Implementation of Quality Function Deployment and Kansei Engineering for GABA Rice Snack Development

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Abstract

GABA rice has gained popularity in Thai society during the last couple of years due to its high nutritional value, as well as a more healthy-conscious trend among Thai consumers. Product development for GABA rice snacks proposed in this study was based on a healthy snack target group. Mood Consumption theory was employed for dividing potential customers into 4 categories: Innovation, Intuition, Perfection and Satisfaction, and then, the Quality Function Deployment (QFD) technique was implemented for developing appropriate GABA snack products with respect to consumer's preferences. Furthermore, Kansei engineering techniques have been implemented in order to suggest a proper snack package form for each specific group. According to these product development techniques, the results showed that each group of mood consumption customers presented different responses of the final products. However, most consumers preferred a product package with "easy to eat" and "attractive" character, leading to the preference of package designs as a quad seal or Doy pack bag. Finally, the proposed products and packages have been prototyped and verified by measuring consumers' satisfaction levels.

Key words: GABA rice/ Snack product/ Mood consumption/ Quality function deployment/ Kansei engineering

1. Introduction

GABA rice or germinated brown rice was introduced to Thai rice consumers in the last couple of years. However, GABA rice and its products have gained recognition as an innovative food and generated value-added for the Thai rice industry (Bank for Agriculture, 2011). The processing of GABA rice begins when brown rice is soaked in water until its root starts to grow, then its moisture content is reduced to 15% before packing in the vacuum-sealed bag, or processing into other rice products. During the germination of brown rice, the nutritional value called GABA or Gamma-amino butyric acid in the rice kernel increases about 15 times over regular brown rice. This substance helps suppress blood pressure and improve sleeplessness (Okada et al., 2000). GABA also plays a role in regulating neuronal excitability throughout the nervous system, as well as being directly responsible for the regulation of muscle tone (Watanabe et al., 2002). However, GABA rice normally has a shorter shelf life than regular rice, which is about 6 months; processing GABA rice into snack products not only prolongs its shelf life, but also increases its value.

In order to produce appropriate GABA rice snack products in this study, many product design techniques have been implemented. First of all, the theory called mood consumption technique has been employed to categorize the characteristics into 4 different target groups of consumer. This technique was introduced by Style-vision in 2006 to help manufacturers understand consumer behavior based on his or her mood or personality. This technique has been

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implemented in many product developments such as rice and parboiled rice, in order to create different types of product belonging to each consumer group (Naiwikul et al., 2007; Wattanuchariya, 2010). The descriptions of customer groups based on mood consumption theory are as the followings (Style-Vision, 2006)

(1) *Innovation group* describes people who are excited to learn about new things, or have new experiences. They think solving problems is challenging. They are interested in the latest technology, products or inventions resulting from the exchange of arts and culture of each ethnic mix. Interesting features added to food can attract the attention of consumers in this group, such as self-flavored food or self-designed food. In addition, they are also interested in food that has a combination of raw materials from Western and Eastern with a modern look, beautiful and easy to eat.

(2) *Intuition group* refers to people who like to find their true self, optimistic, gentle, and heart caring. They choose their preferred work tasks. They have high energy and like to wear clothes that are multi-functional and appropriate for all situations. They also prefer to travel alone either for business or leisure. The food of this consumer groups should be organic food.

(3) *Perfection group* are people who like stability and accuracy. Life is organized according to their customary practices. The customers in this group choose products that maintain the ecological protection of life, such as popular brands of cosmetics, free from animal testing. They are concerned about health care and are against fast food because they believe that good food must be cooked thoroughly and carefully prepared. In addition, they also look at food as a representation or symbolic of their lifestyle.

(4) *Satisfaction group* describes people who love having fun and socializing. They have high self-confidence, and love accuracy and humanity to learn and adapt well with others. They are easy going, simple, love to help others, and passionate about entertainment of all types. They get bored easily, and change things like appliances according to fashion. They look at the world as a beautiful thing and like to travel to exotic places.

The second technique employed in this study, includes the first matrix of QFD or House of Quality (HOQ). QFD is a set of powerful product development tools and procedures which takes the concepts of quality control from manufacturing and transfers them to the new product development process (Lowe et al., 2000). This technique has been used in food product development (Benner et al., 2003; Costa et al., 2001) such as healthy rice crackers (Satafang and Wattanutchariya, 2007), ready-to-eat liquid food for the aging population (Phonpai, 2008), among others. The composition of HOQ, as shown in Figure 1, consists of six major components: (1) customer requirements (2) technical requirements (3) planning matrix (4) interrelationship matrix (5) technical correlation matrix, and (6) priorities, benchmarks and targets for technical descriptors.

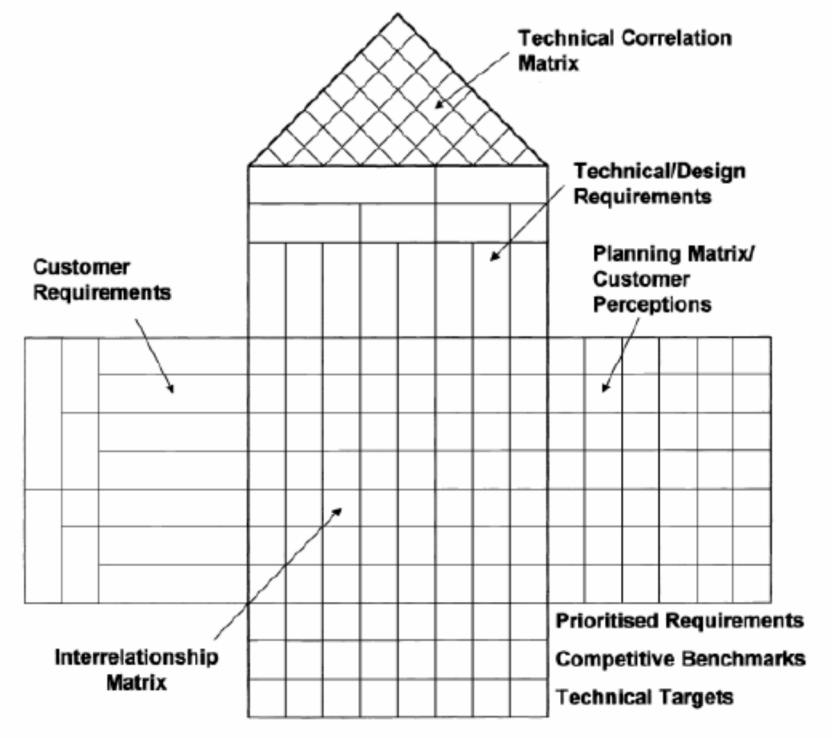


Figure 1 A generic QFD house of quality (Chan et al., 2005)

The HOQ matrix translates the needs, expressed by a customer, into the design targets of a proposed new product. This is affected by entering weightings into the central interrelationship matrix, representing the scale of the perceived relationship between each customer and technical requirements. These weightings are combined with measures of the relative importance of each customer requirements to calculate a priority for each of the technical requirements in terms of satisfying customers.

Kansei Engineering is the last concept implemented in this study, to ensure proper package form for GABA snack product developed from both mood consumption and QFD techniques. Kansei engineering is used to translate customer's emotion or perception of product in design attributes or design element such as size, form or color of surface which can be used as an information base to develop products before launching to market (Ahmady, 2008). Kansei technique uses the impression that somebody gets from a certain artifact, environment or situation using all senses of sight, hearing, feeling, smell, taste as well as their recognition, to develop appropriate products corresponding to those responses (Nagamachi, 2001). Kansei engineering has been implemented for many product developments including packaging design such as bathtub salt packaging (Nagamachi, 2008) and chocolate packaging (Huang, 2008). Kansei engineering procedures, as shown in Figure 2, include (1) Choosing a domain which is the customer target, market group and specification to develop products. (2) Collecting and selecting semantic adjectives which are consistent with product development. (3) Collecting and selecting of product properties. (4) Synthesizing or linking between Kansei word and product properties. (5) Testing of validity and model building by using statistic method.

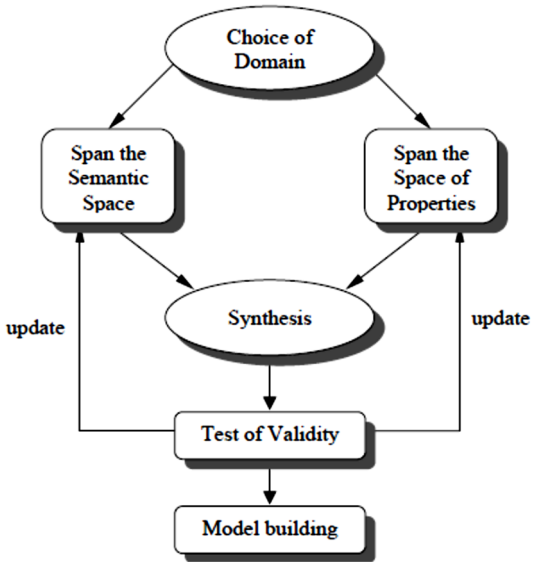


Figure 2 Abstract model of Kansei engineering

2. Methodology

The methodology for designing and developing GABA rice snack products is based on mood consumption, quality function deployment, and Kansei engineering, consisting of 6 steps as follows.

2.1 Interview customer about attitudes to general snacks.

A one-on-one interview has been performed on 20 related participants to survey customer requirements on the GABA rice snack product. The objective of this interview is to seek issues that could be used in the questionnaire. Open-ended questions were asked concerning consumers' attitude towards current GABA snack products in the market and criteria in buying decisions.

2.2 Evaluate customer requirements with quality tools

In this step, an affinity diagram was used to capture the voice of customers and build a hierarchy of customer requirements based on words and phrases used in the answers from interviews. Furthermore, a tree diagram was then implemented to categorize customer's major concerns and then transform them into a list of queries for the questionnaire.

2.3 Categorizing customers into 4 mood consumption groups, assess importance rating of customer's needs, and choose preferred product characteristic, by questionnaire

Questionnaires were carried out on 400 participants. The query consists of 4 sections: personal information, mood consumption classification questions, customer's need rating, and product characteristic rating. To categorize participants based on mood consumption theory; logical questions related to their own behavior will be asked in terms of personal interests, relationships with others, as well as life management.

2.4 Design QFD matrix for product planning

The construction of QFD starts with the HOQ matrix which has all 4 groups of mood consumption in one house. This matrix is composed of customer requirements and its ranking, as well as technical requirements, technical correlation matrix, interrelationship matrix, and technical target sections. Information from the questionnaires incorporated with comments from the experts is then applied to complete the HOQ matrix.

2.5 Develop and validate prototype products

The preferred product characteristics from the questionnaire and HOQ results will be developed into a prototype corresponding to each specific group of mood consumption. Afterward, 40 participants from all 4 mood consumption groups are requested to rate their satisfaction level on the prototype

product using a questionnaire and sensory evaluation.

2.6 Develop package form by Kansei engineering

The packaging design process based on Kansei engineering starts from collecting Kansei word and package form from related literature such as textbooks and magazines. Then, 2 packaging design experts will select the proper choice of Kansei word and package form before letting participants rate these chosen words and package styles. Finally, statistical evaluation is applied to confirm the significant level of Kansei word and package form.

3. Results and Discussion

The results from the implementation of Mood Consumption, QFD, and Kansei engineering can be explained and discussed as follows:

3.1 Analyzing customer's response with affinity diagram and tree diagram

The results from the preliminary interview showed that most customers think that GABA rice has more nutrition than regular rice. Furthermore, its snack products should still have a good taste, cleanliness, no rancid odor, natural smell and proper serving size. Its ingredients should be healthy with minimum amounts of sugar, salt, fat, and monosodium glutamate and preservatives. This information is categorized by the tree diagram, as shown in Figure 3, and will be developed into a section of the questionnaire.

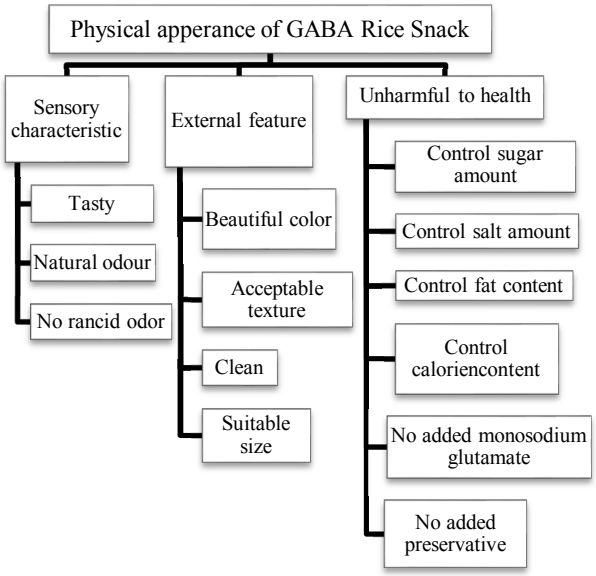


Figure 3 Tree Diagram of customer requirements on GABA rice snacks

3.2 Mood consumption with percentage of customers

According to 400 participants from Muang district, Chiang Mai province, Thailand, the majority of them belong to the Intuition group (34%), Innovation group came second (27.5%) followed by Satisfaction group at 23% and finally the Perfection group with 15.5%.

3.3 Importance rating and preference products

Figure 4 displays the importance rating of GABA rice snack for each specific mood consumption group. As can be seen from this graph, most customers from the Innovation and Intuition group were concerned with rancid odor and cleanliness of the snack product, while Perfection and Satisfaction group were concerned about the product's taste. In addition to importance rating, each customer group was asked to choose their preferred product characteristic such as flavor and form. The results from these queries showed that customers from the Innovation group preferred a bar shape rice cracker with chili paste flavor, while the Intuition group chose a sheet shape

puffed rice-cake with Tom-yum flavor. The Perfection group liked a bar shape rice snack bar with chili paste flavor and finally the Satisfaction group selected a bar shape fried rice pastry with pepper flavor.

3.4 Implementation of QFD

The QFD phase 1 or house of quality (HOQ) was implemented to translate important customer requirements regarding product quality into important end-product control characteristics. The relationships were key elements of any QFD chart and were depicted by placing symbols at the intersections of the customer requirements and technical requirements. This symbol not only symbolized the relationship, but it also represented the score used in the technical requirement importance calculation.

HOQ was conducted to identify what technical characteristic of GABA snack product should be more focused during product development. According to Figure 5, the technical requirement which had the highest score is the fat content, while sugar content and total energy intake came in second and third. On the other hand, the product's taste and form scored just a moderate level. These results suggested that consumers from the target group, whether categorized into any mood consumption group, were mostly concerned with the product's nutrition over other characteristics.

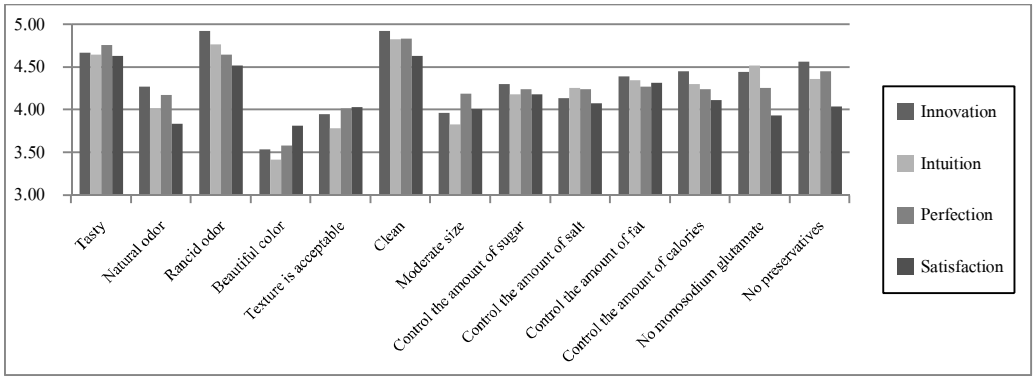
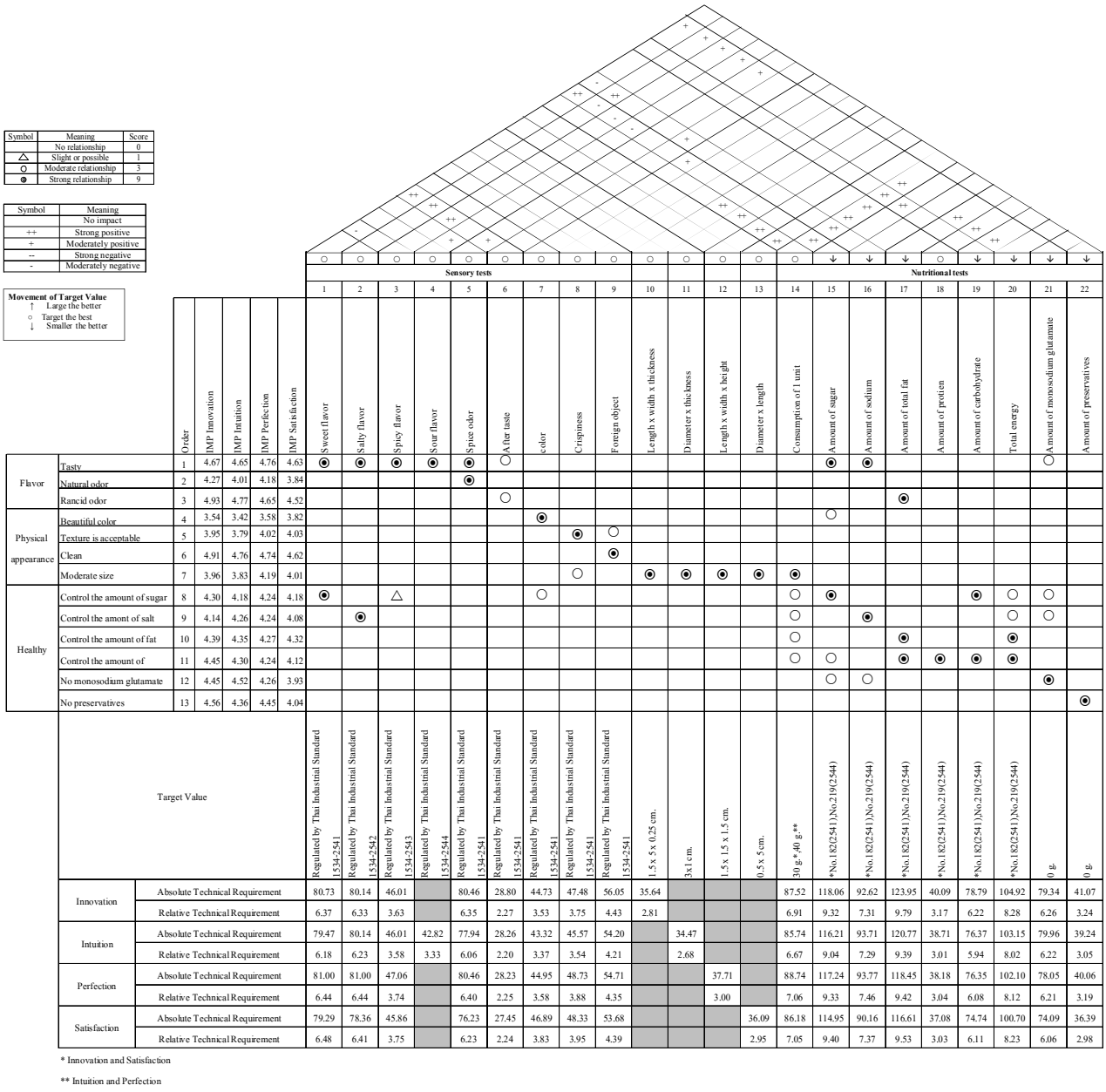


Figure 4 Importance rating of GABA rice snack product



Symbol	Meaning	Score
	No relationship	0
△	Slight or possible	1
○	Moderate relationship	3
◉	Strong relationship	9

Symbol	Meaning
	No impact
++	Strong positive
+	Moderately positive
--	Strong negative
-	Moderately negative

Movement of Target Value
↑ Large the better
○ Target the best
↓ Smaller the better

		Order	IMP Innovation	IMP Intuition	IMP Perfection	IMP Satisfaction	1 Sweet flavor	2 Salty flavor	3 Spicy flavor	4 Sour flavor	5 Spice odor	6 After taste	7 color	8 Crispiness	9 Foreign object	10 Length x width x thickness	11 Diameter x thickness	12 Length x height	13 Diameter x length	14 Consumption of 1 unit	15 Amount of sugar	16 Amount of sodium	17 Amount of total fat	18 Amount of protien	19 Amount of carbohydrate	20 Total energy	21 Amount of monosodium glutamate	22 Amount of preservatives
							Sensory tests													Nutritional tests								
							○	○	○	○	○	○	○	○	○	○	○	○	○	○	↓	↓	↓	○	↓	↓	↓	↓
Flavor	Tasty	1	4.67	4.65	4.76	4.63	◉	◉	◉	◉	◉	○									◉	◉					○	
	Natural odor	2	4.27	4.01	4.18	3.84					◉																	
	Rancid odor	3	4.93	4.77	4.65	4.52						○											◉					
Physical appearance	Beautiful color	4	3.54	3.42	3.58	3.82							◉								○							
	Texture is acceptable	5	3.95	3.79	4.02	4.03								◉	○													
	Clean	6	4.91	4.76	4.74	4.62									◉													
	Moderate size	7	3.96	3.83	4.19	4.01								○		◉	◉	◉	◉	◉								
Healthy	Control the amount of sugar	8	4.30	4.18	4.24	4.18	◉		△				○							○	◉				◉	○	○	
	Control the amont of salt	9	4.14	4.26	4.24	4.08		◉												○		◉				○	○	
	Control the amount of fat	10	4.39	4.35	4.27	4.32														○			◉			◉		
	Control the amount of	11	4.45	4.30	4.24	4.12														○	○		◉	◉	◉	◉		
	No monosodium glutamate	12	4.45	4.52	4.26	3.93															○	○					◉	
	No preservatives	13	4.56	4.36	4.45	4.04																						◉

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Target Value		Regulated by Thai Industrial Standard 1534-2541	Regulated by Thai Industrial Standard 1534-2542	Regulated by Thai Industrial Standard 1534-2543	Regulated by Thai Industrial Standard 1534-2544	Regulated by Thai Industrial Standard 1534-2541	Regulated by Thai Industrial Standard 1534-2541	Regulated by Thai Industrial Standard 1534-2541	Regulated by Thai Industrial Standard 1534-2541	Regulated by Thai Industrial Standard 1534-2541	1.5 x 5 x 0.25 cm.	3x1 cm.	1.5 x 1.5 x 1.5 cm.	0.5 x 5 cm.	30 g.*,40 g.**	*No.182(2541),No.219(2544)	*No.182(2541),No.219(2544)	*No.182(2541),No.219(2544)	*No.182(2541),No.219(2544)	*No.182(2541),No.219(2544)	*No.182(2541),No.219(2544)	0 gb	0 gb
Innovation	Absolute Technical Requirement	80.73	80.14	46.01		80.46	28.80	44.73	47.48	56.05	35.64				87.52	118.06	92.62	123.95	40.09	78.79	104.92	79.34	41.07
	Relative Technical Requirement	6.37	6.33	3.63		6.35	2.27	3.53	3.75	4.43	2.81				6.91	9.32	7.31	9.79	3.17	6.22	8.28	6.26	3.24
Intuition	Absolute Technical Requirement	79.47	80.14	46.01	42.82	77.94	28.26	43.32	45.57	54.20		34.47			85.74	116.21	93.71	120.77	38.71	76.37	103.15	79.96	39.24
	Relative Technical Requirement	6.18	6.23	3.58	3.33	6.06	2.20	3.37	3.54	4.21		2.68			6.67	9.04	7.29	9.39	3.01	5.94	8.02	6.22	3.05
Perfection	Absolute Technical Requirement	81.00	81.00	47.06		80.46	28.23	44.95	48.73	54.71			37.71		88.74	117.24	93.77	118.45	38.18	76.35	102.10	78.05	40.06
	Relative Technical Requirement	6.44	6.44	3.74		6.40	2.25	3.58	3.88	4.35			3.00		7.06	9.33	7.46	9.42	3.04	6.08	8.12	6.21	3.19
Satisfaction	Absolute Technical Requirement	79.29	78.36	45.86		76.23	27.45	46.89	48.33	53.68				36.09	86.18	114.95	90.16	116.61	37.08	74.74	100.70	74.09	36.39
	Relative Technical Requirement	6.48	6.41	3.75		6.23	2.24	3.83	3.95	4.39				2.95	7.05	9.40	7.37	9.53	3.03	6.11	8.23	6.06	2.98

* Innovation and Satisfaction

** Intuition and Perfection

Figure 5 Illustration of main parts of the House of Quality (HOQ)

3.5 Prototype product verification

Prototype products based on the characteristics identified by each group of mood consumption were developed, as shown in Figure 6. The Questionnaire and 9-point hedonic scale sensory technique have been used to evaluate customer satisfaction level on the prototype products. The results from the questionnaire demonstrated that every customer group was satisfied with the product prototypes and will buy these products if they are launched. Sensory evaluation was another evaluation technique used to identify satisfaction levels of customers from each mood consumption group, as shown in Figure 7. According to this Figure, it shows that consumers from the Innovation and Perfection group were satisfied with color with a score of 7.48 and 7.47, respectively, while the Intuition group was satisfied with a sour taste and spicy odor with a score of 7.56. Finally, the Satisfaction

group was satisfied with a spicy taste at 7.52 point score.

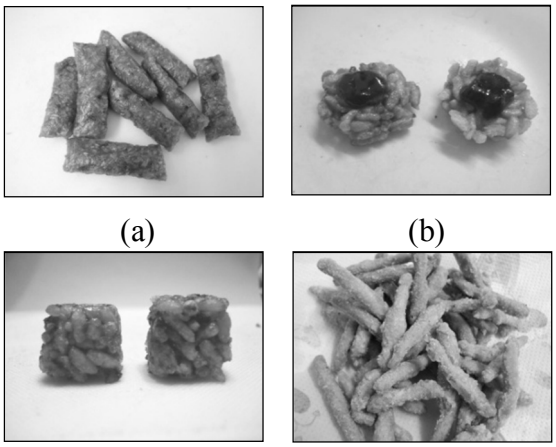


Figure 6 GABA rice snack product prototype (a) Rice cracker with chili paste flavor, (b) Puffed rice-cake with Tom-yum flavor, (c) Rice snack bar with chili paste flavor, (d) Fried rice pastry with pepper flavor

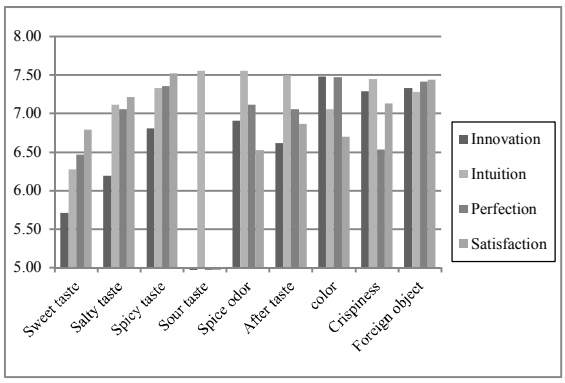


Figure 7 Sensory evaluation of GABA snack product

3.6 Package development with Kansei engineering

According to packaging design experts, 6 out of 105 Kansei words and 6 out of 88 package forms were recommended for generating another questionnaire for packaging design corresponding to the Kansei engineering technique. These 6 Kansei words are protecting, attractive, reduce waste, easy to eat, portable and modern, whereas 6 package forms are pillow style, quad seal, tetrahedron, Doy pack, stick pack and cone-shape bag, as illustrated in Figure 8. Packaging questionnaires were distributed at the same time as the prototype verification test; therefore, participants have been categorized into each mood consumption group prior to response to the package style query. These participants were asked to rate the Kansei words and package forms on a 5-point Likert scale, corresponding to the preference GABA rice snack product.

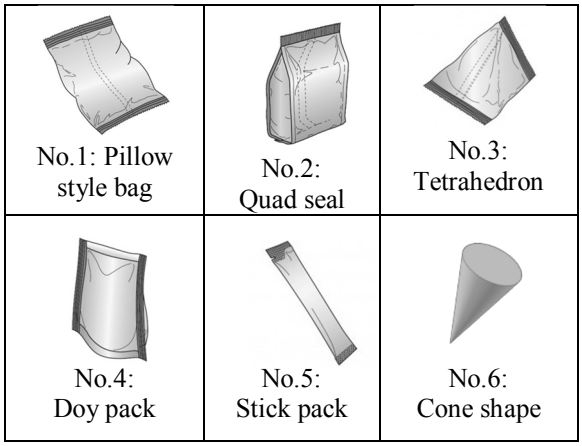


Figure 8 Selected packaging forms

According to statistical evaluation, the Kansei word and package form from 4 mood consumption groups were not significantly different at 95% confidence interval, but the most preferable Kansei words were “easy to eat” and “attractive”, while quad seal and Doy pack bag scored the top two of package forms.

4. Conclusion

Mood consumption theory has been implemented in this study to evaluate the influence of consumer behavior on the preference of snack product and packaging. The results from this study suggested that customers belonging to each mood consumption group preferred different type of snack products. The chosen GABA rice snack product from the Innovation, Intuition, Perfection,

Satisfaction group are bar-shape rice cracker with chili paste flavor, sheet-shape puffed rice-cake with hot and spicy flavor, cube-shape rice snack bar with chili paste flavor, and bar-shape fried rice pastry with pepper flavor, respectively. However, one thing that all groups have in common is the product taste, which belongs to Thai-style flavor. Afterward, the QFD technique has been successfully employed to transfer customer requirements into sensory and technical requirements of GABA rice snack products. The results from the HOQ matrix showed that cleanliness, tastiness, and no rancid odor are among major concerns of health-conscious consumers. When transforming customer requirements into technical requirements, it was found that fat and sugar content, as well as energy intake were the top ranking in technical importance ratings. Furthermore, Kansei engineering technique was introduced to ensure proper packaging form for developing GABA products. As a result, most consumers chose a quad seal or Doy pack bag as their preference for packaging, which corresponded to their preferred Kansei words: easy to eat and attractive. In addition, verification of prototype products and packages has confirmed high satisfaction levels from target consumer groups. Consequently, this study could be beneficial to snack food manufacturers wanting to develop appropriate products to satisfy the expectations of consumers in this highly competitive market.

5. Acknowledgement

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