International Journal of Innovations in Engineering and Technology (IJIET)
http://dx.doi.org/10.21172/ijiet.212.01

Consumer Preference Mapping of Tom Yum Seasoning Products

Supaporn Koohathong
Department of Applied Bio-Resource Science,
Faculty of Interdisciplinary studies, Khon Kaen University, Nong Khai Campus,
Nong Khai 43000 Thailand

Kritsda Khajarern
Department of Applied Bio-Resource Science,
Faculty of Interdisciplinary studies, Khon Kaen University, Nong Khai Campus,
Nong Khai 43000 Thailand

Abstract- The aim of the study was to utilize multivariate statistic analysis on consumer acceptance data in order to understand Tom Yum seasoning products in the market. There were 24 samples with various forms (1 cube, 1 sauce, 1 UHT soup, 2 powders, 4 pastes, 4 sets and 11 instant noodle soup powders) included in the study. The sensory preference, sensory intensity and willingness to pay of all products were evaluated in 17 items using 9-point hedonic scale, 7-point Just About Right scale and 5-point structure scale, respectively. The data were analyzed using Principal Component Analysis (PCA) and cluster analysis. It was found that PCA results indicated that all items were reduced to two uncorrelated principal components (PCs). Both PCs were interpreted as (1) sensory preferences and willingness to pay and (2) salt content and MSG content. According to the cluster analysis, there were 3 main clusters based on form of the seasoning products.

Keywords – Consumer Preference Map, Tom Yum Seasoning Product, Principal Component Analysis, Cluster Analysis

I. INTRODUCTION

Product idea generation is the first step of new product development process [1]. It is the most important step for all food manufacturers, and the company to create new products that meet consumer needs guidance to success and profitability [2] which can be success through marketing research and consumer study [3]. Perceptual mapping is a technique generally used to understand how consumers differentiate objects, such as brands in a product category [4]. It is one of the techniques which was used to generate new product ideas [5]

Preference mapping is one type of perceptual mapping which has been widely used to help scientists understand the product attributes that drive consumer preference or acceptability [5] within the market segment of interest. There are two distinct types of preference mapping using sensory data, known as external preference mapping and internal preference mapping. External preference mapping is created based on sensory descriptive data by trained panelists [6] while internal preference mapping (Consumer preference mapping) using hedonic or preference data by consumers or untrained panels [7]. Since internal preference mapping was prepared by consumer data, it held a clear advantage on marketing action ability and new product creativity [3]. Internal preference mapping can be derived using the basis of principal component analysis (PCA) [8]. Internal preference mapping is a multivariate statistical technique to analyze hedonic data in order to decrease a set of attributes into a smaller set of factors using correlation among the attributes [9]. The results can then be profiled and differentiated products based on the sensory preference dimensions.

Tom Yum is one of the Thai local soup (Tom) products, it consists of mixed spices and herbs (Yum) such as galangal, shallots, lemon grass, and kaffir lime leaves [10]. The three main tastes of this product are sour, sweet and salty that results from the addition of lime juice, sugar and sodium salt, respectively [11]. Nowadays, mono-sodium glutamate (MSG), a source of umami taste, is also added to this product to increase the palatability [12]. Tom Yum is divided into two different types including a creamy soup type with milk or coconut milk adding and a clear soup type without milk or coconut milk addition [13]. The popularity of Tom Yum soup could be seen in the presence of Tom Yum essence in various products, such as snacks, seasoning powder, instant noodle and soup [14]. Today, Tom Yum is becoming more popular in Thailand as well as in other countries around the world.

There are a lot of Tom Yum seasoning products in various forms available in the market such as powder, paste, cube, sauce, instant soup, dried spice set and instant noodle soup. [10] characterized the sensory profile (External preference mapping) of 12 instant tom yum soups using sensory descriptive data by trained panels. They found that aroma and flavor intensity were main sensory characteristics of Tom Yum. To have a completed understanding about the product category, it is interesting to position 24 marketed Tom Yum seasoning products on the internal preference maps using acceptance or hedonic data by consumer or untrained panels. Focusing on consumer attitudes towards these products and how consumer responses to products in sensory acceptance relate to salt content and MSG content in order to develop reduced sodium Tom Yum Goong seasoning powder following [15]. Due to the amount of sodium salt of it was over than WHO recommendation. The trend of the possibility of product success in the market will be also met from gaps on the map including consumer segmentation in the product market as well.

Understanding the consumer preference of products has until now presented a challenge. However, it was found that consumer hedonic data could successfully characterize and discriminate between products on the basis of their sensory attributes [16]. This procedure could, therefore, facilitate the use of consumer preference mapping to help understand the Tom Yum seasoning product attributes which drive consumer preference, as has been done previously for products' sensory attributes.

II. METHODOLOGY

1. Sample preparation

Twenty-four instant Tom Yum seasoning products available in Thai market were selected using purposive sampling from a few of superstores in Udon Thani province, Thailand. They consisted of

1) Cube form: sample C,
2) Paste form: sample E (Without MSG), A, F and R,
3) Powder form: K and X,
4) Sauce form: sample N,
5) UHT soup form: sample Q,
6) Paste set form: sample J (low sodium), B, T, and U, and
7) Powder form for instant noodles: sample V (Without MSG), D, G, H, I, L, M, O, P, S, and W.

All of the samples are commercial samples that have been approved by Thai FDA. The samples were mixed with a certain amount of boiling water according to each product instruction. The mixture of each sample (20 ml.) was served in a transparent plastic container with a lid cover and encoded with random three-digit numbers to avoid bias. All samples were presented in controlled temperature at 45^{o}C for a test (They were kept in the hot cabinet and temperature of the equipment was checked using infrared thermometer GM320 between -50 – 380^{o}C, calibrated with ice water at 0^{o}C and boiling water at 100^{o}C).

2. Subjects

Eighty nine consumer panels ([17] recommended 50-100 consumer panel size for various consumer sensory testing laboratory) of which 52 females (Mean age was 23.2 ± 2.5) and 44 males (Mean age was 23.4 ± 2.1) were recruited using purposive sampling to the sensory laboratory of Food Technology and Innovation Department, Khon Kaen University, Nongkhai Campus. This sample size was perfectly fit with the experimental design for 24 samples (4 samples per a session/6 sessions). They were staff and students of Khon Kaen University, Nongkhai Campus who are aware of the salt intake. Individuals with food allergies especially to shrimp and MSG were not approved to participate in this study. Signed consent forms were obtained from all suitable volunteers who took part in the study. This research project was exempted by Khon Kaen University Ethics Committee for Human Research based on Declaration of Helsinki and the ICH Good Clinical Practice Guideline.

3. The experimental design

The Randomized Complete Block Design (RCBD) was assigned for arranging the test replications [18]. There were 6 sessions (4 samples per session), each subject was tested for all sessions (24 samples) in the different times to avoid sensory fatigue. The test was organized as blinded with sequential monadic style. Each of the samples were presented to individual consumer panel for sensory evaluation. Before and after tasting each sample, individuals were asked to rinse their palate with drinking water at room temperature and a piece of white bread. Then, they were subsequently asked to complete the scales in 3 parts; they were 1) sensory preference test, 2) sensory intensity test and 3) willingness to pay test, respectively. The air conditioning was set to control the room temperature at 25^{o}C.

To measure consumer preference, after serving each of the samples, subjects were asked to taste each sample and evaluate to what extent they liked or disliked each sample in 14 terms namely, appearance, spiciness, saltiness, sweetness, sourness, chili hot, spice hot, taste intensity, palatability, creaminess, mouth feel, natural, authentic and

overall liking using a nine-point hedonic scale (1 = dislike extremely, 2 = dislike very much, 3 = dislike moderately, 4 = dislike slightly, 5 = Neither liked nor disliked, 6 = like slightly, 7 = like moderately, 8 = like very much and 9 = extremely liked) [18]. For sensory intensity test, sensory attribute level such as salt content [19] and umami level was evaluated using the following 7 point Just About Right (JAR) scale (1 = much too low, 2 too low, = 3 = low, 4 = just about right, 5 = high 6 = too high and 7 = much too high) [20]. In addition, a salinity salt tester meter (AZ 8371; AZ Instrument, Taiwan) was used to analyze sodium chloride (NaCl) content of all samples with a reading NaCl content ranging from 0 to 9999 mg/L (ppm). An assessment related to the willingness to pay, consumers' purchase intention was carried out regarding the samples. The 5-point structured scale was used, in which 1 indicated that the consumers would definitely not buy; 2 = the consumers would probably not buy; 3 = the consumers may/may not buy; 4 = consumers would probably buy and 5 = consumers would definitely buy [21].

4. Statistical analysis

The scale reliability was tested by internal consistency method using Cronbach's alpha [22]. The data from all scales were analyzed using multivariate analyses of variance (MANOVA) ($p \leq 0.05$) considering sample and block as sources of variation. The level of significance for all statistical analysis was set at 0.05.

Sensory preference data were further analyzed using principal component analysis (PCA) [23] to identify any factors differentiating the marketed Tom Yum seasoning product samples. And, only the principal components (PCs) with an eigen-value of at least 1.0 were selected for further interpretation. These PCs were then subjected to a varimax rotation, before interpretation. Each selected and rotated PC was interpreted judgmentally by determining attributes that were highly correlated with the particular PCs [7]. Only the attributes with component loading of 0.5 or more were used in the description of the selected PCs [23]. Cluster analysis (ward method) was applied to the data in order to determine group of samples that received the similar consumer's responses. The means of the component scores of all respondents on each product across all selected and rotated PCs were also calculated. Since all selected PCs (Axes) were always orthogonal to each product that can be viewed as co-ordinates of that specific product on the space defined by those axes. These co-ordinates could be simply use to plot the products on an n-dimensional map. The directions of overall liking [24] from the consumer preference map were used to describe which products responded to sensory acceptance most. It also provided the salt content and MSG content of the selected Tom Yum spicy soup seasoning products. All data analyses were carried out using the statistical package for social science (SPSS) version 26.0 developed by SPSS Inc., Chicaco, USA.

III. RESULT AND DISCUSSION

Results of the sensory comparison of all samples were presented in Table 1. Sample K received the highest liking ratings ($p \leq 0.05$) especially to liking of appearance, salty, sweet, sour, after taste, authentic, overall liking and willingness to pay. The sample B received the highest liking ratings ($p \leq 0.05$) in terms of sweet, sour, chili hot, spicy, hot taste, palatability, creamy, aftertaste, natural, authentic, and overall liking.

From PCA results, the sensory attributes of Tom Yum seasoning products were reduced to two uncorrelated PCs with 75.30 cumulative percentage of the total variance, as shown in Table 2. The PC1 consisted of palatability, overall liking, taste intensity, authentic, mouth feel, creaminess, natural, saltiness, sweetness, chili hot, sourness, spice hot, spicy flavor intensity, appearance and willingness to pay. Then first two PCs were plotted as a consumer preference map.

As showed in Figure 1, twenty four Tom Yum seasoning product samples were positioned on this map with seventeen attributes. It could identify the differences among these samples. Sample K had the highest positive loading for both of PC1 and PC2 (Right up space) and positioned on the vector of overall liking. It means that sample K was preferred in all attributes as compared to other samples, it was a thickening Tom Yum seasoning powder. This result was in agreement with the work of [25] which reported that this seasoning products is a number one for seasoning product market of Thailand for a long time with 70% market segmentation and still grow up continuously. However, sample K had high salt content and MSG content, thus they should be reduced and replaced with natural salt replacer as fish sauce powder and some umami substances as local vegetable mix (Umami replacer) developed by [26] and produced by Yang Loan community enterprises, Thailand. This may relate to motives of food choice and may be of considerable commercial value in healthy marketing. Noticeably, sample X was a clear Tom Yum seasoning powder of the same sample K's company but was less accepted due to it contained highest sodium salt level. And the fact that other products such as U and A were positioned on the overall liking vector might be because they contained fried chili paste which had a mixture of dried shrimp powder that results in a good flavor and taste of Tom Yum soup [27].

However, salt reduction might impact to consumer acceptance directly. Sample J contained low sodium salt, it positioned on the other hand of overall liking vector if the salt was reduced in excess. The reduction in sodium salt

might also include reducing MSG. Sample E (Paste form) and V (Noodle soup seasoning) had no MSG, but sample V closed up the overall liking vector more. Thus it was possible to reduce MSG but still keep consumers acceptance. Another unique characteristics of Tom Yum, besides various spices and herbs, were three main tastes including sour, sweet and salty. The R sample had the most sourness taste, thus it was positioned against the direction of consumer preference. And sample B and K were more sweetness taste, making it positioned on overall liking vector. Thus interaction between sour, salty and sweet tastes is therefore important for consumer acceptance that must also be important [11]. The results of this research can be combined with the research results of [10] for development of reduced sodium Tom Yum Goong in a future by enhancing intensity of flavor and taste of Tom Yum more.

Cluster analysis was applied in data analysis process, it was found that the samples can be categorized into 3 clusters. Cluster 1 had only sample J that was a low Sodium in the form of paste-set and obtained the lowest acceptance scores in all attributes as well as amount of salt, MSG, and WTP. There were 13 samples included in cluster 2 as shown in Table 1. Cluster 2 samples were mostly seasoning powder in instant noodle (10 samples) and obtained the highest acceptance score from the consumer. Cluster 3 consisted of 10 samples. Most of samples belong in cluster 3 were in paste, sauce, and UHT soup.

Table - 1 Liking scores of each item, salt content, MSG content, and WTP of tested samples arrange based on cluster.

Cluster	Product	Form	Additional information	Appearance	Spicy	Salty	Sweet	Sour	Chili hot	Spice hot	Taste	palatability	Creamy	After Taste	Natural	Authentic	Overall Liking	Salt Content	MSG Content	WTP
1	J	**Paste-set**	Low_Na	**5.03ghi**	**4.38h-k**	**2.28i**	**2.06h**	**2.19i**	**2.34i**	**2.56k**	**2.19g**	**2.13f**	**2.34j**	**2.00h**	**2.25h**	**2.09l**	**2.25h**	**2.16f**	**1.97d**	**1.13$_{l}$**
2	A	Paste		6.84ab	5.56b-f	5.13c-f	5.00a-d	5.25a-d	5.69a-d	5.75a-d	5.56cd	5.38cd	6.00abc	5.28b-f	5.16a-d	5.25b-e	5.56a-d	4.41a-e	3.72abc	2.88$_{c-i}$
2	B	Paste-set		6.44a-d	6.09abc	6.22ab	**5.97a**	**6.25a**	**6.47a**	**6.56a**	**6.91a**	**6.56a**	**6.72a**	**6.31a**	5.94ab	**6.38a**	**6.56a**	4.16b-e	4.06abc	3.66$_{a-h}$
2	D	Powder_IN		5.66c-h	4.97d-j	5.09c-f	5.16abc	5.06b-e	5.72abc	5.97ab	5.41d	5.22cd	4.88d-g	5.00def	4.72cde	4.78c-f	5.31cd	3.84b-e	3.81abc	2.50$_{e-k}$
2	G	Powder_IN		6.56abc	6.31ab	5.75abc	**5.91a**	6.03abc	5.94abc	6.03ab	5.97a-d	5.97a-d	6.00abc	6.06abc	5.69abc	5.81ab	6.19abc	4.06b-e	4.16abc	**3.78a**
2	H	Powder_IN		5.81c-g	5.97a-d	5.97abc	**5.63a**	6.03abc	5.41a-d	5.34b-e	5.75bcd	5.88a-d	5.72bcd	5.47a-d	5.47abc	5.53abc	6.00a-d	3.47de	4.22abc	3.25a-d
2	I	Powder_IN		**7.19a**	**6.66a**	6.19ab	5.56ab	6.09abc	6.34ab	5.91ab	6.47abc	6.41ab	**6.78a**	6.19ab	**5.97a**	6.00ab	6.34ab	3.63cde	**4.66a**	**3.94a**
2	K	**Powder**		**7.03a**	5.81a-e	**6.34a**	**5.94a**	**6.38a**	6.25ab	6.09ab	6.66ab	6.44ab	6.63ab	**6.31a**	5.88ab	**6.28a**	**6.56a**	4.41a-e	4.19abc	**3.72a**
2	M	Powder_IN		5.53d-h	5.88a-d	5.50a-d	5.38ab	5.78abc	6.16ab	6.06ab	5.75bcd	5.56bcd	5.06c-g	5.53a-d	5.19a-d	5.19b-e	5.59a-d	4.03b-e	3.94abc	3.03b-e
2	O	Powder_IN		5.31e-i	4.97d-j	5.25b-f	5.00a-d	5.00cde	5.50a-d	5.25b-e	5.13de	5.09d	4.59e-h	5.13c-f	4.91b-e	4.50d-g	5.09de	3.28e	3.69abc	2.78c-f
2	p	Powder_IN		5.97b-g	6.00a-d	5.78abc	5.50ab	6.19ab	6.03ab	6.06ab	6.00a-d	6.13abc	5.69bcd	5.91a-d	5.88ab	6.00ab	5.91a-d	4.00b-e	4.44ab	3.38abc
2	S	Powder_IN		5.31e-i	5.50b-f	5.44a-d	4.97a-d	5.31a-d	6.19ab	6.19ab	5.50cd	5.38cd	4.53fgh	5.44a-e	5.06a-d	5.41a-d	5.50bcd	3.69cde	4.03abc	2.81c-f
2	V	Powder_IN	NO MSG	6.03b-f	5.75 a-e	5.41a-e	5.16abc	5.09b-e	4.97cde	5.19b-f	5.22de	5.31cd	5.56cde	5.09c-f	5.13a-d	5.03b-f	5.34bcd	3.91b-e	3.50abc	2.63d-g
2	W	Powder_IN		5.22e-i	5.09c-i	5.38a-e	5.41ab	5.66abc	5.91abc	5.88abc	5.47d	5.69a-d	5.31c-f	5.56a-d	5.19a-d	5.16b-e	5.53bcd	3.66cde	3.72abc	2.72c-f
	Mean cluster 2			**6.07**	**5.74**	**5.65**	**5.43**	**5.70**	**5.89**	**5.87**	**5.83**	**5.77**	**5.65**	**5.64**	**5.40**	**5.49**	**5.81**	**3.89**	**4.01**	**3.16**
3	C	Cube		3.28l	4.13i-l	4.50d-g	4.09c-f	4.28d-g	4.31efg	4.44e-i	3.75f	3.66g	3.59hi	3.75g	4.03ef	3.47hij	3.94fg	3.66cde	3.59abc	1.78i-l
3	E	Paste	No MSG	5.34e-h	5.25c-h	4.31fg	4.09c-f	4.31d-g	4.75def	4.94c-g	4.34ef	4.03g	4.28gh	3.94g	4.03ef	4.16f-i	4.16ef	4.59a-d	3.50abc	1.88h-k
3	F	Paste		6.13b-e	5.41b-g	4.41e-g	4.50b-e	4.50def	5.03cde	4.72e-h	4.22f	4.19g	4.34fgh	4.31fg	4.31def	4.25e-h	4.28ef	4.81abc	3.41bc	2.28f-i
3	L	Powder_IN		5.59d-h	4.84e-j	4.09gh	3.91ef	4.00efg	4.72def	4.81d-g	4.09f	4.25g	4.25ghi	4.47efg	3.94ef	4.06f-j	4.31ef	3.81b-e	4.13abc	1.91hij
3	N	Sauce		4.75hij	4.47g-k	3.78gh	4.06d-f	4.00efg	4.28efg	4.16ghi	4.09f	3.91g	3.78hi	3.72g	3.63f	3.28hij	3.56fg	4.91ab	4.00abc	1.56jkl
3	Q	UHT Soup		3.78kl	3.72kl	3.84gh	3.78ef	3.81fgh	3.44gh	3.50ij	3.91f	4.00g	4.31fgh	3.59g	3.50f	3.16ij	3.63fg	4.03b-e	3.69abc	2.00g-j
3	R	Paste		3.63kl	3.28l	2.50i	2.56gh	2.81hi	2.81hi	3.13jk	2.44g	2.34f	2.41j	2.34h	2.47gh	2.22kl	2.41h	4.56a-d	3.34bc	1.19kl
3	T	Paste-Set		4.41ijk	4.25h-k	3.75gh	3.47efg	3.66fgh	4.41ef	4.25f-i	3.94f	3.59g	3.81hi	3.66g	3.97ef	3.56g-j	3.72fg	4.78abc	3.81abc	1.56jkl
3	U	Paste-Set		4.03jkl	4.56f-m	3.19hi	3.16fg	3.31gh	3.91fg	3.84hij	3.44f	3.31g	3.25ij	3.50g	3.38fg	3.09jk	3.09gh	4.09b-e	3.13c	1.31jkl
3	X	Powder		5.16f-i	4.00j-l	3.63gh	3.72ef	4.38d-g	4.72def	4.41e-i	4.06f	3.75g	3.56hi	3.50g	3.34fg	3.41hij	3.75fg	**5.44a**	4.28abc	1.66i-l
	Mean cluster 3			**4.61**	**4.39**	**3.80**	**3.73**	**3.91**	**4.24**	**4.22**	**3.83**	**3.70**	**3.76**	**3.68**	**3.66**	**3.47**	**3.69**	**4.47**	**3.69**	**1.71**

Table - 2 Loading of sensory attributes response on two principal components which was defined as their underlying dimensions, evaluated by consumer panels on a range of twenty four samples.

Attributes	Principal Component	
	1	2
Liking of appearance	0.68	
Liking of spiciness	0.77	
Liking of saltiness	0.87	
Liking of sweetness	0.86	
Liking of sourness	0.85	
Liking of chili hot	0.86	
Liking of spice hot	0.85	
Liking of taste intensity	0.93	
Liking of palatability	0.94	
Liking of creaminess	0.89	
Liking of mouth feel	0.91	
Liking of natural taste	0.89	
Liking of authentic taste	0.92	
Overall liking	0.94	
Salt content		0.86
MSG content		0.81
Willingness to pay	0.73	
Percentage of Variance	65.81	9.49
Cumulative percentage	65.81	75.30

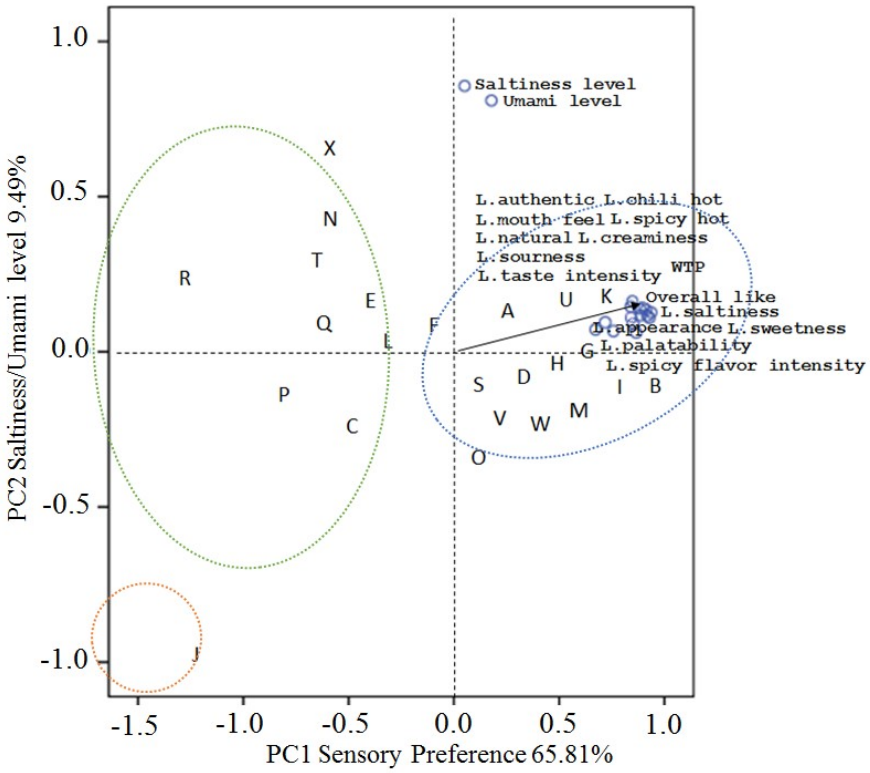

Figure 1 The consumer preference map of the sensory attribute descriptors of twenty four samples (A-X) on first two principal components (PCs) 1 and 2.
Remark: B, F, I, K, N, Q, R, T, U = high sodium salt (84.1-88.95 mg/L), A, C, D, E, G, H, L, M, O, P, S, V, W= medium sodium salt (71.8-76.8 mg/L), X: highest sodium salt = 90.45 mg/L, and J: lowest sodium salt = 49.95 ppm.

IV.CONCLUSION

From the results, consumer preference map helped for revealing the differential of all marketed Tom Yum seasoning products for all liking of sensory attributes. By analyzing the positions of different Tom Yum seasoning

products on the map, it could show the advantages and disadvantages of each product clearly. This would be benefit for generating new product idea to develop reduced sodium Tom Yum Goong seasoning powder further. On the map, the vector of overall liking pointed to sample K which was a thickening Tom Yum seasoning powder product of Ajinomoto Co., Lt. and its position was on both principal components, indicating that it had the highest loading factors for all attributes among all samples. However, this product had a very high amount of sodium chloride and MSG need to be reduced in the future.

REFERENCES

[1] J. Callan, "The New Product Development Process (NPD) – 8 Steps", Retrieved on June 27, 2020 from Website: https://marketing-insider.eu/new-product-development-process, 2019.

[2] J. A. McEwan, "Preference mapping for product optimization". In Multivariate Analysis of Data in Sensory Science, pp. 71-101, Elsevier, Amsterdam, 1996.

[3] Kleef, E.V., Trijp, H.C.M.V. and Luning, P. (2006). Internal versus external preference analysis: An exploratory study on end-user evaluation. Food Quality and Preference, 17(5), 387-399.

[4] D. J. Best, J. C. W. Rayner, M. G. O'Sullivan, "Product maps for consumer categorical data", *Food Quality and Preference,* Vol. 11, pp. 91-97, 2000.

[5] E. V. Kleef, H.C.M.V. Trijp, P. Luning, "Consumer research in the early stages of new product development: a critical review of methods and techniques", *Food Quality and Preference,* Vol. 16, pp. 181-201, 2005.

[6] J. Yang, J. Lee, "Application of sensory descriptive analysis and consumer studies to investigate traditional and authentic foods: A Review", *Foods,* Vol. 8, pp. 54, 2019.

[7] K. Greenhoff and H. J. H. MacFie, "Preference mapping in practice", In Measurement of Food Preferences, pp. 137-166, Springer, Boston, MA, 1994.

[8] J. X. Guinard, "Internal and external preference mapping: Understanding market segmentation and identifying drivers of liking", *ACS Symposium Series,* Vol. 825, pp. 227-242, 2002

[9] H. T. Lawless and H. Heymann, "Sensory Evaluation of Food", Chapman and Hall, New York, 1998.

[10] K. Kitsawad and N. Tuntisripreecha, "Sensory characterization of instant Tom Yum soup", *KMUTNB International Journal Applied Science Technology,* Vol. 9, pp. 145–152, 2016.

[11] K. Khajarern, S. Suwannasing, A. Upahad, "Palatability and Sensory Interaction between Umami and Other Taste Substances: A Case of Instant Thai Spicy Prawn Soup (Tom Yum Kung)", Proceeding of 1st Academic Conference Khon Kaen University Nongkhai Campus, 2010.

[12] N. Barylko-Pikielna and E. Kostyra, "Sensory interaction of umami substances with model food matrices and its hedonic effect", *Food Quality and Preference,* Vol. 18, pp. 751–758, 2007.

[13] C. Suwankanit, S. Pandolsook, V. Vittayaporn, K. Tohtubtiang, N. Nantaragsa, "Influences of different soup stocks on chemical and organoleptic properties of Tom Yum", *Journal of Science and Technology, Ubon Ratchathani University,* Vol. 17, pp. 56-69, 2015.

[14] S. Phornphisutthimas, "Pilot-scale development of dried seasoning with Tom Yam flavour using mushroom as adsorbent", *Asian Journal of Food and Agro-Industry,* Vol. 3, pp. 335-342, 2010.

[15] U. Srisirirat, "Formulation of low sodium Tom Yum Kung Seasoning", Siam University, Bangkok, 2017.

[16] H. J. H. Macfie, "Preference mapping and food product development", In Consumer-Led Food Product Development, pp.551-592, Woodhead Publishing, UK, 2007.

[17] A.V.A. Resurreccion, "Consumer Sensory Testing For Product Development", Aspen Publication, Gaithersburg, 1998.

[18] M. Meilgaard, G. V. Civille, B. T. Carr, "Sensory Evaluation Techniques", CRC Press, USA, 2006.

[19] R. E. Stanley, C. G. Bower, G. A. Sullivan, "Influence of sodium chloride reduction and replacement with potassium chloride based salts on the sensory and physico-chemical characteristics of pork sausage patties", *Meat Science,* Vol. 133, pp. 36-42, 2017.

[20] R. Popper, "Novel Techniques in Sensory Characterization and Consumer Profiling", CRC Press, USA, 2014.

[21] M. A. De Almeida, N. D. M. Villanueva, J. S. Da Silva Pinto, E. Saldaña, C. J. Contreras-Castillo, "Sensory and physicochemical characteristics of low sodium salami", *Scientia Agricola,* Vol. 73, pp. 347-355, 2016.

[22] C. M. Shapiro, M. Flanigan, J. A. E Fleming, R. Morehouse, A. Moscovitch, J. Plamondon, L. Reinish, G. M. Devins, "Development of an adjective checklist to measure five FACES of fatigue and sleepiness data from a national survey of insomniacs", *Journal of Psychosomatic Research,* Vol. 52, pp. 467– 473, 2002.

[23] K. Nanthachai, T. Rojanakorn, R. Tangwongchai, "Understanding consumer sensory perception of food and its relationship with food acceptability", *Khon Kaen University Research Journal,* Vol. 2, pp. 54-61, 1997.

[24] F. T. Kleij and P. A. D. Musters, "Text analysis of open-ended survey responses: a complementary approach to preference mapping", *Food Quality and Preference,* Vol. 14, pp. 43–52, 2003.

[25] Siam Business, "Seasoning competition", *Siamturakij advertising,* July 8, 2014.

[26] P. Yayee, "Vegetable Seasoning Powder", Siam University, Bangkok, 2019.

[27] U. Deesawas, "Tom Yum Gung Paste", Rajamangala University of Technology Krungthep, Bangkok, 2007.