufficient data in each low and high categories of groups to run statistical analysis.

All statistical analysis were performed using XLSTAT (Addinsoft, New York, NY, U SA).

Results and Discussion

Descriptive Analysis

From 21 attributes evaluated, the following 14 attributes were found significantly different ($p<0.05$): pomegranate ID, green tea like, berry, cranberry, cherry, grape, floral, fruity, beet, green, sweet overall, sweet, bitter and color intensity. As expected, as samples increased in Pomegranate juice content, these were higher in intensity in attributes like cherry, grape, floral, pomegranate ID, sweetness, sweetness overall and color intensity, while with increasing Green Tea concentration, samples showed higher green, green tea like and lower color Intensity, beet and fruity flavor intensities (Table 4-2, Table 4-3). All samples had green and green tea like flavors, but the intensities decreased as Juice concentration rose.

Catechin content is the main responsible component of bitterness in green tea (Lee and Chambers 2007; Senanayake 2013); however, bitterness in the evaluated samples was found to be of low intensity, more similar to PJ bitterness reported by Koppel *et al.* (2014a), since samples were higher in PJ than GT.

Flavor attributes had weak intensities, lower than 4 points on a scale from 0 to 15 points. Koppel *et al.* (2014b) obtained similar results where frozen, pasteurized and dehydrated PJ samples were evaluated by a descriptive panel.

Lee and Chambers (2013) found that steam processed teas were characterized by green flavors like green, green beans and green herb-like, while roasting of leaves gave higher brown related flavors. Processing information (roast or steam processed) was not detailed from the GT producer. However, no brown notes were detected in the samples in this study. This may have been related to the more prominent PJ characteristics in the samples.

Lee and Chambers (2009) studied the effect of flavor changes when variables like brewing times and water temperature changed, and found that higher temperatures result in higher bitter, astringent and toothetch intensities, as well as longer brewing times that also provided higher intensities in seaweed flavor. The samples in this study were all brewed following the same time and temperatures. However, factors influencing flavor must be taken into account depending upon the desired characteristics of the product. For example, higher brewing times will result in higher Total Phenolic Content (TPC), but will result in a beverage higher in bitterness.

Table 4-2 – Mean intensity scores for PG-GT attributes. Means with different subscripts were significantly different (p<0.05) using Fisher´s LSD test.

	Pomegranate ID	Green Tea Like	Berry	Cranberry	Cherry	Grape	Floral	Fruity	Beet	Green	Musty/Earthy
90/10	3.61 a	2.19 d	2.86 ab	2.36 a	2.17 ab	1.86 ab	2.42 a	2.81 ab	1.47	1.86	1.97
80/20	3.75 a	2.25 d	2.92 a	2.47 a	2.25 a	2.03 a	2.47 a	2.89 a	1.50	1.944	2.03
70/30	3.67 a	2.53 c	2.67 bc	2.36 a	2.11 ab	2.03 a	2.44 a	2.75 ab	1.36	2.06	2.00
60/40	3.31 b	2.58 c	2.50 c	2.39 a	1.94 bc	1.69 bc	2.36 a	2.64 b	1.22	2.03	1.92
50/50	2.81 c	2.83 b	2.19 d	1.97 b	1.75 c	1.50 cd	2.14 b	2.36 c	1.22	2.08	1.83
40/60	2.58 c	3.14 a	1.92 e	2.00 b	1.36 d	1.31 d	1.92 c	2.17 c	1.14	2.31	1.86

Table 4-3 – (cont.) Mean Intensity scores for PJ-GT attributes. Means with different subscripts were significantly different (p<0.05) using Fisher's LSD test.

Sample	Woody	Sweet Overall	Sweet	Salt	Sour	Bitter	Metallic	Astringent	Toothetch	Color Intensity
90/10	1.83	3.08 a	2.58 a	1.86	2.56	3.00	0.86	2.92	2.31	12.06 a
80/20	1.86	3.11 a	2.50 a	1.89	2.64	2.89	0.83	2.86	2.25	11.58 b
70/30	1.92	2.92 ab	2.39 ab	1.83	2.56	2.81	0.69	3.00	2.29	10.86 c
60/40	1.89	2.78 bc	2.28 b	1.72	2.53	2.83	0.89	2.81	2.06	9.75 d
50/50	1.83	2.56 cd	2.19 b	1.72	2.56	2.89	0.86	2.92	2.06	8.72 e
40/60	1.86	2.38 d	1.88 c	1.72	2.58	3.14	1.00	3.00	2.22	8.25 f

Consumer Research

Overall liking

Overall liking of samples in Figure 4-1 showed that as GT concentration increased, the overall liking decreased. Sample 90-10 was the most liked, with an average overall liking of 6.5, while the least liked sample was the one with the highest GT concentration (40:60).

After Antioxidant Information was provided, consumers were asked to re-score overall liking. The mean scores for all samples increased. This information agreed with research conducted by Sabbe *et al.* (2009) where health claims had a positive effect on consumer acceptance of two different concentrations of acaí juices, at 4 and 40%. The overall mean liking scores were higher for the 40% concentration juice. However, 4% acai juice had higher scores than the 40% juice before and after information was provided to consumers, concluding that the acceptance of a product is more influenced on sensory liking rather than health claims of the products.

These results are also in line with Lawless *et al.* (2013), where different juice blends were evaluated and health related information was provided before and after tasting of products. Tourila *et al.* (1994) reported that providing verbal information increased the acceptance of novel and familiar foods.

According to Coleman *et al.* (2014), overall liking of bread rolls, before and after health claims were provided, were not significantly different, this might be due to presenting a product that consumers are not familiar with, or that the claims are also product dependent. However, Kihlberg *et al.* (2005) found that providing health related information to consumers affected their liking responses in a study conducted where health effect and ingredient origin were presented in different bread samples. The authors found that liking of three out of four samples was increased when health information was provided.

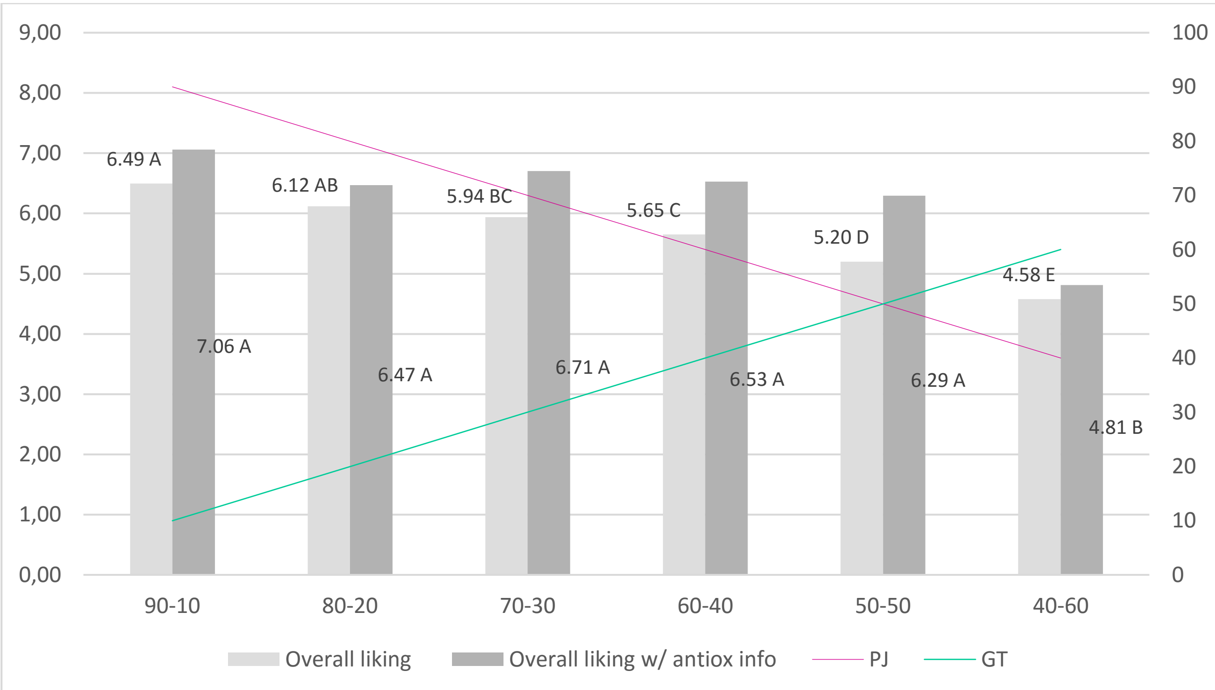

Figure 4-1-Mean scores for Overall Liking. Samples with different letters were significantly different (p<0.05) following Fisher's LSD significant differences.

Just about Right scales (JAR) combine attribute liking and intensity (Lawless and Heymann, 2010) on certain attributes of interest. The middle of the scale represents "just about right" intensity, and the anchors are "too little" to the left and "too much" to the right. The 20% cutoff limit was set for the percentage of not JAR consumers, which is generally used for Penalty analysis (Narayanan *et al.* 2014).

Figure 4-2 shows the percentage of consumers that perceived the attributes too little, JAR and too much. Consumers perceived higher PJ samples (70-30, 80-20, 90-40) to be Just About Right in Fruity Flavor, and Sweetness, but the Color of the samples was too dark. For Sourness and Tea Flavor attributes, the scores were similar for all samples. Sample 40-60 was too low in fruity flavor and sweetness.

Table 4-4 showed the mean drops for each attribute vs percentage of consumers. Sample 90-10 was perceived by half of consumers as being too low in tea flavor with too dark color, while sample 40-60 and 50-50 were perceived as too low in fruity flavor and sweetness, and with too much tea flavor. Samples 70-30 and 80-20 could be considered potential blends, since they were perceived by around 50% of consumer population to be JAR in all attributes.

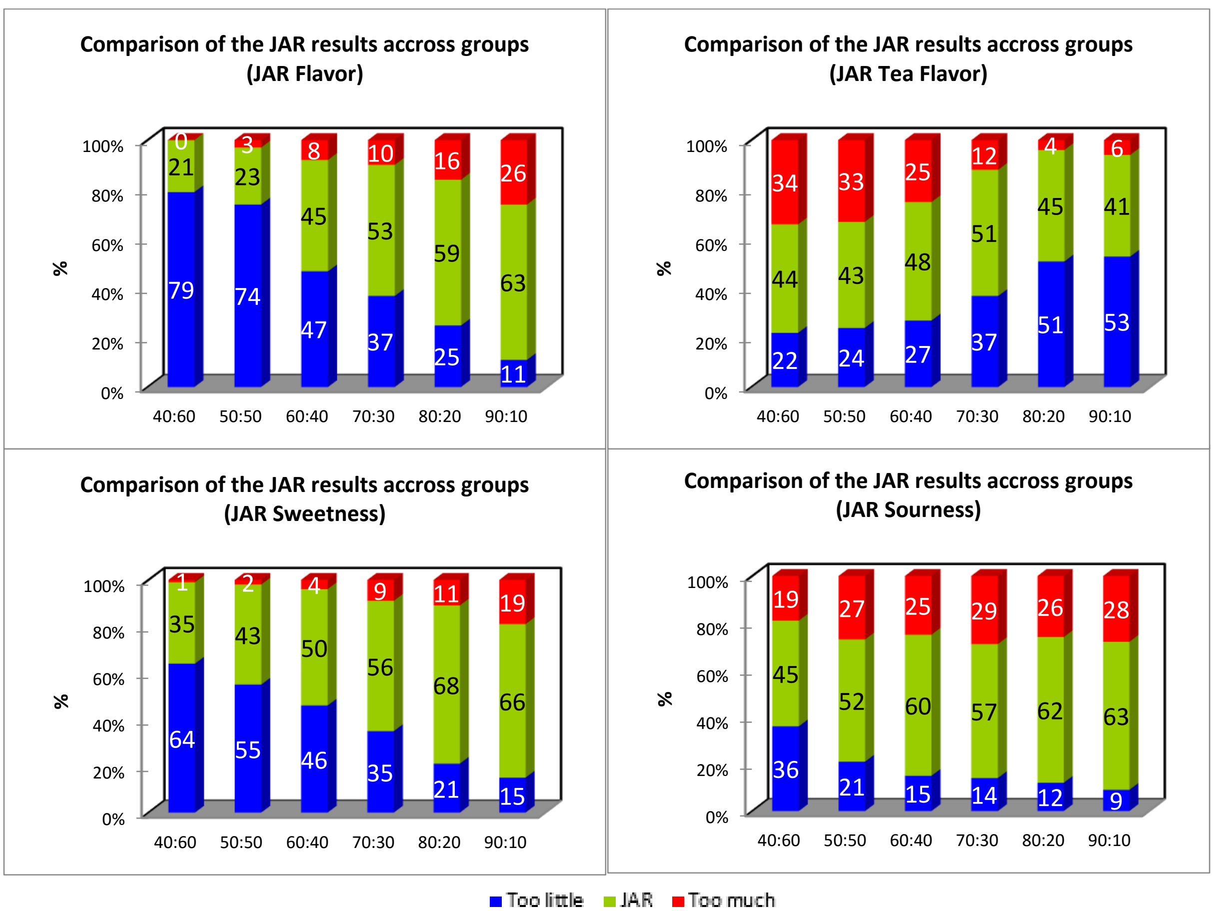

Figure 4-2 – Comparison of the JAR results across groups.

Table 4-4–Mean drops vs. percentages of samples. There is a significant drop in liking at p<0.05 for the attributes that are significant.

		40-60			50-50			60-40			70-30			80-20			90-10		
Variable	Level	%	Mean drops	p-value	%	Mean drops	p-value	%	Mean drops	p-value	%	Mean drops	p-value	%	Mean drops	p-value	%	Mean drops	p-value
JAR Flavor	Too little	79%	2,04	< 0.0001	74%	1,75	< 0.0001	47%	1,97	< 0.0001	37%	2,26	< 0.0001	25%	2,37	< 0.0001	11%	0,90	
	JAR	21%			23%			45%			53%			59%			63%		
	Too much	0%			3%	0,86		8%	2,53		10%	1,31		16%	0,85		26%	1,85	< 0.0001
JAR Tea Flavor	Too little	22%	0,98	0,026	24%	1,01	0,008	27%	0,55	0,188	37%	1,29	0,001	51%	1,06	0,004	53%	0,91	0,008
	JAR	44%			43%			48%			51%			45%			41%		
	Too much	34%	1,34	0,001	33%	2,11	< 0.0001	25%	1,81	< 0.0001	12%	2,08		4%	1,21		6%	1,93	
JAR Sourness	Too little	36%	1,32	0,000	21%	1,63	0,000	15%	0,12		14%	2,06		12%	1,00		9%	-0,73	
	JAR	45%			52%			60%			57%			62%			63%		
	Too much	19%	1,11		27%	1,20	0,002	25%	1,80	< 0.0001	29%	2,12	< 0.0001	26%	1,00	0,014	28%	1,79	< 0.0001
JAR Sweetness	Too little	64%	1,39	0,000	55%	1,60	< 0.0001	46%	1,90	< 0.0001	35%	1,51	< 0.0001	21%	2,28	< 0.0001	15%	1,66	
	JAR	35%			43%			50%			56%			68%			66%		
	Too much	1%	1,49		2%	0,59		4%	1,85		9%	1,13		11%	0,16		19%	0,92	
JAR Color	Too little	23%	0,85	0,038	13%	0,53		3%	1,35		3%	0,36		1%	2,35		1%	0,98	
	JAR	68%			72%			70%			64%			62%			52%		
	Too much	9%	-1,10		15%	-0,31		27%	-0,02	0,966	33%	1,24	0,001	37%	0,57	0,129	47%	1,00	0,003

Preference Mapping

A Preference Mapping (Figure 4-3) was performed to visualize how the different samples were related to descriptive attributes, and the drivers of overall liking of the samples. Dimension 1 accounted for 71.19% of the variability, and it can be explained with attributes like bitter, astringent and toothetch, while Dimension 2 with 10.83% of the variation was correlated with attributes like sweet, berry, pomegranate ID, fruity, grape, sweet overall, cranberry, cherry, floral, green tea like, and metallic.

Sweet, sweet overall, floral, and fruity attributes like pomegranate ID, berry, grape, cherry and cranberry were the main drivers of liking of the samples. This is consistent with the high overall liking scores of samples 90-10, 80-20 and 70-30.

Opposite to these attributes, attributes like green, green tea like and metallic were negatively correlated with consumer liking of the samples. Samples higher in this attributes, like sample 40- 60 and 50-50 were the least liked ones, and were perceived to be too low in sweetness, and fruity flavor.

Cluster Analysis

Cluster analysis (Figure 4-4) was performed and 3 consumer clusters were found. Demographics were similar for the three clusters. Cluster 1, composed by the majority of the consumers (n=44, 22% females and 18% males) liked samples 80-20 and 90-10 and disliked sample 40-60. The overall liking scores for this cluster were higher than for the other two clusters. Cluster 2 (n=30, 25% females and 8% males) disliked samples higher in GT: 50-50 and 40-60, but liked sample 90-10. Participants in Cluster 3 (n=26, 18% females and 10% males), liked sample 50-50 and gave the highest scores for the samples with higher GT concentration. This cluster did not have participants of 65 years or over.

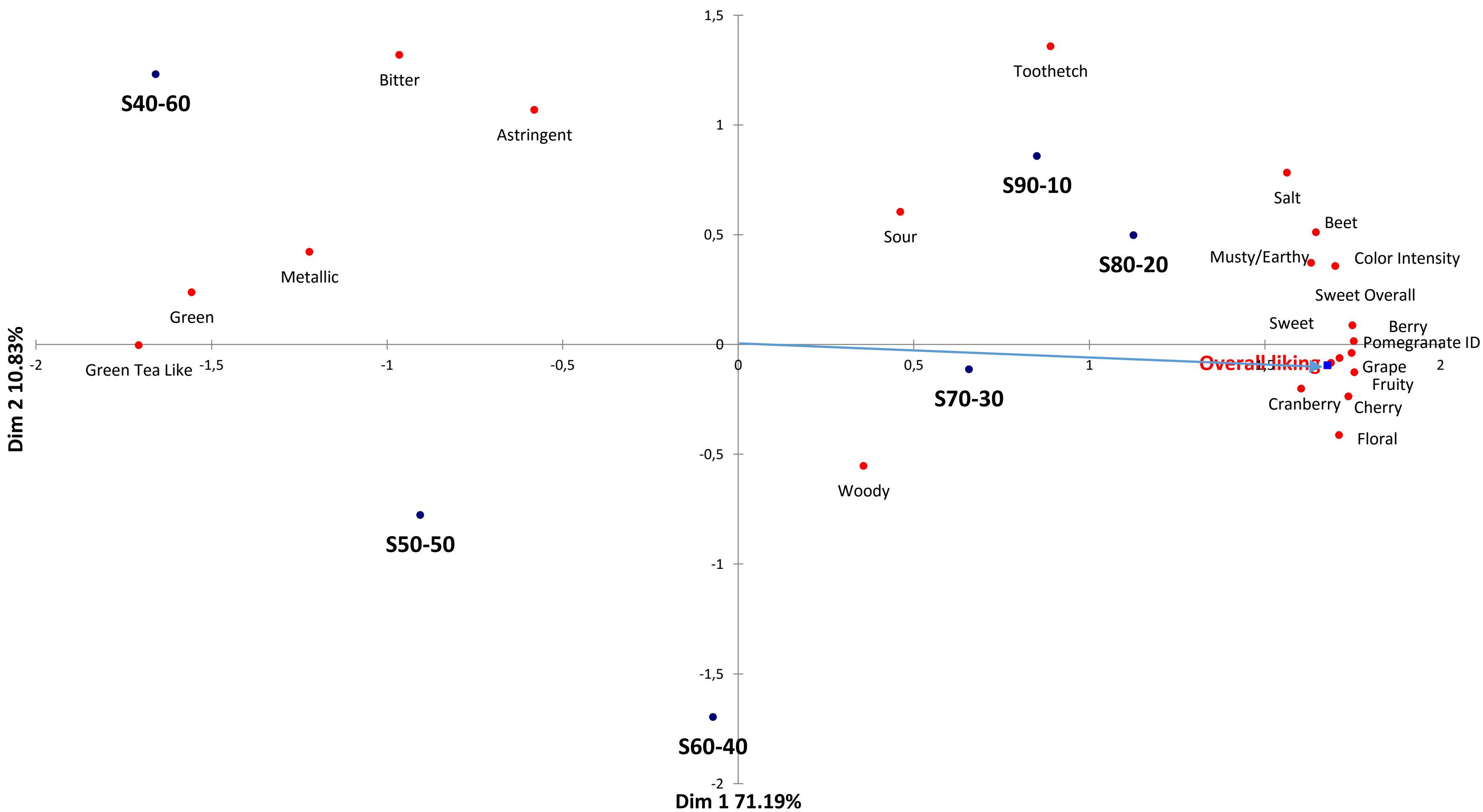

Figure 4-3 – Preference Mapping of Samples with dimensions 1 and 2 for the 6 PJ-GT samples and 21 descriptive attributes.

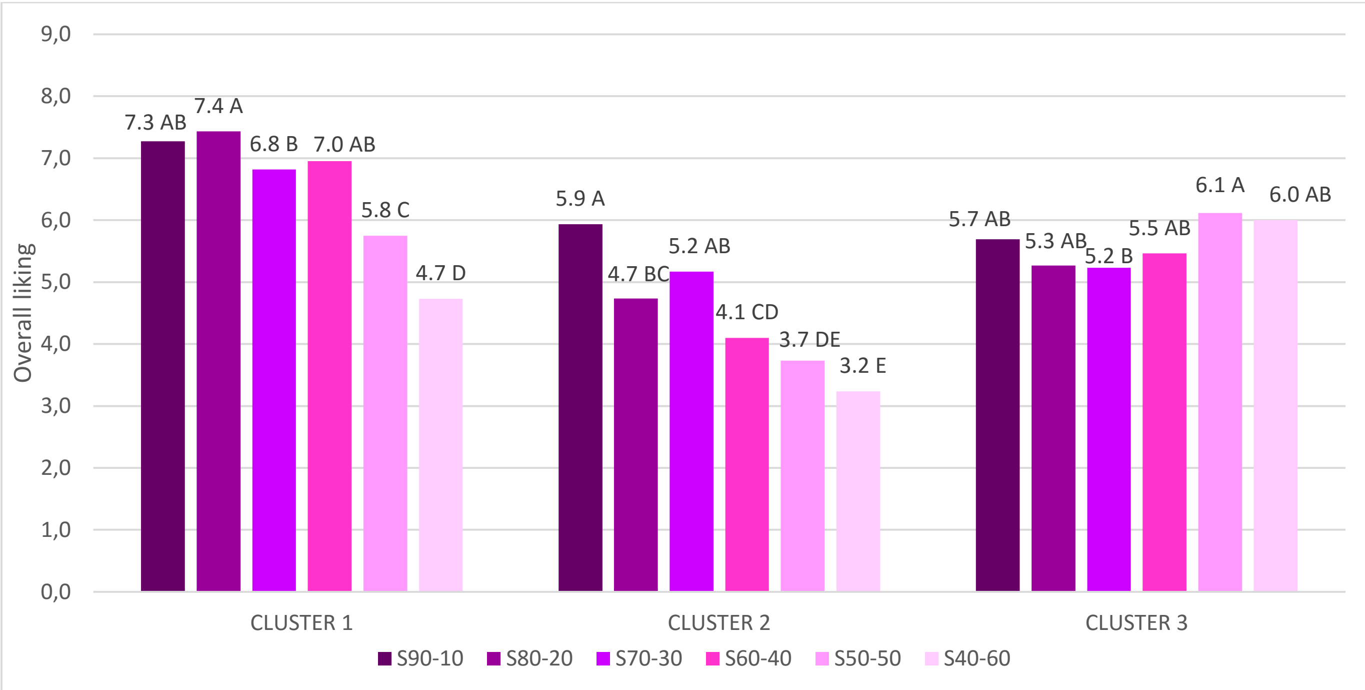

Figure 4-4 – Mean Overall liking by Cluster. Samples with different letters were significantly different (P<0.05) following Fisher's LSD significant differences.

Health and Taste Attitudes

It was found that in the high involvement subgroups of the Health factors, the percentage of women was higher than men. (Table 4-5). This might be due because women tend to be the primary food shoppers, and main responsible of the meal preparations in the household, as well as more open to make dietary changes in order to follow a healthy diet (Beardsworth *et al.* 2002).

Participants between 55 to 64 rated higher than younger participants in Light product interest and General Health. Probably due mainly to an increase in interest for maintaining good health and healthy eating (Hayes and Ross, 1987; Roininen *et al.* 1999).

For the taste related factors, males rated lower in Cravings for sweet foods than women. Roininen *et al.* (1999) found that cravings for chocolate, sweets and ice cream were correlated, and that chocolate was one of the foods that women craved the most. Also, in line with the results from this study, regardless of the Health factors, women were more worried about receiving pleasure from food, and therefore rated higher in the Pleasure factor.

Overall liking & Health and Taste Attitude Scales (HTAS)

Based on the Health and Taste categories, liking scores were compared across high and low groups. Results were similar to those obtained in the general Consumer results (Table 4-6). Blends high in Green Tea were less liked than those containing higher juice concentrations. Consumers from both Health and Taste categories were able to discriminate among juices. None of the Health and taste groups presented high overall liking for any of the low Juice concentration samples. These samples were characterized by higher tea and green tea like and lower berry, cranberry and sweetness. Just About Right results showed that samples higher in Green Tea were not sweet enough, and with too much tea flavor.

Overall liking scores were expected to be higher for the Health groups, in particular for the Natural Products interest, which contemplates including organic foods and non-processed foods into the diet. These results are in contrast with those obtained by Verbeke *et al.* (2006) who found higher acceptance of functional foods, given the health benefit of the product. However, in line with the present results, in a study on consumer acceptance of PJ with different processing treatments (Anderson *et al.* 2015), studied if acceptance of the juices was related to variety seeking tendencies finding only few differences among the different juices for different variety seeking groups. These results can be explained by the results obtained from Roininen *et al.* (1999) who found that General Health Interest and Pleasure scales were not correlated. This could show that given a determined health involvement of a consumer, no matter if it is high or low, it won't be related to the pleasure taste factor of a determined product.

Table 4-5 – Percentages of demographics by Health and Taste characteristics.

					Age						Education					Income			
		Total	Male	Female	18- 24	25-34	35-44	45-54	55-64	65 or over	Some school but no degree	High school degree	Some college	College degree	Graduate professional	Less than 25000	25000-50000	51000-10000	over 100000
General Interest	Low	44.00	29.54	70.45	11.36	18.18	20.45	22.73	22.73	4.55	2.33	2.33	20.93	39.53	34.88	20.93	18.60	46.51	13.95
	High	56.00	37.50	62.50	10.71	19.64	14.29	17.86	35.71	1.79	0.00	6.25	18.75	33.33	41.67	27.08	14.58	37.50	20.83
Light Products	Low	50.00	36.00	64.00	16.00	16.00	24.00	24.00	18.00	2.00	2.17	8.70	8.70	36.96	43.48	19.57	10.87	47.83	21.74
	High	50.00	32.00	68.00	6.00	22.00	10.00	16.00	42.00	4.00	0.00	0.00	31.11	35.56	33.33	28.89	22.22	35.56	13.33
Natural Products	Low	54.00	29.63	70.37	12.96	12.96	18.52	18.52	33.33	3.70	2.08	6.25	20.83	37.50	33.33	25.00	6.25	47.92	20.83
	High	46.00	39.13	60.86	8.70	26.09	15.22	21.74	26.09	2.17	0.00	2.33	18.60	34.88	44.19	23.26	27.91	34.88	13.95
Craving for Sweet	Low	45.00	44.44	55.55	8.89	28.89	15.56	17.78	28.89	0.00	0.00	7.32	12.20	41.46	39.02	26.19	26.19	38.10	9.52
	High	55.00	25.45	74.54	12.73	10.91	18.18	21.82	30.91	5.45	2.04	2.04	24.49	32.65	38.78	22.45	8.16	44.90	24.49
Food as Reward	Low	47.00	36.17	63.83	10.64	21.28	14.89	12.77	34.04	6.38	2.27	4.55	22.73	36.36	34.09	20.45	11.36	50.00	18.18
	High	53.00	32.08	67.92	11.32	16.98	18.87	26.42	26.42	0.00	0.00	4.26	17.02	36.17	42.55	27.66	21.28	34.04	17.02
Pleasure	Low	55.00	43.64	56.36	14.55	18.18	21.82	18.18	23.64	3.64	1.92	5.77	21.15	36.54	34.62	23.08	17.31	46.15	13.46
	High	45.00	22.22	77.78	6.67	20.00	11.11	22.22	37.78	2.22	0.00	2.56	17.95	35.90	43.59	25.64	15.38	35.90	23.08

Table 4-6 – Health and Taste overall liking mean scores. Samples with different letters were significantly different (p<0.05) following Fisher's LSD significant differences

	General Health Interest		Light Product Interest		Natural Products		Cravings for Sweet Foods		Food as Reward		Pleasure	
Sample	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
90-10	6.4 AB	6.5 A	6.3 A	6.6 A	6.7 A	6.2 A	6.51 A	6.4 A	6.7 A	6.2 A	6.4 A	6.6 A
80-20	6.5 A	5.7 B	6.3 A	5.8 BC	5.8 B	6.3 A	5.8 B	6.2 A	6.2 AB	5.9 AB	6.0 AB	6.1 AB
70-30	5.8 BC	6.0 AB	5.7 B	6.2 AB	5.6 BC	6.2 A	5.7 BC	6.0 A	6.0 B	5.8 ABC	5.6 BC	6.3 AB
60-40	5.7 C	5.7 B	5.6 B	5.7 BC	5.5 BC	5.9 A	5.5 BC	5.8 AB	5.9 B	5.5 BC	5.6 BC	5.8 BC
50-50	5.0 D	5.4 B	4.9 C	5.5 C	5.2 C	5.2 B	5.2 C	5.3 BC	5.2 C	5.3 C	5.2 C	5.2 CD
40-60	4.7 D	4.6 C	4.6 C	4.7 D	4.4 D	4.8 B	4.5 D	4.7 C	4.8 C	4.4 D	4.6 D	4.6 D

Total Phenolic content of Pomegranate Juice and Green tea blends.

TPC of the samples aligned from 697.4 to 2450.3 mg/L Gallic acid. Tezcan *et al.* (2009), Turkyilmaz *et al.* (2013), and Vazquez-Araujo *et al.* (2011), reported similar results.

It was found that the highest sample was the PJ. These results were found similar to those reported by other authors with the same juice extraction methods (Gil *et al.* 2000, Vázquez-Araujo *et al.*2010). With an increasing GT ratio, the samples showed decreasing Phenolic content. Plain GT had the lowest TPC (Table 4-7).

However, the TPC of the mixtures showed to be the sum of the TPC of the individual GT and PJ. Similar results were obtained by González-Molina *et al.* (2009) where mixtures of 25, 50 and 75% of PJ and lemon juice reported that TPC values were the sum of TPC of each component separately.

The TPC from the PJ showed to be higher to those obtained from juice prepared with arils only (Koppel *et al.* 2014 a). Gil *et al.* (2000) reported antioxidant activity of different PJ extraction methods, and juice extracted by pressing the fruit with the rind showed higher TPC and antioxidant results than those prepared using only seeds.

Results from TPC of Green Tea, was similar to those reported by Astill *et al.* (2001) who prepared the samples using an aqueous extract and no agitation following the product package instructions like the present study. Astill *et al.* (2001) reported several factors that affect the polyphenols extracted from tea infusions: particle size of leaves, manufacturing, variety, growing conditions and brewing method (loose leafs, tea bags and tea bag material), amount and temperature of water and agitation.

While agitation of the tea bag, higher brewing times and temperatures increases the extraction of chemicals in the liquid, the material of the bag will determine the ease of the soluble components to be transported to the outside liquid, as well as the leaf to water ratio, where lower ratios allow higher extraction of soluble compounds.

It also needs to be taken into account, that in Asian countries were drinking GT is very common, the first brew is sometimes discarded and the same leaves are used for multiple brews (Astill *et al.* 2001; Lee and Chambers, 2013; Hicks *et al.* 1996) this results in that the portion discarded is the one containing the highest polyphenol content.

Table 4-7 Total Phenolic Compounds in PJ and GT blends.

Sample	**TPC (mg Gallic Acid equivalents/L)**
Tea	697.436 ± 0.003
40:60	1312.821 ± 0.003
50:50	1564.569 ±0.008
60:40	1802.331± 0.003
70:30	1960.839 ± 0.005
80:20	2091.375 ± 0.009
90:10	2310.490 ± 0.013
Juice	2450.350 ± 0.009

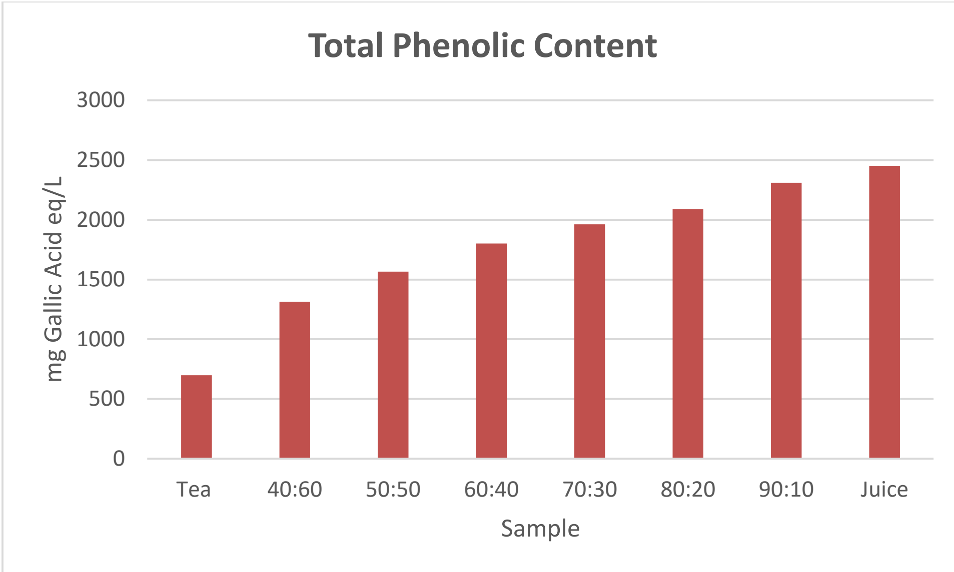

Figure 4-5- Total Phenolic Content in PJ – GT blends.

Conclusions

A descriptive sensory panel determined the flavor characteristics evaluated in six PJ-GT blends at different ratios, and a consumer panel of juice and tea drinkers assessed the overall liking of the samples before and after antioxidant information was provided.

Descriptive analysis on the samples showed higher intensities of juice related attributes for samples higher in Pomegranate Juice. green was the only attribute present related to a previous developed Green Tea lexicon

The overall liking was higher for samples with higher juice ratios. These samples were higher in sweetness, fruity, berry, pomegranate ID, cherry and grape flavors, and low in green tea like, green, bitter and astringent attributes.

Beneficial health information of the product had a positive influence on the overall liking of the samples, showing that providing information about the product can be a positive marketing approach.

TPC determinations showed that the mixtures of PJ and GT were the sum of their individual TPC content, and that the results accorded to those previously reported by other authors.

Further studies could be performed, changing variables like brewing time, water temperature, use of agitation, different tea bags or the use of loose leaves, as well as different particle size of leaves, to change the resulting TPC of the samples, to achieve a higher antioxidant beverage. However, it must be taken into account that flavor characteristics of the green tea, and consequently the blends, will also change.

Future research could also focus on determination of catechin content since catechin stability is dependent on pH (stable at pH < 4.5) and temperature (15% degradation for 7 hrs. at 100 °C) (Chen *et al.* 2001; Zhu *et al.* 1997). This factors are of importance in order to maintain the catechin content throughout the blends production process, taking into account how the addition of preservatives and pasteurization processes would influence on the final product.

It would be interesting to develop a reverse version of the blends, that means ratios higher in tea, enriched with Pomegranate juice, in order to increase the likeability of tea and enhance the health properties given that PJ has higher TPC content than GT, as well as adding value to GT which is a product that has a lower cost than PJ.

The study presents some limitations. The effect of added information was studied only for PJ-GT blends and with the addition of one specific health information. Further studies might consider investigating the different health effects as well as different products. The consumer sample might be higher for future studies in order to be able to compare the effect of added information on Health and Taste subgroups, given that the sample data was too small to run statistical analysis.

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Appendix A - Ballot for Descriptive Sensory Analysis of Pomegranate Seeds

Panelist __________ Sample _____________ Date ______________

Berry: 0 0.5 1 1.5 2 2.5 3 3.5 4 4.5 5 5.5 6 6.5 7 7.5 8 8.5 9 9.5 10 10.5 11 11.5 12 12.5 13 13.5 14 14.5 15

Cranberry: 0 0.5 1 1.5 2 2.5 3 3.5 4 4.5 5 5.5 6 6.5 7 7.5 8 8.5 9 9.5 10 10.5 11 11.5 12 12.5 13 13.5 14 14.5 15

Cherry: 0 0.5 1 1.5 2 2.5 3 3.5 4 4.5 5 5.5 6 6.5 7 7.5 8 8.5 9 9.5 10 10.5 11 11.5 12 12.5 13 13.5 14 14.5 15

Grape: 0 0.5 1 1.5 2 2.5 3 3.5 4 4.5 5 5.5 6 6.5 7 7.5 8 8.5 9 9.5 10 10.5 11 11.5 12 12.5 13 13.5 14 14.5 15

Floral: 0 0.5 1 1.5 2 2.5 3 3.5 4 4.5 5 5.5 6 6.5 7 7.5 8 8.5 9 9.5 10 10.5 11 11.5 12 12.5 13 13.5 14 14.5 15

Fruity: 0 0.5 1 1.5 2 2.5 3 3.5 4 4.5 5 5.5 6 6.5 7 7.5 8 8.5 9 9.5 10 10.5 11 11.5 12 12.5 13 13.5 14 14.5 15

Beet: 0 0.5 1 1.5 2 2.5 3 3.5 4 4.5 5 5.5 6 6.5 7 7.5 8 8.5 9 9.5 10 10.5 11 11.5 12 12.5 13 13.5 14 14.5 15

Musty Earthy: 0 0.5 1 1.5 2 2.5 3 3.5 4 4.5 5 5.5 6 6.5 7 7.5 8 8.5 9 9.5 10 10.5 11 11.5 12 12.5 13 13.5 14 14.5 15

Woody: 0 0.5 1 1.5 2 2.5 3 3.5 4 4.5 5 5.5 6 6.5 7 7.5 8 8.5 9 9.5 10 10.5 11 11.5 12 12.5 13 13.5 14 14.5 15

Sweet: 0 0.5 1 1.5 2 2.5 3 3.5 4 4.5 5 5.5 6 6.5 7 7.5 8 8.5 9 9.5 10 10.5 11 11.5 12 12.5 13 13.5 14 14.5 15

Salt: 0 0.5 1 1.5 2 2.5 3 3.5 4 4.5 5 5.5 6 6.5 7 7.5 8 8.5 9 9.5 10 10.5 11 11.5 12 12.5 13 13.5 14 14.5 15

Sour: 0 0.5 1 1.5 2 2.5 3 3.5 4 4.5 5 5.5 6 6.5 7 7.5 8 8.5 9 9.5 10 10.5 11 11.5 12 12.5 13 13.5 14 14.5 15

Bitter: 0 0.5 1 1.5 2 2.5 3 3.5 4 4.5 5 5.5 6 6.5 7 7.5 8 8.5 9 9.5 10 10.5 11 11.5 12 12.5 13 13.5 14 14.5 15

Astringent : 0 0.5 1 1.5 2 2.5 3 3.5 4 4.5 5 5.5 6 6.5 7 7.5 8 8.5 9 9.5 10 10.5 11 11.5 12 12.5 13 13.5 14 14.5 15

Toothetch: 0 0.5 1 1.5 2 2.5 3 3.5 4 4.5 5 5.5 6 6.5 7 7.5 8 8.5 9 9.5 10 10.5 11 11.5 12 12.5 13 13.5 14 14.5 15

Texture

Peel Firmness: 0 0.5 1 1.5 2 2.5 3 3.5 4 4.5 5 5.5 6 6.5 7 7.5 8 8.5 9 9.5 10 10.5 11 11.5 12 12.5 13 13.5 14 14.5 15

Seed Hardness: 0 0.5 1 1.5 2 2.5 3 3.5 4 4.5 5 5.5 6 6.5 7 7.5 8 8.5 9 9.5 10 10.5 11 11.5 12 12.5 13 13.5 14 14.5 15

Appendix B - Ballot for Descriptive Sensory Analysis of Pomegranate Seeds: Individual evaluations and Consensus

Panelist __________ Sample _____________ Date ______________

Berry: **0 0.5 1 1.5 2 2.5 3 3.5 4 4.5 5 5.5 6 6.5 7 7.5 8 8.5 9 9.5 10 10.5 11 11.5 12 12.5 13 13.5 14 14.5 15**

Cranberry: **0 0.5 1 1.5 2 2.5 3 3.5 4 4.5 5 5.5 6 6.5 7 7.5 8 8.5 9 9.5 10 10.5 11 11.5 12 12.5 13 13.5 14 14.5 15**

Cherry: **0 0.5 1 1.5 2 2.5 3 3.5 4 4.5 5 5.5 6 6.5 7 7.5 8 8.5 9 9.5 10 10.5 11 11.5 12 12.5 13 13.5 14 14.5 15**

Grape: **0 0.5 1 1.5 2 2.5 3 3.5 4 4.5 5 5.5 6 6.5 7 7.5 8 8.5 9 9.5 10 10.5 11 11.5 12 12.5 13 13.5 14 14.5 15**

Floral: **0 0.5 1 1.5 2 2.5 3 3.5 4 4.5 5 5.5 6 6.5 7 7.5 8 8.5 9 9.5 10 10.5 11 11.5 12 12.5 13 13.5 14 14.5 15**

Fruity: **0 0.5 1 1.5 2 2.5 3 3.5 4 4.5 5 5.5 6 6.5 7 7.5 8 8.5 9 9.5 10 10.5 11 11.5 12 12.5 13 13.5 14 14.5 15**

Beet: **0 0.5 1 1.5 2 2.5 3 3.5 4 4.5 5 5.5 6 6.5 7 7.5 8 8.5 9 9.5 10 10.5 11 11.5 12 12.5 13 13.5 14 14.5 15**

Musty Earthy: **0 0.5 1 1.5 2 2.5 3 3.5 4 4.5 5 5.5 6 6.5 7 7.5 8 8.5 9 9.5 10 10.5 11 11.5 12 12.5 13 13.5 14 14.5 15**

Woody: **0 0.5 1 1.5 2 2.5 3 3.5 4 4.5 5 5.5 6 6.5 7 7.5 8 8.5 9 9.5 10 10.5 11 11.5 12 12.5 13 13.5 14 14.5 15**

Sweet: **0 0.5 1 1.5 2 2.5 3 3.5 4 4.5 5 5.5 6 6.5 7 7.5 8 8.5 9 9.5 10 10.5 11 11.5 12 12.5 13 13.5 14 14.5 15**

Salt: **0 0.5 1 1.5 2 2.5 3 3.5 4 4.5 5 5.5 6 6.5 7 7.5 8 8.5 9 9.5 10 10.5 11 11.5 12 12.5 13 13.5 14 14.5 15**

Sour: **0 0.5 1 1.5 2 2.5 3 3.5 4 4.5 5 5.5 6 6.5 7 7.5 8 8.5 9 9.5 10 10.5 11 11.5 12 12.5 13 13.5 14 14.5 15**

Bitter: **0 0.5 1 1.5 2 2.5 3 3.5 4 4.5 5 5.5 6 6.5 7 7.5 8 8.5 9 9.5 10 10.5 11 11.5 12 12.5 13 13.5 14 14.5 15**

Astringent : **0 0.5 1 1.5 2 2.5 3 3.5 4 4.5 5 5.5 6 6.5 7 7.5 8 8.5 9 9.5 10 10.5 11 11.5 12 12.5 13 13.5 14 14.5 15**

Toothetch: **0 0.5 1 1.5 2 2.5 3 3.5 4 4.5 5 5.5 6 6.5 7 7.5 8 8.5 9 9.5 10 10.5 11 11.5 12 12.5 13 13.5 14 14.5 15**

Texture

Peel Firmness: **0 0.5 1 1.5 2 2.5 3 3.5 4 4.5 5 5.5 6 6.5 7 7.5 8 8.5 9 9.5 10 10.5 11 11.5 12 12.5 13 13.5 14 14.5 15**

Seed Hardness: **0 0.5 1 1.5 2 2.5 3 3.5 4 4.5 5 5.5 6 6.5 7 7.5 8 8.5 9 9.5 10 10.5 11 11.5 12 12.5 13 13.5 14 14.5 15**

Appendix C - Ballot for Descriptive Sensory Analysis of PJ-GT blends

Panelist __________ Sample ______________ Date _______

Pomegranate ID:	**0**	**0.5**	**1**	**1.5**	**2**	**2.5**	**3**	**3.5**	**4**	**4.5**	**5**	**5.5**	**6**	**6.5**	**7**	**7.5**	**8**	**8.5**	**9**	**9.5**	**10**	**10.5**	**11**	**11.5**	**12**	**12.5**	**13**	**13.5**	**14**	**14.5**	**15**
Green Tea-like:	**0**	**0.5**	**1**	**1.5**	**2**	**2.5**	**3**	**3.5**	**4**	**4.5**	**5**	**5.5**	**6**	**6.5**	**7**	**7.5**	**8**	**8.5**	**9**	**9.5**	**10**	**10.5**	**11**	**11.5**	**12**	**12.5**	**13**	**13.5**	**14**	**14.5**	**15**
Berry:	**0**	**0.5**	**1**	**1.5**	**2**	**2.5**	**3**	**3.5**	**4**	**4.5**	**5**	**5.5**	**6**	**6.5**	**7**	**7.5**	**8**	**8.5**	**9**	**9.5**	**10**	**10.5**	**11**	**11.5**	**12**	**12.5**	**13**	**13.5**	**14**	**14.5**	**15**
Cranberry:	**0**	**0.5**	**1**	**1.5**	**2**	**2.5**	**3**	**3.5**	**4**	**4.5**	**5**	**5.5**	**6**	**6.5**	**7**	**7.5**	**8**	**8.5**	**9**	**9.5**	**10**	**10.5**	**11**	**11.5**	**12**	**12.5**	**13**	**13.5**	**14**	**14.5**	**15**
Cherry:	**0**	**0.5**	**1**	**1.5**	**2**	**2.5**	**3**	**3.5**	**4**	**4.5**	**5**	**5.5**	**6**	**6.5**	**7**	**7.5**	**8**	**8.5**	**9**	**9.5**	**10**	**10.5**	**11**	**11.5**	**12**	**12.5**	**13**	**13.5**	**14**	**14.5**	**15**
Grape:	**0**	**0.5**	**1**	**1.5**	**2**	**2.5**	**3**	**3.5**	**4**	**4.5**	**5**	**5.5**	**6**	**6.5**	**7**	**7.5**	**8**	**8.5**	**9**	**9.5**	**10**	**10.5**	**11**	**11.5**	**12**	**12.5**	**13**	**13.5**	**14**	**14.5**	**15**
Floral:	**0**	**0.5**	**1**	**1.5**	**2**	**2.5**	**3**	**3.5**	**4**	**4.5**	**5**	**5.5**	**6**	**6.5**	**7**	**7.5**	**8**	**8.5**	**9**	**9.5**	**10**	**10.5**	**11**	**11.5**	**12**	**12.5**	**13**	**13.5**	**14**	**14.5**	**15**
Fruity:	**0**	**0.5**	**1**	**1.5**	**2**	**2.5**	**3**	**3.5**	**4**	**4.5**	**5**	**5.5**	**6**	**6.5**	**7**	**7.5**	**8**	**8.5**	**9**	**9.5**	**10**	**10.5**	**11**	**11.5**	**12**	**12.5**	**13**	**13.5**	**14**	**14.5**	**15**
Beet:	**0**	**0.5**	**1**	**1.5**	**2**	**2.5**	**3**	**3.5**	**4**	**4.5**	**5**	**5.5**	**6**	**6.5**	**7**	**7.5**	**8**	**8.5**	**9**	**9.5**	**10**	**10.5**	**11**	**11.5**	**12**	**12.5**	**13**	**13.5**	**14**	**14.5**	**15**
Green:	**0**	**0.5**	**1**	**1.5**	**2**	**2.5**	**3**	**3.5**	**4**	**4.5**	**5**	**5.5**	**6**	**6.5**	**7**	**7.5**	**8**	**8.5**	**9**	**9.5**	**10**	**10.5**	**11**	**11.5**	**12**	**12.5**	**13**	**13.5**	**14**	**14.5**	**15**
Musty Earthy:	**0**	**0.5**	**1**	**1.5**	**2**	**2.5**	**3**	**3.5**	**4**	**4.5**	**5**	**5.5**	**6**	**6.5**	**7**	**7.5**	**8**	**8.5**	**9**	**9.5**	**10**	**10.5**	**11**	**11.5**	**12**	**12.5**	**13**	**13.5**	**14**	**14.5**	**15**
Woody:	**0**	**0.5**	**1**	**1.5**	**2**	**2.5**	**3**	**3.5**	**4**	**4.5**	**5**	**5.5**	**6**	**6.5**	**7**	**7.5**	**8**	**8.5**	**9**	**9.5**	**10**	**10.5**	**11**	**11.5**	**12**	**12.5**	**13**	**13.5**	**14**	**14.5**	**15**
Sweet Overall:	**0**	**0.5**	**1**	**1.5**	**2**	**2.5**	**3**	**3.5**	**4**	**4.5**	**5**	**5.5**	**6**	**6.5**	**7**	**7.5**	**8**	**8.5**	**9**	**9.5**	**10**	**10.5**	**11**	**11.5**	**12**	**12.5**	**13**	**13.5**	**14**	**14.5**	**15**
Sweet:	**0**	**0.5**	**1**	**1.5**	**2**	**2.5**	**3**	**3.5**	**4**	**4.5**	**5**	**5.5**	**6**	**6.5**	**7**	**7.5**	**8**	**8.5**	**9**	**9.5**	**10**	**10.5**	**11**	**11.5**	**12**	**12.5**	**13**	**13.5**	**14**	**14.5**	**15**
Salt:	**0**	**0.5**	**1**	**1.5**	**2**	**2.5**	**3**	**3.5**	**4**	**4.5**	**5**	**5.5**	**6**	**6.5**	**7**	**7.5**	**8**	**8.5**	**9**	**9.5**	**10**	**10.5**	**11**	**11.5**	**12**	**12.5**	**13**	**13.5**	**14**	**14.5**	**15**
Sour:	**0**	**0.5**	**1**	**1.5**	**2**	**2.5**	**3**	**3.5**	**4**	**4.5**	**5**	**5.5**	**6**	**6.5**	**7**	**7.5**	**8**	**8.5**	**9**	**9.5**	**10**	**10.5**	**11**	**11.5**	**12**	**12.5**	**13**	**13.5**	**14**	**14.5**	**15**
Bitter:	**0**	**0.5**	**1**	**1.5**	**2**	**2.5**	**3**	**3.5**	**4**	**4.5**	**5**	**5.5**	**6**	**6.5**	**7**	**7.5**	**8**	**8.5**	**9**	**9.5**	**10**	**10.5**	**11**	**11.5**	**12**	**12.5**	**13**	**13.5**	**14**	**14.5**	**15**

Metallic: **0 0.5 1 1.5 2 2.5 3 3.5 4 4.5 5 5.5 6 6.5 7 7.5 8 8.5 9 9.5 10 10.5 11 11.5 12 12.5 13 13.5 14 14.5 15**

Astringent: **0 0.5 1 1.5 2 2.5 3 3.5 4 4.5 5 5.5 6 6.5 7 7.5 8 8.5 9 9.5 10 10.5 11 11.5 12 12.5 13 13.5 14 14.5 15**

Toothetch: **0 0.5 1 1.5 2 2.5 3 3.5 4 4.5 5 5.5 6 6.5 7 7.5 8 8.5 9 9.5 10 10.5 11 11.5 12 12.5 13 13.5 14 14.5 15**

Color Intensity: **0 0.5 1 1.5 2 2.5 3 3.5 4 4.5 5 5.5 6 6.5 7 7.5 8 8.5 9 9.5 10 10.5 11 11.5 12 12.5 13 13.5 14 14.5 15**

Appendix D - Consumer Study Screener

1. Gender - Single Selection

Male 1

Female 2

2. Are you pregnant or nursing? – Single Selection

Yes 1 * **terminate**

No 2

3. What is your age? – Single Selection

Under 18 1 * **terminate**

18-24 2

25-34 3

35-44 4

45-54 5

55-64 6

65 or over 7

4. Do you have any known allergies or dietary restrictions?

Yes 1 * **terminate**

No 2

5. Which of the following drinks do you consume regularly? (mark all that apply) – Multiple Selection

Soda 1

Juice 2 * **terminate if not selected**

Iced Tea 3 * **terminate if not selected**

Juice-Tea beverages 4 * **terminate if not selected**

Coffee 5

Iced Coffee 6

6. How often do you drink any of the above selected drinks? – Single Selection

Once per day 1

4 to 5 times per week 2

2 to 3 times per week 3

Once per week 4 * **terminate**

Less than once per week 5 * **terminate**

7. Which of the following flavors would you consider trying in a cold beverage? – Multiple Selection

Cranberry – Mango 1

Pomegranate - Green Tea 2 * **terminate if not selected**

Orange – Pineapple 3

Blueberry – Cherry 4

Cherry - Black Tea 5

Qualified Message

You have qualified for a Mixed beverage study starting on February 29th, 2016. The study will take approximately a half hour, and you will be compensated with $ 15 for your time.

Are you interested in participating in this study?

Yes 1

No 2

Option 1 – Yes takes the participant to schedule the session.

Option 2 – No – Send to end message

End Message

Thank you for your interest in participating in Project Green Study. Thank you for your time. We look forward your participation in future studies at The Sensory Analysis Center.

Appendix E - Consumer Study Consent Form

1.I agree to participate as a panelist for research at the Kansas State University Sensory Analysis Center.

2. I understand that the purpose of this research is to participate in a taste test evaluating six samples of Pomegranate Juice and Green Tea blends.

3. I understand that if I have any food allergies I should not participate in the study.

4. For this test, I will receive $15 when I complete this 30-45-minute study.

5. I understand that my performance as an individual will be treated as research data and will in no way be associated with me for identification purposes, thereby assuring confidentiality of my performance and responses.

6. I understand that I do not have to participate in research, and that if I choose not to participate, there will be no penalty.

7. I understand that I may withdraw from this research at any time.

8. If I have any questions concerning this study, I understand that I may contact Federica Higa, 136 Ice Hall, Kansas State University, Manhattan, KS at 785-532-0144, or Kadri Koppel at 785-532-0163.

9. If I have questions about my rights as a consumer or about the manner in which this research was conducted, I may contact Rick Scheidt, Chair, Committee on Research Involving Human Subjects, at 203 Fairchild Hall, or Gerald Jaax, Associate Vice-provost for Research, 1 Fairchild Hall (785-532-2334).

Appendix F - Consumer Study – Questionnaire

CONSUMER QUESTIONNAIRE

Date:

Panelist # _____

Sample: ____

Mark an X in the box that best represents your answer. Please taste the sample and answer the following questions. Re-taste as necessary.

1. How much do you LIKE or DISLIKE this sample OVERALL?

Dislike Extremely	Dislike Very Much	Dislike Moderately	Dislike Slightly	Neither Like nor Dislike	Like Slightly	Like Moderately	Like Very Much	Like Extremely

2. How would you describe the FRUITY FLAVOR in this sample?

Not at all Fruity	Not Fruity enough	Just About Right Fruity	Too Fruity	Much Too Fruity
☐	☐	☐	☐	☐

3. How would you describe the TEA FLAVOR in this sample?

Not at all Tea	Not Tea enough	Just About Right Tea	Too Tea	Much Too Tea
☐	☐	☐	☐	☐

4. How would you describe the SOURNESS of this sample?

Not at all Sour	Not Sour enough	Just About Right Sour	Too Sour	Much Too Sour
☐	☐	☐	☐	☐

5. How would you describe the SWEETNESS of this sample?

Not at all Sweet Not Sweet enough Just About Right Sweet Too Sweet Much Too Sweet

☐ ☐ ☐ ☐ ☐

6. How would you describe the COLOR of this sample?

Not at all Dark Not Dark enough Just About Right Dark Too Dark Much Too Dark

☐ ☐ ☐ ☐ ☐

CONSUMER QUESTIONNAIRE – Last Sample

Date:

Panelist # _____

Sample: ____

Mark an X in the box that best represents your answer. Please taste the sample and answer the following questions. Re-taste as necessary.

1. How much do you LIKE or DISLIKE this sample OVERALL?

Dislike Extremely	Dislike Very Much	Dislike Moderately	Dislike Slightly	Neither Like nor Dislike	Like Slightly	Like Moderately	Like Very Much	Like Extremely

2. How would you describe the FRUITY FLAVOR in this sample?

Not at all Fruity Not Fruity enough Just About Right Fruity Too Fruity Much Too Fruity

☐ ☐ ☐ ☐ ☐

3. How would you describe the TEA FLAVOR in this sample?

Not at all Tea Not Tea enough Just About Right Tea Too Tea Much Too Tea

☐ ☐ ☐ ☐ ☐

4. How would you describe the SOURNESS of this sample?

Not at all Sour	Not Sour enough	Just About Right Sour	Too Sour	Much Too Sour
☐	☐	☐	☐	☐

5. How would you describe the SWEETNESS of this sample?

Not at all Sweet	Not Sweet enough	Just About Right Sweet	Too Sweet	Much Too Sweet
☐	☐	☐	☐	☐

6. How would you describe the COLOR of this sample?

Not at all Dark	Not Dark enough	Just About Right Dark	Too Dark	Much Too Dark
☐	☐	☐	☐	☐

7. Antioxidants are substances that protect cells from the damage caused by free radicals. Free radicals may play a part in cancer, heart disease, stroke, and other diseases of aging. (from www.cancer.gov)

Antioxidants are found in several nuts, vegetables and fruits such as Pomegranates, and herbs such as green tea,

After reading this information on the beverage you just tasted, please indicate:

How much do you LIKE or DISLIKE this sample OVERALL?

Dislike Extremely	Dislike Very Much	Dislike Moderately	Dislike Slightly	Neither Like nor Dislike	Like Slightly	Like Moderately	Like Very Much	Like Extremely

Appendix G - Consumer Study – Attitudinal Questions

Please, answer the following questions:

The scale presented was a 7 point Likert scale for all questions:

Strongly Disagree	Disagree	Somewhat Disagree	Neither Agree or Disagree	Agree	Somewhat Agree	Strongly Agree

1. I am very particular about the healthiness of food
2. I always follow a healthy and balanced diet
3. It is important for me that my diet is low in fat
4. It is important for me that my daily diet contains a lot of vitamins and minerals
5. I eat what I like and I do not worry about healthiness of food
6. I do not avoid any foods, even if they may raise my cholesterol
7. The healthiness of foods has little impact on my food choices
8. The healthiness of snacks makes no difference to me
9. In my opinion, the use of light products does not improve one's health
10. I do not think that light products are healthier than conventional products
11. I believe that eating light products keeps one's cholesterol level under control
12. In my opinion light products don't help drop cholesterol levels
13. I believe that eating light products keeps one's body in good shape
14. In my opinion by eating light products one can eat more without getting too many calories
15. I do not care about additives in my daily diet
16. In my opinion, organically grown foods are no better for my health than those grown conventionally
17. In my opinion, artificially flavored foods are not harmful for my health
18. I try to eat foods that do not contain additives

19. I would like to eat organically grown vegetables
20. I do not eat processed foods, because I do not know what they contain
21. In my opinion it is strange that some people have cravings for chocolate
22. In my opinion it is strange that some people have cravings for sweets
23. In my opinion it is strange that some people have cravings for ice-cream
24. I often have cravings for sweets
25. I often have cravings for chocolate
26. I often have cravings for ice-cream
27. I reward myself by buying something really tasty
28. I reward myself by buying something really delicious
29. When I am feeling down I want to treat myself with something really delicious
30. I avoid rewarding myself with food
31. In my opinion, comforting oneself by eating is self-deception
32. I try to avoid eating delicious food when I am feeling down
33. I do not believe that food should always be a source of pleasure
34. The appearance of food makes no difference to me
35. It is important to me to eat delicious food on weekdays as well as weekends
36. When I eat, I concentrate on enjoying the taste of food
37. I finish my meal even when I do not like the taste of food
38. An essential part of my weekend is eating delicious food

Appendix H - SAS ® Code for Analyzing descriptive data of Consensus and Individual data

ANOVA

```
ods rtf;

data (data name);

input Fruit$ Location$ atr1 atr2 atr3 atr4 atr5 atr6 atr7 atr8 atr9 atr10 atr11 atr12 atr13 atr14
atr15 atr16 atr17;

datalines;
(insert raw data here)
;

proc sort;

by Fruit Location;
run;

proc print; run;
ods rtf;
proc means;

var atr1 atr2 atr3 atr4 atr5 atr6 atr7 atr8 atr9 atr10 atr11 atr12 atr13 atr14 atr15 atr16 atr17;

by Fruit Location;
run;
proc glimmix;
class Fruit Location;
model atr1 = Fruit Location /ddfm=sat;
lsmeans Fruit Location/ lines;

run;

proc mixed;
class Fruit Location;
model atr1 = Fruit Location /ddfm=sat;
lsmeans Fruit Location;

run;
```

Appendix I - SAS ® Code for Analyzing descriptive data Methods

ANOVA

```
ods rtf;

data Pom seeds consensus;

input Method$ Fruit$ Location$ atr1 atr2 atr3 atr4 atr5 atr6 atr7 atr8 atr9 atr10 atr11 atr12
atr13 atr14 atr15 atr16 atr17;

datalines;
(insert raw data here)
;
proc sort;
by Fruit Location;
run;

proc print; run;
ods rtf;
proc means;

var atr1 atr2 atr3 atr4 atr5 atr6 atr7 atr8 atr9 atr10 atr11 atr12 atr13 atr14 atr15 atr16 atr17;


by Method Fruit Location;
run;
proc glimmix;
class Method Fruit Location;
model Berry = Method Fruit Location /ddfm=sat;
lsmeans Method Fruit Location/ lines;

run;

proc mixed;
class Method Fruit Location;
model atr1 = Method Fruit Location /ddfm=sat;
lsmeans Method Fruit Location;

run;
```