Sensory Profiles and Consumer Insight of Thai Honey

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A Thesis Submitted in Partial Fulfillment of the Requirement for the Degree of Master of Science in Food Biotechnology
Department of Food Technology
Assumption University

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ABSTRACT

The market of honey is growing since consumers become more health conscious. Some consumers concern more about their health due to benefits of honey over granulated sugar. This study was aimed to investigate consumers' behavior toward honey by using consumer survey with 120 consumers and to determine sensory characteristics, consumers' preference and honey applications by applying sorting technique with different groups of consumers. Moreover, to group pure honey and different ratios of mixed honey and glucose syrup; and to generate sensory profiles of Thai honeys by using semi-trained descriptive assessors. Lastly, to determine important physicochemical properties of honey. According to the study, consumer (50.8%) consumed honey 1-2 times/ month and more than 70% of the consumer bought honey from supermarket. Top three most important factors that affected on buying decision were the origin of honey, safety and sensory quality. In case of sensory quality, consumers paid more attention on taste, flavor and aroma respectively. The sorting was applied by three different groups of consumers including non-honey user (n=30), regular honey user (n=30) and culinary group (n=30). The characteristics of honeys were categorized and described in the similar manner by all groups of assessors, however, some of them were different in details. The preferred honeys were described related to floral flavor. On the other hand, the non-preferred honey sample were indicated related to chemical flavor and fermented flavor. For honey application in food, most assessors identified product with categorical words which the top three were dessert, beverage and bakery. Next, the sorting was also applied by 30 assessors with various ratios of honey per glucose syrup from 10% of honey to 100% of honey with 10% increments which the seventy-percentage honey with thirty-percentage glucose syrup was a ratio with the highest percentage of honey which the assessor not considered as significant difference from the original honey. The terminologies and references of Thai honey were generated for 22 sensorial characteristics by 6 semi-trained descriptive assessors. The assessors were trained for 47 sessions before generating the sensory profiles, paralleling with analysis of important physicochemical properties such as color and Brix. The uniqueness of samples was discovered in many samples; especially Stingless which was rated as the highest intensity for several attributes.

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INTRODUCTION

In 2015, the global market food sweetener had been recorded $87.7 billion. The sweetener market had been expected to increase its compound annual growth rate (CAGR) of 4.5 % and reach $111 billion within 2020. The majority share of sweetener market was held by sugar which was about 80% of the market (Mordor intelligence, 2016). Sugar is the most commonly used sweetener which is almost utilized in every type of food. However, sweetness and energy are only two things which people receive from sugar intake. Honey is one of the best choices for sugar substitute because honey is a natural sweetener that contain a lot of nourishment; the trend of honey consumption is still rising from people who concern more about their health due to benefits of honey over granulated sugar. In 2017, global sales from natural honey exports by country totaled US$2.4 billion which expanded from last year 5.8%. Asian countries accounted 23.1 of global exports. Due to the increasing demand of honey consumption; the honey was adulterated by different sugar syrups (Wu et al., 2017). Adulterated honey was mainly divided adulteration of honey into 2 categories which were direct and indirect methods. Indirect adulteration was occurred by feeding honey bee with honey, chemical or industrial sugars (Guler et al., 2007), on the other hand direct adulteration was generated by adding sugar syrup or any other substances into authentic honey (Zábrodská & Vorlová, 2015). Adulterated honey was not only affecting on quality and nutrition but also could be harmful to consumers. There were several studies which have been experimented to detect honey adulterations. (Yilmaz et al., 2014; Zábrodská & Vorlová, 2015; Wu et al., 2017; and Nalia et al., 2018). However, these approaches mostly were chemical or enzymatic reactions which had to take time for analysis due to several preparation steps; besides, laborious preliminary experiments and expert operators were also required (Yilmaz et al, 2014). Sensory analysis is one of the interesting and promising approaches to detect adulterants in honey by determining the unique characteristics of each adulterant. Moreover, sensory analysis also could be used to establish sensory profiles of honey by applying human's senses as a tool. Besides, the relationship between sensory profiles of honey and consumers' preference can be applied to determine factors influencing on purchasing intention of consumers.

Thailand is not a major producer and exporter comparing to the other countries, Thai honey is demanded by world market due to its unique sensory characteristics because it is produced with different types of flower from other countries such as longan, lychee, wild flower etc. which gives an advantage over honey from other countries (Kongpitak, 2014). These variety of floral types are directly related to the sensory characteristics of honey due to different compositions of nectar in each type of flower which provide distinct color, texture, tastes and aromas especially flavors that reflected the flowering plants (Overton & Manura, 1995; Manyi-Loh et al, 2011). Moreover, there are also other factors affecting sensory characteristics of honey such as bee species and environmental conditions.

There are many sensory studies on honey in many parts of the world; however, there are only few of them in Thailand. Therefore, the aim of this study was divided in to 4 parts. First, the consumer survey was applied to study consumers' behavior toward honey. Second, free sorting task was applied with different groups of consumers to determine sensory characteristics, consumers' preference and honey applications. Additionally, to group pure honey and different ratios of mixed honey and glucose syrup, and to generate sensory profiles of honeys available in Thailand by using semi-trained descriptive assessors and to determine important physicochemical properties.

AIM

- To study sensory profiles and consumer insight of Thai honey

OBJECTIVES

- To study consumers' behavior toward honey by using consumer survey.
- To determine sensory characteristics, consumers' preference and honey applications by applying sorting technique with different groups of consumers.
- To group pure honey and different ratios of mixed honey and glucose syrup by sorting technique
- To generate sensory profiles of honeys available in Thailand by using semi-trained descriptive assessors and determine important physicochemical properties

CHAPTER 1: LITERATURE REVIEW

Sweetener

The sweetness from monosaccharaides and disaccharides, including glucose, fructose and sucrose, can be found naturally in fruits and vegetables. These sugars have long been part of the human food, although the consumption of sweeteners has changed due to availability and affordability which represented used sweeteners in each era. In pre-colonial times, sweet flavorings were obtained from natural and usually local sources. Honey might be the world's oldest sweetener which was used by the Ancient Egyptians around 2100 BC (Erejuwa et al., 2012a). In the 17th century, the sap of maple trees was boiled to obtain maple syrup which was commonly used in Americas. The sucrose or table sugar could be extracted from cane and beets in 18th century which also became primary sweetener in 19th century because its availability and affordability. The global sugar production was dramatically increased especially refined sugars which were used in a wide range of food. In this era, the production of processed food was also increased. On the other hand, lifestyle of people became more inactive so the obesity began to rise.

1.) Non-nutritive sweeteners (NNS)

Non-nutritive sweeteners were developed over the past century. In last twenty years, people are concerned by diseases from consuming excessively sweetener which are obesity and type 2 diabetes. Mostly, non-nutritive sweeteners are chemically synthesized which can be called as artificial sweetener. They are required in a little amount to provide adequately the demand for a sweet taste. Non-nutritive sweetener provides no metabolizable energy when used as a sugar substitute. On the other hand, consuming nutritive sweetener is provided energy from the metabolism of carbohydrate.

This type of sweetener provides high intensity of sweetness with almost no calories or no calories which is very attractive for someone who want to lose weight or concern about their health. The non-nutritive sweeteners intake was estimated only about 3% of population in 1965. However, the consumption of these sweeteners was highly increased to 15% in 2003-2004 (Mattes & Popkin, 2009). The rising of NNS intake represented how much people in this day concern about obesity and healthy so this is one of the reasons why people pay more attention on the products composing of non-nutritive sweetener. Only little evidences are showed the effect of using non-nutritive sweetener on obesity for both positive and negative effect which still be studied extensively. For consumer, reducing total calories intake is one of the reasons why people consume these sweeteners. However, non-nutritive sweeteners are not being used instead of sugar, they are used as an additional ingredient for sugar which the purpose of adding these sweeteners can be used in sustaining weight loss.

The physiological of nutritive and non-nutritive sweetener are different. An ambiguous psychobiological signal is activated by non-nutritive sweetener to increase appetite and palatability (Ferreira et al., 2014 and Gardner et al., 2012). However, this problem can be solved by consuming NNS as part of an energy-yielding food because the other food components can be function to provide sensory stimuli which signal appropriate metabolic and fulfill satiation. On the other hand, it cannot be used for weight loss in non-energy-yielding food or diet product because these types of product normally are lacked of satiation which may be had opposite effect in supporting weight loss. The consumption of NNS is also concern for making people to addict or prefer sweet food and drink in daily life. It is a question that using NNS with diet product has an effect on increasing total energy intake and body mass index or not, and there is insufficient evidence to fulfill this question.

The using non-nutritive sweeteners can be successfully used as a sugar substitute is limited. The amount of NSS can be added into food is restricted because they may be an effect on product quality. Processing under some conditions are not suitable for this type of sweetener because it will be affected on sensory properties to be undesirable which is really importance for every product. The amount of NSS adding is also restricted for safety of consumer. (Should not more than 0.3–3 g NNS/d for a 75 kg adult, depending on type of NNS). These sweeteners are assessed by regulatory panels which long-term effect from consuming the sweeteners still be concerned. Mostly, NNS are artificial compound and unnatural introductions to the human diet. NSS cannot be digested by small intestine so they are sent to the large intestine without any digesting which impact on human gut microbiota. Recently, the study of NSS consumption in mice and humans showed that the risk of glucose intolerance through modulation of both the functionality and composition of the gut microbiota is increased (Suez et al., 2014). It has been proposed that such effects may underpin suggested links between sweeteners and increased diabetes risk. Moreover, non-nutritive sweetener cannot be consumed by some groups of people for example aspartame cannot be consumed by people who got phenylketonuria.

The high-intensity sweeteners that are currently approved for use in the EU are aspartame (E951), saccharin (E954) acesulfame-K (E950), cyclamate (E952), neohesperidin

DC (E959), sucralose (E955), thaumatin (E957) and also the recently approved steviol glycosides (E960) a natural extract from Stevia rebaudiana Bertoni (Yang, 2010).

2.) Nutritive sweeteners (NS)

The main component for sweet tasting in food and beverage in this era are glucose, fructose and galactose. These sugars can be combined to be disaccharide sugar which are sucrose, lactose and maltose which these sugars also be the combination of wide range for oligo- and poly-saccharides such as starch, maltodextrin and fructans. High fructose corn syrup and table sugar are the most common used sweeteners which both of them compose of basic sugar like glucose and fructose. Normally, nutritive sweeteners will be hydrolyzed in small intestine to be monosaccharide which absorbed and metabolized to yield dietary energy. Normally, sugars are carbohydrate which provide 4 kcal/ g. However, the variations in chemical structure in different type of sugar are effect on varied digestion, absorption and metabolization of sugars which can be proved in the glycemic index of monosaccharide and disaccharide (Edwards .et al, 2016). There is some concern on product which compose of sugars because people in this age mostly consumed sweet food. Providing sweetness and energy are only two main functions of sugars. However, lack of nourishment and excessive intake are concerned.

Polyols (sugar alcohols) are saccharide derivatives which can be found in vegetable, fruit and some fermented foods such as xylitol, maltitol, and sorbitol. They can be produced by hydrogenation of both monosaccharide and disaccharide. Generally, the number of calories for polyols should be 4 calories per gram because they are also carbohydrates which same as sugar but human body cannot fully metabolize them so they provide fewer available calories per gram. Polyols are promoted as an ingredient for diabetic and low-calorie products. Moreover, most polyols are not readily fermented by oral bacteria and are therefore non-cariogenic which are suitable for making chewing gum. This type of sweetener also used as a combination with non-nutritive sweetener. However, the glycemic index of NSS is quite higher than polyols so the polyols can be used in larger amount than NSS. The quantity of polyols that should be consumed is limited to prevent laxation form poor gastrointestinal.

3.) Traditional sweetener

The traditional sweeteners usually can be found in natural source especially in plant source which consume as the same form as receiving from nature and require some processes to make sure that they can be safely consumed. They are obtained from plant and tree sap (e.g., maple syrup, agave nectar), fruits (e.g., carob syrup), seeds, roots (e.g. Yakón syrup), leaves (e.g., stevia) and bees (e.g., honey) (Edwards .et al, 2016). The composition and sensory properties are affected by plant origins, processing methods and environmental conditions. For example, different sources and/or species of vanilla have an effect on variation of aromatic compound in vanilla. These compound also can be developed during processes by maillard reaction which occurred during heat treatment. However, these variation and inconsistency of product are not the exactly advantages because it can be used in the different purpose and application.

In fact, traditional sweeteners are also classified as natural sweeteners because they mostly compose of more than 50% of monosaccharide and disaccharide from plant-derived syrups and honey with little number of polyols. The obvious difference between traditional sweetener and refined sugar are the moisture content, the traditional sweetener is often stored in form of liquid and contained moisture content between 17 – 35 %. The amount of energy from traditional sweeteners are 250 – 310 kcal per 100 g of wet weight. Lower moisture solid sweeteners which contain moisture content less than 1 % and also contain 380–390 kcal per 100 g wet weight (Edwards .et al, 2016). So, energy intake from traditional sweetener is lower compared to table sugar theoretically. However, this is uncertain since it will depend on how consumers use various sugar substitutes.

3.1) Glycemic potency

Some of traditional sweeteners such as agave, carob and honey contain a lower glycemic index than refine sugar because of high amount of fructose, which has a low GI of 19, compared with glucose (GI = 100) and sucrose (GI = 68) (Foster-Powell et al., 2002). However, excessive fructose consumption which is more than 15% of total dietary energy can be a cause of hyperlipidaemia (cardiovascular disease). Proper fructose intake seems not to be a problem anyway. For the other natural sweeteners which contain lower amount of fructose such as maple syrup, may provide a suitable alternative. There are also some studied which mentioned about variation of the other components in traditional sweeteners have an ability to reduce the glycemic potency especially phytochemical compounds. The presence of variously phytochemical compounds not only lower the glycemic index but also have anti-diabetic effects and blood glucose-lowering effects.

3.2) Polyphenolic and related compounds

Maple syrup and honey contain many (poly) phenolic compounds including various flavonoids (e.g., quercetin, kaempferol, myricetin, proanthocyanidins, and 'condensed tannins'), and non-flavonoids such as phenolic acids (e.g., caffeic-, coumaric-, vanillic-, syringic-, hydroxybenzoic-acids), lignans (e.g. lariciresinol, secoisolariciresinol), coumarins and stilbenoids (Bogdanov et al., 2008, Li & Seeram, 2010 and St-Pierre et al., 2014). These compounds have many properties which could have a potential impact on nutrition and health. It is clearly evident from laboratory studies that phenolic compounds in traditional sweeteners contain a range of compounds with anti-oxidant properties which have an ability to eliminate harmful reactive oxygen species. Moreover, many phenolic compounds can be interacted with proteins including enzymes, transcription factors, and receptors. Flavanols seem to have benefits on circulatory system especially cardiovascular health and whole-body metabolism (jascual-Teresa et al., 2010). Polyphenolic compounds may also have effects on the digestion, absorption and metabolism of available carbohydrates such as limit digestion of starch through inhibition of α-amylase and/or α-glucosidase, delay and/or prevent glucose absorption through inhibition of glucose transporters SGLT-1 and/or GLUT-2 and reduce undesirable effects of the sugars on glycaemia and lipid metabolism (Hanhineva et al., 2010). Even there is a number of health benefits from these compounds but there is insufficient evidence to establish currently whether or not these compounds have any effect on human health, especially when consumed as part of a normal diet so some of the mechanisms still remain unclear.

4.) Future trends

Obesity is a huge problem in many countries around the world, and Thailand ranks in the second place of top five Asia-Pacific nations in this regard. The rate of obesity is continuously accelerated. In the period 2005-2007, obesity rates in Thailand increased from 10 million in 2005 to 17 million in 2007 (Bickerstaff, 2013). Furthermore, these increases are now occurring across many demographic groups, and in both urban and rural areas. One of the most important cause of obesity is a sweeteners consumption because almost every type of food and beverage compose of sweeteners. The previous study showed that an average Thai consumes about 26 teaspoons or 104 grams of sugar per day which is four times more than the recommended amount of 6 teaspoons per day (Languepin, 2015). So, the future use of sugars and sweeteners is likely to be influenced by the perceived nutritional requirements of an increasingly obese population.

The easiest method to reduce sugar intake seem to be decreased the quantity of sugar in products. However, it is not that easy, the amount of sweetener in food and beverage industry cannot be reduced because sugar not provide only sweetness but also used as a preservative so if amount of sugar has been reduced, the shelf-life of these product may be shorter. Moreover, some of product require much sugar to control texture which refer to the quality of products. Sugar substitutes which contain an ability to replace the function of sugar for maintaining the quality of products should be determined. However, the consumer preference of sweet taste still be continuously developed.

The manufacturers are expected to develop healthier sweeteners. The ideal answer for healthier sweetener should be non-nutritive sweeteners because they provide intense sweetness without calorie. In contrast, there are some research mentioned that NSS lack of ability to fulfill satiation which require compensatory intake and lead to weight gaining. Moreover, the safety of using non-nutritive sweetener still be concerned in long-term consumption. The traditional sweeteners can be trusted in safety for consumption because they have been consumed for centuries and also preceded the obesity epidemic. These sweeteners are caloric but contain lower glycemic index than refine sugar. They also contain many phenolic compounds which have benefits to human body. The efficiency of phenolic compounds should be studied and confirmed the benefits because they had been interested by manufactures who want to develop more natural product. Overall, trends in sweetener use in the future will continue to be influenced by the obesity epidemic and therefore further research should be continued to make progress in the area to understand the effect of various sweeteners on health to determine whether NNS, NS or traditional sweeteners provide the best solution is encouraged (Edwards .et al, 2016).

Chemical composition and reaction product of honey

There are about 200 compounds presented in honey (Escuredo et al., 2013). The effect of each component should be known to understand the functions of these compounds that related to shelf-life and structural constituent which are one of the factors that effect on consumer decision whether they will buy the product or not.

1.) Sugar

The sugar compositions in honey are affected by botanical origin and environmental origin. They also can be various depend on processing methods and storage conditions. Mostly, seventy-five percentage of overall sugar in honey is represented by monosaccharide with 10 – 15% of disaccharide and small amount of other sugar. Generally, disaccharides and trisaccharides like sucrose and maltotriose are hydrolyzed to monosaccharides by enzymatic reactions (Missio da Silva et al., 2016).

Sugar content may be changed during storage. Comparing the storage temperature of honey at 4 °C and 20 °C for 6 months. The study showed that concentration of sucrose was decreased 14% for storage temperature at 4 °C and decreased 79% for 20 °C. On the other hand, fructose content increased 4% and glucose content increased 1.1% for 4 °C; however, at a temperature of 20 °C, the fructose content increased 7% and the glucose content increased 8.8%. The changing percentage of other sugar such as trehalose and isomaltose not showed any significant difference (Rybak-Chmielewska, 2007).

When honey is heated or stored for a long time, the degradation products of sugars are occurred by furans especially furfural which related to non-enzymatic browning reactions such as maillard reaction, caramelization and sugar degradation in an acidic medium which is a cause of darker color and change in flavor. However, furans can be used to indicate the loss of freshness (Missio da Silva et al., 2016).

2.) Protein

Proteins and amino acids in honeys are varied due to species of bee and vegetal sources, including fluids and the nectar secretions of the salivary glands and pharynx of honeybees (Sak-Bosnar and Sakac, 2012). However, the main source of protein is the pollen. There are about 1% (w/w) of amino acid which the actually amount depend on the origin of honey. There is various type of amino acid, proline is the most found amino acid in honey which represent 50 – 85% of amino acid. The amount of proline can be used to indicate maturation and purity of honey which minimum proline for pure honey is 180 mg per kg. Amadori compunds which are occurred from the reaction of the carboxylic group on the reducing end of sugars and the free amino groups of amino acids and proteins; they are responsible for the occurrence of maillard reaction (Missio da Silva et al., 2016).

Quantitative and qualitative changes of protein content were affected by protein–polyphenol complex formations in honey stored at various temperatures for six months (Brudzynski et al., 2013). Quinones are occurred from the oxidation of polyphenols which play an important role in the interaction with proteins and also modify the protein structure and size leading to covalent bond between protein and quinones. When honey was stored at high temperatures, the interaction is triggered to occur in higher rate.

3.) Organic acids

The organic acids in honey are occurred from deriving of sugar by enzyme secreted by honeybees while transforming nectar to honey which approximately found in honey for 0.57% (Karabagias et al., 2014). They can be used to differentiate the botanical origins and geographical origins which related to color and flavor of honey and also have an effect on chemical properties such as acidity, pH and electrical conductivity. The important acid in honey is gluconic acid which can be used with citric acid to discriminate floral honey from honeydew (Mato et al., 2006).

The concentration of free acidity in honey can be increased by transforming of levulinic and formic acids to be one molecule of levulinic acid and one molecule of formic acid. The increase of acidity is occurred over time, as well as during fermentation because honey sugars and alcohols transform into acids by the action of honey yeasts (Cavia et al., 2007).

4.) Vitamins

There are small number of vitamins in honey such as thiamine (B1), riboflavin (B2), nicotinic acid (B3), pantothenic acid (B5), pyridoxine (B6), biotin (B8 or H), folic acid (B9) and L-ascorbic acid (C). Mostly, vitamin B can be found in the pollen grains in suspension. Vitamin C is found in almost all types of honey. It also has been evaluated mainly due to its antioxidant effect. The amount of vitamin C is difficult to determine because it is very sensitive to chemical and enzymatic oxidation and also accelerated by light, oxygen or heat. The loss of vitamin can be occurred due to the oxidation of ascorbic acid by the hydrogen peroxide. The reduction of vitamin C also can be affected by commercial filtration of honey which almost completely remove the pollen (Missio da Silva et al., 2016).

5.) Minerals

The mineral content in honey ranges 0.04 – 0.2% including both micro and macro minerals (Alqarni et al., 2012). Honey reflects the chemical components of the plants from which the honeybees collect, so the content of trace elements present in honey depends on the type of soil in which the plant and nectar were found and may indicate the botanical origin of a specific honey (Madejczyk & Baralkiewicz, 2008 and Escuredo et al., 2013).

The most found mineral in honey is potassium which is approximately 33% of overall minerals. Honey also contains sodium, iron, copper, silicon, manganese, calcium and magnesium in smaller quantities. Macro elements (such as potassium, calcium, and sodium) and trace minerals (such as iron, copper, zinc, and manganese) have an important function on psychological response, overall metabolism, circulatory system and reproduction. Some mineral is classified as heavy metal which can be harmful if the amounts of them are exceed such as arsenic, lead, mercury and cadmium. Mineral compound cannot be degraded by heat, light, oxidizing agents and extreme pH as vitamins and amino acids (Missio da Silva et al., 2016).

6.) Phenolic compound

The phenolic compounds can be classified into 2 type which are non-flavonoids (phenolic acid) and flavonoids (flavones, flavonols, flavanones, flavanols, anthocyanidin, isoflavones and chalcones) (Andersen & Markham, 2006). Phenolic compounds are used as floral markers in honey. The main functional components of honey are flavonoids. They have an effect on total antioxidant activity of honey which contain an ability to eliminate or reduce the formation of free radicals, causing beneficial effects to human body. The antioxidant activity of flavonoids is varied due to the number and position of hydroxyl groups which the available of hydroxyl groups enhance the antioxidant activity and other substituents and the glycosylation of flavonoid molecules. On the other hand, the glycosylation of flavonoids declines antioxidant activity when compared to the corresponding aglycones. Phenolic compounds are degraded depending on the environmental conditions (Missio da Silva et al., 2016).

7.) Volatile compounds

A main function of volatile compounds is generated aroma. More than 400 different volatile compounds have been identified in honeys which they have a distinctive flavor of the plant, due to the presence of certain volatile organic compounds from nectars. However, volatile compounds are varied due to honeybees which have an ability to produce or convert plant constituents in other compounds with volatile properties. These compounds can be affected by post-harvest processing, presence of micro-organisms and storage time. The volatile compounds in honey are present in very low concentration. The short chain carboxylic acids have a spicy aroma and flavor, while long chain carboxylic acids provide a rancid aroma (Barra et al., 2010).

Adulterated honey

Due to the increasing demand of honey consumption; the honey was adulterated by different sugar syrups (Wu et al., 2017). Chinese honey factories harvested honey while it unripe which it still had high water content, after that the honey was dried artificially and filtrated to remove unwanted matter included pollen (Tamma, 2017). Chinese honeys spread through European countries in last decade due to inadequate of honey production in Europe. However, adulterated honey was mainly divided adulteration of honey into 2 categories which were direct and indirect methods. Indirect adulteration was occurred by feeding honey bee with honey, chemical or industrial sugars (Guler et al., 2007), on the other hand direct adulteration was generated by adding sugar syrup or any other substances into authentic honey (Zábrodská & Vorlová, 2015). The news agencies in Thailand also reported about production of adulterated honey by the villagers. The fake honey was produced by mixing authentic honey with glucose syrup and granulated sugar (TNAMCOT, 2014; ThairathTV, 2017). Adulterated honey was not only affecting on quality and nutrition but also could be harmful to consumers. There were several studies which have been experimented to detect honey adulteration. Yilmaz et al (2014), Zábrodská & Vorlová (2015) and Nalia et al. (2018) summarized all previous approaches for detecting adulterants in honey, moreover Yilmaz et al. (2014) also introduced a novel and potential approach to detect honey adulteration by fructose and saccharose syrups which were steady, dynamic and creep analysis. Likewise, recent study of Wu et al. (2017) revealed the methods to detect sugar-based adulterants in honey which included SRICA, GC, HPAEC, HPLC, IR-based analysis, NMR, Raman spectroscopy speed up and Q-TOF-MS. However, these approaches mostly were chemical or enzymatic reactions which had to take time for analysis due to several preparation steps; besides, laborious preliminary experiments and expert operators were also required (Yilmaz et al, 2014). So, the approaches for the development of a portable test kit were studied which the most effective methods included ELISA, electronic tongue and NIR (Nalia et al., 2018). Many approaches have been constantly developed to detect adulterants in honey, however none of any approaches at present could be applied to detect all the adulterants in the honey individually because there are so several methods of adulteration. (Schwarzinger, 2017; Nalia et al., 2018)

Descriptive Analysis

Descriptive analysis is one of the techniques that most widely used in sensory analysis. The main function of descriptive techniques is used to generate quantitative data which describes the similarities and differences among a set of products. So, these techniques create complete sensory descriptions of products which is very important because true characteristic of product must be describe to consumer clearly to ensure that no any consumer misunderstand product description. Moreover, descriptive analysis also used to determine how each material or process changes affect product characteristics which can help in finding the substitute ingredients or modifying processes which also lead to cost reduction. This method also used to identify key sensory attributes which is really important to consumer acceptance (Sensory Analysis Center, 2015). The well-known descriptive analysis includes Flavor Profile Method, the Texture Profile Method, Quantitative Descriptive Analysis® (QDA®) and Spectrum™ Descriptive Analysis which all of them were widely applied in many sensory studies because they can be used to manage quantitative comparisons to be made across different products on specific attributes (Murray et al., 2001). However, these methods require much time to spend on recruiting and training the assessors. Therefore, multiple rapid sensory profiling techniques had been developed to improve the efficiency of the data collection process while trying to maintain the information obtained as in classical descriptive analysis which included check-all-that-apply (CATA), sorting, and polarized sensory positioning (PSP) (Fleming et al., 2015).

Related research review

The widely-known honey is produced by honey bees (the genus Apis) which is the one most commonly referred to. However, honey also can be produced by bumblebees, stingless bees, and other hymenopteran insects such as honey wasps. The variety of bee had an effect on chemical composition of honey which related to sensory characteristics of honey, not only the types of bee that had an effect on sensory characteristic of honey but floral type also had an effect which were providing distinct color, texture, tastes and aromas especially flavors that reflected the flowering plants (Overton &Manura, 1995; Manyi-Loh et al, 2011).

The relationship between sensory profiles of honey and consumers' preference can be applied to determine factors influencing on purchasing intention of consumers. There were many studies focusing on determining these factors. In Poland, there is a study revealing that the origin of the honey and quality which was guaranteed with certificates were the most important factors for deciding to purchase honey (Roman et al., 2013). Likewise, the consumer study in Italy revealed that the country of origin had a substantial effect on the interviewees' who participated this study (Cosmina et al., 2016). Moreover, the study in Western Australia also mentioned that taste is the most influential variable in the decision to purchase. However, taste can only be evaluated in post-purchase. For purchasing honey from a retail store, there were three most influential factors in the consumer's decision to purchase honey such as brand reputation, origin and value for money (Batt & Liu, 2012).

The sorting technique is a method for collecting similarity data to generate perceptual map by using stimulated perception of assessors to categorize samples into groups based on knowledge and experience. This technique works really well for reducing large sample sets to smaller numbers and, with word labelling, for revealing the sensory or other attributes (Sensory dimensions, 2015). It is also widely used because it is rapid and simple for participants, moreover it also provides reliable result (Lawless & Glatter, 1990; Lawless et al., 1995; King et al., 1998). However, the result from this method may lack some details so this method is not suitable for someone who need to understand product precisely. Additionally, the performance of assessor can be influenced by sensory and memory fatigue due to excessive number of sample and the characteristic of product itself especially the product that requires to evaluate flavor and aroma.

Sensory characteristics of honey were varied due to floral types, bee species and environmental conditions which all of them had effects on providing distinct color, texture, tastes and aromas especially flavors (Overton & Manura, 1995; Manyi-Loh et al., 2011; Stolzenbach et al., 2011). There were several studies on sensory of honey in the last few decades. Terminology of floral honey was developed by Galan-Soldevilla et al. (2005). Ciappini et al. (2013) established an approach for recruiting and training assessors to determine characteristics that could be used to differentiate clover honey from eucalyptus honey by using descriptive quantitative analysis. Moreover, sensory analysis of honey from honeybee were researched worldwide by focusing on distinct factors included differences of bee species, honey varietals, geography and seasons; mostly sensory analysis of honey was studied together with physiochemical properties (Gupta et al., 1992; Esti et al., 1997; Anupama et al., 2002; Castro-Vázquez et al., 2008; Stolzenbach et al., 2011; Silvano et al., 2014; Kortesniemi et al., 2018; Kumar et al., 2018). Sensory profile of honey from stingless bees was also studied (Ferreira et al., 2009; Costa et al., 2018).

CHAPTER 2: MATERIALS AND METHODS

Study consumers' behavior toward honeys

There were 120 participants in Bangkok Metropolitan Region participated in this study. Participants have to consume honey before in order to take part in the survey. Questionnaire was developed as a tool to gather the information, it was divided into 2 parts which were Part1: Consumer's Behavior and Part2: General Information. The first part is a series of questions regarding to honey-related consumption habits, awareness of floral types of honey and the variables used in their decision to purchase honey. The variables were divided into two categories such as general characteristics and sensory characteristics. The variables were rated by using level of importance which used 1 - 5 important scale where one referred to not at all importance and five referred to extremely importance. The last part of the questionnaire included questions regarding demographic and socioeconomic position of participants such as age, gender, education, income, occupation, and ethnicity. The data from questionnaire was analyzed by Cross tab table of Microsoft Excel and, ANOVA with Duncan multiple comparison and Chi-square of SAS 9.4 The data from both descriptive training and consumer test were processed using ANOVA with Duncan multiple comparison of SAS 9.4 (Copyright © [2017] SAS Institute Inc., Cary, NC, USA.)

Sorting technique with different groups of consumers

Twenty-four honey samples were selected due to their variety and availability in Thailand which included honey from longan, lychee, sesame sunflower, wild flower (siam weed), coffee, forest and macadamia. Two samples were chosen from each of them except macadamia which had only one. Moreover, the multi-floral honey from each part of Thailand were selected which were multi-floral honey from northern, north eastern, eastern, western, southern and middle part of Thailand. The rest of them were also multi-floral honey which were produced by distinct types of bee such as cerana, florea and stingless. All of these three honeys were not passed any heat treatment included lychee1, forest1 and multi-floral honey from the South.

All of samples were provided on the tray to assessors at the same time with water, plastic coffee spoons and sorting ballot. Each sample was labeled with different 3-digit code. The samples were served in 1 Oz white plastic cups at room temperature. The amount of honey per cup was about 5 grams. The water was applied as a rinsing product.

Most of Thai consumers consumed honey 1-2 times/ month (Ketwaropaskul et al., 2017). The consumption frequency was applied as criteria to categorize the assessors. The assessors who not consumed honey or rarely consumed honey, less than once a month were categorized as non-honey user, on the other hand the assessors who consumed honey once a month or more were grouped together as regular honey user. The last group is composed of chefs or consumers who have culinary background on honey. Therefore, the sorting was applied by three different groups of consumers including non-honey users (n=30), regular honey users (n=30) and culinary group (n=30).

Sorting technique was applied to study sensory characteristics of honey samples. The assessors were assigned to group the samples according to similarity based on experience and knowledge of each person. The ballot is composed of 5 parts to fill in which include group number, sample codes, characteristics, liking score and honey application on consuming product. Group number part was applied to write down the group number and sample code part was used to write down 3-digit code of samples within the same group. The similar characteristics within group were described in the part of characteristics. Nine-point hedonic scale was used to rate the liking score of groups in overall liking part. The last part was applied to write down the products that should be consumed or cooked with honey. The number of groups could be as many as they deemed appropriate, however the characteristics for sorting must be explained, moreover the time for sorting was not limited due to a high number of samples. Any criteria could be applied on sorting except color of honey because it was the physical property perceived immediately which could be easily categorized. The samples might be sorted without smelling and tasting, so color was prohibited for the sorting.

The data from sorting of honey characteristics and honey application was analyzed by DISTATIS of RStudio 0.99.467. The liking score was analyzed by ANOVA with Duncan multiple comparison of SAS9.4.

<u>Sensory profiles and physicochemical properties of Thai honeys</u>

Twenty-seven honey samples were selected due to honey varietals and availability of them in Thailand which included honey from Longan, Lychee, Sesame, Sunflower, Wild flower (siam weed), Coffee, Forest and Macadamia. Two samples were chosen for each of them except Macadamia which had only one. Moreover, the multi-floral honey from each part of Thailand were selected which included multi-floral honey from Northern, North Eastern, Eastern, Western, Southern and Middle part of Thailand. The rest of them were also multi-floral honey which were produced by distinct types of bee such as Cerana, Florea and Stingless. All of these three honeys were not passed any heat treatment included Lychee1, Forest1 and multi-floral honey from the South. Additionally, adulterated honeys were formulated in this study; two ratios of them were selected to be samples based on sorting technique. The last sample was the most well-known honey in Thailand with unidentified floral type (Ketwaropaskul, 2017).

The samples were served in 1 Oz white plastic cups at room temperature. The amount of honey per cup was about 5 grams. All samples were provided to participants on trays with plastic coffee spoons. Water was provided as a mouth-rinsing between samples.

Six assessors were recruited from students of Faculty of Biotechnology, Assumption University based on their availability and willingness to participate the training. All of them were semi-trained assessors who had experiences in descriptive training for 2-3 food products, so they already had some skill for the training especially ability to describe product by using attributes and intensities.

According to news agencies in Thailand, adulterated honey was produced by pure honey with additional of glucose syrup and/or granulated sugar. The most available honey in the market was applied to formulated adulterated honey which was Forest2. The honey was adulterated with the addition of adulterants, namely glucose syrup. Started with mixing glucose syrup with hot water (about 95°C) at a ratio of 70%, 80% and 90% by weight, then compared their viscosity with the honey sample Forest2 by ten assessors who were familiar with sensory analysis. The criteria of comparison were based on eyesight and mouthfeel. Ninety percentage of glucose syrup was selected by all assessors due to the most similar viscosity to the sample. After that, the ninety-percentage glucose syrup solution was added into Forest2 at a ratio of 10% to 90% by weight which each ratio was different by 10%. All of ratios with addition of the authentic honey were used in free sorting task. The sorting technique was applied by 30 assessors to determine the ratio that started to reveal significant difference between pure honey from adulterated honey ($P<0.05$).

The training composed of forty-seven sessions; the time per session was about one hour. The review of using scale and reference was applied in the first session. A 0-15 scale was used for rating, where 0 = none and 15 = extremely intense; the gap between each scale was 0.5 only. Two honey samples were provided to the assessors to taste and compare them with the references by focusing on basic tastes. The second session focused on development of the descriptive terminology for honey samples. All of samples were provided to the assessors except two adulterated honey samples. The assessors were assigned to list the characteristics of honeys. Additionally, the terminologies were also generated by four experienced sensory analysts who had many experiences in sensory analysis in wide range of product categories for several years. The generated characteristics from both groups were compared and selected for the training by the discussion of the sensory analysts. Four tastes, seventeen flavors and one appearance were selected as the attributes for the training. In the third session, four of basic tastes was applied to the assessors which composed of every taste except umami. The samples for training were selected based on sorting technique in the previous study (Ketwaropaskul, 2018). Six representatives of samples were chosen according to the grouping from sorting technique such as Longan1, Coffee1, Lychee2, Sesame2, Cerana and Stingless. All of them were applied for the whole training. The references were determined by making consensus among the assessors; moreover, the intensities of references had to cover intensities of all representative samples for all attributes. The replications of samples were applied in each session to check repeatability of the assessors. The consensus of representative samples was also generated for every attribute to check their consistency on scoring. The training of basic tastes was applied until the standard deviation of samples lower than one which was the session fifteen. Clinical session was individually applied for the assessor who had problems in consistency and repeatability. The trainings of flavors and an appearance were initiated from the sixteenth session. The references and definitions of seventeen flavors and one appearance were generated. The reference products were changed for many times to determine the products with the most similar characteristics to honeys' flavors. Besides, the intensities of references were also adjusted to make sure that the references of each attribute covered intensities of samples; the references and definitions of these attributes were determined until the twenty-fourth session. The first four flavors were applied between session twenty-five to thirty-one which included the flavors of plastic, soy sauce, worcester sauce and dried fruit. The training of basic tastes was applied in the thirty-second session to review the training and check their performance. After that, cotton candy, butterscotch, molasses and coffee flavors were trained for five sessions. In the thirty-eighth session, five flavors were introduced to the assessors which composed of perfume, flora, fruit, jasmine and wood flavor; all flavors were applied until the forty-first session. The last six sessions included five attributes. Four of them were flavors such as ferment, medicine, herb and iron flavors. The remaining attribute was viscosity which was trained by focusing on appearance.

Testing was applied to generate sensory profiles of twenty-seven honeys from Thailand which the sensory profiles composed of 22 sensorial attributes; each sample were applied for 3 replications. The testing was divided into 9 sessions; nine samples were presented to the assessors for each session and were also separated into 3 serves. Three samples were provided to the assessors for each serving, after the assessors finished evaluating the samples, they had taken a break for 5-10 minutes before the next serving; each sample could be repeatedly served or not within the session because they were randomly picked up for every session except the first session because the replications of sample were required to determine repeatability and standard deviation which related to performance of the assessors. The references of all attributes, mouth-rinsing and ballot were provided to the assessors before serving samples.

For the physicochemical properties, color and sugar content of honey samples were determined in this study. The color of honey samples was measured by using HunterLab MiniScan EZ 4500L Spectrophotometer. The spectrophotometer was standardized by using black tile and white tile before the color was measured. During the process, the rubber must be put into the Hunterlab cup due to its ability to prevent light from the outside. After that, the cup was covered with white lid and black lid respectively; the white lid was applied because white color could be used to reflect light from machine to the sample without cross over to surrounding environment. Likewise, the black lid was used because black color could be used to absorb lightness and also prevent another light source from environment. The 5mm port was applied to measure the lightness of color because honey is a liquid form substance; so, it required the size of port that could be used to measure throughout the whole area of honey when the sample was poured in to the Hunterlab cup. The appearance of bubble was prohibited for the color measurement because the reflection might be occurred when light source of the machine shined on the bubble. The color of each sample was measured for 5 replications. The result was presented in form of L*, a*, and b*. On the other hand, Brix of the honey samples was measured by using refractometer with 0 to 90-degree Brix. Brix of samples were determined for 3 replications.

The data from grouping pure honey and mixed ratios of mixed honey and glucose syrup was analyzed by DISTATIS of RStudio 0.99.467. Data from the training were processed using ANOVA with Duncan multiple comparison. The data from testing was analyzed by PCA of R-Program-2.15.3 and ANOVA with Duncan multiple comparison.

CHAPTER 3: CONSUMER BEHAVIOR AND ACCEPTANCE TOWARDS DIFFERENT UNIFLORAL HONEYS

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ABSTRACT

The market of honey is growing since consumers become more health conscious. Some consumers prefer honey over granulated sugar due to benefits of honey such as providing blood sugar regulation, reducing gastrointestinal disorders and reducing throat irritation. This study was aimed to investigate consumers' preference and behavior related with honey and its characteristics. The study was divided into three parts including consumer survey with 120 consumers, intensity rating by trained panel, and consumer acceptance test towards different types of honey. According to the study, consumer (50.8%) consumed honey 1-2 times/ month and more than 70% of the consumer bought honey from supermarket. Amount of people who unaware of floral type of honey that they consumed was 55%. Top three most important factors that affected on buying decision were the origin of honey, safety and sensory quality. In case of sensory quality, consumers paid more attention on taste, flavor and aroma respectively. Descriptive trained panel evaluated eight samples of unifloral honey from different floral type including longan, forest, orange, lychee, macadamia, orange, sesame and sunflower. The profiles of these honeys were generated by visually impaired panelists which focused on five attributes such as sweetness, sourness, bitterness, viscosity and floral flavor. The same 8 samples of honey were used in consumer acceptance test. These sensory profiles of honey were used to explain consumers (50people) of each attribute to determine the characteristic of honey that people prefer the most. There was significant difference consumer liking in every attribute. There were five attributes (sweetness, sourness, bitterness, viscosity, and floral flavor) classified in the group of the highest score for sunflower (6.92, 6.54, 6.62, 7.20 and 7.06) and longan honey (6.94 6.54, 6.58, 6.76 and 6.98). The sensory profiles showed that both honeys contained sweetness, sourness, bitterness and floral flavor less than other samples except sourness which macadamia contained lower than longan. However, both types of honey contained higher viscosity than all samples of honey except sesame that got higher viscosity than longan. Therefore, the characteristics of honey which Thai consumers preferred, are less sweetness, sourness and bitterness included mild floral flavor and thick texture.

Keywords: Honey, Consumer behavior, Sensory property, Sensory evaluation

INTRODUCTION

In 2013, 1.7 million tonnes of honey were produced worldwide (FAOSTAT 2013). The trend of honey consumption still rising from people who concern more about their health due to benefits of honey over granulated sugar because honey is a natural sweetener that contain a lot of nourishment. The widely-known honey is produced by honey bees (the genus Apis) which is the one most commonly referred to. However, honey also can be produced by bumblebees, stingless bees, and other hymenopteran insects such as honey wasps. The variety of bee had an effect on chemical composition of honey which related to sensory characteristics of honey, not only the types of bee that had an effect on sensory characteristic of honey but floral type also had an effect which were providing distinct color, texture, tastes and aromas especially flavors that reflected the flowering plants (Overton &Manura, 1995; Manyi-Loh et al, 2011).

In sensory analysis, human's senses can be applied as a tool to establish sensory profiles from each types of honey, also it is used to understand consumer preferences. So, the relationship between sensory profiles of honey and consumers' preference can be applied to determine factors influencing on purchasing intention of consumers. There were many studies focusing on determining these factors. In Poland, there is a study revealing that the origin of the honey and quality which was guaranteed with certificates were the most important factors for deciding to purchase honey (Roman et al., 2013). Likewise, the consumer study in Italy revealed that the country of origin had a substantial effect on the interviewees' who participated this study (Cosmina et al, 2016). Moreover, the study in Western Australia also mentioned that taste is the most influential variable in the decision to purchase. However, taste can only be evaluated in post-purchase. For purchasing honey from a retail store, there were three most influential factors in the consumer's decision to purchase honey such as brand reputation, origin and value for money (Batt & Liu, 2012).

In the last few decades, there were many studies on sensory analysis of honey which helped in developing terminology of honey (Galan-Soldevilla et al., 2005). Additionally, the protocol of selection and training of assessors was adequately established to generate sensory profiles for differentiating clover honey (more intense flavors, vegetable notes, aromatic, warm, small crystals with a high tendency to quick crystallization in mass) and eucalyptus honey (light, fruity and floral flavor with low intensity) by using descriptive quantitative analysis (Ciappini et al, 2013). Stingless bee honeys were evaluated by sensory descriptive analysis using free choice method. Honeys from stingless bee were describe as sweeter and less acid which also preferred by untrained assessors comparing to commercial honey from honeybee (Apis mellifera) (Ferreira et al, 2009)

Therefore, the aim of this project was to study consumers' behavior toward honey by using consumer survey and to generate sensory profiles of eight different unifloral honeys available in the market using trained descriptive panelists (visually impaired panel). Lastly, to determine consumers' preferences toward different unifloral honey.

MATERIALS AND METHODS

Samples

Eight honey samples were selected due to honey varietals and availability of them in the market which included honey from longan, forest, orange, lychee, orange macadamia, sesame and sunflower.

Panelists

There were 120 participants in Bangkok Metropolitan Region participated in the consumer survey. Participants also have to consume honey before in order to take part in the survey. There were 13 trained descriptive panelists participated in the descriptive analysis. Most of them were visual impairment and legal blindness, the rest of them were total blindness. All of them already passed descriptive training of food product for 100 hours. Therefore, they were familiar with training and had some skills which helped the training be easier especially ability to describe product using attributes and intensities. Lastly, there were 50 consumers participated in the consumer test; all of them have to consume honey before in order to take part in the consumer test.

Procedure

Questionnaire was developed as a tool to gather the information, it was divided into 2 parts which were Part1: Consumer's Behavior and Part2: General Information. The first part is a series of questions regarding to honey-related consumption habits, awareness of floral types of honey and the variables used in their decision to purchase honey. The variables were divided into two categories such as general characteristics and sensory characteristics. The variables were rated by using level of importance which used 1 - 5 important scale where one referred to not at all importance and five referred to extremely importance. The last part of the questionnaire included questions regarding demographic and socioeconomic position of participants such as age, gender, education, income, occupation, and ethnicity.

The descriptive training was applied in this study to generate sensory profiles of unifloral honeys. Eight-floral types of honey samples were applied in descriptive training which were longan, forest, orange, lychee, orange macadamia, sesame and sunflower. Five important attributes were applied in the training which were sweetness, sourness, bitterness, viscosity and floral flavor because these attributes cover taste, flavor, and mouthfeel attributes. A 0-15 scale were used for rating, where 0 = none and 15 = extremely intense. The rinse agent being used for honey evaluation was water. After the training was finished, the references, rinsing materials, 0-15 scale and ballot were applied as in descriptive training. Each sample will be tested for 3 replications.

There were 50 consumers participated in this study. Eight different unifloral honeys from previous part also were applied in this part. The 9-point hedonic scale were used to determine consumers' preferences among various unifloral honeys by focusing on 5 important attributes as in training which were sweetness, sourness, bitterness, viscosity and floral flavor with an additional attribute which was an overall-liking. The samples were served in 1 Oz white plastic cups at room temperature. The amount of honey per cup was 5 grams. All samples were provided to participants on trays with plastic coffee spoons and ballot by serving four samples at a time. Water was used as rising product between each sample. The serving orders were randomized by using William Square Design.

Data analysis

The data from every part of the questionnaire was analyzed by Cross tab table of Microsoft Excel and, ANOVA with Duncan multiple comparison and Chi-square of SAS 9.4 except the variables affecting on consumer decision which was analyzed by Friedman's test. The data from both descriptive training and consumer test were processed using ANOVA with Duncan multiple comparison of SAS 9.4 (Copyright © [2017] SAS Institute Inc., Cary, NC, USA.)

RESULTS AND DISCUSSION

Study consumers' behavior toward honey

Table 1: Demographic information

Demographic Profiles	Freq.	%
Gender		
Male	36	30
Female	84	70
Age		
18 - 24 years old	23	19.2
25 - 34 years old	45	37.5
35 - 44 years old	36	30.0
45 - 54 years old	10	8.3
More than 54 years old	6	5.0
Level of education		
High school or lower	4	3.4
Diploma (Vocational certificate)	5	4.2
Bachelor Degree	78	65
Master degree or higher	33	27.5
Occupation		
Company Employee	54	45.0
Student	22	18.3
Business Owner	21	17.5
Teacher	8	6.7
Government Employee	6	5.0
Others	6	5.0
Housewife/ househusband	3	2.5
Income per month		
Lower than 8,000 baht	11	9.2
8,000 - 15,000 baht	13	10.8
15,001 - 25,000 baht	22	18.3
25,001 - 35,000 baht	20	16.7
35,001 - 45,000 baht	15	12.5
More than 45,000 baht	39	32.5

According to the study, it was found that most of participants who lived in Bangkok Metropolitan Region (50.8%) consumed honey 1-2 times per month, 18.3% of them consumed 1-2 times per week, 11% of participants consume honey 3-4 times per week and only 6% who consumed honey every day. The rest of them consumed honey less than once a month or consumed it occasionally. Forty-five percentage of participants aware of floral type of honey that they consumed which not much different from the participants who unaware (55%). The floral type of honey that most of the participants be aware of, were forest honey (42.71%) and longan honey (29.17%). The participants purchase honey at supermarket (57.2%), hypermarket (17.1%) and beekeeper (9.9%). The top three most well-known brand of Thai honey were Chitralada (39.5%), Doi Kham (18.5%), and Vejchapong (10.2%); the percentages of these three brands were combined together for almost 70% of participants who lived in Bangkok Metropolitan Region. However, some participants (17.6%) cannot recognize the brand of honey or consume no brand honey. The participants usually consume honey with pancake, waffle, tea and toast respectively. On the other hand, they usually applied honey as an ingredient with tea, honey baked meat, crepe and yoghurt.

Table 2: General factors on buying honey

Factors	Mean±SD
Safety	7.6 ± 1.5^{a}
Source	5.6 ± 1.9^{b}
Sensory Quality	5.5 ± 2.2^{b}
Specified Use	4.9 ± 2.1^{c}
Package	4.8 ± 1.9^{c}
Price	4.6 ± 1.9^{cd}
Volume	4.2 ± 1.9^{de}
Uniqueness	4.1 ± 1.9^{de}
Brand	3.7 ± 2.1^{e}

Note: Mean with the same letter are not significantly different at alpha level = 0.05

There was significant difference between buying factors influencing affecting on consumer decision to purchase honey. ($P<0.05$). The most important attributes in general term was a safety followed by source and sensory quality which all of this were significantly more important than price. It is mean that Thai consumer do not mind to spend more money on the honey that is safe to consume, producing from reliable origin and containing good sensory quality of honey. The reason why the consumers emphasize on safety because there was the news about the production of adulterated honey by villager in Khon Kaen, Northern Thailand (TNAMCOT, 2014). The origin of honey was mentioned as one of the most important attributes affecting on purchasing honey in many studies (Murphy et al., 2000; Batt & Liu, 2012; Roman et al., 2013; Cosmina et al., 2016). The origin of honey is also reflected to the authenticity of honey. There are many street vendors and villagers in Thailand who sell honey without brand and labeling which sometimes those honeys might be artificial honey. So, the consumer might prefer to buy honey from reliable source such as buy it directly from beekeeper or buy the honey that is labeled with certification from the relevant. The sensory quality is also significantly important in the same level as origin of honey. The sensory quality of honey was directly related to perception of consumers and consumers' preference on characteristic of honey which the sensory characteristics are various due to floral type of honey and environmental condition. Both of specify use and packaging are in the same level of importance as price. If consumers do not have an experience in consuming any brand of honey, the attractiveness and utility of packaging might be included in their consideration. Plastic and glass are usually used as a material to produce container of honey. The glass container is considered to be the most desirable and attractive for customers (Ssenoga, 2015). On the other hand, the capital cost of plastic container is obviously cheaper and it also can be utilized by producing as a squeeze bottle to make consumer applied honey easily. In Asia, honey is not only used to consume because its deliciousness but people also applied it as a health supplement, an energy additive and to treat pre-existing medical conditions (Batt & Liu, 2012). The possible health benefits of honey have been documented since ancient time which were healing wound, fighting infection, treating infantile gastroenteritis, etc. (Haffejee et al, 1985; Deb Mandal et al, 2011; Nordqvist, 2015). Volume, uniqueness and brand are the factors of honey which Thai consumer do not mind much about them especially brand of honey. According to the result, most of Thai consumer consumed honey 1-2 times/ month and when they consumed it, they may not really know the brand of honey because they consumed it as complete product or providing condiment for example the honey that served with pancake in dessert shop, the honey that applied in honey roasted meat in restaurant or the honey that already mixed with lemon juice in beverage store. Besides, 17% of Thai consumers cannot remember the brand of honey or consumed no brand honey. Therefore, these are the reasons why brand is the least important factor for Thai consumers.

Table 3: Sensory factors on buying honey

Factors	Mean ± SD
Taste	4.3±1.2[a]
Flavor	4.1±1.1[a]
Aroma	3.6±1.1[b]
Viscosity	3.1±1.1[c]
Clarity	3.0±1.1[c]
Color	2.9±1.1[c]

Note: Mean with the same letter are not significantly different at alpha level = 0.05

There was also significant difference between factors in term of sensory (P<0.0001). Both taste and flavor are the most important attributes according to statistical analysis. There was a study in Australia mentioned that taste is unsurprisingly most influential factor (Batt & Liu, 2012). The important of flavor is due to its properties because flavor can be used to identify botanical and geographical origin of honey which the honeys from defined botanical and geographical origins possess distinctive sensory characteristics and also are considered as premium products which tend to have higher prices than honeys from mixed botanical origins (Cuevas-Glory et al, 2007; Manyi-Loh et al, 2011). In fact, there is a relationship between taste and flavor, somewhere between 75 and 95 % of what people usually aware of as taste actually occurs from the sense of smell which is flavor (Spence, 2015). Even aroma is less important than flavor but it also occurred from the sense of smell which its properties quite similar to flavor but aroma mainly perceived using nose instead of mouth like flavor. However, these factors can only be perceived after purchasing. So, the consumers who buy honey for the first time may consider more about general factors (Batt & Liu, 2012). Consumers tend to prefer honey with a thick texture and dark golden color due to its higher utility (Murphy et al, 2000). Viscosity of honey varies depending on the nectar source, floral type and environmental condition (Benefits of Honey, 2017). Color is the physical property perceived immediately by the consumer. It is also a useful criterion to classification unifloral honey. (Belay et al, 2015). Moreover, color is also related to flavor of honey. The darker honey tends to have stronger flavors due to more amount of phenolic compound derivatives (Bogdanov et al., 2004). Clarity was used in grading system of honey in U.S. to prevent pollen removing from filtrated process because consumers preferred honey with a trace of pollen due to its benefits. Even though clarity is correctly considered a relative less important (White, 2018).

Generate sensory profiles of unifloral honeys by trained descriptive panelists

All attributes had been selected for training require references for each of them to help panelists when they tasted the samples which were helped them in rating intensities to be easier. The references must be covered the intensity of every samples. Some references were brought from previous research which already had the name of products and intensities. Any attributes that did not have reference from previous research were determined by providing many types of product which represent each attribute to the panelists for one attribute at a time so they decided which one was selected to be the reference. They also rated the new selected references which never have an intensity before and make a consensus of intensity for each reference. The name of reference is available in Table 4.

Table 4: Reference of all attributes in training

Attributes	Intensity	Name of Product
Sweet	7	15% Sucrose (150g per a liter of water)
	8.5	20% Sucrose (200g per a liter of water)
	9.5	22.5% Sucrose (225g per a liter of water)
	10	25% Sucrose (250g per a liter of water)
Sour	1.5	0.015% Citric acid (0.15g per a liter of water)
	2.5	0.025% Citric acid (0.25g per a liter of water)
	3.5	0.050% Citric acid (0.50g per a liter of water)
Bitter	1.5	0.011% Caffeine (0.11g per a liter of water)
	2	0.015% Caffeine (0.15g per a liter of water)
	3.5	0.025% Caffeine (0.25g per a liter of water)
Floral Flavor	3.5	TEAS' TEA (Jasmine Green Tea-Sweet)
	5	DEEDO (Orange)
	7	KATO (Orange)
Viscosity	9	HERSHRY'S SYRUP (Genuine Chocolate Flavor)
	11	KARO (Dark Corn Syrup)
	12	MALI (Sweet Condense milk)
	13	SMUCKER Butter Scotch (Flavored Topping)

Table 5: Sensory characteristics of unifloral honeys for five attributes

Honey	Sweetness	Sourness	Bitterness	Viscosity	Floral Flavor
Eucalyptus	8.44 ± 0.33^{ab}	1.78 ± 0.25^{a}	1.49 ± 0.33^{bc}	10.44 ± 0.43^{c}	4.49 ± 0.39^{bc}
Forest2	8.29 ± 0.34^{b}	1.53 ± 0.28^{b}	1.36 ± 0.32^{cd}	10.27 ± 0.39^{c}	4.33 ± 0.37^{cd}
Longan1	8.27 ± 0.43^{b}	1.47 ± 0.30^{b}	1.31 ± 0.39^{d}	10.88 ± 0.51^{b}	4.22 ± 0.39^{d}
Lychee2	8.35 ± 0.43^{b}	1.53 ± 0.23^{b}	1.81 ± 0.39^{a}	10.85 ± 0.37^{b}	4.76 ± 0.44^{a}
Macadamia	8.53 ± 0.40^{a}	1.46 ± 0.33^{b}	1.54 ± 0.39^{b}	10.74 ± 0.40^{b}	4.55 ± 0.44^{b}
Orange	8.35 ± 0.31^{b}	1.53 ± 0.23^{b}	1.37 ± 0.34^{cd}	10.83 ± 0.37^{b}	4.40 ± 0.35^{bcd}
Sesame1	8.32 ± 0.33^{b}	1.77 ± 0.32^{a}	1.33 ± 0.29^{cd}	10.90 ± 0.39^{b}	4.54 ± 0.49^{b}
Sunflower1	7.72 ± 0.38^{c}	1.12 ± 0.24^{c}	0.72 ± 0.28^{e}	11.77 ± 0.39^{a}	3.82 ± 0.41^{e}

Note: Mean with the same letter are not significantly different at alpha level = 0.05

According to Table 5, there were significant difference between unifloral honeys product for every attribute ($P<0.05$). Macadamia honey contain the highest sweetness followed by eucalyptus honey. There was no significant difference between sweetness of forest, longan, lychee, orange and sesame which all of them contain less sweetness than eucalyptus honey. However, sunflower honey contained the lowest sweetness. Both of eucalyptus and sesame honey significantly in group of the highest sourness. There was no significant difference in sourness between the rest of them except sunflower honey that had the lowest sourness. The intensity of bitterness in these honeys from high to low were lychee, macadamia, eucalyptus, orange, forest, sesame and sunflower honey. There was significant difference within bitterness of all honeys except orange, forest and sesame, there were no significant difference within their bitterness. Sunflower honey significantly contained the highest viscosity followed by sesame, longan, lychee and orange honey respectively which were no significant difference in their viscosity. Both of eucalyptus and forest honey significantly contained the lowest level of viscosity. There was significant difference between floral flavors of all honey samples except macadamia and sesame honey which were no significant difference between them. Lychee honey contained the strongest floral flavor followed by macadamia, sesame eucalyptus, orange, forest, longan and sunflower honey respectively.

Table 6: Liking score of honey samples from 50 assessors in 6 attributes

Honey	Overall Liking	Sweetness	Sourness	Bitterness	Viscosity	Floral Flavor
Eucalyptus	5.7 ± 1.80^{bc}	5.7 ± 2.11^{cd}	5.5 ± 2.03^{bc}	5.6 ± 2.08^{bc}	6.5 ± 1.59^{b}	5.4 ± 1.80^{bc}
Forest2	6.2 ± 1.59^{b}	6.3 ± 1.64^{b}	6.0 ± 1.77^{b}	5.8 ± 1.67^{b}	6.7 ± 1.35^{b}	5.9 ± 1.85^{b}
Longan1	7.2 ± 1.47^{a}	6.9 ± 1.63^{a}	6.5 ± 1.55^{a}	6.6 ± 1.65^{a}	6.8 ± 1.68^{ab}	7.0 ± 1.48^{a}
Lychee2	5.2 ± 1.75^{c}	5.4 ± 2.04^{d}	5.3 ± 1.69^{c}	5.1 ± 1.96^{c}	6.3 ± 1.51^{b}	5.4 ± 1.92^{bc}
Macadamia	5.5 ± 1.83^{c}	5.8 ± 1.99^{bcd}	5.5 ± 1.69^{bc}	5.6 ± 1.84^{bc}	6.3 ± 1.47^{b}	5.3 ± 1.90^{bc}
Orange	5.4 ± 1.84^{c}	5.7 ± 1.85^{cd}	5.5 ± 1.75^{bc}	5.6 ± 1.79^{bc}	6.5 ± 1.42^{b}	5.0 ± 1.74^{c}
Sesame1	6.2 ± 1.78^{b}	6.0 ± 1.96^{bc}	5.7 ± 1.71^{bc}	6.1 ± 1.66^{ab}	6.7 ± 1.52^{ab}	5.9 ± 1.79^{b}
Sunflower1	7.3 ± 1.37^{a}	6.9 ± 1.51^{a}	6.5 ± 1.67^{a}	6.6 ± 1.61^{a}	7.2 ± 1.23^{a}	7.0 ± 1.46^{a}

Note: Mean with the same letter are not significantly different at alpha level = 0.05

Determine consumers' preferences toward different unifloral honeys

There was significant difference between honey samples in overall liking, sweetness, sourness, bitterness and floral flavor ($P<0.05$). There was also significant difference in viscosity of honey samples. According to statistical analysis in Table 6, the significantly most preferred honeys for all attributes were sunflower and longan honey which the sensory attributes of them showed that these both types of honey contained sweetness, sourness, bitterness and floral flavor less than other honey samples except the sour taste which only macadamia contained lower sweetness than longan. However, both types of honey contain higher viscosity than all samples of honey except sesame which got higher viscosity than longan. On the other hand, the significantly least preferred honey was lychee honey. It contained the lowest liking score in most characteristics which were overall liking, sweetness, sourness, bitterness. Likewise, it almost contained lowest score in viscosity and floral flavor, only eucalyptus that got lower score than lychee honey in viscosity and only orange honey that contained liking score less than it. Comparing sensory characteristics with liking score of all samples, consumers tend to prefer the honey that contained less sweetness, sourness and bitterness. Moreover, they also preferred honey that contained mild flavor and thick texture.

CONCLUSION

Studies shown that most of Thai consumers consumed honey 1-2 times/months and usually buy honey at supermarket. The consumers are willing to pay for safety of honey, reliable source and good sensory quality due to availability of adulterated honey in Thailand. Thai consumers also pay attention on taste, flavor and aroma for sensory characteristics, however these physiological factors can be perceived after purchasing only, so the consumers should be more considered about general characteristics if they do not have any experience in those honeys before. The sensory profiles of eight unifloral honey were generated by focusing on five attributes which were sweetness, sourness, bitterness, viscosity, and floral flavor. Thai consumers tend to prefer the unifloral honey that contained less sweetness, sourness and bitterness. Moreover, they also preferred honey that contained mild flavor and thick texture which these sensory characteristics referred to sunflower and longan honey.

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REFERENCES

Batt, P.J. & Liu, A. (2012). Consumer behaviour towards honey products in Western Australia. *British Food Journal, 114(2)*, 285-297.

Belay, A., Solomon, W.K., Bultossa, G., Adgaba, N. & Melaku, S. (2015). Botanical origin, colour, granulation, and sensory properties of the Harenna forest honey, Bale, Ethiopia. *Food Chemistry, 167*, 213-219.

Benefits of honey (Access Date: 2017, April 5). 17 Honey FAQs [Frequently Asked Information About Honey] Retrieved from http://www.benefits-of-honey.com/information - about-honey.html

Bogdanov, S., Ruoffa, K. & Persano-Oddo, L. (2004). Physico-chemical methods for the characterization of unifloral honeys: a review. *Apidologie, 35,* 4-17.

Ciappini, M.C., Di Vito, M.V., Gatti, M.B. & Calviño. A.M. (2013). Development of a Quantitative Descriptive Sensory Honey Analysis: Application to Eucalyptus and Clover Honeys. *Advance Journal of Food Science and Technology*, *5(7)*, 829-838.

Cosmina, M., Gallenti, G., Marangon, F. & Troiano, S. (2016). Reprint of "Attitudes towards honey among Italian consumers: A choice experiment approach". *Appetite, 106,* 110-116

Cuevas-Glory, L.F., Pino, J.A., Santiago, L.S., & Sauri-Duch, E. (2007). A review of volatile analytical methods for determining the botanical origin of honey. *Food Chemistry, 103,* 1032-1043.

FAOSTAT (2013) Honey production: Browse data - FAOSTAT Domains /Production/ Livestock Primary; Item: Honey, natural; Area: World; Year: as needed". *United Nations, Food and Agriculture Organization, Statistics Division (FAOSTAT).*

Ferreira, E.L., Lencioni, C., Benassi, M.T., Barth, M.O. & Bastos, D.H.M. (2009). Descriptive Sensory Analysis and Acceptance of Stingless Bee Honey. *Food Science and Technology International, 15(3),* 251-258.

Galan-Soldevilla, H., Rui-Perez-Cacho, M.P., Jimenez, S.S., Villarejo, M.J. & Manzanares, A.B. (2005). Development of a preliminary sensory lexicon for floral honey. *Food Quality and Preference, 16,* 71-77.

Haffejee, I.E. & Moosa, A. (1985). Honey in the treatment of infantile gastroenteritis. *BMJ: British medical journal, 290,* 1866-1867

Mandal, M.D. & Mandal, S. (2011). Honey: its medicinal property and antibacterial activity. *Asian Pac J Trop Biomed, 1(2),* 154-160.

Manyi-Loh, C.E., Clarke, A.M. & Ndipa, R.N. (2012). Volatile Compounds in Honey: A Review on Their Involvement in Aroma, Botanical Origin Determination and Potential Biomedical Activities. *International Journal of Molecular Sciences, 12(12)*, 9514–9532.

Murphy, M., Cowan, C., Henchion, M. & O'Reilly, S., (2000). Irish consumer preferences for honey: a conjoint approach, *British Food Journal, 102(8)*, 585 - 598

Nordqvist, J. (2018, February 11). Honey: Health Benefits and Uses in Medicine.

Retrieve from http://www.medicalnews today.com/articles/264667.php

Overton, S.V., and Manura, J.J., (1999) Note 25: Flavor and Aroma in Natural Bee Honey. Scientific Instrument Service (SIS). Retrieved from http://www.sisweb.com/referenc/applnote/app-25.htm

Roman, A., Popiela-Pleban, E., Kozak, M., and Roman, K. (2013). Factors influencing consumer behaviour relating to the purchase of honey, part 2. Product quality and packaging. *Journal of Apicultural Science, 57(2),* 175-185.

Spence, C. (2015, November 2). Just how much of what we taste derives from the sense of smell? *Spence Flavour 2015 4:30*

Ssenoga, B. (2015, June 17). Beekeepers, honey packers tipped on packaging. Retrieved from http://www.monitor.co.ug/Magazines/Farming/Beekeepers-honey-packers-packaging/689860-2753990-doomvi/index.html

White, J.W. (Access Date: 2018, July 19). Clarity as a Quality Factor in Honey Grading Request for Reconsideration. Honey Industry Council of America, Inc. Retrieved from https://collection1.libraries.psu.edu/cdm/ref/collection/honeyboard/id/258

CHAPTER 4: DETERMINATION OF THE SENSORY CHARACTERISTICS OF THAI HONEY USING A SORTING TECHNIQUE WITH DIFFERENT GROUPS OF CONSUMERS

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ABSTRACT

Thailand is not a major honey producer and exporter, but Thai honey is demanded by world market due to its unique flavor from tropical fruit blossoms, originating from South Eastern Asia. This study aimed to determine the sensory characteristics of Thai honey and their food applications using a sorting technique with different groups of consumers together with consumer acceptance level towards each group of honey. Twenty-four honey samples were selected based on honey varietal and availability in Thailand. The sorting was applied by three different groups of consumers including non-honey user (n=30), a regular honey user (n=30) and a culinary group (n=30). According to the study, Longan1, Longan2, Sunflower1, multi-floral honey from Northern, North Eastern and Western part of Thailand were grouped together and were preferred by all groups of assessors. The characteristics of these honeys were described related to floral flavor; jasmine flavor was described by all groups, moreover both non-honey user and culinary group used the words "floral flavor" directly. Non-honey user also applied more words to explain these honeys such as lotus and chrysanthemum. On the other hand, the similarities also appeared in the opposite direction. The five non-preferred honey sample were categorized into two groups; the first group was composed of Lychee1 and Lychee2, and these samples were associated with chemical flavor which was described by non-honey user, regular honey user and culinary group as chemical, alcohol and plastic respectively. The other group included multi-floral honey from the South, Stingless and Florea, which were described similarly with terms related to fermented flavor. Vinegar flavor had been mentioned by both non-honey user and culinary group, however regular honey user also explained them as spoiled and fermented flavor. For honey application in food, most assessors identified product with categorical words such as dessert, beverage and bakery.

Keywords: Honey, Consumer behavior, Sensory property, Sorting

INTRODUCTION

In 2013, 1.7 million tons of honey were produced worldwide (FAOSTAT 2013). In Asia, honey is not only used for consumption because its deliciousness but people also applied it as a health supplement, an energy additive and to treat pre-existing medical conditions (Batt & Liu, 2012). Even if Thailand is not a major producer and exporter comparing to the other countries, Thai honey is demanded by world market due to its unique characteristics because it is produced with different types of flower from other countries such as longan, lychee, wild flower etc. which gives an advantage over honey from other countries (Kongpitak, 2014). These variety of floral types are directly related to the sensory characteristics of honey due to different compositions of nectar in each type of flower which provide distinct color, texture, tastes and aromas especially flavors that reflected the flowering plants (Overton & Manura, 1995; Manyi-Loh et al, 2011). Moreover, there are also other factors affecting sensory characteristics of honey such as bee species and environmental conditions.

There are dissimilar perception perspectives between different groups of people especially consumers and experts. Experts' opinion on product do not always indicate the needs of consumer because they may prioritize on distinct factors. There are some studies revealing that consumers and experts focused on different criteria whereas consumers paid more attention on their liking to decide whether they want to buy product or not, on the other hand experts are more concerned by the quality of product (Caporale et al., 2006; Schiefer & Fischer, 2008). Likewise, Chef can be considered as a culinary expert who has to seriously cook for serving delicious food to customers every day (Dhavale, 2018). Their knowledge and experience had been increased through the time, therefore the way that they use to describe food may be dissimilar to consumers.

In sensory analysis, human's senses can be applied as a tool to establish sensory profiles from each types of honey. The most common method that is used to determine sensory characteristics is descriptive analysis. The well-known descriptive analysis includes Flavor Profile Method, the Texture Profile Method, Quantitative Descriptive Analysis® (QDA®) and Spectrum™ Descriptive Analysis which all of them were widely applied in many sensory studies because they can be used to manage quantitative comparisons to be made across different products on specific attributes (Murray et al., 2001). However, these methods require much time to spend on recruiting and training the assessors. Sorting is one of the rapid sensory profiling techniques that had been developed to improve the efficiency of the data collection process while trying to maintain the information obtained as in classical descriptive analysis

(Fleming et al., 2015). The sorting technique is a method for collecting similarity data to generate perceptual map by using stimulated perception of assessors to categorize samples into groups based on knowledge and experience. This technique works really well for reducing large sample sets to smaller numbers and, with word labelling, for revealing the sensory or other attributes (Sensory dimensions, 2015). It is also widely used because it is rapid and simple for participants, moreover it also provides reliable result (Lawless & Glatter, 1990; Lawless et al., 1995; King et al., 1998). However, the result from this method may lack some details so this method is not suitable for someone who need to understand product precisely. Additionally, the performance of assessor can be influenced by sensory and memory fatigue due to excessive number of sample and the characteristic of product itself especially the product that requires to evaluate flavor and aroma.

Honey is a naturally occurring sweetener that is produced by bees which can be applied in various categories of food due to its sweetness and properties. Honey is used a lot in baking industry to enhance flavor, keeping quality and improving texture of bakery product. It is also used in confectionary production as flavoring, binding and sweetening agent. Besides, the antibacterial property of honey is utilized for inhibiting microbial spoilage of food. The ability of honey is also used to improve the growth of dairy starter cultures in milk and other dairy products which also can be used as a prebiotic additive to probiotic dairy products (Aibolita, 2018). Additionally, antioxidant properties of honey are applied to prevent oxidation of food during storage including lipid oxidation of meat (Nagai et al. 2006). Meanwhile, honey is also used by consumer themselves as an ingredient in cooking or directly to consume it with other products. Some people prefer to use honey as a sugar replacement due to nutrients and benefits of honey over granulated sugar, however different types of honey contain distinct aroma, taste and flavor so the application of each type of honey on food may be dissimilar.

Therefore, the aim of this project was to study sensory characteristics of Thai honey by applying sorting technique with different groups of consumers and to determine consumers' preferences toward these honeys. Lastly, to define types of food that should be consumed with varied sensory characteristics of honey.

MATERIALS AND METHODS

Samples

Twenty-four honey samples were selected due to their variety and availability in Thailand which included honey from longan, lychee, sesame sunflower, wild flower (siam weed), coffee, forest and macadamia. Two samples were chosen from each of them except macadamia which had only one. Moreover, the multi-floral honey from each part of Thailand were selected which were multi-floral honey from northern, north eastern, eastern, western, southern and middle part of Thailand. The rest of them were also multi-floral honey which were produced by distinct types of bee such as cerana, florea and stingless. All of these three honeys were not passed any heat treatment included lychee1, forest1 and multi-floral honey from the South.

All of samples were provided on the tray to assessors at the same time with water, plastic coffee spoons and sorting ballot. Each sample was labeled with different 3-digit code. The samples were served in 1 Oz white plastic cups at room temperature. The amount of honey per cup was about 5 grams. The water was applied as a rinsing product.

Panelists

According to the previous part, most of Thai consumers consumed honey 1-2 times/ month (Ketwaropaskul et al., 2017). The consumption frequency was applied as criteria to categorize the assessors. The assessors who not consumed honey or rarely consumed honey, less than once a month were categorized as non-honey user, on the other hand the assessors who consumed honey once a month or more were grouped together as regular honey user. The last group is composed of chefs or consumers who have culinary background on honey. Therefore, the sorting was applied by three different groups of consumers including non-honey users (n=30), regular honey users (n=30) and culinary group (n=30).

Procedure

Sorting technique was applied to study sensory characteristics of honey samples. The assessors were assigned to group the samples according to similarity based on experience and knowledge of each person. The ballot is composed of 5 parts to fill in which include group number, sample codes, characteristics, liking score and honey application on consuming product.

Group number part was applied to write down the group number and sample code part was used to write down 3-digit code of samples within the same group. The similar characteristics within group were described in the part of characteristics. Nine-point hedonic scale was used to rate the liking score of groups in overall liking part. The last part was applied to write down the products that should be consumed or cooked with honey.

Data analysis

The data from sorting of honey characteristics and honey application was analyzed by DISTATIS of RStudio 0.99.467. The liking score was analyzed by ANOVA with Duncan multiple comparison of SAS9.4.

RESULTS AND DISCUSSION

Consumers' preferences toward honey

Table 7: Liking score of honey samples by non-honey user

Honey	Mean±SD
West	7.3 ± 1.1^{a}
Wild1	7.0 ± 1.1^{ab}
Sunflower1	7.0 ± 1.4^{ab}
Longan1	6.9 ± 1.2^{ab}
North	6.8 ± 1.3^{ab}
Sesame2	6.6 ± 1.5^{abc}
Longan2	6.6 ± 1.6^{abc}
North East	6.5 ± 1.7^{abcd}
Middle	6.3 ± 1.5^{abcd}
East	6.2 ± 1.8^{abcde}
Coffee2	6.0 ± 2.1^{abcde}
Wild2	5.8 ± 2.1^{abcdef}
Macadamia	5.7 ± 1.8^{bcdef}
Sesame1	5.3 ± 1.9^{cdefg}
Cerena	5.3 ± 1.8^{cdefg}
Sunflower2	5.2 ± 1.6^{cdefg}
Forest2	5.1 ± 2.0^{defg}
Lychee2	5.1 ± 1.9^{defg}
Coffee1	4.8 ± 1.96^{efg}
Lychee1	4.8 ± 2.3^{efg}
Florea	4.5 ± 1.8^{fgh}
Forest1	3.9 ± 2.2^{gh}
South	3.9 ± 2.0^{gh}
Stingless	3.2 ± 1.84^{h}

Table 8: Liking score of honey samples by regular honey user

Honey	Mean±SD
Longan2	6.9 ± 1.6^{a}
Longan1	6.9 ± 1.6^{a}
Sunflower1	6.8 ± 1.7^{ab}
Coffee2	6.8 ± 1.6^{ab}
East	6.8 ± 1.5^{ab}
North	6.7 ± 1.5^{ab}
West	6.7 ± 2.0^{ab}
Middle	6.5 ± 2.0^{abc}
North East	6.2 ± 1.9^{abcd}
Wild2	6.2 ± 1.8^{abcd}
Sesame2	6.2 ± 2.1^{abcd}
Wild1	6.0 ± 2.2^{abcd}
Sesame1	5.9 ± 2.4^{abcde}
Cerena	5.8 ± 2.1^{abcde}
Sunflower2	5.3 ± 2.2^{bcdef}
Forest2	5.1 ± 1.9^{cdefg}
Macadamia	5.1 ± 2.2^{cdefg}
Coffee1	4.8 ± 2.4^{defgh}
Florea	4.7 ± 2.4^{defgh}
Lychee2	4.7 ± 2.4^{defgh}
Lychee1	4.4 ± 2.3^{efgh}
Forest1	3.8 ± 2.2^{fgh}
South	3.6 ± 2.2^{gh}
Stingless	3.4 ± 2.3^{h}

Table 9: Liking score of honey samples by culinary group

Honey	Mean±SD
Longan1	7.1 ± 1.9^{a}
Sunflower1	7.0 ± 1.8^{a}
Coffee2	7.0 ± 1.8^{ab}
West	7.0 ± 1.8^{ab}
Longan2	6.9 ± 1.8^{ab}
Wild1	6.9 ± 2.0^{ab}
North East	6.8 ± 1.5^{ab}
North	6.7 ± 2.1^{abc}
Sesame2	6.4 ± 2.5^{abcd}
Sesame1	5.9 ± 2.1^{abcd}
Wild2	5.8 ± 2.3^{abcd}
East	5.7 ± 2.3^{abcd}
Forest2	5.4 ± 2.0^{abcde}
Middle	5.4 ± 2.2^{abcde}
Macadamia	5.3 ± 2.8^{abcde}
Cerena	5.2 ± 2.2^{bcdef}
Sunflower2	4.9 ± 2.3^{cdefg}
Coffee1	4.8 ± 2.7^{defg}
Lychee2	3.9 ± 2.4^{efgh}
Stingless	3.4 ± 1.9^{fgh}
Lychee1	3.4 ± 1.9^{fgh}
Florea	3.2 ± 1.9^{gh}
Forest1	3.2 ± 2.1^{gh}
South	2.5 ± 1.9^{h}

Note: Mean with the same letter are not significantly different at alpha level = 0.05

There was significant difference between liking scores of honey samples in every groups of consumers ($P<0.0001$). According to the Table 7 to 9, the most preferred honey of non-honey user was multi-floral honey from Western part of Thailand followed by Wild1, Sunflower1, Longan1 and Northern part honey. On the other hand, the least preferred honey sample for this group was stingless followed by Forest1 and multi-floral honey from Southern Thailand which also similar to dislike of regular-honey user. The most preferred honey samples were both Longan1 and Longan2 followed by Sunflower1, Coffee2, multi-floral honey from Northern, Eastern and Western part of Thailand. For culinary group, the most preferred honeys were Longan1 and Sunflower1 followed by Coffee2, Longan2, Wild1, multi-floral honey from

Western and North Eastern Thailand, multi-floral honey from Southern Thailand was disliked by culinary group followed by Forest1 and Florea.

Sorting

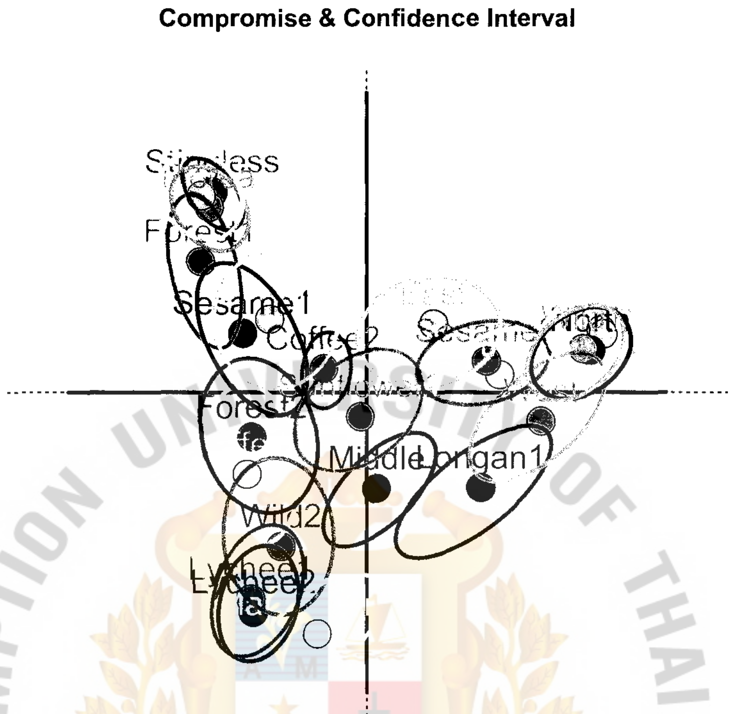

Figure 1: The confidence intervals of sorting task by DISTATIS which showed the configuration of ellipsoids of 24 honey samples by non-honey user.

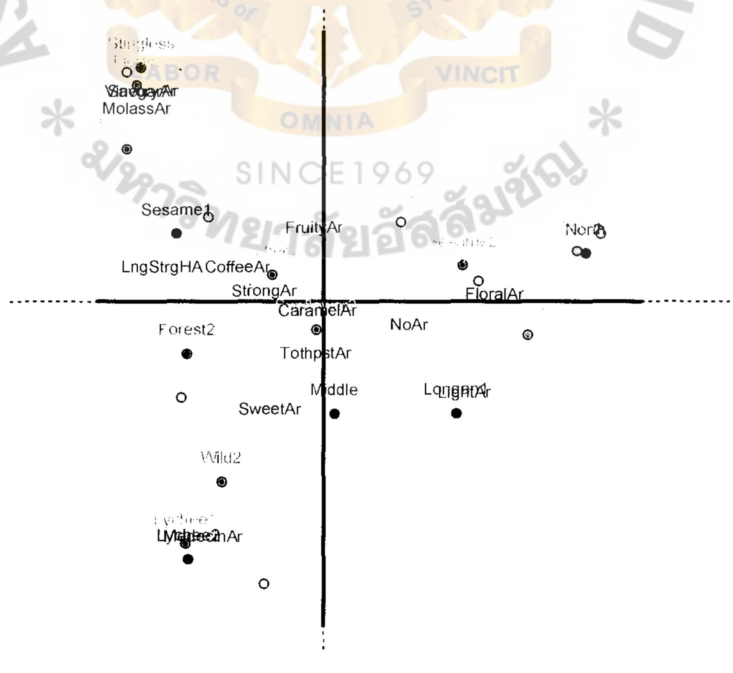

Figure 2: The description of aroma on DISTATIS map by non-honey user

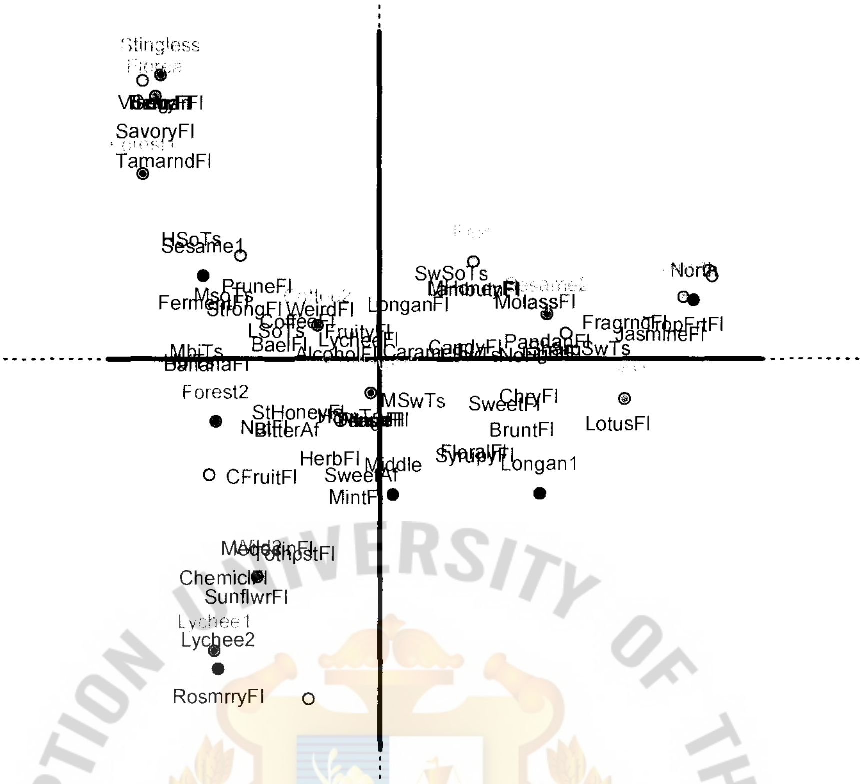

Figure 3: The description of taste and flavor on DISTATIS map by non-honey user

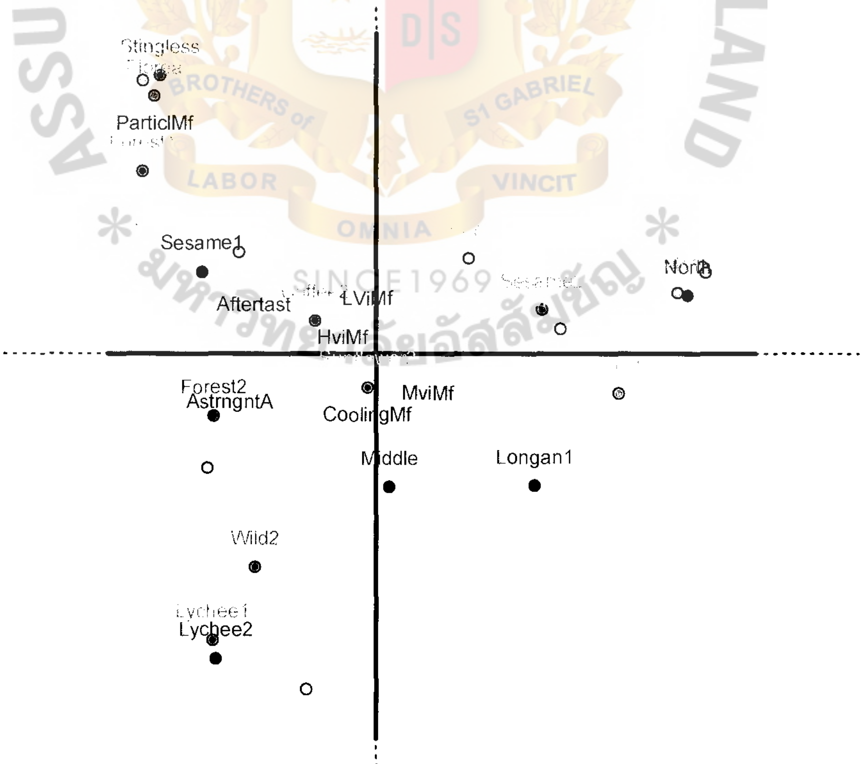

Figure 4: The description of mouthfeel on DISTATIS map by non-honey user

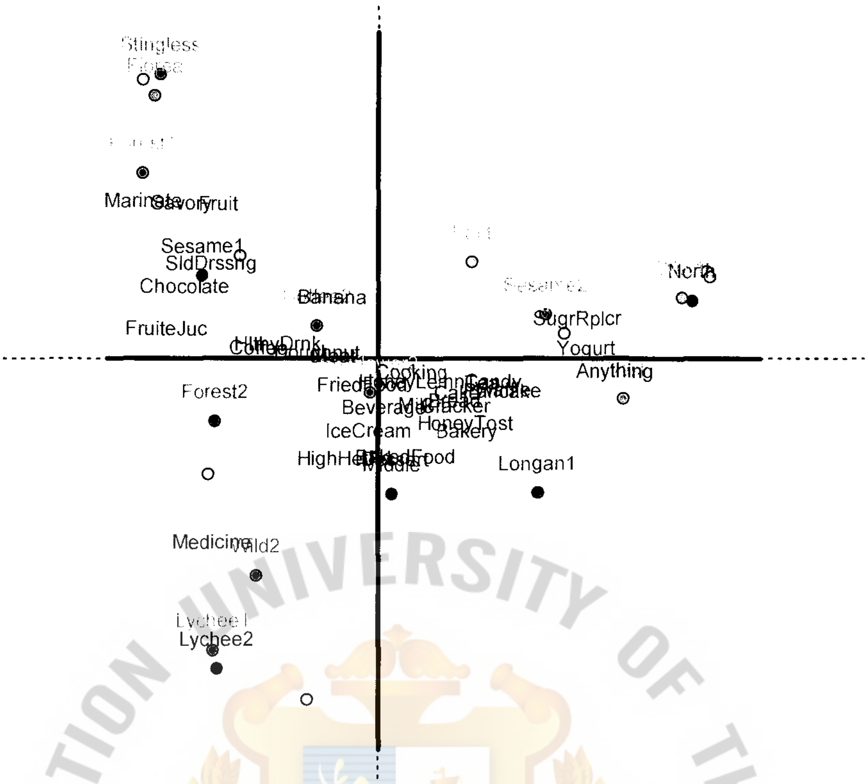

Figure 5: The description of honey applications on DISTATIS map by non-honey user

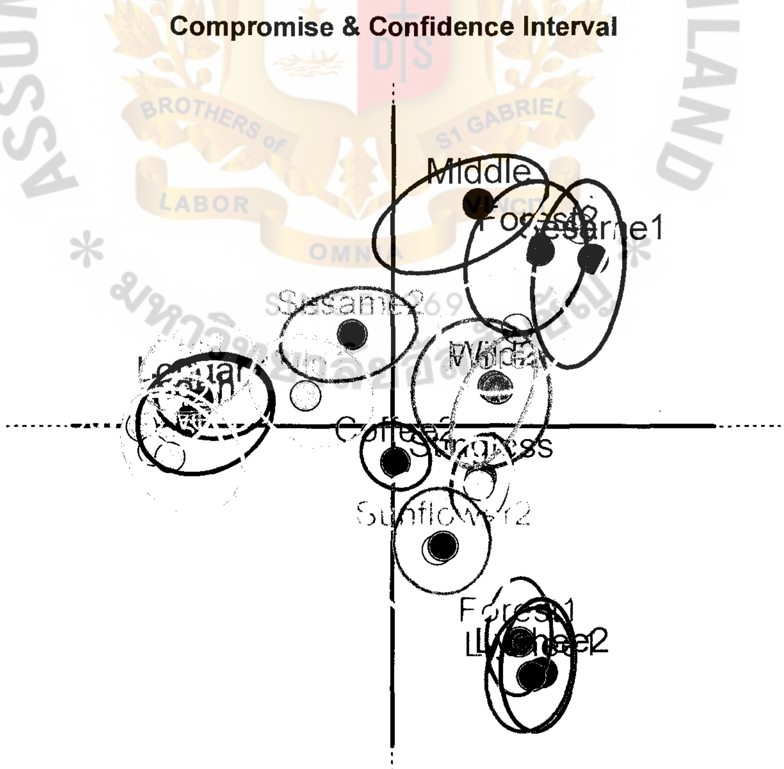

Figure 6: The confidence intervals of sorting task by DISTATIS which showed the configuration of ellipsoids of 24 honey samples by regular honey user.

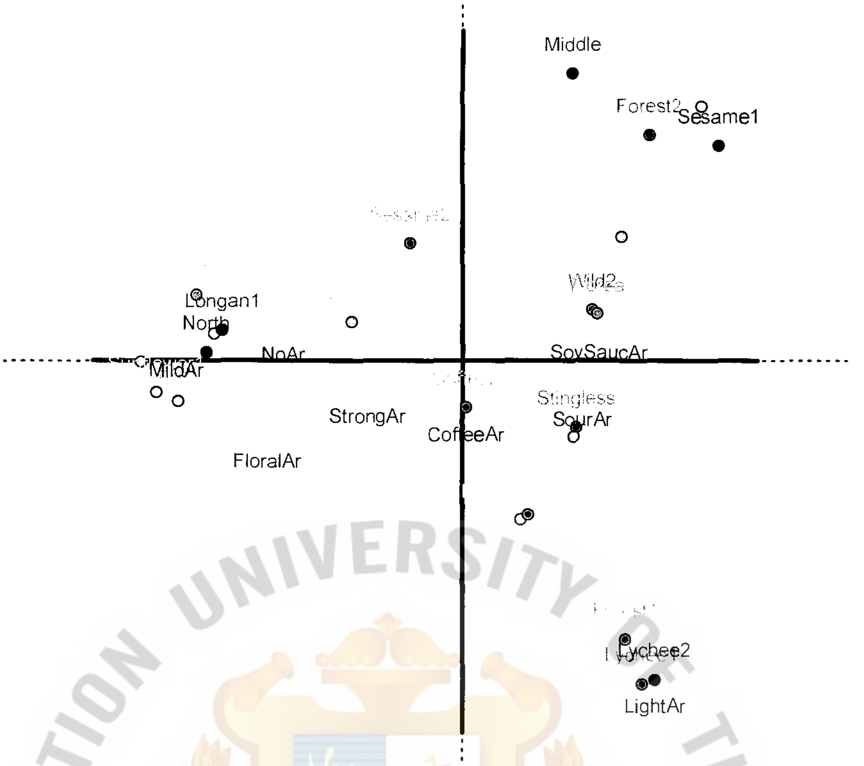

Figure 7: The description of aroma on DISTATIS map by regular honey user

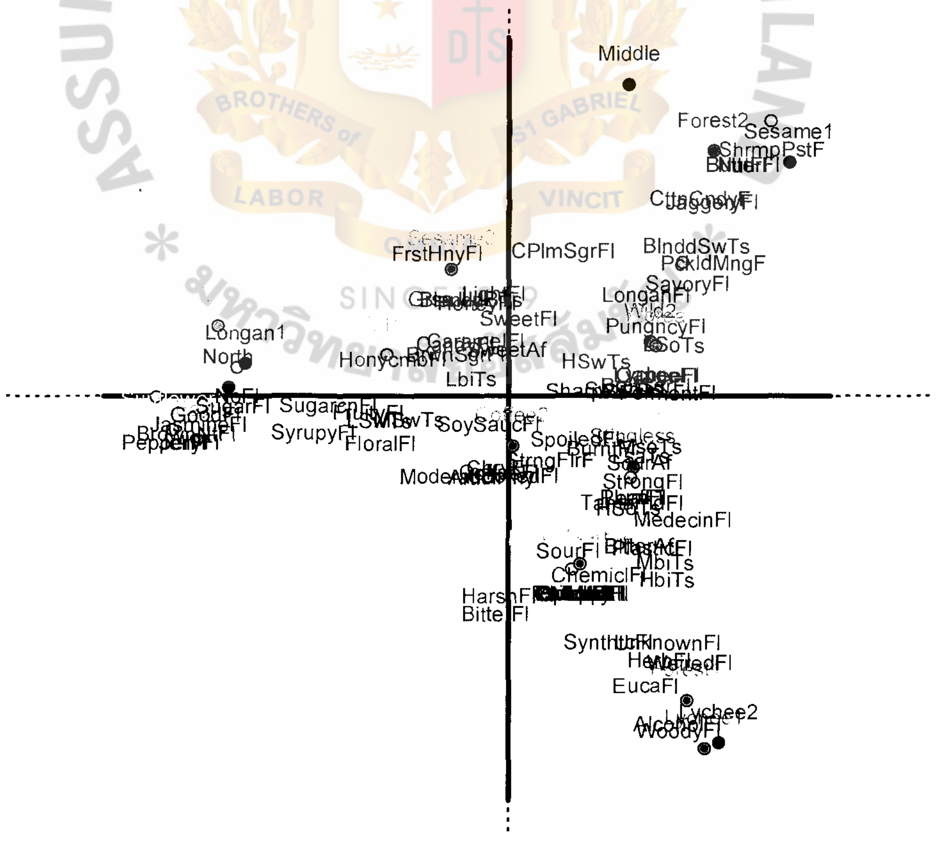

Figure 8: The description of taste and flavor on DISTATIS map by regular honey user

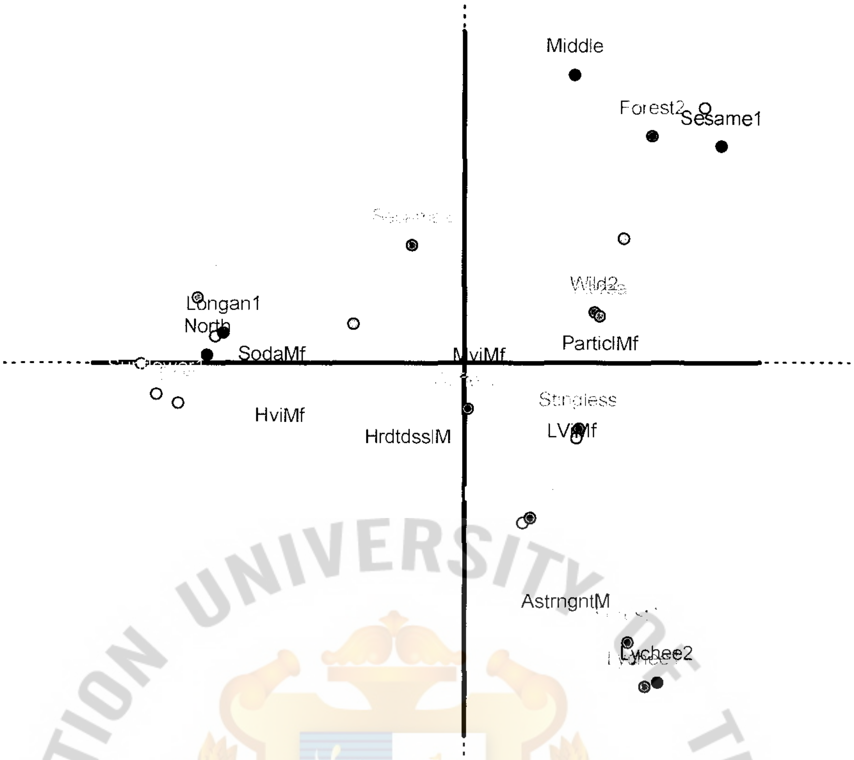

Figure 9: The description of mouthfeel on DISTATIS map by regular honey user

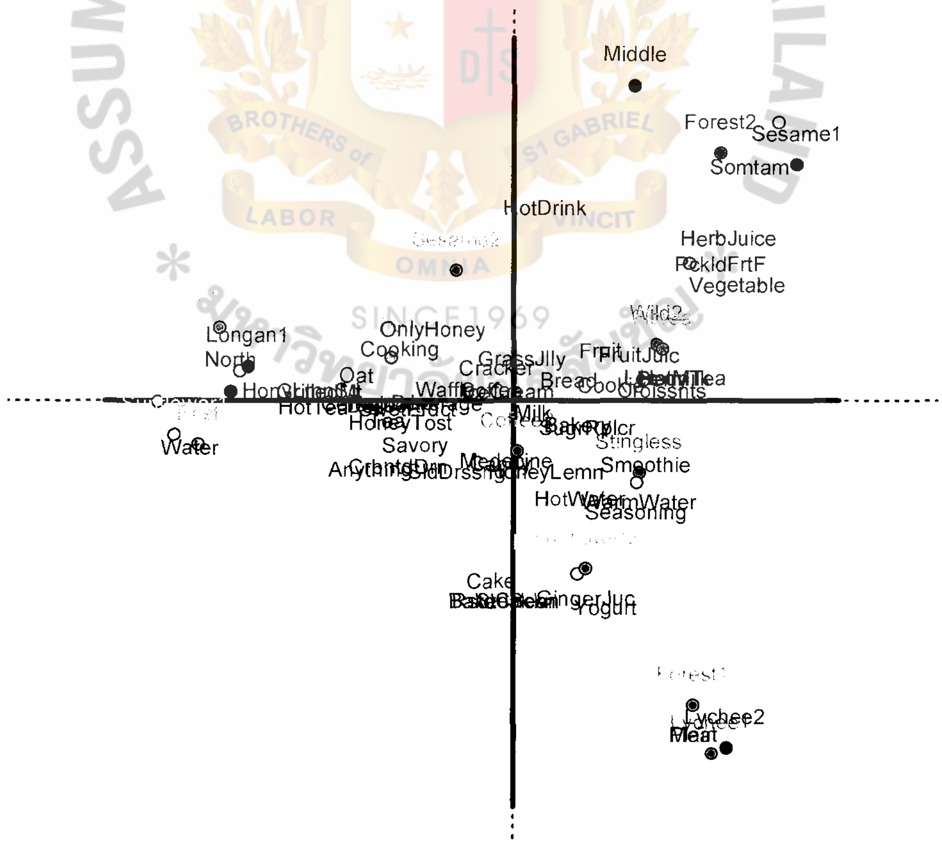

Figure 10: The description of honey applications on DISTATIS map by regular honey user

Compromise & Confidence Interval

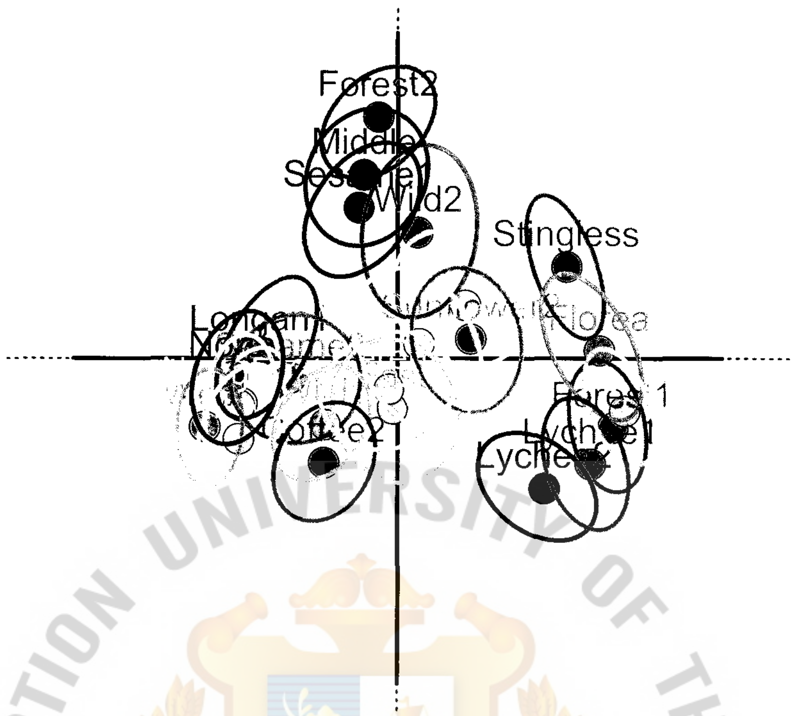

Figure 11: The confidence intervals of sorting task by DISTATIS which showed the configuration of ellipsoids of 24 honey samples by culinary group.

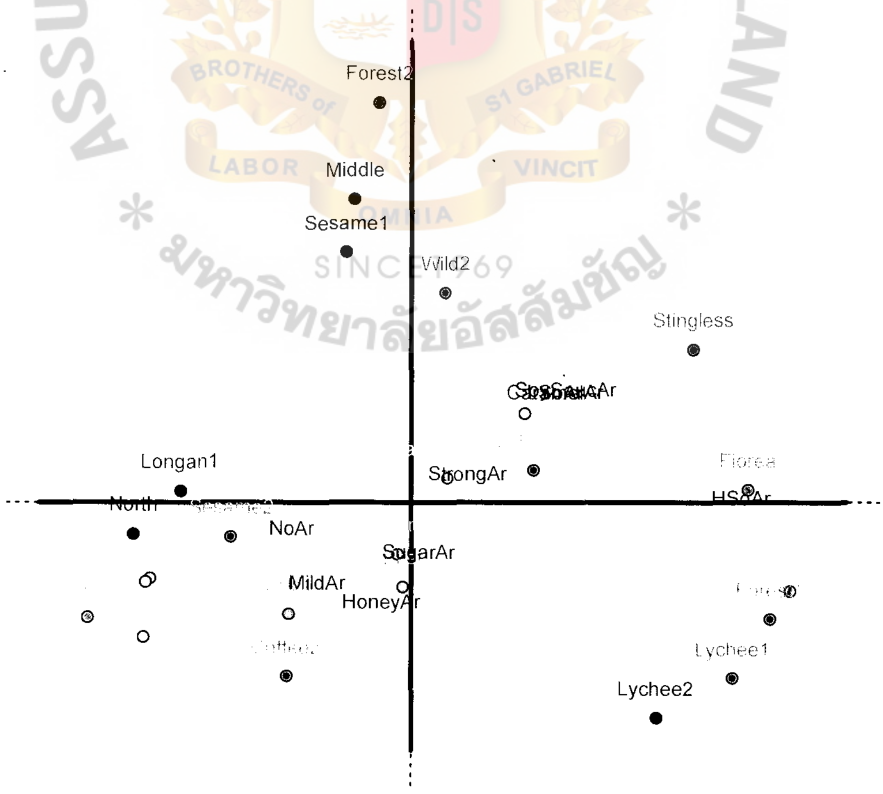

Figure 12: The description of aroma on DISTATIS map by culinary group

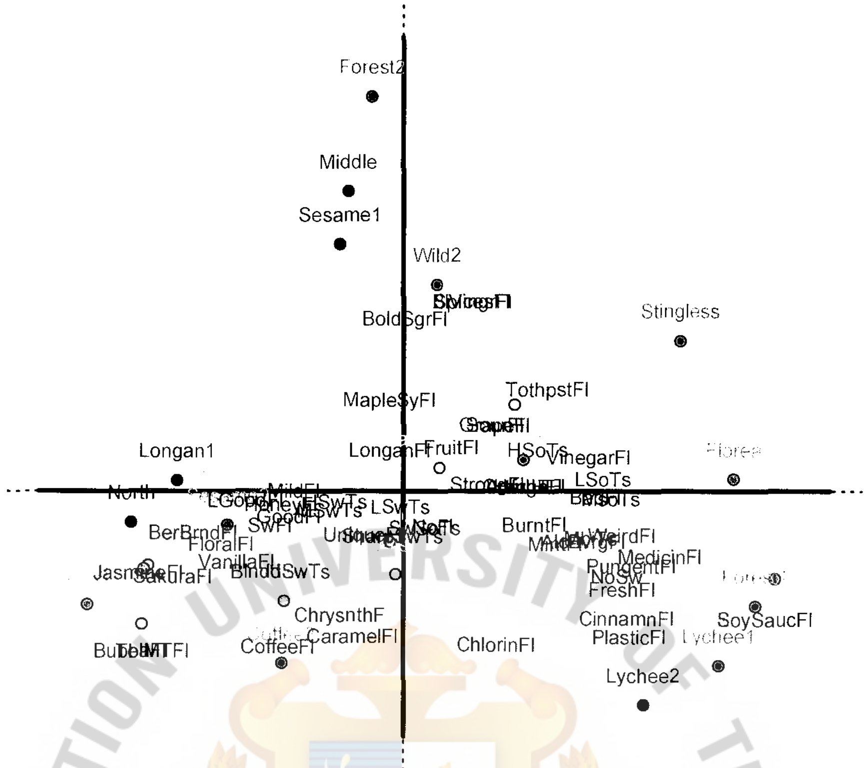

Figure 13: The description of taste and flavor on DISTATIS map by culinary group

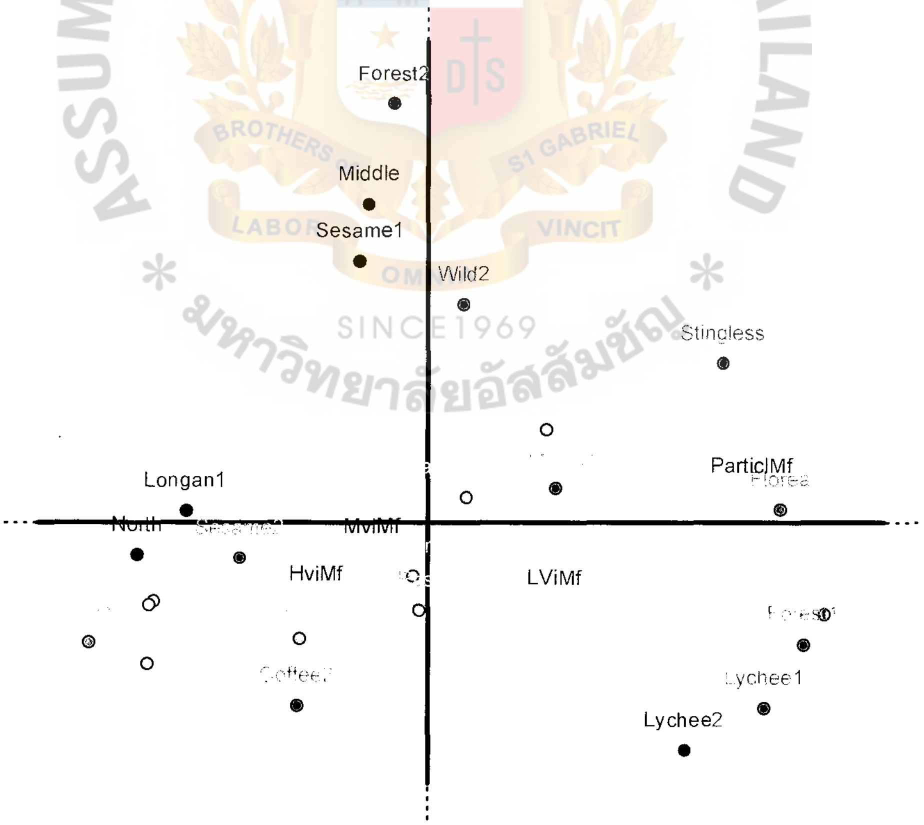

Figure 14: The description of taste and flavor on DISTATIS map by culinary group

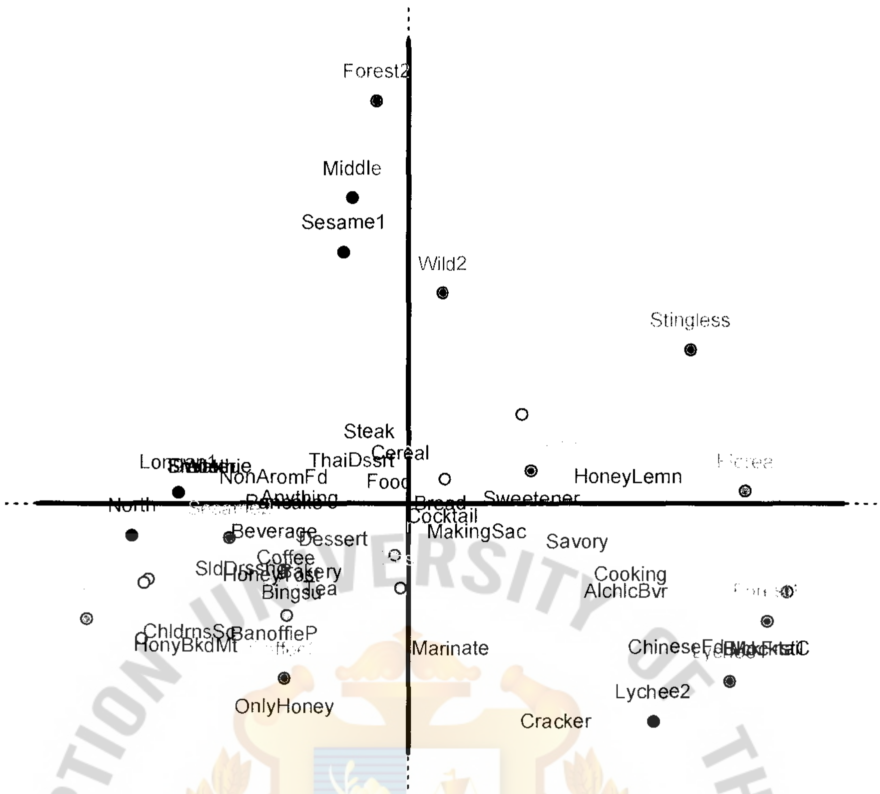

Figure 15: The description of honey applications on DISTATIS map by culinary group

According to the Figure 1 to 9, Twenty-four honey samples were sorted by non-honey user, regular honey user and culinary group where the samples were categorized into 3, 4 and 3 groups respectively. The confidence interval showed the information to compute statistical confident ellipses around the samples. If the confidence ellipsoids of any samples are not intercept, those samples are considered as significant difference by assessors. Confidence interval is significant at $P<0.05$.

<u>*Non-honey user*</u>

According to Figure 1 to 4, Twenty-four honey samples were mainly categorized into 3 groups. Longan1, Longan2, Sesame2, Sunflower1, Wild1, multi-floral honey from Northern, North Eastern and Western part of Thailand were the top eight most preferred honey for non-honey user group which were grouped together and were mainly described as floral flavor; chrysanthemum flavor was used to indicate all of honeys in this group. Jasmine flavor was also applied to explain characteristic of Sunflower1, Longan2, multi-floral honey from Northern and Western. Moreover, both Longan1 and multi-floral honey from the North were also mentioned as lotus flavor. The word "floral" was also applied in term of aroma which was used to explain these honeys except Longan1. Sunflower1, Longan1, multi-floral honey from North Eastern and Western part of Thailand were described as mild aroma.

On the other hand, the second group were ordered as four of the most disliked samples for this group which included Forest1, Florea, Stingless and multi-floral honey from Southern Thailand. Tamarind flavor was used to explain these four honeys. Besides all of these honeys also contained savory flavor except Stingless which contain savory aroma instead. Some of them had their own uniqueness. Vinegar was mentioned in both aroma and flavor to express unique characteristics of Stingless, moreover it was also described as berry flavor. Florea was indicated as molasses aroma and particle mouthfeel. Lychee1, Lychee2, Macadamia and Wild2 were combined in the same group due to similar attributes which were chemical and medicinal flavors, besides Lychee1 and Wild2 were also described as medicine aroma Coffee2 was uniquely mentioned as both aroma and flavor of coffee.

Regular honey user

Regular honey user mainly classified the samples into 4 groups according to Figure 6 to 9. Longan1, Longan2, Sunflower1, multi-floral honey from Northern, Eastern, North Eastern and Western part of Thailand were grouped together due to similarities of characteristics; good flavor was used to indicate all of honeys in this group. Syrup flavor was also mentioned by the assessors for these honey except multi-floral honey from the West. Jasmine flavor was used to describe characteristic of Sunflower1, Longan2, multi-floral honey from Northern and North Eastern part of Thailand. These honeys were preferred by the honey user group.

The next group was disliked by the assessors which were Lychee1, Lychee2 and Forest1. Alcohol flavors was used to explain attributes of these three samples. Both Lychee samples were also mentioned as woody and herb flavors. Wild2, Florea, Stingless and multi-floral honey from Southern Thailand were grouped together; All of them were described as ferment flavor. Spoiled flavor was used to indicate these honeys except Florea. Stingless and Florea were mentioned as soy sauce aroma and burnt flavor, moreover some assessor specified stingless as burnt sugar flavor with Wild2. Florea, Stingless and honey from the South were also described as sour aroma. Particle mouthfeel was used to explain Florea. The last group composed of Coffee1, Sesame1, Forest2 and Cerana; Jaggery flavor was used to indicate all of honeys in this group except Cerana. Sesame1 and Cerana were expressed as cotton candy flavor. Butter and nut flavors were mentioned for Coffee1 and Forest2. Lastly, both coffee flavor and aroma were used to described unique characteristic of Coffee2.

Culinary group

According to Figure 11 to 14, the honey samples were mainly categorized into 3 groups. Lychee1, Lychee2, Forest1, Florea, Stingless and multi-floral honey from the South were grouped together because they had their own unique characteristics, therefore some of them were described differently. Both Lychee honeys were described as plastic flavor, however Lychee1 was also mentioned as soy sauce flavor with Forest1 and multi-floral honey from the South. Soy sauce was also mentioned in term of aroma with honey from the South, Stingless, Florea and Forest1. Medicine flavor was applied to explain characteristic of Lychee1, Forest1 and Florea. Florea was also described as vinegar flavor and particle mouthfeel with Stingless. Stingless and honey from the South were mentioned as intense sour aroma honey. Due to these disliked characteristics for honey, these samples were ranked as the six least preferred honey for the culinary group.

On the other hand, the second group was preferred by these assessors which composed of Longan1, Longan2, Sesame2, Sunflower1, multi-floral honey from Northern, North Eastern and Western part of Thailand. All of these samples were described as floral flavor. Vanilla flavor was also applied to explain all honeys except multi-floral honey from North Eastern of Thailand and Sesame2, however both of these honeys were mentioned as sakura flavor with Longan2 and Sunflower1. Jasmine flavor was used to describe characteristic of Longan2 and multi-floral honey from the North. Coffee and caramel flavors represented characteristics of Coffee2. Forest2, Sesame1, Wild2 and multi-floral honey from the Middle part of Thailand; all of these honeys were described as spices and black vinegar flavors except Sesame1.

Similarities and differences

The similarities of grouping were occurred among three groups of assessors; even the characteristics of honeys were described in the same manner, some of them were different in details. Longan1, Longan2, Sunflower1, multi-floral honey from Northern, North Eastern and Western part of Thailand were grouped together and were preferred by all groups of assessors. The characteristics of these honeys were described related to floral flavor; jasmine flavor was described by all groups, moreover both non-honey user and culinary group used the words "floral flavor" directly. Sakura flavor was mentioned by the culinary group. Non-honey user also applied more words to explain these honeys such as lotus and chrysanthemum flavors.

On the other hand, the similarities also appeared in the opposite direction. The five non-preferred honey sample were categorized into 2 groups; the first group was composed of

Lychee1 and Lychee2, and these samples were associated with chemical flavor which was described by non-honey user, regular honey user and culinary group as chemical, alcohol and plastic respectively. The other group included multi-floral honey from the South, Stingless and Florea which were described in the similar direction related to fermented flavor. Vinegar flavor had been mentioned by both non-honey user and culinary group, however regular honey user also explained them as spoiled and fermented flavor. Both regular honey user and culinary group described Stingless and honey from the South as sour aroma, however culinary group mentioned that the aroma was intense. Stingless was also specified as vinegar aroma by non-honey user which related to sour aroma. Florea was described as particle mouthfeel by all groups of assessors. Actually, these three sample were raw honey which were not processed in any heat treatment. Finally, coffee flavor and aroma were applied to explain unique attributes of Coffee2 by every groups except coffee aroma for culinary group.

Four categories of characteristics were used to described honey samples. Tastes were prioritized by all groups of assessors especially sweetness. The reason why the assessors paid attention on tastes is because there were only five tastes and everyone exactly recognized and distinguished at least four of them; some people might not understand taste of umami, however tastes were not used because they were mentioned for a lot on samples, so most of tastes attributes appeared on the middle area of the DISTATIS map. Therefore, it might be better to use flavors to described honey samples due to variety of them.

Flavors were also used to explain attributes of honeys; however, the number of flavors was numerous comparing to tastes. There might not be only one flavor in one honey; one honey might have several complex flavors which assessor could not separate and identify. Even they applied the identical words, they might refer to distinct flavors. For example, floral flavor was mentioned the most for flavors; some of them also specified floras as chrysanthemum or jasmine which both of them obviously provided different smells. Aromas were applied fewer than flavors; the reason might be related to the intensity of aroma because some of honeys were described as mild or no aroma. It might occur due to amount of honey in the plastic cup which was only 5 grams per cup. Lastly, viscosity was usually mentioned in term of mouthfeel.

Table 10: The number of words that were described by each group of assessors

Groups of assessors	Words (Mean ± SD)
Non-honey user	12.2 ± 5.0 a
Regular honey user	12.9 ± 6.0 a
Culinary group	9.8 ± 2.7 b

Note: Mean with the same letter are not significantly different at alpha level = 0.05

According to table 10, there was significant difference between groups of assessors in number of words that used to describe characteristics of honeys. Surprisingly that culinary group showed significantly fewer words than non-user and regular user group. The culinary group should have more words to explain honey samples because they were familiar with cooking, therefore they should have more knowledge and experience in characteristics of food. Additionally, the total amount of characteristics was provided by non-honey user, regular honey user and culinary group were 80, 97 and 67 respectively. So, the culinary group also got fewer of total characteristics. However, it might refer that they could categorize sample in the similar words with more frequency. The total number of honey applications were indicated by the most regular honey user (57) followed by culinary group (35) and non-honey user (33). The regular honey user provided the most honey applications on consumable product. The reason might occur from familiarity of using honey; this group of assessors already applied honey at least once a month, so they might have more ideas from the products that they used to consume with honey before.

Honey applications

Most assessors explained product in categorical words such as dessert, beverage and bakery, however some of them also identified product specifically. The honey applications in food were described according to the similarities of grouping in Figure 5, 10 and 15. Starting with the preferred honey group for which their characteristics were described related to floral flavor. Non-honey user mentioned that these honeys should be consumed with yoghurt and applied as sugar substitute, besides some of them also described that it could be consumed with anything. Beverage products had been mentioned by regular honey user and culinary group; water was identified by both of them. Regular honey user described more products such as hot tea and honey lemon, on the other hand smoothie and beverage were mentioned by culinary group. Lychee1 and Lychee2 were grouped together based on chemical attributes. Nothing was mentioned by non-honey user and regular honey user, however the culinary group described that both of them should be applied in Chinese food. Forest1 was also mentioned to be utilized in Chinese food by culinary group, besides meat and marinade were described by regular honey user and non-honey user respectively. So, the applications of Forest1 could be related to savory food. The last group included multi-floral honey from the South, Stingless and Florea which represented fermented flavor. Non-honey user could not match these honeys with any product. However, honey lemon and smoothie were mentioned by regular honey user and culinary group respectively.

CONCLUSION

Studies showed that the characteristics of honey preferred by the assessors was flavor which is related to flora which should be consumed with beverage product. On the other hand, the disliked attributes of honey mentioned by the assessors are composed of characteristics related to fermented and chemical flavors especially vinegar; only some of them mentioned that honeys with these flavors should be applied with Chinese food and beverage respectively. Moreover sour-related aroma was also indicated. Tastes were the most mentioned characteristics, however most of them appeared on central area of DISTATIS map, therefore flavors were applied to explain honey characteristics instead of tastes. The words described by culinary group was obviously fewer than the others even they were more familiar in cooking, however it also depended on individual experiences because some assessors from other groups might perceived something that was perfectly proper to described characteristics of honey before. Finally, Number of honey application were the most mentioned by regular honey user due to their routine consumption of honey, at least once a month.

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REFERENCES

Aibolita (Access Date: 2018, June 16). HONEY IN THE FOOD INDUSTRY. Retrieved from http://aibolita.com/heart-and-vessels/51112-honey-in-the-food-industry.html

Batt, P.J. & Liu, A. (2012). Consumer behaviour towards honey products in Western Australia. British Food Journal, 114, 285-297

Caporale, G., Policastro, S., Carlucci, A. & Monteleone, E., (2006). Consumer expectations for sensory properties in virgin olive oils. Food Quality and Preference, 17, 116-125

Dhavale, R. (Access Date: 2018, February 19). What is the difference between a chef and a culinary expert? Retrieved from https:// www.quora.com/What-is-the-difference-between-a-chef-and-a-culinary-expert

FAOSTAT, (2013). Honey production: Browse data - FAOSTAT Domains /Production/ Livestock Primary; Item: Honey, natural; Area: World; Year: as needed. United Nations, Food and Agriculture Organization, Statistics Division (FAOSTAT).

Fleming, E.E., Zieglerb, G.R., & Hayes, J.E. (2015). Check-all-that-apply (CATA), sorting, and polarized sensory positioning (PSP) with astringent stimuli. Food Quality and Preference, 45, 41-49

King, M.C., Cliff, M.A. & Hall, J.W. (1998). Comparison of projective mapping and sorting data collection and multivariate methodologies for identification of similarity-of-use snack bars. Journal of Sensory Studies, 13, 347-358

Kongpitak, P. (2014, July 8) FTA bolstered Thai honeys to world market. Retrieved from https://www.thairath.co.th/content/435036

Ketwaropaskul, B., Duangphakdee, O., Kantachan, T. & Soontrunnarudrungsri, A. (2017). Consumer Behavior and Acceptance Towards Different Unifloral Honey. In S. C. of Sensory and Consumer Research Joint Symposium 2017(Ed.) FIAC2017: Innovative Food Science and Technology For Mankind: Empowering Research for Health and Aging Society, (pp. 86-94). Bangkok, Thailand: BITEC.

Lawless, H.T. & Glatter, S. (1990). Consistency of Multidimensional Scaling Models Derived from Odor Sorting. Journal of Sensory Studies, 5, 217-277

Lawless, H.T., Sheng, N., & Knoops, S.C. (1995). Multidimensional scaling of sorting data applied to cheese perception. Food Quality and Preference, 6, 91-98

Manyi-Loh, C.E., Clarke, A.M., & Ndipa, R.N. (2012). Volatile Compounds in Honey: A Review on Their Involvement in Aroma, Botanical Origin Determination and Potential Biomedical Activities. International Journal of Molecular Sciences, 12, 9514–9532.

Murray, J., Delahunty, C., & Baxter, I. (2001). Descriptive sensory analysis: Past, present and future. Food Research International, 34, 461-471

Nagai T, Inoue R, Kanamori N, Suzuki N, & Nagashima T. (2006). Characterization of honey from different floral sources. Its functional properties and effects of honey species on storage of meat. Food Chemistry, 97, 256-262

Overton, S.V., & Manura, J.J., (1999) Note 25: Flavor and Aroma in Natural Bee Honey. Scientific Instrument Service (SIS). (Access Date: 5/6/2018) [Online] Available: http:// www.sisweb.com/referenc/applnote/app-25.htm

Schiefer, J. & Fischer, C., (2008). The gap between wine expert ratings and consumer preferences: Measures, determinants and marketing implications. International Journal of Wine Business Research, 20, 335-351.

Sensory dimensions (Access Date: 2018, June 5). Sorting methods in sensory and consumer research. Retrieved from http:// www.sensorydimensions.com/blog/sorted-sorting-methods-sensory-and-consumer-reserch

CHAPTER 5: GROUP PURE HONEY AND DIFFERENT RATIOS OF MIXED HONEY AND GLUCOSE SYRUP, AND DETERMINATION OF THE SENSORY CHARACTERISTICS AND PHYSICOCHEMICAL PROPERTIES OF THAI HONEYS

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ABSTRACT

Thai honey is demanded by world market due to its unique flavor from tropical fruit blossoms, originating from South Eastern Asia. Due to the increasing demand of honey consumption; the honey was adulterated by different sugar syrups. This study is aimed to group pure honey and different ratios of mixed honey and glucose syrup; and to generate sensory profiles of Thai honeys by using semi-trained descriptive assessors. Lastly, to determine important physicochemical properties of honey. Twenty-seven honey samples were selected based on honey varietal, availability in Thailand and adulterated honey by glucose syrup. The sorting was applied by 30 assessors with various ratios of honey per glucose syrup from 10% of honey to 100% of honey with 10% increments. According to the study, the seventy-percentage honey with thirty-percentage glucose syrup was a ratio with the highest percentage of honey which the assessor not considered as significant difference from the original honey. The terminologies and references of Thai honey were generated for 22 sensorial characteristics by 6 semi-trained descriptive assessors. The assessors were trained for 47 sessions before generating the sensory profiles which included one appearance four tastes and seventeen flavors. The sensory profiles of Thai honey were also generated based on these attributes, paralleling with analysis of physicochemical properties such as color and Brix. The uniqueness of samples was discovered in many samples; however, Stingless was the most unique honey due to the highest intensity in many attributes such as sourness, and fruit, ferment, worcester sauce and herb flavors. Moreover, the L*, a* and b* of stingless were significantly the least for all three values which were 0.2, 1.0 and 0.3 respectively; so, the color of stingless must be the darkest. On the other hand, the L*, a* and b* of Sunflower2 (61.4, 31.0, 103.9) and Lychee2(58.3, 35.7, 98.5) were rated as the top two highest values which represented lighter, reddish and very yellowish color. Lastly, the degree Brix could not be applied to measure sweetness in honey if the types of sugar are unidentified.

Keywords: Honey, Adulterated honey, Sensory property, Sorting

INTRODUCTION

In 2017, global sales from natural honey exports by country totaled US$2.4 billion which expanded from last year 5.8%. Asian countries accounted 23.1 of global exports; 11.44% of them were from China (Workman, 2018). Due to the increasing demand of honey consumption; the honey was adulterated by different sugar syrups (Wu et al., 2017). Chinese honey factories harvested honey while it unripe which it still had high water content, after that the honey was dried artificially and filtrated to remove unwanted matter included pollen (Tamma, 2017). Chinese honeys spread through European countries in last decade due to inadequate of honey production in Europe. However, adulterated honey was mainly divided adulteration of honey into 2 categories which were direct and indirect methods. Indirect adulteration was occurred by feeding honey bee with honey, chemical or industrial sugars (Guler et al., 2007), on the other hand direct adulteration was generated by adding sugar syrup or any other substances into authentic honey (Zábrodská & Vorlová, 2015). The news agencies in Thailand also reported about production of adulterated honey by the villagers. The fake honey was produced by mixing authentic honey with glucose syrup and granulated sugar (TNAMCOT, 2014; ThairathTV, 2017). Adulterated honey was not only affecting on quality and nutrition but also could be harmful to consumers. There were several studies which have been experimented to detect honey adulteration. Yilmaz et al (2014), Zábrodská & Vorlová (2015) and Nalia et al. (2018) summarized all previous approaches for detecting adulterants in honey, moreover Yilmaz et al. (2014) also introduced a novel and potential approach to detect honey adulteration by fructose and saccharose syrups which were steady, dynamic and creep analysis. Likewise, recent study of Wu et al. (2017) revealed the methods to detect sugar-based adulterants in honey which included SRICA, GC, HPAEC, HPLC, IR-based analysis, NMR, Raman spectroscopy speed up and Q-TOF-MS. However, these approaches mostly were chemical or enzymatic reactions which had to take time for analysis due to several preparation steps; besides, laborious preliminary experiments and expert operators were also required (Yilmaz et al, 2014). So, the approaches for the development of a portable test kit were studied which the most effective methods included ELISA, electronic tongue and NIR (Nalia et al., 2018). Many approaches have been constantly developed to detect adulterants in honey, however none of any approaches at present could be applied to detect all the adulterants in the honey individually because there are so several methods of adulteration. (Schwarzinger, 2017; Nalia et al., 2018)

Sensory analysis is one of the interesting and promising approaches to detect adulterants in honey by determining the unique characteristics of each adulterant. Moreover, sensory analysis also could be used to establish sensory profiles of honey by applying human's senses as a tool. The well-known descriptive analysis included Flavor Profile Method, the Texture Profile Method, Quantitative Descriptive Analysis® (QDA®) and Spectrum™ Descriptive Analysis. These approaches were widely applied in many sensory studies to determine sensory profiles which could be utilized in various ways, however all of them were also time-consuming methods which composed of panel recruitment and panel training; maintaining skill of assessors after training was also required (Chambers & Wolf, 1996). Therefore, rapid sensory profiling techniques have been developed to increase efficiency for alternating traditional sensory descriptive analysis which included check-all-that-apply (CATA), sorting, and polarized sensory positioning (PSP). However, these approaches lack of direct scaling of multiple attributes (Fleming et al., 2015).

Sensory characteristics of honey were varied due to floral types, bee species and environmental conditions which all of them had effects on providing distinct color, texture, tastes and aromas especially flavors (Overton & Manura, 1995; Manyi-Loh et al., 2011; Stolzenbach et al., 2011). There were several studies on sensory of honey in the last few decades. Terminology of floral honey was developed by Galan-Soldevilla et al. (2005). Ciappini et al. (2013) established an approach for recruiting and training assessors to determine characteristics that could be used to differentiate clover honey from eucalyptus honey by using descriptive quantitative analysis. Moreover, sensory analysis of honey from honeybee were researched worldwide by focusing on distinct factors included differences of bee species, honey varietals, geography and seasons; mostly sensory analysis of honey was studied together with physiochemical properties (Gupta et al., 1992; Esti et al., 1997; Anupama et al., 2002; Castro-Vázquez et al., 2008; Stolzenbach et al., 2011; Silvano et al., 2014; Kortesniemi et al., 2018; Kumar et al., 2018). There were numerous studies focusing on physicochemical properties of honey. Two of the most important physiochemical factors were color and sugar content because color is not only used in representing honey varietals but it is also the physical property perceived immediately by the consumers; moreover, color is one of the main factors consumers use when making choices in consumable product, and it even affects our perception of flavor because many people associate a specific color with a certain flavor expectation (Katrina, 2014; Helena,2017). Moreover, the darker honey is suggestively related to a very flavored product, whereas the lighter honey tends to be more subtle and refined fragrances (Gonnet & Aubert, 1986; Grembecka & Szefer, 2013). Sugar content is directly associated with sweetness which is obviously a main function of honey as sweetener. Around seventy-five percentage of overall sugar in honey is represented by monosaccharide which roughly half is glucose and half is fructose; however, the proportions may vary depending on the honey varietals (Saxelby, 2014; Missio da Silva et al., 2016). Sensory profile of honey from stingless bees was also studied (Ferreira et al., 2009; Costa et al., 2018).

Thai honey is also demanded by world market due to its unique flavor from tropical fruit blossoms, originated from South Eastern Asia (Kongpitak, 2014). Therefore, the aim of this study was to group pure honey and different ratios of mixed honey and glucose syrup; and to generate sensory profiles of honeys available in Thailand by using semi-trained descriptive assessors. Lastly, to determine important physicochemical properties of honey

MATERIALS AND METHODS

Samples

Twenty-seven honey samples were selected due to honey varietals and availability of them in Thailand which included honey from Longan, Lychee, Sesame, Sunflower, Wild flower (siam weed), Coffee, Forest and Macadamia. Two samples were chosen for each of them except Macadamia which had only one. Moreover, the multi-floral honey from each part of Thailand were selected which included multi-floral honey from Northern, North Eastern, Eastern, Western, Southern and Middle part of Thailand. The rest of them were also multi-floral honey which were produced by distinct types of bee such as Cerana, Florea and Stingless. All of these three honeys were not passed any heat treatment included Lychee1, Forest1 and multi-floral honey from the South. Additionally, adulterated honeys were formulated in this study; two ratios of them were selected to be samples based on sorting technique. The last sample was the most well-known honey in Thailand with unidentified floral type (Ketwaropaskul, 2017).

The samples were served in 1 Oz white plastic cups at room temperature. The amount of honey per cup was about 5 grams. All samples were provided to participants on trays with plastic coffee spoons. Water was provided as a mouth-rinsing between samples.

Panelists

Six assessors were recruited from students of Faculty of Biotechnology, Assumption University based on their availability and willingness to participate the training. All of them were semi-trained assessors who had experiences in descriptive training for 2-3 food products, so they already had some skill for the training especially ability to describe product by using attributes and intensities.

Procedure

According to news agencies in Thailand, adulterated honey was produced by pure honey with additional of glucose syrup and/or granulated sugar. The most available honey in the market was applied to formulated adulterated honey which was Forest2. The honey was adulterated with the addition of adulterants, namely glucose syrup. Started with mixing glucose syrup with hot water (about 95°C) at a ratio of 70%, 80% and 90% by weight, then compared their viscosity with the honey sample Forest2 by ten assessors who were familiar with sensory analysis. The criteria of comparison were based on eyesight and mouthfeel. Ninety percentage of glucose syrup was selected by all assessors due to the most similar viscosity to the sample. After that, the ninety-percentage glucose syrup solution was added into Forest2 at a ratio of 10% to 90% by weight which each ratio was different by 10%. All of ratios with addition of the authentic honey were used in free sorting task. The sorting technique was applied by 30 assessors to determine the ratio that started to reveal significant difference between pure honey from adulterated honey ($P<0.05$).

The training composed of forty-seven sessions; the time per session was about one hour. The review of using scale and reference was applied in the first session. A 0-15 scale was used for rating, where 0 = none and 15 = extremely intense; the gap between each scale was 0.5 only. Two honey samples were provided to the assessors to taste and compare them with the references by focusing on basic tastes. The second session focused on development of the descriptive terminology for honey samples. All of samples were provided to the assessors except two adulterated honey samples. The assessors were assigned to list the characteristics of honeys. Additionally, the terminologies were also generated by four experienced sensory analysts who had many experiences in sensory analysis in wide range of product categories for several years. The generated characteristics from both groups were compared and selected for the training by the discussion of the sensory analysts. Four tastes, seventeen flavors and one appearance were selected as the attributes for the training. In the third session, four of basic tastes was applied to the assessors which composed of every taste except umami. The samples for training were selected based on sorting technique in the previous study (Ketwaropaskul, 2018). Six representatives of samples were chosen according to the grouping from sorting technique such as Longan1, Coffee1, Lychee2, Sesame2, Cerana and Stingless. All of them were applied for the whole training. The references were determined by making consensus among the assessors; moreover, the intensities of references had to cover intensities of all representative samples for all attributes. The replications of samples were applied in each session to check repeatability of the assessors. The consensus of representative samples was also generated for every attribute to check their consistency on scoring. The training of basic tastes was applied until the standard deviation of samples lower than one which was the session fifteen. Clinical session was individually applied for the assessor who had problems in consistency and repeatability. The trainings of flavors and an appearance were initiated from the sixteenth session. The references and definitions of seventeen flavors and one appearance were generated. The reference products were changed for many times to determine the products with the most similar characteristics to honeys' flavors. Besides, the intensities of references were also adjusted to make sure that the references of each attribute covered intensities of samples; the references and definitions of these attributes were determined until the twenty-fourth session. The first four flavors were applied between session twenty-five to thirty-one which included the flavors of plastic, soy sauce, worcester sauce and dried fruit. The training of basic tastes was applied in the thirty-second session to review the training and check their performance. After that, cotton candy, butterscotch, molasses and coffee flavors were trained for five sessions. In the thirty-eighth session, five flavors were introduced to the assessors which composed of perfume, flora, fruit, jasmine and wood flavor; all flavors were applied until the forty-first session. The last six sessions included five attributes. Four of them were flavors such as ferment, medicine, herb and iron flavors. The remaining attribute was viscosity which was trained by focusing on appearance.

Testing was applied to generate sensory profiles of twenty-seven honeys from Thailand which the sensory profiles composed of 22 sensorial attributes; each sample were applied for 3 replications. The testing was divided into 9 sessions; nine samples were presented to the assessors for each session and were also separated into 3 serves. Three samples were provided to the assessors for each serving, after the assessors finished evaluating the samples, they had taken a break for 5-10 minutes before the next serving; each sample could be repeatedly served or not within the session because they were randomly picked up for every session except the first session because the replications of sample were required to determine repeatability and standard deviation which related to performance of the assessors. The references of all attributes, mouth-rinsing and ballot were provided to the assessors before serving samples.

For the physicochemical properties, color and sugar content of honey samples were determined in this study. The color of honey samples was measured by using HunterLab MiniScan EZ 4500L Spectrophotometer. The spectrophotometer was standardized by using black tile and white tile before the color was measured. During the process, the rubber must be put into the Hunterlab cup due to its ability to prevent light from the outside. After that, the cup was covered with white lid and black lid respectively; the white lid was applied because white color could be used to reflect light from machine to the sample without cross over to surrounding environment. Likewise, the black lid was used because black color could be used to absorb lightness and also prevent another light source from environment. The 5mm port was applied to measure the lightness of color because honey is a liquid form substance; so, it required the size of port that could be used to measure throughout the whole area of honey when the sample was poured in to the Hunterlab cup. The appearance of bubble was prohibited for the color measurement because the reflection might be occurred when light source of the machine shined on the bubble. The color of each sample was measured for 5 replications. The result was presented in form of L*, a*, and b*. On the other hand, Brix of the honey samples was measured by using refractometer with 0 to 90-degree Brix. Brix of samples were determined for 3 replications

Data Analysis

The data from grouping pure honey and mixed ratios of mixed honey and glucose syrup was analyzed by DISTATIS of RStudio 0.99.467. Data from the training were processed using ANOVA with Duncan multiple comparison. The data from testing was analyzed by PCA of R-Program-2.15.3 and ANOVA with Duncan multiple comparison.

RESULTS AND DISCUSSION

Grouping of pure honey and different ratios of mixed honey and glucose syrup by sorting technique

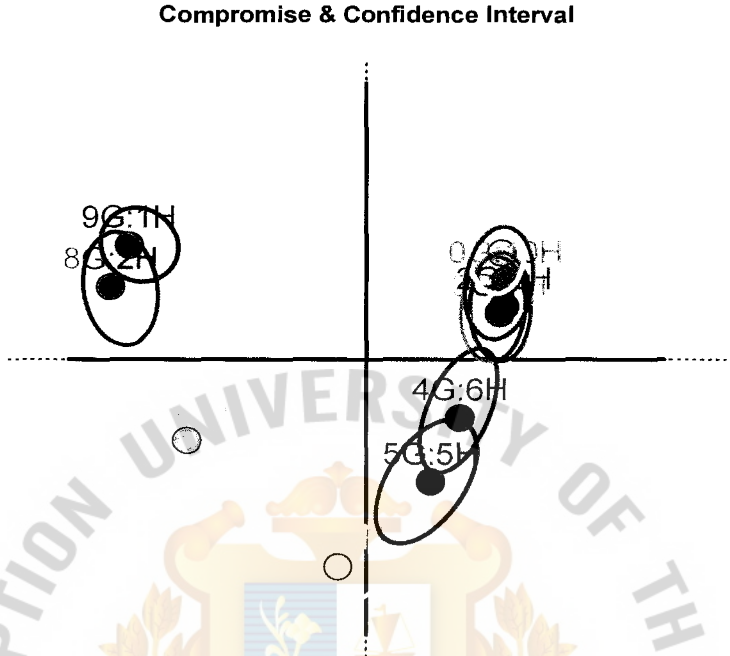


Figure 16: The confidence intervals of sorting task by DISTATIS which showed the configuration of ellipsoids of pure honey and different ratios of mixed honey and glucose syrup. (G=Glucose syrup and H=Honey)

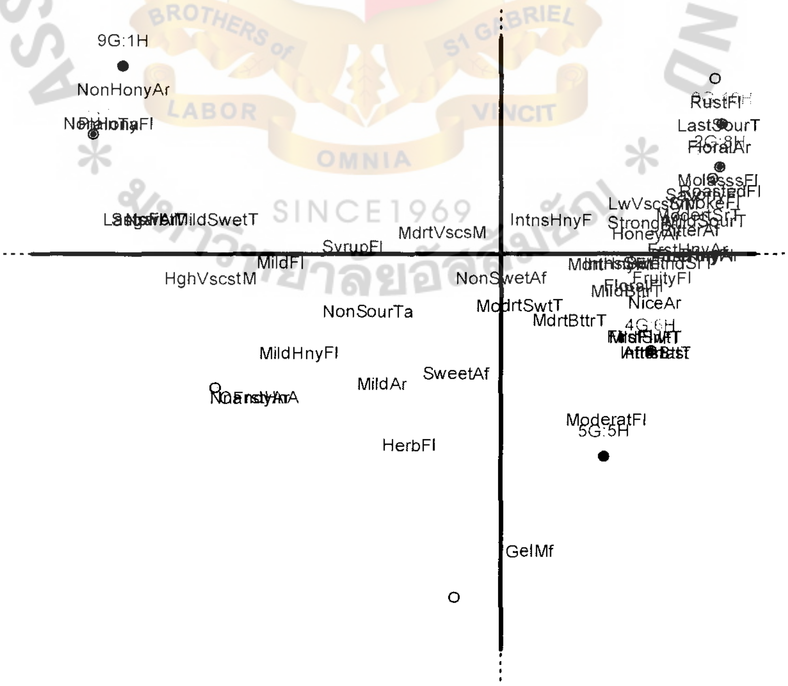


Figure 17: The description of pure honey and different ratios of mixed honey and glucose syrup on DISTATIS map by 30 assessors

Ten samples of pure honey and different ratios of mixed honey and glucose syrup were sorted by thirty assessors. The confidence interval shown the information to compute statistical confident ellipses around the samples, If the confidence ellipsoids of any samples are not intercept, those samples are considered as significant difference by assessors. Confidence interval is significant at $P<0.05$.

According to the Figure 16 and 17, the sample were categorized in to 3 groups. Pure, 90%, 80% and 70% honeys were grouped together due to similar characteristics; Floral aroma was indicated to describe all honey in this group. Smoke, molasses and savory were applied to describe these samples in term of flavor. Besides, these four samples also contained the most percentages of honey among mixed honey and glucose syrup samples. The next group included 50% and 60% honeys. Both of them also had more percentages of honey than the remaining ratios which were explained as intense bitter taste, mild floral flavor and aftertaste. The last group composed of two samples that had only 10 and 20 percentages of honey which referred to high ratios of glucose syrup. Non-honey was applied to describe both of them in terms of aroma and flavor.

The seventy-percentage honey was a sample with the most percentage of honey that was not significant difference from pure honey. On the other hand, the sixty-percentage honey was identified starting to reveal significant difference from pure honey. Therefore, both 60% and 70% honeys were selected to be representatives of adulterated honey samples.

Definitions and references

The attributes were generated by six assessors and four experienced sensory analysts. Twenty-two attributes were selected by the experienced sensory analysts which included one appearance, four tastes and seventeen flavors. The definition and references of each attribute were determined by the assessors. The definition and reference products were accommodated to be proper with characteristics of honeys; moreover, the intensities of references were adapted while the training to ensure that the intensities of samples were covered as shown in the Table 11. The references of most attributes were provided in form of solution for tasting except perfume, butterscotch, coffee, worcester sauce, soy sauce and molasses which all of them were served in Ocean Madison Cognac 650 ml and plastic covering lid for smelling. Likewise, the intensity of viscosity was determined by using plastic coffee spoons to scoop up the references/samples for full spoon; lifted the spoon up above the cup for 5 inches, and then measured the rate of flow when the references/samples were poured back in to the cup.

Moreover, the references and samples must be prevented from air contact before their viscosities were measured.

Table 11: Definition and reference of the attributes which were generated in the training

Type	Attribute	Definition	Reference
Appearance	Viscosity	The degree of resistance of flow. Measured by the rate of flow when the reference is poured from a spoon.	Hershey's Chocolate Syrup (bottle) = 9.0 Mali's Sweetened Condensed Milk = 11.0 Smucker's Butterscotch = 12.0 Karo Dark Corn Syrup = 14.0
Taste	Sweetness	A fundamental taste sensation of which sucrose is typical.	15% Sucrose solution = 7.0 20% Sucrose solution = 8.5 22.5% Sucrose solution = 9.5 25% Sucrose solution = 10.0
Taste	Sourness	A fundamental taste sensation of which citric acid is typical.	0.015% Citric acid solution = 1.5 0.025% Citric acid solution = 2.5 0.050% Citric acid solution = 3.5
Taste	Bitterness	A fundamental taste sensation of which caffeine is typical.	0.011% Caffeine solution = 1.5 0.015% Caffeine solution = 2 0.025% Caffeine solution = 3.5
Taste	Saltiness	A fundamental taste sensation of which sodium chloride is typical.	0.15% Sodium Chloride Solution = 1.5
Flavor	Perfume	Floral aromatics with somewhat sweet, non-natural notes not generally associated with fresh fruit.	1 drop of Ferminich's perfumey fragrance + 140 ml of water = 2 1 drop of Ferminich's perfumey fragrance + 105 ml of water = 4 1 drop of Ferminich's perfumey fragrance + 70 ml of water = 5
Flavor	Butterscotch	Sweet, round, light brown aromatics which may also include the character notes identified as vanillin and caramelized.	5 g of Smucker's Butterscotch = 4 15 g of Smucker's Butterscotch = 6
Flavor	Molasses	Dark caramelized top notes which may include slightly sharp, acrid notes characteristic of molasses.	3 g of Karo Dark Corn Syrup = 4 8 g of Karo Dark Corn Syrup = 7
Flavor	Coffee	genuine finely ground roasted coffee with addition of whitener and sugar which was also described as 3 in 1 coffee.	1g of Nescafe Blend & Brew Rich Aroma = 3 5g of Nescafe Blend & Brew Rich Aroma = 5

Flavor	Worcester sauce	Dark brown, caramelized, slightly sour, fermented aromatics typical of Worcestershire Sauce.	1 drop of Gy-Nguang Worcester Sauce + 2 drops of water = 4 1 drop of Gy-Nguang Worcester Sauce + 1 drops of water = 5 1 drop of Gy-Nguang Worcester Sauce = 7
Flavor	Soy sauce	A brown, slightly fermented aromatic typical of soy sauce.	1 drop of Dek Som Boon Soy Sauce + 2 drops of water = 2 1 drop of Dek Som Boon Soy Sauce + 1 drops of water = 3 1 drop of Dek Som Boon Soy Sauce = 5
Flavor	Fruit	An aromatic blend, which is sweet and reminiscent of a variety of different fruits.	7 drops of Ferminich's fruity flavor + 500 ml of water = 3 10 drops of Ferminich's fruity flavor + 500 ml of water = 5.5 13 drops of Ferminich's fruity flavor + 500 ml of water = 8
Flavor	Flora	Sweet, heavy aromatic blend of a combination of flowers that can be somewhat chemical and perfume-like	1 drop of Ferminich's floral flavor + 500 ml of water = 2 3 drops of Ferminich's floral flavor + 500 ml of water = 5 5 drops of Ferminich's floral flavor + 500 ml of water = 7
Flavor	Jasmine	A sweet aromatics impression associated with jasmine.	2 drops of Ferminich's jasmine flavor + 500 ml of water = 2 5 drops of Ferminich's jasmine flavor + 500 ml of water = 5 7 drops of Ferminich's jasmine flavor + 500 ml of water = 8
Flavor	Dried fruit	Aromatics associated with dried brown fruit.	1 drop of Ferminich's dried fruit flavor + 1000 ml of water = 2 1 drop of Ferminich's dried fruit flavor + 500 ml of water = 3 2 drops of Ferminich's dried fruit flavor + 500 ml of water = 5
Flavor	Woody	A sweet, brown, musty, dry aromatic associated with the bark of a tree.	2 drops of Ferminich's woody flavor + 500 ml of water = 1 4 drops of Ferminich's woody flavor + 500 ml of water = 2 6 drops of Ferminich's woody flavor + 500 ml of water = 5
Flavor	Cotton candy	Confection-like aromatics associated with sweet substance.	5 drops of Ferminich's cotton candy flavor + 500 ml of water = 2 7 drops of Ferminich's cotton candy flavor + 500 ml of water = 4 9 drops of Ferminich's cotton candy flavor + 500 ml of water = 6
Flavor	Ferment	The pungent sharp aromatics associated with ripe/over ripe fruit; yeasty. These can also be somewhat sweet and fruity.	10 drops of Ferminich's fermented flavor + 500 ml of water = 1 15 drops of Ferminich's fermented flavor + 500 ml of water = 3.5 20 drops of Ferminich's fermented flavor + 500 ml of water = 5

Flavor	Medicine	A clean, sterile aromatic characteristic of antiseptic-like products such as Band-Aids, alcohol, and iodine.	10 drops of Ferminich's medicinal flavor + 500 ml of water = 2 15 drops of Ferminich's medicinal flavor + 500 ml of water = 4 20 drops of Ferminich's medicinal flavor + 500 ml of water = 6
Flavor	Plastic	An aromatic associated with plastic polyethylene containers or food stored in plastic.	2 drops of Ferminich's plastic flavor + 500 ml of water = 3 3 drops of Ferminich's plastic flavor + 500 ml of water = 5 5 drops of Ferminich's plastic flavor + 500 ml of water = 7.5
Flavor	Herb	The aromatics associated with dry green herbs that may include celery flakes, parsley flakes, chives, oregano, and dill.	1 drop of Ferminich's herb flavor + 1000 ml of water = 2.5 1 drop of Ferminich's herb flavor + 500 ml of water = 4 3 drops of Ferminich's herb flavor + 500 ml of water = 6
Flavor	Iron	Aromatics associated with cooked organ meat/liver	1 drop of Ferminich's iron flavor + 500 ml of water = 2 4 drops of Ferminich's iron flavor + 500 ml of water = 4 6 drops of Ferminich's iron flavor + 500 ml of water = 6

Sensory profiles and physicochemical properties of Thai honeys

Twenty-seven honey samples were applied to generate sensory profiles of them by using semi-trained descriptive assessors. The terminologies of honey were generated and selected by six assessors and four experienced sensory analysts which resulted in 22 sensorial attributes; the attributes included one appearance, four basic tastes and seventeen flavors.as showed in Table1. The assessors were trained for 47 sessions; the time for session was about one hour and 0-15 scale was applied for rating in this study. The performance of the assessors was checked by focusing on standard deviation of samples in each attribute; the standard deviation in the range between 0.50 to 0.99 was acceptable. If the standard deviation was lower than 0.50, the performance was indicated as good. However, if the standard deviation was more than or equal to 1, the performance of the assessors was labeled as non-good. The performance of the assessors was also indicated by using consistency and repeatability. So, if the assessors had any problem in their performance, the clinical session was applied to them individually. After the training was completed; testing was applied to generate sensory profiles samples which each were applied for 3 replications. The testing was divided into 9 sessions; nine samples were presented to the assessors for each session; the time for testing was not limited due to large number of attributes. The references of all attributes, mouth-rinsing and ballot were provided to the assessors before serving samples.

Figure 18: The Principal Component Analysis of 22 sensorial attributes

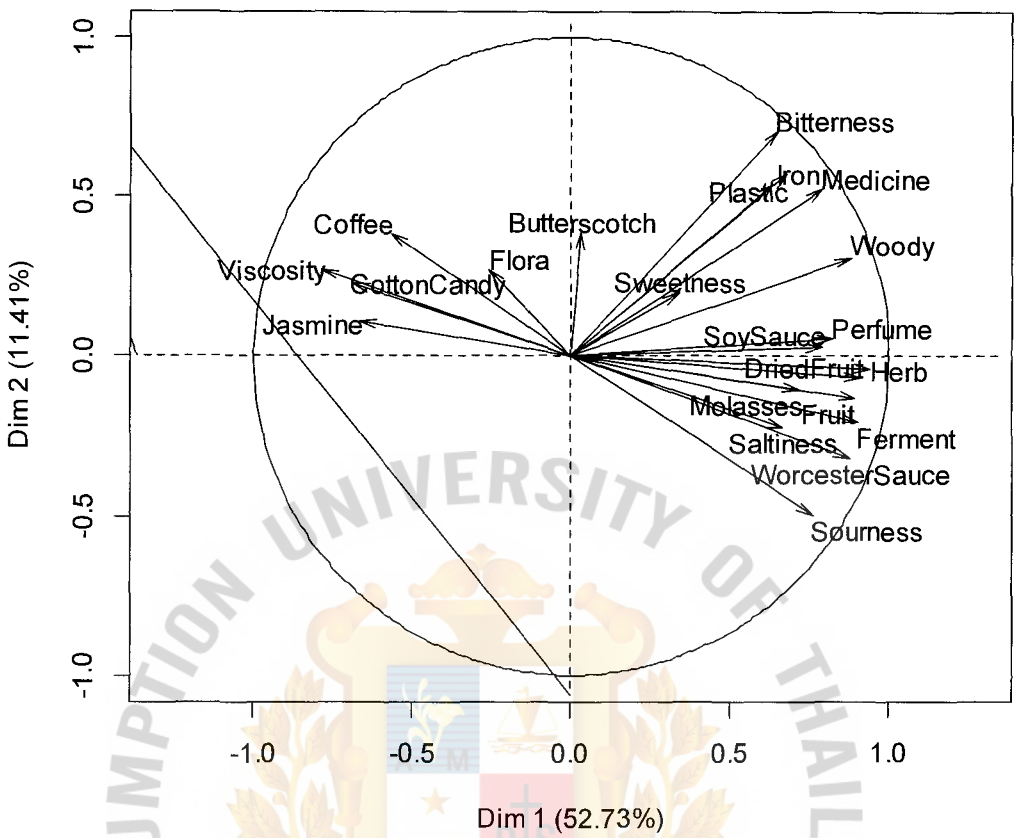


Figure 19: The Principal Component Analysis of 27 honey samples for 22 sensorial attributes

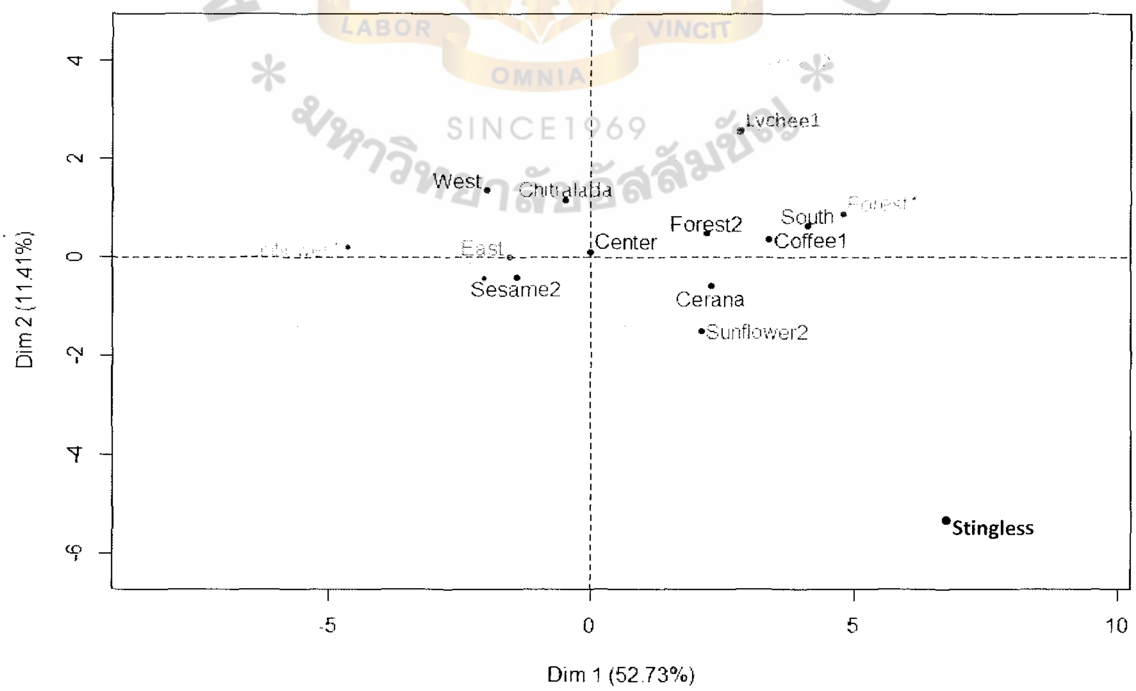
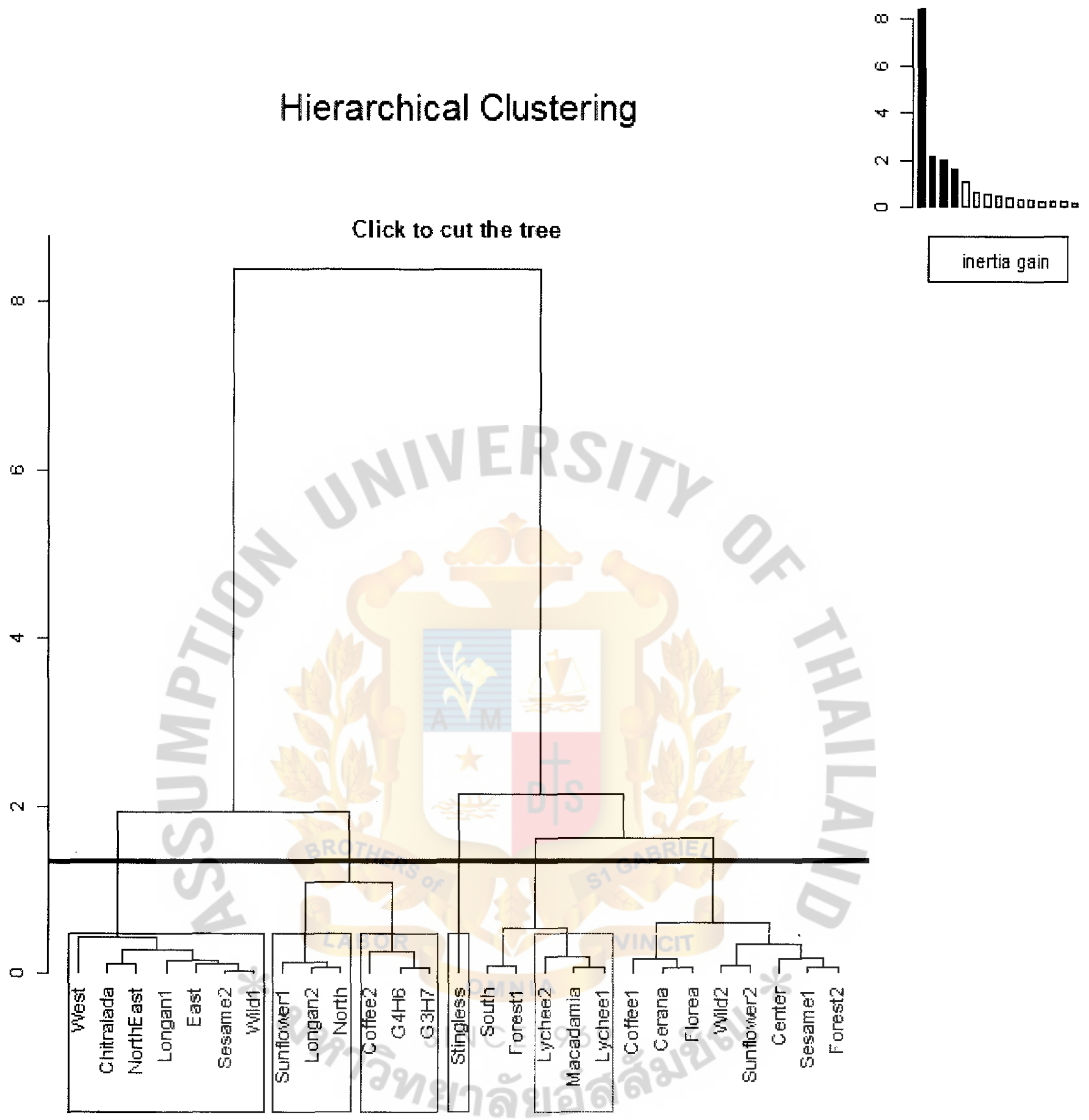


Figure 20: Cluster analysis of 27 honey samples for 22 sensorial attributes



The cluster analysis was applied to make the sensory profiles to be easier to explain according to the figure 18 to 25, twenty-seven samples were analyzed by Principal Component Analysis (PCA) with 22 sensorial characteristics. The samples were divided into 8 groups by using cluster analysis. There was significant difference between clusters in every attribute except coffee flavor. Three groups of samples appeared on the left side of the map; additionally, there were 5 attributes available on the left side such as viscosity, jasmine flavor, cotton candy flavor, coffee flavor and flora flavor. The first cluster; Chitralada, North East, Longan1, East, West, Sesame2 and Wild1 were grouped together as the first group. The second cluster composed of Sunflower1, Longan2 and North. Coffee2, G3H7 and G4H6 were grouped together as the third cluster. Both second and third clusters showed significantly the highest viscosity followed by the first cluster which was also rated in high intensity for viscosity comparing to the other cluster. There was no significant difference in cotton candy flavor for these three clusters. Even there was no significant difference in coffee flavor but the Coffee2 was obviously rated as the highest intensity for coffee flavor. The second cluster was significantly rated as the highest intensity of jasmine and flora flavor followed by the first cluster which was also scored in high intensity for both attributes comparing to the other cluster. Moreover, all of honeys in the second cluster were ranked as the top 3 highest intensity for jasmine flavor. However, three honeys in the third group were rated as the least floral flavor from all samples.

Figure 21: Viscosity and sweetness profiles of Thai honeys

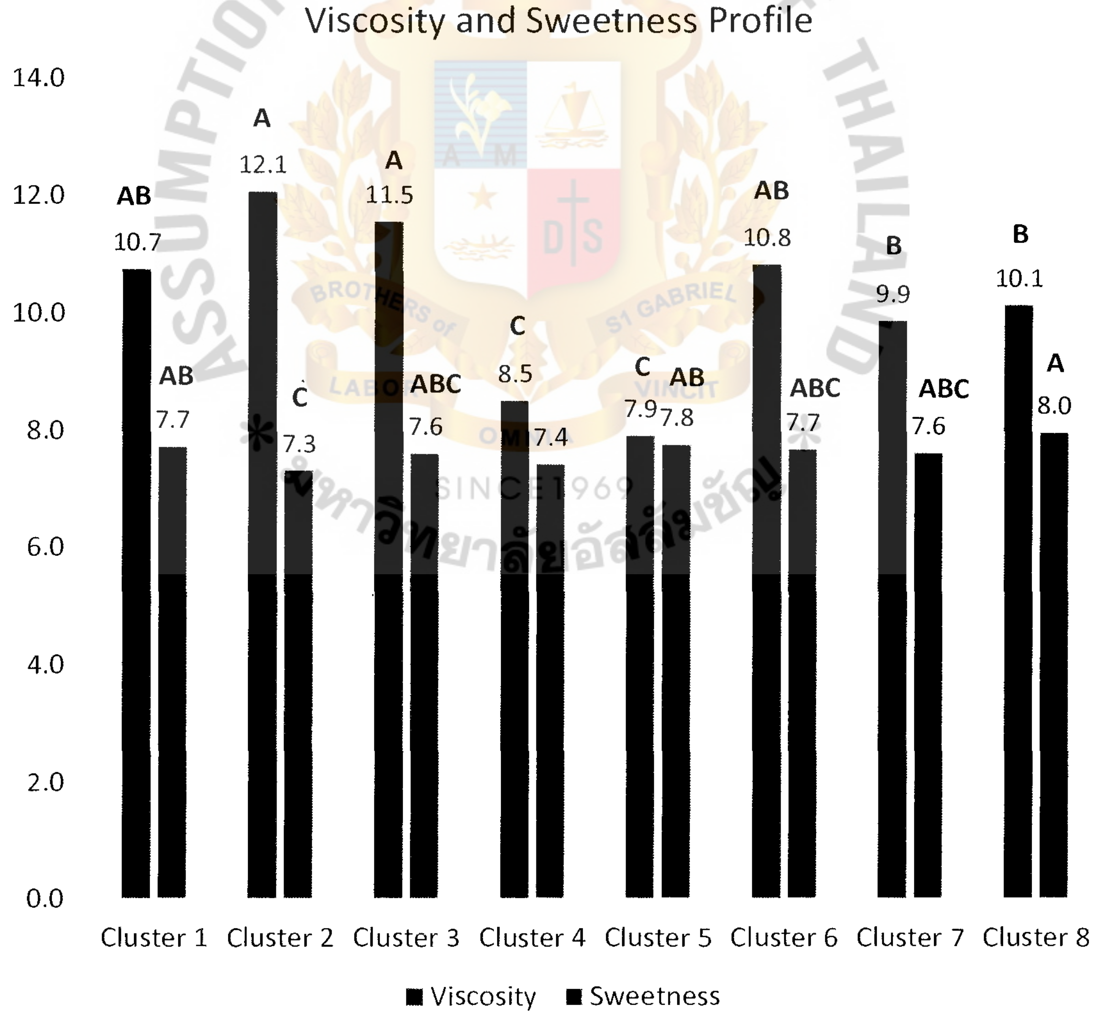


Figure 22: Bitterness and, cotton candy, flora, jasmine, medicine and plastic flavors profiles of Thai honeys

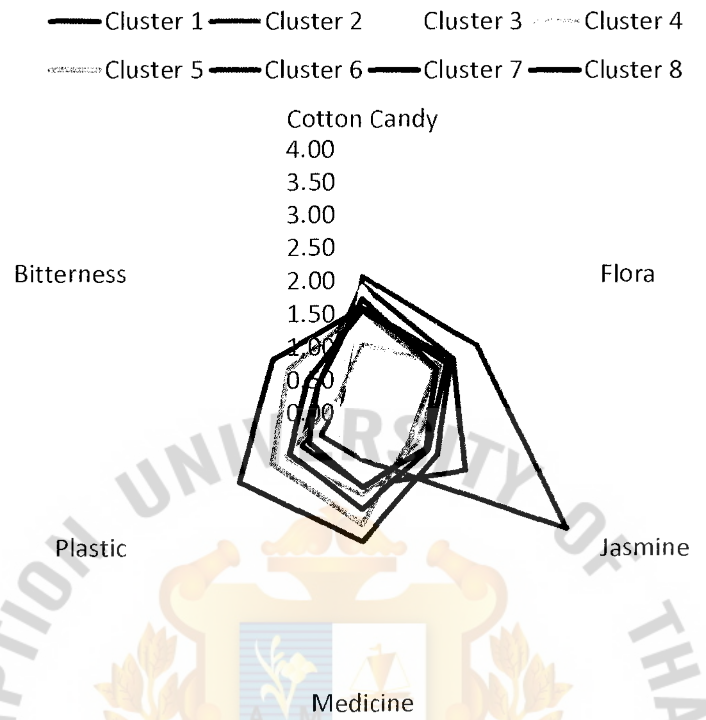


Figure 23: Sourness, fruit, dried fruit, worcester sauce, ferment and herb flavors profiles of Thai honeys

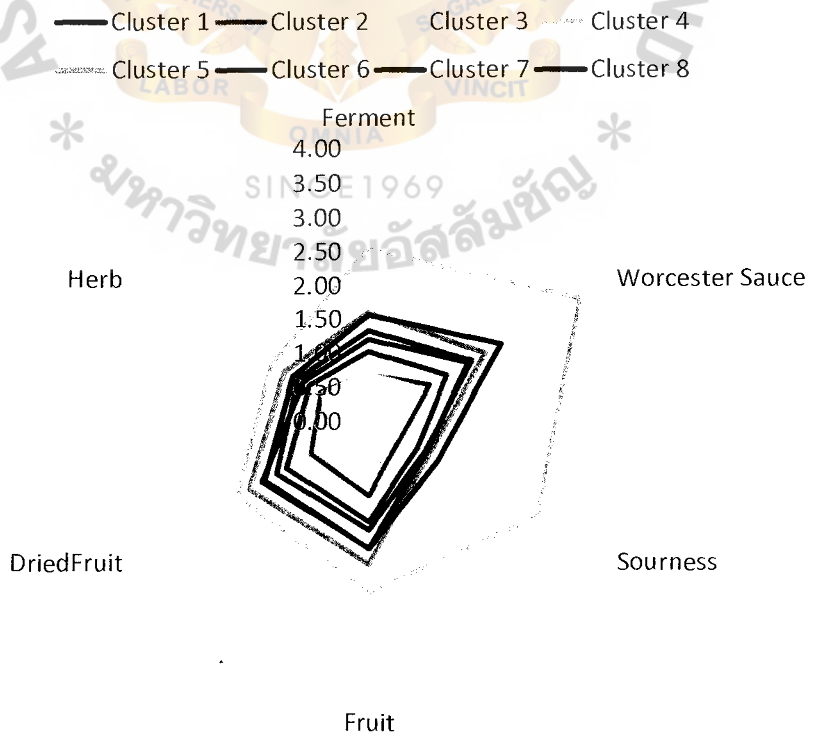


Figure 24: Perfume, iron, and wood flavors profiles of Thai honeys

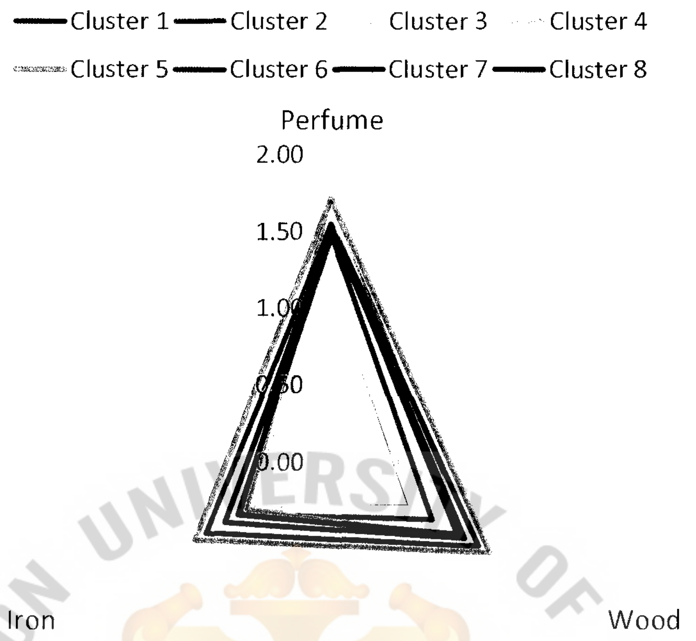
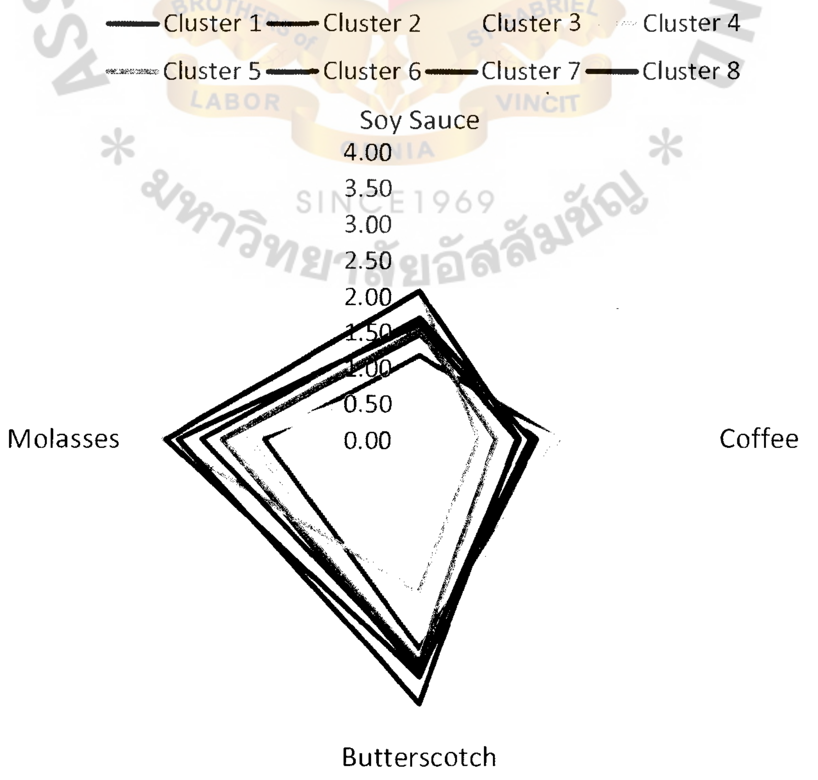


Figure 25: Molasses, butterscotch, soy sauce and coffee flavors profiles of Thai honeys



On the other hand, the rest cluster were showed on the other side of the map. Stingless was the only sample of the fourth cluster and also was represented in the position that far away from other samples which referred to unique characteristics of stingless comparing to the other samples. Both South and Forest1 were grouped together as the fifth cluster. The sixth cluster included Lychee2, Lychee1 and Macadamia. Coffee1, Cerana and Florea were categorized as the seventh cluster. The last cluster included Wild2, Sunflower2, Center, Sesame1 and Forest2. The sixth cluster was significantly rated as the highest intensity of bitterness, plastic flavor and medicine flavor followed by the fifth cluster which was also scored in high intensity for these three attributes comparing to the other cluster; both lychee samples were also ranked as the most intense samples for these attributes. Likewise, the honeys in fifth cluster were significantly rated as the most intense samples of wood and iron flavors followed by the sixth cluster which was also rated in high intensity for both attributes comparing to the other cluster. The forth cluster was significantly rated as the highest intensity for fruit, dried fruit, ferment and herb flavors followed by the fifth cluster which was also rated in high intensity for all of these attributes. Moreover, both fourth and fifth clusters were the most intense perfume flavor. The forth cluster was also significantly scored as the most intense sample for sourness and worcester sauce flavor followed by the seventh cluster which was also rated in high intensity for both attributes comparing to the other samples. Besides, the fourth and seventh cluster were labeled as the most intensity for soy sauce flavor and fourth, seventh and eighth cluster were rated as the high intensity of molasses flavor. The eighth cluster was significantly rated as the highest intensity in both sweetness and butterscotch flavor. Lastly, comparing the positions of adulterated honey and Forest2; they were not only differentiated by the cluster analysis but the position of them was also far away from each other which referred to obvious changes in sensory characteristics from adding glucose syrup.

A 0-15 scale was applied in the training and testing. However, the intensities of every samples for most attributes were rated in the range between 0 and 5 which was in the low range of scale; almost attributes were rated in the low range of scale except viscosity and sweetness. Both sweetness and viscosity were rated in the moderate and moderate to high ranges respectively. Sweetness was rated in the range between 7.2 and 8.2 which referred to the moderate range of scale. On the other hand, viscosity was rated in the range between 7.8 to 12.3 which represented the range of scale between moderate to high scale. The different ranges of intensity from both of them might have some effects on the rest from principal component analysis and cluster analysis. So, the principal component analysis and cluster analysis were repeatedly analyzed without viscosity and sweetness.

Figure 26: The Principal Component Analysis of 20 sensorial attributes

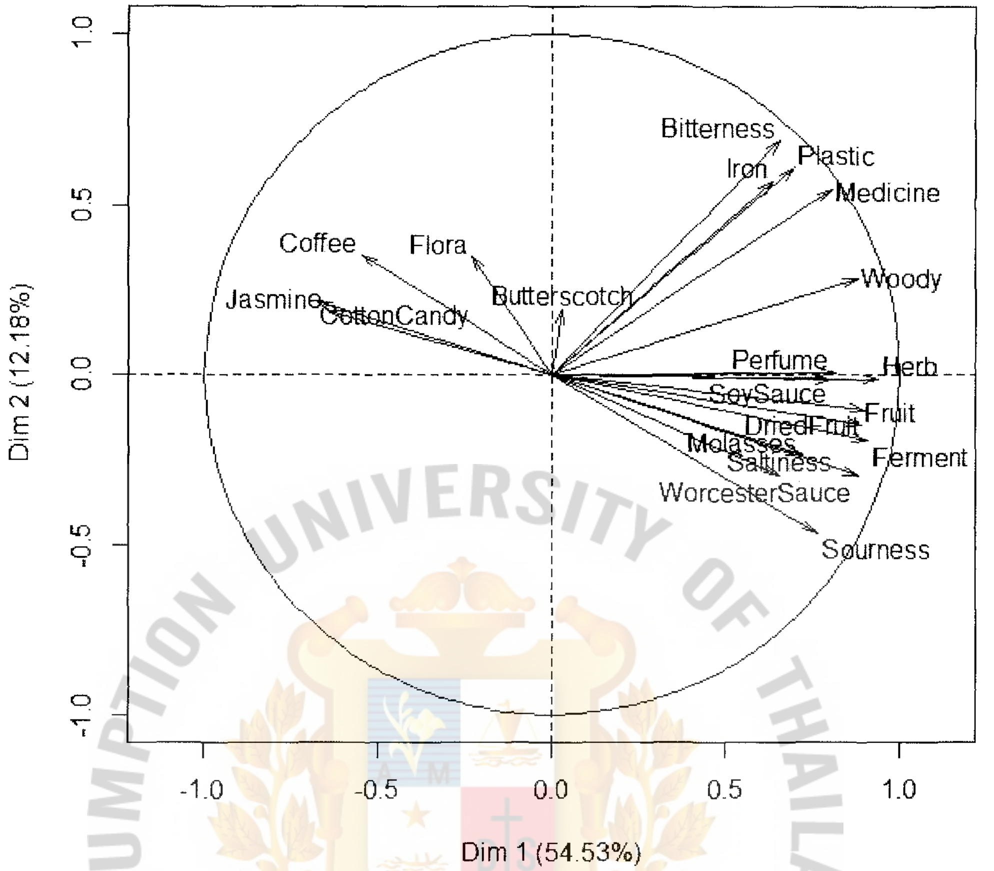


Figure 27: The Principal Component Analysis of 27 honey samples for 20 sensorial attributes

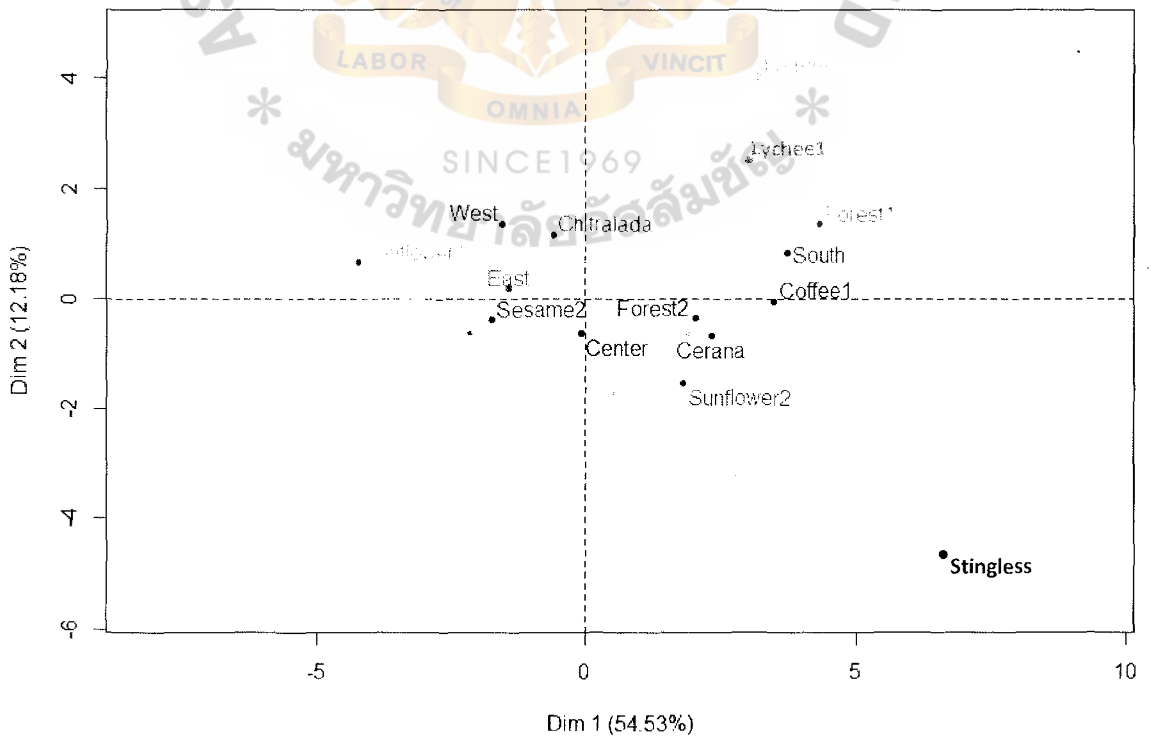
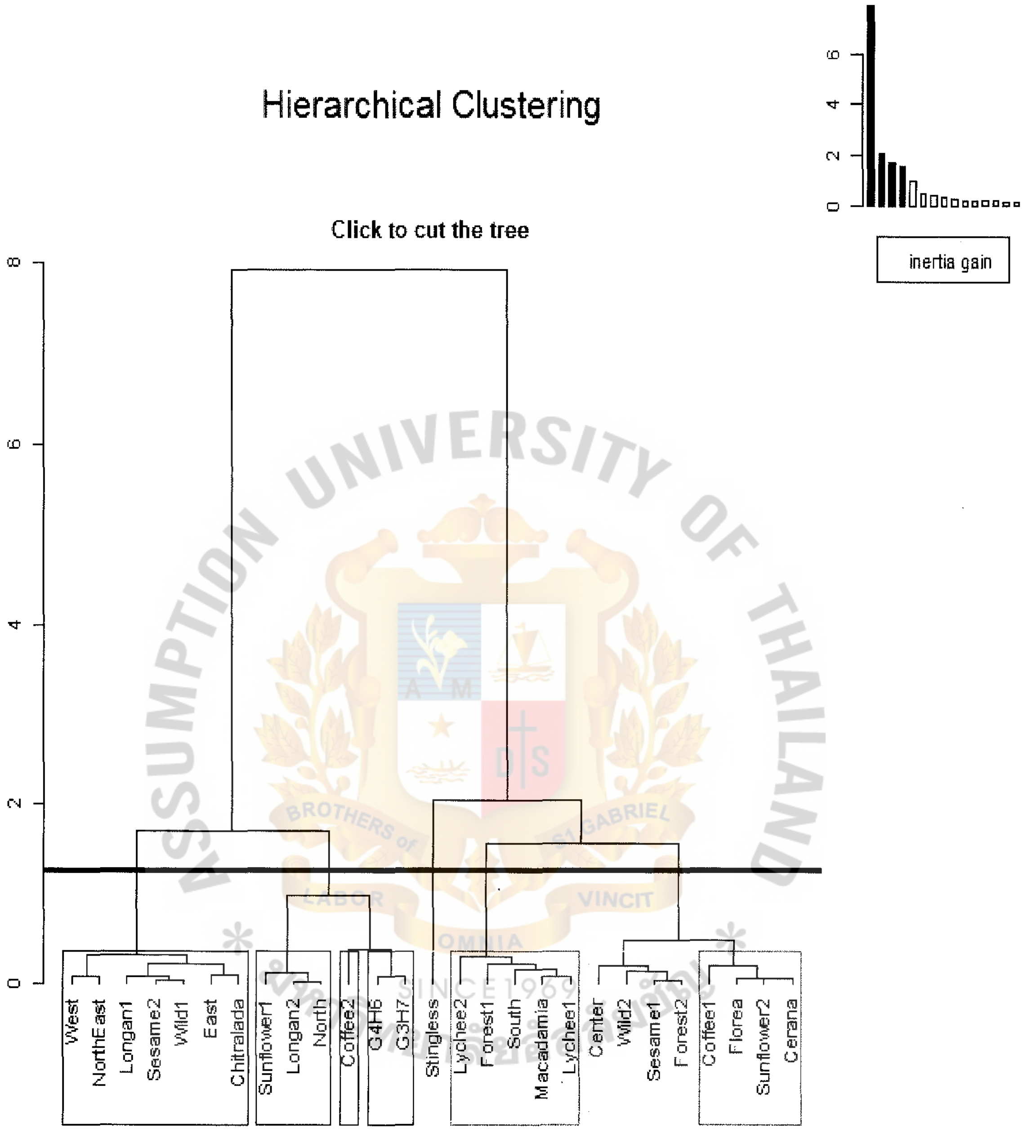


Figure 28: Cluster analysis of 27 honey samples for 20 sensorial attributes



Twenty-seven samples were repeatedly analyzed with 20 sensorial attributes by using principal component analysis and cluster analysis according to figure 26 to 32. The position of honey samples and sensorial attributes on PCA map were changed for some samples and attributes; however, most of them still be appeared in the similar position as previous analysis. The samples were also grouped into 8 groups by using cluster analysis. There was significant difference between clusters in every attribute which the changing of cluster was also occurred for some samples.

Figure 29: Sourness, fruit, dried fruit, worcester sauce, ferment and herb flavors profiles of Thai honeys

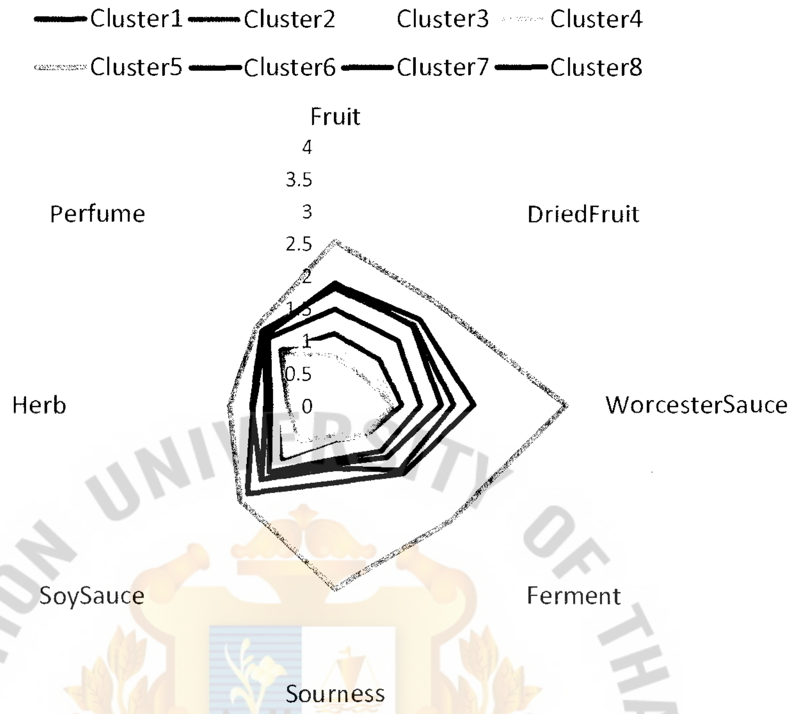


Figure 30: Sourness, fruit, dried fruit, worcester sauce, ferment and herb flavors profiles of Thai honeys

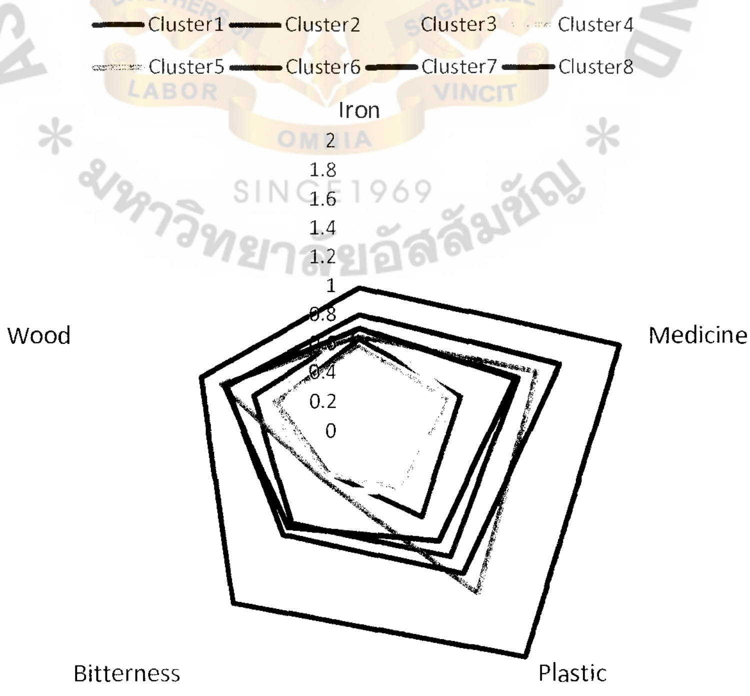


Figure 31: Butterscotch, molasses and coffee flavors profiles of Thai honeys

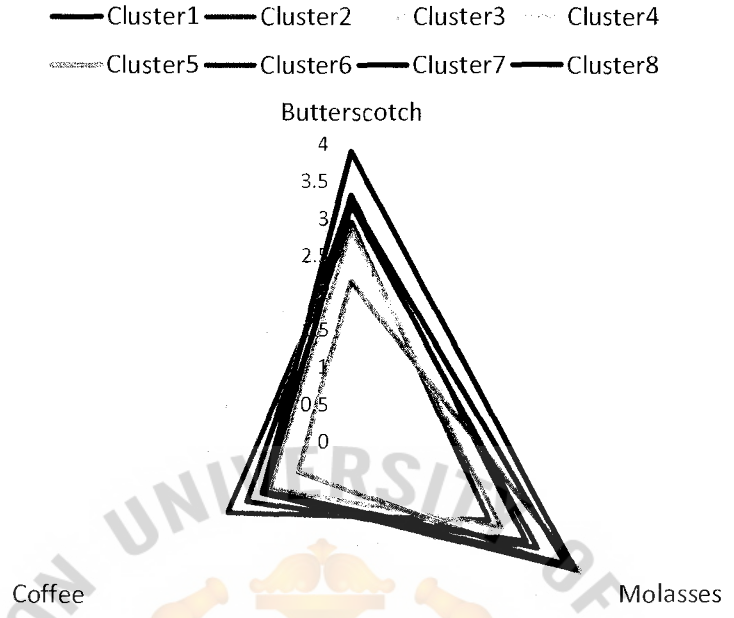
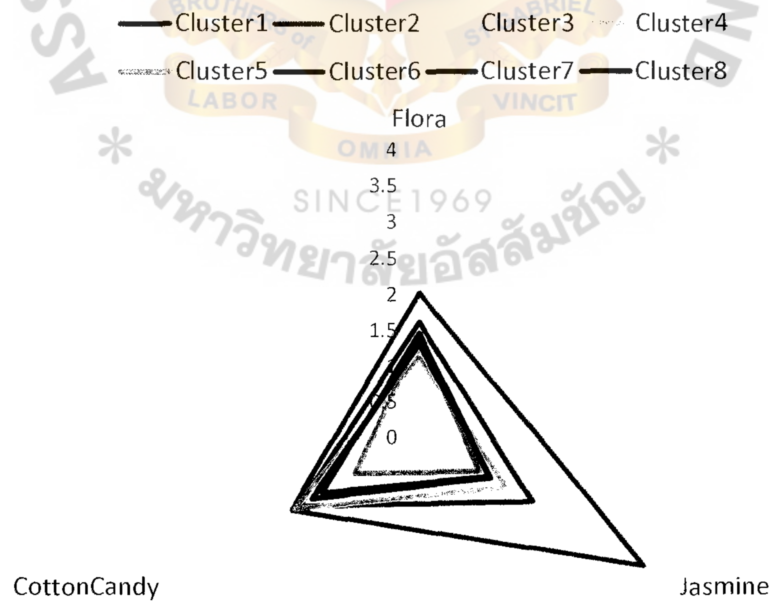


Figure 32: Cotton candy, flora and jasmine flavors profiles of Thai honeys



The first cluster included Chitralada, North East, Longan1, East, West, Sesame2 and Wild1. Sunflower1, Longan2 and North were grouped together as the second cluster. Coffee2 was the only one sample of the third cluster. Both adulterated samples, G3H7 and G4H6 were grouped together as the fourth cluster. Stingless was mentioned as the only sample of fifth cluster. The sixth cluster included Lychee2, Lychee1, Macadamia, Forest1 and South. Wild2, Center, Sesame1 and Forest2 were categorized as the seventh cluster. The last cluster included Coffee1, Florea, Sunflower2 and Cerana. The sixth cluster was significantly rated as the highest intensity for bitterness and, plastic, medicine and iron flavors. Additionally, the sixth cluster was also significantly rated as the most intensity for wood flavor with fifth and seventh cluster. The only sample of the fifth cluster or Stingless significantly contained the highest intensity for several characteristics which included sourness, fruit, dried fruit, ferment, worcester sauce, molasses, perfume and herb flavors. Besides, Stingless was also mentioned as the most intensity with the eighth cluster for soy sauce flavor. The second cluster was significantly rated as the highest intensity. The second cluster was significantly rated as the highest intensity for jasmine and flora flavors. The third and seventh clusters were significantly rated as the highest intensity for coffee and butterscotch flavors respectively. The fourth cluster was significantly mentioned as the lowest intensity for several attributes such as sourness, bitterness and, perfume, fruit, flora, dried fruit, medicine, ferment plastic, worcester sauce, soy sauce, herb, wood and iron flavors. Lastly, there was no significant difference between every clusters for cotton candy flavor except the fifth cluster.

Figure 33: Degrees Brix of 27 honey samples

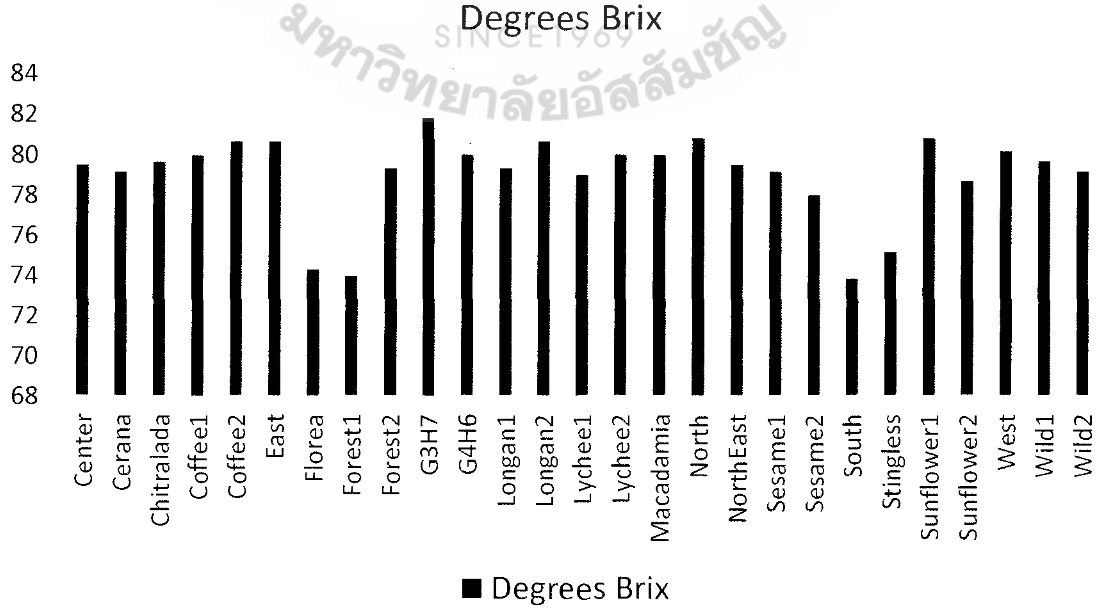
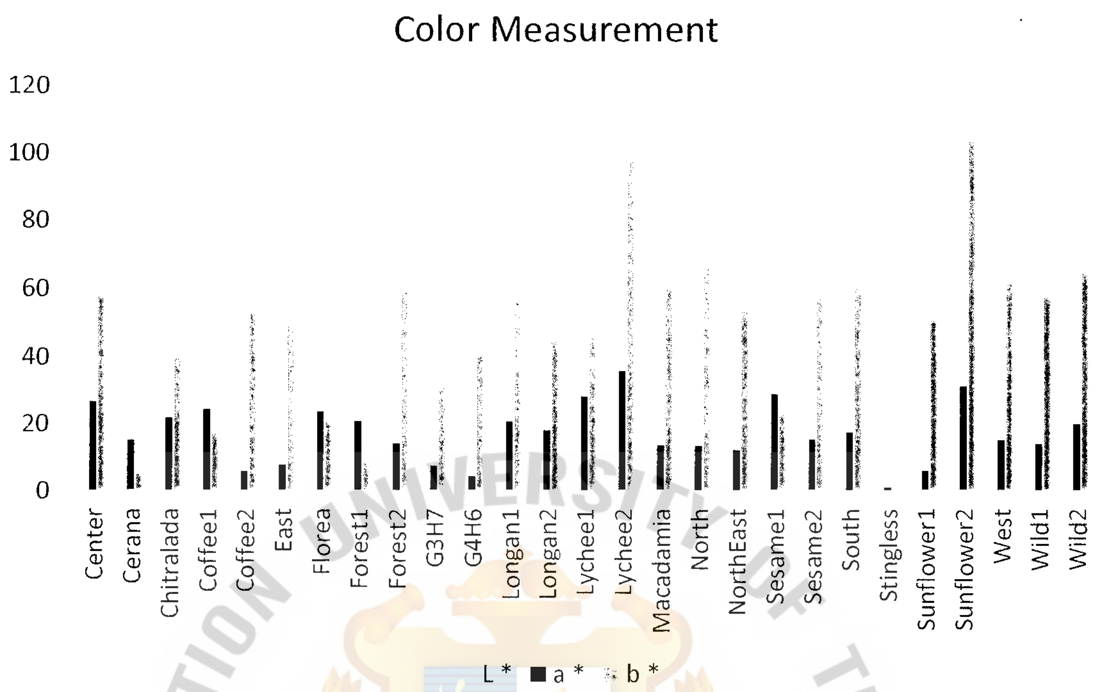


Figure 34: L*, a* and b* value of 27 honey samples



The results of physicochemical properties of honeys were showed in the table 33 and 34. The L* axis runs from top to bottom. The maximum for L* is 100, which represents a perfect reflecting diffuser. The minimum for L* is 0, which represent black. Sunflower 2 was the outstanding sample; the color of Sunflower2 was measured as the significantly highest L*value from all samples followed by Lychee2, then Coffee2 and Sunflower1. So, the honey samples with high value of L* was explained as the samples with lighter color. On the other hand, the a* and b* axes have no specific numerical limits. Positive a* is red whereas negative a* is green. For the a* Lychee2 was analyzed as the significantly highest value of a* followed by Sunflower2, then Sesame1 and Lychee1. Lastly, positive b* is yellow whereas negative b* is blue. Sunflower2 and Lychee2 were significantly rated as the highest value of b* followed by North and Wild2. The value of both a* and b* were not represented in the negative value; so, the a* and b* were used to explain red and yellow color respectively. The refractometer was applied to measure degrees Brix of honey samples which represented the percentage of total soluble solid; most of total soluble solid in honey was sugar. G3H7 was ranked as the highest degrees Brix followed by North and Sunflower1. On the other hand, South contained the lowest degrees Brix followed by Forest1 and Florea. So, the degrees Brix and intensity of sweetness should be rated in the similar manner; however, sweetness and degrees brix were rated in the opposite way for some samples. The reason might occur from type of sugar because refractometer was only used to measure total soluble solid, so the percentages for each types of sugar were not specified; overall sugar in honey is represented by monosaccharide (mainly glucose and fructose) with 10 – 15% of disaccharide and small amount of other sugar. Moreover, different types of sugar provided different level of sweetness. The sugar component in honey was mainly varied by the source of nectar.

Figure 35: Cluster analysis of 27 honey samples for 22 sensorial attributes with 2 physicochemical properties

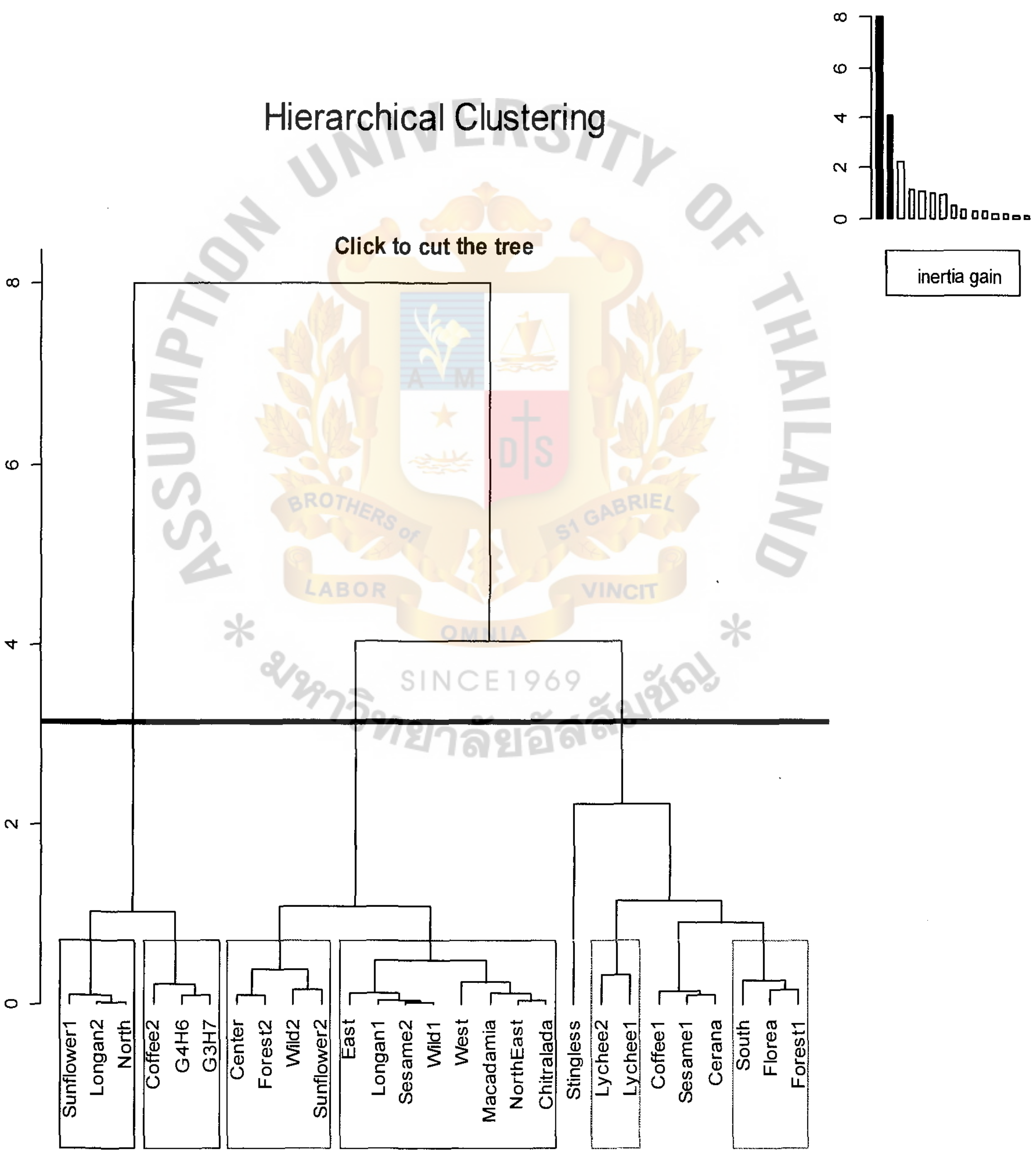


Figure 36: The Principal Component Analysis of 22 sensorial attributes with 2 physicochemical properties

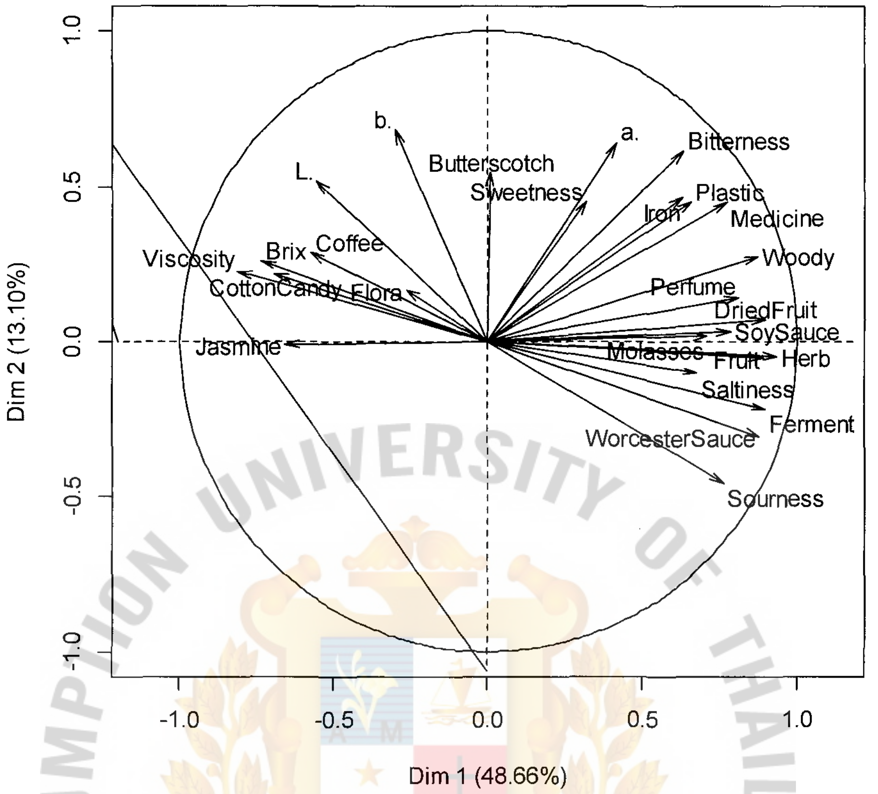
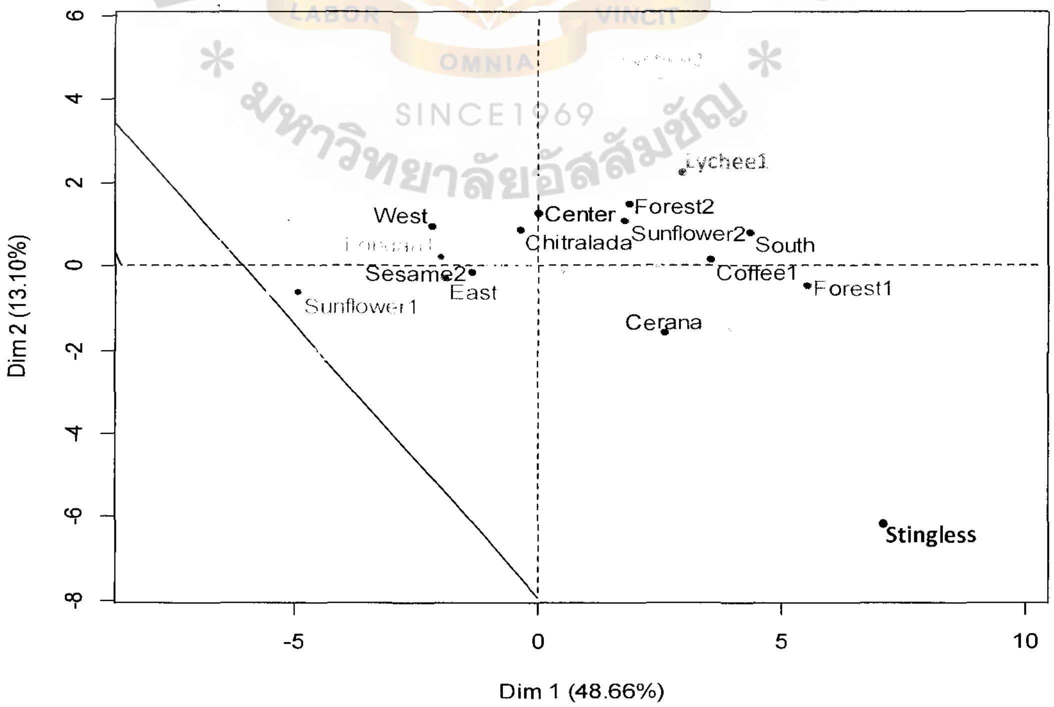


Figure 37: The Principal Component Analysis of 27 honey samples 22 sensorial attributes with 2 physicochemical properties



According to figure 35 to 37, the twenty-seven samples was repeatedly analyzed by PCA with more variables such as degrees Brix, L*, a* and b*. The changes were occurred on the position of some samples and attributes on the PCA map. The samples were also categorized into 8 groups as the first time which only focusing on sensorial attributes. The pattern of cluster was obviously changed from the first time; however, some clusters was also maintained the same samples which were first cluster (Sunflower1, Longan2 and North; second cluster of the first analysis), second cluster (Coffee2, G3:H7 and G4:H6; third cluster of the first analysis) and fifth cluster (Stingless; fourth of the first analysis). The third cluster included Center, Forest2, Wild2 and Sunflower2 (eighth cluster of the first analysis). Chitralada, North East, Longan1, East, West, Macadamia, Sesame2 and Wild1 were grouped together as the fourth cluster (first cluster of the first analysis). The sixth cluster included both Lychee1 and Lychee2 (also sixth cluster of the first analysis). Coffee1, Cerana and Sesame1 were grouped together as the seventh cluster (also seventh cluster of the first analysis). The eighth cluster included South Florea and Forest1 (fifth cluster of the first analysis). The second and first clusters were significantly the highest value of degrees Brix followed by the fourth cluster. The first, second, third and sixth clusters showed the highest value of L* which referred to be lighter color. The cluster that had most value of a* was the sixth cluster followed by third and seventh clusters which referred to be reddish color. The cluster sixth and three showed significantly highest value of b* followed by first and fourth clusters which b* represented the yellowish color.

Table 12: Comparing viscosity, sweetness and sourness of adulterated samples and original honey

Viscosity		**Sweetness**		**Sourness**	
Honey	Mean±SD	**Honey**	Mean±SD	**Honey**	Mean±SD
G3H7	11.4±0.7[a]	**Forest2**	8.2±0.6[a]	**Forest2**	0.9±0.4[a]
G4H6	11.0±0.5[a]	**G3H7**	7.5±0.9[b]	**G4H6**	0.5±0.4[b]
Forest2	10.5±0.8[b]	**G4H6**	7.5±0.8[b]	**G3H7**	0.4±0.4[b]

Note: Mean with the same letter are not significantly different at alpha level = 0.05

Table 13: Comparing bitterness, saltiness and perfume flavor of adulterated samples and original honey

Bitterness		**Saltiness**		**Perfume flavor**	
Honey	Mean±SD	**Honey**	Mean±SD	**Honey**	Mean±SD
Forest2	0.9±0.5[a]	**Forest2**	0.3±0.4[a]	**Forest2**	1.6±0.8[a]
G3H7	0.4±0.5[b]	**G3H7**	0.3±0.5[a]	**G4H6**	1.2±0.8[b]
G4H6	0.3±0.5[b]	**G4H6**	0.1±0.3[a]	**G3H7**	1.1±0.7[b]

Note: Mean with the same letter are not significantly different at alpha level = 0.05

Table 14: Comparing fruit, flora and jasmine flavors of adulterated samples and original honey

Fruit flavor		**Flora flavor**		**Jasmine flavor**	
Honey	Mean±SD	**Honey**	Mean±SD	**Honey**	Mean±SD
Forest2	1.8±0.8^{a}	**Forest2**	1.2±0.8^{a}	**G4H6**	1.5±1.0^{a}
G3H7	0.8±0.4^{a}	**G3H7**	1.1±0.8^{a}	**G3H7**	1.4±0.9^{ab}
G4H6	0.7±0.5^{b}	**G4H6**	1.1±0.8^{a}	**Forest2**	1.1±0.6^{b}

Note: Mean with the same letter are not significantly different at alpha level = 0.05

Table 15: Comparing cotton candy, butterscotch and molasses of adulterated samples and original honey

Cotton candy flavor		**Butterscotch flavor**		**Molasses flavor**	
Honey	Mean±SD	**Honey**	Mean±SD	**Honey**	Mean±SD
G4H6	2.1±1.3^{a}	**Forest2**	4.1±1.2^{a}	**Forest2**	3.9±1.5^{a}
G3H7	1.9±1.1^{a}	**G3H7**	3.0±1.5^{b}	**G3H7**	2.6±1.4^{b}
Forest2	1.7±0.7^{a}	**G4H6**	2.7±1.3^{b}	**G4H6**	2.1±1.4^{b}

Note: Mean with the same letter are not significantly different at alpha level = 0.05

Table 16: Comparing Coffee, dried fruit and medicine flavors of adulterated samples and original honey

Coffee flavor		**Dried fruit flavor**		**Medicine flavor**	
Honey	Mean±SD	**Honey**	Mean±SD	**Honey**	Mean±SD
Forest2	1.3±0.7^{a}	**Forest2**	1.8±0.8^{a}	**Forest2**	1.2±0.5^{a}
G4H6	1.3±0.9^{a}	**G4H6**	0.6±0.6^{b}	**G4H6**	0.7±0.6^{b}
G3H7	1.2±0.9^{a}	**G3H7**	0.6±0.6^{b}	**G3H7**	0.6±0.4^{b}

Note: Mean with the same letter are not significantly different at alpha level = 0.05

Table 17: Comparing Ferment, plastic and worcester sauce flavors of adulterated samples and original honey

Ferment flavor		**Plastic flavor**		**Worcester sauce flavor**	
Honey	Mean±SD	**Honey**	Mean±SD	**Honey**	Mean±SD
Forest2	1.3±0.5^{a}	**Forest2**	1.1±0.5^{a}	**Forest2**	1.6±0.8^{a}
G3H7	0.7±0.4^{b}	**G4H6**	0.5±0.5^{b}	**G3H7**	0.9±0.9^{b}
G4H6	0.7±0.5^{b}	**G3H7**	0.5±0.4^{b}	**G4H6**	0.9±0.8^{b}

Note: Mean with the same letter are not significantly different at alpha level = 0.05

Table 18: Comparing soy sauce, herb and wood flavors of adulterated samples and original honey

Soy sauce flavor		**Herb flavor**		**Wood flavor**	
Honey	Mean±SD	**Honey**	Mean±SD	**Honey**	Mean±SD
Forest2	1.8±1.0^{a}	**Forest2**	1.1±0.7^{a}	**Forest2**	1.0±0.4^{a}
G3H7	0.8±0.6^{b}	**G4H6**	0.8±0.6^{b}	**G3H7**	0.7±0.4^{b}
G4H6	0.8±0.6^{b}	**G3H7**	0.7±0.7^{b}	**G4H6**	0.6±0.5^{b}

Note: Mean with the same letter are not significantly different at alpha level = 0.05

Table 19: Comparing Iron flavor profiles, degrees Brix and L* value of adulterated samples and original honey

Iron flavor		Degree Brix		L* value	
Honey	Mean±SD	**Honey**	Mean±SD	**Honey**	Mean±SD
Forest2	0.8±0.4[a]	**G3H7**	81.8±0.3[a]	**Forest2**	43.6±7.0[a]
G4H6	0.6±0.4[ab]	**G4H6**	80.0±0.0[b]	**G4H6**	43.4±1.1[a]
G3H7	0.5±0.4[b]	**Forest2**	79.6±0.3[c]	**G3H7**	33.5±1.7[b]

Note: Mean with the same letter are not significantly different at alpha level = 0.05

Table 20: Comparing a* and b* values of adulterated samples and original honey

a* value		b* value	
Honey	Mean±SD	**Honey**	Mean±SD
Forest2	14.1±1.0[a]	**Forest2**	60.7±4.3[a]
G3H7	7.4±0.2[b]	**G4H6**	40.7±3.7[b]
G4H6	4.2±1.7[c]	**G3H7**	30.7±0.3[c]

Note: Mean with the same letter are not significantly different at alpha level = 0.05

Comparing both adulterated honeys by glucose syrup and the original sample Forest2 according to table 21 to 29, there was no significant difference between Forest2 and adulterated samples in some attributes such as saltiness, and flora, cotton candy, coffee flavors; however, the intensity of Forest2 for several attributes were significantly rated higher in sweetness, sourness, bitterness, a*, b* and perfume, fruit, butterscotch, molasses, dried fruit, medicine, ferment, plastic, worcester sauce, soy sauce, herb and wood flavors. There was no significant difference between Forest2 and G4:H6 for L* and iron flavor; Forest2 still contained the higher intensity for both attributes than adulterated samples. On the other hand, G3:H7 and G4:H6 were significantly rated higher than Forest2 for viscosity and degrees Brix; likewise, the intensity of jasmine flavor for both adulterated samples were also higher than forest2 but, there was no significant difference between G3:H7 and Forest2. So, Forest2 contained higher intensity than adulterated honeys by glucose syrup for almost attributes; it might refer that if the honey is adulterated by glucose syrup, the flavors of honey will be milder than the origins. However, glucose syrup was also enhanced viscosity, jasmine flavor and cotton candy flavor; even their intensities were not significant difference from the original samples. However, the higher values for a* and b* of Forest2 represented more reddish and yellowish color than adulterated honey samples which referred to more intense color. These characteristics might be applied to differentiate authentic honey from the honey that was adulterated by glucose syrup but it will be hard for the consumers to detect the adulterant by themselves due to inadequate knowledge and experience, and wide range of honey varietals; it might better for expert who had several experience and familiarity on honey characteristics. Most of available approaches were chemical or enzymatic reactions which had to spend time for analysis in the laboratory with many preparation steps. Therefore, this approach might be one of the most interesting and promising methods for detecting honey adulterations because it requires nothing except expert; so, honey could be examined its authenticity outside laboratory.

CONCLUSION

Studies showed that the seventy-percentage honey was a sample with the most percentage of honey per glucose syrup which the assessor not considered as significant difference from the original honey whereas the sixty-percentage honey was identified starting to reveal significant difference from the original honey. The definitions and references of Thai honey were generated for 22 sensorial characteristics by semi trained descriptive panels. The sensory profiles of Thai honey were also generated, paralleling with 2 physicochemical properties. Both lychee samples were rated as the highest intensity of bitterness, medicine flavor and plastic flavor which these three attributes were used to represent uniqueness of lychee honey. Moreover, Sunflower1 and Longan2 were also outstanding on flora and jasmine flavors. Coffe2 was clearly rated as the highest intensity of coffee flavor. Stingless was the most unique honey in this study because it was rated as the highest intensity for many attributes such as sourness, and fruit, ferment, worcester sauce and herb flavors. Moreover, the L*, a* and b* of stingless were significantly the least for all three values; additionally, the all of them were almost zero, so, the color of stingless must be very dark comparing to other samples. On the other hand, Sunflower2 and Lychee2 was rated as the top two highest intensity for L*, a* and b*; so, its color must be lighter, reddish and very yellowish comparing to other samples. Degrees Brix was used to measure the total soluble solid of honey; even almost total soluble solid composition in honey was sugar but there were many types of sugar which each of them provided different level of sweetness. The types and portion of sugar in honey were varied due to variety of the nectar source. Besides, distinct types of sugar provided different level of sweetness. Therefore, the degree Brix should not be applied to compare to the intensity of sweetness until the types of sugar and their portion in honey are identified. Lastly, if honey is adulterated by glucose syrup, most flavors of honey will be milder than the origins; however, the milder characteristics should only be detected with expert who was really familiar with various types of honey. Moreover, this approach could be helped to reduce cost and time for laborious experiment. It also could be applied anywhere for detecting adulterants in honey. Sometimes, if the authenticity could not be confirmed by the expert, the sample must be examined at the laboratory anyway; so, this method might be considered as a screening test. However, glucose syrup was only used in this study due to its various-used as an adulterant for honey in Thailand; so, another types of adulterants should be investigated in further study.

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REFERENCES

Anupama, D., Bhat, K.K. & Sapna, V.K. (2003). Sensory and physico-chemical properties of commercial samples of honey. *Food Research International, 36(2)*, 183-191.

Castro-Vázquez, L., Díaz-Maroto, M. C., González-Viñas, M. A., de la Fuente, E., & Pérez-Coello, M. (2008). Influence of storage conditions on chemical composition and sensory properties of citrus honey. *Journal of Agricultural and Food Chemistry, 56(6)*, 1999-2006.

Chambers, E., & Wolf, M.B. (1996). Sensory testing methods, *American Society for Testing and Materials 1996*.

Costa, A.C.V., Sousa, J.M.B., Silva, M.A.A.P., Garruti, D.S. & Madruga, M.S. (2015). Sensory and volatile profiles of monofloral honeys produced by native stingless bees of the brazilian semiarid region. *Food Research International, 105*, 110-120

Esti, M., Panfili, G., Marconi, E. & Trivisonno, M.C. (1997). Valorization of the honeys from the Molise region through physico-chemical, organoleptic and nutritional assessment. *Food Chemistry, 58*, 125-128

Ferreira, E.L., Lencioni, C., Benassi, M.T., Barth, M.O. & Bastos, D.H.M. (2009). Descriptive Sensory Analysis and Acceptance of Stingless Bee Honey. *Food Science and Technology International, 15(3)*, 251-258.

Fleming, E.E., Ziegler, G.R., & Hayes J.E. (2015) Check-all-that-apply (CATA), sorting, and polarized sensory positioning (PSP) with astringent stimuli. *Food Quality and Preference, 45*, 41-49

Gonnet, M. & Aubert, S. (1986) Color grading of honey. Retrieved from http://www.fiitea.org/foundation/files/1986/S.%20AUBERT,%20M.%20GONNET.pdf

Grembecka, M. & Szefer, P. (2013) Evaluation of honeys and bee products quality based on their mineral composition using multivariate techniques. *Environmental Monitoring and Assessment; Dordrecht, 185(5),* 4033-4047.

Guler, A., Bakan, A., Nisbet, C., & Yavuz, O. (2007) Determination of important biochemical properties of honey to discriminate pure and adulterated honey with sucrose (Saccharum officinarum L.) syrup, *Food Chemistry, 105*, 1119-1125

Gupta, J.K., Kaushik, R. & Joshi V.K. (1992). Influence of different treatments storage temperature and period on some physico chemical characteristics and sensory qualities of indian honey. *Journal of Food Science & Technology, 29(2)*, 84-87.

Helena, K. (2017, May 26) Spectrophotometric Evaluation of Honey Color Helps Boost Appeal. Retrieved from https://www.hunterlab.com/blog/color-food-industry/spectrophotometric-evaluation-honey-color-helps-boost-appeal/

Katrina, C. (2014, September 19) The Taste of Success: How Colorimetry Can Exploit the Brain's Perception of Food Quality. Retrieved from https://www.hunterlab.com/blog/color-food-industry/taste-success-colorimetry-can-exploit-brains-perception-food-quality/

Ketwaropaskul, B., Duangphakdee, O., Kantachan, T. & Soontrunnarudrungsri, A. (2017). Consumer Behavior and Acceptance Towards Different Unifloral Honey. In S. C. of Sensory and Consumer Research Joint Symposium 2017(Ed.) FIAC2017: Innovative Food Science and Technology For Mankind: Empowering Research for Health and Aging Society, (pp. 86-94). Bangkok, Thailand: BITEC.

Ketwaropaskul, B., Duangphakdee, O. & Soontrunnarudrungsri, A. (2018). Determination of The Sensory Characteristics of Thai Honey Using A Sorting Technique with Different Groups of Consumers. In S. C. of Summer Program in Sensory Evaluation 2018(Ed.) SPISE2018: Measuring the Multiple Factors of Consumers' Experience: Inter-Individual Differences in Sensory Evaluation, (pp. 7-21). Danang, Vietnam: University of Danang.

Kongpitak, P. (2014, July 8) FTA bolstered Thai honeys to world market. Retrieved from https://www.thairath.co.th/content/435036

Kortesniemi, M., Rosenvald, S., Laaksonen, O., Vanag, A., Ollikka, T., Vene, K., & Yang, B. (2018). Sensory and chemical profiles of Finnish honeys of different botanical origins and consumer preferences, *Food Chemistry, 246*, 351-359

Kumar, A., Gill, J.P.S., Bedi, J.S, Manav, M., Ansari, M.J., Walia, G.S. (2018) Sensorial and physicochemical analysis of Indian honeys for assessment of quality and floral origins, *Food Research International, 108*, 571-583

Manyi-Loh, C.E., Clarke, A.M., Ndipa, R.N. (2011). Volatile Compounds in Honey: A Review on Their Involvement in Aroma, Botanical Origin Determination and Potential Biomedical Activities. *International Journal of Molecular Sciences, 12(12)*, 9514–9532.

Missio da Silva, P., Gauche, C., Gonzaga, L.V., Costa, A.N.O. & Fett, R. (2016) Honey: Chemical composition, stability and authenticity. *Food Chemistry, 196*, 309–323

Naila, A., Flint, S.H., Sulaiman, A.Z., Ajit, A., & Weeds, Z. (2018) Classical and novel approaches to the analysis of honey and detection of adulterants. *Food Control, 90*, 152-165.

Overton, S.V., & Manura, J.J. (1999) Note 25: Flavor and Aroma in Natural Bee Honey. Scientific Instrument Service (SIS). (Access Date: 5/6/2018) [Online] Available: http://www.sisweb.com/referenc/applnote/app-25.htm

Saxelby, C. (2014, March 3) Honey - is it healthier than sugar? Retrieved from https://foodwatch.com.au/blog/carbs-sugars-and-fibres/item/honey-is-it-healthier-than-sugar.html

Silvano, M.F., Varela, M.S., Palacio, M.A., Ruffinengo, S. & Yamul, D.K. (2014) Physicochemical parameters and sensory properties of honeys from Buenos Aires region, *Food Chemistry, 52*, 500-507

Stolzenbach, S., Byrne, D.V. & Bredie, W.L.P. (2011). Sensory local uniqueness of Danish honeys. *Food Research International, 44*(9), 2766-2774

Tamma, P. (2018, July 20) Honeygate: How Europe is being flooded with fake honey. Retrieved from https://www.euractiv.com/section/agriculture-food/news/honeygate-how-europe-is-being-flooded-with-fake-honey/

ThairathTv (2017) Investigating adulterated honey production in Lamphun. Retrieved from https://www.youtube.com/watch?v=j79JtqEKyx4

TNAMCOT (2014) Investigating adulterated honey production in Khon Kaen. Retrieved from https://www.youtube.com/watch?v=aWKK5vlCGIQ

Workman, D. (2018, May 20) Natural Honey Exports by Country. Retrieved from http://www.worldstopexports.com/natural-honey-exporters/

Zábrodská, B., & Vorlová, L. (2015) Adulteration of honey and available methods for detection–a review. *Acta Veterinaria Brno, 83(10),* 85-102

CHAPTER 6: CONCLUSION

This aim of research was to study sensory profiles and consumer insight of Thai honey which mainly divided in to 4 objectives. First, to study consumers' behavior toward honey. The consumer survey was applied with 120 participants. Studies revealed that most of the participants in Bangkok Metropolitan Region consumed honey 1-2 times/months and usually buy honey at supermarket. The participants are willing to pay for safety of honey, reliable source and good sensory quality due to availability of adulterated honey in Thailand. The participants also pay attention on taste, flavor and aroma for sensory characteristics; however, these physiological factors can be perceived after purchasing only, so the participants should be more considered about general characteristics if they do not have any experience in those honeys before.

Second, to study sensory characteristics, consumers' preference and applications of honeys by applying sorting technique with different groups of consumers. The study showed that all group of the assessors had similarities in grouping and preference. The characteristics of honey were also described in the same manner but some of them were different in details. The characteristics of honey preferred by the assessors was described related to flora flavor. On the other hand, the disliked attributes of honey were mentioned by the assessors which composed of characteristics related to fermented and chemical flavors especially vinegar. Tastes were the most mentioned characteristics, however most of them appeared on central area of DISTATIS map, therefore flavors were applied to explain honey characteristics instead of tastes due to variety of flavor. Actually, the group that should provide the highest number of the description and application should be culinary group due to their familiarity of cooking. However, the regular honey user provided the highest number of both of them. The reason might relate to routine consumption of honey, at least once a month. Sorting is also depended on individual experiences because some assessors might perceive something that perfectly proper to describe characteristics of honey before even they were not familiar with honey or cooking.

Third, to group pure honey and different ratios of mixed honey and glucose syrup by sorting technique. Adulterated honey in Thailand was mainly contaminated by glucose syrup. Seventy-percentage honey was a sample with the most percentage of honey per glucose syrup which the assessor not considered as significant difference from the original honey whereas the sixty-percentage honey was identified starting to reveal significant difference from the original honey.

Fourth, to generate sensory profiles of honeys available in Thailand by using semi-trained descriptive assessors and determine important physicochemical properties. Twenty-two attributes of Thai honeys were generated by 6 semi-trained descriptive assessors, including their definitions and references. The assessors were trained for 47 sessions before generating the sensory profiles which included one appearance four tastes and seventeen flavors. The sensory profiles of Thai honey were also generated based on these attributes, paralleling with analysis of physicochemical properties such as color and Brix. The uniqueness of samples was discovered in many samples; however, Stingless was the most unique honey due to the highest intensity in many attributes such as sourness, and fruit, ferment, worcester sauce and herb flavors. Moreover, the L*, a* and b* of stingless were significantly the least for all three values which were 0.2, 1.0 and 0.3 respectively; so, the color of stingless must be the darkest. On the other hand, the L*, a* and b* of Sunflower2 (61.4, 31.0, 103.9) and Lychee2(58.3, 35.7, 98.5) were rated as the top two highest values which represented lighter, reddish and very yellowish color. Degree Brix could not be applied to measure sweetness in honey if the types of sugar are unidentified. Lastly, if honey is adulterated by glucose syrup, most flavors of honey will be milder than the origins; however, the milder characteristics should only be detected with expert who was really familiar with various types of honey. Moreover, this approach could be helped to reduce cost and time for laborious experiment. It also could be applied anywhere for detecting adulterants in honey.

CHAPTER 7: RECOMMENDATION

- The top three most well-known brand of Thai honey were Chitralada, Doi Kham, and Vejchapong which the percentages of these three brands were combined together for almost 70% of participants who lived in Bangkok Metropolitan Region. These brands were really strong comparing to the other; so, if any brand want to compete with them, safety is the important attributes that should be focused followed by origin and sensory quality. Safety is obviously the most important factor due to availability of adulterated honey in Thailand because adulterated honey is not only affecting on quality and nutrition of honey but also can be harmful to consumers. So, the honey should be labeled with certification from the relevant to ensure the consumer's trust. The honeys from defined botanical and geographical origins possess distinctive sensory characteristics and also are considered as premium products which tend to have higher prices than honeys from mixed botanical origins. The sensory quality of honey was directly related to perception of consumers and consumers' preference on characteristic of honey which the sensory characteristics; the sensory quality is one of the most important factors that honey will be repeatedly purchased by the consumers or not. The characteristics of honey preferred by the assessors was described related to flora flavor. On the other hand, the disliked attributes of honey were mentioned by the assessors which composed of characteristics related to fermented and chemical flavors especially vinegar.

- The consumers' behaviour and sensory profiles of Thai honeys were researched in this study; however, there was some part of the study that can be developed to get more efficient results. For the factors affecting on consumer's decision, there should be some definition to describe each factor to make consumer understand the meaning of factors in the same manner because some word may have different meaning for each person. Moreover, the data of demographic information should be balanced as much as possible to generate more efficient outcome. In the training, a 0-15 scale was applied. The intensity of samples was rate in the low part of scale (0 to 5) for almost attributes which was also similar to the intensity of reference for several attributes; the results showed only little difference of samples for some attributes. The range of reference should be extended to create more different of samples; so, the distinction of sensory profile may be easier to explain. For the physicochemical properties, the refractometer was applied to measure degrees Brix of honey samples which represented the percentage of total soluble solid or sugar. So, the degrees Brix and intensity of sweetness should be rated in the similar manner; however, both of them were rated in the opposite way for some samples. The reason might occur from type of sugar because refractometer was only used to measure percentage of sugar but the types of sugar were not specified which different types of sugar provided different level of sweetness. Therefore, the percentage for each type of sugar should be identified. The rheology property of honey also should be analysed to compare with intensity of viscosity.

- The honey that is adulterated by glucose syrup will provide milder for most tastes and flavors but the milder characteristics might be easier to detect for the expert who was had several experience and familiarity on characteristics of honey. Moreover, this approach could be helped to reduce cost and time for laborious experiment. It also could be applied anywhere for detecting adulterants in honey. Sometimes, if the authenticity could not be confirmed by the expert, the sample must be examined at the laboratory anyway; so, this method might be considered as a screening test. However, glucose syrup was only used in this study due to its various-used as an adulterant for honey in Thailand; so, another types of adulterants should be investigated in further study.

REFERENCES

Aibolita (Access Date: 2018, June 16). HONEY IN THE FOOD INDUSTRY. Retrieved from http://aibolita.com/heart-and-vessels/51112-honey-in-the-food-industry.html

Alqarni, A.S., Owayss, A.A. & Mahmoud, A.A. (2012) Mineral content and physical properties of local and imported honeys in Saudi Arabia. Journal of Saudi Chemical Society, 5, 618–625

Andersen, Ø.M. & Markham, K.R. (2006) Chapter1: Separation and Quantification of Flavonoids. Flavonoids chemistry, biochemistry and applications, Taylor and Francis Group, 1-32

Batt, P.J. & Liu, A. (2012). Consumer behaviour towards honey products in Western Australia. *British Food Journal, 114(2)*, 285-297.

Belay, A., Solomon, W.K., Bultossa, G., Adgaba, N. & Melaku, S. (2015). Botanical origin, colour, granulation, and sensory properties of the Harenna forest honey, Bale, Ethiopia. *Food Chemistry, 167*, 213-219.

Benefits of honey (Access Date: 2017, April 5). 17 Honey FAQs [Frequently Asked Information About Honey] Retrieved from http://www.benefits-of-honey.com/information - about-honey.html

Bickerstaff, B. (2013, July 14). Obesity in Thailand: Behold the perfect storm. Retrieved from http://www.burning-bison.com/obesity.htm

Bogdanov, S., Ruoffa, K. & Persano-Oddo, L. (2004). Physico-chemical methods for the characterization of unifloral honeys: a review. *Apidologie, 35,* 4-17.

Brudzynski, K., Sjaarda, C. & Maldonado-Alvarez, L. (2013) A new look on protein–polyphenol complexation during honey storage: Is this a random or organized event with the help of dirigent-like proteins? PLOS One, 8, 1–9

Caporale, G., Policastro, S., Carlucci, A. & Monteleone, E., (2006). Consumer expectations for sensory properties in virgin olive oils. Food Quality and Preference, 17, 116-125

Castro-Vázquez, L., Díaz-Maroto, M. C., González-Viñas, M. A., de la Fuente, E., & Pérez-Coello, M. (2008). Influence of storage conditions on chemical composition and sensory properties of citrus honey. Journal of Agricultural and Food Chemistry, 56(6), 1999-2006.

Cavia, M.M., Fernández-Muino, M.A., Alonso-Torre, S.R., Huidobro, J.F. & Sancho, M.T. (2007) Evolution of acidity of honeys from continental climates: Influence of induced granulation. Food Chemistry, 100, 1728–1733

Chambers, E., & Wolf, M.B. (1996). Sensory testing methods, American Society for Testing and Materials 1996.

Ciappini, M.C., Di Vito, M.V., Gatti, M.B. & Calviño. A.M. (2013). Development of a Quantitative Descriptive Sensory Honey Analysis: Application to Eucalyptus and Clover Honeys. *Advance Journal of Food Science and Technology, 5(7)*, 829-838.

Cosmina, M., Gallenti, G., Marangon, F. & Troiano, S. (2016). Reprint of "Attitudes towards honey among Italian consumers: A choice experiment approach". *Appetite, 106,* 110-116

Costa, A.C.V., Sousa, J.M.B., Silva, M.A.A.P., Garruti, D.S. & Madruga, M.S. (2015). Sensory and volatile profiles of monofloral honeys produced by native stingless bees of the brazilian semiarid region. Food Research International, 105, 110-120

Cuevas-Glory, L.F., Pino, J.A., Santiago, L.S., & Sauri-Duch, E. (2007). A review of volatile analytical methods for determining the botanical origin of honey. *Food Chemistry, 103,* 1032-1043.

Dhavale, R. (Access Date: 2018, February 19). What is the difference between a chef and a culinary expert? Retrieved from https:// www.quora.com/What-is-the-difference-between-a-chef-and-a-culinary-expert

Edwards, C.H., Rossi, M., Corpe, C.P., Butterworth, P.J. & Ellis, P.R. (2016) The role of sugars and sweeteners in food, diet and health: Alternatives for the future. Trends in Food Science & Technology, 56, 158–166

Erejuwa, O.O., Sulaiman, S.A. & Ab Wahab, M.S. (2012a) Honey - A novel antidiabetic agent. International Journal of Biological Sciences, 8, 913–934

Escuredo, O., Míguez, M., Fernández-González, M. & Seijo, M.C. (2013) Nutritional value and antioxidant activity of honeys produced in a European Atlantic area. Food Chemistry, 138, 851–856

Esti, M., Panfili, G., Marconi, E. & Trivisonno, M.C. (1997). Valorization of the honeys from the Molise region through physico-chemical, organoleptic and nutritional assessment. Food Chemistry, 58, 125-128

FAOSTAT (2013) Honey production: Browse data - FAOSTAT Domains /Production/ Livestock Primary; Item: Honey, natural; Area: World; Year: as needed". *United Nations, Food and Agriculture Organization, Statistics Division (FAOSTAT).*

Fleming, E.E., Zieglerb, G.R., & Hayes, J.E. (2015). Check-all-that-apply (CATA), sorting, and polarized sensory positioning (PSP) with astringent stimuli. Food Quality and

Preference, 45, 41-49

Ferreira, E.L., Lencioni, C., Benassi, M.T., Barth, M.O. & Bastos, D.H.M. (2009). Descriptive Sensory Analysis and Acceptance of Stingless Bee Honey. *Food Science and Technology International, 15(3),* 251-258.

Foster-Powell, K., Holt, S.H. & Brand-Miller, J.C. (2002) International table of glycemic index and glycemic load values. The American Journal of Clinical Nutrition, 76, 5–56

Galan-Soldevilla, H., Rui-Perez-Cacho, M.P., Jimenez, S.S., Villarejo, M.J. & Manzanares, A.B. (2005). Development of a preliminary sensory lexicon for floral honey. *Food Quality and Preference, 16,* 71-77.

Gardner, C., Wylie-Rosett, J., Gidding, S.S., Steffen, L.M., Johnson, R.K. & Reader, D. (2012) Nonnutritive sweeteners: Current use and health perspectives. A scientific statement from the American Heart Association and the American Diabetes Association, Diabetes Care, 35, 1798–1808

Gonnet, M. & Aubert, S. (1986) Color grading of honey. Retrieved from http://www.fiitea.org/foundation/files/1986/S.%20AUBERT,%20M.%20GONNET.pdf

Grembecka, M. & Szefer, P. (2013) Evaluation of honeys and bee products quality based on their mineral composition using multivariate techniques. Environmental Monitoring and Assessment; Dordrecht, 185(5), 4033-4047.

Guler, A., Bakan, A., Nisbet, C., & Yavuz, O. (2007) Determination of important biochemical properties of honey to discriminate pure and adulterated honey with sucrose (Saccharum officinarum L.) syrup, Food Chemistry, 105, 1119-1125

Gupta, J.K., Kaushik, R. & Joshi V.K. (1992). Influence of different treatments storage temperature and period on some physico chemical characteristics and sensory qualities of indian honey. Journal of Food Science & Technology, 29(2), 84-87

Haffejee, I.E. & Moosa, A. (1985). Honey in the treatment of infantile gastroenteritis. *BMJ: British medical journal, 290,* 1866-1867

Hanhineva, K., Törrönen, R., Bondia-Pons, I., Pekkinen, J., Kolehmainen, M., Mykkänen, H. (2010) Impact of dietary polyphenols on carbohydrate metabolism. International Journal of Molecular Sciences, 11, 1365–1402

Helena, K. (2017, May 26) Spectrophotometric Evaluation of Honey Color Helps Boost Appeal. Retrieved from https://www.hunterlab.com/blog/color-food-industry/spectrophotometric-evaluation-honey-color-helps-boost-appeal/

Karabagias, I.K., Badeka, A., Kontakos, S., Karabournioti, S. & Kontominas, M.G.

(2014) Characterisation and classification of Greek pine honeys according to their geographical origin based on volatiles, physicochemical parameters and chemometrics. Food Chemistry, 146, 548–557

King, M.C., Cliff, M.A. & Hall, J.W. (1998). Comparison of projective mapping and sorting data collection and multivariate methodologies for identification of similarity-of-use snack bars. Journal of Sensory Studies, 13, 347-358

Katrina, C. (2014, September 19) The Taste of Success: How Colorimetry Can Exploit the Brain's Perception of Food Quality. Retrieved from https://www.hunterlab.com/blog/color-food-industry/taste-success-colorimetry-can-exploit-brains-perception-food-quality/

Ketwaropaskul, B., Duangphakdee, O., Kantachan, T. & Soontrunnarudrungsri, A. (2017). Consumer Behavior and Acceptance Towards Different Unifloral Honey. In S. C. of Sensory and Consumer Research Joint Symposium 2017(Ed.) FIAC2017: Innovative Food Science and Technology For Mankind: Empowering Research for Health and Aging Society, (pp. 86-94). Bangkok, Thailand: BITEC.

Ketwaropaskul, B., Duangphakdee, O. & Soontrunnarudrungsri, A. (2018). Determination of The Sensory Characteristics of Thai Honey Using A Sorting Technique with Different Groups of Consumers. In S. C. of Summer Program in Sensory Evaluation 2018(Ed.) SPISE2018: Measuring the Multiple Factors of Consumers' Experience: Inter-Individual Differences in Sensory Evaluation, (pp. 7-21). Danang, Vietnam: University of Danang.

Kongpitak, P. (2014, July 8) FTA bolstered Thai honeys to world market. Retrieved from https://www.thairath.co.th/content/435036

Kortesniemi, M., Rosenvald, S., Laaksonen, O., Vanag, A., Ollikka, T., Vene, K., & Yang, B. (2018). Sensory and chemical profiles of Finnish honeys of different botanical origins and consumer preferences, *Food Chemistry, 246*, 351-359

Kumar, A., Gill, J.P.S., Bedi, J.S, Manav, M., Ansari, M.J., Walia, G.S. (2018) Sensorial and physicochemical analysis of Indian honeys for assessment of quality and floral origins, *Food Research International, 108*, 571-583

Languepin, O. (2015, November 5) Thailand's Dangerous Sugar Addiction Retrieved from: http://www.thailand-business-news.com/news/headline/51508-thailands-dangerous-sugar-addiction.html

Lawless, H.T. & Glatter, S. (1990). Consistency of Multidimensional Scaling Models

Derived from Odor Sorting. Journal of Sensory Studies, 5, 217-277

Lawless, H.T., Sheng, N., & Knoops, S.C. (1995). Multidimensional scaling of sorting data applied to cheese perception. Food Quality and Preference, 6, 91-98

Li, L. & Seeram, N.P. (2010) Maple syrup phytochemicals include lignans, coumarins, a stilbene, and other previously unreported antioxidant phenolic compounds. Journal of Agricultural & Food Chemistry, 58, 11673–11679

Madejczyk, M. & Baralkiewicz, D. (2008) Characterization of Polish rape and honeydew honey according to their mineral contents using ICP-MS and F-AAS/AES. Analytica Chimica Acta, 617, 11–17

Mandal, M.D. & Mandal, S. (2011). Honey: its medicinal property and antibacterial activity. *Asian Pac J Trop Biomed, 1(2),* 154-160.

Manyi-Loh, C.E., Clarke, A.M. & Ndipa, R.N. (2012). Volatile Compounds in Honey: A Review on Their Involvement in Aroma, Botanical Origin Determination and Potential Biomedical Activities. *International Journal of Molecular Sciences, 12(12)*, 9514–9532.

Mato, I.S., Huidobro, J.F., Simal-Lozano, J.S. & Sancho, M.T. (2006) Rapid determination of nonaromatic organic acids in honey by capillary zone electrophoresis with direct ultraviolet detection. Journal of Agricultural and Food Chemistry, 54, 1541–1550

Mattes, R.D. & Popkin B.M. (2009) Nonnutritive sweetener consumption in humans: Effects on appetite and food intake and their putative mechanisms. The American Journal of Clinical Nutrition, 89, 1–14

Missio da Silva, P., Gauche, C., Gonzaga, L.V., Costa, A.N.O. & Fett, R. (2016) Honey: Chemical composition, stability and authenticity. Food Chemistry, 196, 309–323

Murphy, M., Cowan, C., Henchion, M. & O'Reilly, S., (2000). Irish consumer preferences for honey: a conjoint approach, *British Food Journal, 102(8)*, 585 – 598

Murray, J., Delahunty, C., & Baxter, I. (2001). Descriptive sensory analysis: Past, present and future. Food Research International, 34, 461-471

Nagai T, Inoue R, Kanamori N, Suzuki N, & Nagashima T. (2006). Characterization of honey from different floral sources. Its functional properties and effects of honey species on storage of meat. Food Chemistry, 97, 256-262

Naila, A., Flint, S.H., Sulaiman, A.Z., Ajit, A., & Weeds, Z. (2018) Classical and novel approaches to the analysis of honey and detection of adulterants. Food Control, 90, 152-165

Nordqvist, J. (2018, February 11). Honey: Health Benefits and Uses in Medicine. Retrieve from http://www.medicalnews today.com/articles/264667.php

Overton, S.V., and Manura, J.J., (1999) Note 25: Flavor and Aroma in Natural Bee Honey. Scientific Instrument Service (SIS). Retrieved from http://www.sisweb.com/referenc/applnote/app-25.htm

Roman, A., Popiela-Pleban, E., Kozak, M., and Roman, K. (2013). Factors influencing consumer behaviour relating to the purchase of honey, part 2. Product quality and packaging. *Journal of Apicultural Science, 57(2),* 175-185

Rybak-Chmielewska, H. (2007) Changes in the carbohydrate composition of honey undergoing during storage. Journal of Apicultural Science, 51, 39–48

Sak-Bosnar, M. & Sakac, N. (2012) Direct potentiometric determination of diastase activity in honey. Food Chemistry, 135, 827–831

Saxelby, C. (2014, March 3) Honey - is it healthier than sugar? Retrieved from https://foodwatch.com.au/blog/carbs-sugars-and-fibres/item/honey-is-it-healthier-than-sugar.html

Schiefer, J. & Fischer, C., (2008). The gap between wine expert ratings and consumer preferences: Measures, determinants and marketing implications. International Journal of Wine Business Research, 20, 335-351

Sensory dimensions (Access Date: 2018, June 5). Sorting methods in sensory and consumer research. Retrieved from http:// www.sensorydimensions.com/blog/sorted-sorting-methods-sensory-and-consumer-reserch

Silvano, M.F., Varela, M.S., Palacio, M.A., Ruffinengo, S. & Yamul, D.K. (2014) Physicochemical parameters and sensory properties of honeys from Buenos Aires region, Food Chemistry, 52, 500-507

Spence, C. (2015, November 2). Just how much of what we taste derives from the sense of smell? *Spence Flavour 2015 4:30*

Ssenoga, B. (2015, June 17). Beekeepers, honey packers tipped on packaging. Retrieved from http://www.monitor.co.ug/Magazines/Farming/Beekeepers-honey-packers-packaging/689860-2753990-doomvi/index.html

St-Pierre, P., Pilon, G., Dumais, V., Dion, C., Dubois, M.J. & Dubé, P. (2014) Comparative analysis of maple syrup to other natural sweeteners and evaluation of their metabolic responses in healthy rats. Journal of Functional Foods, 11, 460–471

Stolzenbach, S., Byrne, D.V. & Bredie, W.L.P. (2011). Sensory local uniqueness of Danish honeys. Food Research International, 44(9), 2766-2774

Suez, J., Korem, T., Zeevi, D., Zilberman-Schapira, G., Thaiss, C.A. & Maza, O. (2014) Artificial sweeteners induce glucose intolerance by altering the gut microbiota. Nature, 514, 181–186

Tamma, P. (2018, July 20) Honeygate: How Europe is being flooded with fake honey. Retrieved from https://www.euractiv.com/section/agriculture-food/news/honeygate-how-europe-is-being-flooded-with-fake-honey/

ThairathTv (2017) Investigating adulterated honey production in Lamphun. Retrieved from https://www.youtube.com/watch?v=j79JtqEKyx4

TNAMCOT (2014) Investigating adulterated honey production in Khon Kaen. Retrieved from https://www.youtube.com/watch?v=aWKK5vlCGIQ

White, J.W. (Access Date: 2018, July 19). Clarity as a Quality Factor in Honey Grading Request for Reconsideration. Honey Industry Council of America, Inc. Retrieved from https://collection1.libraries.psu.edu/cdm/ref/collection/honeyboard/id/258

Workman, D. (2018, May 20) Natural Honey Exports by Country. Retrieved from http://www.worldstopexports.com/natural-honey-exporters/

Yang, Q. (2010) Gain weight by "going diet?" Artificial sweeteners and the neurobiology of sugar cravings. Neuroscience 2010 The Yale Journal of Biology and Medicine, 83, 101–108

Zábrodská, B., & Vorlová, L. (2015) Adulteration of honey and available methods for detection–a review. Acta Veterinaria Brno, 83(10), 85-102

APPENDIX

TABLE

Table 21: Viscosity, sweetness and sourness profiles of Thai honeys

Viscosity		Sweetness		Sourness	
Honey	Mean±SD	Honey	Mean±SD	Honey	Mean±SD
Coffee2	12.3±0.8 ^{a}	Forest2	8.2±0.6 ^{a}	Stingless	2.8±0.7 ^{a}
Sunflower1	12.2±1.1 ^{a}	Center	8.0±0.7 ^{ab}	Sunflower2	1.3±0.5 ^{b}
West	12.1±0.8 ^{a}	Sunflower2	8.0±0.6 ^{abc}	Cerana	1.3±0.4 ^{b}
Longan2	12.1±0.9 ^{a}	Chitralada	8.2±0.7 ^{abc}	Florea	1.1±0.5 ^{bc}
North	11.9±0.8 ^{a}	Longan1	7.9±0.5 ^{abcd}	Coffee1	1.1±0.6 ^{bc}
G3H7	11.4±0.7 ^{b}	Coffee2	7.9±0.4 ^{abcde}	Sesame1	1.1±0.5 ^{bcd}
East	11.2±0.6 ^{bc}	Sesame2	7.8±0.6 ^{abcde}	Forest1	1.1±0.5 ^{bcd}
G4H6	11.0±0.5 ^{bcd}	Forest1	7.8±0.5 ^{abcde}	Lychee2	1.0±0.4 ^{bcd}
Macadamia	10.9±0.5 ^{bcd}	Sesame1	7.8±0.5 ^{abcde}	South	1.0±0.5 ^{bcd}
Longan1	10.8±0.9 ^{bcde}	Coffee1	7.8±0.8 ^{abcde}	Wild1	0.9±0.4 ^{cd}
Center	10.8±0.6 ^{bcde}	Lychee2	7.8±0.7 ^{abcde}	Lychee1	0.9±0.4 ^{cd}
Lychee2	10.8±0.6 ^{bcde}	Wild2	7.8±0.5 ^{abcde}	Macadamia	0.9±0.4 ^{cd}
Coffee1	10.8±0.9 ^{cde}	NorthEast	7.8±0.6 ^{abcde}	NorthEast	0.9±0.6 ^{cd}
Lychee1	10.7±0.9 ^{cedf}	Wild1	7.8±0.5 ^{abcde}	Forest2	0.9±0.4 ^{cde}
Wild1	10.6±0.6 ^{def}	South	7.7±0.4 ^{bcdef}	Wild2	0.9±0.4 ^{cde}
Chitralada	10.5±0.6 ^{def}	Lychee1	7.6±0.8 ^{bcdefg}	Center	0.8±0.4 ^{de}
NorthEast	10.5±0.5 ^{def}	Cerana	7.6±0.5 ^{bcdefg}	Sesame2	0.8±0.4 ^{de}
Forest2	10.5±0.8 ^{def}	Macadamia	7.6±0.7 ^{bcdefg}	Longan1	0.8±0.4 ^{def}
Wild2	10.3±0.9 ^{ef}	East	7.5±0.7 ^{cdefg}	Chitralada	0.8±0.4 ^{defg}
Cerana	10.1±0.6 ^{f}	Longan2	7.5±0.5 ^{defg}	West	0.8±0.4 ^{defgh}
Sesame1	9.6±0.8 ^{g}	G3H7	7.5±0.9 ^{defg}	East	0.8±0.4 ^{defgh}
Sunflower2	9.5±0.8 ^{g}	G4H6	7.5±0.8 ^{defg}	Sunflower1	0.6±0.4 ^{efghi}
Sesame2	9.4±0.9 ^{g}	Florea	7.4±0.7 ^{efg}	Longan2	0.5±0.4 ^{fghi}
Florea	8.7±0.7 ^{h}	Stingless	7.4±0.6 ^{efg}	Coffee2	0.5±0.3 ^{ghi}
Stingless	8.5±0.7 ^{hi}	West	7.3±0.8 ^{fg}	North	0.5±0.4 ^{ghi}
South	8.1±1.1 ^{ij}	North	7.3±0.5 ^{fg}	G4H6	0.5±0.4 ^{hi}
Forest1	7.8±0.8 ^{j}	Sunflower1	7.2±0.8 ^{g}	G3H7	0.4±0.4 ^{i}

Note: Mean with the same letter are not significantly different at alpha level = 0.05

Table 22: Bitterness, saltiness and perfume flavor profiles of Thai honeys

Bitterness		Saltiness		Perfume flavor	
Honey	Mean±SD	Honey	Mean±SD	Honey	Mean±SD
Lychee2	1.7±0.6 a	Center	0.4±0.4 a	South	1.8±0.6 a
Lychee1	1.6±0.7 a	Forest1	0.4±0.5 a	Stingless	1.7±0.9 ab
Forest1	1.5±0.4 a	Stingless	0.3±0.4 ab	Chitralada	1.7±0.6 ab
Macadamia	1.5±0.6 a	Coffee1	0.3±0.5 ab	Macadamia	1.7±0.8 ab
South	1.1±0.7 b	Sunflower2	0.3±0.4 ab	Forest1	1.6±0.9 abc
Chitralada	1.1±0.6 bc	Sesame1	0.3±0.5 abc	Forest2	1.6±0.8 abcd
Cerana	1.0±0.5 bc	Cerana	0.3±0.4 abc	Wild2	1.6±0.8 abcd
NorthEast	1.0±0.5 bcd	Forest2	0.3±0.4 abc	Sunflower2	1.6±0.8 abcd
Forest2	0.9±0.5 bcde	Wild2	0.3±0.4 abc	Florea	1.6±0.6 abcde
Florea	0.9±0.6 bcde	G3H7	0.3±0.5 abc	Coffee1	1.6±0.6 abcde
Coffee1	0.9±0.5 bcde	Lychee1	0.3±0.4 abc	Longan1	1.6±0.7 abcde
Sesame1	0.9±0.6 bcdef	Florea	0.3±0.4 abc	Center	1.5±0.7 abcdefg
West	0.8±0.5 cdefg	Sesame2	0.3±0.4 abc	Sesame1	1.5±0.8 abcdefg
Longan1	0.8±0.5 cdefg	NorthEast	0.3±0.4 abc	Lychee1	1.5±0.7 abcdefg
Center	0.8±0.5 cdefg	South	0.2±0.4 abc	Lychee2	1.4±0.6 abcdefg
East	0.7±0.4 defgh	Longan2	0.2±0.5 abc	Cerana	1.4±0.7 abcdefg
Wild2	0.7±0.5 defghi	Lychee2	0.2±0.4 abc	Wild1	1.4±0.8 abcdefg
Sunflower2	0.6±0.3 efghij	Sunflower1	0.2±0.4 abc	NorthEast	1.4±0.9 abcdefg
Wild1	0.6±0.3 fghijk	Longan1	0.2±0.4 abc	East	1.4±0.6 abcdefg
Sesame2	0.6±0.5 fghijk	Wild1	0.2±0.4 abc	West	1.4±0.6 abcdefg
Coffee2	0.5±0.6 ghijk	Macadamia	0.2±0.3 abc	Coffee2	1.3±0.7 bcdefg
Sunflower1	0.4±0.4 hijk	Chitralada	0.2±0.3 abc	Sesame2	1.3±0.6 bcdefg
Stingless	0.4±0.5 hijk	West	0.2±0.3 abc	Sunflower1	1.3±0.7 cdefg
G3H7	0.4±0.5 hijk	Coffee2	0.2±0.3 abc	Longan2	1.2±0.8 defg
Longan2	0.4±0.3 ijk	East	0.2±0.4 abc	G3H7	1.2±0.8 efg
G4H6	0.3±0.5 jk	North	0.1±0.3 bc	North	1.1±0.7 fg
North	0.3±0.3 k	G4H6	0.1±0.3 c	G4H6	1.1±0.7 g

Note: Mean with the same letter are not significantly different at alpha level = 0.05

Table 23: Fruit, flora and jasmine flavors profiles of Thai honeys

Fruit flavor		Flora flavor		Jasmine flavor	
Honey	Mean±SD	Honey	Mean±SD	Honey	Mean±SD
Stingless	2.5±1.2 [a]	Sunflower1	2.3±1.4 [a]	Sunflower1	4.0±1.7 [a]
South	2.2±0.6 [ab]	Longan2	2.0±1.2 [ab]	Longan2	3.7±1.4 [a]
Florea	2.1±0.7 [bc]	Lychee2	1.9±1.0 [bc]	North	3.1±1.5 [b]
Wild2	2.1±0.7 [bcd]	West	1.8±1.2 [bcd]	Chitralada	2.3±1.2 [c]
Forest1	2.0±0.9 [bcde]	NorthEast	1.8±0.8 [bcde]	West	2.3±1.4 [c]
Sesame1	1.9±0.7 [bcde]	Chitralada	1.8±0.5 [bcde]	Longan1	2.0±1.0 [cd]
Coffee1	1.8±0.9 [bcdef]	Longan1	1.7±0.8 [bcde]	NorthEast	1.9±0.9 [cde]
Sunflower2	1.8±0.7 [bcdef]	North	1.7±0.9 [bcde]	Sesame2	1.7±0.8 [cdef]
Forest2	1.8±0.8 [bcdefg]	Coffee1	1.7±1.0 [bcdef]	Lychee2	1.6±0.8 [defg]
NorthEast	1.8±0.7 [bcdefg]	East	1.5±0.7 [cdefg]	Coffee1	1.5±0.8 [defg]
Lychee2	1.8±0.7 [bcdefg]	Macadamia	1.5±0.7 [cdefg]	G4H6	1.5±1.0 [defg]
Cerana	1.7±0.9 [bcdefg]	Cerana	1.5±0.9 [cdefg]	Macadamia	1.4±0.6 [defgh]
Center	1.7±0.9 [bcdefg]	Sesame2	1.5±0.8 [cdefg]	East	1.4±0.6 [efgh]
West	1.6±0.7 [cdefgh]	Stingless	1.4±0.9 [defg]	G3H7	1.4±0.9 [efgh]
Macadamia	1.6±0.6 [defgh]	South	1.4±0.5 [defg]	Center	1.4±0.7 [efgh]
East	1.6±0.7 [efgh]	Sesame1	1.4±0.7 [defg]	Coffee2	1.2±0.7 [fgh]
Chitralada	1.4±0.7 [fghi]	Center	1.4±0.8 [defg]	Wild2	1.1±0.7 [fgh]
Lychee1	1.4±0.8 [fghi]	Sunflower2	1.3±0.7 [efg]	Wild1	1.1±0.7 [fgh]
Wild1	1.4±0.7 [fghij]	Florea	1.3±0.6 [efg]	Forest2	1.1±0.6 [fgh]
Longan1	1.4±0.5 [fghijk]	Lychee1	1.3±0.8 [efg]	Sesame1	1.1±0.5 [fgh]
Sunflower1	1.3±0.7 [ghijk]	Wild2	1.3±0.6 [efg]	Cerana	1.0±0.7 [gh]
Sesame2	1.2±0.7 [hijkl]	Wild1	1.3±0.7 [fg]	Sunflower2	1.0±0.7 [gh]
Longan2	1.1±0.8 [ijklm]	Forest2	1.2±0.8 [g]	Lychee1	1.0±0.5 [gh]
Coffee2	0.9±0.6 [jklm]	Forest1	1.2±0.7 [g]	Stingless	1.0±0.7 [gh]
North	0.9±0.5 [klm]	Coffee2	1.2±0.7 [g]	Florea	0.9±0.6 [gh]
G3H7	0.8±0.5 [lm]	G3H7	1.1±0.8 [g]	South	0.9±0.6 [gh]
G4H6	0.7±0.5 [m]	G4H6	1.1±0.8 [g]	Forest1	0.8±0.5 [h]

Note: Mean with the same letter are not significantly different at alpha level = 0.05

Table 24: Cotton candy, butterscotch and molasses flavors profiles of Thai honeys

Cotton candy flavor		Butterscotch flavor		Molasses flavor	
Honey	Mean±SD	Honey	Mean±SD	Honey	Mean±SD
West	2.5 ± 1.0^{a}	Forest2	4.1 ± 1.2^{a}	Forest2	3.9 ± 1.5^{a}
Center	2.3 ± 1.1^{ab}	Center	4.1 ± 1.1^{a}	Coffee1	3.7 ± 1.1^{ab}
G4H6	2.1 ± 1.3^{abc}	Coffee1	3.8 ± 1.2^{ab}	Sesame1	3.6 ± 1.5^{ab}
NorthEast	2.1 ± 0.7^{abc}	Sesame1	3.7 ± 1.3^{abc}	Cerana	3.6 ± 1.3^{ab}
North	2.1 ± 1.0^{abc}	Wild2	3.7 ± 1.2^{abc}	Stingless	3.6 ± 1.4^{abc}
Longan2	2.1 ± 0.9^{abc}	South	3.6 ± 1.1^{abcd}	Center	3.4 ± 1.4^{abcd}
Sesame2	2.0 ± 1.0^{abcd}	West	3.6 ± 0.6^{abcd}	Florea	3.3 ± 1.7^{abcde}
Sunflower1	2.0 ± 0.7^{abcd}	Coffee2	3.5 ± 1.3^{abcde}	Lychee1	3.2 ± 1.1^{abcdef}
Wild1	1.9 ± 1.0^{bcde}	Wild1	3.5 ± 1.0^{abcde}	Wild2	3.0 ± 1.5^{bcdefg}
G3H7	1.9 ± 1.1^{bcdef}	Macadamia	3.4 ± 1.1^{bcdef}	Longan1	3.0 ± 1.6^{bcdefg}
Coffee1	1.8 ± 0.6^{bcdef}	Longan1	3.4 ± 1.4^{bcdef}	South	3.0 ± 1.4^{bcdefg}
East	1.7 ± 1.0^{bcdef}	Sesame2	3.3 ± 1.3^{bcdefg}	Macadamia	3.0 ± 1.0^{bcdefg}
Macadamia	1.7 ± 0.5^{bcdef}	Cerana	3.3 ± 1.4^{bcdefg}	Wild1	2.9 ± 1.2^{cdefgh}
Forest2	1.7 ± 0.7^{cdef}	NorthEast	3.3 ± 1.2^{bcdefg}	Lychee2	2.8 ± 1.1^{cdefgh}
Longan1	1.7 ± 0.8^{cdef}	Lychee1	3.2 ± 1.1^{bcdefg}	West	2.8 ± 1.4^{defgh}
Coffee2	1.6 ± 0.7^{cdef}	Chitralada	3.2 ± 1.3^{bcdefg}	Sunflower2	2.8 ± 1.3^{defgh}
South	1.6 ± 0.8^{cdef}	Sunflower1	3.1 ± 0.8^{cdefg}	Sesame2	2.8 ± 1.3^{defgh}
Sunflower2	1.6 ± 0.6^{cdef}	G3H7	3.0 ± 1.5^{defg}	G3H7	2.6 ± 1.4^{efghi}
Chitralada	1.6 ± 0.8^{cdef}	Lychee2	3.0 ± 1.0^{defg}	East	2.6 ± 1.8^{efghi}
Lychee2	1.6 ± 0.9^{cdef}	East	2.9 ± 1.6^{defg}	NorthEast	2.5 ± 1.6^{efghi}
Sesame1	1.6 ± 0.6^{cdef}	Florea	2.9 ± 1.7^{defg}	Chitralada	2.5 ± 1.6^{fghi}
Cerana	1.5 ± 0.6^{cdefg}	Sunflower2	2.9 ± 1.2^{defg}	Forest1	2.5 ± 1.5^{fghi}
Lychee1	1.4 ± 0.7^{defg}	North	2.9 ± 1.4^{defg}	Coffee2	2.4 ± 1.4^{ghi}
Forest1	1.4 ± 0.8^{defg}	Longan2	2.8 ± 1.3^{efg}	North	2.3 ± 1.4^{ghi}
Wild2	1.4 ± 0.6^{efg}	G4H6	2.7 ± 1.3^{fgh}	Sunflower1	2.2 ± 1.3^{hi}
Florea	1.3 ± 0.5^{fg}	Forest1	2.6 ± 1.2^{gh}	G4H6	2.1 ± 1.4^{hi}
Stingless	1.0 ± 0.7^{g}	Stingless	2.1 ± 1.0^{h}	Longan2	2.0 ± 1.3^{i}

Note: Mean with the same letter are not significantly different at alpha level = 0.05

Table 25: Coffee, dried fruit and medicine flavors profiles of Thai honeys

Coffee flavor		Dried fruit flavor		Medicine flavor	
Honey	Mean±SD	Honey	Mean±SD	Honey	Mean±SD
Coffee2	3.2±1.0 [a]	South	2.3±0.7 [a]	Lychee2	2.3±1.3 [a]
Sunflower1	2.0±1.1 [b]	Stingless	2.2±1.0 [ab]	Lychee1	2.0±0.9 [ab]
West	1.9±0.5 [bc]	Sunflower2	2.2±1.4 [abc]	Forest1	1.9±0.8 [abc]
Longan2	1.9±1.0 [bcd]	Coffee1	1.9±0.9 [abcd]	Macadamia	1.7±1.2 [bcd]
NorthEast	1.9±0.8 [bcde]	Forest2	1.8±0.8 [bcde]	South	1.6±0.9 [bcde]
North	1.9±1.0 [bcde]	Sesame1	1.8±0.8 [bcde]	Coffee1	1.5±0.8 [cdef]
Chitralada	1.8±0.9 [bcdef]	Wild2	1.8±0.8 [bcdef]	Florea	1.5±0.6 [cdefg]
Center	1.8±0.7 [bcdefg]	Forest1	1.8±0.7 [cdefg]	Cerana	1.5±0.6 [cdefg]
Sesame2	1.6±0.7 [bcdefgh]	Florea	1.8±0.8 [cdefg]	West	1.4±0.9 [cdefgh]
Macadamia	1.6±0.8 [bcdefgh]	Lychee1	1.7±0.6 [defg]	NorthEast	1.4±0.5 [cdefgh]
East	1.6±0.9 [bcdefghi]	Cerana	1.7±0.7 [defg]	Sunflower2	1.3±0.6 [defghi]
Lychee1	1.5±0.6 [bcdefghi]	Chitralada	1.6±0.9 [defgh]	Stingless	1.3±0.5 [defghij]
Lychee2	1.5±0.7 [bcdefghi]	Lychee2	1.6±0.6 [defgh]	Chitralada	1.3±1.0 [defghij]
Florea	1.4±1.1 [cdefghi]	NorthEast	1.6±0.9 [defgh]	Sesame1	1.3±0.6 [efghij]
Coffee1	1.4±0.6 [defghi]	Center	1.4±0.9 [defgh]	Forest2	1.2±0.5 [efghij]
Wild1	1.4±0.7 [efghi]	Macadamia	1.4±0.8 [defgh]	Wild1	1.1±0.5 [fghijk]
Cerana	1.4±0.6 [efghi]	West	1.4±1.0 [efghi]	Wild2	1.1±0.6 [ghijkl]
Forest2	1.3±0.7 [fghij]	Longan1	1.4±0.7 [efghi]	East	1.0±0.5 [ghijkl]
G4H6	1.3±0.9 [ghij]	Wild1	1.3±0.7 [fghij]	Center	1.0±0.2 [hijkl]
Sunflower2	1.3±0.6 [hij]	East	1.3±0.5 [ghij]	Sesame2	0.9±0.4 [ijkl]
Sesame1	1.3±0.7 [hij]	Sesame2	1.3±0.6 [ghij]	Sunflower1	0.8±0.4 [jkl]
Longan1	1.2±0.6 [hij]	Sunflower1	1.1±0.7 [hij]	Longan1	0.8±0.6 [jkl]
G3H7	1.2±0.9 [hij]	Longan2	0.9±0.6 [ijk]	Longan2	0.7±0.5 [kl]
Wild2	1.2±0.5 [hij]	North	0.9±0.5 [jk]	Coffee2	0.7±0.4 [kl]
Forest1	1.1±0.6 [hij]	Coffee2	0.9±0.6 [jk]	North	0.7±0.4 [kl]
South	1.0±0.5 [ij]	G4H6	0.6±0.6 [k]	G3H7	0.7±0.6 [kl]
Stingless	0.8±0.4 [j]	G3H7	0.6±0.6 [k]	G4H6	0.6±0.4 [l]

Note: Mean with the same letter are not significantly different at alpha level = 0.05

Table 26: Ferment, plastic and worcester sauce flavors profiles of Thai honeys

Ferment flavor		Plastic flavor		Worcester sauce flavor	
Honey	Mean±SD	Honey	Mean±SD	Honey	Mean±SD
Stingless	2.5±1.1 a	Lychee2	2.7±1.2 a	Stingless	3.6±1.1 a
Coffee1	1.9±0.9 b	Lychee1	2.2±0.9 b	Florea	2.3±1.0 b
Forest1	1.6±0.7 bc	Forest1	1.9±1.0 bc	Cerana	2.2±1.0 bc
South	1.5±0.7 cd	Macadamia	1.7±1.0 cd	Coffee1	2.2±1.0 bcd
Cerana	1.4±0.5 cde	Cerana	1.4±0.8 de	South	2.1±1.3 bcde
Lychee2	1.4±0.4 cde	Stingless	1.4±0.7 de	Lychee2	1.9±0.7 bcdef
Sunflower2	1.4±0.5 cde	Coffee1	1.4±0.6 de	Sunflower2	1.9±1.0 bcdef
Florea	1.3±0.6 cdef	NorthEast	1.4±0.8 de	Sesame1	1.8±0.8 bcdefg
Lychee1	1.3±0.5 cdef	Chitralada	1.3±1.3 def	Forest1	1.8±0.5 bcdefg
Forest2	1.3±0.5 cdef	West	1.3±0.6 def	Macadamia	1.8±0.8 cdefgh
NorthEast	1.3±0.5 cdef	South	1.3±0.7 def	NorthEast	1.7±0.8 defghi
Macadamia	1.3±0.5 def	Forest2	1.1±0.5 efg	Forest2	1.6±0.8 efghi
West	1.1±0.6 efg	Florea	1.1±0.5 efg	Lychee1	1.6±0.7 fghi
Sesame1	1.1±0.6 efg	Sesame1	1.0±0.5 efgh	Center	1.6±0.9 fghi
Wild2	1.1±0.5 efg	Sunflower2	1.0±0.5 efgh	Wild2	1.6±0.9 fghi
Center	1.0±0.4 efgh	Center	1.0±0.5 efgh	West	1.4±0.9 fghij
Wild1	1.0±0.3 efgh	East	1.0±0.6 efgh	Sesame2	1.4±0.8 fghij
Chitralada	0.9±0.6 fghi	Sunflower1	0.9±0.7 fghi	Chitralada	1.3±0.9 ghij
East	0.9±0.5 fghi	Sesame2	0.9±0.7 fghi	Wild1	1.3±0.7 hij
Sesame2	0.9±0.4 ghi	Wild1	0.9±0.4 fghi	North	1.2±0.8 ij
Sunflower1	0.8±0.5 ghi	Longan1	0.8±0.6 ghi	East	1.2±0.7 ij
Longan1	0.8±0.3 ghi	North	0.7±0.5 ghi	Longan1	1.0±0.9 j
Coffee2	0.7±0.4 hi	Wild2	0.7±0.6 ghi	Longan2	1.0±0.7 j
G4H6	0.7±0.4 hi	Longan2	0.6±0.5 hi	Sunflower1	0.9±0.6 j
G3H7	0.7±0.5 hi	Coffee2	0.5±0.5 i	Coffee2	0.9±0.5 j
North	0.6±0.4 i	G4H6	0.5±0.5 i	G3H7	0.9±0.9 j
Longan2	0.6±0.4 i	G3H7	0.5±0.4 i	G4H6	0.9±0.8 j

Note: Mean with the same letter are not significantly different at alpha level = 0.05

Table 27: Soy sauce, herb and wood flavors profiles of Thai honeys

Soy sauce flavor		Herb flavor		Wood flavor	
Honey	Mean±SD	Honey	Mean±SD	Honey	Mean±SD
Coffee1	2.2 ± 0.8^{a}	Stingless	1.6 ± 0.7^{a}	Lychee1	1.2 ± 0.4^{a}
Florea	2.1 ± 0.7^{ab}	Forest1	1.5 ± 0.6^{ab}	Forest1	1.2 ± 0.5^{a}
Stingless	2.1 ± 0.6^{abc}	South	1.4 ± 0.7^{abc}	South	1.2 ± 0.6^{ab}
Cerana	1.8 ± 0.5^{abcd}	Lychee2	1.4 ± 0.5^{abc}	Lychee2	1.1 ± 0.6^{abc}
Macadamia	1.8 ± 0.8^{abcd}	Coffee1	1.4 ± 0.5^{abc}	Florea	1.1 ± 0.3^{abc}
Forest2	1.8 ± 1.0^{abcde}	Florea	1.3 ± 0.8^{bcd}	Coffee1	1.0 ± 0.4^{abcd}
Sesame2	1.8 ± 0.9^{bcde}	Sunflower2	1.3 ± 0.6^{bcde}	Forest2	1.0 ± 0.4^{abcd}
Center	1.7 ± 0.7^{cdef}	Cerana	1.2 ± 0.5^{bcde}	Macadamia	1.0 ± 0.4^{abcd}
West	1.7 ± 1.1^{cdef}	Lychee1	1.2 ± 0.6^{bcde}	Sesame1	1.0 ± 0.4^{abcd}
NorthEast	1.7 ± 0.9^{cdef}	NorthEast	1.2 ± 0.5^{cdef}	Stingless	1.0 ± 0.5^{abcd}
Sesame1	1.6 ± 0.8^{defg}	Sesame1	1.1 ± 0.7^{cdefg}	Center	1.0 ± 0.2^{abcd}
Lychee1	1.6 ± 0.7^{defg}	Forest2	1.1 ± 0.7^{cdefgh}	Cerana	0.9 ± 0.3^{bcde}
Lychee2	1.6 ± 0.8^{defg}	Wild1	1.1 ± 0.6^{cdefgh}	Chitralada	0.9 ± 0.5^{cdef}
Forest1	1.6 ± 0.6^{defg}	East	1.1 ± 0.6^{cdefgh}	West	0.9 ± 0.5^{cdef}
Sunflower2	1.5 ± 0.6^{defg}	Wild2	1.1 ± 0.6^{cdefgh}	Wild2	0.9 ± 0.4^{cdef}
South	1.5 ± 0.9^{defgh}	Chitralada	1.1 ± 0.7^{cdefgh}	Sunflower2	0.8 ± 0.4^{cdef}
Wild1	1.4 ± 0.6^{defghi}	Macadamia	1.1 ± 0.5^{cdefgh}	Wild1	0.8 ± 0.4^{defg}
Wild2	1.4 ± 0.8^{efghi}	Center	1.0 ± 0.5^{defghi}	East	0.8 ± 0.3^{defg}
Chitralada	1.3 ± 0.8^{fghi}	West	0.9 ± 0.6^{efghi}	Sesame2	0.8 ± 0.4^{defg}
Sunflower1	1.3 ± 1.0^{fghi}	Sunflower1	0.9 ± 0.7^{efghi}	NorthEast	0.7 ± 0.4^{efgh}
North	1.2 ± 0.8^{ghij}	Sesame2	0.9 ± 0.6^{efghi}	Sunflower1	0.7 ± 0.3^{efgh}
East	1.2 ± 0.8^{ghij}	Coffee2	0.8 ± 0.6^{fghi}	G3H7	0.7 ± 0.4^{efgh}
Longan1	1.2 ± 0.9^{ghij}	North	0.8 ± 0.4^{ghi}	Coffee2	0.6 ± 0.4^{fgh}
Coffee2	1.1 ± 0.7^{hij}	Longan1	0.8 ± 0.5^{hi}	North	0.6 ± 0.4^{fgh}
Longan2	1.1 ± 0.9^{ij}	G4H6	0.8 ± 0.6^{i}	G4H6	0.6 ± 0.5^{gh}
G3H7	0.8 ± 0.6^{j}	G3H7	0.7 ± 0.7^{i}	Longan1	0.5 ± 0.4^{gh}
G4H6	0.8 ± 0.6^{j}	Longan2	0.7 ± 0.5^{i}	Longan2	0.5 ± 0.4^{h}

Note: Mean with the same letter are not significantly different at alpha level = 0.05

Table 28: Iron flavor profiles, degrees Brix and L* value of Thai honeys

Iron flavor		Degrees Brix		L* value	
Honey	Mean±SD	Honey	Mean±SD	Honey	Mean±SD
Lychee2	1.1 ± 0.8^{a}	G3H7	81.8 ± 0.3^{a}	Sunflower2	61.4 ± 10.1^{a}
Forest1	1.0 ± 0.7^{ab}	North	80.8 ± 0.3^{b}	Lychee2	58.3 ± 3.2^{ab}
South	1.0 ± 0.5^{ab}	Sunflower1	80.8 ± 0.3^{b}	Coffee2	54.5 ± 0.5^{b}
Lychee1	0.9 ± 0.3^{abc}	Coffee2	80.7 ± 0.3^{bc}	Sunflower1	54.3 ± 0.6^{b}
Florea	0.9 ± 0.2^{abcd}	East	80.7 ± 0.8^{bc}	East	48.9 ± 0.8^{c}
Coffee1	0.8 ± 0.5^{abcde}	Longan2	80.7 ± 0.3^{bc}	North	47.8 ± 1.4^{cd}
Macadamia	0.8 ± 0.6^{abcde}	West	80.2 ± 0.3^{bcd}	Macadamia	44.2 ± 0.8^{cde}
Forest2	0.8 ± 0.4^{abcdef}	Coffee1	80.0 ± 0.0^{cde}	Forest2	43.6 ± 7.0^{cde}
Sesame1	0.8 ± 0.4^{abcdef}	Macadamia	80.0 ± 0.0^{cde}	G4H6	43.3 ± 1.2^{de}
East	0.8 ± 0.7^{abcdef}	G4H6	80.0 ± 0.0^{cde}	NorthEast	43.2 ± 1.2^{de}
Wild1	0.8 ± 0.3^{bcdef}	Lychee2	80.0 ± 0.5^{cde}	Wild1	42.3 ± 3.6^{de}
Sunflower2	0.8 ± 0.4^{bcdef}	Wild1	79.7 ± 0.3^{def}	Sesame2	41.1 ± 4.6^{ef}
Coffee2	0.7 ± 0.5^{cdef}	Chitralada	79.7 ± 0.3^{def}	West	41.1 ± 5.1^{ef}
Cerana	0.7 ± 0.3^{cdef}	NorthEast	79.5 ± 0.5^{def}	Wild2	40.3 ± 6.1^{ef}
Sesame2	0.7 ± 0.3^{cdef}	Center	79.5 ± 0.0^{def}	South	38.6 ± 5.5^{efg}
Chitralada	0.7 ± 0.5^{cdef}	Longan1	79.3 ± 0.3^{efg}	Longan1	36.2 ± 5.5^{fg}
Longan1	0.7 ± 0.5^{cdef}	Forest2	79.3 ± 0.3^{efg}	Center	34.2 ± 2.5^{g}
North	0.6 ± 0.5^{cdef}	Cerana	79.2 ± 0.3^{fg}	G3H7	33.5 ± 1.7^{g}
West	0.6 ± 0.4^{cdef}	Sesame1	79.2 ± 0.6^{fg}	Longan2	27.1 ± 2.5^{h}
NorthEast	0.6 ± 0.4^{cdef}	Wild2	79.2 ± 0.3^{fg}	Lychee1	26.6 ± 2.0^{h}
Stingless	0.6 ± 0.3^{cdef}	Lychee1	79.0 ± 0.0^{fg}	Chitralada	23.5 ± 4.5^{h}
G4H6	0.6 ± 0.4^{def}	Sunflower2	78.7 ± 0.6^{g}	Sesame1	13.2 ± 2.7^{i}
Longan2	0.6 ± 0.6^{def}	Sesame2	78.0 ± 0.0^{h}	Florea	12.0 ± 1.5^{i}
Sunflower1	0.6 ± 0.4^{def}	Stingless	75.2 ± 0.3^{i}	Coffee1	10.1 ± 5.2^{i}
Center	0.6 ± 0.3^{ef}	Florea	74.3 ± 0.3^{j}	Forest1	5.0 ± 1.4^{j}
Wild2	0.6 ± 0.4^{ef}	Forest1	74.0 ± 0.0^{j}	Cerana	3.0 ± 0.4^{j}
G3H7	0.5 ± 0.4^{f}	South	73.8 ± 0.8^{j}	Stingless	0.2 ± 0.1^{j}

Note: Mean with the same letter are not significantly different at alpha level = 0.05

Table 29: a* and b* values of Thai honeys

a* value		b* value	
Honey	Mean±SD	Honey	Mean±SD
Lychee2	35.7±4.1 ^{a}	Sunflower2	103.9±15.6 ^{a}
Sunflower2	31.0±1.7 ^{b}	Lychee2	98.5±4.4 ^{a}
Sesame1	28.6±1.8 ^{bc}	North	66.1±1.0 ^{b}
Lychee1	28.2±1.7 ^{bc}	Wild2	64.8±7.7 ^{bc}
Center	26.7±1.8 ^{cd}	Macadamia	62.1±1.5 ^{bcd}
Coffee1	24.4±7.0 ^{de}	West	61.5±3.9 ^{bcd}
Florea	23.5±0.8 ^{def}	Forest2	60.7±4.2 ^{bcde}
Chitralada	21.8±1.7 ^{efg}	South	60.1±5.9 ^{cbde}
Forest1	20.7±3.8 ^{fgh}	Longan1	59.9±6.6 ^{bcde}
Longan1	20.7±1.0 ^{fgh}	Center	58.0±3.9 ^{cdef}
Wild2	20.0±2.0 ^{ghi}	Sesame2	57.7±3.2 ^{cdef}
Longan2	17.9±1.0 ^{hij}	Wild1	57.7±3.1 ^{cdef}
South	17.3±2.4 ^{ijk}	Coffee2	55.4±2.0 ^{defg}
Sesame2	15.2±1.2 ^{jkl}	NorthEast	53.6±3.4 ^{efg}
Cerana	15.1±1.9 ^{jkl}	Sunflower1	50.8±4.9 ^{fgh}
West	15.0±3.4 ^{jkl}	East	50.1±4.1 ^{gh}
Forest2	14.1±1.2 ^{kl}	Lychee1	45.6±3.4 ^{hi}
Wild1	13.9±3.3 ^{kl}	Longan2	44.7±3.5 ^{hi}
Macadamia	13.3±1.4 ^{l}	G4H6	40.7±3.7 ^{i}
North	13.3±0.6 ^{l}	Chitralada	39.6±6.8 ^{i}
NorthEast	12.0±2.1 ^{l}	G3H7	30.7±0.3 ^{j}
East	7.6±2.2 ^{m}	Sesame1	22.7±4.6 ^{k}
G3H7	7.4±0.5 ^{mn}	Florea	20.5±2.6 ^{k}
Coffee2	6.0±0.9 ^{mn}	Coffee1	17.4±9.0 ^{k}
Sunflower1	5.6±2.1 ^{mn}	Forest1	8.6±2.4 ^{l}
G4H6	4.2±1.8 ^{n}	Cerana	5.1±0.8 ^{lm}
Stingless	1.0±0.3 ^{o}	Stingless	0.3±0.1 ^{m}

Note: Mean with the same letter are not significantly different at alpha level = 0.05

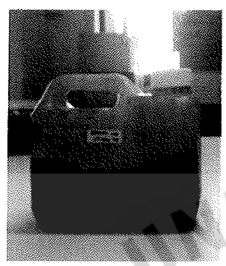
PICTURE

Table 30: The picture of each honey samples

No.	Picture of honeys	Type of Honey (Source/ Brand)
1		**Longan1** (Doi Kham) **Description:** Pure longan honey which has uniqueness flavor and be more sweeter comparing to the honey from other flora.
2		**Longan2** (Chumchon) **Description:** The honey that was produced from longan flower.
3		**Lychee1** (KMUTT) **Description**: The honey that was produced from lychee flower.
4		**Lychee2** (TPA) **Description**: The honey that was produced from lychee flower.

5		**Forest1** (KMUTT) **Description**: The raw honey from Nan which are harvested straight from the beehive from trees forests. by Mlabri tribe.
6		**Forest2** (Healthy Mate) **Description**: Raw Organic Forest Honey which are harvested straight from the beehive from trees forests.
7		**Sesame1** (TPA) **Description**: The honey that was produced from sesame flower.
8		**Sesame2** (Supha Bee Farm) **Description**: The Sesame honey from Rim Tai sub-district, Mae Rim district, Chiang Mai
9		**Coffee1** (Fora Bee) **Description**: The coffee honey was produced from the nectar of coffee flower in the mountain area of Northern Thailand.

10		**Coffee2** (Fifth Month Honey) **Description**: The honey that was produce from coffee flower.
11		**Wild1** (Fora Bee) **Description**: The wild flower honey was produced from the nectar of wild flower/ siam weed flower in the mountain area of Northern Thailand.
12		**Wild2** (Ambrosia) **Description**: The wild flower honey was produced from Nan.
13		**Sunflower1** (Good.b) **Description**: Pure sunflower honey from Lopburi; the best source of sunflower honey in Thailand.
14		**Sunflower2** (Sa-ard Bee Farm) **Description**: The sunflower honey from Phatthana Nikom sub-district, Phatthana Nikom district, Lopburi. This honey is certified with OTOP.

15		**Macadamia** (Doi Tung) **Description**: The macadamia honey from Chiang Rai which macadamia honey can be only collected in January to March.
16		**Stingless** (KMUTT) **Description**: The honey that was produced by stingless with unidentified floral type.
17		**Cerana** (KMUTT) **Description**: The honey that was produced by *Apis cerana* or eastern honey bee with unidentified floral type.
18		**Florea** (KMUTT) **Description**: The honey that was produced by *Apis florea* or dwarf honey bee with unidentified floral type.
19		**Center** (Sa-ard Bee Farm) **Description**: The multi-floral honey from Phatthana Nikom sub-district, Phatthana Nikom district, Lopburi. This honey is certified with OTOP.

20		**North** (Fifth Month Honey - Giant Bee) **Description**: The raw wild forest honey from giant honey bee in the forest at Mae Hong Son.
21		**East** (Arun) **Description**: The honey from Khitchakut Honey Community Enterprise, Chakthai sub-district, Khao Khitchakut District, Chanthaburi.
22		**West** (Cobbie Brown) **Description**: The natural honey that was produced from the flower of Western Thailand for example Manilkara hexandra.
23		**South** (No brand from Nakornsrithammarat) **Description**: The raw honey from the forest area of Nakornsrithammarat which not pass any treatment.
24		**North East** (OTOP Gallery Ploenchit) **Description**: The multi-floral honey from Dan Sai district, Loei

25		**Chitralada** (Royal Project Chitralada) **Description**: The most well-known brand of Thai honey with unidentified floral type.
26		**Eucalyptus** (Lune de Miel) **Description**: The eucalyptus honey of the most well-known brand from France
27		**Orange** (Lune de Miel) **Description**: The eucalyptus honey of the most well-known brand from France

Figure 38: The 24 Thai honey samples for sorting

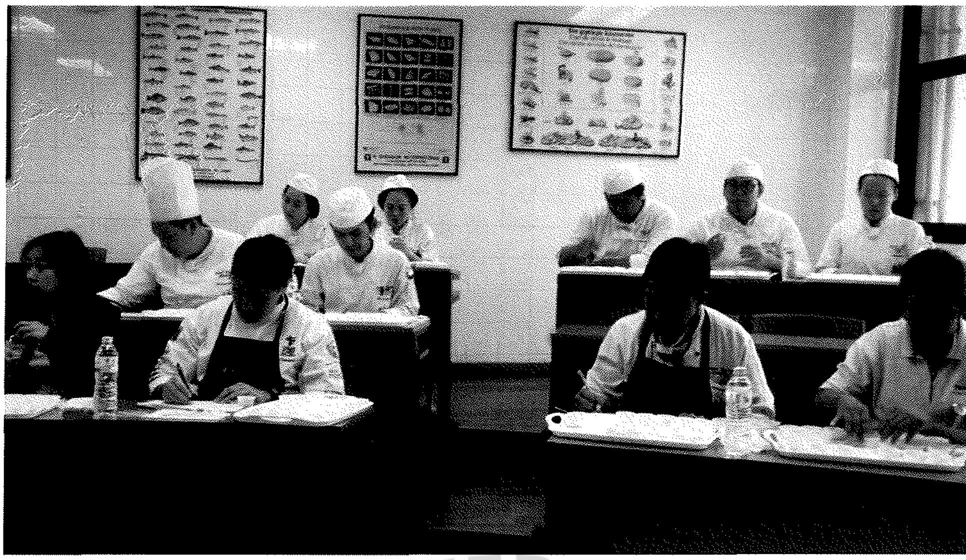


Figure 39: The assessors in culinay group were sorting honeys

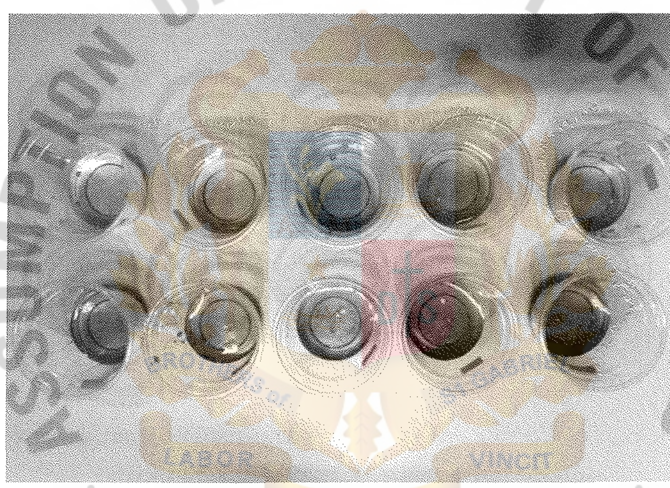


Figure 40: The samples of pure honey and different ratios of mixed honey and glucose syrup.

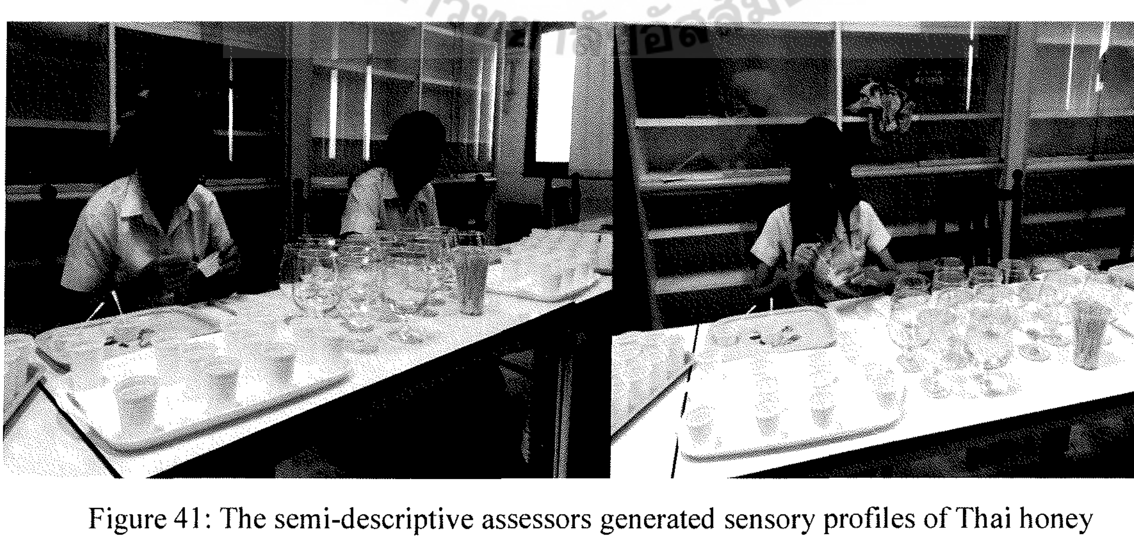


Figure 41: The semi-descriptive assessors generated sensory profiles of Thai honey

QUESTIONNAIRES AND BALLOT

1. Questionnaires for studying consumers' behavior and perspective toward honey

Honey (น้ำผึ้ง)

Instruction: The purpose of this questionnaire is to obtain the information of consumer behavior on honey. Please kindly complete the questions below and carefully give mark ✓ on the ☐ answer(s) based on your opinion

(คำแนะนำ: แบบสอบถามนี้จัดทำขึ้นเพื่อใช้ศึกษาพฤติกรรมของผู้บริโภคที่มีต่อน้ำผึ้ง กรุณาตอบแบบสอบถามด้านล่างโดยการกาเครื่องหมาย ✓ ลง ใน ☐ ตามความคิดเห็นของคุณ)

Part I: Consumer's Behavior (พฤติกรรมของผู้บริโภค)

1.) In the last 6 months, how often did you consume honey in average?
(คุณรับประทานน้ำผึ้งโดยเฉลี่ยบ่อยแค่ไหนภายใน 6 เดือนที่ผ่านมา?)

☐ Everyday (ทุกวัน)
☐ 3-4 times/ week (3-4 ครั้งต่อสัปดาห์)
☐ 1-2 times/ week (1-2 ครั้งต่อสัปดาห์)
☐ 1-2 times/ month (1-2 ครั้งต่อเดือน)
☐ Other, please specify (อื่นๆโปรดระบุ) ....

2.) Which brand of honey have you consumed before? [Check all that apply]
(น้ำผึ้งยี่ห้อไหนที่คุณเคยรับประทาน?) [สามารถเลือกได้มากกว่า 1 คำตอบ]

☐ Vejpong Honey (น้ำผึ้งเวชพงศ์) ☐ Doi Kham (ดอยคำ)
☐ TPA Honey (น้ำผึ้งเทพภักดี) ☐ Chitralada Royal Project (จิตรลดา)
☐ Lune de Miel (ลูนเดอเมล) ☐ Langnese (แลงนีส)
☐ Good.b (กู๊ดบี) ☐ Cannot remember (ไม่สามารถจำได้)
☐ Other, please specify (อื่นๆโปรดระบุ) ....

3.) Do you know the honey that you consumed come from which type of flora? [If "No", skip to question number 6] (คุณทราบหรือไม่ว่าน้ำผึ้งที่คุณรับประทานมาจากดอกไม้ชนิดใด) [ถ้าตอบว่า "ไม่" ข้ามไปที่คำถามข้อที่ 6]

☐ Yes (ใช่) ☐ No (ไม่)

4.) Which type of honey's flora you have had before? [Check all that apply]
(คุณเคยรับประทานน้ำผึ้งจากดอกไม้ชนิดใดบ้าง?) [สามารถเลือกได้มากกว่า 1 คำตอบ]

☐ Longan honey (น้ำผึ้งลำไย) ☐ Lychee honey (น้ำผึ้งลิ้นจี่)
☐ Sunflower Honey (น้ำผึ้งดอกทานตะวัน) ☐ Forest Honey (น้ำผึ้งป่า)
☐ Sesame Honey (น้ำผึ้งดอกงา) ☐ Multi-Floral Honey (น้ำผึ้งดอกไม้หลายชนิด)
☐ Other, please specify (อื่นๆโปรดระบุ) ....

5.) Which type of honey's flora do you like the most?
(คุณชอบน้ำผึ้งจากดอกไม้ชนิดใดมากที่สุด?)

☐ Longan honey (น้ำผึ้งลำไย) ☐ Lychee honey (น้ำผึ้งลิ้นจี่)
☐ Sunflower Honey (น้ำผึ้งดอกทานตะวัน) ☐ Forest Honey (น้ำผึ้งป่า)
☐ Sesame Honey (น้ำผึ้งดอกงา) ☐ Multi-Floral Honey (น้ำผึ้งดอกไม้หลายชนิด)
☐ No preference (ไม่ได้ชอบน้ำผึ้งจากดอกไม้ชนิดใดเป็นพิเศษ)
☐ Other, please specify (อื่นๆโปรดระบุ) ....

6.) Where do you normally buy honey?
(ปกติแล้วคุณซื้อน้ำผึ้งที่ไหน)

☐ Supermarket (ซุปเปอร์มาเก็ต): Home Fresh Mart, Gourmet Market, Tops Supermarket (โฮม เฟรชมาร์ท, กูร์เมต์ มาร์เก็ต, ท็อป ซุปเปอร์มาเก็ต)
☐ Hypermarket (ไฮเปอร์มาเก็ต): Big C, Makro, Lotus (บิ๊กซี, แมคโคร, โลตัส)
☐ Fresh Market (ตลาดสด)
☐ Bee Keeper (คนเลี้ยงผึ้ง)
☐ Other, please specify (อื่นๆโปรดระบุ) ....

7.) What food that you normally **consume with honey**? [Check all that apply]
(ปกติแล้วคุณทานอาหารชนิดใด**คู่กับน้ำผึ้ง**) [สามารถเลือกได้มากกว่า 1 คำตอบ]

Bakery (ขนมปัง)
☐ Waffle (วาฟเฟิล) ☐ Pancake (แพนเค้ก) ☐ Toast (ขนมปังปิ้ง)
☐ Cake (เค้ก) ☐ Crepe (เครป)
☐ Sandwich bread (ขนมปังที่ใช้สำหรับทำแซนด์วิช)

Dessert (ของหวาน)
☐ Ice cream (ไอศครีม) ☐ Shave ice (น้ำแข็งใส) ☐ Bingsu (บิงซู)

Beverage (เครื่องดื่ม)
☐ Fruit juice (น้ำผลไม้) ☐ Coffee (กาแฟ) ☐ Herbal juice (น้ำสมุนไพร)
☐ Tea (ชา) ☐ Milk (นม)

Other
☐ Other, please specify (อื่นๆโปรดระบุ) ....

8.) What food that you normally consume **used honey as an ingredient**? [You can select more than one choice] (ปกติแล้วคุณบริโภคอาหารชนิดใดที่**มีน้ำผึ้งเป็นส่วนประกอบ**) [คุณสามารถเลือกได้มากกว่า 1 คำตอบ]

Bakery (ขนมปัง)
☐ Cake (เค้ก) ☐ Brownie (บราวนี่) ☐ Cookie (คุกกี้)
☐ Crepe (เครป)

Grains (ธัญพืช)
☐ Cereal snack (ขนมซีเรียล) ☐ Energy bar (อาหารแท่งที่ให้พลังงานสูง)
☐ Breakfast cereal (ซีเรียลอาหารเช้า)

Confectionary (ลูกกวาด)

☐ Candy (ลูกอม/ ลูกกวาด) ☐ Chocolate (ช็อคโกแลต)

Dessert (ของหวาน)

☐ Ice cream (ไอศครีม) ☐ Yoghurt (โยเกิร์ต) ☐ Pudding (พุดดิ้ง)

Meat dish (อาหารคาว)

☐ Honey Broiled meat (เนื้อสัตว์อบน้ำผึ้ง) ☐ Honey roasted meat (เนื้อสัตว์ย่างน้ำผึ้ง)

☐ Honey roasted vegetable (ผักย่างน้ำผึ้ง) ☐ Honey roasted seafood (อาหารทะเลย่างน้ำผึ้ง)

Beverage (เครื่องดื่ม)

☐ Coffee (กาแฟ) ☐ Tea (ชา) ☐ Milk (นม)

☐ Alcoholic beverage (เครื่องดื่มแอลกอฮอล์)

Other

☐ Other, please specify (อื่นๆโปรดระบุ) ....

Please give mark ✓ into the box about factor affecting on purchasing honey

(กรุณากาเครื่องหมาย ✓ ลงใน ช่องว่าง เกี่ยวกับปัจจัยที่ส่งผลต่อการซื้อน้ำผึ้ง)

General term (ทั่วไป)

Factors (ปัจจัย)	Level of importance (ระดับของความสำคัญ)				
	Not at all important (ไม่สำคัญ)	Slightly important (สำคัญเล็กน้อย)	Moderately Important (สำคัญปานกลาง)	Very important (สำคัญมาก)	Extremely important (สำคัญที่สุด)
Brand (ยี่ห้อ)					
Price (ราคา)					
Volume (ปริมาตร)					
Source (แหล่งที่มา)					
Safety (ความปลอดภัย)					
Match with specific use/ food (เหมาะกับการใช้งานที่จำเพาะ/ อาหาร)					
Type of packaging (ประเภทของบรรจุภัณฑ์)					
Uniqueness (ความเป็นเอกลักษณ์)					
Sensory quality (คุณภาพทางประสัมผัส)					

Other, please specify (อื่นๆโปรดระบุ)

....

Attributes (คุณลักษณะ)

Factors (ปัจจัย)	Level of importance (ระดับของความสำคัญ)				
	Not at all important (ไม่สำคัญ)	Slightly important (สำคัญเล็กน้อย)	Moderately Important (สำคัญปานกลาง)	Very important (สำคัญมาก)	Extremely important (สำคัญที่สุด)
Color (สี)					
Clarity (ความใส)					
Aroma (กลิ่นเวลาดม)					
Viscosity (ความหนืด)					
Taste (รสชาติ)					
Flavor (กลิ่นเวลารับประทาน)					

Other, please specify (อื่นๆโปรดระบุ)

....

Part II: General Information (ข้อมูลทั่วไป)

1.) Gender (เพศ)

☐ Male (ชาย) ☐ Female (หญิง)

2.) Age (อายุ)

☐ Less than 18 years old (น้อยกว่า 18 ปี) ☐ 18 – 24 years (18 – 24 ปี)
☐ 25 – 34 years (25 – 34 ปี) ☐ 35 – 44 years (35 – 44 ปี)
☐ 45 – 54 years (45 – 54 ปี) ☐ More than 54 years old (มากกว่า 54 ปี)

3.) Level of education (ระดับการศึกษา)

☐ High school or lower (มัธยมศึกษาหรือต่ำกว่า)
☐ Diploma: Vocational certificate/ High vocational certificate (อนุปริญญา: ปวช./ ปวส.)
☐ Bachelor Degree (ปริญญาตรี) ☐ Master Degree or higher (ปริญญาโทหรือสูงกว่า)

4.) Occupation (อาชีพ)

☐ Student (นักเรียน/ นักศึกษา) ☐ Company employee (พนักงานบริษัท/ ลูกจ้างบริษัท)
☐ Business owner (เจ้าของธุรกิจ) ☐ Teacher (ครู/ อาจารย์)
☐ Government employee (ข้าราชการ) ☐ Housewife/ househusband (พ่อบ้าน/แม่บ้าน)
☐ Other, please specify (อื่นๆโปรดระบุ) ....

5.) Income (รายได้)

☐ Lower than 8,000 baht (ต่ำกว่า 8,000 บาท)

☐ 8,000 – 15,000 baht (8,000 – 15,000 บาท)

☐ 15,001 – 25,000 baht (15,001 – 25,000 บาท)

☐ 25,001 – 35,000 baht (25,001 – 35,000 บาท)

☐ 35,001 – 45,000 baht (35,001 – 45,000 บาท)

☐ More than 45,000 baht (สูงกว่า 45,000 บาท)

6.) Nationality (สัญชาติ)

☐ Thai (ไทย)

☐ Other, please specify (อื่นๆโปรดระบุ) ....

End of the questionnaire, thank you for your participation.

จบแบบสอบถาม ขอบคุณสำหรับความร่วมมือครับ

2. Ballot for sorting Thai honeys

Sorting Honey

Instruction: Twenty-four samples of honey are included in this study. Please observe, smell and taste them, then group the samples according to their similarities. You can make many groups as possible, moreover the amount of sample in each group is unlimited. You can use any criteria to categorize samples except color then describe characteristics of each group. Lastly, please rate the overall-liking of each group of samples based on your preference by using 9-point hedonic scale (the table below) and also answer the question on the last column.

1 - Extremely dislike	2 - Dislike very much	3 - Moderately dislike
4 - Slightly dislike	5 - Neither like or dislike	6 - Slightly like
7 - Moderately like	8 - Like very much	9 - Extremely like

The smell you perceive through your nose = Aroma

The smell while tasting sample is in your mouth = Flavor

คำแนะนำ: น้ำผึ้งทั้งหมดจำนวนยี่สิบสี่ตัวอย่างจะถูกนำมาใช้ในการศึกษาครั้งนี้ โปรด สังเกตุ ดมกลิ่น และชิมตัวอย่างน้ำผึ้ง หลังจากนั้นโปรดจัดกลุ่มตัวอย่างตามความคล้ายคลึงกัน โดยคุณสามารถแบ่งตัวอย่างให้เป็นหลายกลุ่มได้ตามที่คุณต้องการ นอกจากนี้จำนวนตัวอย่างในแต่ละกลุ่มนั้นสามารถมีได้อย่างไม่จำกัด คุณสามารถใช้เกณฑ์ใดๆก็ได้ในการจัดกลุ่มยกเว้นสีของตัวอย่าง กรุณาเขียนคำบรรยายเพื่ออธิบายแต่ละกลุ่มตัวอย่าง สุดท้ายโปรดให้คะแนนโดยรวมของแต่ละกลุ่มตัวอย่างตามตวามชอบของคุณโดยการใช้สเกลความชอบ 9 คะแนน(ตารางด้านล่าง)และกรุณาตอบคำถามที่อยู่ในแถวสุดท้าย

1 - ไม่ชอบมากที่สุด	2 - ไม่ชอบมาก	3 - ไม่ชอบปานกลาง
4 - ไม่ชอบเล็กน้อย	5 - เฉยๆ	6 - ชอบเล็กน้อย
7 - ชอบปานกลาง	8 - ชอบมาก	9 - ชอบมากที่สุด

กลิ่นที่ได้รับจากการดมผ่าจมูกเรียกว่า กลิ่น*(Aroma)

กลิ่นที่ได้รับระหว่างที่ตัวอย่างอยู่ในปากเรียกว่า กลิ่นรส*(Flavor)*

Group กลุ่ม	Sample Code รหัสตัวอย่าง	Characteristic ลักษณะ	Overall Liking ความชอบโดยรวม	Which types of product should be consume/cook with honey in this group? น้ำผึ้งในกลุ่มนี้เหมาะกับการบริโภค/ใช้ปรุงอาหารชนิดใด

3. Ballot for rating intensity of sweetness, sourness, bitterness and saltiness

Name..

Please rate the intensity of each attribute by tasting sample and comparing to the reference (Bold numbers are intensity of the reference)

Set 1

Attributes				
Sweetness **(Ref.= 7, 8.5, 9.5, 10)**				
Sourness **(Ref.= 1.5, 2.5, 3.5)**				
Bitterness **(Ref.= 1.5, 2, 3.5)**				
Saltiness (**Ref.= 1.5)**				

Set 2

Attributes				
Sweetness **(Ref.= 7, 8.5, 9.5, 10)**				
Sourness **(Ref.= 1.5, 2.5, 3.5)**				
Bitterness **(Ref.= 1.5, 2, 3.5)**				
Saltiness (**Ref.= 1.5)**				

Set 3

Attributes				
Sweetness **(Ref.= 7, 8.5, 9.5, 10)**				
Sourness **(Ref.= 1.5, 2.5, 3.5)**				
Bitterness **(Ref.= 1.5, 2, 3.5)**				
Saltiness (**Ref.= 1.5)**				

4. Ballot for rating intensity of plastic, worcester sauce, dried fruit and soy sauce flavors

Name.....................................

Please rate the intensity of each attribute by tasting sample and comparing to the reference (Bold numbers are intensity of the reference)

Set 1

Attributes				
Plastic **(Ref.= 3, 5, 7.5)**				
Worcester Sauce **(Ref.= 4, 5, 7)**				
Dried Fruit **(Ref.= 2, 3, 5)**				
Soy Sauce (**Ref.= 2, 3, 4.5)**				

Set 2

Attributes				
Plastic **(Ref.= 3, 5, 7.5)**				
Worcester Sauce **(Ref.= 4, 5, 7)**				
Dried Fruit **(Ref.= 2, 3, 5)**				
Soy Sauce (**Ref.= 2, 3, 4.5)**				

Set 3

Attributes				
Plastic **(Ref.= 3, 5, 7.5)**				
Worcester Sauce **(Ref.= 4, 5, 7)**				
Dried Fruit **(Ref.= 2, 3, 5)**				
Soy Sauce (**Ref.= 2, 3, 4.5)**				

5. Ballot for rating intensity of molasses, butterscotch, coffee and cotton candy flavors

Name......................................

Please rate the intensity of each attribute by tasting sample and comparing to the reference (Bold numbers are intensity of the reference)

Set 1

Attributes				
Molasses **(Ref.= 4, 7)**				
Butterscotch **(Ref.=4, 6)**				
Coffee **(Ref.= 3,5)**				
Cotton Candy **(Ref.= 2, 4, 6)**				

Set 2

Attributes				
Molasses **(Ref.= 4, 7)**				
Butterscotch **(Ref.=4, 6)**				
Coffee **(Ref.= 3,5)**				
Cotton Candy **(Ref.= 2, 4, 6)**				

Set 3

Attributes				
Molasses **(Ref.= 4, 7)**				
Butterscotch **(Ref.=4, 6)**				
Coffee **(Ref.= 3,5)**				
Cotton Candy **(Ref.= 2, 4, 6)**				

6. Ballot for rating intensity of jasmine, fruit, perfume, flora and wood flavors

Name.......................................

Please rate the intensity of each attribute by tasting sample and comparing to the reference (Bold numbers are intensity of the reference)

Set 1

Attributes				
Jasmine **(Ref.= 2, 5, 7)**				
Fruit **(Ref.= 3, 5.5, 8)**				
Perfume **(Ref.= 2, 4, 5)**				
Flora (**Ref.= 2, 5, 7)**				
Wood (**Ref.= 1, 2, 5)**				

Set 2

Attributes				
Jasmine **(Ref.= 2, 5, 7)**				
Fruit **(Ref.= 3, 5.5, 8)**				
Perfume **(Ref.= 2, 4, 5)**				
Flora (**Ref.= 2, 5, 7)**				
Wood (**Ref.= 1, 2, 5)**				

Set 3

Attributes				
Jasmine **(Ref.= 2, 5, 7)**				
Fruit **(Ref.= 3, 5.5, 8)**				
Perfume **(Ref.= 2, 4, 5)**				
Flora (**Ref.= 2, 5, 7)**				
Wood (**Ref.= 1, 2, 5)**				

7. Ballot for rating intensity of viscosity, and ferment, medicine, herb and iron flavors

Name......................................

Please rate the intensity of each attribute by tasting sample and comparing to the reference (Bold numbers are intensity of the reference)

Set 1

Attributes				
Viscosity (**Ref.= 9, 11, 12, 13**)				
Ferment (**Ref.= 1, 3.5, 5**)				
Medicine (**Ref.= 2, 4, 6**)				
Herb (**Ref.= 2.5, 4, 6**)				
Iron (**Ref.= 1, 4, 6**)				

Set 2

Attributes				
Viscosity (**Ref.= 9, 11, 12, 13**)				
Ferment (**Ref.= 1, 3.5, 5**)				
Medicine (**Ref.= 2, 4, 6**)				
Herb (**Ref.= 2.5, 4, 6**)				
Iron (**Ref.= 1, 4, 6**)				

Set 3

Attributes				
Viscosity (**Ref.= 9, 11, 12, 13**)				
Ferment (**Ref.= 1, 3.5, 5**)				
Medicine (**Ref.= 2, 4, 6**)				
Herb (**Ref.= 2.5, 4, 6**)				
Iron (**Ref.= 1, 4, 6**)				

STATISTICAL ANALYSIS

1. Chi square of questionnaries

1. *Frequency of consumption*

Age

Statistic	DF	Value	Prob
Chi-Square	16	24.8286	0.0729
Likelihood Ratio Chi-Square	16	25.8735	0.0558
Mantel-Haenszel Chi-Square	1	0.0113	0.9153
Phi Coefficient		0.4549	
Contingency Coefficient		0.4140	
Cramer's V		0.2274	
WARNING: 68% of the cells have expected counts less than 5. Chi-Square may not be a valid test.			

Education

Statistic	DF	Value	Prob
Chi-Square	12	10.8742	0.5397
Likelihood Ratio Chi-Square	12	13.8814	0.3083
Mantel-Haenszel Chi-Square	1	4.8476	0.0277
Phi Coefficient		0.3010	
Contingency Coefficient		0.2883	
Cramer's V		0.1738	
WARNING: 70% of the cells have expected counts less than 5. Chi-Square may not be a valid test.			

Gender

Statistic	DF	Value	Prob
Chi-Square	4	8.0608	0.0894
Likelihood Ratio Chi-Square	4	7.9204	0.0945
Mantel-Haenszel Chi-Square	1	4.1505	0.0416
Phi Coefficient		0.2592	
Contingency Coefficient		0.2509	
Cramer's V		0.2592	
WARNING: 30% of the cells have expected counts less than 5. Chi-Square may not be a valid test.			

Income

Statistic	DF	Value	Prob
Chi-Square	20	19.6701	0.4787
Likelihood Ratio Chi-Square	20	26.1195	0.1619
Mantel-Haenszel Chi-Square	1	0.0214	0.8836
Phi Coefficient		0.4049	
Contingency Coefficient		0.3753	
Cramer's V		0.2024	
WARNING: 73% of the cells have expected counts less than 5. Chi-Square may not be a valid test.			

Occupation

Statistic	DF	Value	Prob
Chi-Square	24	19.8462	0.7055
Likelihood Ratio Chi-Square	24	22.2919	0.5618
Mantel-Haenszel Chi-Square	1	1.8169	0.1777
Phi Coefficient		0.4067	
Contingency Coefficient		0.3767	
Cramer's V		0.2033	
WARNING: 83% of the cells have expected counts less than 5. Chi-Square may not be a valid test.			

2. *Brand of honey*

Age

Statistic	DF	Value	Prob
Chi-Square	16	27.6117	0.0352
Likelihood Ratio Chi-Square	16	28.7360	0.0258
Mantel-Haenszel Chi-Square	1	0.5836	0.4449
Phi Coefficient		0.5255	
Contingency Coefficient		0.4652	
Cramer's V		0.2627	
WARNING: 76% of the cells have expected counts less than 5. Chi-Square may not be a valid test.			

Education

Statistic	DF	Value	Prob
Chi-Square	21	14.6904	0.8382
Likelihood Ratio Chi-Square	21	15.4037	0.8022
Mantel-Haenszel Chi-Square	1	0.0904	0.7637
Phi Coefficient		0.2677	
Contingency Coefficient		0.2586	
Cramer's V		0.1546	
WARNING: 72% of the cells have expected counts less than 5. Chi-Square may not be a valid test.			

Gender

Statistic	DF	Value	Prob
Chi-Square	7	6.4270	0.4909
Likelihood Ratio Chi-Square	7	6.7555	0.4548
Mantel-Haenszel Chi-Square	1	1.6312	0.2015
Phi Coefficient		0.1771	
Contingency Coefficient		0.1744	
Cramer's V		0.1771	
WARNING: 44% of the cells have expected counts less than 5. Chi-Square may not be a valid test.			

Income

Statistic	DF	Value	Prob
Chi-Square	35	34.1522	0.5089
Likelihood Ratio Chi-Square	35	41.5818	0.2059
Mantel-Haenszel Chi-Square	1	0.1133	0.7364
Phi Coefficient		0.4082	
Contingency Coefficient		0.3779	
Cramer's V		0.1825	
WARNING: 73% of the cells have expected counts less than 5. Chi-Square may not be a valid test.			

Occupation

Statistic	DF	Value	Prob
Chi-Square	42	44.6373	0.3615
Likelihood Ratio Chi-Square	42	45.5078	0.3282
Mantel-Haenszel Chi-Square	1	0.7371	0.3906
Phi Coefficient		0.4666	
Contingency Coefficient		0.4229	
Cramer's V		0.1905	
WARNING: 79% of the cells have expected counts less than 5. Chi-Square may not be a valid test.			

3. *Awareness of honey floral type*

Age

Statistic	DF	Value	Prob
Chi-Square	4	2.3335	0.6747
Likelihood Ratio Chi-Square	4	2.3486	0.6719
Mantel-Haenszel Chi-Square	1	0.0336	0.8545
Phi Coefficient		0.1394	
Contingency Coefficient		0.1381	
Cramer's V		0.1394	
WARNING: 30% of the cells have expected counts less than 5. Chi-Square may not be a valid test.			

Education

Statistic	DF	Value	Prob
Chi-Square	3	8.8837	0.0309
Likelihood Ratio Chi-Square	3	8.9696	0.0297
Mantel-Haenszel Chi-Square	1	7.2106	0.0072
Phi Coefficient		0.2721	
Contingency Coefficient		0.2625	
Cramer's V		0.2721	
WARNING: 50% of the cells have expected counts less than 5. Chi-Square may not be a valid test.			

Gender

Statistic	DF	Value	Prob
Chi-Square	1	0.1814	0.6702
Likelihood Ratio Chi-Square	1	0.1810	0.6705
Continuity Adj. Chi-Square	1	0.0511	0.8212
Mantel-Haenszel Chi-Square	1	0.1799	0.6715
Phi Coefficient		-0.0386	
Contingency Coefficient		0.0385	
Cramer's V		-0.0386	

Income

Statistic	DF	Value	Prob
Chi-Square	5	11.6536	0.0399
Likelihood Ratio Chi-Square	5	12.0225	0.0345
Mantel-Haenszel Chi-Square	1	4.8596	0.0275
Phi Coefficient		0.3116	
Contingency Coefficient		0.2975	
Cramer's V		0.3116	

Occupation

Statistic	DF	Value	Prob
Chi-Square	6	4.2866	0.6380
Likelihood Ratio Chi-Square	6	4.5139	0.6075
Mantel-Haenszel Chi-Square	1	0.7169	0.3972
Phi Coefficient		0.1890	
Contingency Coefficient		0.1857	
Cramer's V		0.1890	
WARNING: 57% of the cells have expected counts less than 5. Chi-Square may not be a valid test.			

4. *The floral type of honey that consumer aware*

Age

Statistic	DF	Value	Prob
Chi-Square	20	18.7402	0.5388
Likelihood Ratio Chi-Square	20	19.7822	0.4716
Mantel-Haenszel Chi-Square	1	0.0613	0.8044
Phi Coefficient		0.4418	
Contingency Coefficient		0.4041	
Cramer's V		0.2209	
WARNING: 80% of the cells have expected counts less than 5. Chi-Square may not be a valid test.			

Education

Statistic	DF	Value	Prob
Chi-Square	15	7.4292	0.9446
Likelihood Ratio Chi-Square	15	9.2101	0.8663
Mantel-Haenszel Chi-Square	1	0.0335	0.8547
Phi Coefficient		0.2782	
Contingency Coefficient		0.2680	
Cramer's V		0.1606	
WARNING: 75% of the cells have expected counts less than 5. Chi-Square may not be a valid test.			

Gender

Statistic	DF	Value	Prob
Chi-Square	5	9.1542	0.1031
Likelihood Ratio Chi-Square	5	10.2231	0.0692
Mantel-Haenszel Chi-Square	1	2.6076	0.1064
Phi Coefficient		0.3088	
Contingency Coefficient		0.2951	
Cramer's V		0.3088	
WARNING: 50% of the cells have expected counts less than 5. Chi-Square may not be a valid test.			

Income

Statistic	DF	Value	Prob
Chi-Square	25	17.5915	0.8592
Likelihood Ratio Chi-Square	25	19.6409	0.7654
Mantel-Haenszel Chi-Square	1	0.0024	0.9609
Phi Coefficient		0.4281	
Contingency Coefficient		0.3935	
Cramer's V		0.1914	
WARNING: 89% of the cells have expected counts less than 5. Chi-Square may not be a valid test.			

Occupation

Statistic	DF	Value	Prob
Chi-Square	30	29.8355	0.4741
Likelihood Ratio Chi-Square	30	32.3534	0.3513
Mantel-Haenszel Chi-Square	1	0.2120	0.6452
Phi Coefficient		0.5575	
Contingency Coefficient		0.4869	
Cramer's V		0.2493	
WARNING: 86% of the cells have expected counts less than 5. Chi-Square may not be a valid test.			

5. *The floral type of honey that consumer prefer*

Age

Statistic	DF	Value	Prob
Chi-Square	20	10.0782	0.9667
Likelihood Ratio Chi-Square	20	10.2529	0.9634
Mantel-Haenszel Chi-Square	1	0.8518	0.3560
Phi Coefficient		0.4065	
Contingency Coefficient		0.3765	
Cramer's V		0.2032	
WARNING: 90% of the cells have expected counts less than 5. Chi-Square may not be a valid test.			

Education

Statistic	DF	Value	Prob
Chi-Square	15	10.1988	0.8071
Likelihood Ratio Chi-Square	15	11.6953	0.7019
Mantel-Haenszel Chi-Square	1	1.0487	0.3058
Phi Coefficient		0.4089	
Contingency Coefficient		0.3785	
Cramer's V		0.2361	
WARNING: 75% of the cells have expected counts less than 5. Chi-Square may not be a valid test.			

Gender

Statistic	DF	Value	Prob
Chi-Square	5	3.2271	0.6650
Likelihood Ratio Chi-Square	5	3.6389	0.6025
Mantel-Haenszel Chi-Square	1	0.1938	0.6598
Phi Coefficient		0.2300	
Contingency Coefficient		0.2242	
Cramer's V		0.2300	
WARNING: 67% of the cells have expected counts less than 5. Chi-Square may not be a valid test.			

Income

Statistic	DF	Value	Prob
Chi-Square	25	20.5530	0.7172
Likelihood Ratio Chi-Square	25	17.3853	0.8673
Mantel-Haenszel Chi-Square	1	0.0443	0.8332
Phi Coefficient		0.5805	
Contingency Coefficient		0.5020	
Cramer's V		0.2596	
WARNING: 92% of the cells have expected counts less than 5. Chi-Square may not be a valid test.			

Occupation

Statistic	DF	Value	Prob
Chi-Square	30	41.5980	0.0774
Likelihood Ratio Chi-Square	30	24.5616	0.7460
Mantel-Haenszel Chi-Square	1	0.0002	0.9892
Phi Coefficient		0.8258	
Contingency Coefficient		0.6367	
Cramer's V		0.3693	
WARNING: 93% of the cells have expected counts less than 5. Chi-Square may not be a valid test.			

2. *Friedman's test on variables affecting on consumer decision*

1. <u>*Buying factors*</u>

Source	DF	Anova SS	Mean Square	F Value	Pr > F
Consumer	119	0.000000	0.000000	0.00	1.0000
Factors	8	1272.983333	159.122917	37.46	<.0001

Means with the same letter are not significantly different.				
Duncan Grouping		Mean	N	Factors
	A	7.5792	120	Safety
	B	5.5833	120	Source
	B			
	B	5.5375	120	Sensory Quality
	C	4.9000	120	Specified Use
	C			
	C	4.8167	120	Package
	C			
D	C	4.5708	120	Price
D				
D	E	4.1542	120	Volume
D	E			
D	E	4.1417	120	Uniqueness
	E			
	E	3.7167	120	Brand

Level of Factor	N	Rorder	
		Mean	Std Dev
Brand	120	3.71666667	2.08811496
Price	120	4.57083333	1.90785179
Volume	120	4.15416667	1.88402822
Source	120	5.58333333	1.93956303
Safety	120	7.57916667	1.54075698
Specified Use	120	4.90000000	2.08697441
Package	120	4.81666667	1.90855365
Uniqueness	120	4.14166667	1.85864247
Sensory quality	120	5.53750000	2.20023156

2. *Sensory characteristics*

Source	DF	Anova SS	Mean Square	F Value	Pr > F
Consumer	119	0.0000000	0.0000000	0.00	1.0000
Factor	5	192.2458333	38.4491667	25.06	<.0001

Means with the same letter are not significantly different.				
Tukey Grouping		Mean	N	Factor
	A	4.2708	120	Taste
	A			
B	A	4.0542	120	Flavor
B				
B		3.6000	120	Aroma
	C	3.1083	120	Viscosity
	C			
	C	3.0250	120	Clarity
	C			
	C	2.9417	120	Color

Level of Factor	N	Rorder	
		Mean	Std Dev
Color	120	2.94166667	1.13793144
Clarity	120	3.02500000	1.14284401
Aroma	120	3.60000000	1.09927402
Viscosity	120	3.10833333	1.08887293
Taste	120	4.27083333	1.17554892
Flavor	120	4.05416667	1.13721581

3. Sorting technique with different groups of consumers

<u>Non-honey user</u>

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Panelist	29	492.6611111	16.9883142	6.94	<.0001
Honey	23	863.7277778	37.5533816	15.34	<.0001

Means with the same letter are not significantly different.								
Tukey Grouping						**Mean**	**N**	**Honey**
			A			7.3000	30	West
			A					
	B		A			7.0333	30	Wild1
	B		A					
	B		A			6.9667	30	Sunflower1
	B		A					
	B		A			6.8667	30	Longan1
	B		A					
	B		A			6.8000	30	North
	B		A					
	B		A	C		6.6333	30	Sesame2
	B		A	C				
	B		A	C		6.6333	30	Longan2
	B		A	C				
	B	D	A	C		6.5333	30	NorthEast
	B	D	A	C				
	B	D	A	C		6.3333	30	Middle
	B	D	A	C				
E	B	D	A	C		6.2333	30	East
E	B	D	A	C				

Means with the same letter are not significantly different.								
Tukey Grouping						Mean	N	Honey
E	B	D	A	C		6.0333	30	Coffee2
E	B	D	A	C				
E	B	D	A	C	F	5.8333	30	Wild2
E	B	D		C	F			
E	B	D		C	F	5.7333	30	Macadamia
E		D		C	F			
E		D	G	C	F	5.3000	30	Sesame1
E		D	G	C	F			
E		D	G	C	F	5.2667	30	Cerena
E		D	G	C	F			
E		D	G	C	F	5.2333	30	Sunflower2
E		D	G		F			
E		D	G		F	5.1333	30	Forest2
E		D	G		F			
E		D	G		F	5.0667	30	Lychee2
E			G		F			
E			G		F	4.8000	30	Coffee1
E			G		F			
E			G		F	4.8000	30	Lychee1
			G		F			
	H		G		F	4.5333	30	Florea
	H		G					
	H		G			3.9333	30	Forest1
	H		G					
	H		G			3.9000	30	South
	H							
	H					3.1667	30	Stingless

Level of Honey	N	Hedonic	
		Mean	Std Dev
Cerena	30	5.26666667	1.81817137
Coffee1	30	4.80000000	1.86436640
Coffee2	30	6.03333333	2.10882110
East	30	6.23333333	1.83234038
Florea	30	4.53333333	1.81437428
Forest1	30	3.93333333	2.16449936
Forest2	30	5.13333333	1.99539700
Longan1	30	6.86666667	1.16658456
Longan2	30	6.63333333	1.58621939
Lychee1	30	4.80000000	2.28035085
Lychee2	30	5.06666667	1.92861096
Macadamia	30	5.73333333	1.77983597
Middle	30	6.33333333	1.51619609
North	30	6.80000000	1.32352716
NorthEast	30	6.53333333	1.45586408
Sesame1	30	5.30000000	1.93248099
Sesame2	30	6.63333333	1.51960370
South	30	3.90000000	1.98876153
Stingless	30	3.16666667	1.83985257
Sunflower1	30	6.96666667	1.40155907
Sunflower2	30	5.23333333	1.65432210
West	30	7.30000000	1.08754707
Wild1	30	7.03333333	1.06619961
Wild2	30	5.83333333	2.05247258

Regular honey user

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Panelist	29	1137.050000	39.208621	14.82	<.0001
Honey	23	859.616667	37.374638	14.12	<.0001

Means with the same letter are not significantly different.						
Tukey Grouping				Mean	N	Honey
		A		6.9333	30	Longan2
		A				
		A		6.9333	30	Longan1
		A				
B		A		6.8333	30	Sunflower1
B		A				
B		A		6.7667	30	Coffee2
B		A				
B		A		6.7667	30	East
B		A				
B		A		6.7333	30	North
B		A				
B		A		6.7000	30	West
B		A				
B		A	C	6.4667	30	Middle
B		A	C			
B	D	A	C	6.2333	30	NorthEast
B	D	A	C			
B	D	A	C	6.2333	30	Wild2
B	D	A	C			
B	D	A	C	6.1667	30	Sesame2
B	D	A	C			
B	D	A	C	6.0000	30	Wild1
B	D	A	C			

Means with the same letter are not significantly different.							
Tukey Grouping					**Mean**	**N**	**Honey**
E	B	D	A	C	5.8667	30	Sesame1
E	B	D	A	C			
E	B	D	A	C	5.7667	30	Cerena
E	B	D		C			
E	B	D	F	C	5.3000	30	Sunflower2
E		D	F	C			
E	G	D	F	C	5.1333	30	Forest2
E	G	D	F	C			
E	G	D	F	C	5.1000	30	Macadamia
E	G	D	F				
E	G	D	F	H	4.8333	30	Coffee1
E	G	D	F	H			
E	G	D	F	H	4.7333	30	Florea
E	G	D	F	H			
E	G	D	F	H	4.7000	30	Lychee2
E	G		F	H			
E	G		F	H	4.4333	30	Lychee1
	G		F	H			
	G		F	H	3.7667	30	Forest1
	G			H			
	G			H	3.6000	30	South
				H			
				H	3.4000	30	Stingless

Level of Honey	N	Hedonic	
		Mean	Std Dev
Cerena	30	5.76666667	2.06252830
Coffee1	30	4.83333333	2.35010394
Coffee2	30	6.76666667	1.54659433
East	30	6.76666667	1.50134040
Florea	30	4.73333333	2.36254295
Forest1	30	3.76666667	2.22343836
Forest2	30	5.13333333	1.88886635
Longan1	30	6.93333333	1.59597194
Longan2	30	6.93333333	1.59597194
Lychee1	30	4.43333333	2.31462119
Lychee2	30	4.70000000	2.40903472
Macadamia	30	5.10000000	2.21826276
Middle	30	6.46666667	2.06336406
North	30	6.73333333	1.52978099
NorthEast	30	6.23333333	1.88795334
Sesame1	30	5.86666667	2.40306318
Sesame2	30	6.16666667	2.11860939
South	30	3.60000000	2.20657325
Stingless	30	3.40000000	2.31337938
Sunflower1	30	6.83333333	1.74362550
Sunflower2	30	5.30000000	2.21515159
West	30	6.70000000	1.95024313
Wild1	30	6.00000000	2.14957895
Wild2	30	6.23333333	1.83234038

Culinary group

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Panelist	29	644.762500	22.233190	6.04	<.0001
Honey	23	1469.287500	63.882065	17.35	<.0001

Means with the same letter are not significantly different.							
Tukey Grouping					Mean	N	Honey
			A		7.0667	30	Longan1
			A				
			A		7.0333	30	Sunflower1
			A				
	B		A		6.9667	30	Coffee2
	B		A				
	B		A		6.9667	30	West
	B		A				
	B		A		6.9333	30	Longan2
	B		A				
	B		A		6.8667	30	Wild1
	B		A				
	B		A		6.8333	30	NorthEast
	B		A				
	B		A	C	6.6667	30	North
	B		A	C			
	B	D	A	C	6.3667	30	Sesame2
	B	D	A	C			
	B	D	A	C	5.8667	30	Sesame1
	B	D	A	C			
	B	D	A	C	5.8333	30	Wild2
	B	D	A	C			
	B	D	A	C	5.7000	30	East

Means with the same letter are not significantly different.							
Tukey Grouping					Mean	N	Honey
	B	D	A	C			
E	B	D	A	C	5.4333	30	Forest2
E	B	D	A	C			
E	B	D	A	C	5.3667	30	Middle
E	B	D	A	C			
E	B	D	A	C	5.3333	30	Macadamia
E	B	D		C			
E	B	D	F	C	5.1667	30	Cerena
E		D	F	C			
E	G	D	F	C	4.9000	30	Sunflower2
E	G	D	F				
E	G	D	F		4.8333	30	Coffee1
E	G		F				
E	G		F	H	3.8667	30	Lychee2
	G		F	H			
	G		F	H	3.4333	30	Stingless
	G		F	H			
	G		F	H	3.3667	30	Lychee1
	G			H			
	G			H	3.2000	30	Florea
	G			H			
	G			H	3.1667	30	Forest1
				H			
				H	2.5333	30	South

Level of Honey	N	Hedonic	
		Mean	Std Dev
Cerena	30	5.16666667	2.21411356
Coffee1	30	4.83333333	2.65334315
Coffee2	30	6.96666667	1.86590707
East	30	5.70000000	2.24606936
Florea	30	3.20000000	1.86436640
Forest1	30	3.16666667	2.11860939
Forest2	30	5.43333333	2.02881541
Longan1	30	7.06666667	1.91064772
Longan2	30	6.93333333	1.81817137
Lychee1	30	3.36666667	1.90250893
Lychee2	30	3.86666667	2.40306318
Macadamia	30	5.33333333	2.75847701
Middle	30	5.36666667	2.20474931
North	30	6.66666667	2.07336697
NorthEast	30	6.83333333	1.48749577
Sesame1	30	5.86666667	2.12916259
Sesame2	30	6.36666667	2.47028315
South	30	2.53333333	1.88886635
Stingless	30	3.43333333	1.94197435
Sunflower1	30	7.03333333	1.82857271
Sunflower2	30	4.90000000	2.30964992
West	30	6.96666667	1.75151822
Wild1	30	6.86666667	1.99539700
Wild2	30	5.83333333	2.30566519

4. Comparing number of words between each group

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Panelists	29	898.4888889	30.9823755	1.65	0.0521
Group	2	151.3555556	75.6777778	4.04	0.0228

Means with the same letter are not significantly different.			
t Grouping	**Mean**	**N**	**Group**
A	12.867	30	Regular honey user
A			
A	12.167	30	Non-honey user
B	9.833	30	Culinary group

Level of Group	N	Words	
		Mean	**Std Dev**
Culinary group	30	9.8333333	2.67920901
Non-honey user	30	12.1666667	5.01090764
Regular honey user	30	12.8666667	6.01568830

5. Performance of the assessors from the training (Performance checking based on last session of training for each sets of attributes)

Session 15: Sweetness, sourness, bitterness and saltiness

Sweetness

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Product	5	5.39236111	1.07847222	3.99	0.0034
Panelist	5	4.80902778	0.96180556	3.56	0.0069
Rep	1	0.08680556	0.08680556	0.32	0.5729

Means with the same letter are not significantly different.				
Duncan Grouping		Mean	N	Product
	A	8.1250	12	Macadamia
	A			
B	A	7.7500	12	Stingless
B	A			
B	A	7.7083	12	Lychee2
B				
B		7.5417	12	Forest1
B				
B		7.3333	12	Longan1
B				
B		7.3333	12	Coffee2

Level of Product	N	Sweet	
		Mean	Std Dev
Coffee2	12	7.33333333	0.61545745
Forest1	12	7.54166667	0.45016832
Longan1	12	7.33333333	0.74873631
Lychee2	12	7.70833333	0.65568609
Macadamia	12	8.12500000	0.43301270
Stingless	12	7.75000000	0.39886202

Sourness

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Product	5	63.55902778	12.71180556	70.31	<.0001
Panelist	5	3.22569444	0.64513889	3.57	0.0068
Rep	1	0.28125000	0.28125000	1.56	0.2171

Means with the same letter are not significantly different.			
Duncan Grouping	**Mean**	**N**	**Product**
A	3.3333	12	Stingless
B	1.1250	12	Forest1
B			
B	1.0000	12	Lychee2
B			
B	0.9583	12	Macadamia
B			
B	0.8333	12	Longan1
C	0.4583	12	Coffee2

Level of Product	N	Sour	
		Mean	**Std Dev**
Coffee2	12	0.45833333	0.45016832
Forest1	12	1.12500000	0.60771554
Longan1	12	0.83333333	0.49236596
Lychee2	12	1.00000000	0.30151134
Macadamia	12	0.95833333	0.49810246
Stingless	12	3.33333333	0.38924947

Bitterness

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Product	5	25.65277778	5.13055556	12.13	<.0001
Panelist	5	5.90277778	1.18055556	2.79	0.0248
Rep	1	0.88888889	0.88888889	2.10	0.1523

Means with the same letter are not significantly different.				
Duncan Grouping		**Mean**	**N**	**Product**
	A	1.7917	12	Lychee2
	A			
	A	1.5000	12	Forest1
	B	0.7917	12	Macadamia
	B			
C	B	0.4167	12	Longan1
C	B			
C	B	0.3750	12	Coffee2
C				
C		0.2083	12	Stingless

Level of Product	N	Bitter	
		Mean	**Std Dev**
Coffee2	12	0.37500000	0.22613351
Forest1	12	1.50000000	1.02247472
Longan1	12	0.41666667	0.28867513
Lychee2	12	1.79166667	1.13734806
Macadamia	12	0.79166667	0.58225008
Stingless	12	0.20833333	0.33427896

Saltiness

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Product	5	0.14236111	0.02847222	1.10	0.3709
Panelist	5	1.10069444	0.22013889	8.49	<.0001
Rep	1	0.03125000	0.03125000	1.21	0.2766

Means with the same letter are not significantly different.			
Duncan Grouping	Mean	N	Product
A	0.16667	12	Coffee2
A			
A	0.08333	12	Stingless
A			
A	0.08333	12	Macadamia
A			
A	0.04167	12	Lychee2
A			
A	0.04167	12	Longan1
A			
A	0.04167	12	Forest1

Level of Product	Salty	
	Mean	Std Dev
Coffee2	0.16666667	0.32566947
Forest1	0.04166667	0.14433757
Longan1	0.04166667	0.14433757
Lychee2	0.04166667	0.14433757
Macadamia	0.08333333	0.19462474
Stingless	0.08333333	0.19462474

Session 31: Plastic, worcester sauce, dried fruit and soy sauce flavors

Plastic flavor

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Product	5	152.9303571	30.5860714	22.61	<.0001
Panelist	5	17.0694444	3.4138889	2.52	0.0387
Rep	1	0.0041667	0.0041667	0.00	0.9559

Means with the same letter are not significantly different.				
Duncan Grouping		Mean	N	Product
	A	5.9583	12	Lychee2
	B	2.7917	12	Coffee1
	B			
C	B	2.2083	12	Sesame2
C	B			
C	B	2.0833	12	Cerana
C	B			
C	B	1.9167	12	Longan1
C				
C		1.7083	12	Stingless

Level of Product	N	Plastic	
		Mean	Std Dev
Cerana	12	2.08333333	0.82112266
Coffee1	12	2.79166667	0.89082019
Longan1	12	1.91666667	1.14481704
Lychee2	12	5.95833333	1.69837266
Sesame2	12	2.20833333	0.72168784
Stingless	12	1.70833333	1.65774125

Worcester sauce flavor

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Product	5	38.78452381	7.75690476	13.95	<.0001
Panelist	5	5.32291667	1.06458333	1.91	0.1052
Rep	1	1.50416667	1.50416667	2.71	0.1052

Means with the same letter are not significantly different.				
Duncan Grouping		Mean	N	Product
	A	5.0417	12	Stingless
	B	4.0417	12	Coffee1
	B			
C	B	3.5833	12	Lychee2
C				
C	D	3.2083	12	Cerana
	D			
	D	2.9167	12	Sesame2
	D			
	D	2.8333	12	Longan1

Level of Product	Worcester Sauce	
	Mean	Std Dev
Cerana	3.20833333	0.72168784
Coffee1	4.04166667	0.62005620
Longan1	2.83333333	1.11464086
Lychee2	3.58333333	0.41742355
Sesame2	2.91666667	0.87472940
Stingless	5.04166667	0.75252102

Dried fruit flavor

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Product	5	7.02559524	1.40511905	1.14	0.3482
Panelist	5	10.77777778	2.15555556	1.75	0.1366
Rep	1	0.50416667	0.50416667	0.41	0.5245

Means with the same letter are not significantly different.			
Duncan Grouping	**Mean**	**N**	**Product**
A	4.4583	12	Coffee1
A			
A	4.2917	12	Stingless
A			
A	4.1667	12	Lychee2
A			
A	3.7083	12	Longan1
A			
A	3.6667	12	Cerana
A			
A	3.6250	12	Sesame2

Level of Product	Dried fruit	
	Mean	Std Dev
Cerana	3.66666667	1.37068883
Coffee1	4.45833333	0.62005620
Longan1	3.70833333	1.58771324
Lychee2	4.16666667	1.02985730
Sesame2	3.62500000	0.88227495
Stingless	4.29166667	1.05439197

Soy sauce flavor

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Product	5	9.58750000	1.91750000	2.63	0.0324
Panelist	5	58.95833333	11.79166667	16.17	<.0001
Rep	1	0.20416667	0.20416667	0.28	0.5987

Means with the same letter are not significantly different.				
Duncan Grouping		Mean	N	Product
	A	4.2917	12	Coffee1
	A			
B	A	3.7500	12	Cerana
B	A			
B	A	3.5833	12	Stingless
B				
B		3.4583	12	Lychee2
B				
B		3.2917	12	Sesame2
B				
B		3.1250	12	Longan1

Level of Product	Soy sauce	
	Mean	Std Dev
Cerana	3.75000000	1.03352882
Coffee1	4.29166667	1.28732163
Longan1	3.12500000	1.52442239
Lychee2	3.45833333	0.98761267
Sesame2	3.29166667	1.38921713
Stingless	3.58333333	1.18385605

Session 37: Molasses, butterscotch, coffee and cotton candy flavors

Molasses flavor

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Product	5	7.26736111	1.45347222	1.57	0.1836
Panelist	5	8.35069444	1.67013889	1.80	0.1268
Rep	1	0.00347222	0.00347222	0.00	0.9514

Means with the same letter are not significantly different.			
Duncan Grouping	Mean	N	Product
A	5.2083	12	Coffee1
A			
A	5.1250	12	Cerana
A			
A	4.8750	12	Lychee2
A			
A	4.7917	12	Stingless
A			
A	4.4167	12	Sesame2
A			
A	4.3750	12	Longan1

Level of Product	N	Molasses	
		Mean	Std Dev
Cerana	12	5.12500000	0.95643752
Coffee1	12	5.20833333	0.78213964
Longan1	12	4.37500000	1.18944219
Lychee2	12	4.87500000	0.52764485
Sesame2	12	4.41666667	0.79296146
Stingless	12	4.79166667	1.40548169

Butterscotch flavor

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Product	5	13.76736111	2.75347222	4.15	0.0027
Panelist	5	4.10069444	0.82013889	1.23	0.3041
Rep	1	0.03125000	0.03125000	0.05	0.8290

Means with the same letter are not significantly different.				
Duncan Grouping		**Mean**	**N**	**Product**
	A	5.2500	12	Coffee1
	A			
B	A	4.7083	12	Cerana
B	A			
B	A	4.5833	12	Longan1
B				
B	C	4.3333	12	Sesame2
B	C			
B	C	4.2500	12	Lychee2
	C			
	C	3.8333	12	Stingless

Level of Product	N	Butterscotch	
		Mean	**Std Dev**
Cerana	12	4.70833333	0.75252102
Coffee1	12	5.25000000	0.62158156
Longan1	12	4.58333333	1.08362467
Lychee2	12	4.25000000	0.58387421
Sesame2	12	4.33333333	0.68534442
Stingless	12	3.83333333	1.02985730

Coffee flavor

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Product	5	11.62500000	2.32500000	5.59	0.0003
Panelist	5	8.25000000	1.65000000	3.97	0.0036
Rep	1	0.05555556	0.05555556	0.13	0.7160

Means with the same letter are not significantly different.				
Duncan Grouping		Mean	N	Product
	A	2.5000	12	Longan1
	A			
	A	2.2917	12	Lychee2
	A			
B	A	2.0417	12	Coffee1
B	A			
B	A	2.0000	12	Cerana
B				
B	C	1.6250	12	Sesame2
	C			
	C	1.2917	12	Stingless

Level of Product	N	Coffee	
		Mean	Std Dev
Cerana	12	2.00000000	0.73854895
Coffee1	12	2.04166667	0.75252102
Longan1	12	2.50000000	0.79772404
Lychee2	12	2.29166667	0.62005620
Sesame2	12	1.62500000	0.64402851
Stingless	12	1.29166667	0.68947718

Cotton candy flavor

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Product	5	9.86458333	1.97291667	4.80	0.0009
Panelist	5	18.28125000	3.65625000	8.90	<.0001
Rep	1	0.17013889	0.17013889	0.41	0.5224

Means with the same letter are not significantly different.			
Duncan Grouping	**Mean**	**N**	**Product**
A	2.4583	12	Longan1
A			
A	2.4167	12	Coffee1
A			
A	2.2500	12	Sesame2
A			
A	2.2083	12	Cerana
A			
A	1.9167	12	Lychee2
B	1.3750	12	Stingless

Level of Product	N	Cotton candy	
		Mean	Std Dev
Cerana	12	2.20833333	0.86493125
Coffee1	12	2.41666667	0.51492865
Longan1	12	2.45833333	0.89082019
Lychee2	12	1.91666667	0.97312368
Sesame2	12	2.25000000	0.83937206
Stingless	12	1.37500000	0.67840053

Session 41: Jasmine, fruit, perfume , floral, wood flavors

Jasmine flavor

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Product	5	99.14236111	19.82847222	37.07	<.0001
Panelist	5	29.80902778	5.96180556	11.14	<.0001
Rep	1	1.53125000	1.53125000	2.86	0.0959

Means with the same letter are not significantly different.			
Duncan Grouping	**Mean**	**N**	**Product**
A	4.5833	12	Longan1
B	3.1250	12	Sesame2
C	1.8750	12	Cerana
C			
C	1.5833	12	Lychee2
C			
C	1.5417	12	Coffee1
C			
C	1.2500	12	Stingless

Level of Product	N	Jasmine	
		Mean	**Std Dev**
Cerana	12	1.87500000	1.02524942
Coffee1	12	1.54166667	0.68947718
Longan1	12	4.58333333	1.29392520
Lychee2	12	1.58333333	0.70172947
Sesame2	12	3.12500000	1.35050496
Stingless	12	1.25000000	0.50000000

Fruit flavor

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Product	5	15.89236111	3.17847222	5.43	0.0003
Panelist	5	1.80902778	0.36180556	0.62	0.6865
Rep	1	0.17013889	0.17013889	0.29	0.5918

Means with the same letter are not significantly different.			
Duncan Grouping	**Mean**	**N**	**Product**
A	3.2917	12	Stingless
B	2.5000	12	Cerana
B			
B	2.4583	12	Coffee1
B			
B	2.0417	12	Longan1
B			
B	2.0000	12	Sesame2
B			
B	1.9167	12	Lychee2

Level of Product	N	Fruit	
		Mean	Std Dev
Cerana	12	2.50000000	0.52223297
Coffee1	12	2.45833333	0.54181233
Longan1	12	2.04166667	0.89082019
Lychee2	12	1.91666667	0.66855792
Sesame2	12	2.00000000	0.85280287
Stingless	12	3.29166667	0.91597770

Perfume flavor

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Product	5	1.11111111	0.22222222	0.85	0.5182
Panelist	5	14.40277778	2.88055556	11.05	<.0001
Rep	1	0.12500000	0.12500000	0.48	0.4913

Means with the same letter are not significantly different.			
Duncan Grouping	**Mean**	**N**	**Product**
A	1.6250	12	Longan1
A			
A	1.5833	12	Coffee1
A			
A	1.4583	12	Stingless
A			
A	1.3750	12	Sesame2
A			
A	1.3333	12	Lychee2
A			
A	1.2917	12	Cerana

Level of Product	N	Perfume	
		Mean	**Std Dev**
Cerana	12	1.29166667	0.49810246
Coffee1	12	1.58333333	0.76376262
Longan1	12	1.62500000	0.93237234
Lychee2	12	1.33333333	0.57735027
Sesame2	12	1.37500000	0.64402851
Stingless	12	1.45833333	0.54181233

Flora flavor

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Product	5	11.02777778	2.20555556	4.12	0.0028
Panelist	5	15.69444444	3.13888889	5.87	0.0002
Rep	1	0.00000000	0.00000000	0.00	1.0000

Means with the same letter are not significantly different.				
Duncan Grouping		Mean	N	Product
	A	2.9583	12	Longan1
	A			
B	A	2.4167	12	Lychee2
B	A			
B	A	2.4167	12	Cerana
B	A			
B	A	2.4167	12	Sesame2
B				
B		2.2500	12	Coffee1
	C	1.6250	12	Stingless

Level of Product	N	Floral	
		Mean	Std Dev
Cerana	12	2.41666667	0.87472940
Coffee1	12	2.25000000	0.83937206
Longan1	12	2.95833333	1.21465171
Lychee2	12	2.41666667	0.70172947
Sesame2	12	2.41666667	0.76376262
Stingless	12	1.62500000	0.56909018

Wood flavor

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Product	5	29.62500000	5.92500000	12.39	<.0001
Panelist	5	5.62500000	1.12500000	2.35	0.0513
Rep	1	0.05555556	0.05555556	0.12	0.7344

Means with the same letter are not significantly different.				
Duncan Grouping		**Mean**	**N**	**Product**
	A	2.6667	12	Lychee2
	B	1.8750	12	Coffee1
	B			
C	B	1.4167	12	Cerana
C	B			
C	B	1.4167	12	Stingless
C				
C	D	0.8750	12	Sesame2
	D			
	D	0.7500	12	Longan1

Level of Product	N	Wood	
		Mean	**Std Dev**
Cerana	12	1.41666667	0.59670814
Coffee1	12	1.87500000	0.90766934
Longan1	12	0.75000000	0.39886202
Lychee2	12	2.66666667	1.07308674
Sesame2	12	0.87500000	0.56909018
Stingless	12	1.41666667	0.55732043

Session 47: Viscosity, and ferment, medicine herb iron flavors

Viscosity

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Product	5	77.89236111	15.57847222	22.57	<.0001
Panelist	5	4.18402778	0.83680556	1.21	0.3145
Rep	1	3.33680556	3.33680556	4.83	0.0318

Means with the same letter are not significantly different.				
Duncan Grouping		Mean	N	Product
	A	11.7500	12	Coffee1
	A			
B	A	11.4583	12	Lychee2
B	A			
B	A	11.4167	12	Cerana
B				
B		10.9583	12	Longan1
	C	9.7500	12	Sesame2
	D	8.8750	12	Stingless

Level of Product	N	Viscosity	
		Mean	Std Dev
Cerana	12	11.4166667	0.70172947
Coffee1	12	11.7500000	1.05528971
Longan1	12	10.9583333	0.89082019
Lychee2	12	11.4583333	0.65568609
Sesame2	12	9.7500000	0.72299881
Stingless	12	8.8750000	1.04718237

Ferment flavor

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Product	5	19.44444444	3.88888889	6.59	<.0001
Panelist	5	12.61111111	2.52222222	4.27	0.0022
Rep	1	0.01388889	0.01388889	0.02	0.8786

Means with the same letter are not significantly different.				
Duncan Grouping		Mean	N	Product
	A	2.5833	12	Coffee1
	A			
	A	2.5833	12	Stingless
	A			
B	A	2.1667	12	Cerana
B				
B	C	1.7500	12	Sesame2
B	C			
B	C	1.7083	12	Lychee2
	C			
	C	1.1250	12	Longan1

Level of Product	N	Ferment	
		Mean	Std Dev
Cerana	12	2.16666667	1.07308674
Coffee1	12	2.58333333	1.10439892
Longan1	12	1.12500000	0.48265365
Lychee2	12	1.70833333	0.45016832
Sesame2	12	1.75000000	0.62158156
Stingless	12	2.58333333	1.08362467

Medicine flavor

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Product	5	35.78125000	7.15625000	8.63	<.0001
Panelist	5	5.36458333	1.07291667	1.29	0.2784
Rep	1	0.08680556	0.08680556	0.10	0.7474

Means with the same letter are not significantly different.				
Duncan Grouping		**Mean**	**N**	**Product**
	A	3.1667	12	Lychee2
	B	2.0417	12	Coffee1
	B			
C	B	1.7500	12	Cerana
C	B			
C	B	1.3750	12	Sesame2
C	B			
C	B	1.2500	12	Longan1
C				
C		1.0417	12	Stingless

Level of Product	**N**	**Medicine**	
		Mean	**Std Dev**
Cerana	12	1.75000000	0.45226702
Coffee1	12	2.04166667	0.86493125
Longan1	12	1.25000000	0.39886202
Lychee2	12	3.16666667	1.88695683
Sesame2	12	1.37500000	0.48265365
Stingless	12	1.04166667	0.33427896

Herb flavor

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Product	5	1.56944444	0.31388889	1.22	0.3087
Panelist	5	5.15277778	1.03055556	4.02	0.0033
Rep	1	0.01388889	0.01388889	0.05	0.8167

Means with the same letter are not significantly different.			
Duncan Grouping	**Mean**	**N**	**Product**
A	1.6667	12	Stingless
A			
A	1.4167	12	Cerana
A			
A	1.4167	12	Coffee1
A			
A	1.3750	12	Sesame2
A			
A	1.2500	12	Lychee2
A			
A	1.2083	12	Longan1

Level of Product	N	Herb	
		Mean	**Std Dev**
Cerana	12	1.41666667	0.41742355
Coffee1	12	1.41666667	0.51492865
Longan1	12	1.20833333	0.45016832
Lychee2	12	1.25000000	0.33709993
Sesame2	12	1.37500000	0.56909018
Stingless	12	1.66666667	0.88762536

Iron flavor

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Product	5	0.86111111	0.17222222	1.26	0.2935
Panelist	5	1.52777778	0.30555556	2.23	0.0624
Rep	1	0.22222222	0.22222222	1.62	0.2074

Means with the same letter are not significantly different.			
Duncan Grouping	Mean	N	Product
A	1.0417	12	Coffee1
A			
A	1.0417	12	Lychee2
A			
A	0.9167	12	Sesame2
A			
A	0.8333	12	Cerana
A			
A	0.8333	12	Stingless
A			
A	0.7500	12	Longan1

Level of Product	N	Iron	
		Mean	Std Dev
Cerana	12	0.83333333	0.24618298
Coffee1	12	1.04166667	0.49810246
Longan1	12	0.75000000	0.26111648
Lychee2	12	1.04166667	0.62005620
Sesame2	12	0.91666667	0.28867513
Stingless	12	0.83333333	0.24618298

6. Sensory profiles of Thai honey by semi-trained descriptive assessors

Viscosity

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Panel	5	20.8374486	4.1674897	7.29	<.0001
Replication	2	0.2664609	0.1332305	0.23	0.7921
Product	26	707.9053498	27.2271288	47.65	<.0001

Means with the same letter are not significantly different.						
Duncan Grouping				Mean	N	Product
		A		12.3056	18	Coffee2
		A				
		A		12.1944	18	Sunflower1
		A				
		A		12.1111	18	West
		A				
		A		12.0833	18	Longan2
		A				
		A		11.8889	18	North
		B		11.3611	18	G3H7
		B				
C		B		11.1944	18	East
C		B				
C		B	D	10.9722	18	G4H6
C		B	D			
C		B	D	10.9444	18	Macadamia
C		B	D			
C	E	B	D	10.8333	18	Longan1
C	E	B	D			
C	E	B	D	10.8333	18	Center
C	E	B	D			

Means with the same letter are not significantly different.						
Duncan Grouping				Mean	N	Product
C	E	B	D	10.8056	18	Lychee2
C	E		D			
C	E		D	10.7500	18	Coffee1
C	E		D			
C	E	F	D	10.6944	18	Lychee1
	E	F	D			
	E	F	D	10.6111	18	Wild1
	E	F	D			
	E	F	D	10.5278	18	Chitralada
	E	F	D			
	E	F	D	10.5000	18	NorthEast
	E	F	D			
	E	F	D	10.4722	18	Forest2
	E	F				
	E	F		10.2500	18	Wild2
		F				
		F		10.1389	18	Cerana
		G		9.5833	18	Sesame1
		G				
		G		9.4722	18	Sunflower2
		G				
		G		9.4444	18	Sesame2
		H		8.6667	18	Florea
		H				
I		H		8.5000	18	Stingless
I						
I		J		8.0556	18	South
		J				
		J		7.7500	18	Forest1

Level of Product	N	Viscosity	
		Mean	Std Dev
Center	18	10.8333333	0.64168895
Cerana	18	10.1388889	0.63721719
Chitralada	18	10.5277778	0.62947743
Coffee1	18	10.7500000	0.94324222
Coffee2	18	12.3055556	0.82495791
East	18	11.1944444	0.59751665
Florea	18	8.6666667	0.68599434
Forest1	18	7.7500000	0.84453259
Forest2	18	10.4722222	0.83087874
G3H7	18	11.3611111	0.65989205
G4H6	18	10.9722222	0.52782078
Longan1	18	10.8333333	0.85749293
Longan2	18	12.0833333	0.91152748
Lychee1	18	10.6944444	0.85987155
Lychee2	18	10.8055556	0.59751665
Macadamia	18	10.9444444	0.48169092
North	18	11.8888889	0.84983659
NorthEast	18	10.5000000	0.48507125
Sesame1	18	9.5833333	0.80895721
Sesame2	18	9.4444444	0.92177720
South	18	8.0555556	1.05564155
Stingless	18	8.5000000	0.72760688
Sunflower1	18	12.1944444	1.08653373
Sunflower2	18	9.4722222	0.79469236
West	18	12.1111111	0.83235236
Wild1	18	10.6111111	0.58298309
Wild2	18	10.2500000	0.92752041

Sweetness

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Panel	5	39.97942387	7.99588477	23.87	<.0001
Replication	2	0.51337449	0.25668724	0.77	0.4654
Product	26	29.28497942	1.12634536	3.36	<.0001

Means with the same letter are not significantly different.								
Duncan Grouping						Mean	N	Product
			A			8.1944	18	Forest2
			A					
	B		A			8.0000	18	Center
	B		A					
	B		A	C		7.9722	18	Sunflower2
	B		A	C				
	B		A	C		7.9722	18	Chitralada
	B		A	C				
	B	D	A	C		7.9167	18	Longan1
	B	D	A	C				
E	B	D	A	C		7.8611	18	Coffee2
E	B	D	A	C				
E	B	D	A	C		7.8333	18	Sesame2
E	B	D	A	C				
E	B	D	A	C		7.8333	18	Forest1
E	B	D	A	C				
E	B	D	A	C		7.8333	18	Sesame1
E	B	D	A	C				
E	B	D	A	C		7.8056	18	Coffee1
E	B	D	A	C				
E	B	D	A	C		7.8056	18	Lychee2
E	B	D	A	C				
E	B	D	A	C		7.8056	18	Wild2

Means with the same letter are not significantly different.								
Duncan Grouping						Mean	N	Product
E	B	D	A	C				
E	B	D	A	C		7.7778	18	NorthEast
E	B	D	A	C				
E	B	D	A	C		7.7500	18	Wild1
E	B	D		C				
E	B	D	F	C		7.6944	18	South
E	B	D	F	C				
E	B	D	F	C	G	7.6389	18	Lychee1
E	B	D	F	C	G			
E	B	D	F	C	G	7.6111	18	Cerana
E	B	D	F	C	G			
E	B	D	F	C	G	7.5833	18	Macadamia
E		D	F	C	G			
E		D	F	C	G	7.5278	18	East
E		D	F		G			
E		D	F		G	7.5000	18	Longan2
E		D	F		G			
E		D	F		G	7.5000	18	G3H7
E		D	F		G			
E		D	F		G	7.4722	18	G4H6
E			F		G			
E			F		G	7.4167	18	Florea
E			F		G			
E			F		G	7.4167	18	Stingless
			F		G			
			F		G	7.2778	18	West
			F		G			
			F		G	7.2500	18	North
					G			
					G	7.1944	18	Sunflower1

Level of Product	N	Sweetness	
		Mean	Std Dev
Center	18	8.00000000	0.66421116
Cerana	18	7.61111111	0.53013748
Chitralada	18	7.97222222	0.65242133
Coffee1	18	7.80555556	0.82495791
Coffee2	18	7.86111111	0.41322105
East	18	7.52777778	0.65242133
Florea	18	7.41666667	0.73264228
Forest1	18	7.83333333	0.54232614
Forest2	18	8.19444444	0.64486407
G3H7	18	7.50000000	0.90748521
G4H6	18	7.47222222	0.81298691
Longan1	18	7.91666667	0.49259218
Longan2	18	7.50000000	0.54232614
Lychee1	18	7.63888889	0.81899428
Lychee2	18	7.80555556	0.68896531
Macadamia	18	7.58333333	0.69133290
North	18	7.25000000	0.52159258
NorthEast	18	7.77777778	0.57451315
Sesame1	18	7.83333333	0.54232614
Sesame2	18	7.83333333	0.64168895
South	18	7.69444444	0.42491829
Stingless	18	7.41666667	0.57522374
Sunflower1	18	7.19444444	0.76962345
Sunflower2	18	7.97222222	0.62947743
West	18	7.27777778	0.77121413
Wild1	18	7.75000000	0.52159258
Wild2	18	7.80555556	0.54607931

Sourness

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Panel	5	29.19753086	5.83950617	40.11	<.0001
Replication	2	0.13271605	0.06635802	0.46	0.6342
Product	26	93.73148148	3.60505698	24.76	<.0001

Means with the same letter are not significantly different.							
Duncan Grouping					Mean	N	Product
			A		2.8333	18	Stingless
			B		1.2500	18	Sunflower2
			B				
			B		1.2500	18	Cerana
			B				
	C		B		1.1389	18	Florea
	C		B				
	C		B		1.1389	18	Coffee1
	C		B				
	C		B	D	1.0556	18	Sesame1
	C		B	D			
	C		B	D	1.0556	18	Forest1
	C		B	D			
	C		B	D	1.0000	18	Lychee2
	C		B	D			
	C		B	D	0.9722	18	South
	C			D			
	C			D	0.9167	18	Wild1
	C			D			
	C			D	0.9167	18	Lychee1
	C			D			
	C			D	0.9167	18	Macadamia

Means with the same letter are not significantly different.							
Duncan Grouping					Mean	N	Product
	C			D			
	C			D	0.9167	18	NorthEast
	C			D			
	C		E	D	0.8611	18	Forest2
	C		E	D			
	C		E	D	0.8611	18	Wild2
			E	D			
			E	D	0.8333	18	Center
			E	D			
			E	D	0.8333	18	Sesame2
			E	D			
	F		E	D	0.8056	18	Longan1
	F		E	D			
	F	G	E	D	0.7778	18	Chitralada
	F	G	E	D			
H	F	G	E	D	0.7500	18	West
H	F	G	E	D			
H	F	G	E	D	0.7500	18	East
H	F	G	E				
H	F	G	E	I	0.5833	18	Sunflower1
H	F	G		I			
H	F	G		I	0.5278	18	Longan2
H		G		I			
H		G		I	0.5000	18	Coffee2
H		G		I			
H		G		I	0.5000	18	North
H				I			
H				I	0.4722	18	G4H6
				I			
				I	0.4167	18	G3H7

Level of Product	N	Sourness	
		Mean	Std Dev
Center	18	0.83333333	0.42008403
Cerana	18	1.25000000	0.39295262
Chitralada	18	0.77777778	0.42779263
Coffee1	18	1.13888889	0.61370513
Coffee2	18	0.50000000	0.34299717
East	18	0.75000000	0.39295262
Florea	18	1.13888889	0.50890758
Forest1	18	1.05555556	0.45012707
Forest2	18	0.86111111	0.41322105
G3H7	18	0.41666667	0.42874646
G4H6	18	0.47222222	0.43630205
Longan1	18	0.80555556	0.42491829
Longan2	18	0.52777778	0.36267885
Lychee1	18	0.91666667	0.42874646
Lychee2	18	1.00000000	0.42008403
Macadamia	18	0.91666667	0.39295262
North	18	0.50000000	0.38348249
NorthEast	18	0.91666667	0.60024505
Sesame1	18	1.05555556	0.51130999
Sesame2	18	0.83333333	0.42008403
South	18	0.97222222	0.46879766
Stingless	18	2.83333333	0.74754500
Sunflower1	18	0.58333333	0.35355339
Sunflower2	18	1.25000000	0.46177407
West	18	0.75000000	0.42874646
Wild1	18	0.91666667	0.42874646
Wild2	18	0.86111111	0.41322105

Bitterness

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Panel	5	39.17901235	7.83580247	45.45	<.0001
Replication	2	0.09567901	0.04783951	0.28	0.7578
Product	26	70.80555556	2.72329060	15.80	<.0001

Means with the same letter are not significantly different.								
Duncan Grouping						Mean	N	Product
			A			1.6667	18	Lychee2
			A					
			A			1.6111	18	Lychee1
			A					
			A			1.4722	18	Forest1
			A					
			A			1.4722	18	Macadamia
			B			1.1389	18	South
			B					
	C		B			1.0556	18	Chitralada
	C		B					
	C		B			1.0278	18	Cerana
	C		B					
	C		B	D		0.9722	18	NorthEast
	C		B	D				
	C	E	B	D		0.9444	18	Forest2
	C	E	B	D				
	C	E	B	D		0.9444	18	Florea
	C	E	B	D				
	C	E	B	D		0.9444	18	Coffee1
	C	E	B	D				
F	C	E	B	D		0.9167	18	Sesame1
F	C	E		D				

Means with the same letter are not significantly different.								
Duncan Grouping						Mean	N	Product
F	C	E	G	D		0.8056	18	West
F	C	E	G	D				
F	C	E	G	D		0.7778	18	Longan1
F	C	E	G	D				
F	C	E	G	D		0.7778	18	Center
F		E	G	D				
F	H	E	G	D		0.6944	18	East
F	H	E	G	D				
F	H	E	G	D	I	0.6667	18	Wild2
F	H	E	G		I			
F	H	E	G	J	I	0.6389	18	Sunflower2
F	H		G	J	I			
F	H	K	G	J	I	0.6111	18	Wild1
F	H	K	G	J	I			
F	H	K	G	J	I	0.6111	18	Sesame2
	H	K	G	J	I			
	H	K	G	J	I	0.5000	18	Coffee2
	H	K		J	I			
	H	K		J	I	0.4167	18	Sunflower1
	H	K		J	I			
	H	K		J	I	0.4167	18	Stingless
	H	K		J	I			
	H	K		J	I	0.4167	18	G3H7
		K		J	I			
		K		J	I	0.3611	18	Longan2
		K		J				
		K		J		0.3333	18	G4H6
		K						
		K				0.3056	18	North

Level of Product	N	Bitterness	
		Mean	Std Dev
Center	18	0.77777778	0.46088860
Cerana	18	1.02777778	0.46879766
Chitralada	18	1.05555556	0.61569876
Coffee1	18	0.94444444	0.48169092
Coffee2	18	0.50000000	0.61834694
East	18	0.69444444	0.42491829
Florea	18	0.94444444	0.56591646
Forest1	18	1.47222222	0.43630205
Forest2	18	0.94444444	0.51130999
G3H7	18	0.41666667	0.49259218
G4H6	18	0.33333333	0.45374261
Longan1	18	0.77777778	0.52080882
Longan2	18	0.36111111	0.33455658
Lychee1	18	1.61111111	0.69780234
Lychee2	18	1.66666667	0.59408853
Macadamia	18	1.47222222	0.55498337
North	18	0.30555556	0.34890117
NorthEast	18	0.97222222	0.46879766
Sesame1	18	0.91666667	0.57522374
Sesame2	18	0.61111111	0.47140452
South	18	1.13888889	0.70305124
Stingless	18	0.41666667	0.54906337
Sunflower1	18	0.41666667	0.35355339
Sunflower2	18	0.63888889	0.33455658
West	18	0.80555556	0.54607931
Wild1	18	0.61111111	0.32338083
Wild2	18	0.66666667	0.45374261

Saltiness

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Panel	5	40.31738683	8.06347737	118.03	<.0001
Replication	2	0.09362140	0.04681070	0.69	0.5045
Product	26	2.08127572	0.08004907	1.17	0.2572

Means with the same letter are not significantly different.					
Duncan Grouping			**Mean**	**N**	**Product**
	A		0.36111	18	Center
	A				
	A		0.36111	18	Forest1
	A				
B	A		0.33333	18	Stingless
B	A				
B	A		0.33333	18	Coffee1
B	A				
B	A		0.33333	18	Sunflower2
B	A				
B	A	C	0.30556	18	Sesame1
B	A	C			
B	A	C	0.30556	18	Cerana
B	A	C			
B	A	C	0.27778	18	Forest2
B	A	C			
B	A	C	0.27778	18	Wild2
B	A	C			
B	A	C	0.27778	18	G3H7
B	A	C			
B	A	C	0.27778	18	Lychee1
B	A	C			
B	A	C	0.25000	18	Florea
B	A	C			

Means with the same letter are not significantly different.					
Duncan Grouping			Mean	N	Product
B	A	C	0.25000	18	Sesame2
B	A	C			
B	A	C	0.25000	18	NorthEast
B	A	C			
B	A	C	0.22222	18	South
B	A	C			
B	A	C	0.22222	18	Longan2
B	A	C			
B	A	C	0.22222	18	Lychee2
B	A	C			
B	A	C	0.22222	18	Sunflower1
B	A	C			
B	A	C	0.22222	18	Longan1
B	A	C			
B	A	C	0.22222	18	Wild1
B	A	C			
B	A	C	0.22222	18	Macadamia
B	A	C			
B	A	C	0.19444	18	Chitralada
B	A	C			
B	A	C	0.16667	18	West
B	A	C			
B	A	C	0.16667	18	Coffee2
B	A	C			
B	A	C	0.16667	18	East
B		C			
B		C	0.13889	18	North
		C			
		C	0.11111	18	G4H6

Level of Product	N	Saltiness	
		Mean	Std Dev
Center	18	0.36111111	0.44739624
Cerana	18	0.30555556	0.38877216
Chitralada	18	0.19444444	0.30384249
Coffee1	18	0.33333333	0.48507125
Coffee2	18	0.16666667	0.29704426
East	18	0.16666667	0.38348249
Florea	18	0.25000000	0.39295262
Forest1	18	0.36111111	0.47914002
Forest2	18	0.27777778	0.42779263
G3H7	18	0.27777778	0.49176220
G4H6	18	0.11111111	0.27415944
Longan1	18	0.22222222	0.35239609
Longan2	18	0.22222222	0.52080882
Lychee1	18	0.27777778	0.35239609
Lychee2	18	0.22222222	0.35239609
Macadamia	18	0.22222222	0.30784938
North	18	0.13888889	0.33455658
NorthEast	18	0.25000000	0.39295262
Sesame1	18	0.30555556	0.45822191
Sesame2	18	0.25000000	0.42874646
South	18	0.22222222	0.35239609
Stingless	18	0.33333333	0.38348249
Sunflower1	18	0.22222222	0.39191169
Sunflower2	18	0.33333333	0.42008403
West	18	0.16666667	0.34299717
Wild1	18	0.22222222	0.35239609
Wild2	18	0.27777778	0.39191169

Perfume flavor

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Panel	5	133.4485597	26.6897119	109.82	<.0001
Replication	2	0.1769547	0.0884774	0.36	0.6950
Product	26	16.2849794	0.6263454	2.58	<.0001

Means with the same letter are not significantly different.									
Duncan Grouping							Mean	N	Product
			A				1.7778	18	South
			A						
	B		A				1.7222	18	Stingless
	B		A						
	B		A				1.7222	18	Chitralada
	B		A						
	B		A				1.7222	18	Macadamia
	B		A						
	B		A		C		1.6389	18	Forest1
	B		A		C				
	B	D	A		C		1.5833	18	Forest2
	B	D	A		C				
	B	D	A		C		1.5833	18	Wild2
	B	D	A		C				
	B	D	A		C		1.5833	18	Sunflower2
	B	D	A		C				
E	B	D	A		C		1.5556	18	Florea
E	B	D	A		C				
E	B	D	A		C		1.5556	18	Coffee1
E	B	D	A		C				
E	B	D	A		C		1.5556	18	Longan1
E	B	D	A		C				
E	B	D	A		C	F	1.5000	18	Center

Means with the same letter are not significantly different.									
Duncan Grouping							Mean	N	Product
E	B	D	A		C	F			
E	B	D	A	G	C	F	1.4722	18	Sesame1
E	B	D	A	G	C	F			
E	B	D	A	G	C	F	1.4722	18	Lychee1
E	B	D	A	G	C	F			
E	B	D	A	G	C	F	1.4444	18	Lychee2
E	B	D	A	G	C	F			
E	B	D	A	G	C	F	1.4167	18	Cerana
E	B	D	A	G	C	F			
E	B	D	A	G	C	F	1.4167	18	Wild1
E	B	D	A	G	C	F			
E	B	D	A	G	C	F	1.4167	18	NorthEast
E	B	D	A	G	C	F			
E	B	D	A	G	C	F	1.4167	18	East
E	B	D	A	G	C	F			
E	B	D	A	G	C	F	1.3889	18	West
E	B	D		G	C	F			
E	B	D		G	C	F	1.3333	18	Coffee2
E	B	D		G	C	F			
E	B	D		G	C	F	1.3333	18	Sesame2
E		D		G	C	F			
E		D		G	C	F	1.2500	18	Sunflower1
E		D		G		F			
E		D		G		F	1.1944	18	Longan2
E				G		F			
E				G		F	1.1667	18	G3H7
				G		F			
				G		F	1.1389	18	North
				G					
				G			1.0833	18	G4H6

Level of Product	N	Perfume	
		Mean	Std Dev
Center	18	1.50000000	0.72760688
Cerana	18	1.41666667	0.66972338
Chitralada	18	1.72222222	0.64676167
Coffee1	18	1.55555556	0.63913749
Coffee2	18	1.33333333	0.66421116
East	18	1.41666667	0.64739296
Florea	18	1.55555556	0.59133172
Forest1	18	1.63888889	0.88791818
Forest2	18	1.58333333	0.80895721
G3H7	18	1.16666667	0.82247832
G4H6	18	1.08333333	0.73264228
Longan1	18	1.55555556	0.74535599
Longan2	18	1.19444444	0.75027228
Lychee1	18	1.47222222	0.65242133
Lychee2	18	1.44444444	0.59133172
Macadamia	18	1.72222222	0.79005253
North	18	1.13888889	0.74371001
NorthEast	18	1.41666667	0.87866878
Sesame1	18	1.47222222	0.79469236
Sesame2	18	1.33333333	0.56879646
South	18	1.77777778	0.57451315
Stingless	18	1.72222222	0.87820375
Sunflower1	18	1.25000000	0.69133290
Sunflower2	18	1.58333333	0.75244699
West	18	1.38888889	0.63142126
Wild1	18	1.41666667	0.82693623
Wild2	18	1.58333333	0.79056942

Fruit flavor

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Panel	5	79.95679012	15.99135802	42.45	<.0001
Replication	2	0.86111111	0.43055556	1.14	0.3198
Product	26	93.28703704	3.58796296	9.52	<.0001

Means with the same letter are not significantly different.								
Duncan Grouping						Mean	N	Product
			A			2.5278	18	Stingless
			A					
	B		A			2.1667	18	South
	B							
	B		C			2.0833	18	Florea
	B		C					
	B		C	D		2.0556	18	Wild2
	B		C	D				
	B	E	C	D		2.0278	18	Forest1
	B	E	C	D				
	B	E	C	D		1.9444	18	Sesame1
	B	E	C	D				
F	B	E	C	D		1.8333	18	Coffee1
F	B	E	C	D				
F	B	E	C	D		1.8333	18	Sunflower2
F	B	E	C	D				
F	B	E	C	D	G	1.8056	18	Forest2
F	B	E	C	D	G			
F	B	E	C	D	G	1.8056	18	NorthEast
F	B	E	C	D	G			
F	B	E	C	D	G	1.8056	18	Lychee2
F	B	E	C	D	G			
F	B	E	C	D	G	1.7222	18	Cerana
F	B	E	C	D	G			

Means with the same letter are not significantly different.								
Duncan Grouping						Mean	N	Product
F	B	E	C	D	G	1.7222	18	Center
F		E	C	D	G			
F	H	E	C	D	G	1.6389	18	West
F	H	E		D	G			
F	H	E		D	G	1.5833	18	Macadamia
F	H	E			G			
F	H	E			G	1.5556	18	East
F	H				G			
F	H		I		G	1.4167	18	Chitralada
F	H		I		G			
F	H		I		G	1.4167	18	Lychee1
F	H		I		G			
F	H		I	J	G	1.3889	18	Wild1
F	H		I	J	G			
F	H	K	I	J	G	1.3611	18	Longan1
	H	K	I	J	G			
	H	K	I	J	G	1.3333	18	Sunflower1
	H	K	I	J				
L	H	K	I	J		1.1944	18	Sesame2
L		K	I	J				
L	M	K	I	J		1.0556	18	Longan2
L	M	K		J				
L	M	K		J		0.9444	18	Coffee2
L	M	K						
L	M	K				0.9167	18	North
L	M							
L	M					0.8056	18	G3H7
	M							
	M					0.7222	18	G4H6

Level of Product	N	Fruit	
		Mean	Std Dev
Center	18	1.72222222	0.91107923
Cerana	18	1.72222222	0.92707989
Chitralada	18	1.41666667	0.73264228
Coffee1	18	1.83333333	0.90748521
Coffee2	18	0.94444444	0.61569876
East	18	1.55555556	0.70479219
Florea	18	2.08333333	0.71228712
Forest1	18	2.02777778	0.89889184
Forest2	18	1.80555556	0.78849986
G3H7	18	0.80555556	0.45822191
G4H6	18	0.72222222	0.46088860
Longan1	18	1.36111111	0.53702765
Longan2	18	1.05555556	0.76483156
Lychee1	18	1.41666667	0.77174363
Lychee2	18	1.80555556	0.66727913
Macadamia	18	1.58333333	0.64739296
North	18	0.91666667	0.54906337
NorthEast	18	1.80555556	0.70998941
Sesame1	18	1.94444444	0.70479219
Sesame2	18	1.19444444	0.70998941
South	18	2.16666667	0.61834694
Stingless	18	2.52777778	1.23040192
Sunflower1	18	1.33333333	0.70710678
Sunflower2	18	1.83333333	0.72760688
West	18	1.63888889	0.72366623
Wild1	18	1.38888889	0.65429701
Wild2	18	2.05555556	0.68360827

Flora flavor

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Panel	5	181.9840535	36.3968107	119.59	<.0001
Replication	2	0.2170782	0.1085391	0.36	0.7002
Product	26	39.9732510	1.5374327	5.05	<.0001

Means with the same letter are not significantly different.							
Duncan Grouping					**Mean**	**N**	**Product**
			A		2.2778	18	Sunflower1
			A				
	B		A		2.0278	18	Longan2
	B						
	B		C		1.8889	18	Lychee2
	B		C				
	B		C	D	1.7778	18	West
	B		C	D			
	B	E	C	D	1.7500	18	NorthEast
	B	E	C	D			
	B	E	C	D	1.7500	18	Chitralada
	B	E	C	D			
	B	E	C	D	1.7222	18	Longan1
	B	E	C	D			
	B	E	C	D	1.7222	18	North
	B	E	C	D			
F	B	E	C	D	1.6667	18	Coffee1
F		E	C	D			
F	G	E	C	D	1.5000	18	East
F	G	E	C	D			
F	G	E	C	D	1.5000	18	Macadamia
F	G	E	C	D			
F	G	E	C	D	1.4722	18	Cerana
F	G	E	C	D			

Means with the same letter are not significantly different.							
Duncan Grouping					Mean	N	Product
F	G	E	C	D	1.4722	18	Sesame2
F	G	E		D			
F	G	E		D	1.4167	18	Stingless
F	G	E		D			
F	G	E		D	1.3889	18	South
F	G	E		D			
F	G	E		D	1.3611	18	Sesame1
F	G	E		D			
F	G	E		D	1.3611	18	Center
F	G	E					
F	G	E			1.3333	18	Sunflower2
F	G	E					
F	G	E			1.3333	18	Florea
F	G	E					
F	G	E			1.3056	18	Lychee1
F	G	E					
F	G	E			1.3056	18	Wild2
F	G						
F	G				1.2778	18	Wild1
	G						
	G				1.1944	18	Forest2
	G						
	G				1.1667	18	Forest1
	G						
	G				1.1667	18	Coffee2
	G						
	G				1.1111	18	G3H7
	G						
	G				1.1111	18	G4H6

Level of Product	N	Flora	
		Mean	Std Dev
Center	18	1.36111111	0.83675767
Cerana	18	1.47222222	0.89889184
Chitralada	18	1.75000000	0.52159258
Coffee1	18	1.66666667	0.95486371
Coffee2	18	1.16666667	0.66421116
East	18	1.50000000	0.70710678
Florea	18	1.33333333	0.56879646
Forest1	18	1.16666667	0.70710678
Forest2	18	1.19444444	0.75027228
G3H7	18	1.11111111	0.77754432
G4H6	18	1.11111111	0.75839528
Longan1	18	1.72222222	0.75190390
Longan2	18	2.02777778	1.16911508
Lychee1	18	1.30555556	0.76962345
Lychee2	18	1.88888889	0.97852764
Macadamia	18	1.50000000	0.70710678
North	18	1.72222222	0.92707989
NorthEast	18	1.75000000	0.82693623
Sesame1	18	1.36111111	0.72366623
Sesame2	18	1.47222222	0.81298691
South	18	1.38888889	0.47140452
Stingless	18	1.41666667	0.89524890
Sunflower1	18	2.27777778	1.40610248
Sunflower2	18	1.33333333	0.72760688
West	18	1.77777778	1.22741026
Wild1	18	1.27777778	0.73208450
Wild2	18	1.30555556	0.57237608

Jasmine flavor

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Panel	5	68.5457819	13.7091564	20.25	<.0001
Replication	2	0.1275720	0.0637860	0.09	0.9101
Product	26	323.4547325	12.4405666	18.38	<.0001

Means with the same letter are not significantly different.							
Duncan Grouping					**Mean**	**N**	**Product**
			A		3.9722	18	Sunflower1
			A				
			A		3.6667	18	Longan2
			B		3.1111	18	North
			C		2.2778	18	Chitralada
			C				
			C		2.2778	18	West
			C				
	D		C		2.0278	18	Longan1
	D		C				
	D		C	E	1.9444	18	NorthEast
	D		C	E			
	D	F	C	E	1.6944	18	Sesame2
	D	F		E			
	D	F	G	E	1.5556	18	Lychee2
	D	F	G	E			
	D	F	G	E	1.5278	18	Coffee1
	D	F	G	E			
	D	F	G	E	1.4722	18	G4H6
	D	F	G	E			
H	D	F	G	E	1.4444	18	Macadamia

Means with the same letter are not significantly different.							
Duncan Grouping					Mean	N	Product
H		F	G	E			
H		F	G	E	1.3611	18	East
H		F	G	E			
H		F	G	E	1.3611	18	G3H7
H		F	G	E			
H		F	G	E	1.3611	18	Center
H		F	G				
H		F	G		1.1667	18	Coffee2
H		F	G				
H		F	G		1.1389	18	Wild2
H		F	G				
H		F	G		1.0833	18	Wild1
H		F	G				
H		F	G		1.0556	18	Forest2
H		F	G				
H		F	G		1.0556	18	Sesame1
H			G				
H			G		1.0278	18	Cerana
H			G				
H			G		1.0000	18	Sunflower2
H			G				
H			G		0.9722	18	Lychee1
H			G				
H			G		0.9722	18	Stingless
H			G				
H			G		0.9167	18	Florea
H			G				
H			G		0.8889	18	South
H							
H					0.8056	18	Forest1

Level of Product	N	Jasmine	
		Mean	Std Dev
Center	18	1.36111111	0.72366623
Cerana	18	1.02777778	0.69604391
Chitralada	18	2.27777778	1.15328460
Coffee1	18	1.52777778	0.83087874
Coffee2	18	1.16666667	0.68599434
East	18	1.36111111	0.61370513
Florea	18	0.91666667	0.57522374
Forest1	18	0.80555556	0.48926382
Forest2	18	1.05555556	0.63913749
G3H7	18	1.36111111	0.92044675
G4H6	18	1.47222222	1.03571831
Longan1	18	2.02777778	0.99220821
Longan2	18	3.66666667	1.40377642
Lychee1	18	0.97222222	0.49918234
Lychee2	18	1.55555556	0.78382338
Macadamia	18	1.44444444	0.63913749
North	18	3.11111111	1.49071198
NorthEast	18	1.94444444	0.93759531
Sesame1	18	1.05555556	0.53930481
Sesame2	18	1.69444444	0.76962345
South	18	0.88888889	0.55718715
Stingless	18	0.97222222	0.69604391
Sunflower1	18	3.97222222	1.74450585
Sunflower2	18	1.00000000	0.66421116
West	18	2.27777778	1.36362646
Wild1	18	1.08333333	0.66972338
Wild2	18	1.13888889	0.68181323

Cotton candy flavor

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Panel	5	80.47325103	16.09465021	31.21	<.0001
Replication	2	0.44855967	0.22427984	0.43	0.6476
Product	26	47.34670782	1.82102722	3.53	<.0001

Means with the same letter are not significantly different.							
Duncan Grouping					**Mean**	**N**	**Product**
			A		2.5000	18	West
			A				
	B		A		2.2500	18	Center
	B		A				
	B		A	C	2.1111	18	G4H6
	B		A	C			
	B		A	C	2.0833	18	NorthEast
	B		A	C			
	B		A	C	2.0833	18	North
	B		A	C			
	B		A	C	2.0556	18	Longan2
	B		A	C			
	B	D	A	C	2.0000	18	Sesame2
	B	D	A	C			
	B	D	A	C	2.0000	18	Sunflower1
	B	D		C			
	B	D	E	C	1.9167	18	Wild1
	B	D	E	C			
F	B	D	E	C	1.8889	18	G3H7
F	B	D	E	C			
F	B	D	E	C	1.7500	18	Coffee1
F	B	D	E	C			
F	B	D	E	C	1.7222	18	East

Means with the same letter are not significantly different.							
Duncan Grouping					Mean	N	Product
F	B	D	E	C			
F	B	D	E	C	1.6944	18	Macadamia
F		D	E	C			
F		D	E	C	1.6667	18	Forest2
F		D	E	C			
F		D	E	C	1.6667	18	Longan1
F		D	E	C			
F		D	E	C	1.6389	18	Coffee2
F		D	E	C			
F		D	E	C	1.6389	18	South
F		D	E	C			
F		D	E	C	1.6389	18	Sunflower2
F		D	E	C			
F		D	E	C	1.5833	18	Chitralada
F		D	E	C			
F		D	E	C	1.5833	18	Lychee2
F		D	E	C			
F		D	E	C	1.5833	18	Sesame1
F		D	E	C			
F	G	D	E	C	1.5278	18	Cerana
F	G	D	E				
F	G	D	E		1.4444	18	Lychee1
F	G	D	E				
F	G	D	E		1.4444	18	Forest1
F	G		E				
F	G		E		1.3889	18	Wild2
F	G						
F	G				1.3333	18	Florea
	G						
	G				1.0278	18	Stingless

Level of Product	N	Cotton Candy	
		Mean	Std Dev
Center	18	2.25000000	1.07443556
Cerana	18	1.52777778	0.55498337
Chitralada	18	1.58333333	0.79056942
Coffee1	18	1.75000000	0.64739296
Coffee2	18	1.63888889	0.70305124
East	18	1.72222222	0.97350522
Florea	18	1.33333333	0.51449576
Forest1	18	1.44444444	0.76483156
Forest2	18	1.66666667	0.66421116
G3H7	18	1.88888889	1.11876449
G4H6	18	2.11111111	1.30108050
Longan1	18	1.66666667	0.78590525
Longan2	18	2.05555556	0.90568286
Lychee1	18	1.44444444	0.74535599
Lychee2	18	1.58333333	0.89524890
Macadamia	18	1.69444444	0.51845043
North	18	2.08333333	1.03255822
NorthEast	18	2.08333333	0.69133290
Sesame1	18	1.58333333	0.64739296
Sesame2	18	2.00000000	0.97014250
South	18	1.63888889	0.81899428
Stingless	18	1.02777778	0.71686044
Sunflower1	18	2.00000000	0.72760688
Sunflower2	18	1.63888889	0.56374680
West	18	2.50000000	1.00000000
Wild1	18	1.91666667	0.98890908
Wild2	18	1.38888889	0.55718715

Butterscotch flavor

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Panel	5	359.4814815	71.8962963	96.53	<.0001
Replication	2	2.6141975	1.3070988	1.75	0.1741
Product	26	91.5833333	3.5224359	4.73	<.0001

Means with the same letter are not significantly different.								
Duncan Grouping						Mean	N	Product
			A			4.0833	18	Forest2
			A					
			A			4.0556	18	Center
			A					
	B		A			3.7500	18	Coffee1
	B		A					
	B		A	C		3.7222	18	Sesame1
	B		A	C				
	B		A	C		3.6944	18	Wild2
	B		A	C				
	B	D	A	C		3.6111	18	South
	B	D	A	C				
	B	D	A	C		3.5556	18	West
	B	D	A	C				
E	B	D	A	C		3.5278	18	Coffee2
E	B	D	A	C				
E	B	D	A	C		3.4722	18	Wild1
E	B	D		C				
E	B	D	F	C		3.3611	18	Macadamia
E	B	D	F	C				
E	B	D	F	C		3.3611	18	Longan1
E	B	D	F	C				
E	B	D	F	C	G	3.3056	18	Sesame2

Means with the same letter are not significantly different.								
Duncan Grouping						**Mean**	**N**	**Product**
E	B	D	F	C	G			
E	B	D	F	C	G	3.2778	18	Cerana
E	B	D	F	C	G			
E	B	D	F	C	G	3.2500	18	NorthEast
E	B	D	F	C	G			
E	B	D	F	C	G	3.2222	18	Lychee1
E	B	D	F	C	G			
E	B	D	F	C	G	3.1944	18	Chitralada
E		D	F	C	G			
E		D	F	C	G	3.0556	18	Sunflower1
E		D	F		G			
E		D	F		G	3.0000	18	G3H7
E		D	F		G			
E		D	F		G	3.0000	18	Lychee2
E		D	F		G			
E		D	F		G	2.9444	18	East
E		D	F		G			
E		D	F		G	2.9444	18	Florea
E		D	F		G			
E		D	F		G	2.9167	18	Sunflower2
E		D	F		G			
E		D	F		G	2.9167	18	North
E			F		G			
E			F		G	2.8333	18	Longan2
			F		G			
	H		F		G	2.6667	18	G4H6
	H				G			
	H				G	2.6389	18	Forest1
	H							
	H					2.1389	18	Stingless

Level of Product	N	Butterscotch	
		Mean	Std Dev
Center	18	4.05555556	1.14902630
Cerana	18	3.27777778	1.36362646
Chitralada	18	3.19444444	1.32995897
Coffee1	18	3.75000000	1.20354867
Coffee2	18	3.52777778	1.33363967
East	18	2.94444444	1.58938472
Florea	18	2.94444444	1.70543154
Forest1	18	2.63888889	1.18576800
Forest2	18	4.08333333	1.17885787
G3H7	18	3.00000000	1.46528455
G4H6	18	2.66666667	1.26025208
Longan1	18	3.36111111	1.43286586
Longan2	18	2.83333333	1.30609431
Lychee1	18	3.22222222	1.12749361
Lychee2	18	3.00000000	0.95486371
Macadamia	18	3.36111111	1.10886210
North	18	2.91666667	1.37466573
NorthEast	18	3.25000000	1.21570604
Sesame1	18	3.72222222	1.28592176
Sesame2	18	3.30555556	1.32995897
South	18	3.61111111	1.09215862
Stingless	18	2.13888889	1.02620884
Sunflower1	18	3.05555556	0.83822096
Sunflower2	18	2.91666667	1.17885787
West	18	3.55555556	0.59133172
Wild1	18	3.47222222	0.97727445
Wild2	18	3.69444444	1.16491465

Molasses flavor

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Panel	5	486.9238683	97.3847737	107.78	<.0001
Replication	2	2.0195473	1.0097737	1.12	0.3280
Product	26	123.8590535	4.7638097	5.27	<.0001

Means with the same letter are not significantly different.								
Duncan Grouping						**Mean**	**N**	**Product**
			A			3.9444	18	Forest2
			A					
	B		A			3.6667	18	Coffee1
	B		A					
	B		A			3.6111	18	Sesame1
	B		A					
	B		A			3.6111	18	Cerana
	B		A					
	B		A	C		3.5556	18	Stingless
	B		A	C				
	B	D	A	C		3.3611	18	Center
	B	D	A	C				
E	B	D	A	C		3.2778	18	Florea
E	B	D	A	C				
E	B	D	A	C	F	3.2222	18	Lychee1
E	B	D		C	F			
E	B	D	G	C	F	3.0278	18	Wild2
E	B	D	G	C	F			
E	B	D	G	C	F	3.0278	18	Longan1
E	B	D	G	C	F			
E	B	D	G	C	F	3.0000	18	South
E	B	D	G	C	F			
E	B	D	G	C	F	3.0000	18	Macadamia
E		D	G	C	F			

Means with the same letter are not significantly different.								
Duncan Grouping						Mean	N	Product
E	H	D	G	C	F	2.8611	18	Wild1
E	H	D	G	C	F			
E	H	D	G	C	F	2.8333	18	Lychee2
E	H	D	G		F			
E	H	D	G		F	2.8056	18	West
E	H	D	G		F			
E	H	D	G		F	2.8056	18	Sunflower2
E	H	D	G		F			
E	H	D	G		F	2.7778	18	Sesame2
E	H		G		F			
E	H		G	I	F	2.5556	18	G3H7
E	H		G	I	F			
E	H		G	I	F	2.5556	18	East
E	H		G	I	F			
E	H		G	I	F	2.5278	18	NorthEast
	H		G	I	F			
	H		G	I	F	2.5000	18	Chitralada
	H		G	I	F			
	H		G	I	F	2.4722	18	Forest1
	H		G	I				
	H		G	I		2.4444	18	Coffee2
	H		G	I				
	H		G	I		2.2778	18	North
	H			I				
	H			I		2.2222	18	Sunflower1
	H			I				
	H			I		2.1389	18	G4H6
				I				
				I		1.9722	18	Longan2

Level of Product	N	Molasses	
		Mean	Std Dev
Center	18	3.36111111	1.39120722
Cerana	18	3.61111111	1.30108050
Chitralada	18	2.50000000	1.61791442
Coffee1	18	3.66666667	1.05718828
Coffee2	18	2.44444444	1.40261194
East	18	2.55555556	1.78958497
Florea	18	3.27777778	1.68227981
Forest1	18	2.47222222	1.52886177
Forest2	18	3.94444444	1.50380780
G3H7	18	2.55555556	1.44394159
G4H6	18	2.13888889	1.42256557
Longan1	18	3.02777778	1.63124116
Longan2	18	1.97222222	1.34462134
Lychee1	18	3.22222222	1.11437429
Lychee2	18	2.83333333	1.07100832
Macadamia	18	3.00000000	0.98518437
North	18	2.27777778	1.37436854
NorthEast	18	2.52777778	1.58552480
Sesame1	18	3.61111111	1.45071540
Sesame2	18	2.77777778	1.27443439
South	18	3.00000000	1.37198868
Stingless	18	3.55555556	1.37079720
Sunflower1	18	2.22222222	1.34188434
Sunflower2	18	2.80555556	1.31885522
West	18	2.80555556	1.37347658
Wild1	18	2.86111111	1.16069902
Wild2	18	3.02777778	1.48988967

Coffee flavor

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Panel	5	63.46553498	12.69310700	29.16	<.0001
Replication	2	1.58744856	0.79372428	1.82	0.1626
Product	26	94.82818930	3.64723805	8.38	<.0001

Means with the same letter are not significantly different.										
Duncan Grouping								Mean	N	Product
				A				3.1944	18	Coffee2
				B				2.0278	18	Sunflower1
				B						
	C			B				1.9167	18	West
	C			B						
	C			B		D		1.8889	18	Longan2
	C			B		D				
	C	E		B		D		1.8611	18	NorthEast
	C	E		B		D				
	C	E		B		D		1.8611	18	North
	C	E		B		D				
F	C	E		B		D		1.8333	18	Chitralada
F	C	E		B		D				
F	C	E		B		D	G	1.8056	18	Center
F	C	E		B		D	G			
F	C	E		B	H	D	G	1.6389	18	Sesame2
F	C	E		B	H	D	G			
F	C	E		B	H	D	G	1.5833	18	Macadamia
F	C	E		B	H	D	G			
F	C	E	I	B	H	D	G	1.5556	18	East
F	C	E	I	B	H	D	G			
F	C	E	I	B	H	D	G	1.5278	18	Lychee1
F	C	E	I	B	H	D	G			

Means with the same letter are not significantly different.										
Duncan Grouping								Mean	N	Product
F	C	E	I	B	H	D	G	1.5278	18	Lychee2
F	C	E	I		H	D	G			
F	C	E	I		H	D	G	1.4167	18	Florea
F		E	I		H	D	G			
F		E	I		H	D	G	1.3889	18	Coffee1
F		E	I		H		G			
F		E	I		H		G	1.3611	18	Wild1
F		E	I		H		G			
F		E	I		H		G	1.3611	18	Cerana
F			I		H		G			
F			I	J	H		G	1.3333	18	Forest2
			I	J	H		G			
			I	J	H		G	1.3056	18	G4H6
			I	J	H					
			I	J	H			1.2500	18	Sunflower2
			I	J	H					
			I	J	H			1.2500	18	Sesame1
			I	J	H					
			I	J	H			1.2222	18	Longan1
			I	J	H					
			I	J	H			1.2222	18	G3H7
			I	J	H					
			I	J	H			1.1667	18	Wild2
			I	J	H					
			I	J	H			1.1111	18	Forest1
			I	J						
			I	J				1.0278	18	South
				J						
				J				0.8333	18	Stingless

Level of Product	N	Coffee	
		Mean	Std Dev
Center	18	1.80555556	0.73040861
Cerana	18	1.36111111	0.56374680
Chitralada	18	1.83333333	0.87447463
Coffee1	18	1.38888889	0.60768499
Coffee2	18	3.19444444	0.97224556
East	18	1.55555556	0.87260410
Florea	18	1.41666667	1.07443556
Forest1	18	1.11111111	0.58298309
Forest2	18	1.33333333	0.70710678
G3H7	18	1.22222222	0.86129557
G4H6	18	1.30555556	0.85987155
Longan1	18	1.22222222	0.57451315
Longan2	18	1.88888889	0.97852764
Lychee1	18	1.52777778	0.60566498
Lychee2	18	1.52777778	0.65242133
Macadamia	18	1.58333333	0.80895721
North	18	1.86111111	0.95186436
NorthEast	18	1.86111111	0.80083698
Sesame1	18	1.25000000	0.69133290
Sesame2	18	1.63888889	0.74371001
South	18	1.02777778	0.49918234
Stingless	18	0.83333333	0.38348249
Sunflower1	18	2.02777778	1.10443254
Sunflower2	18	1.25000000	0.62426427
West	18	1.91666667	0.46177407
Wild1	18	1.36111111	0.68181323
Wild2	18	1.16666667	0.48507125

Dried fruit flavor

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Panel	5	116.2124486	23.2424897	62.96	<.0001
Replication	2	0.6213992	0.3106996	0.84	0.4317
Product	26	92.8930041	3.5728079	9.68	<.0001

Means with the same letter are not significantly different.							
Duncan Grouping					Mean	N	Product
			A		2.2778	18	South
			A				
	B		A		2.2222	18	Stingless
	B		A				
	B		A	C	2.1667	18	Sunflower2
	B		A	C			
	B	D	A	C	1.8889	18	Coffee1
	B	D		C			
	B	D	E	C	1.8333	18	Forest2
	B	D	E	C			
	B	D	E	C	1.8056	18	Sesame1
	B	D	E	C			
F	B	D	E	C	1.7778	18	Wild2
F		D	E	C			
F	G	D	E	C	1.7500	18	Forest1
F	G	D	E	C			
F	G	D	E	C	1.7222	18	Florea
F	G	D	E				
F	G	D	E		1.6944	18	Lychee1
F	G	D	E				
F	G	D	E		1.6667	18	Cerana
F	G	D	E				
F	G	D	E	H	1.6111	18	Chitralada
F	G	D	E	H			

Means with the same letter are not significantly different.							
Duncan Grouping					Mean	N	Product
F	G	D	E	H	1.5556	18	Lychee2
F	G	D	E	H			
F	G	D	E	H	1.5556	18	NorthEast
F	G	D	E	H			
F	G	D	E	H	1.4444	18	Center
F	G	D	E	H			
F	G	D	E	H	1.4167	18	Macadamia
F	G		E	H			
F	G	I	E	H	1.3611	18	West
F	G	I	E	H			
F	G	I	E	H	1.3611	18	Longan1
F	G	I		H			
F	G	I	J	H	1.3056	18	Wild1
	G	I	J	H			
	G	I	J	H	1.2778	18	East
	G	I	J	H			
	G	I	J	H	1.2778	18	Sesame2
		I	J	H			
		I	J	H	1.1389	18	Sunflower1
		I	J				
	K	I	J		0.9167	18	Longan2
	K		J				
	K		J		0.8889	18	North
	K		J				
	K		J		0.8611	18	Coffee2
	K						
	K				0.6389	18	G4H6
	K						
	K				0.6111	18	G3H7

Level of Product	N	Dried fruit	
		Mean	Std Dev
Center	18	1.44444444	0.88929729
Cerana	18	1.66666667	0.74754500
Chitralada	18	1.61111111	0.93235243
Coffee1	18	1.88888889	0.86696827
Coffee2	18	0.86111111	0.61370513
East	18	1.27777778	0.54831888
Florea	18	1.72222222	0.84404875
Forest1	18	1.75000000	0.66972338
Forest2	18	1.83333333	0.82247832
G3H7	18	0.61111111	0.60768499
G4H6	18	0.63888889	0.58925565
Longan1	18	1.36111111	0.65989205
Longan2	18	0.91666667	0.64739296
Lychee1	18	1.69444444	0.57237608
Lychee2	18	1.55555556	0.61569876
Macadamia	18	1.41666667	0.79056942
North	18	0.88888889	0.53013748
NorthEast	18	1.55555556	0.90568286
Sesame1	18	1.80555556	0.82495791
Sesame2	18	1.27777778	0.64676167
South	18	2.27777778	0.66911316
Stingless	18	2.22222222	1.01781517
Sunflower1	18	1.13888889	0.70305124
Sunflower2	18	2.16666667	1.42457424
West	18	1.36111111	0.98227760
Wild1	18	1.30555556	0.73040861
Wild2	18	1.77777778	0.77121413

Medicine flavor

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Panel	5	57.75565844	11.55113169	32.56	<.0001
Replication	2	0.28497942	0.14248971	0.40	0.6694
Product	26	85.25102881	3.27888572	9.24	<.0001

Means with the same letter are not significantly different.										
Duncan Grouping								**Mean**	**N**	**Product**
			A					2.2500	18	Lychee2
			A							
	B		A					2.0000	18	Lychee1
	B		A							
	B		A		C			1.8611	18	Forest1
	B				C					
	B		D		C			1.6944	18	Macadamia
	B		D		C					
	B	E	D		C			1.5833	18	South
		E	D		C					
	F	E	D		C			1.5278	18	Coffee1
	F	E	D		C					
G	F	E	D		C			1.4722	18	Florea
G	F	E	D		C					
G	F	E	D		C			1.4722	18	Cerana
G	F	E	D		C					
G	F	E	D		C	H		1.4167	18	West
G	F	E	D		C	H				
G	F	E	D		C	H		1.4167	18	NorthEast
G	F	E	D			H				
G	F	E	D		I	H		1.3056	18	Sunflower2
G	F	E	D		I	H				
G	F	E	D	J	I	H		1.2778	18	Stingless

Means with the same letter are not significantly different.									
Duncan Grouping							**Mean**	**N**	**Product**
G	F	E	D	J	I	H			
G	F	E	D	J	I	H	1.2500	18	Chitralada
G	F	E	D	J	I	H			
G	F	E	D	J	I	H	1.2500	18	Sesame1
G	F	E		J	I	H			
G	F	E		J	I	H	1.1944	18	Forest2
G	F			J	I	H			
G	F		K	J	I	H	1.1111	18	Wild1
G			K	J	I	H			
G	L		K	J	I	H	1.0556	18	Wild2
G	L		K	J	I	H			
G	L		K	J	I	H	1.0278	18	East
	L		K	J	I	H			
	L		K	J	I	H	0.9722	18	Center
	L		K	J	I				
	L		K	J	I		0.9444	18	Sesame2
	L		K	J					
	L		K	J			0.8333	18	Sunflower1
	L		K	J					
	L		K	J			0.8333	18	Longan1
	L		K						
	L		K				0.6944	18	Longan2
	L		K						
	L		K				0.6944	18	Coffee2
	L		K						
	L		K				0.6944	18	North
	L		K						
	L		K				0.6944	18	G3H7
	L								
	L						0.6111	18	G4H6

Level of Product	N	Medicine	
		Mean	Std Dev
Center	18	0.97222222	0.49918234
Cerana	18	1.47222222	0.58087718
Chitralada	18	1.25000000	0.95870624
Coffee1	18	1.52777778	0.79469236
Coffee2	18	0.69444444	0.38877216
East	18	1.02777778	0.52782078
Florea	18	1.47222222	0.62947743
Forest1	18	1.86111111	0.80083698
Forest2	18	1.19444444	0.51845043
G3H7	18	0.69444444	0.57237608
G4H6	18	0.61111111	0.43910188
Longan1	18	0.83333333	0.56879646
Longan2	18	0.69444444	0.51845043
Lychee1	18	2.00000000	0.90748521
Lychee2	18	2.25000000	1.27475488
Macadamia	18	1.69444444	1.22641142
North	18	0.69444444	0.38877216
NorthEast	18	1.41666667	0.54906337
Sesame1	18	1.25000000	0.57522374
Sesame2	18	0.94444444	0.41617618
South	18	1.58333333	0.91152748
Stingless	18	1.27777778	0.49176220
Sunflower1	18	0.83333333	0.42008403
Sunflower2	18	1.30555556	0.62164130
West	18	1.41666667	0.86176972
Wild1	18	1.11111111	0.47140452
Wild2	18	1.05555556	0.59133172

Ferment flavor

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Panel	5	31.05967078	6.21193416	25.32	<.0001
Replication	2	0.00720165	0.00360082	0.01	0.9854
Product	26	86.85596708	3.34061412	13.62	<.0001

Means with the same letter are not significantly different.						
Duncan Grouping				Mean	N	Product
		A		2.5278	18	Stingless
		B		1.8889	18	Coffee1
		B				
C		B		1.6389	18	Forest1
C						
C		D		1.5278	18	South
C		D				
C		D	E	1.4167	18	Cerana
C		D	E			
C		D	E	1.3611	18	Lychee2
C		D	E			
C		D	E	1.3611	18	Sunflower2
C		D	E			
C	F	D	E	1.3333	18	Florea
C	F	D	E			
C	F	D	E	1.3333	18	Lychee1
C	F	D	E			
C	F	D	E	1.3056	18	Forest2
C	F	D	E			
C	F	D	E	1.3056	18	NorthEast
	F	D	E			
	F	D	E	1.2500	18	Macadamia
	F		E			

Means with the same letter are not significantly different.						
Duncan Grouping				**Mean**	**N**	**Product**
	F	G	E	1.1389	18	West
	F	G	E			
	F	G	E	1.1389	18	Sesame1
	F	G	E			
	F	G	E	1.0833	18	Wild2
	F	G	E			
H	F	G	E	1.0278	18	Center
H	F	G	E			
H	F	G	E	1.0278	18	Wild1
H	F	G				
H	F	G	I	0.9444	18	Chitralada
H	F	G	I			
H	F	G	I	0.9444	18	East
H		G	I			
H		G	I	0.8611	18	Sesame2
H		G	I			
H		G	I	0.8333	18	Sunflower1
H		G	I			
H		G	I	0.8333	18	Longan1
H			I			
H			I	0.6667	18	Coffee2
H			I			
H			I	0.6667	18	G4H6
H			I			
H			I	0.6667	18	G3H7
			I			
			I	0.6111	18	North
			I			
			I	0.5833	18	Longan2

Level of Product	N	Ferment	
		Mean	Std Dev
Center	18	1.02777778	0.43630205
Cerana	18	1.41666667	0.52159258
Chitralada	18	0.94444444	0.59133172
Coffee1	18	1.88888889	0.93235243
Coffee2	18	0.66666667	0.38348249
East	18	0.94444444	0.48169092
Florea	18	1.33333333	0.56879646
Forest1	18	1.63888889	0.68181323
Forest2	18	1.30555556	0.54607931
G3H7	18	0.66666667	0.45374261
G4H6	18	0.66666667	0.42008403
Longan1	18	0.83333333	0.34299717
Longan2	18	0.58333333	0.39295262
Lychee1	18	1.33333333	0.51449576
Lychee2	18	1.36111111	0.41322105
Macadamia	18	1.25000000	0.49259218
North	18	0.61111111	0.36604225
NorthEast	18	1.30555556	0.48926382
Sesame1	18	1.13888889	0.61370513
Sesame2	18	0.86111111	0.41322105
South	18	1.52777778	0.65242133
Stingless	18	2.52777778	1.11766856
Sunflower1	18	0.83333333	0.51449576
Sunflower2	18	1.36111111	0.53702765
West	18	1.13888889	0.56374680
Wild1	18	1.02777778	0.31956875
Wild2	18	1.08333333	0.54906337

Plastic flavor

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Panel	5	83.3544239	16.6708848	52.06	<.0001
Replication	2	0.7849794	0.3924897	1.23	0.2945
Product	26	123.5596708	4.7522950	14.84	<.0001

Means with the same letter are not significantly different.						
Duncan Grouping				Mean	N	Product
		A		2.6667	18	Lychee2
		B		2.1667	18	Lychee1
		B				
C		B		1.9167	18	Forest1
C						
C		D		1.6667	18	Macadamia
		D				
E		D		1.4167	18	Cerana
E		D				
E		D		1.3889	18	Stingless
E		D				
E		D		1.3889	18	Coffee1
E		D				
E		D		1.3611	18	NorthEast
E		D				
E		D	F	1.3333	18	Chitralada
E		D	F			
E		D	F	1.3056	18	West
E		D	F			
E		D	F	1.2778	18	South
E			F			
E		G	F	1.1111	18	Forest2

Means with the same letter are not significantly different.						
Duncan Grouping				**Mean**	**N**	**Product**
E		G	F			
E		G	F	1.0833	18	Florea
E		G	F			
E	H	G	F	1.0000	18	Sesame1
E	H	G	F			
E	H	G	F	1.0000	18	Sunflower2
E	H	G	F			
E	H	G	F	0.9722	18	Center
E	H	G	F			
E	H	G	F	0.9722	18	East
	H	G	F			
I	H	G	F	0.8889	18	Sunflower1
I	H	G	F			
I	H	G	F	0.8889	18	Sesame2
I	H	G	F			
I	H	G	F	0.8889	18	Wild1
I	H	G				
I	H	G		0.7778	18	Longan1
I	H	G				
I	H	G		0.7222	18	North
I	H	G				
I	H	G		0.6944	18	Wild2
I	H					
I	H			0.6111	18	Longan2
I						
I				0.5278	18	Coffee2
I						
I				0.5278	18	G4H6
I						
I				0.4722	18	G3H7

Level of Product	N	Plastic	
		Mean	Std Dev
Center	18	0.97222222	0.52782078
Cerana	18	1.41666667	0.77174363
Chitralada	18	1.33333333	1.29478592
Coffee1	18	1.38888889	0.58298309
Coffee2	18	0.52777778	0.46879766
East	18	0.97222222	0.60566498
Florea	18	1.08333333	0.54906337
Forest1	18	1.91666667	0.95870624
Forest2	18	1.11111111	0.53013748
G3H7	18	0.47222222	0.43630205
G4H6	18	0.52777778	0.49918234
Longan1	18	0.77777778	0.57451315
Longan2	18	0.61111111	0.53013748
Lychee1	18	2.16666667	0.87447463
Lychee2	18	2.66666667	1.22474487
Macadamia	18	1.66666667	0.95486371
North	18	0.72222222	0.54831888
NorthEast	18	1.36111111	0.78225834
Sesame1	18	1.00000000	0.54232614
Sesame2	18	0.88888889	0.65429701
South	18	1.27777778	0.73208450
Stingless	18	1.38888889	0.65429701
Sunflower1	18	0.88888889	0.67639954
Sunflower2	18	1.00000000	0.54232614
West	18	1.30555556	0.62164130
Wild1	18	0.88888889	0.43910188
Wild2	18	0.69444444	0.57237608

Worcester sauce flavor

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Panel	5	139.5534979	27.9106996	64.68	<.0001
Replication	2	1.7170782	0.8585391	1.99	0.1379
Product	26	158.2355967	6.0859845	14.10	<.0001

Means with the same letter are not significantly different.								
Duncan Grouping						Mean	N	Product
			A			3.5556	18	Stingless
			B			2.2778	18	Florea
			B					
	C		B			2.2222	18	Cerana
	C		B					
	C		B	D		2.1667	18	Coffee1
	C		B	D				
	C	E	B	D		2.1111	18	South
	C	E	B	D				
F	C	E	B	D		1.8889	18	Lychee2
F	C	E	B	D				
F	C	E	B	D		1.8611	18	Sunflower2
F	C	E	B	D				
F	C	E	B	D	G	1.8056	18	Sesame1
F	C	E	B	D	G			
F	C	E	B	D	G	1.8056	18	Forest1
F	C	E		D	G			
F	C	E	H	D	G	1.7500	18	Macadamia
F		E	H	D	G			
F	I	E	H	D	G	1.6667	18	NorthEast
F	I	E	H		G			
F	I	E	H		G	1.6111	18	Forest2
F	I		H		G			

Means with the same letter are not significantly different.								
Duncan Grouping						Mean	N	Product
F	I		H		G	1.5833	18	Lychee1
F	I		H		G			
F	I		H		G	1.5556	18	Center
F	I		H		G			
F	I		H		G	1.5556	18	Wild2
F	I		H		G			
F	I		H	J	G	1.3889	18	West
F	I		H	J	G			
F	I		H	J	G	1.3889	18	Sesame2
	I		H	J	G			
	I		H	J	G	1.3056	18	Chitralada
	I		H	J				
	I		H	J		1.2778	18	Wild1
	I			J				
	I			J		1.1944	18	North
	I			J				
	I			J		1.1944	18	East
				J				
				J		1.0278	18	Longan1
				J				
				J		0.9722	18	Longan2
				J				
				J		0.9444	18	Sunflower1
				J				
				J		0.8889	18	Coffee2
				J				
				J		0.8889	18	G3H7
				J				
				J		0.8889	18	G4H6

Level of Product	N	Worcester Sauce	
		Mean	Std Dev
Center	18	1.55555556	0.87260410
Cerana	18	2.22222222	1.03216252
Chitralada	18	1.30555556	0.90973314
Coffee1	18	2.16666667	1.00000000
Coffee2	18	0.88888889	0.53013748
East	18	1.19444444	0.73040861
Florea	18	2.27777778	0.95828005
Forest1	18	1.80555556	0.51845043
Forest2	18	1.61111111	0.77754432
G3H7	18	0.88888889	0.86696827
G4H6	18	0.88888889	0.81449291
Longan1	18	1.02777778	0.89889184
Longan2	18	0.97222222	0.73708931
Lychee1	18	1.58333333	0.66972338
Lychee2	18	1.88888889	0.73875005
Macadamia	18	1.75000000	0.80895721
North	18	1.19444444	0.80693481
NorthEast	18	1.66666667	0.76696499
Sesame1	18	1.80555556	0.82495791
Sesame2	18	1.38888889	0.81449291
South	18	2.11111111	1.31233465
Stingless	18	3.55555556	1.10996673
Sunflower1	18	0.94444444	0.63913749
Sunflower2	18	1.86111111	0.98227760
West	18	1.38888889	0.91644382
Wild1	18	1.27777778	0.69074176
Wild2	18	1.55555556	0.93759531

Soy sauce flavor

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Panel	5	143.9012346	28.7802469	91.52	<.0001
Replication	2	0.2438272	0.1219136	0.39	0.6788
Product	26	64.6481481	2.4864672	7.91	<.0001

Means with the same letter are not significantly different.								
Duncan Grouping						**Mean**	**N**	**Product**
			A			2.2222	18	Coffee1
			A					
	B		A			2.1389	18	Florea
	B		A					
	B		A	C		2.0833	18	Stingless
	B		A	C				
	B	D	A	C		1.8333	18	Cerana
	B	D	A	C				
	B	D	A	C		1.8333	18	Macadamia
	B	D	A	C				
E	B	D	A	C		1.8056	18	Forest2
E	B	D		C				
E	B	D		C		1.7500	18	Sesame2
E		D		C				
E		D	F	C		1.6944	18	Center
E		D	F	C				
E		D	F	C		1.6944	18	West
E		D	F	C				
E		D	F	C		1.6667	18	NorthEast
E		D	F					
E	G	D	F			1.6389	18	Sesame1
E	G	D	F					
E	G	D	F			1.6389	18	Lychee1
E	G	D	F					

Means with the same letter are not significantly different.								
Duncan Grouping						Mean	N	Product
E	G	D	F			1.6111	18	Lychee2
E	G	D	F					
E	G	D	F			1.5556	18	Forest1
E	G	D	F					
E	G	D	F			1.5278	18	Sunflower2
E	G	D	F					
E	G	D	F	H		1.5000	18	South
E	G	D	F	H				
E	G	D	F	H	I	1.4444	18	Wild1
E	G		F	H	I			
E	G		F	H	I	1.3611	18	Wild2
	G		F	H	I			
	G		F	H	I	1.2778	18	Chitralada
	G		F	H	I			
	G		F	H	I	1.2500	18	Sunflower1
	G			H	I			
	G		J	H	I	1.1944	18	North
	G		J	H	I			
	G		J	H	I	1.1944	18	East
	G		J	H	I			
	G		J	H	I	1.1944	18	Longan1
			J	H	I			
			J	H	I	1.0833	18	Coffee2
			J		I			
			J		I	1.0556	18	Longan2
			J					
			J			0.8056	18	G3H7
			J					
			J			0.7778	18	G4H6

Level of Product	N	Soy Sauce	
		Mean	Std Dev
Center	18	1.69444444	0.68896531
Cerana	18	1.83333333	0.54232614
Chitralada	18	1.27777778	0.75190390
Coffee1	18	2.22222222	0.82644209
Coffee2	18	1.08333333	0.73264228
East	18	1.19444444	0.75027228
Florea	18	2.13888889	0.65989205
Forest1	18	1.55555556	0.59133172
Forest2	18	1.80555556	1.01661041
G3H7	18	0.80555556	0.62164130
G4H6	18	0.77777778	0.64676167
Longan1	18	1.19444444	0.85987155
Longan2	18	1.05555556	0.85558526
Lychee1	18	1.63888889	0.72366623
Lychee2	18	1.61111111	0.84983659
Macadamia	18	1.83333333	0.82247832
North	18	1.19444444	0.80693481
NorthEast	18	1.66666667	0.87447463
Sesame1	18	1.63888889	0.83675767
Sesame2	18	1.75000000	0.91152748
South	18	1.50000000	0.87447463
Stingless	18	2.08333333	0.57522374
Sunflower1	18	1.25000000	1.00366974
Sunflower2	18	1.52777778	0.55498337
West	18	1.69444444	1.12640617
Wild1	18	1.44444444	0.63913749
Wild2	18	1.36111111	0.81899428

Herb flavor

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Panel	5	90.17746914	18.03549383	101.66	<.0001
Replication	2	0.59259259	0.29629630	1.67	0.1894
Product	26	27.39814815	1.05377493	5.94	<.0001

Means with the same letter are not significantly different.								
Duncan Grouping						Mean	N	Product
			A			1.6389	18	Stingless
			A					
	B		A			1.5000	18	Forest1
	B		A					
	B		A	C		1.3611	18	South
	B		A	C				
	B		A	C		1.3611	18	Lychee2
	B		A	C				
	B		A	C		1.3611	18	Coffee1
	B			C				
	B		D	C		1.3056	18	Florea
	B		D	C				
	B	E	D	C		1.2500	18	Sunflower2
	B	E	D	C				
	B	E	D	C		1.1944	18	Cerana
	B	E	D	C				
	B	E	D	C		1.1944	18	Lychee1
		E	D	C				
	F	E	D	C		1.1667	18	NorthEast
	F	E	D	C				
G	F	E	D	C		1.1389	18	Sesame1
G	F	E	D	C				
G	F	E	D	C	H	1.1111	18	Forest2
G	F	E	D	C	H			

Means with the same letter are not significantly different.								
Duncan Grouping						Mean	N	Product
G	F	E	D	C	H	1.1111	18	Wild1
G	F	E	D	C	H			
G	F	E	D	C	H	1.1111	18	East
G	F	E	D	C	H			
G	F	E	D	C	H	1.0833	18	Wild2
G	F	E	D	C	H			
G	F	E	D	C	H	1.0833	18	Chitralada
G	F	E	D	C	H			
G	F	E	D	C	H	1.0833	18	Macadamia
G	F	E	D		H			
G	F	E	D	I	H	1.0000	18	Center
G	F	E		I	H			
G	F	E		I	H	0.9167	18	West
G	F	E		I	H			
G	F	E		I	H	0.9167	18	Sunflower1
G	F	E		I	H			
G	F	E		I	H	0.9167	18	Sesame2
G	F			I	H			
G	F			I	H	0.8333	18	Coffee2
G				I	H			
G				I	H	0.8056	18	North
				I	H			
				I	H	0.7778	18	Longan1
				I				
				I		0.7500	18	G4H6
				I				
				I		0.7222	18	G3H7
				I				
				I		0.7222	18	Longan2

Level of Product	N	Herb	
		Mean	Std Dev
Center	18	1.00000000	0.48507125
Cerana	18	1.19444444	0.51845043
Chitralada	18	1.08333333	0.66972338
Coffee1	18	1.36111111	0.53702765
Coffee2	18	0.83333333	0.59408853
East	18	1.11111111	0.63142126
Florea	18	1.30555556	0.76962345
Forest1	18	1.50000000	0.61834694
Forest2	18	1.11111111	0.65429701
G3H7	18	0.72222222	0.66911316
G4H6	18	0.75000000	0.64739296
Longan1	18	0.77777778	0.54831888
Longan2	18	0.72222222	0.52080882
Lychee1	18	1.19444444	0.57237608
Lychee2	18	1.36111111	0.50890758
Macadamia	18	1.08333333	0.52159258
North	18	0.80555556	0.38877216
NorthEast	18	1.16666667	0.51449576
Sesame1	18	1.13888889	0.74371001
Sesame2	18	0.91666667	0.57522374
South	18	1.36111111	0.72366623
Stingless	18	1.63888889	0.65989205
Sunflower1	18	0.91666667	0.69133290
Sunflower2	18	1.25000000	0.64739296
West	18	0.91666667	0.64739296
Wild1	18	1.11111111	0.63142126
Wild2	18	1.08333333	0.62426427

Wood flavor

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Panel	5	29.50874486	5.90174897	50.09	<.0001
Replication	2	0.10596708	0.05298354	0.45	0.6381
Product	26	20.57818930	0.79146882	6.72	<.0001

Means with the same letter are not significantly different.						
Duncan Grouping				**Mean**	**N**	**Product**
		A		1.2222	18	Lychee1
		A				
		A		1.2222	18	Forest1
		A				
B		A		1.1667	18	South
B		A				
B		A	C	1.0833	18	Lychee2
B		A	C			
B		A	C	1.0556	18	Florea
B		A	C			
B	D	A	C	1.0278	18	Coffee1
B	D	A	C			
B	D	A	C	1.0278	18	Forest2
B	D	A	C			
B	D	A	C	1.0278	18	Macadamia
B	D	A	C			
B	D	A	C	1.0278	18	Sesame1
B	D	A	C			
B	D	A	C	1.0000	18	Stingless
B	D	A	C			
B	D	A	C	1.0000	18	Center
B	D		C			
B	D	E	C	0.9167	18	Cerana
	D	E	C			

Means with the same letter are not significantly different.						
Duncan Grouping				**Mean**	**N**	**Product**
F	D	E	C	0.8889	18	Chitralada
F	D	E	C			
F	D	E	C	0.8611	18	West
F	D	E	C			
F	D	E	C	0.8611	18	Wild2
F	D	E	C			
F	D	E	C	0.8333	18	Sunflower2
F	D	E				
F	D	E	G	0.7778	18	Wild1
F	D	E	G			
F	D	E	G	0.7778	18	East
F	D	E	G			
F	D	E	G	0.7778	18	Sesame2
F		E	G			
F	H	E	G	0.7222	18	NorthEast
F	H	E	G			
F	H	E	G	0.6667	18	Sunflower1
F	H	E	G			
F	H	E	G	0.6667	18	G3H7
F	H		G			
F	H		G	0.6389	18	Coffee2
F	H		G			
F	H		G	0.6389	18	North
	H		G			
	H		G	0.5556	18	G4H6
	H		G			
	H		G	0.5278	18	Longan1
	H					
	H			0.5000	18	Longan2

Level of Product	N	Wood	
		Mean	Std Dev
Center	18	1.00000000	0.24253563
Cerana	18	0.91666667	0.30917347
Chitralada	18	0.88888889	0.53013748
Coffee1	18	1.02777778	0.43630205
Coffee2	18	0.63888889	0.41322105
East	18	0.77777778	0.30784938
Florea	18	1.05555556	0.33819977
Forest1	18	1.22222222	0.52080882
Forest2	18	1.02777778	0.43630205
G3H7	18	0.66666667	0.38348249
G4H6	18	0.55555556	0.51130999
Longan1	18	0.52777778	0.43630205
Longan2	18	0.50000000	0.38348249
Lychee1	18	1.22222222	0.42779263
Lychee2	18	1.08333333	0.57522374
Macadamia	18	1.02777778	0.36267885
North	18	0.63888889	0.37595195
NorthEast	18	0.72222222	0.35239609
Sesame1	18	1.02777778	0.40118289
Sesame2	18	0.77777778	0.35239609
South	18	1.16666667	0.56879646
Stingless	18	1.00000000	0.45374261
Sunflower1	18	0.66666667	0.34299717
Sunflower2	18	0.83333333	0.38348249
West	18	0.86111111	0.53702765
Wild1	18	0.77777778	0.42779263
Wild2	18	0.86111111	0.44739624

Iron flavor

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Panel	5	37.16460905	7.43292181	54.62	<.0001
Replication	2	0.46090535	0.23045267	1.69	0.1851
Product	26	10.21090535	0.39272713	2.89	<.0001

Means with the same letter are not significantly different.								
Duncan Grouping						Mean	N	Product
			A			1.0833	18	Lychee2
			A					
	B		A			1.0278	18	Forest1
	B		A					
	B		A			1.0278	18	South
	B		A					
	B		A	C		0.9167	18	Lychee1
	B		A	C				
	B	D	A	C		0.8889	18	Florea
	B	D	A	C				
E	B	D	A	C		0.8333	18	Coffee1
E	B	D	A	C				
E	B	D	A	C		0.8333	18	Macadamia
E	B	D	A	C				
E	B	D	A	C	F	0.8056	18	Forest2
E	B	D	A	C	F			
E	B	D	A	C	F	0.8056	18	Sesame1
E	B	D	A	C	F			
E	B	D	A	C	F	0.8056	18	East
E	B	D		C	F			
E	B	D		C	F	0.7500	18	Wild1
E	B	D		C	F			
E	B	D		C	F	0.7500	18	Sunflower2

Means with the same letter are not significantly different.								
Duncan Grouping						Mean	N	Product
E		D		C	F			
E		D		C	F	0.7222	18	Coffee2
E		D		C	F			
E		D		C	F	0.6944	18	Cerana
E		D		C	F			
E		D		C	F	0.6944	18	Sesame2
E		D		C	F			
E		D		C	F	0.6667	18	Chitralada
E		D		C	F			
E		D		C	F	0.6667	18	Longan1
E		D		C	F			
E		D		C	F	0.6389	18	North
E		D		C	F			
E		D		C	F	0.6389	18	West
E		D		C	F			
E		D		C	F	0.6389	18	NorthEast
E		D		C	F			
E		D		C	F	0.6389	18	Stingless
E		D			F			
E		D			F	0.6111	18	G4H6
E		D			F			
E		D			F	0.6111	18	Longan2
E		D			F			
E		D			F	0.6111	18	Sunflower1
E					F			
E					F	0.5833	18	Center
E					F			
E					F	0.5833	18	Wild2
					F			
					F	0.5278	18	G3H7

Level of Product	N	Iron	
		Mean	Std Dev
Center	18	0.58333333	0.30917347
Cerana	18	0.69444444	0.34890117
Chitralada	18	0.66666667	0.54232614
Coffee1	18	0.83333333	0.48507125
Coffee2	18	0.72222222	0.52080882
East	18	0.80555556	0.66727913
Florea	18	0.88888889	0.21389632
Forest1	18	1.02777778	0.67458532
Forest2	18	0.80555556	0.38877216
G3H7	18	0.52777778	0.40118289
G4H6	18	0.61111111	0.40422604
Longan1	18	0.66666667	0.51449576
Longan2	18	0.61111111	0.55718715
Lychee1	18	0.91666667	0.25724788
Lychee2	18	1.08333333	0.80895721
Macadamia	18	0.83333333	0.59408853
North	18	0.63888889	0.47914002
NorthEast	18	0.63888889	0.37595195
Sesame1	18	0.80555556	0.42491829
Sesame2	18	0.69444444	0.34890117
South	18	1.02777778	0.49918234
Stingless	18	0.63888889	0.33455658
Sunflower1	18	0.61111111	0.36604225
Sunflower2	18	0.75000000	0.42874646
West	18	0.63888889	0.41322105
Wild1	18	0.75000000	0.30917347
Wild2	18	0.58333333	0.35355339

7. Physiochemical properties of Thai honeys

Degrees Brix

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Replication	2	0.0061728	0.0030864	0.02	0.9773
Product	26	358.2469136	13.7787274	102.45	<.0001

Means with the same letter are not significantly different.					
Duncan Grouping			Mean	N	Product
	A		81.8333	3	G3H7
	B		80.8333	3	North
	B				
	B		80.8333	3	Sunflower1
	B				
C	B		80.6667	3	East
C	B				
C	B		80.6667	3	Coffee2
C	B				
C	B		80.6667	3	Longan2
C	B				
C	B	D	80.1667	3	West
C		D			
C	E	D	80.0000	3	Coffee1
C	E	D			
C	E	D	80.0000	3	Macadamia
C	E	D			
C	E	D	80.0000	3	G4H6
C	E	D			
C	E	D	80.0000	3	Lychee2
	E	D			
F	E	D	79.6667	3	Wild1

Means with the same letter are not significantly different.					
Duncan Grouping			**Mean**	**N**	**Product**
F	E	D			
F	E	D	79.6667	3	Chitralada
F	E	D			
F	E	D	79.5000	3	NorthEast
F	E	D			
F	E	D	79.5000	3	Center
F	E				
F	E	G	79.3333	3	Longan1
F	E	G			
F	E	G	79.3333	3	Forest2
F		G			
F		G	79.1667	3	Cerana
F		G			
F		G	79.1667	3	Sesame1
F		G			
F		G	79.1667	3	Wild2
F		G			
F		G	79.0000	3	Lychee1
		G			
		G	78.6667	3	Sunflower2
	H		78.0000	3	Sesame2
	I		75.1667	3	Stingless
	J		74.3333	3	Florea
	J				
	J		74.0000	3	Forest1
	J				
	J		73.8333	3	South

Level of Product	N	Brix	
		Mean	Std Dev
Center	3	79.5000000	0.00000000
Cerana	3	79.1666667	0.28867513
Chitralada	3	79.6666667	0.28867513
Coffee1	3	80.0000000	0.00000000
Coffee2	3	80.6666667	0.28867513
East	3	80.6666667	0.76376262
Florea	3	74.3333333	0.28867513
Forest1	3	74.0000000	0.00000000
Forest2	3	79.3333333	0.28867513
G3H7	3	81.8333333	0.28867513
G4H6	3	80.0000000	0.00000000
Longan1	3	79.3333333	0.28867513
Longan2	3	80.6666667	0.28867513
Lychee1	3	79.0000000	0.00000000
Lychee2	3	80.0000000	0.50000000
Macadamia	3	80.0000000	0.00000000
North	3	80.8333333	0.28867513
NorthEast	3	79.5000000	0.50000000
Sesame1	3	79.1666667	0.57735027
Sesame2	3	78.0000000	0.00000000
South	3	73.8333333	0.76376262
Stingless	3	75.1666667	0.28867513
Sunflow1	3	80.8333333	0.28867513
Sunflow2	3	78.6666667	0.57735027
West	3	80.1666667	0.28867513
Wild1	3	79.6666667	0.28867513
Wild2	3	79.1666667	0.28867513

L* value

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Replication	4	0.19762	0.04940	0.00	1.0000
Product	26	39181.89585	1506.99599	97.17	<.0001

Means with the same letter are not significantly different.					
Duncan Grouping			**Mean**	**N**	**Product**
	A		61.424	5	Sunflower2
	A				
B	A		58.272	5	Lychee2
B					
B			54.470	5	Coffee2
B					
B			54.338	5	Sunflower1
	C		48.896	5	East
	C				
D	C		47.764	5	North
D	C				
D	C	E	44.234	5	Macadamia
D	C	E			
D	C	E	43.556	5	Forest2
D		E			
D		E	43.388	5	G4H6
D		E			
D		E	43.218	5	NorthEast
D		E			
D		E	42.322	5	Wild1
		E			
	F	E	41.060	5	Sesame2
	F	E			

Means with the same letter are not significantly different.					
Duncan Grouping			**Mean**	**N**	**Product**
	F	E	41.060	5	West
	F	E			
	F	E	40.256	5	Wild2
	F	E			
G	F	E	38.618	5	South
G	F				
G	F		36.152	5	Longan1
G					
G			34.186	5	Center
G					
G			33.502	5	G3H7
	H		27.068	5	Longan2
	H				
	H		26.646	5	Lychee1
	H				
	H		23.486	5	Chitralada
	I		13.198	5	Sesame1
	I				
	I		11.968	5	Florea
	I				
	I		10.110	5	Coffee1
	J		4.978	5	Forest1
	J				
	J		2.952	5	Cerana
	J				
	J		0.190	5	Stingless

Level of Product	N	L*	
		Mean	Std Dev
Cerana	5	2.9520000	0.4532880
Chitralada	5	23.4860000	4.4590784
Coffee1	5	10.1100000	5.2178396
Coffee2	5	54.4700000	0.5444263
East	5	48.8960000	0.8324242
Florea	5	11.9680000	1.4892011
Forest1	5	4.9780000	1.3702263
Forest2	5	43.5560000	7.0008128
G3H7	5	33.5020000	1.6677590
G4H6	5	43.3880000	1.1266410
Longan1	5	36.1520000	5.4952680
Longan2	5	27.0680000	2.4799032
Lychee1	5	26.6460000	2.0538939
Lychee2	5	58.2720000	3.2347133
Macadamia	5	44.2340000	0.7776760
Center	5	34.1860000	2.4665522
North	5	47.7640000	1.3561821
NorthEast	5	43.2180000	1.2163347
Sesame1	5	13.1980000	2.6681867
Sesame2	5	41.0600000	4.6356068
South	5	38.6180000	5.4671675
Stingless	5	0.1900000	0.0744983
Sunflow1	5	54.3380000	0.5647743
Sunflow2	5	61.4240000	10.1047256
West	5	41.0600000	5.0910510
Wild1	5	42.3220000	3.6109445
Wild2	5	40.2560000	6.0732965

a* value

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Replication	4	23.747699	5.936925	1.05	0.3863
Product	26	9930.068873	381.925726	67.41	<.0001

Means with the same letter are not significantly different.					
Duncan Grouping			Mean	N	Product
	A		35.706	5	Lychee2
	B		31.010	5	Sunflower2
	B				
C	B		28.584	5	Sesame1
C	B				
C	B		28.210	5	Lychee1
C					
C	D		26.684	5	Center
	D				
E	D		24.380	5	Coffee1
E	D				
E	D	F	23.544	5	Florea
E		F			
E	G	F	21.808	5	Chitralada
	G	F			
H	G	F	20.708	5	Forest1
H	G	F			
H	G	F	20.666	5	Longan1
H	G				
H	G	I	19.956	5	Wild2
H		I			
H	J	I	17.926	5	Longan2
	J	I			

Means with the same letter are not significantly different.					
Duncan Grouping			Mean	N	Product
K	J	I	17.302	5	South
K	J				
K	J	L	15.174	5	Sesame2
K	J	L			
K	J	L	15.102	5	Cerana
K	J	L			
K	J	L	14.998	5	West
K		L			
K		L	14.124	5	Forest2
K		L			
K		L	13.940	5	Wild1
		L			
		L	13.336	5	Macadamia
		L			
		L	13.302	5	North
		L			
		L	12.014	5	NorthEast
	M		7.648	5	East
	M				
N	M		7.386	5	G3H7
N	M				
N	M		5.952	5	Coffee2
N	M				
N	M		5.650	5	Sunflower1
N					
N			4.250	5	G4H6
	O		1.028	5	Stingless

Level of Product	N	a*	
		Mean	Std Dev
Cerana	5	15.1020000	1.86074447
Chitralada	5	21.8080000	1.71647022
Coffee1	5	24.3800000	7.04626852
Coffee2	5	5.9520000	0.93790724
East	5	7.6480000	2.19507859
Florea	5	23.5440000	0.77170590
Forest1	5	20.7080000	3.81500590
Forest2	5	14.1240000	1.18803619
G3H7	5	7.3860000	0.48552034
G4H6	5	4.2500000	1.74636766
Longan1	5	20.6660000	1.05445721
Longan2	5	17.9260000	1.00793353
Lychee1	5	28.2100000	0.74431176
Lychee2	5	35.7060000	4.11085514
Macadamia	5	13.3360000	1.44304539
Center	5	26.6840000	1.82609693
North	5	13.3020000	0.62231021
NorthEast	5	12.0140000	2.10913015
Sesame1	5	28.5840000	0.95824318
Sesame2	5	15.1740000	1.17689422
South	5	17.3020000	2.38901026
Stingless	5	1.0280000	0.27398905
Sunflower1	5	5.6500000	2.05568723
Sunflower2	5	31.0100000	1.71474488
West	5	14.9980000	3.42055113
Wild1	5	13.9400000	3.30562400
Wild2	5	19.9560000	1.98142121

b* value

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Replication	4	61.06618	15.26655	0.56	0.6937
Product	26	79688.47317	3064.94128	112.02	<.0001

Means with the same letter are not significantly different.						
Duncan Grouping				Mean	N	Product
		A		103.912	5	Sunflower2
		A				
		A		98.486	5	Lychee2
		B		66.130	5	North
		B				
C		B		64.788	5	Wild2
C		B				
C		B	D	62.114	5	Macadamia
C		B	D			
C		B	D	61.540	5	West
C		B	D			
C	E	B	D	60.700	5	Forest2
C	E	B	D			
C	E	B	D	60.138	5	South
C	E	B	D			
C	E	B	D	59.858	5	Longan1
C	E		D			
C	E	F	D	57.960	5	Center
C	E	F	D			
C	E	F	D	57.728	5	Sesame2
C	E	F	D			
C	E	F	D	57.678	5	Wild1
	E	F	D			

Means with the same letter are not significantly different.						
Duncan Grouping				Mean	N	Product
G	E	F	D	55.398	5	Coffee2
G	E	F				
G	E	F		53.608	5	NorthEast
G		F				
G		F	H	50.782	5	Sunflower1
G			H			
G			H	50.102	5	East
			H			
		I	H	45.590	5	Lychee1
		I	H			
		I	H	44.686	5	Longan2
		I				
		I		40.694	5	G4H6
		I				
		I		39.568	5	Chitralada
		J		30.742	5	G3H7
		K		22.730	5	Sesame1
		K				
		K		20.556	5	Florea
		K				
		K		17.410	5	Coffee1
		L		8.580	5	Forest1
		L				
M		L		5.088	5	Cerana
M						
M				0.328	5	Stingless

Level of Product	N	b*	
		Mean	Std Dev
Cerana	5	5.088000	0.7790507
Chitralada	5	39.568000	6.8220063
Coffee1	5	17.410000	8.9858277
Coffee2	5	55.398000	2.0549258
East	5	50.102000	4.1427612
Florea	5	20.556000	2.5599863
Forest1	5	8.580000	2.3610167
Forest2	5	60.700000	4.2575697
G3H7	5	30.742000	0.2653677
G4H6	5	40.694000	3.6991323
Longan1	5	59.858000	6.5897815
Longan2	5	44.686000	3.5258375
Lychee1	5	45.590000	3.4411335
Lychee2	5	98.486000	4.4149383
Macadamia	5	62.114000	1.4522672
Center	5	57.960000	3.9295992
North	5	66.130000	1.0465180
NorthEast	5	53.608000	3.3611412
Sesame1	5	22.730000	4.5877500
Sesame2	5	57.728000	3.2256658
South	5	60.138000	5.8881805
Stingless	5	0.328000	0.1285302
Sunflower1	5	50.782000	4.9495980
Sunflower2	5	103.912000	15.5715115
West	5	61.540000	3.8663355
Wild1	5	57.678000	3.0635551
Wild2	5	64.788000	7.6674650

8. Comparing adulterated samples by glucose syrup with original honey

Viscosity

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Panel	5	8.02314815	1.60462963	4.49	0.0022
Replication	2	0.12037037	0.06018519	0.17	0.8456
Product	2	7.14814815	3.57407407	10.00	0.0003

Means with the same letter are not significantly different.			
t Grouping	Mean	N	Product
A	11.3611	18	G3H7
A			
A	10.9722	18	G4H6
B	10.4722	18	Forest2

Level of Product	N	Viscosity	
		Mean	Std Dev
Forest2	18	10.4722222	0.83087874
G3H7	18	11.3611111	0.65989205
G4H6	18	10.9722222	0.52782078

Sweetness

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Panel	5	18.16666667	3.63333333	11.94	<.0001
Replication	2	0.75000000	0.37500000	1.23	0.3015
Product	2	6.02777778	3.01388889	9.90	0.0003

Means with the same letter are not significantly different.			
t Grouping	**Mean**	**N**	**Product**
A	8.1944	18	Forest2
B	7.5000	18	G3H7
B			
B	7.4722	18	G4H6

Level of Product	N	Sweetness	
		Mean	**Std Dev**
Forest2	18	8.19444444	0.64486407
G3H7	18	7.50000000	0.90748521
G4H6	18	7.47222222	0.81298691

Sourness

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Panel	5	5.65277778	1.13055556	14.10	<.0001
Replication	2	0.08333333	0.04166667	0.52	0.5983
Product	2	2.11111111	1.05555556	13.17	<.0001

Means with the same letter are not significantly different.			
t Grouping	Mean	N	Product
A	0.86111	18	Forest2
B	0.47222	18	G4H6
B			
B	0.41667	18	G3H7

Level of Product	N	Sourness	
		Mean	Std Dev
Forest2	18	0.86111111	0.41322105
G3H7	18	0.41666667	0.42874646
G4H6	18	0.47222222	0.43630205

Bitterness

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Panel	5	6.80092593	1.36018519	11.44	<.0001
Replication	2	0.03703704	0.01851852	0.16	0.8562
Product	2	3.95370370	1.97685185	16.63	<.0001

Means with the same letter are not significantly different.			
t Grouping	Mean	N	Product
A	0.9444	18	Forest2
B	0.4167	18	G3H7
B			
B	0.3333	18	G4H6

Level of Product	N	Bitterness	
		Mean	Std Dev
Forest2	18	0.94444444	0.51130999
G3H7	18	0.41666667	0.49259218
G4H6	18	0.33333333	0.45374261

Saltiness

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Panel	5	4.22222222	0.84444444	8.86	<.0001
Replication	2	0.08333333	0.04166667	0.44	0.6487
Product	2	0.33333333	0.16666667	1.75	0.1859

Means with the same letter are not significantly different.			
t Grouping	**Mean**	**N**	**Product**
A	0.2778	18	Forest2
A			
A	0.2778	18	G3H7
A			
A	0.1111	18	G4H6

Level of Product	N	Saltiness	
		Mean	**Std Dev**
Forest2	18	0.27777778	0.42779263
G3H7	18	0.27777778	0.49176220
G4H6	18	0.11111111	0.27415944

Perfume flavor

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Panel	5	24.27777778	4.85555556	28.70	<.0001
Replication	2	0.02777778	0.01388889	0.08	0.9213
Product	2	2.58333333	1.29166667	7.63	0.0014

Means with the same letter are not significantly different.			
t Grouping	**Mean**	**N**	**Product**
A	1.5833	18	Forest2
B	1.1667	18	G3H7
B			
B	1.0833	18	G4H6

Level of Product	N	Perfume	
		Mean	**Std Dev**
Forest2	18	1.58333333	0.80895721
G3H7	18	1.16666667	0.82247832
G4H6	18	1.08333333	0.73264228

Fruit flavor

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Panel	5	8.38888889	1.67777778	8.20	<.0001
Replication	2	0.36111111	0.18055556	0.88	0.4209
Product	2	13.08333333	6.54166667	31.98	<.0001

Means with the same letter are not significantly different.			
t Grouping	Mean	N	Product
A	1.8056	18	Forest2
B	0.8056	18	G3H7
B			
B	0.7222	18	G4H6

Level of Product	N	Fruit	
		Mean	Std Dev
Forest2	18	1.80555556	0.78849986
G3H7	18	0.80555556	0.45822191
G4H6	18	0.72222222	0.46088860

Flora flavor

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Panel	5	24.09722222	4.81944444	38.56	<.0001
Replication	2	0.02777778	0.01388889	0.11	0.8951
Product	2	0.08333333	0.04166667	0.33	0.7183

Means with the same letter are not significantly different.			
t Grouping	**Mean**	**N**	**Product**
A	1.1944	18	Forest2
A			
A	1.1111	18	G3H7
A			
A	1.1111	18	G4H6

Level of Product	N	Flora	
		Mean	**Std Dev**
Forest2	18	1.19444444	0.75027228
G3H7	18	1.11111111	0.77754432
G4H6	18	1.11111111	0.75839528

Jasmine flavor

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Panel	5	29.20370370	5.84074074	25.05	<.0001
Replication	2	0.12037037	0.06018519	0.26	0.7737
Product	2	1.67592593	0.83796296	3.59	0.0358

Means with the same letter are not significantly different.				
t Grouping		**Mean**	**N**	**Product**
	A	1.4722	18	G4H6
	A			
B	A	1.3611	18	G3H7
B				
B		1.0556	18	Forest2

Level of Product	**N**	**Jasmine**	
		Mean	**Std Dev**
Forest2	18	1.05555556	0.63913749
G3H7	18	1.36111111	0.92044675
G4H6	18	1.47222222	1.03571831

Cotton candy flavor

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Panel	5	24.22222222	4.84444444	6.50	0.0001
Replication	2	0.52777778	0.26388889	0.35	0.7039
Product	2	1.77777778	0.88888889	1.19	0.3132

Means with the same letter are not significantly different.			
t Grouping	Mean	N	Product
A	2.1111	18	G4H6
A			
A	1.8889	18	G3H7
A			
A	1.6667	18	Forest2

Level of Product	N	Cotton Candy	
		Mean	Std Dev
Forest2	18	1.66666667	0.66421116
G3H7	18	1.88888889	1.11876449
G4H6	18	2.11111111	1.30108050

Butterscotch flavor

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Panel	5	54.65277778	10.93055556	15.21	<.0001
Replication	2	0.86111111	0.43055556	0.60	0.5536
Product	2	19.75000000	9.87500000	13.75	<.0001

Means with the same letter are not significantly different.			
t Grouping	**Mean**	**N**	**Product**
A	4.0833	18	Forest2
B	3.0000	18	G3H7
B			
B	2.6667	18	G4H6

Level of Product	N	Butterscotch	
		Mean	Std Dev
Forest2	18	4.08333333	1.17885787
G3H7	18	3.00000000	1.46528455
G4H6	18	2.66666667	1.26025208

Molasses flavor

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Panel	5	79.52314815	15.90462963	25.78	<.0001
Replication	2	1.62037037	0.81018519	1.31	0.2793
Product	2	32.17592593	16.08796296	26.07	<.0001

Means with the same letter are not significantly different.			
t Grouping	**Mean**	**N**	**Product**
A	3.9444	18	Forest2
B	2.5556	18	G3H7
B			
B	2.1389	18	G4H6

Level of Product	N	Molasses	
		Mean	**Std Dev**
Forest2	18	3.94444444	1.50380780
G3H7	18	2.55555556	1.44394159
G4H6	18	2.13888889	1.42256557

Coffee flavor

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Panel	5	16.02314815	3.20462963	9.87	<.0001
Replication	2	3.37037037	1.68518519	5.19	0.0095
Product	2	0.12037037	0.06018519	0.19	0.8315

Means with the same letter are not significantly different.			
t Grouping	Mean	N	Product
A	1.3333	18	Forest2
A			
A	1.3056	18	G4H6
A			
A	1.2222	18	G3H7

Level of Product	N	Coffee	
		Mean	Std Dev
Forest2	18	1.33333333	0.70710678
G3H7	18	1.22222222	0.86129557
G4H6	18	1.30555556	0.85987155

Dried fruit flavor

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Panel	5	15.65277778	3.13055556	18.16	<.0001
Replication	2	0.44444444	0.22222222	1.29	0.2856
Product	2	17.52777778	8.76388889	50.85	<.0001

Means with the same letter are not significantly different.			
t Grouping	Mean	N	Product
A	1.8333	18	Forest2
B	0.6389	18	G4H6
B			
B	0.6111	18	G3H7

Level of Product	N	Dried fruit	
		Mean	Std Dev
Forest2	18	1.83333333	0.82247832
G3H7	18	0.61111111	0.60768499
G4H6	18	0.63888889	0.58925565

Medicine flavor

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Panel	5	7.94444444	1.58888889	13.04	<.0001
Replication	2	0.11111111	0.05555556	0.46	0.6368
Product	2	3.58333333	1.79166667	14.70	<.0001

Means with the same letter are not significantly different.			
t Grouping	Mean	N	Product
A	1.1944	18	Forest2
B	0.6944	18	G3H7
B			
B	0.6111	18	G4H6

Level of Product	N	Medicine	
		Mean	Std Dev
Forest2	18	1.19444444	0.51845043
G3H7	18	0.69444444	0.57237608
G4H6	18	0.61111111	0.43910188

Ferment flavor

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Panel	5	5.52314815	1.10462963	8.20	<.0001
Replication	2	0.12037037	0.06018519	0.45	0.6425
Product	2	4.89814815	2.44907407	18.18	<.0001

Means with the same letter are not significantly different.			
t Grouping	Mean	N	Product
A	1.3056	18	Forest2
B	0.6667	18	G3H7
B			
B	0.6667	18	G4H6

Level of Product	N	Ferment	
		Mean	Std Dev
Forest2	18	1.30555556	0.54607931
G3H7	18	0.66666667	0.45374261
G4H6	18	0.66666667	0.42008403

Plastic flavor

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Panel	5	8.70370370	1.74074074	22.36	<.0001
Replication	2	0.12037037	0.06018519	0.77	0.4678
Product	2	4.50925926	2.25462963	28.96	<.0001

Means with the same letter are not significantly different.			
t Grouping	Mean	N	Product
A	1.11111	18	Forest2
B	0.52778	18	G4H6
B			
B	0.47222	18	G3H7

Level of Product	N	Plastic	
		Mean	Std Dev
Forest2	18	1.11111111	0.53013748
G3H7	18	0.47222222	0.43630205
G4H6	18	0.52777778	0.49918234

Worcester sauce flavor

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Panel	5	28.03703704	5.60740741	41.06	<.0001
Replication	2	0.28703704	0.14351852	1.05	0.3583
Product	2	6.25925926	3.12962963	22.92	<.0001

Means with the same letter are not significantly different.			
t Grouping	Mean	N	Product
A	1.6111	18	Forest2
B	0.8889	18	G3H7
B			
B	0.8889	18	G4H6

Level of Product	N	Worcester Sauce	
		Mean	Std Dev
Forest2	18	1.61111111	0.77754432
G3H7	18	0.88888889	0.86696827
G4H6	18	0.88888889	0.81449291

Soy sauce flavor

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Panel	5	11.87037037	2.37407407	5.39	0.0006
Replication	2	0.00925926	0.00462963	0.01	0.9895
Product	2	12.34259259	6.17129630	14.02	<.0001

Means with the same letter are not significantly different.			
t Grouping	Mean	N	Product
A	1.8056	18	Forest2
B	0.8056	18	G3H7
B			
B	0.7778	18	G4H6

Level of Product	N	Soy Sauce	
		Mean	Std Dev
Forest2	18	1.80555556	1.01661041
G3H7	18	0.80555556	0.62164130
G4H6	18	0.77777778	0.64676167

Herb flavor

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Panel	5	16.48611111	3.29722222	27.93	<.0001
Replication	2	0.33333333	0.16666667	1.41	0.2545
Product	2	1.69444444	0.84722222	7.18	0.0020

Means with the same letter are not significantly different.			
t Grouping	Mean	N	Product
A	1.1111	18	Forest2
B	0.7500	18	G4H6
B			
B	0.7222	18	G3H7

Level of Product	N	Herb Mean	Herb Std Dev
Forest2	18	1.11111111	0.65429701
G3H7	18	0.72222222	0.66911316
G4H6	18	0.75000000	0.64739296

Wood flavor

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Panel	5	5.59722222	1.11944444	10.81	<.0001
Replication	2	0.02777778	0.01388889	0.13	0.8748
Product	2	2.19444444	1.09722222	10.60	0.0002

Means with the same letter are not significantly different.			
t Grouping	**Mean**	**N**	**Product**
A	1.0278	18	Forest2
B	0.6667	18	G3H7
B			
B	0.5556	18	G4H6

Level of Product	N	Woody	
		Mean	**Std Dev**
Forest2	18	1.02777778	0.43630205
G3H7	18	0.66666667	0.38348249
G4H6	18	0.55555556	0.51130999

Iron flavor

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Panel	5	3.98148148	0.79629630	8.56	<.0001
Replication	2	0.00925926	0.00462963	0.05	0.9515
Product	2	0.73148148	0.36574074	3.93	0.0268

Means with the same letter are not significantly different.				
t Grouping		**Mean**	**N**	**Product**
	A	0.8056	18	Forest2
	A			
B	A	0.6111	18	G4H6
B				
B		0.5278	18	G3H7

Level of Product	N	Iron	
		Mean	**Std Dev**
Forest2	18	0.80555556	0.38877216
G3H7	18	0.52777778	0.40118289
G4H6	18	0.61111111	0.40422604

Degrees Brix

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Replication	2	0.22222222	0.11111111	4.00	0.1111
Product	2	10.05555556	5.02777778	181.00	0.0001

Means with the same letter are not significantly different.			
t Grouping	**Mean**	**N**	**Product**
A	81.8333	3	G3H7
B	80.0000	3	G4H6
C	79.3333	3	Forest2

Level of Product	N	Brix	
		Mean	**Std Dev**
Forest2	3	79.3333333	0.28867513
G3H7	3	81.8333333	0.28867513
G4H6	3	80.0000000	0.00000000

L* value

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Replication	4	71.2257733	17.8064433	1.01	0.4565
Product	2	331.4068933	165.7034467	9.40	0.0079

Means with the same letter are not significantly different.			
t Grouping	**Mean**	**N**	**Product**
A	43.556	5	Forest2
A			
A	43.388	5	G4H6
B	33.502	5	G3H7

Level of Product	N	L	
		Mean	Std Dev
Forest2	5	43.5560000	7.00081281
G3H7	5	33.5020000	1.66775898
G4H6	5	43.3880000	1.12664103

a* value

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Replication	4	5.5050000	1.3762500	0.83	0.5427
Product	2	254.5516933	127.2758467	76.66	<.0001

Means with the same letter are not significantly different.			
t Grouping	Mean	N	Product
A	14.1240	5	Forest2
B	7.3860	5	G3H7
C	4.2500	5	G4H6

Level of Product	N	a	
		Mean	Std Dev
Forest2	5	14.1240000	1.18803619
G3H7	5	7.3860000	0.48552034
G4H6	5	4.2500000	1.74636766

b* value

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Replication	4	44.342573	11.085643	1.07	0.4328
Product	2	2327.940173	1163.970087	111.95	<.0001

Means with the same letter are not significantly different.			
t Grouping	**Mean**	**N**	**Product**
A	60.700	5	Forest2
B	40.694	5	G4H6
C	30.742	5	G3H7

Level of Product	N	b Mean	b Std Dev
Forest2	5	60.7000000	4.25756973
G3H7	5	30.7420000	0.26536767
G4H6	5	40.6940000	3.69913233

9. Sensory profiles of Thai honey based on clusters for every attribute

Viscosity

Source	DF	Type III SS	Mean Square	F Value	Pr > F
cluster	7	30.66945265	4.38135038	9.66	<.0001

Means with the same letter are not significantly different.				
Duncan Grouping		Mean	N	cluster
	A	12.0533	3	2
	A			
	A	11.5467	3	3
	A			
B	A	10.8133	3	6
B	A			
B	A	10.7443	7	1
B				
B		10.1200	5	8
B				
B		9.8533	3	7
	C	8.5000	1	4
	C			
	C	7.9050	2	5

Level of cluster	N	Viscosity Mean	Viscosity Std Dev
1	7	10.7442857	0.80580926
2	3	12.0533333	0.15176737
3	3	11.5466667	0.68922662
4	1	8.5000000	.
5	2	7.9050000	0.21920310
6	3	10.8133333	0.12503333
7	3	9.8533333	1.06922090
8	5	10.1200000	0.58258047

Sweetness

Source	DF	Type III SS	Mean Square	F Value	Pr > F
cluster	7	0.91642011	0.13091716	3.53	0.0135

Means with the same letter are not significantly different.					
Duncan Grouping			Mean	N	cluster
	A		7.9600	5	8
	A				
B	A		7.7600	2	5
B	A				
B	A		7.7229	7	1
B	A				
B	A	C	7.6767	3	6
B	A	C			
B	A	C	7.6133	3	7
B	A	C			
B	A	C	7.6100	3	3
B		C			
B		C	7.4200	1	4
		C			
		C	7.3133	3	2

Level of cluster	N	Sweetness	
		Mean	Std Dev
1	7	7.72285714	0.24108880
2	3	7.31333333	0.16441817
3	3	7.61000000	0.21702534
4	1	7.42000000	.
5	2	7.76000000	0.09899495
6	3	7.67666667	0.11930353
7	3	7.61333333	0.19502137
8	5	7.96000000	0.15329710

Sourness

Source	DF	Type III SS	Mean Square	F Value	Pr > F
cluster	7	5.01195677	0.71599382	73.64	<.0001

Means with the same letter are not significantly different.				
Duncan Grouping		Mean	N	cluster
	A	2.83000	1	4
	B	1.17667	3	7
	B			
C	B	1.01500	2	5
C				
C		0.97200	5	8
C				
C		0.94667	3	6
C				
C		0.82286	7	1
	D	0.53667	3	2
	D			
	D	0.46333	3	3

Level of cluster	N	Sourness	
		Mean	Std Dev
1	7	0.82285714	0.07250616
2	3	0.53666667	0.04041452
3	3	0.46333333	0.04041452
4	1	2.83000000	.
5	2	1.01500000	0.06363961
6	3	0.94666667	0.04618802
7	3	1.17666667	0.06350853
8	5	0.97200000	0.18047160

Bitterness

Source	DF	Type III SS	Mean Square	F Value	Pr > F
cluster	7	3.56537963	0.50933995	27.00	<.0001

Means with the same letter are not significantly different.			
Duncan Grouping	**Mean**	**N**	**cluster**
A	1.5833	3	6
B	1.3050	2	5
C	0.9700	3	7
C			
C	0.7900	5	8
C			
C	0.7900	7	1
D	0.4200	1	4
D			
D	0.4167	3	3
D			
D	0.3633	3	2

Level of cluster	N	Bitterness	
		Mean	**Std Dev**
1	7	0.79000000	0.17349352
2	3	0.36333333	0.05507571
3	3	0.41666667	0.08504901
4	1	0.42000000	.
5	2	1.30500000	0.23334524
6	3	1.58333333	0.10263203
7	3	0.97000000	0.05196152
8	5	0.79000000	0.13820275

Saltiness

Source	DF	Type III SS	Mean Square	F Value	Pr > F
cluster	7	0.06838667	0.00976952	3.99	0.0076

Means with the same letter are not significantly different.						
Duncan Grouping				Mean	N	cluster
		A		0.33000	1	4
		A				
		A		0.31200	5	8
		A				
B		A		0.29667	3	7
B		A				
B		A	C	0.29000	2	5
B		A	C			
B	D	A	C	0.24000	3	6
B	D		C			
B	D		C	0.21000	7	1
	D		C			
	D		C	0.19333	3	2
	D					
	D			0.18667	3	3

Level of cluster	N	Saltiness	
		Mean	Std Dev
1	7	0.21000000	0.03415650
2	3	0.19333333	0.04618802
3	3	0.18666667	0.08621678
4	1	0.33000000	.
5	2	0.29000000	0.09899495
6	3	0.24000000	0.03464102
7	3	0.29666667	0.04163332
8	5	0.31200000	0.03420526

Perfume flavor

Source	DF	Type III SS	Mean Square	F Value	Pr > F
cluster	7	0.68246709	0.09749530	8.29	0.0001

Means with the same letter are not significantly different.				
Duncan Grouping		Mean	N	cluster
	A	1.72000	1	4
	A			
	A	1.71000	2	5
	A			
B	A	1.54333	3	6
B	A			
B	A	1.54200	5	8
B	A			
B	A	1.51333	3	7
B				
B		1.46571	7	1
	C	1.19333	3	3
	C			
	C	1.19333	3	2

Level of cluster	N	Perfume	
		Mean	Std Dev
1	7	1.46571429	0.13163803
2	3	1.19333333	0.05507571
3	3	1.19333333	0.12662280
4	1	1.72000000	.
5	2	1.71000000	0.09899495
6	3	1.54333333	0.15373137
7	3	1.51333333	0.08082904
8	5	1.54200000	0.05310367

Fruit flavor

Source	DF	Type III SS	Mean Square	F Value	Pr > F
cluster	7	4.60255280	0.65750754	21.32	<.0001

Means with the same letter are not significantly different.				
Duncan Grouping		Mean	N	cluster
	A	2.5300	1	4
	B	2.1000	2	5
	B			
C	B	1.8767	3	7
C	B			
C	B	1.8720	5	8
C				
C	D	1.6033	3	6
	D			
	D	1.4814	7	1
	E	1.1033	3	2
	E			
	E	0.8233	3	3

Level of cluster	N	Fruit	
		Mean	Std Dev
1	7	1.48142857	0.20456691
2	3	1.10333333	0.20840665
3	3	0.82333333	0.11060440
4	1	2.53000000	.
5	2	2.10000000	0.09899495
6	3	1.60333333	0.19604421
7	3	1.87666667	0.18448125
8	5	1.87200000	0.13103435

Flora flavor

Source	DF	Type III SS	Mean Square	F Value	Pr > F
cluster	7	1.56806455	0.22400922	6.47	0.0005

Means with the same letter are not significantly different.				
Duncan Grouping		Mean	N	cluster
	A	2.0100	3	2
	B	1.6071	7	1
	B			
	B	1.5667	3	6
	B			
C	B	1.4900	3	7
C	B			
C	B	1.4200	1	4
C	B			
C	B	1.3100	5	8
C	B			
C	B	1.2800	2	5
C				
C		1.1300	3	3

Level of cluster	N	Flora	
		Mean	Std Dev
1	7	1.60714286	0.19180844
2	3	2.01000000	0.28053520
3	3	1.13000000	0.03464102
4	1	1.42000000	.
5	2	1.28000000	0.15556349
6	3	1.56666667	0.29569128
7	3	1.49000000	0.17088007
8	5	1.31000000	0.07035624

Jasmine flavor

Source	DF	Type III SS	Mean Square	F Value	Pr > F
cluster	7	15.78380169	2.25482881	19.72	<.0001

Means with the same letter are not significantly different.				
Duncan Grouping		Mean	N	cluster
	A	3.5833	3	2
	B	1.8086	7	1
	B			
C	B	1.3333	3	3
C	B			
C	B	1.3233	3	6
C	B			
C	B	1.1600	3	7
C	B			
C	B	1.1240	5	8
C				
C		0.9700	1	4
C				
C		0.8500	2	5

Level of cluster	N	Jasmine	
		Mean	Std Dev
1	7	1.80857143	0.45769089
2	3	3.58333333	0.43650124
3	3	1.33333333	0.15176737
4	1	0.97000000	.
5	2	0.85000000	0.05656854
6	3	1.32333333	0.31182260
7	3	1.16000000	0.32511536
8	5	1.12400000	0.14099645

Cotton candy flavor

Source	DF	Type III SS	Mean Square	F Value	Pr > F
cluster	7	1.37731598	0.19675943	2.97	0.0277

Means with the same letter are not significantly different.			
Duncan Grouping	**Mean**	**N**	**cluster**
A	2.0467	3	2
A			
A	1.9243	7	1
A			
A	1.8800	3	3
A			
A	1.7060	5	8
A			
A	1.5700	3	6
A			
A	1.5400	2	5
A			
A	1.5367	3	7
B	1.0300	1	4

Level of cluster	N	Cotton Candy	
		Mean	Std Dev
1	7	1.92428571	0.31261569
2	3	2.04666667	0.04163332
3	3	1.88000000	0.23515952
4	1	1.03000000	.
5	2	1.54000000	0.14142136
6	3	1.57000000	0.12529964
7	3	1.53666667	0.21007935
8	5	1.70600000	0.32300155

Butterscotch flavor

Source	DF	Type III SS	Mean Square	F Value	Pr > F
cluster	7	2.68340566	0.38334367	3.04	0.0254

Means with the same letter are not significantly different.				
Duncan Grouping		Mean	N	cluster
	A	3.6940	5	8
	A			
B	A	3.3233	3	7
B	A			
B	A	3.2971	7	1
B	A			
B	A	3.1933	3	6
B	A			
B	A	3.1250	2	5
B	A			
B	A	3.0667	3	3
B				
B		2.9367	3	2
	C	2.1400	1	4

Level of cluster	N	Butterscotch	
		Mean	Std Dev
1	7	3.29714286	0.20180141
2	3	2.93666667	0.11590226
3	3	3.06666667	0.43385866
4	1	2.14000000	.
5	2	3.12500000	0.68589358
6	3	3.19333333	0.18147543
7	3	3.32333333	0.40673497
8	5	3.69400000	0.46976590

Molasses flavor

Source	DF	Type III SS	Mean Square	F Value	Pr > F
cluster	7	5.37958598	0.76851228	9.73	<.0001

Means with the same letter are not significantly different.				
Duncan Grouping		Mean	N	cluster
	A	3.5600	1	4
	A			
	A	3.5200	3	7
	A			
	A	3.3500	5	8
	A			
B	A	3.0167	3	6
B				
B	C	2.7350	2	5
B	C			
B	C	2.7243	7	1
	C			
D	C	2.3800	3	3
D				
D		2.1567	3	2

Level of cluster	N	Molasses	
		Mean	Std Dev
1	7	2.72428571	0.19890175
2	3	2.15666667	0.16441817
3	3	2.38000000	0.21633308
4	1	3.56000000	.
5	2	2.73500000	0.37476659
6	3	3.01666667	0.19553346
7	3	3.52000000	0.21000000
8	5	3.35000000	0.44994444

Coffee flavor

Source	DF	Type III SS	Mean Square	F Value	Pr > F
cluster	7	2.07660677	0.29665811	1.77	0.1523

Means with the same letter are not significantly different.				
Duncan Grouping		Mean	N	cluster
	A	1.9267	3	2
	A			
	A	1.9067	3	3
	A			
B	A	1.6271	7	1
B	A			
B	A	1.5467	3	6
B	A			
B	A	1.3900	3	7
B	A			
B	A	1.3620	5	8
B	A			
B	A	1.0700	2	5
B				
B		0.8300	1	4

Level of cluster	N	Coffee	
		Mean	Std Dev
1	7	1.62714286	0.26550043
2	3	1.92666667	0.09073772
3	3	1.90666667	1.11230991
4	1	0.83000000	.
5	2	1.07000000	0.05656854
6	3	1.54666667	0.02886751
7	3	1.39000000	0.03000000
8	5	1.36200000	0.25674890

Dried fruit flavor

Source	DF	Type III SS	Mean Square	F Value	Pr > F
cluster	7	4.50505857	0.64357980	18.66	<.0001

Means with the same letter are not significantly different.				
Duncan Grouping		Mean	N	cluster
	A	2.2200	1	4
	A			
B	A	2.0150	2	5
B				
B	C	1.8060	5	8
B	C			
B	C	1.7600	3	7
	C			
D	C	1.5567	3	6
D				
D		1.3943	7	1
	E	0.9833	3	2
	E			
	E	0.7033	3	3

Level of cluster	N	Dried Fruit	
		Mean	Std Dev
1	7	1.39428571	0.13513662
2	3	0.98333333	0.13650397
3	3	0.70333333	0.13650397
4	1	2.22000000	.
5	2	2.01500000	0.37476659
6	3	1.55666667	0.13503086
7	3	1.76000000	0.11532563
8	5	1.80600000	0.25870833

Medicine flavor

Source	DF	Type III SS	Mean Square	F Value	Pr > F
cluster	7	4.14663344	0.59237621	18.40	<.0001

Means with the same letter are not significantly different.				
Duncan Grouping		Mean	N	cluster
	A	1.9800	3	6
	A			
B	A	1.7200	2	5
B				
B	C	1.4900	3	7
	C			
	C	1.2800	1	4
	C			
	C	1.1560	5	8
	C			
	C	1.1429	7	1
	D	0.7367	3	2
	D			
	D	0.6633	3	3

Level of cluster	N	Medicine	
		Mean	Std Dev
1	7	1.14285714	0.23019660
2	3	0.73666667	0.08082904
3	3	0.66333333	0.04618802
4	1	1.28000000	.
5	2	1.72000000	0.19798990
6	3	1.98000000	0.28053520
7	3	1.49000000	0.03464102
8	5	1.15600000	0.13921207

Ferment flavor

Source	DF	Type III SS	Mean Square	F Value	Pr > F
cluster	7	4.35442788	0.62206113	24.32	<.0001

Means with the same letter are not significantly different.				
Duncan Grouping		Mean	N	cluster
	A	2.5300	1	4
	B	1.5850	2	5
	B			
	B	1.5467	3	7
	B			
C	B	1.3133	3	6
C				
C		1.1840	5	8
C				
C		1.0071	7	1
	D	0.6733	3	2
	D			
	D	0.6700	3	3

Level of cluster	N	Ferment Mean	Ferment Std Dev
1	7	1.00714286	0.16928421
2	3	0.67333333	0.13650397
3	3	0.67000000	0.00000000
4	1	2.53000000	.
5	2	1.58500000	0.07778175
6	3	1.31333333	0.05686241
7	3	1.54666667	0.30072135
8	5	1.18400000	0.14432602

Plastic flavor

Source	DF	Type III SS	Mean Square	F Value	Pr > F
cluster	7	5.61213820	0.80173403	11.86	<.0001

Means with the same letter are not significantly different.					
Duncan Grouping			Mean	N	cluster
	A		2.1700	3	6
	B		1.6000	2	5
	B				
C	B		1.3900	1	4
C	B				
C	B		1.2967	3	7
C					
C	D		1.0757	7	1
C	D				
C	D	E	0.9540	5	8
	D	E			
	D	E	0.7400	3	2
		E			
		E	0.5100	3	3

Level of cluster	N	Plastic	
		Mean	Std Dev
1	7	1.07571429	0.24764606
2	3	0.74000000	0.14106736
3	3	0.51000000	0.03464102
4	1	1.39000000	.
5	2	1.60000000	0.45254834
6	3	2.17000000	0.50000000
7	3	1.29666667	0.18823744
8	5	0.95400000	0.15693948

Worcester sauce flavor

Source	DF	Type III SS	Mean Square	F Value	Pr > F
cluster	7	8.36459788	1.19494255	49.96	<.0001

Means with the same letter are not significantly different.				
Duncan Grouping		Mean	N	cluster
	A	3.5600	1	4
	B	2.2233	3	7
	B			
C	B	1.9600	2	5
C				
C		1.7400	3	6
C				
C		1.6800	5	8
	D	1.3229	7	1
	E	1.0333	3	2
	E			
	E	0.8900	3	3

Level of cluster	N	Worcester Sauce Mean	Worcester Sauce Std Dev
1	7	1.32285714	0.19788164
2	3	1.03333333	0.13650397
3	3	0.89000000	0.00000000
4	1	3.56000000	.
5	2	1.96000000	0.21213203
6	3	1.74000000	0.15524175
7	3	2.22333333	0.05507571
8	5	1.68000000	0.14404860

Soy sauce flavor

Source	DF	Type III SS	Mean Square	F Value	Pr > F
cluster	7	2.91640169	0.41662881	11.91	<.0001

Means with the same letter are not significantly different.				
Duncan Grouping		Mean	N	cluster
	A	2.0800	1	4
	A			
	A	2.0633	3	7
	B	1.6933	3	6
	B			
	B	1.6060	5	8
	B			
C	B	1.5300	2	5
C	B			
C	B	1.4586	7	1
C				
C	D	1.1667	3	2
	D			
	D	0.8900	3	3

Level of cluster	N	Soy Sauce Mean	Soy Sauce Std Dev
1	7	1.45857143	0.24484203
2	3	1.16666667	0.09712535
3	3	0.89000000	0.16522712
4	1	2.08000000	.
5	2	1.53000000	0.04242641
6	3	1.69333333	0.11930353
7	3	2.06333333	0.20599353
8	5	1.60600000	0.17038192

Herb flavor

Source	DF	Type III SS	Mean Square	F Value	Pr > F
cluster	7	1.27572233	0.18224605	14.18	<.0001

Means with the same letter are not significantly different.					
Duncan Grouping			Mean	N	cluster
	A		1.6400	1	4
	A				
B	A		1.4300	2	5
B					
B	C		1.2867	3	7
B	C				
B	C	D	1.2100	3	6
	C	D			
	C	D	1.1160	5	8
		D			
	E	D	1.0129	7	1
	E				
F	E		0.8167	3	2
F					
F			0.7667	3	3

Level of cluster	N	Herb	
		Mean	Std Dev
1	7	1.01285714	0.14115173
2	3	0.81666667	0.10016653
3	3	0.76666667	0.05686241
4	1	1.64000000	.
5	2	1.43000000	0.09899495
6	3	1.21000000	0.14106736
7	3	1.28666667	0.08736895
8	5	1.11600000	0.09126883

Wood flavor

Source	DF	Type III SS	Mean Square	F Value	Pr > F
cluster	7	0.96250344	0.13750049	14.95	<.0001

Means with the same letter are not significantly different.				
Duncan Grouping		Mean	N	cluster
	A	1.19500	2	5
	A			
B	A	1.11000	3	6
B				
B		1.00333	3	7
B				
B		1.00000	1	4
B				
B		0.95000	5	8
	C	0.76286	7	1
	C			
	C	0.62333	3	3
	C			
	C	0.60333	3	2

Level of cluster	N	Woody	
		Mean	Std Dev
1	7	0.76285714	0.11729085
2	3	0.60333333	0.09073772
3	3	0.62333333	0.05686241
4	1	1.00000000	.
5	2	1.19500000	0.03535534
6	3	1.11000000	0.09848858
7	3	1.00333333	0.07371115
8	5	0.95000000	0.09721111

Iron flavor

Source	DF	Type III SS	Mean Square	F Value	Pr > F
cluster	7	0.41993820	0.05999117	7.56	0.0002

Means with the same letter are not significantly different.				
Duncan Grouping		Mean	N	cluster
	A	1.03000	2	5
	A			
B	A	0.94333	3	6
B				
B	C	0.80333	3	7
	C			
	C	0.70600	5	8
	C			
	C	0.69571	7	1
	C			
	C	0.64000	1	4
	C			
	C	0.62000	3	3
	C			
	C	0.62000	3	2

Level of cluster	N	Iron	
		Mean	Std Dev
1	7	0.69571429	0.06267832
2	3	0.62000000	0.01732051
3	3	0.62000000	0.09539392
4	1	0.64000000	.
5	2	1.03000000	0.00000000
6	3	0.94333333	0.12662280
7	3	0.80333333	0.10263203
8	5	0.70600000	0.11760102

10.Sensory profiles of Thai honey based on clusters for 20 attributes

Sourness

Source	DF	Type III SS	Mean Square	F Value	Pr > F
cluster	7	5.10094177	0.72870597	144.59	<.0001

Means with the same letter are not significantly different.				
Duncan Grouping		Mean	N	cluster
	A	2.83000	1	5
	B	1.19500	4	8
	C	0.97400	5	6
	C			
D	C	0.90250	4	7
D				
D		0.82286	7	1
	E	0.53667	3	2
	E			
	E	0.50000	1	3
	E			
	E	0.44500	2	4

Level of cluster	N	Sourness Mean	Sourness Std Dev
1	7	0.82285714	0.07250616
2	3	0.53666667	0.04041452
3	1	0.50000000	.
4	2	0.44500000	0.03535534
5	1	2.83000000	.
6	5	0.97400000	0.05899152
7	4	0.90250000	0.10594810
8	4	1.19500000	0.06350853

Bitterness

Source	DF	Type III SS	Mean Square	F Value	Pr > F
cluster	7	3.42928296	0.48989757	18.82	<.0001

Means with the same letter are not significantly different.				
Duncan Grouping		Mean	N	cluster
	A	1.4720	5	6
	B	0.8875	4	8
	B			
C	B	0.8275	4	7
C	B			
C	B	0.7900	7	1
C				
C	D	0.5000	1	3
	D			
	D	0.4200	1	5
	D			
	D	0.3750	2	4
	D			
	D	0.3633	3	2

Level of cluster	N	Bitterness	
		Mean	Std Dev
1	7	0.79000000	0.17349352
2	3	0.36333333	0.05507571
3	1	0.50000000	.
4	2	0.37500000	0.06363961
5	1	0.42000000	.
6	5	1.47200000	0.20523158
7	4	0.82750000	0.12685293
8	4	0.88750000	0.17036725

Saltiness

Source	DF	Type III SS	Mean Square	F Value	Pr > F
cluster	7	0.06537500	0.00933929	3.59	0.0125

Means with the same letter are not significantly different.					
Duncan Grouping			Mean	N	cluster
	A		0.33000	1	5
	A				
B	A		0.30750	4	7
B	A				
B	A		0.30500	4	8
B	A				
B	A	C	0.26000	5	6
B		C			
B		C	0.21000	7	1
B		C			
B		C	0.19500	2	4
B		C			
B		C	0.19333	3	2
		C			
		C	0.17000	1	3

Level of cluster	N	Saltiness	
		Mean	Std Dev
1	7	0.21000000	0.03415650
2	3	0.19333333	0.04618802
3	1	0.17000000	.
4	2	0.19500000	0.12020815
5	1	0.33000000	.
6	5	0.26000000	0.06164414
7	4	0.30750000	0.03774917
8	4	0.30500000	0.03785939

Perfume flavor

Source	DF	Type III SS	Mean Square	F Value	Pr > F
cluster	7	0.67562209	0.09651744	7.96	0.0001

Means with the same letter are not significantly different.					
Duncan Grouping			Mean	N	cluster
	A		1.7200	1	5
	A				
B	A		1.6100	5	6
B	A				
B	A	C	1.5325	4	7
B	A	C			
B	A	C	1.5300	4	8
B		C			
B		C	1.4657	7	1
		C			
	D	C	1.3300	1	3
	D				
	D		1.1933	3	2
	D				
	D		1.1250	2	4

Level of cluster	N	Perfume	
		Mean	Std Dev
1	7	1.46571429	0.13163803
2	3	1.19333333	0.05507571
3	1	1.33000000	.
4	2	1.12500000	0.06363961
5	1	1.72000000	.
6	5	1.61000000	0.15033296
7	4	1.53250000	0.05619905
8	4	1.53000000	0.07393691

Fruit flavor

Source	DF	Type III SS	Mean Square	F Value	Pr > F
cluster	7	4.32752780	0.61821826	13.64	<.0001

Means with the same letter are not significantly different.				
Duncan Grouping		Mean	N	cluster
	A	2.5300	1	5
	B	1.8825	4	7
	B			
	B	1.8650	4	8
	B			
	B	1.8020	5	6
	B			
C	B	1.4814	7	1
C				
C	D	1.1033	3	2
	D			
	D	0.9400	1	3
	D			
	D	0.7650	2	4

Level of cluster	N	Fruit	
		Mean	Std Dev
1	7	1.48142857	0.20456691
2	3	1.10333333	0.20840665
3	1	0.94000000	.
4	2	0.76500000	0.06363961
5	1	2.53000000	.
6	5	1.80200000	0.30930567
7	4	1.88250000	0.14885675
8	4	1.86500000	0.15242484

Flora flavor

Source	DF	Type III SS	Mean Square	F Value	Pr > F
cluster	7	1.45315122	0.20759303	5.10	0.0021

Means with the same letter are not significantly different.				
Duncan Grouping		Mean	N	cluster
	A	2.0100	3	2
	A			
B	A	1.6071	7	1
B				
B	C	1.4520	5	6
B	C			
B	C	1.4500	4	8
B	C			
B	C	1.4200	1	5
B	C			
B	C	1.3050	4	7
B	C			
B	C	1.1700	1	3
	C			
	C	1.1100	2	4

Level of cluster	N	Flora	
		Mean	Std Dev
1	7	1.60714286	0.19180844
2	3	2.01000000	0.28053520
3	1	1.17000000	.
4	2	1.11000000	0.00000000
5	1	1.42000000	.
6	5	1.45200000	0.27280029
7	4	1.30500000	0.08020806
8	4	1.45000000	0.16083117

Jasmine flavor

Source	DF	Type III SS	Mean Square	F Value	Pr > F
cluster	7	15.55498503	2.22214072	17.58	<.0001

Means with the same letter are not significantly different.				
Duncan Grouping		Mean	N	cluster
	A	3.5833	3	2
	B	1.8086	7	1
	B			
C	B	1.4150	2	4
C	B			
C	B	1.1700	1	3
C	B			
C	B	1.1550	4	7
C	B			
C	B	1.1340	5	6
C	B			
C	B	1.1200	4	8
C				
C		0.9700	1	5

Level of cluster	N	Jasmine	
		Mean	Std Dev
1	7	1.80857143	0.45769089
2	3	3.58333333	0.43650124
3	1	1.17000000	.
4	2	1.41500000	0.07778175
5	1	0.97000000	.
6	5	1.13400000	0.34151135
7	4	1.15500000	0.14177447
8	4	1.12000000	0.27724838

Cotton candy flavor

Source	DF	Type III SS	Mean Square	F Value	Pr > F
cluster	7	1.46007265	0.20858181	3.37	0.0164

Means with the same letter are not significantly different.			
Duncan Grouping	**Mean**	**N**	**cluster**
A	2.0467	3	2
A			
A	2.0000	2	4
A			
A	1.9243	7	1
A			
A	1.7225	4	7
A			
A	1.6400	1	3
A			
A	1.5625	4	8
A			
A	1.5580	5	6
B	1.0300	1	5

Level of cluster	N	Cotton Candy	
		Mean	Std Dev
1	7	1.92428571	0.31261569
2	3	2.04666667	0.04163332
3	1	1.64000000	.
4	2	2.00000000	0.15556349
5	1	1.03000000	.
6	5	1.55800000	0.11454257
7	4	1.72250000	0.37052890
8	4	1.56250000	0.17914147

Butterscotch flavor

Source	DF	Type III SS	Mean Square	F Value	Pr > F
cluster	7	3.62665566	0.51809367	6.77	0.0004

Means with the same letter are not significantly different.				
Duncan Grouping		Mean	N	cluster
	A	3.8875	4	7
	A			
B	A	3.5300	1	3
B				
B	C	3.2971	7	1
B	C			
B	C	3.2225	4	8
B	C			
B	C	3.1660	5	6
B	C			
B	C	2.9367	3	2
	C			
	C	2.8350	2	4
	D	2.1400	1	5

Level of cluster	N	Butterscotch	
		Mean	Std Dev
1	7	3.29714286	0.20180141
2	3	2.93666667	0.11590226
3	1	3.53000000	.
4	2	2.83500000	0.23334524
5	1	2.14000000	.
6	5	3.16600000	0.36807608
7	4	3.88750000	0.21124630
8	4	3.22250000	0.38853357

Molasses flavor

Source	DF	Type III SS	Mean Square	F Value	Pr > F
cluster	7	5.27620765	0.75374395	8.93	<.0001

Means with the same letter are not significantly different.				
Duncan Grouping		Mean	N	cluster
	A	3.5600	1	5
	A			
B	A	3.4850	4	7
B	A			
B	A	3.3425	4	8
B				
B	C	2.9040	5	6
	C			
D	C	2.7243	7	1
D	C			
D	C	2.4400	1	3
D	C			
D	C	2.3500	2	4
D				
D		2.1567	3	2

Level of cluster	N	Molasses Mean	Molasses Std Dev
1	7	2.72428571	0.19890175
2	3	2.15666667	0.16441817
3	1	2.44000000	.
4	2	2.35000000	0.29698485
5	1	3.56000000	.
6	5	2.90400000	0.27933850
7	4	3.48500000	0.38527047
8	4	3.34250000	0.39423977

Coffee flavor

Source	DF	Type III SS	Mean Square	F Value	Pr > F
cluster	7	4.27535011	0.61076430	11.78	<.0001

Means with the same letter are not significantly different.				
Duncan Grouping		Mean	N	cluster
	A	3.1900	1	3
	B	1.9267	3	2
	B			
C	B	1.6271	7	1
C				
C		1.3900	4	7
C				
C		1.3560	5	6
C				
C		1.3550	4	8
C				
C	D	1.2650	2	4
	D			
	D	0.8300	1	5

Level of cluster	N	Coffee	
		Mean	Std Dev
1	7	1.62714286	0.26550043
2	3	1.92666667	0.09073772
3	1	3.19000000	.
4	2	1.26500000	0.06363961
5	1	0.83000000	.
6	5	1.35600000	0.26340084
7	4	1.39000000	0.28751812
8	4	1.35500000	0.07416198

Dried fruit flavor

Source	DF	Type III SS	Mean Square	F Value	Pr > F
cluster	7	4.32933690	0.61847670	14.14	<.0001

Means with the same letter are not significantly different.				
Duncan Grouping		Mean	N	cluster
	A	2.2200	1	5
	A			
B	A	1.8625	4	8
B				
B	C	1.7400	5	6
B	C			
B	C	1.7150	4	7
	C			
D	C	1.3943	7	1
D				
D	E	0.9833	3	2
	E			
	E	0.8600	1	3
	E			
	E	0.6250	2	4

Level of cluster	N	Dried Fruit	
		Mean	Std Dev
1	7	1.39428571	0.13513662
2	3	0.98333333	0.13650397
3	1	0.86000000	.
4	2	0.62500000	0.02121320
5	1	2.22000000	.
6	5	1.74000000	0.32749046
7	4	1.71500000	0.18448125
8	4	1.86250000	0.22559181

Medicine flavor

Source	DF	Type III SS	Mean Square	F Value	Pr > F
cluster	7	4.07192511	0.58170359	16.10	<.0001

Means with the same letter are not significantly different.				
Duncan Grouping		Mean	N	cluster
	A	1.8760	5	6
	B	1.4450	4	8
	B			
	B	1.2800	1	5
	B			
	B	1.1429	7	1
	B			
C	B	1.1175	4	7
C				
C	D	0.7367	3	2
	D			
	D	0.6900	1	3
	D			
	D	0.6500	2	4

Level of cluster	N	Medicine	
		Mean	Std Dev
1	7	1.14285714	0.23019660
2	3	0.73666667	0.08082904
3	1	0.69000000	.
4	2	0.65000000	0.05656854
5	1	1.28000000	.
6	5	1.87600000	0.26349573
7	4	1.11750000	0.12632630
8	4	1.44500000	0.09433981

Ferment flavor

Source	DF	Type III SS	Mean Square	F Value	Pr > F
cluster	7	4.27845122	0.61120732	20.67	<.0001

Means with the same letter are not significantly different.				
Duncan Grouping		Mean	N	cluster
	A	2.5300	1	5
	B	1.5000	4	8
	B			
	B	1.4220	5	6
	B			
C	B	1.1400	4	7
C				
C	D	1.0071	7	1
	D			
	D	0.6733	3	2
	D			
	D	0.6700	1	3
	D			
	D	0.6700	2	4

Level of cluster	N	Ferment	
		Mean	Std Dev
1	7	1.00714286	0.16928421
2	3	0.67333333	0.13650397
3	1	0.67000000	.
4	2	0.67000000	0.00000000
5	1	2.53000000	.
6	5	1.42200000	0.15896541
7	4	1.14000000	0.12192894
8	4	1.50000000	0.26267851

Plastic flavor

Source	DF	Type III SS	Mean Square	F Value	Pr > F
cluster	7	5.15949487	0.73707070	8.06	0.0001

Means with the same letter are not significantly different.				
Duncan Grouping		Mean	N	cluster
	A	1.9420	5	6
	A			
B	A	1.3900	1	5
B				
B		1.2225	4	8
B				
B	C	1.0757	7	1
B	C			
B	C	0.9425	4	7
B	C			
B	C	0.7400	3	2
	C			
	C	0.5300	1	3
	C			
	C	0.5000	2	4

Level of cluster	N	Plastic	
		Mean	Std Dev
1	7	1.07571429	0.24764606
2	3	0.74000000	0.14106736
3	1	0.53000000	.
4	2	0.50000000	0.04242641
5	1	1.39000000	.
6	5	1.94200000	0.52313478
7	4	0.94250000	0.17876894
8	4	1.22250000	0.21360009

Worcester sauce flavor

Source	DF	Type III SS	Mean Square	F Value	Pr > F
cluster	7	8.24800955	1.17828708	39.20	<.0001

Means with the same letter are not significantly different.				
Duncan Grouping		**Mean**	**N**	**cluster**
	A	3.5600	1	5
	B	2.1325	4	8
	B			
C	B	1.8280	5	6
C				
C	D	1.6350	4	7
	D			
E	D	1.3229	7	1
E				
E	F	1.0333	3	2
	F			
	F	0.8900	1	3
	F			
	F	0.8900	2	4

Level of cluster	N	Worcester Sauce	
		Mean	**Std Dev**
1	7	1.32285714	0.19788164
2	3	1.03333333	0.13650397
3	1	0.89000000	.
4	2	0.89000000	0.00000000
5	1	3.56000000	.
6	5	1.82800000	0.19447365
7	4	1.63500000	0.11902381
8	4	2.13250000	0.18714967

Soy sauce flavor

Source	DF	Type III SS	Mean Square	F Value	Pr > F
cluster	7	2.73242503	0.39034643	8.74	<.0001

Means with the same letter are not significantly different.				
Duncan Grouping		Mean	N	cluster
	A	2.0800	1	5
	A			
	A	1.9300	4	8
	A			
B	A	1.6280	5	6
B	A			
B	A	1.6250	4	7
B				
B	C	1.4586	7	1
	C			
D	C	1.1667	3	2
D	C			
D	C	1.0800	1	3
D				
D		0.7950	2	4

Level of cluster	N	Soy Sauce	
		Mean	Std Dev
1	7	1.45857143	0.24484203
2	3	1.16666667	0.09712535
3	1	1.08000000	.
4	2	0.79500000	0.02121320
5	1	2.08000000	.
6	5	1.62800000	0.12477981
7	4	1.62500000	0.19052559
8	4	1.93000000	0.31527766

Herb flavor

Source	DF	Type III SS	Mean Square	F Value	Pr > F
cluster	7	1.24509566	0.17787081	12.29	<.0001

Means with the same letter are not significantly different.					
Duncan Grouping			Mean	N	cluster
	A		1.6400	1	5
	B		1.2980	5	6
	B				
	B		1.2775	4	8
	B				
C	B		1.0825	4	7
C					
C	D		1.0129	7	1
C	D				
C	D	E	0.8300	1	3
	D	E			
	D	E	0.8167	3	2
		E			
		E	0.7350	2	4

Level of cluster	N	Herb	
		Mean	Std Dev
1	7	1.01285714	0.14115173
2	3	0.81666667	0.10016653
3	1	0.83000000	.
4	2	0.73500000	0.02121320
5	1	1.64000000	.
6	5	1.29800000	0.16407315
7	4	1.08250000	0.06020797
8	4	1.27750000	0.07365460

Wood flavor

Source	DF	Type III SS	Mean Square	F Value	Pr > F
cluster	7	0.94971677	0.13567382	13.74	<.0001

Means with the same letter are not significantly different.				
Duncan Grouping		Mean	N	cluster
	A	1.14400	5	6
	A			
	A	1.00000	1	5
	A			
	A	0.98000	4	7
	A			
B	A	0.96000	4	8
B				
B	C	0.76286	7	1
	C			
	C	0.64000	1	3
	C			
	C	0.61500	2	4
	C			
	C	0.60333	3	2

Level of cluster	N	Wood	
		Mean	Std Dev
1	7	0.76285714	0.11729085
2	3	0.60333333	0.09073772
3	1	0.64000000	.
4	2	0.61500000	0.07778175
5	1	1.00000000	.
6	5	1.14400000	0.08561542
7	4	0.98000000	0.08124038
8	4	0.96000000	0.10551461

Iron flavor

Source	DF	Type III SS	Mean Square	F Value	Pr > F
cluster	7	0.42621153	0.06088736	8.00	0.0001

Means with the same letter are not significantly different.				
Duncan Grouping		Mean	N	cluster
	A	0.97800	5	6
	B	0.79000	4	8
	B			
C	B	0.72000	1	3
C	B			
C	B	0.69571	7	1
C	B			
C	B	0.69500	4	7
C	B			
C	B	0.64000	1	5
C	B			
C	B	0.62000	3	2
C				
C		0.57000	2	4

Level of cluster	N	Iron	
		Mean	Std Dev
1	7	0.69571429	0.06267832
2	3	0.62000000	0.01732051
3	1	0.72000000	.
4	2	0.57000000	0.05656854
5	1	0.64000000	.
6	5	0.97800000	0.10134101
7	4	0.69500000	0.13279056
8	4	0.79000000	0.08793937

11.Sensory profiles of Thai honey based on clusters for every attributes with physicochemical analysis

Viscosity

Source	DF	Type III SS	Mean Square	F Value	Pr > F
cluster	7	32.23595324	4.60513618	12.41	<.0001

Means with the same letter are not significantly different.				
Duncan Grouping		Mean	N	cluster
	A	12.0533	3	1
	A			
B	A	11.5467	3	2
B				
B	C	10.7688	8	4
B	C			
B	C	10.7500	2	6
	C			
	C	10.2550	4	3
	C			
	C	10.1567	3	7
	D	8.5000	1	5
	D			
	D	8.1600	3	8

Level of cluster	N	Viscosity	
		Mean	Std Dev
1	3	12.0533333	0.15176737
2	3	11.5466667	0.68922662
3	4	10.2550000	0.57535496
4	8	10.7687500	0.74923652
5	1	8.5000000	.
6	2	10.7500000	0.08485281
7	3	10.1566667	0.58517804
8	3	8.1600000	0.46808119

Sweetness

Source	DF	Type III SS	Mean Square	F Value	Pr > F
cluster	7	0.90310463	0.12901495	3.41	0.0156

Means with the same letter are not significantly different.					
Duncan Grouping			Mean	N	cluster
	A		7.9925	4	3
	A				
B	A		7.7500	3	7
B	A				
B	A		7.7250	2	6
B	A				
B	A	C	7.7050	8	4
B	A	C			
B	A	C	7.6467	3	8
B	A	C			
B	A	C	7.6100	3	2
B		C			
B		C	7.4200	1	5
		C			
		C	7.3133	3	1

Level of cluster	N	Sweetness	
		Mean	Std Dev
1	3	7.31333333	0.16441817
2	3	7.61000000	0.21702534
3	4	7.99250000	0.15585784
4	8	7.70500000	0.22884805
5	1	7.42000000	.
6	2	7.72500000	0.12020815
7	3	7.75000000	0.12165525
8	3	7.64666667	0.20840665

Sourness

Source	DF	Type III SS	Mean Square	F Value	Pr > F
cluster	7	4.99389630	0.71341376	66.84	<.0001

Means with the same letter are not significantly different.				
Duncan Grouping		Mean	N	cluster
	A	2.83000	1	5
	B	1.15000	3	7
	B			
	B	1.05667	3	8
	B			
C	B	0.96000	2	6
C	B			
C	B	0.95000	4	3
C				
C		0.83500	8	4
	D	0.53667	3	1
	D			
	D	0.46333	3	2

Level of cluster	N	Sourness	
		Mean	Std Dev
1	3	0.53666667	0.04041452
2	3	0.46333333	0.04041452
3	4	0.95000000	0.20049938
4	8	0.83500000	0.07540368
5	1	2.83000000	.
6	2	0.96000000	0.05656854
7	3	1.15000000	0.09539392
8	3	1.05666667	0.08504901

Bitterness

Source	DF	Type III SS	Mean Square	F Value	Pr > F
cluster	7	3.11088796	0.44441257	10.39	<.0001

Means with the same letter are not significantly different.				
Duncan Grouping		Mean	N	cluster
	A	1.6400	2	6
	B	1.1833	3	8
	B			
C	B	0.9633	3	7
C	B			
C	B	0.8750	8	4
C				
C	D	0.7575	4	3
	D			
	D	0.4200	1	5
	D			
	D	0.4167	3	2
	D			
	D	0.3633	3	1

Level of cluster	N	Bitterness	
		Mean	Std Dev
1	3	0.36333333	0.05507571
2	3	0.41666667	0.08504901
3	4	0.75750000	0.13573872
4	8	0.87500000	0.28913665
5	1	0.42000000	.
6	2	1.64000000	0.04242641
7	3	0.96333333	0.05859465
8	3	1.18333333	0.26764404

Saltiness

Source	DF	Type III SS	Mean Square	F Value	Pr > F
cluster	7	0.07103750	0.01014821	4.40	0.0047

Means with the same letter are not significantly different.				
Duncan Grouping		Mean	N	cluster
	A	0.33000	1	5
	A			
	A	0.31667	3	7
	A			
	A	0.31250	4	3
	A			
B	A	0.27667	3	8
B	A			
B	A	0.25000	2	6
B				
B		0.21125	8	4
B				
B		0.19333	3	1
B				
B		0.18667	3	2

Level of cluster	N	Saltiness	
		Mean	Std Dev
1	3	0.19333333	0.04618802
2	3	0.18666667	0.08621678
3	4	0.31250000	0.03947573
4	8	0.21125000	0.03181981
5	1	0.33000000	.
6	2	0.25000000	0.04242641
7	3	0.31666667	0.01154701
8	3	0.27666667	0.07371115

Perfume flavor

Source	DF	Type III SS	Mean Square	F Value	Pr > F
cluster	7	0.66718519	0.09531217	7.58	0.0002

Means with the same letter are not significantly different.				
Duncan Grouping		Mean	N	cluster
	A	1.7200	1	5
	A			
B	A	1.6600	3	8
B	A			
B	A	1.5600	4	3
B	A			
B	A	1.4975	8	4
B				
B		1.4833	3	7
B				
B		1.4550	2	6
	C	1.1933	3	1
	C			
	C	1.1933	3	2

Level of cluster	N	Perfume	
		Mean	Std Dev
1	3	1.19333333	0.05507571
2	3	1.19333333	0.12662280
3	4	1.56000000	0.04000000
4	8	1.49750000	0.15144542
5	1	1.72000000	.
6	2	1.45500000	0.02121320
7	3	1.48333333	0.07094599
8	3	1.66000000	0.11135529

Fruit flavor

Source	DF	Type III SS	Mean Square	F Value	Pr > F
cluster	7	4.64424769	0.66346396	23.17	<.0001

Means with the same letter are not significantly different.				
Duncan Grouping		Mean	N	cluster
	A	2.5300	1	5
	B	2.0933	3	8
	B			
C	B	1.8550	4	3
C	B			
C	B	1.8300	3	7
C				
C	D	1.6150	2	6
	D			
	D	1.4938	8	4
	E	1.1033	3	1
	E			
	E	0.8233	3	2

Level of cluster	N	Fruit	
		Mean	Std Dev
1	3	1.10333333	0.20840665
2	3	0.82333333	0.11060440
3	4	1.85500000	0.14479871
4	8	1.49375000	0.19257188
5	1	2.53000000	.
6	2	1.61500000	0.27577164
7	3	1.83000000	0.11000000
8	3	2.09333333	0.07094599

Flora flavor

Source	DF	Type III SS	Mean Square	F Value	Pr > F
cluster	7	1.57514491	0.22502070	6.57	0.0005

Means with the same letter are not significantly different.				
Duncan Grouping		Mean	N	cluster
	A	2.0100	3	1
	B	1.6000	2	6
	B			
	B	1.5938	8	4
	B			
C	B	1.5000	3	7
C	B			
C	B	1.4200	1	5
C	B			
C	B	1.2975	4	3
C	B			
C	B	1.2967	3	8
C				
C		1.1300	3	2

Level of cluster	N	Flora	
		Mean	Std Dev
1	3	2.01000000	0.28053520
2	3	1.13000000	0.03464102
3	4	1.29750000	0.07455423
4	8	1.59375000	0.18157545
5	1	1.42000000	.
6	2	1.60000000	0.41012193
7	3	1.50000000	0.15716234
8	3	1.29666667	0.11372481

Jasmine flavor

Source	DF	Type III SS	Mean Square	F Value	Pr > F
cluster	7	15.74134074	2.24876296	19.29	<.0001

Means with the same letter are not significantly different.				
Duncan Grouping		Mean	N	cluster
	A	3.5833	3	1
	B	1.7625	8	4
	B			
C	B	1.3333	3	2
C	B			
C	B	1.2650	2	6
C	B			
C	B	1.2067	3	7
C	B			
C	B	1.1400	4	3
C				
C		0.9700	1	5
C				
C		0.8733	3	8

Level of cluster	N	Jasmine	
		Mean	Std Dev
1	3	3.58333333	0.43650124
2	3	1.33333333	0.15176737
3	4	1.14000000	0.15748016
4	8	1.76250000	0.44332349
5	1	0.97000000	.
6	2	1.26500000	0.41719300
7	3	1.20666667	0.28041636
8	3	0.87333333	0.05686241

Cotton candy flavor

Source	DF	Type III SS	Mean Square	F Value	Pr > F
cluster	7	1.40299907	0.20042844	3.09	0.0237

Means with the same letter are not significantly different.				
Duncan Grouping		Mean	N	cluster
	A	2.0467	3	1
	A			
B	A	1.8950	8	4
B	A			
B	A	1.8800	3	2
B	A			
B	A	1.7375	4	3
B	A			
B	A	1.6200	3	7
B				
B	C	1.5100	2	6
B	C			
B	C	1.4700	3	8
	C			
	C	1.0300	1	5

Level of cluster	N	Cotton Candy	
		Mean	Std Dev
1	3	2.04666667	0.04163332
2	3	1.88000000	0.23515952
3	4	1.73750000	0.36399405
4	8	1.89500000	0.30104580
5	1	1.03000000	.
6	2	1.51000000	0.09899495
7	3	1.62000000	0.11532563
8	3	1.47000000	0.15716234

Butterscotch flavor

Source	DF	Type III SS	Mean Square	F Value	Pr > F
cluster	7	2.89204352	0.41314907	3.59	0.0125

Means with the same letter are not significantly different.				
Duncan Grouping		Mean	N	cluster
	A	3.6875	4	3
	A			
B	A	3.5833	3	7
B	A			
B	A	3.3050	8	4
B	A			
B	A	3.1100	2	6
B	A			
B	A	3.0667	3	2
B	A			
B	A	3.0633	3	8
B				
B		2.9367	3	1
	C	2.1400	1	5

Level of cluster	N	Butterscotch Mean	Butterscotch Std Dev
1	3	2.93666667	0.11590226
2	3	3.06666667	0.43385866
3	4	3.68750000	0.54217924
4	8	3.30500000	0.18814888
5	1	2.14000000	.
6	2	3.11000000	0.15556349
7	3	3.58333333	0.26312228
8	3	3.06333333	0.49662192

Molasses flavor

Source	DF	Type III SS	Mean Square	F Value	Pr > F
cluster	7	5.28576991	0.75510999	9.00	<.0001

Means with the same letter are not significantly different.					
Duncan Grouping			Mean	N	cluster
	A		3.6300	3	7
	A				
B	A		3.5600	1	5
B	A				
B	A	C	3.2850	4	3
B		C			
B		C	3.0250	2	6
		C			
	D	C	2.9167	3	8
	D	C			
	D	C	2.7588	8	4
	D				
E	D		2.3800	3	2
E					
E			2.1567	3	1

Level of cluster	N	Molasses	
		Mean	Std Dev
1	3	2.15666667	0.16441817
2	3	2.38000000	0.21633308
3	4	3.28500000	0.49169774
4	8	2.75875000	0.20835667
5	1	3.56000000	.
6	2	3.02500000	0.27577164
7	3	3.63000000	0.03464102
8	3	2.91666667	0.41137979

Coffee flavor

Source	DF	Type III SS	Mean Square	F Value	Pr > F
cluster	7	2.00127546	0.28589649	1.67	0.1774

Means with the same letter are not significantly different.				
Duncan Grouping		Mean	N	cluster
	A	1.9267	3	1
	A			
	A	1.9067	3	2
	A			
B	A	1.6213	8	4
B	A			
B	A	1.5300	2	6
B	A			
B	A	1.3900	4	3
B	A			
B	A	1.3333	3	7
B	A			
B	A	1.1867	3	8
B				
B		0.8300	1	5

Level of cluster	N	Coffee	
		Mean	Std Dev
1	3	1.92666667	0.09073772
2	3	1.90666667	1.11230991
3	4	1.39000000	0.28751812
4	8	1.62125000	0.24637008
5	1	0.83000000	.
6	2	1.53000000	0.00000000
7	3	1.33333333	0.07371115
8	3	1.18666667	0.20599353

Dried fruit flavor

Source	DF	Type III SS	Mean Square	F Value	Pr > F
cluster	7	4.47630000	0.63947143	17.76	<.0001

Means with the same letter are not significantly different.				
Duncan Grouping		Mean	N	cluster
	A	2.2200	1	5
	A			
B	A	1.9167	3	8
B				
B		1.8050	4	3
B				
B		1.7900	3	7
B				
B	C	1.6250	2	6
	C			
	C	1.3975	8	4
	D	0.9833	3	1
	D			
	D	0.7033	3	2

Level of cluster	N	Dried Fruit	
		Mean	Std Dev
1	3	0.98333333	0.13650397
2	3	0.70333333	0.13650397
3	4	1.80500000	0.29871949
4	8	1.39750000	0.12544208
5	1	2.22000000	.
6	2	1.62500000	0.09192388
7	3	1.79000000	0.11135529
8	3	1.91666667	0.31501323

Medicine flavor

Source	DF	Type III SS	Mean Square	F Value	Pr > F
cluster	7	3.93915046	0.56273578	13.05	<.0001

Means with the same letter are not significantly different.				
Duncan Grouping		Mean	N	cluster
	A	2.1250	2	6
	B	1.6367	3	8
	B			
C	B	1.4167	3	7
C	B			
C	B	1.2800	1	5
C				
C		1.2113	8	4
C				
C		1.1325	4	3
	D	0.7367	3	1
	D			
	D	0.6633	3	2

Level of cluster	N	Medicine	
		Mean	Std Dev
1	3	0.73666667	0.08082904
2	3	0.66333333	0.04618802
3	4	1.13250000	0.14885675
4	8	1.21125000	0.28782125
5	1	1.28000000	.
6	2	2.12500000	0.17677670
7	3	1.41666667	0.14742230
8	3	1.63666667	0.20108042

Ferment flavor

Source	DF	Type III SS	Mean Square	F Value	Pr > F
cluster	7	4.16150741	0.59450106	16.64	<.0001

Means with the same letter are not significantly different.				
Duncan Grouping		Mean	N	cluster
	A	2.5300	1	5
	B	1.5000	3	8
	B			
	B	1.4833	3	7
	B			
C	B	1.3450	2	6
C	B			
C	B	1.1950	4	3
C				
C	D	1.0375	8	4
	D			
	D	0.6733	3	1
	D			
	D	0.6700	3	2

Level of cluster	N	Ferment Mean	Ferment Std Dev
1	3	0.67333333	0.13650397
2	3	0.67000000	0.00000000
3	4	1.19500000	0.16421531
4	8	1.03750000	0.17870566
5	1	2.53000000	.
6	2	1.34500000	0.02121320
7	3	1.48333333	0.37898989
8	3	1.50000000	0.15716234

Plastic flavor

Source	DF	Type III SS	Mean Square	F Value	Pr > F
cluster	7	5.46155463	0.78022209	10.33	<.0001

Means with the same letter are not significantly different.					
Duncan Grouping			Mean	N	cluster
	A		2.4200	2	6
	B		1.4267	3	8
	B				
	B		1.3900	1	5
	B				
C	B		1.2700	3	7
C	B				
C	B		1.1500	8	4
C	B				
C	B	D	0.9425	4	3
C		D			
C		D	0.7400	3	1
		D			
		D	0.5100	3	2

Level of cluster	N	Plastic	
		Mean	Std Dev
1	3	0.74000000	0.14106736
2	3	0.51000000	0.03464102
3	4	0.94250000	0.17876894
4	8	1.15000000	0.31098921
5	1	1.39000000	.
6	2	2.42000000	0.35355339
7	3	1.27000000	0.23430749
8	3	1.42666667	0.43878620

Worcester sauce flavor

Source	DF	Type III SS	Mean Square	F Value	Pr > F
cluster	7	8.06396157	1.15199451	28.99	<.0001

Means with the same letter are not significantly different.				
Duncan Grouping		Mean	N	cluster
	A	3.5600	1	5
	B	2.0667	3	7
	B			
	B	2.0667	3	8
	B			
C	B	1.7350	2	6
C				
C		1.6475	4	3
C				
C	D	1.3763	8	4
	D			
E	D	1.0333	3	1
E				
E		0.8900	3	2

Level of cluster	N	Worcester Sauce	
		Mean	Std Dev
1	3	1.03333333	0.13650397
2	3	0.89000000	0.00000000
3	4	1.64750000	0.14361407
4	8	1.37625000	0.23742292
5	1	3.56000000	.
6	2	1.73500000	0.21920310
7	3	2.06666667	0.22368132
8	3	2.06666667	0.23797759

Soy sauce flavor

Source	DF	Type III SS	Mean Square	F Value	Pr > F
cluster	7	2.48708241	0.35529749	6.17	0.0007

Means with the same letter are not significantly different.					
Duncan Grouping			Mean	N	cluster
	A		2.0800	1	5
	A				
B	A		1.8967	3	7
B	A				
B	A		1.7333	3	8
B	A				
B	A	C	1.6250	2	6
B	A	C			
B	A	C	1.5975	4	3
B		C			
B		C	1.5050	8	4
		C			
	D	C	1.1667	3	1
	D				
	D		0.8900	3	2

Level of cluster	N	Soy Sauce	
		Mean	Std Dev
1	3	1.16666667	0.09712535
2	3	0.89000000	0.16522712
3	4	1.59750000	0.19551215
4	8	1.50500000	0.26197055
5	1	2.08000000	.
6	2	1.62500000	0.02121320
7	3	1.89666667	0.29569128
8	3	1.73333333	0.35345910

Herb flavor

Source	DF	Type III SS	Mean Square	F Value	Pr > F
cluster	7	1.27691435	0.18241634	14.26	<.0001

Means with the same letter are not significantly different.					
Duncan Grouping			Mean	N	cluster
	A		1.6400	1	5
	B		1.3900	3	8
	B				
C	B		1.2750	2	6
C	B				
C	B	D	1.2300	3	7
C		D			
C		D	1.1100	4	3
		D			
	E	D	1.0213	8	4
	E				
F	E		0.8167	3	1
F					
F			0.7667	3	2

Level of cluster	N	Herb Mean	Herb Std Dev
1	3	0.81666667	0.10016653
2	3	0.76666667	0.05686241
3	4	1.11000000	0.10424331
4	8	1.02125000	0.13281970
5	1	1.64000000	.
6	2	1.27500000	0.12020815
7	3	1.23000000	0.11532563
8	3	1.39000000	0.09848858

Wood flavor

Source	DF	Type III SS	Mean Square	F Value	Pr > F
cluster	7	0.90830880	0.12975840	10.77	<.0001

Means with the same letter are not significantly different.				
Duncan Grouping		Mean	N	cluster
	A	1.15000	3	8
	A			
	A	1.15000	2	6
	A			
B	A	1.00000	1	5
B	A			
B	A	0.99333	3	7
B	A			
B	A	0.93000	4	3
B				
B	C	0.79625	8	4
	C			
	C	0.62333	3	2
	C			
	C	0.60333	3	1

Level of cluster	N	Woody	
		Mean	Std Dev
1	3	0.60333333	0.09073772
2	3	0.62333333	0.05686241
3	4	0.93000000	0.09966611
4	8	0.79625000	0.14391838
5	1	1.00000000	.
6	2	1.15000000	0.09899495
7	3	0.99333333	0.06350853
8	3	1.15000000	0.08185353

Iron flavor

Source	DF	Type III SS	Mean Square	F Value	Pr > F
cluster	7	0.43347963	0.06192566	8.57	<.0001

Means with the same letter are not significantly different.			
Duncan Grouping	**Mean**	**N**	**cluster**
A	1.00000	2	6
A			
A	0.98333	3	8
B	0.77667	3	7
B			
B	0.71250	8	4
B			
B	0.68000	4	3
B			
B	0.64000	1	5
B			
B	0.62000	3	1
B			
B	0.62000	3	2

Level of cluster	N	Iron	
		Mean	Std Dev
1	3	0.62000000	0.01732051
2	3	0.62000000	0.09539392
3	4	0.68000000	0.11803954
4	8	0.71250000	0.07497619
5	1	0.64000000	.
6	2	1.00000000	0.11313708
7	3	0.77666667	0.07571878
8	3	0.98333333	0.08082904

Degrees Brix

Source	DF	Type III SS	Mean Square	F Value	Pr > F
cluster	7	112.4137500	16.0591071	40.94	<.0001

Means with the same letter are not significantly different.				
Duncan Grouping		Mean	N	cluster
	A	80.8333	3	2
	A			
	A	80.7667	3	1
	A			
B	A	79.6375	8	4
B				
B		79.5000	2	6
B				
B		79.4667	3	7
B				
B		79.1750	4	3
	C	75.2000	1	5
	C			
	C	74.0333	3	8

Level of cluster	N	Brix	
		Mean	Std Dev
1	3	80.7666667	0.05773503
2	3	80.8333333	0.90737717
3	4	79.1750000	0.34034296
4	8	79.6375000	0.79271234
5	1	75.2000000	.
6	2	79.5000000	0.70710678
7	3	79.4666667	0.46188022
8	3	74.0333333	0.25166115

L* value

Source	DF	Type III SS	Mean Square	F Value	Pr > F
cluster	7	5210.986567	744.426652	5.39	0.0016

Means with the same letter are not significantly different.				
Duncan Grouping		Mean	N	cluster
	A	44.86	4	3
	A			
	A	43.77	3	2
	A			
	A	43.06	3	1
	A			
	A	42.46	2	6
	A			
B	A	40.05	8	4
B				
B	C	18.52	3	8
	C			
	C	8.75	3	7
	C			
	C	0.19	1	5

Level of cluster	N	L	
		Mean	Std Dev
1	3	43.0566667	14.2303982
2	3	43.7700000	10.4916109
3	4	44.8575000	11.7037384
4	8	40.0537500	7.5826907
5	1	0.1900000	.
6	2	42.4600000	22.3587164
7	3	8.7533333	5.2579495
8	3	18.5233333	17.7516769

a* value

Source	DF	Type III SS	Mean Square	F Value	Pr > F
cluster	7	1450.616750	207.230964	7.35	0.0002

Means with the same letter are not significantly different.				
Duncan Grouping		Mean	N	cluster
	A	31.960	2	6
	A			
B	A	22.945	4	3
B	A			
B	A	22.687	3	7
B				
B		20.517	3	8
B				
B	C	14.948	8	4
B	C			
B	C	12.293	3	1
	C			
D	C	5.863	3	2
D				
D		1.020	1	5

Level of cluster	N	a	
		Mean	Std Dev
1	3	12.2933333	6.20158313
2	3	5.8633333	1.57179303
3	4	22.9450000	7.43550267
4	8	14.9475000	4.55537908
5	1	1.0200000	.
6	2	31.9600000	5.30330086
7	3	22.6866667	6.89769043
8	3	20.5166667	3.12448929

b* value

Source	DF	Type III SS	Mean Square	F Value	Pr > F
cluster	7	10576.33535	1510.90505	5.36	0.0016

Means with the same letter are not significantly different.					
Duncan Grouping			Mean	N	cluster
	A		72.04	2	6
	A				
	A		71.84	4	3
	A				
B	A		55.27	8	4
B	A				
B	A		53.87	3	1
B	A				
B	A	C	42.28	3	2
B		C			
B	D	C	29.76	3	8
	D	C			
	D	C	15.08	3	7
	D				
	D		0.32	1	5

Level of cluster	N	b	
		Mean	Std Dev
1	3	53.8666667	11.0482593
2	3	42.2766667	12.4063304
3	4	71.8375000	21.5584483
4	8	55.2737500	7.5148880
5	1	0.3200000	.
6	2	72.0350000	37.3988777
7	3	15.0766667	9.0485211
8	3	29.7600000	26.9831132