

การประยุกต์ใช้วิศวกรรมคั่นเซและแผนภาพความชอบในผลิตภัณฑ์ข้าวแต๋น
ด้วยลักษณะประสาทสัมผัสด้านรสชาติและกลิ่น

Application of Kansei Engineering and Preference Mapping in
Thai Rice Cracker (Khao Tan) using Taste and Smell Senses

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บทคัดย่อ

ผลิตภัณฑ์ข้าวอบกรอบหรือข้าวแต๋นได้รับความนิยมในการบริโภคจากสังคมไทยมานานหลายปีแล้ว จากเทคนิคการพัฒนาผลิตภัณฑ์ งานวิจัยนี้ได้ประยุกต์ใช้วิศวกรรมคั่นเซและแผนภาพความชอบในผลิตภัณฑ์ข้าวแต๋น ด้วยลักษณะประสาทสัมผัสด้านรสชาติและกลิ่นของผู้บริโภค ผลจากเทคนิควิศวกรรมคั่นเซและการทดสอบลักษณะทางประสาทสัมผัสพบว่า ผู้บริโภคส่วนใหญ่ชอบข้าวแต๋นหน้าธัญพืชด้วยอารมณ์ความรู้สึกถึงความหวาน รสชาติ ทันสมัยและความชอบ ในขณะที่ข้าวแต๋นหน้าต้มยำและหน้าน้ำตาลอ่อนนั้นผู้บริโภคมีความชอบน้อย นอกจากนี้ได้ศึกษาคุณภาพทางกายภาพ และทางเคมีของข้าวแต๋นด้วยเทคนิคแผนภาพความชอบ ประกอบด้วยค่าสี (L^* a^* b^*) ค่า Water activity ค่าปริมาณความชื้น และค่าความแข็ง จากการศึกษพบว่าข้าวแต๋นควรมีค่า Water activity และค่าความแข็ง ควรจะมีค่าสูง ในขณะที่ค่าสี a^* และค่าปริมาณความชื้น ควรจะมีค่าต่ำ

Abstract

Thai rice cracker or Khao Tan has gained popularity in Thai society over the previous years. According to product development technique, we applied Kansei Engineering (KE) and Preference mapping using the taste and smell senses for developing appropriate Khao Tan with respect to consumer preferences. The KE results show that most consumers preferred the Seed&Cashew nut Khao Tan which corresponded to their preferred the emotions of sweet, taste, modern and like as same as the sensory attributes. On the other hand, the lowest preference was found in the Tomyam and Sugarcane flavors. The physical and chemical quality attributes, namely, color (L^* , a^* and b^*), water activity (a_w), moisture content and hardness were studied. These quality attributes were analyzed by using preference mapping. The findings represent Khao Tan should be high

values of a_w and the hardness, whereas the values of a^* and the moisture should be low.

1. General Introduction

Snack is a kind of foods and massive consumption over the period time. The popular snack products which have high demand are cracker [1]. One of the popular crackers in many Asian countries such as Thailand, Malaysia and Indonesia is rice crackers that made from sticky rice. One of the Thai rice cracker is Khao Tan which has a naturally delicious flavors and high nutrition. In addition, it is very crispy and sweet that made from sticky rice and brown sugar. In order to design desirable Khao Tan products in this study, many product design techniques have been implemented. Firstly, Kansei Engineering (KE) technique has been employed to translate customer feelings and impressions into product design parameters. According to Sagara cite in Masayuki et al.[2] proposed food KE as a new realm of scientific and engineering research that conducts quantitative measurements of taste sense and the food preference by the individual techniques such as instrumental analyses, sensory analyses and multivariate analyses. The rapid growth of researches that interest on food perception is the multisensory processes in flavor perception study [3]. Some researchers studied the influence of taste sense in various

products, for example, packaging [4], beverage bottles [5] and Beverage glass [6]. In addition, the researches using smell sense test, for instance, liquid bath soap [7] and scent of store [8].

In this study, I investigated the attributes of Khao Tan products related to customer emotions using only the senses of taste and smell. The second technique applied in this study is the preference mapping which most popular tools of marketing research [9]. This tool helps food designers to develop successful new products. Preference mapping analyzes products which are evaluated the acceptability and product characteristics [10]. The physical and chemical properties of Khao Tan were analyzed with preference mapping in this research. Finally, we integrated the findings of these techniques to develop appropriate Khao Tan products with respect to consumer preferences.

2. Theoretical background

2.1 Kansei Engineering

KE was found by Mitsuo Nagamachi at Hiroshima University in Japan [11]. KE is able to translate customer emotion and requires on existing products or concepts into concrete design which regarding to customer needs [12]. KE can be carried out in different ways using

different types of KE. Presently, six types of KE have been developed, proved and tested such as Category Classification and KE System [13]. In brief, KE is a successful technological tool for reducing the time and resources in product design and development process.

2.2 Preference Mapping

Preference mapping is a technique able to quantify, analyze and interpret consumer preference of products [9]. Generally, there are two types of preference analysis referred to as internal and external preference analysis [14]. Internal preference mapping analyzes the acceptability of the sensory, physical and chemical data to summarize the main preference directions and the associated consumer segments [15]. Otherwise, external preference mapping analyzes the significant of the sensory of product characteristics and the instrumental properties which preferred by consumers [16]. Therefore, external preference mapping is usable in food technological development such as product profiles while internal preference mapping would be used for marketing purposes such as communication, product positioning and consumers' segmentation [9].

3. Methodology

3.1 Kansei Engineering Methodology

This research used KE Type I which translates customer perceptions in terms of Kansei words to product design attributes. The study can be divided into four steps. Step 1 is to collect and select the Kansei words that relative to Khao Tan products. Step 2 is to select product samples from Thai market. Step 3 is to evaluate the product samples using taste and smell senses based on blind condition. Finally, statistical evaluation is applied to confirm the significant level of Kansei words and Khao Tan characteristics. This methodology can be described in the following paragraphs.

3.1.1 Collected and Selected the Kansei Words

In the initial collection from literature reviews, magazines and websites about mug products, a total of 78 different words describing could be extracted. Three professional members from Rajamangala University of Technology Lanna (RMUTL, Thailand) were selected as an expert team. After brainstorming and discussion by the expert team, the final Kansei words for taste test were crispy, sweet, tasty, modern, familiar and like. Only one Kansei word which is used in smell test was aroma.

3.1.2 Collected and Selected the Kansei Words

There are many kinds of Khao Tan products in Thailand. After collecting product samples, the expert team selected 6 popular flavors of Khao Tan, namely, Tomyam (Thai spicy style), Wasabi (Japanese style), Seaweed, Sugarcane, Shredded pork and Seed&Cashew nut as shown in Figure 1.



Figure 1. Khao Tan samples.

Top from left; Tomyam, Wasabi, Seaweed

Bottom from left; Sugarcane, Shredded pork,
Seed&Cashew nut

3.1.3 Investigation and Evaluation

Firstly, the questionnaire is constructed by using the 5-score Likert scale with 5 refers to definitely agree, 4 refers to agree, 3 means fair, 2 means disagree and 1 means definitely disagree. Thirty participants, who were the new generation consumers in aged between 20 - 30 and studied at RMUTL, took part in the experiment. Participants were given a brief

introduction about how to fill in the survey and described about the meaning of Kansei words. During the smell and taste evaluations, participants were blindfold. The participants could not see samples because all the samples were presented to the participants randomly and arranged in a box.

3.1.4 Analyzed with Analysis of Variance

Analysis of variance (ANOVA) was conducted on the customers' scores, considering customer and sample as sources of variation. Means of Kansei words and samples were determined and the significant differences were checked to confirm the significant level of Kansei word and samples using Tukey's range test ($p < 0.05$). The data was analyzed with MINITAB software [17].

3.2 Preference Mapping Methodology

3.2.1 Samples Preparation

A total of 6 Khao Tan samples corresponding to different attributes such as size, flavor, aroma and texture were used for the analysis as same as the KE experiment. The samples were obtained after 2-3 days of production from a local manufacturing in Lampang, Thailand. Samplings were packed in plastic bag and put in plastic box with a lid before each test.

3.2.2 Physical and Chemical Properties Study

All of the 30 consumers who took part in the study were students from RMUTL. Firstly, in the blind condition, the participants started by lifting the sample with their dominant hand. Subsequently, they smelt samplings and were required to answer questions for smell test. Samplings were presented to the consumers in random order and served for the taste evaluation session. Mineral water at ambient temperature was used to wash the mouth. The sensory attributes evaluated were flavor, odour, texture and overall acceptability using a nine-point hedonic scale (1: dislike extremely to 9: like extremely) [18]. In addition to the sensory measurements, instrumental measurements of color (L^* , a^* , b^*), texture, moisture content and water activity (a_w) were carried out. The spectrophotometer (Minolta CR-3500d) was used to investigate the color of rice crackers. Texture of the fried samples was measured using the

Texture Analyzer (TA-XT2). Moisture content was determined using AOAC standard methods [19].

3.2.3 Statistical Analysis

The data were analyzed using the ANOVA procedure of the MINITAB software package [17]. Significant differences ($p < 0.05$) between means were further determined by Tukey's multiple range tests. Preference mapping was carried out using XLSTAT software [20].

4. Results of Kansei Engineering

4.1 Correlations

Pearson's correlations were used to relative between the Kansei words as shown in Table 1. Only one correlation coefficient that greater than |0.7| was like-taste. Three correlations (modern-taste, like-taste and like-modern) were greater than |0.5|. Thus, high positive significant correlation was found between like and taste.

Table 1. Correlation matrix (Pearson)

Variables	aroma	crispy	sweet	taste	modern	familiar	like
aroma	1						
crispy	-0.0060	1					
sweet	0.2818*	0.2291*	1				
taste	0.1174	0.3580*	0.3088*	1			
modern	0.0627	0.2135*	0.1004	0.6650*	1		
familiar	0.2289*	0.2404*	0.4165*	0.4278*	0.2308*	1	
like	0.1285	0.2835*	0.2929*	0.7682*	0.6646*	0.4383*	1

Values with * are different from 0 with a significance level $\alpha=0.05$

Table 2. Mean of Samples

Flavor	aroma	crispy	sweet	taste	modern	familiar	like
Tomyam	2.53 ^b	3.97 ^a	2.53 ^c	3.83 ^{ab}	3.93 ^a	3.33 ^a	3.97 ^{ab}
Wasabi	2.67 ^b	4.00 ^a	2.60 ^c	3.93 ^{ab}	4.40 ^a	3.33 ^a	3.90 ^{ab}
Weaweed	3.50 ^a	4.17 ^a	3.73 ^{ab}	4.37 ^a	4.33 ^a	3.90 ^a	4.33 ^a
Sugarcane	3.07 ^{ab}	4.00 ^a	4.07 ^{ab}	3.43 ^b	3.17 ^b	3.93 ^a	3.47 ^b
Shredded pork	2.90 ^{ab}	4.40 ^a	3.50 ^b	3.97 ^{ab}	3.77 ^{ab}	3.83 ^a	4.17 ^{ab}
Seed&nut	3.30 ^{ab}	4.37 ^a	4.33 ^a	4.40 ^a	4.40 ^a	3.57 ^a	4.40 ^a
F-value	3.7	2.25	19.98	4.22	9.06	1.91	3.49
p value	0.003	0.051	0.000	0.001	0.000	0.094	0.005

Means within each column with different superscript letters are significantly different (Tukey's test, $p < 0.05$)

4.2 Mean of Kansei Words and Samples

Table 2 shows the mean ratings of sample from ANOVA. Tukey's significance tests were conducted to confirm the significant differences. P values illustrate significantly different means for each characteristic. The results showed that there was no significant difference ($p > 0.05$) in crispy and familiar. Therefore, these Kansei words were not used to consideration. In addition, there were all significant differences between samples. The Seed&Cashew nut Khao Tan was almost desirable Kansei words as sweet, taste, modern and like. The Wasabi flavor was received equal highest score in modern as same as the Seed&cashew nut. According to aroma, the Seaweed was the greatest preference. On the other hand, the Sugarcane flavor was almost lowest ratings as like, taste and modern whereas the Tomyam was least sweet and aroma.

The findings can be summarized in emotional characterization of Khao Tan based on their mean rates as the following. For example, the least mean of sweet and aroma in Tomyam flavor was 2.53 and also significant, therefore it was account to make the emotions of "not aroma" and "not sweet".

Tomyam: not aroma, not sweet

Wasabi: not sweet, modern

Seaweed: aroma

Sugarcane: sweet, not taste, not modern, not like

Shredded pork: taste

Seed&Cashew nut: sweet, taste, modern, like

5. Results of Preference Mapping

5.1 Overall Liking and Attribute Intensity

Table 3 shows the sensory attributes of Khao Tan products for the different flavor. The results from ANOVA indicated that there were significant differences in flavor, odour, texture

and overall acceptability in all of the samples. The samples were perceived as quite different all of the attributes, showing that customers need in a quite wide flavor space of products. It was observed that the consumers accepted the flavor, texture and overall acceptability of rice crackers in the Seed&Cashew nut flavor with slight to moderate like level. The mean score of overall acceptance in the Seed&Cashew nut was slightly higher than the Shredded pork but did

not present significant differences. At the opposite extreme, hedonic ratings for the samples that averaged closing a value 5 (neither like nor dislike) were most found in the Tomyam, the Seaweed and the Sugarcane flavor. Interestingly, the consumers noticed a more intense texture in the Shredded pork than the Seed&Cashew nut and the highest scores of odour was the Seaweed flavor in slight to moderate level.

Table 3. Sensory Evaluation of Khao Tana ^a

Flavor	flavor	odour	texture	overall acceptability
Tomyam	6.30 ^{ab} ± 1.82	5.23 ^b ± 1.95	5.23 ^d ± 1.96	4.90 ^c ± 1.75
Wasabi	5.47 ^b ± 1.50	5.57 ^{ab} ± 1.41	5.43 ^{cd} ± 1.36	6.30 ^{ab} ± 1.71
Seaweed	6.97 ^a ± 1.65	6.73 ^a ± 1.66	6.57 ^{abc} ± 1.61	5.67 ^{abc} ± 1.61
Sugarcane	5.13 ^b ± 2.13	6.03 ^{ab} ± 1.97	5.70 ^{bcd} ± 1.77	5.17 ^{bc} ± 1.29
Shredded pork	6.80 ^a ± 1.52	5.77 ^{ab} ± 1.74	7.17 ^a ± 1.78	6.50 ^a ± 1.84
Seed&Cashew nut	7.40 ^a ± 1.57	6.43 ^{ab} ± 1.94	6.77 ^{ab} ± 1.74	6.80 ^a ± 1.90

Means within each column with different superscript letters are significantly different (Tukey's test, $P < 0.05$)

^a Mean + standard deviation

Table 4. The Physical and Chemical Properties of Khao Tana ^a

Flavor	L*	a*	b*	a_w	Moisture content (%)	Hardness (g)
Tomyam	64.02 ^{ab} ± 12.56	-12.77 ^b ± 6.70	40.25 ^a ± 4.36	0.45 ^a ± 0.02	4.00 ^a ± 0.04	1444.3 ^b ± 70.5
Wasabi	48.35 ^{ab} ± 8.40	-16.82 ^b ± 1.16	30.63 ^b ± 2.54	0.48 ^a ± 0.04	3.77 ^a ± 0.45	1442.0 ^b ± 83.5
Seaweed	47.48 ^b ± 12.13	-12.50 ^b ± 1.66	26.13 ^b ± 4.22	0.43 ^a ± 0.01	3.95 ^a ± 0.03	1390.7 ^b ± 57.5
Sugarcane	22.23 ^c ± 7.46	-1.40 ^a ± 2.77	18.35 ^c ± 3.12	0.45 ^a ± 0.02	3.93 ^a ± 0.09	1513.3 ^b ± 49.7
Shredded pork	48.98 ^{ab} ± 9.19	-12.85 ^b ± 2.20	46.07 ^a ± 4.29	0.43 ^a ± 0.01	4.00 ^a ± 0.04	1700.0 ^a ± 18.0
Seed&Cashew nut	64.80 ^a ± 8.21	-11.87 ^b ± 2.24	30.58 ^b ± 4.40	0.46 ^a ± 0.01	3.74 ^a ± 0.44	1786.7 ^a ± 64.5

Means within each column with different superscript letters are significantly different (Tukey's test, $P < 0.05$)

^a Mean + standard deviation

Overall mean and standard deviation of instrumental quality variables were listed in Table 4. The results showed the range of the average values of the lightness (L^*) were between 22.23 and 64.80. The range of average value of the redness (a^*) and the yellowness (b^*) were -12.85 to -1.40 and 18.35 to 46.07, respectively. We found a_w in the range of average value 0.43 to 0.48. Moisture content average was 3.74 to 4.0%. The Tomyam and the Shredded pork were maximum moisture content, whereas the Seed&Cashew nut was the minimum moisture content. The fracture force or hardness varied from 1390.7 to 1786.7.19 g.

5.2 Internal Preference Mapping

The internal preference mapping indicates the distribution of the consumers in relation to their preference of Khao Tan. A dot was each of consumers, and if more dots close

to a sample that mean individuals prefer with similar product. Figure 2 shows the internal preference map of consumers' hedonic scores. The first two principal components (PC) represented 55.58% of the total variation and the third fourth PCs showed 33.73% of the total variation. The dispersion of consumers on the top quadrant indicated some common liking pattern between consumers on the second PC but some differences at the same time on the first one. These results could classify preference of customers into two groups. The first group was the Seed&Cashew nut, the Shredded pork and the Wasabi regarding the slight overall acceptability level. The second group was rest of samples as the Tomyam, the Seaweed and the Sugarcane flavor that consumers neither like nor dislike.

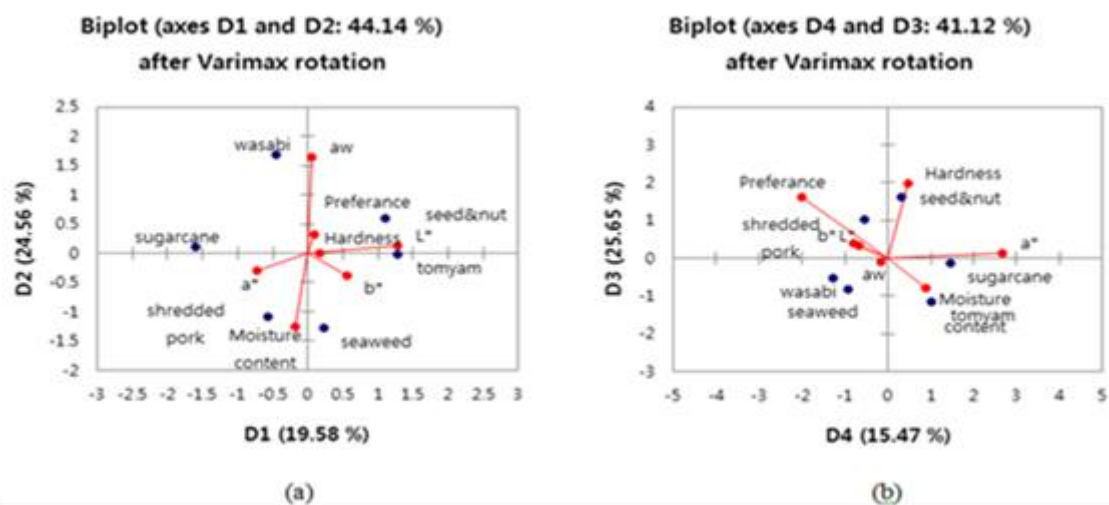


Figure 2. Internal preference: mapping of customers (red points) with Khao products (blue points): (a) in the first and second component map and (b) in the third and fourth component map.

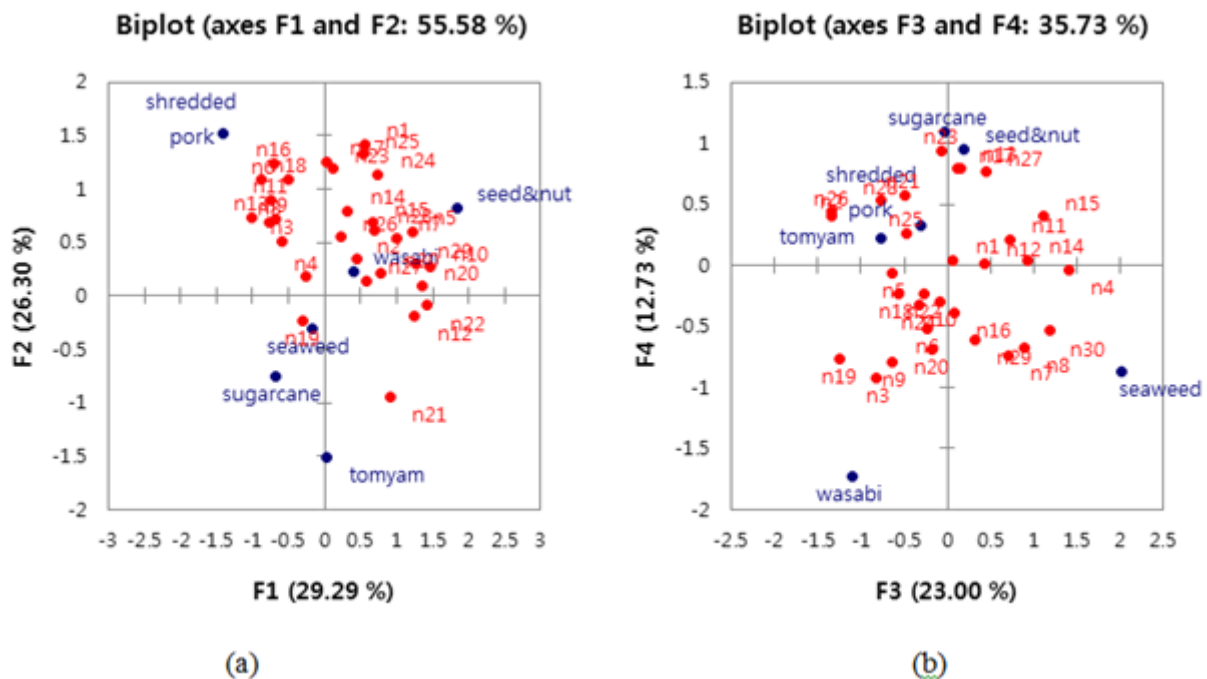


Figure 3. External Preference mapping of Kantan products (blue points) with projections as the physical, chemical properties and preference (red vectors) after Varimax transformation:

(a) in the first and second component map and (b) in the third and fourth component map.

5.3 External Preference Mapping

The projection of the physical and chemical properties on external preference mapping allowed the identification of some key-drivers of preference. The results of factor loading using four factors after varimax rotation are shown in Figure 3. The extracted four factors have a contribution of 19.58%, 24.56%, 25.65% and 15.47% of the total variance, respectively. The total variance explained by the model was 85.26% that illustrated the result is acceptable. In factor 1 (D1), we can see that the attributes L^* and b^* were important effectors. The attribute a_w had a positive contribution, whereas the moisture content had a negative contribution on factor 2

(D2). The hardness and a^* had the largest weight of factor 3 (D3) and factor 4 (D4), respectively. According to the main preference direction, the Seed&Cashew nut and the Shredded pork were as the ones most preferred by consumers, whereas in the opposite direction, it points out the Sugarcane and the Tomyam as the least preferred samples on average. The factors that signify to the consumer preference were a_w and the moisture content as shown in Figure 3 (a). The a_w was related in the same direction of preference, whereas the moisture content was in opposite. Figure 3 (b) shows the hardness was positive related to preference. In contrast, a^* and the moisture content were negative. In summary,

the physical and chemical properties that influence on the preferences of consumers were a_w , the hardness, a^* and the moisture content. If the values of a_w and the hardness of rice crackers increase, the preference of customers will increase too. On the other hand, if the values of a^* and the moisture decrease, the preference of customers will increase.

6. Discussion

According to the results, the Seed&Cashew nut was almost highest scores in Kansei words such as sweet, taste, modern and like. Merely aroma emotion, the Seaweed was the greatest preference. Similar to the results of sensory analysis, the consumers accepted the flavor, odour, texture and overall acceptability in the Seed&Cashew nut flavor. However, the Shredded pork was the most intense in texture sensory. Therefore, I suggest that the Seed&Cashew nut was perceived the most desirable features of Khao Tan. In my opinion, this flavor has many kinds of cereal that consumers prefer and satisfy than the other. The low preference from both of methodologies was found in the Tomyam and the Sugarcane flavor. It seems to me that Thai consumers are familiar Tomyam flavor as the dish eat with rice in the meal that called "Tomyam soup". Hence, it is unsuitable flavor of snack for Thai people, but

foreigners will prefer it with the amazing taste of Thai flavor and spiciness. Similarly, the Sugarcane flavor is the original flavor of Khao Tan that consumers have been familiar and unexciting snack. There were 2 groups of Khao Tan samples that distinguish by internal preference mapping. I think consumers have been impassible with ordinary flavor such as the Sugarcane and the Seaweed flavor whereas pleased with modern flavor such as the Wasabi and the Shredded pork Khao Tan. In the final Khao Tan design, I suggest that Khao Tan should have more components fill on the top of rice cracker such as cereal, dry pork, durian and longan. Various flavor rice crackers will be accepted by customers more than only one flavor rice crackers.

7. Conclusions

In this paper I integrated results from KE and preference mapping using the taste and smell senses regarding the preference of Thai rice cracker products. This study will help food scientists take into account the desirable features of Thai rice crackers perceived by the customers. According to food design experts, 7 Kansei words and 6 kinds of Khao Tan were recommended for generating a questionnaire corresponding to KE technique. These Kansei words were crispy, sweet, tasty, modern, familiar

and like for taste test, while aroma for smell test. The Tomyam, Wasabi, Seaweed, Sugarcane, Shredded pork and Seed&Cashew nut Khao Tan were selected as product samples. There were four sensory tests as flavor, odour, texture and overall acceptability. The physical and chemical properties were also measured by instruments. The results from KE technique was introduced to ensure proper characteristics for developing products. From the findings, most consumers selected the Seed&Cashew nut Khao Tan for the most preference, which corresponded to their preferred the emotions of sweet, taste, modern and like. In addition, the results from KE also had a similar result from sensory analysis. Only Thai participants of this study would limit the general findings. Future research would be to study the preference of Khao Tan in different nationalities such as Japanese, European people and American because of the different of culture, tradition and society.

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