Lexicon Development for Thai Dessert

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Introduction

Thai cuisine is considered to be one of the most well-known class of food worldwide. Without any doubt, savory dishes such as tom yum kung and pad thai are very popular among foreigners. Desserts are also becoming well liked especially the famous sticky rice with mango. In order to heighten the status and quality of Thai cuisine, Thai Delicious unit, under the collaboration of Thailand Sensory Network and the Department of Science Service (Ministry of Science and Technology) see the need to set a standard for Thai food and desserts. To date, there is very little amount of research on the properties of Thai food and desserts in all aspects, especially in sensory properties. Complying to such intention and to add insights with literature, this research will explore the sensory properties of Thai desserts as a starting point as desserts have less variation from ingredients and processing method than most savory dishes. As a matter of fact, flour-based Thai dessert will be the main focus in the research since it is perhaps the largest group among Thai desserts. Thai desserts are unique, yet there is a lack of sufficient information to form a standard for Thai desserts in terms of sensory properties. Accordingly, this affects, to a certain extent, the development of Thai desserts to be commercialized internationally as well as the potential to modernize Thai desserts to adapt with other traditions and cuisines as to promote these desserts globally.

The sensory properties of foods are generally affected by many factors, such as raw materials, processing method, and storage condition. An appropriate and common mean to examine the sensory properties of any food products is to conduct descriptive analysis. The main objective of descriptive analysis is to obtain a detail description of the sensory characteristics of a set of products, which can be further used to explain the differences between products, how raw materials, process, and packaging affect the sensory characteristics of a product, key factors that drive consumer acceptance (Sensory Analysis Center, 2015). The results obtained from this research will benefit academia and industry in several ways, including providing useful information for future research involving Thai dessert formulation and process development and determining the effects of raw materials, processing method, shelf-life, packaging, and storage condition on the characteristics of Thai desserts. Future research in sensory analysis of Thai desserts could use the results of this study as a database. Therefore, the objectives of this study are to examine the consumer perception of sensory characteristics of flour-based Thai dessert and to develop a lexicon for describing the sensory characteristics of Thai desserts.

Literature Review

Types and processing methods for Thai desserts

Thai desserts have unique characteristics which are typically made from flour, bean, egg, sugar, and coconut milk. They can be arranged into various categories depending on the main ingredients and processing technique. When classify according to the main ingredient, Thai desserts could be categorized into four categories, flour-based, egg-based, bean-based, and fruit-based. Of those categories, flour-based appeared to be the largest group and could be further divide into six categories on the basis of the type of flour; rice flour, glutinous rice flour, cassava starch, mungbean starch, arrowroot starch, and wheat flour (Horapa, 2012). Different types of flour based give rise to variation in the textural properties of Thai desserts. For instance, kanom kluay, which is made from rice flour, is less sticky than kanom tuapaab, which is made from glutinous rice flour due to the differences in the amount of amylose and amylopectin as well as the ability to absorb water (Rice Knowledge Bank, nd). The ratio of amylose and amylopectin affects the gelatinization and retrogradation of starch in which low amount of amylose and high amount of amylopectin generally makes the dessert sticky. In addition, within the same type of flour, processing technique will further differentiate one Thai dessert from another. Some common processing technique includes steaming (e.g. kanom chan), boiling (e.g. kanom tom), baking (e.g. kanom dok lum duan), frying (e.g. kanom fak bua), and grilling (e.g. kanom jak).

Thai desserts have been continuously developed, both household level and industrialized, to serve the growing market domestically and internationally. Thus a number of studies have been done on certain type of Thai desserts, focusing mainly on determining the effects of types of starch on the qualities of the Thai dessert (Vatanasuchart et al., 2010, Jangchub et al., 2004, Sook-aim, N., Manarote, A., and Wangnippanto, W., 2001). A few other studies examined the physical, chemical, sensory properties and consumer perceptions of some Thai desserts (Jantathai et al., 2014, Lhieochaiphant et al., 2011, Watcharananun et al., 2009). To date, very few research study the sensory characteristics of Thai desserts.

Lexicon development and descriptive analysis

The study of the sensory characteristics will lead to the development of lexicon and sensory profile, which have been done in many product categories such as green tea, soy sauce, almond, honey, cheese, instant tom yum soup, and among others (Kitsawad and Tuntisripreecha, 2016, Cherdchu et al., 2013, Civille et al., 2010, Lee and Chambers, 2007, Galan-Soldevilla et al., 2005,). The lexicon can be obtained through conducting common sensory method as descriptive analysis. It not only create standard language or vocabulary to describe the sensory characteristics of a product category, but also provide definitions of those vocabulary so as to make it easier to understand and form the same concept of such vocabulary. One of the benefits of developing a lexicon is that different panels would be also to use the same lexicon describing a product category. Moreover, establishing a sensory profile of various product categories have been cited to help researchers and product developers to understand the product quality and key factors that drive consumer acceptance of the products (Kwak et al., 2016, Shepard, et al., 2013, Lee et al., 2012, Lattey, et al., 2010).

Despite the advantages of generic descriptive analysis, it is a rather time-consuming process due to intensive training of panelists to establish consensus understanding of sensory attributes as well as intensity scoring. In addition, after training and prior to product evaluation, the panelists must be assessed for their performances in the ability to discriminate, repeatability, and consistency (Lawless and Heymann, 2010). In cases in which the panelists were not qualify in the state performances, training must be continued. Consequently, generic descriptive analysis process could take up to six months. Another disadvantage of generic descriptive analysis is the high cost in panel development and maintenance. New alternative methods to generic descriptive analysis have been developed which are as efficient as descriptive analysis in providing the sensory profiles of product categories, yet faster. Some examples of the methods are flash profiling method, sorting technique, projective mapping or napping, and check-all-that-apply method (Ares et al., 2010; Dooley et al., 2010, Lelie`vre et al., 2008; Abdi et al., 2007; Blancher et al., 2007; Dairou & Sieffermann, 2002; Chollet and Valentin, 2001; Tang &Heymann, 1999; Lawless et al., 1995).

Alternative methods for descriptive analysis

The flash profile have been developed as a method that providing a quick access to the relative sensory positioning of a products set. In addition, these techniques no need to trained panels on a specific product. This method force panel to creating attributes to describe the product. Panels rank intense the products from the low to the high intense in each attribute that they chose by themselves. The benefits of this method it have only one step to familiarization with the product space, attribute generation, and rating so it is get a can be product map in a very short time. Moreover, this technique, it have some disadvantage for some case that product should presentation of the whole set, when at a time have only one product. However, as in free choice profiling, diversity of the vocabulary it make difficult to analyze the sensory characteristic of the product (Dairou & Sieffermann, 2002).

Projective mapping or napping have been developed by Risvik and Collaborators (Kennedy & Heymann, 2009; Risvik et al., 1997; Risvik et al., 1994). In this method, panels are asked to position the sample in a map with two dimensions due to intensity of the dissimilarity and similarity of each product in the whole set. Normally, PCA can be use to analyzed projective mapping for study coordinates of each product on the map but recently can be use MFA because projective mapping takes data account in differences between panels but pervious technique could be used. For advantages in this technique quit same to flash profile. Moreover this method forces the panels to describe dissimilarity and similarity of products by using only two dimensions (Perrin et al., 2008). For disadvantage are linked to the comparative basis of this method. All of product can be available at the same time (Ares et al., 2011). Moreover, in consumer perception of probiotic yogurt paper, show Napping have some limit discrimination of sample (Cruz et al., 2013).

Sorting method is an easy and simple classification technique (Coxon, 1999) for collect similar data in each panel group base on their perceived. Sorting tasks have also been used to get information about the sensory characteristics of food products in sensory (Lawless et al., 1995; Schiffman et al., 1981) which was used for create the mapping of the product space and to interpret the under dimensions. This method can be applied to a wide range of complex products including cheese (Lawless et al., 1995), wine (Gawel et al., 2001), and yogurt (Saint-Eve et al., 2004). There are several advantages and disadvantages of free sorting method. For advantage, it obtained common and natural

process which easy for participants to do (Coxon, 1999), and it does not require heavy training panels and less fatigue for consumers (Bijmolt & Wedel, 1995). On the other hand, samples should be presented simultaneously in a single session and the number of products to be evaluated should be limited if dealing with complex products.

Check All That Apply (CATA) method is a simple alternative way to gather information about sensory characteristic of product by consumers' perception. Products are presented to consumers in monadic sequence, following a balanced rotation order. Consumers are provided with a checklist of predefined terms and asked to try the products and to answer a CATA question by selecting all general attribute word they consider appropriate to describe a product by check or tick (Adams et al., 2007). The selection of the list of words or phrases included in the CATA question were generated and selected based on attributes evaluated by trained assessors. Finally, the attribute result was determined by counting the number of consumers that used word to describe. As this methodology is mainly used with consumers, the number of assessors necessary to perform a sensory characterization using CATA questions ranges from 50 to 100 and the sufficient sample size ranges from 30-50 consumers (Adams et al., 2007; Ares et al., 2010; Dooley et al., 2010). This analysis provides a sensory map of the samples, which enables to determine the similarities and differences between the samples and also the sensory attributes that characterize their sensory attributes (Ares et al., 2010). The advantage of this technique is requires minimal instruction, is relatively easy and faster to perform and is completed quickly (Adams et al.,2007). Moreover, this method gives product characteristic description with less time-consuming and less cost due to it not requires to specific train panel assessor when compared to generic descriptive analysis methods (Chollet, 2011). On the other hand, there are some disadvantages which are might have small discriminative capacity with quite similar attribute product (Dooley et al., 2010), require a relatively large number of consumers, and use with attributes present in the sample in quite not high concentrations due to it would not be able to detect significant differences between samples. This method has been used for the sensory characterization of several food products studies such as strawberry cultivars (Lado et la., 2010), ice-cream (Dooley et al., 2010), milk desserts (Ares et al., 2010), orange-flavored powdered drinks (Ares et al., 2011), citrus-flavored sodas (Plaehn, 2012), and also snacks (Adams et al., 2007).

Materials and Methodology

Participants

Thai dessert consumers were students and staff at Assumption University, which were recruited based on the consumption frequency of at least 2-3 times per month and availability. Frequent users and likers of the product tended to be more thorough in evaluating and providing detailed descriptions of the samples. In addition, for term generation phase, panelists with experience in sensory descriptive analysis were included as part of the group in order to expand the group dynamic and enhance discussion of the perceived sensory characteristics of the samples. All the panelists have passed through at least 75 hours of descriptive analysis. Experienced panelists could assist in development of sensory terms that may be less obvious for naïve consumers to point out. Moreover, experienced panelists could also explain any terms that naïve consumers did not fully understand. A total of 20 panelists participated in the term generation of Check-all-that-apply (CATA) method and 30 consumers participated in the actual CATA test.

Samples

A total of 12 sample commercial flour-based Thai desserts were used which differed in processing method and flour type (Table 1). All samples were served at room temperature on a plastic cup or small plate as needed. If the amount of a certain sample of Thai dessert needed to be used exceeds the amount contains in a package, all of such sample from different packages were mixed together and used in order to minimize any batch to batch variations. Every consumer and panelist received the same amount of samples in a uniform size and shape to minimize any bias. All of the samples used in this study were coded with three-digit random numbers. Water was provided as palate cleanser.

Table 1: List of commercial flour-based Thai desserts.

Thai dessert	Processing method	Type of flour (main ingredient)	Type of other flour
Kanom nam dok mai	Steam	Rice flour	Arrowroot starch
Kanom chun	Steam	Rice flour	Arrowroot starch Cassava starch
Kanom tarn	Steam	Rice flour	-
Kanom tuay	Steam	Rice flour	Arrowroot starch
Kanom faktong	Steam	Rice flour	Cassava starch
Kanom kluay	Steam	Rice flour	Cassava starch
Kanom peakpoon	Stir	Rice flour	Arrowroot starch
Kanom tom	Boil	Glutinous rice flour	-
Kanom niow	Boil	Glutinous rice flour	-
Kanom tuapaab	Boil	Glutinous rice flour	-
Kanom tien	Steam	Glutinous rice flour	-
Kanom babin	Bake	Glutinous rice flour	-

Check-all-that apply method

Check-all-that-apply method was divided into two phases. In the first phase, two group sessions were conducted to generate terms that can be used to describe the Thai dessert samples. The samples were served one at a time and the panelists were instructed to evaluated and describe the samples in terms of sensory characteristics (aroma, taste and flavor, texture), as well as in terms of emotion. After generation of the sensory and emotion terms, discussion about each term and their meaning was carried out to ensure that all of the Thai desserts were fully described and understood by both experienced and naïve consumers. Terms were qualitatively analyzed based on theme and frequency of usage. In addition, the terms with the same definition were categorized together and were listed as one attribute. The list of terms were subjected to frequency analysis to minimize the number of attributes. The terms described by 50% of the panelists were chosen to be the attributes of Thai dessert for the next phase.

Subsequent to the compilation of the CATA list of attributes, the terms in the CATA list were pre-test with naïve consumers in order to ensure that the terms were well-understood. Terms with unclear meaning were clarified and adjusted as necessary. All of the terms were back translated from English to Thai and the final CATA list was presented in both languages. Prior to the evaluation session, the consumers were given a short orientation to further make certain that all the terms in the CATA list were clear and well comprehended. Thai dessert consumers were recruited to evaluate the sensory and emotion characteristics of each product. Each consumer participated in three sessions with a 10 minute break in between sessions. In each session, four Thai desserts were served and evaluated by consumers. The consumers were instructed to assess each dessert and check the perceived sensory and emotion attributes provided in the CATA list. All samples were served according to William Latin Square Design.

Data analysis

Correspondence analysis and Chi-square test were performed using SAS 9.3 (SAS Institute Cary, NC, USA).

Result and Discussion

Thai desserts made from different flour-based and processing methods had been evaluated by trained panels and consumers. The sensory and emotion attributes were generated in order to study the effect of flour type and processing method on Thai desserts sensory profile and characterization.

Generation of check-all-that-apply (CATA) attribute list

The panelists generated and provide descriptions of attributes to explain the sensory characteristics and emotional perception towards 12 Thai desserts (Table 2). A total of 72 attributes were obtained (17 aroma attributes, 20 taste/flavor attributes, 24 texture attributes, 11 emotion attributes). Each group of panelists consisted of experienced panelists who were knowledgeable in sensory descriptive analysis and panelists who were naïve Thai dessert consumers. Experience panelists were better at describing the sensory characteristics of the Thai desserts and therefore helped enrich the group discussion. Naïve consumers tended to describe the Thai desserts using consumer language, resulting in attributes that general consumers would understand more. It is important to note that the same attributes existed in both aroma and taste/flavor characteristics due to the fact that in certain Thai desserts, some attributes were easier perceived through olfaction sense while others could be perceived more in the retronasal cavity. These attributes were used to build the CATA list for further research in characterization of Thai desserts using Thai dessert consumers.

Table 2: The sensory characteristics and emotional attributes of Thai desserts.

Attributes		Descriptions
Aroma	Palm sugar	Aromatics associated with intense sweetness of palm sugar
	Banana leaf	Aromatics associated with heated banana leaf
	Pandan	Aromatics associated with cooked pandan leaf
	Starch	Aromatics associated with raw rice flour
	Cooked starch	Aromatics associated with steamed rice flour
	Coconut	Aromatics associated with freshly peeled coconut shred
	Coconut milk	Aromatics associated with canned coconut milk
	Sweet	Aromatics associated with syrup
	Sour	Aromatics associated with sour aroma of fruit (such as palm)
	Floral	Aromatics associated with flower (i.e. jasmine, nom maew)
	Banana	Aromatics associated with ripped banana
	Pumpkin	Aromatics associated with steamed pumpkin
	Beany	Aromatics associated with cooked mung bean
	Sesame	Aromatics associated with roasted sesame
	Roasted	Aromatics associated with roasted rice
	Caramel	Aromatics associated with burnt sugar
	Spice	Aromatics associated with spice and pepper
Taste/Flavor	Salty (slightly salty)	Basic taste of NaCl solution
	Sweet (slightly sweet, moderately sweet)	Basic taste of sucrose solution
	Umami	Basic taste of monosodium glutamate
	Slightly bitter	Basic taste of caffeine
	Bland	The absence of basic tastes
	Spicy	Tingling feeling on the tongue

Attributes		Descriptions
	Pepper	Hotness
	Pandan	Boiled pandan leaf
	Caramel	Burnt sugar
	Palm sugar	Intense sweetness with slight coconut aroma
	Coconut milk	Canned coconut milk
	Floral	The degree to which the scent of jasmine is perceived
	Banana	Ripped banana
	Pumpkin	Steamed pumpkin
	Beany	Steamed mung bean paste
	Sesame	Roasted white sesame
	Roasted	Roasted rice
Mouthfeel	Sticky	The degree to which the sample adheres to the teeth
	Chewy	The degree and duration of chewing
	Firm	The degree to which force is applied to the sample
	Cohesive	The degree to which the sample forms a mass
	Easy to cut	The degree to which the sample tears apart
	Soft	The degree to which force is applied to the sample
	Hard	The degree to which force is applied to the sample
	Dry	The dry sensation on the tongue
	Crispy	The level of sound during the sample breaks using front teeth
	Paste	The degree of moistness
	Starchy	The degree of starchy particles in the mouth
	Springy	The degree of semisolid
	Spongy	The amount of air cells
	Astringent	The degree of roughness when rubbing tongue to palate
	Fine particle	The amount of particle residues left in the mouth

Attributes		Descriptions
	Fibrous	The degree of fiber (i.e. celery)
	Oily	The degree of slipperiness when rubbing tongue to palate
	Mouth coating	The degree of liquid residue left in the mouth
	Viscous	The degree to which the liquid flows slowly
	Layer	The degree to which the sample breaks as layers
	Melty	The degree to which a semiliquid substance melts consistently
	Toothpacking	The amount of sample that sticks to the teeth
Emotion	Delicious	Good taste, enjoy
	Satisfied	Feeling fulfilled after eating
	Unstoppable	Cannot stop eating
	Culture	Feeling authentic, dated back to ancient times
	Guilty	Feeling ashamed after eating (especially fatty and/or sweet foods)
	Unhealthy	Feeling unhealthy
	Soso	Feeling neither like nor dislike
	Cheap	Feeling that the sample is not made from quality raw materials
	Childhood	Remind of childhood times
	Thai culture	Feeling associated with Thai culture
	Chinese culture	Feeling associated with Chinese culture

Correspondence analysis of Thai dessert showed that approximately 43% of the variation in the data could be explained from the first two dimensions (Dim1 = 25.03% and Dim2 = 17.91%) (Figure 1). When all of the attributes were used in the analysis, it is rather difficult to distinguish the characteristics of each Thai dessert. Thus, separate the analysis according to each sensory characteristic group was performed and illustrated in Figures 2-5. Chi-square test suggested that there was a significant association between samples and the attributes ($p<0.05$).

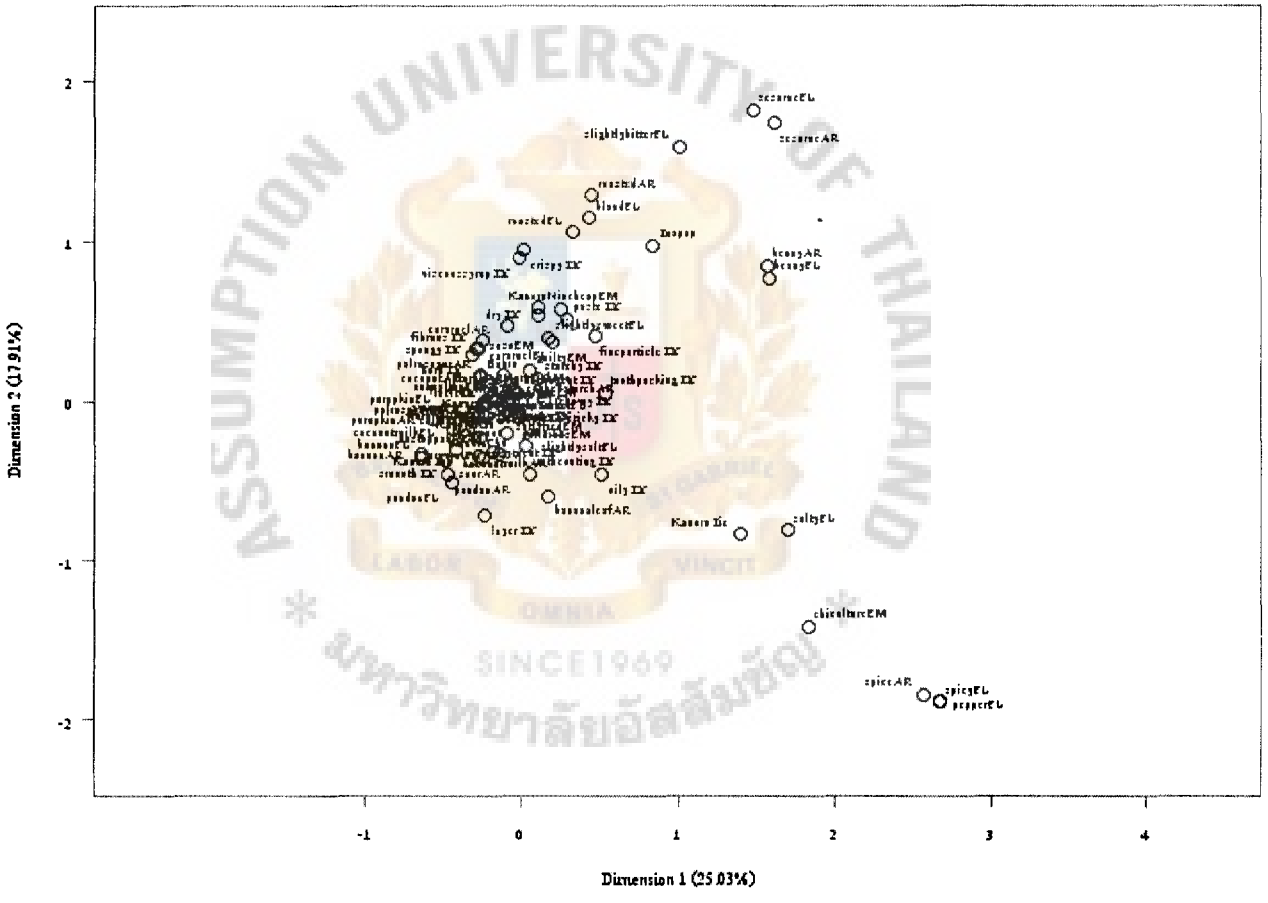

Figure 1: Correspondence analysis (CA) biplot for all samples and sensory attributes.

When classify by aroma attributes, the first two dimensions explained a total of 46.68% of the variance (Dim1 = 27.34% and Dim2 = 19.34%). In correspondence analysis, samples that were close together tend to have similar pattern in the relative frequencies. The interpretation for attributes could be done in the same manner. Dimension 1 generally distinguished between samples made from steamed or boiled

glutinous rice flour, with the exception of kanom tom, from the other samples. Although kanom tom was made from boiled glutinous rice flour, the large proportion of filling to flour played an important role in its aroma characteristics. When the attributes were examined, it was found that dimension 1 distinguished roasted, beany, and spice aroma from sweet, starchy, and coconut-related aroma. Therefore, kanom tien, kanom niow, and kanom tuapap tended to have a relatively high intensity of roasted, beany, sesame, and spicy aroma. Of all these samples, kanom tuapap and kanom niow were more closely related to each other than to kanom tien. Dimension two separated all the samples that were made from glutinous rice flour from those that were made from rice flour or rice flour with the addition of other types of flour. The main aroma characteristics of samples made from glutinous rice flour were having higher intensity in three main subgroups of aroma; sweet aroma (palm sugar, caramel), beany aroma, roasted aroma (coconut, roasted, sesame) than those that made from rice flour base. The samples made from rice flour tended to be described as have more fruity, floral, and green aroma, such as banana leaf, pandan, banana, pumpkin aroma, and sour aroma from fruits.

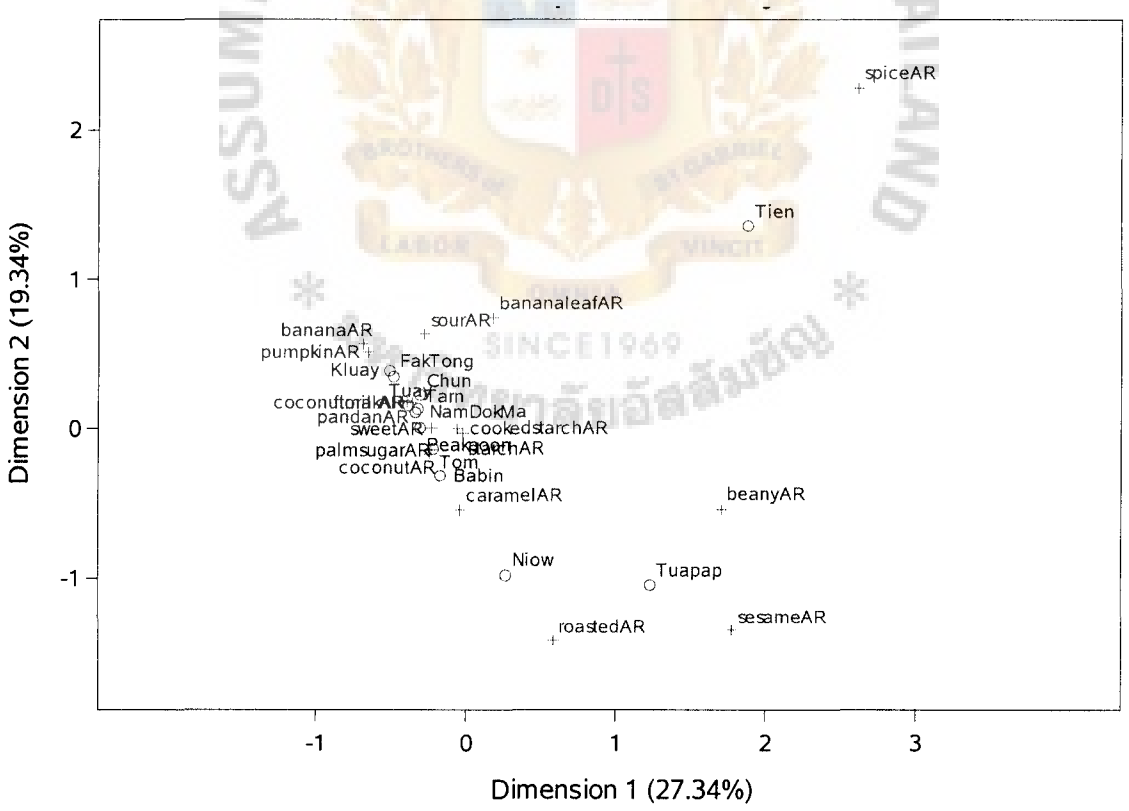

Figure 2: Correspondence analysis (CA) biplot for samples and aroma attributes.

Taste and flavor attributes had a higher percentage of variance explained from the first two dimensions than aroma attributes (50.96%; Dim1 = 30.34% and Dim2 = 20.62%). When using dimension 1, two of the samples made from glutinous flour, kanom tien and kanom tuapap, were clearly distinguished from the other samples. Moreover, dimension 1 separate strong tastes and flavors, including salty, spicy, and peppery, from milder, sweet, fruity tastes and flavors. This suggested that kanom tien and kanom tuapap clearly had stronger tastes than other samples. Dimension 2, on the other hand, suggested that the two samples were not very closely associated due to certain taste and flavor and attributes that differentiated these two samples. Kanom tuapap was rather more associated to kanom nam dok mai and kanom niow. The attributes that were differentiated by dimension 2 were between roasted flavor and weak to mild taste/flavors attributes. It could be suggested from Figure 3 that kanom tuapap had a relatively high sesame and beany flavor. Considering the taste, it was rather bland and had a weak sweetness feel, similarly to those that could describe kanom niow and kanom nam dok mai. Moreover, kanom nam dok mai was rather close to the origin point, suggesting that it did not exhibit unique tastes or flavors. Both kanom niow and kanom tuapap were made from glutinous rice flour. Opposite to these three samples were mainly samples made from rice flour with the exception of kanom tien. Dimension 2 was strongly associated with intense taste and flavor such as pepper and spicy flavor, which were unique characteristics of kanom tien. These attributes were negatively associated with bland taste/flavor. Green, sweet, and fruit flavors such as banana also had an association with dimension 2.

The correspondence analysis biplot of the Thai desserts and textural/mouthfeel attributes were shown in Figure 4. The first two dimensions could explain 59.71% (Dim1 = 34.56% and Dim2 = 25.15%) of the variation in the data, which was considered to be the highest percentage as compared to those obtained from aroma and taste/flavor characterization. As a matter of fact, this indicated that the samples could better be differentiated by texture/mouthfeel characteristics than aroma or taste/flavor characteristics. Dimension 1 distinguished among desserts made from rice flour. The sample made from only rice flour, without any incorporation of any other types of flour, such as kanom tarn, was separated from others. On the opposite direction, samples made from rice flour and arrowroot starch, such as kanom chun, kanom tuay, and kanom peakpoon, were highly associated with one another. In other words, these samples were

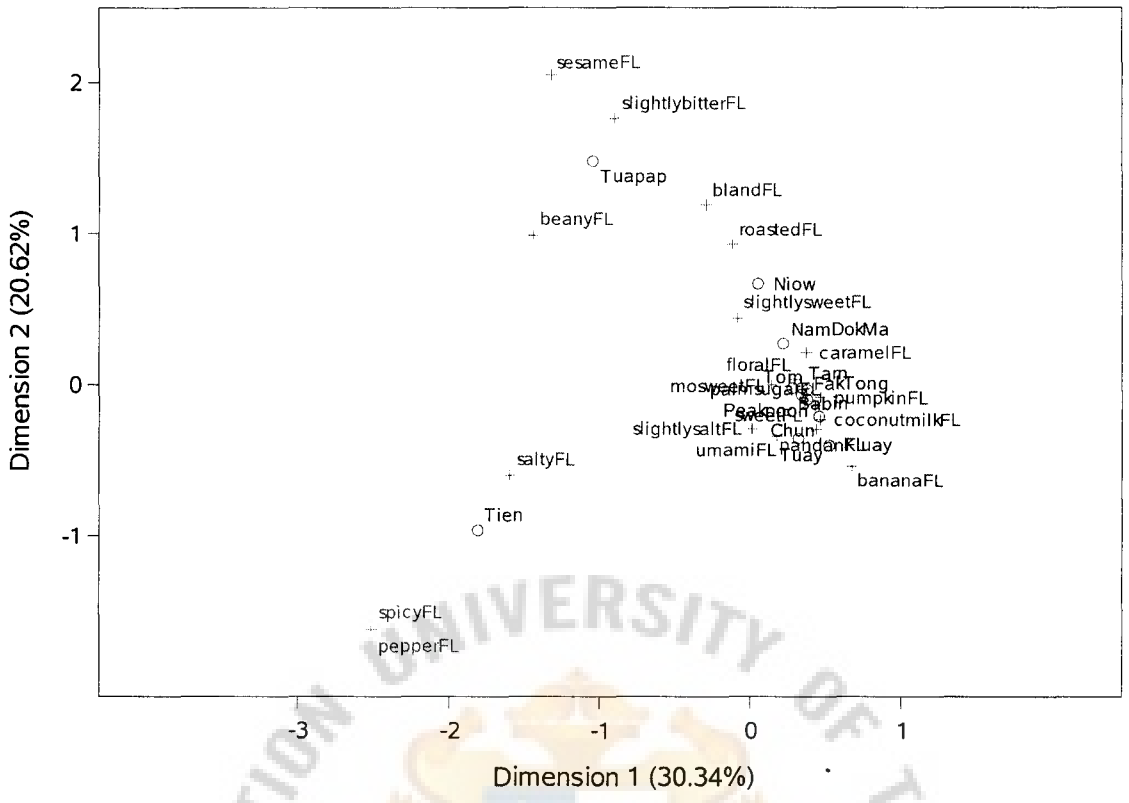

Figure 3: Correspondence analysis (CA) biplot for samples and taste and flavor attributes.

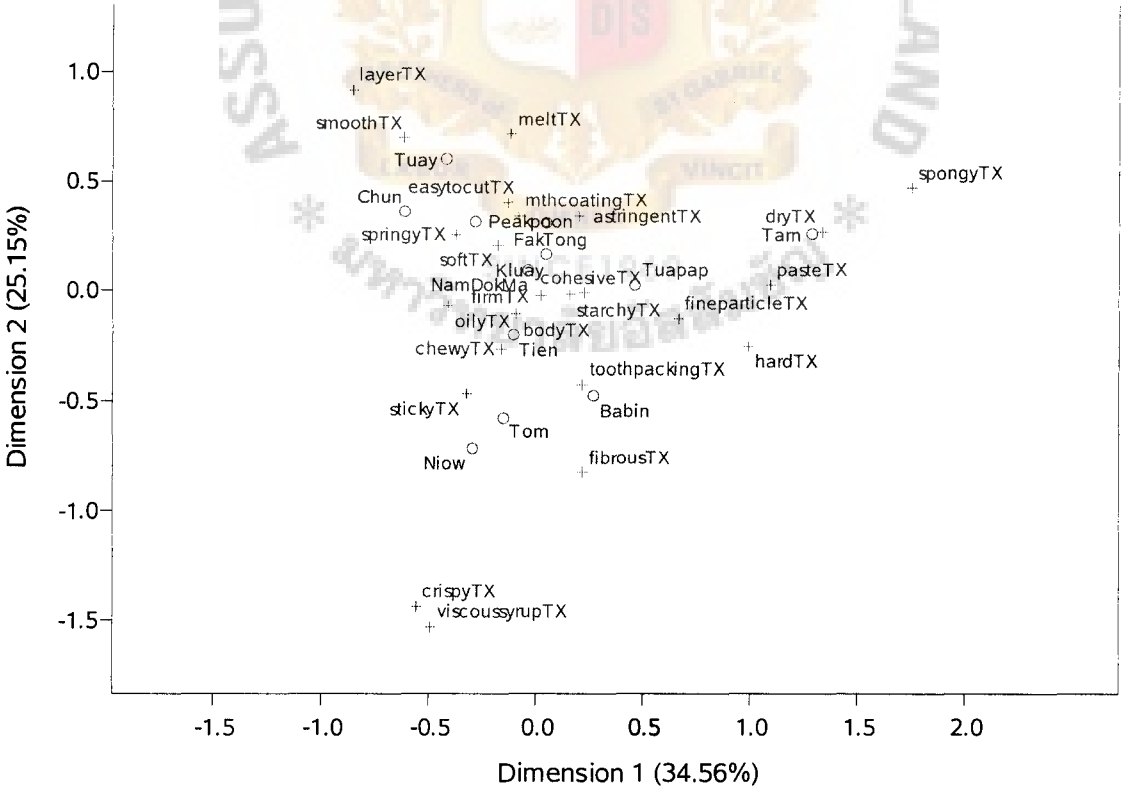

Figure 4: Correspondence analysis (CA) biplot for samples and texture and mouthfeel attributes.

more similar to each other than any other samples. Kanom nam dok mai, kanom kluay, and kanom faktong were not associated with any dimensions. With regards to the attributes, dimension 1 distinguished between firm, hard, starchy, and paste-like texture from soft, sticky, chewy, springy and smooth texture. The findings suggested that desserts that were made only from rice flour tended to have dry, firm, and hard texture. With the addition of arrowroot flour, the desserts would become smoother, softer, and springer. Although kanom peakpoon was the only sample that passed through the stirring process, the textural characteristics were not much different from those that undergo steaming process. Desserts made from the mixture of rice flour and cassava starch such as kanom kluay and kanom faktong were firm and starchy when compared to other rice flour-based samples. On the other hand, glutinous flour-based samples were stickier, chewier than the rice flour-based samples, regardless of processing methods. Distinct characteristics such as crispy and fibrous were attributes specific to samples that contain coconut meat either as a filling or infused as a part of the dessert itself. Samples that contained coconut meat were kanom babin and kanom tom, which were made from glutinous rice flour. Another sample that was made from glutinous rice flour and had distinct sensory attribute was kanom niow. This sample could be described as having crispy texture and viscous syrup mouthfeel. Kanom niow was generally eaten with puffed rice, attributing to the crispy texture and glazed with syrup, attributing to the viscous syrup mouthfeel.

Apart from all the dimensions of sensory characteristics, the emotional attributes related to Thai desserts were also examined. The correspondence analysis biplot of emotion terms showed that 82.9% of the variation in the data could be explained by the first two dimensions (Dim1 = 46.19% and Dim2 = 36.71%). Emotion terms could clearly separate samples into distinct groups. Dimension 1 distinguished kanom tien from all samples and in term of attributes, dimension 1 was highly associated with the emotion related to Chinese culture. Other attributes were either negatively associated with Chinese culture emotion, such as unhealthy, cheap, and Thai culture or were not associated with dimension 1 at all, such as satisfied and unstoppable. Thus, kanom tien largely reminded consumers of Chinese culture. The other 11 samples were perceived to be related to Thai culture. The differences between other samples could better be described by dimension 2. Kanom nam dok mai, kanom tarn, kanom tuapap, and kanom peak poon were positively associated with one another and negatively associated with

kanom tom, kanom chun, kanom kluay, and kanom tuay. The first group of samples could be described by being cheap, soso (neither like nor dislike), and have a guilty feeling after eaten (Note that these emotion attributes were associated with Dimension 2). The second group of samples had the opposite emotion attributes to those of the first one. They were described to be unstoppable, delicious, and reminder of childhood times. As a matter of fact, the type of flour based and processing method did not have an apparent effect on the emotion characteristics. The emotion characterization was based considerably on personal impressions. Kanom babin and kanom faktong did not result in a clear emotional characterization.

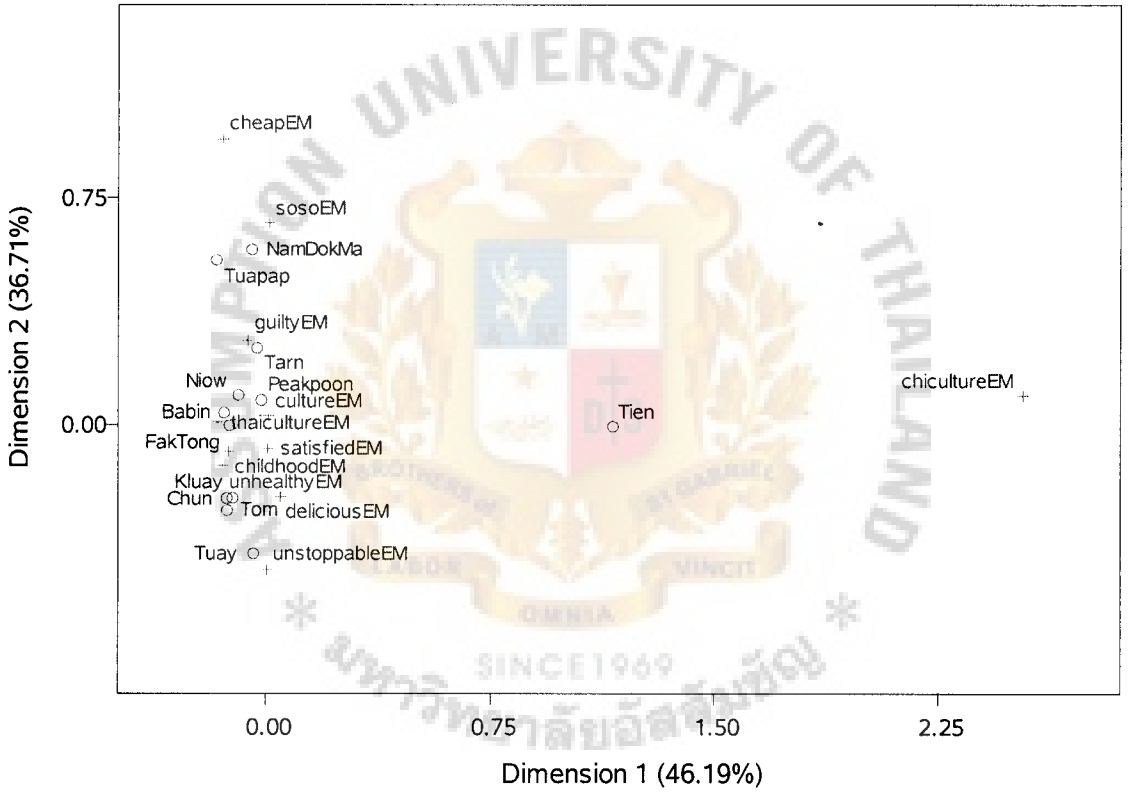

Figure 5: Correspondence analysis (CA) biplot for samples and emotion attributes.

Conclusion

The sensory characteristics of Thai desserts that varied in type of flour and processing method were examined. The findings of this study suggested that the processing method did affect the sensory characteristics of Thai desserts as much as the type of flour. The Thai desserts were best differentiated using texture/mouthfeel attributes. The major distinction was between rice-flour base and glutinous-flour base in which the latter was stickier and chewier. There was a difference among the rice-flour base desserts. The Thai desserts with and without the incorporation of other types of flour were significantly different. The rice-flour base Thai desserts with the mixture of arrowroot flour were softer, smoother, and springier, regardless of the processing method.

Further studies include the use of other consumer group such as foreigner who are not familiar with Thai desserts in order to examine the similarities and differences in the lexicon development. The research could also expand to other categories of Thai desserts, including egg-based desserts, so that the full lexicon for Thai desserts will be developed.

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Appendix

SAS code

```
data attributes;
input product$ palmsugarAR    bananaleafAR      pandanAR    starchAR
      cookedstarchAR    coconutAR   coconutmilkAR     sweetAR     sourAR
      pumpkinAR   beanyAR     roastedAR   caramelAR   sesameAR
      bananaAR    floralAR    spiceAR     umamiFL     sweetFL
      mosweetFL   slightlysweetFL   blandFL     saltyFL
      slightlysaltFL    slightlybitterFL  spicyFL     pepperFL
      pandanFL    caramelFL   palmsugarFL coconutmilkFL     floralFL
      bananaFL    pumpkinFL   beanyFL     sesameFL    roastedFL
      stickyTX    chewyTX     firmTX      cohesiveTX  easytocutTX softTX
      hardTX      dryTX crispyTX    pasteTX     starchyTX   springyTX
      spongyTX    bodyTX      smoothTX    astringentTX
      fineparticleTX    fibrousTX   oilyTX      mthcoatingTX
      viscoussyrupTX    layerTX     meltTX      toothpackingTX
      deliciousEM satisfiedEM unstoppableEM     cultureEM   guiltyEM
      unhealthyEM sosoEM      cheapEM     childhoodEM thaicultureEM
      chicultureEM;
cards;
KanomTien   1     6     0     6     7     2     2     3     1     0
      13    0     1     2     0     2     28    7     3     6     5
      0     18    8     0     15    22    1     0     1     1     3
      0     0     12    1     1     17    22    5     4     6     13
      0     1     0     2     12    3     0     6     0     1     8
      0     11    5     0     2     0     9     15    11    4     9
      2     2     6     1     4     5     11
Babin 7     1     2     11    11    27    10    12    0     0     1
      8     10    0     0     6     0     7     13    9     6     1
      2     7     0     0     0     3     9     10    17    7     0
      0     1     1     3     13    19    11    2     3     4     3
      4     0     6     11    0     0     7     0     1     6     11
      4     2     0     0     0     7     12    13    5     11    1
      4     7     3     6     17    0
Peakpoon    4     2     13    12    12    19    8     12    1     0
      0     0     4     0     0     3     0     4     15    11    3
      1     0     6     1     0     0     11    4     8     6     7
      0     0     1     0     1     3     12    7     3     15    22
      0     0     1     0     9     10    1     4     11    4     1
      4     3     1     0     0     3     0     10    17    1     11
      2     2     7     1     6     15    1
```

The data were deleted to save space

```
;
proc corresp data=attributes out=coord all observed rp cp profile=both
dim=2
print=both;
      var palmsugarAR   bananaleafAR      pandanAR    starchAR
      cookedstarchAR    coconutAR   coconutmilkAR     sweetAR     sourAR
      pumpkinAR   beanyAR     roastedAR   caramelAR   sesameAR
      bananaAR    floralAR    spiceAR     umamiFL     sweetFL
      mosweetFL   slightlysweetFL   blandFL     saltyFL
      slightlysaltFL    slightlybitterFL  spicyFL     pepperFL
      pandanFL    caramelFL   palmsugarFL coconutmilkFL     floralFL
      bananaFL    pumpkinFL   beanyFL     sesameFL    roastedFL
      stickyTX    chewyTX     firmTX      cohesiveTX  easytocutTX softTX
      hardTX      dryTX crispyTX    pasteTX     starchyTX   springyTX
      spongyTX    bodyTX      smoothTX    astringentTX
      fineparticleTX    fibrousTX   oilyTX      mthcoatingTX
```

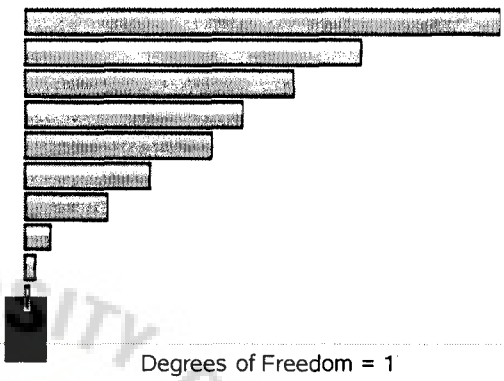
```
      viscoussyrupTX    layerTX     meltTX      toothpackingTX
      deliciousEM satisfiedEM unstoppableEM     cultureEM   guiltyEM
      unhealthyEM sosoEM      cheapEM     childhoodEM thaicultureEM
      chicultureEM;
      id product;
title 'Product characteristic';
title2 'Correspondence analysis';
run;
proc print data=coord;
proc plot data=coord vtoh=2;
      plot dim2 * dim1 = '*' $ product / box haxis=by .1 vaxis=by .1;
 title3 'Correspondence Analysis Biplot';
 run;
data label;
set coord;
xsys='2'; ysys='2';
x = dim1; y = dim2;
text = product;
size = 1.3;
function='LABEL';
if _type_='VAR' then color='RED  '; else color='BLUE';
proc gplot data=coord;
plot dim2 * dim1
/ anno=label frame
href=0 vref=0 lvref=3 lhref=3
vaxis=axis2 haxis=axis1
vminor=1 hminor=1;
axis1 length=6 in order=(-1. to 1. by .5)
label=(h=1.5 'Dimension 1');
axis2 length=3 in order=(-.5 to .5 by .5)
label=(h=1.5 a=90 r=0 'Dimension 2');
symbol v=none;
run;
```

SAS output

Aroma attributes

Inertia and Chi-Square Decompos

Singular Value	Principal Inertia	Chi-Square	Percent	Cumulative Percent
0.69116	0.47771	518.79	27.34	27.34
0.58131	0.33792	366.98	19.34	46.68
0.51995	0.27035	293.60	15.47	62.16
0.46758	0.21863	237.43	12.51	74.67
0.43379	0.18818	204.36	10.77	85.44
0.35573	0.12655	137.43	7.24	92.69
0.28850	0.08323	90.39	4.76	97.45
0.16187	0.02620	28.46	1.50	98.95
0.10648	0.01134	12.31	0.65	99.60
0.07250	0.00526	5.71	0.30	99.90
0.04170	0.00174	1.89	0.10	100.00
	1.74710	1897.35	100.00	



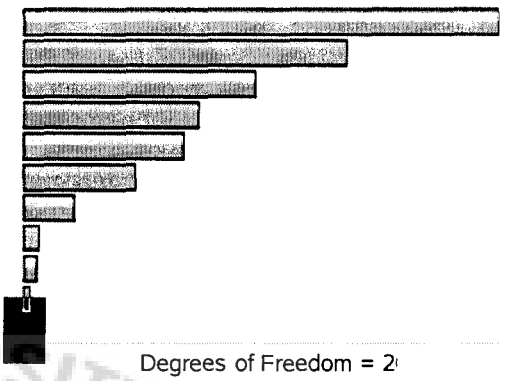
Row Coordinates		
	Dim1	Dim2
Tien	1.8850	1.3622
NamDokMa	-0.3375	0.1083
Niow	0.2678	-0.9803
Tom	-0.2189	-0.1330
Chun	-0.3074	0.2246
Kluay	-0.5099	0.3872
FakTong	-0.4835	0.3462
Tarn	-0.3223	0.1307
Tuapap	1.2360	-1.0454
Tuay	-0.3846	0.1528
Babin	-0.1717	-0.3108
Peakpoon	-0.3064	0.0048

Column Coordinates		
	Dim1	Dim2
palmsugarAR	-0.2322	-0.1399
bananaleafAR	0.1792	0.7415
pandanAR	-0.4225	0.1860
starchAR	-0.0207	-0.0316
cookedstarchAR	-0.0581	-0.0008
coconutAR	-0.2423	-0.1661
coconutmilkAR	-0.3959	0.1767
sweetAR	-0.2301	0.0042
sourAR	-0.2803	0.6356
pumpkinAR	-0.6511	0.5129
beanyAR	1.7114	-0.5394
roastedAR	0.5850	-1.4185
caramelAR	-0.0389	-0.5413
sesameAR	1.7780	-1.3505
bananaAR	-0.6843	0.5677
floralAR	-0.3604	0.1733
spiceAR	2.6179	2.2758

Flavor attributes

Inertia and Chi-Square Decompos

Singular Value	Principal Inertia	Chi-Square	Percent	Cumulative Percent
0.71975	0.51804	547.57	30.34	30.34
0.59336	0.35208	372.14	20.62	50.95
0.50277	0.25277	267.18	14.80	65.76
0.43683	0.19082	201.70	11.17	76.93
0.41834	0.17501	184.98	10.25	87.18
0.34998	0.12249	129.47	7.17	94.35
0.23637	0.05587	59.05	3.27	97.62
0.13261	0.01758	18.59	1.03	98.65
0.12016	0.01444	15.26	0.85	99.50
0.08561	0.00733	7.75	0.43	99.93
0.03538	0.00125	1.32	0.07	100.00
	1.70769	1805.02	100.00	



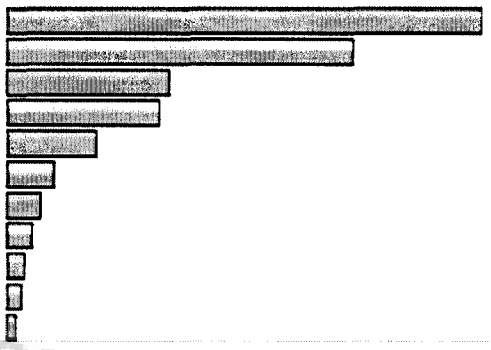
Row Coordinates		
	Dim1	Dim2
Tien	-1.8097	-0.9619
NamDokMa	0.2178	0.2738
Niow	0.0484	0.6685
Tom	0.3738	-0.0326
Chun	0.4539	-0.2058
Kluay	0.5216	-0.4000
FakTong	0.3749	-0.0948
Tarn	0.3396	-0.0189
Tuapap	-1.0444	1.4795
Tuay	0.3190	-0.3548
Babin	0.2750	-0.0219
Peakpoon	0.3387	-0.0649

Column Coordinates		
	Dim1	Dim2
umamiFL	0.1766	-0.3403
sweetFL	0.3603	-0.1059
mosweetFL	0.1438	0.0000
slightlysweetFL	-0.0844	0.4403
blandFL	-0.2930	1.1911
saltyFL	-1.5956	-0.6016
slightlysaltFL	0.0108	-0.2903
slightlybitterFL	-0.9018	1.7609
spicyFL	-2.5143	-1.6211
pepperFL	-2.5143	-1.6211
pandanFL	0.4369	-0.2906
caramelFL	0.3717	0.2136
palmsugarFL	0.4282	-0.1340
coconutmilkFL	0.4632	-0.2268
floralFL	0.2874	0.0341
bananaFL	0.6739	-0.5422
pumpkinFL	0.4613	-0.0795
beanyFL	-1.4420	0.9871
sesameFL	-1.3239	2.0483
roastedFL	-0.1181	0.9276

Texture/Mouthfeel attributes

Inertia and Chi-Square Decompos

Singular Value	Principal Inertia	Chi-Square	Percent	Cumulative Percent
0.47713	0.22765	333.742	34.56	34.56
0.40703	0.16567	242.878	25.15	59.71
0.27887	0.07777	114.006	11.81	71.51
0.27031	0.07307	107.118	11.09	82.61
0.20718	0.04292	62.924	6.52	89.12
0.15113	0.02284	33.483	3.47	92.59
0.12844	0.01650	24.184	2.50	95.09
0.11120	0.01236	18.127	1.88	96.97
0.09206	0.00848	12.425	1.29	98.26
0.08400	0.00706	10.345	1.07	99.33
0.06658	0.00443	6.498	0.67	100.00
	0.65875	965.730	100.00	



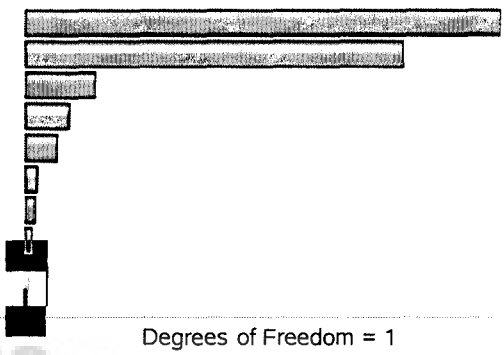
Row Coordinates		
	Dim1	Dim2
Tien	-0.1053	-0.2041
NamDokMa	-0.0359	0.0903
Niow	-0.2961	-0.7167
Tom	-0.1494	-0.5784
Chun	-0.6103	0.3583
Kluay	0.0477	0.1629
FakTong	0.0474	0.3066
Tarn	1.2889	0.2558
Tuapap	0.4637	0.0222
Tuay	-0.4181	0.6025
Babin	0.2710	-0.4756
Peakpoon	-0.2838	0.3122
Column Coordinates		

	Dim1	Dim2
stickyTX	-0.3216	-0.4664
chewyTX	-0.1625	-0.2670
firmTX	0.0247	-0.0251
cohesiveTX	0.2272	-0.0123
easytocutTX	-0.1285	0.4007
softTX	-0.1779	0.2032
hardTX	0.9937	-0.2578
dryTX	1.3369	0.2649
crispyTX	-0.5565	-1.4401
pasteTX	1.0966	0.0234
starchyTX	0.1607	-0.0173
springyTX	-0.3732	0.2507
spongyTX	1.7546	0.4689
bodyTX	-0.0918	-0.1084
smoothTX	-0.6155	0.6983
astringentTX	0.2025	0.3376
fineparticleTX	0.6711	-0.1301
fibrousTX	0.2179	-0.8245
oilyTX	-0.4085	-0.0710
mthcoatingTX	-0.0807	0.3367
viscoussyrupTX	-0.4904	-1.5308
layerTX	-0.8506	0.9158
meltTX	-0.1186	0.7157
toothpackingTX	0.2165	-0.4286

Emotion attributes

Inertia and Chi-Square Decompos

Singular Value	Principal Inertia	Chi-Square	Percent	Cumulative Percent
0.33251	0.11056	103.929	46.19	46.19
0.29646	0.08789	82.612	36.71	82.90
0.12746	0.01625	15.271	6.79	89.69
0.10144	0.01029	9.672	4.30	93.99
0.08558	0.00732	6.884	3.06	97.05
0.05388	0.00290	2.729	1.21	98.26
0.04751	0.00226	2.121	0.94	99.20
0.04077	0.00166	1.563	0.69	99.90
0.01471	0.00022	0.203	0.09	99.99
0.00519	0.00003	0.025	0.01	100.00
	0.23937	225.012	100.00	



Row Coordinates		
	Dim1	Dim2
Tien	1.1610	-0.0060
NamDokMa	-0.0460	0.5781
Niow	-0.0905	0.0958
Tom	-0.1277	-0.2833
Chun	-0.1292	-0.2437
Kluay	-0.1099	-0.2428
FakTong	-0.1205	-0.0024
Tarn	-0.0288	0.2520
Tuapap	-0.1633	0.5429
Tuay	-0.0404	-0.4241
Babin	-0.1382	0.0387
Peakpoon	-0.0147	0.0795
Column Coordinates		

	Dim1	Dim2
deliciousEM	0.0492	-0.2385
satisfiedEM	0.0066	-0.0785
unstoppableEM	0.0048	-0.4780
cultureEM	0.0089	0.0292
guiltyEM	-0.0593	0.2771
unhealthyEM	-0.1427	-0.1333
sosoEM	0.0123	0.6683
cheapEM	-0.1422	0.9413
childhoodEM	-0.1235	-0.0880
thaicultureEM	-0.1597	0.0081
chicultureEM	2.5346	0.0944