

**How to Cite:**

Jainan, A., Thanyakit, S., Suanpang, P., & Suanpang, P. (2022). The development of Kanom Hin Fon Thong product for health. *International Journal of Health Sciences*, 6(S1), 10871–10887.  
<https://doi.org/10.53730/ijhs.v6nS1.7612>

## The development of Kanom Hin Fon Thong product for health

**Dr. Anong Jainan**

Culinary Technology and Service Program, Suan Dusit University Lampang Center, Thailand

Email: [anong\\_jai@dusit.ac.th](mailto:anong_jai@dusit.ac.th)

ORCID ID: 0000-001-9743-753X

**Sureporn Thanyakit**

Culinary Technology and Service Program, Suan Dusit University Lampang Center, Thailand

Email: [sureporn\\_tha@dusit.ac.th](mailto:sureporn_tha@dusit.ac.th)

ORCID ID: 0000-0003-4716-1859

**Assoc. Prof Dr. Pannee Suanpang**

Faculty of Science & Technology, Suan Dusit Rajabhat University, Bangkok, Thailand

Email: [pannee\\_sua@dusit.ac.th](mailto:pannee_sua@dusit.ac.th)

ORCID ID: 0000-0002-0059-2603

**Abstract**---Kanom Hin Fon Thong is an ancient Thai dessert since Ayutthaya Period. It is hard to be found nowadays. The required materials include rice flour, coconut milk, and sugar that bring high energy. This is problematic for consumers who must control carbohydrate amounts in order to prevent the increase of blood sugar levels. In Thailand, people with obesity tend to increase until it becomes an important public health problem in a number of countries including Thailand. The higher rate of obesity caused different required nutrients. Kanom Hin Fon Thong with low GI is interesting for consumption among consumers who like Thai desserts, with worry about blood sugar levels. The development of Kanom Hin Fon Thong formulas with low GI was good for consumer health. Mixture designed was planned to find the proper ratios of Kanom Hin Fon Thong. There were 3 studied factors, i.e., rice flour, coconut milk, and sugar. 8 formulas were obtained from the experiment. The nutritive value and GI (glycemic index) were analyzed, along with sensory test in 50 consumers with the 9-point rating scale. It was found that the tested

characteristics were significantly different ( $p \leq 0.05$ ). The total acceptance of scent, color, taste, texture, and preference were highest ( $7.56 \pm 1.00$ ). This implied that the characteristics affected consumer acceptance of Kanom Hin Fon Thong product. According to the analysis of the proper ratios to use RD43 Rice flour as the substitute for rice flour in Kanom Hin Fon Thong product (Optimization), the ratios obtained included RD43 Rice flour, coconut milk, and sugar at 45.25, 27.15, and 18.10%, respectively. According to the analysis of chemical composition, carbohydrate, moisture, fats, protein, fibers, and ashes, the ratios obtained included 70.86, 14.82, 7.92, 4.04, 1.67, and 0.72%, respectively, with GI of  $49.45 \pm 0.21$ . Based on these ratios, Kanom Hin Fon Thong product for health was finally made as another interesting option for consumers.

**Keywords**---Kanom Hin Fon Thong, RD43 Rice Flour, Low Glycemix Index.

## Introduction

Thai desserts have been regarded as an important and very old cultural heritage of Thailand because they represent fineness of instructions, from local material selection; instructions inherited from ancestors that create scents, colors, tastes, and daintiness; and different consumption practices. For the importance of Thai desserts and Thai people, some areas can narrate stories about consumption culture of inhabitants clearly. Thai desserts can be meaningful on any special occasions and can be perfect representatives of house owners to invite their guests. In Ayutthaya Period, a popular Thai dessert during wars was "Kanom Hin Fon Thong," which is hard to be found nowadays. According to the search and descriptions of Kanom Hin Fon Thong from the list of Thai desserts as a lost one nowadays, this dessert was found in the list of Thai desserts in the trade fair of local Thai products on the occasion of the Royal Celebration of 100th Anniversary of the Rattanakosin Period 1882 (B.E. 2425). And according to the record of a literature, the name of this dessert was found in Ayutthaya period, i.e., "The Testimony Paper of Khun Luang Wat Pradue Somgtham," the document from the Royal Pavilion 1991 (B.E. 2534) (Puchit, 2015). It made us realize that Kanom Hin Fon Thong was a dry dessert that could be stored for a long time as food reserve. The name of Kanom Hin Fon Thong might come from its feature that resembled the gold rubbing stone, which was black and used for checking pure gold or gold foils. The longer the stone was used, the more gold stains remained on it until it could not be used for gold rubbing anymore. The required ingredients of Kanom Hin Fon Thong include rice flour, coconut milk, and sugar; causing high energy.

There are healthcare people or patients who must control their carbohydrate amounts in order to prevent the increase of blood sugar levels. However, rice is the main food in Thailand. Thus, up to 4.4 patients with diabetes were found as the

4th country after China, India, and Japan (Strateic et al., 2016). Thai desserts are another source that causes hyperglycemia to people who like consuming Thai desserts. Thus, the required materials related to dessert making are changed for healthier nutrients. There are various popular Thai desserts for Thai people and foreigners. Some are getting lost from consumption. This causes search for instructions, techniques, and the development of proper formulas for benefits of healthcare people who like consuming Thai desserts. Kanom Hin Fon Thong is a product that has remained since the ancient time. The required materials simply included rice flour, coconut milk, and sugar. It was originated in the flourishing time of Ayutthaya Period. Because rice flour has always been used as a required ingredient, it causes high energy as we as sugar. This conformed to the result of the study on "Development of Hin Fon Thong Dessert Partially Substituted Riceberry Rice Flour for Rice Flour" (Laddawan, 2017). It was found that the mean of consumer acceptance of product development, e.g., preference, purchase decision, and packaging based on percentage was over 50:100, with "moderately high preference," and "need less sweetness." This was another reason to develop Kanom Hin Fon Thong product by changing the required materials, reducing the gap of risk for healthcare people, and obtaining the proper formulas of Kanom Hin Fon Thong product with sensory acceptance from consumers for further commercial development.

## **Literature review**

### **Background of Kanom Hin Fon Thong**

Kanom Hin Fon Thong is an ancient Thai dessert. The ingredients include parched rice flour mixed with coconut milk, sugar, and coir charcoal powder. It is kneaded into a consumable bun topped with gold foil. Then, it is smoked with candles. The dessert is sweet, scented, and soft. Ancient people usually carry it during a long journey or wars because it could be stored for a long time. According to the study on "Thai Food With Rice Culture" Puchit Sawangsuk (2015), it was found that this dessert has remained since Ayutthaya Period based on presumption. It basically looks like the gold rubbing stone for proving pure or fake gold. Its name appeared in Ayutthaya Period, referred from "The Testimony Paper of Khun Luang Wat Pradue Somgtham," the document from the Royal Pavillion, recorded as follows.

*"On the Dessert Forest Street, the villagers make desserts and open their shops of Kanom Chamod, Kong Kwian, Sam Kler, Hin Fon Thong, Kanom Grub, Mung Bean Sweets, Kanom Sum Pun Mee, and other dry desserts."*

In the Tale of Khun Chang - Khun Phaen, the version of the National Library 1971 (B.E. 2514), Kanom Hin Fon Thong was used as part of the offerings for monks in the procession from home to the Dhamma pavilion. It was described in this literature as follows. "Tell servants to prepare the offerings. We have a lot of taros and potatoes. White sugarcane, red sugarcane, watermelon, pomelos, moringa, Burmese grapes, Chamod, Kong Kwian, red sticky rice, Hin Fon Thong, Krong

Kraeng, and big melons. Piles of stuff outside the pavilion. Arrange them in order and do not mess up.”

The above descriptions perfectly implied the exuberance of natural resources as a source of food and materials for cooking among Ayutthaya people, along with the image of the ancient Thai desserts. Some currently have new name and looks because they were changed with time. When the assessment criteria were brought to support the consideration, the importance of Kanom Hin Fon Thong as a wisdom of food in accordance with the criteria could be clarified as follows.

- 1) Kanom Hin Fon Thong represents food identity, with prominence and its origin from wise creativity based on the wisdom of Ayutthaya.
- 2) Kanom Hin Fon Thong confirms historical evidences, cultural connection, economy, and international relations as appearing in “The Testimony Paper of Khun Luang Wat Pradue Somgtham,” the document related to late Ayutthaya - early Rattanakorin. Besides, Kanom Hin Fon Thong also represents local way of life, e.g., travel the ancient time that people must carry portable desserts throughout their travel.
- 3) Kanom Hin Fon Thong is a prominent example of material type that indicates local identity perfectly. It also represents economic, political, social, and cultural development in Ayutthaya; with connection as a perfect historical and cultural indicator.
- 4) Kanom Hin Fon Thong is a prominent example of food in accordance with local identity that represents traditions, customs, or food in rituals as per the examples in the Tale of Khun Chang - Khun Phaen, in which Kanom Hin Fon Thong was used as part of the offerings for monks, representing cultural value and importance.
- 5) Kanom Hin Fon Thong is a direct food cultural indicator because its name came from the feature of the dessert that looks like the stone used by ancient merchants for gold testing by rubbing it on the stone. Such similarity brought the name “Kanom Hin Fon Thong.” This certainly represents general geographic features full of this type of stone. Thus, it was used for naming the dessert as the specific name in accordance with the geographic features of those particular areas.

### **RD43 Rice**

It is a rice variety with low amylose and moderate GI, which is actually low when comparing with other varieties. RD43 rice is not a photoperiod-sensitive variety, obtained by breeding between Aromatic Suphan Buri Rice and Suphan Buri 1 at Suphanburi Rice Research Center. It produces high yields with resistance to diseases and pests. The rice was certified on 17 September 2009, with low amylose (< 20%) and moderate GI (GI = 56-69). According to testing 27 rice varieties with low amylose, those with high amylose (25-33%) slowly changed blood sugar levels because the linear structure motivated our body to digest into sugar and to absorb more slowly than amylopectin, of which structure was a branched chain. According to the study of Wasusunet al. (2017), RD43 rice was with amylose at

18.82%, higher than RD15 Rice between 14-17%. It also caused lower GI of RD43 rice (GI =57.6) than RD15 Rice (GI =69.1). However, both varieties were with moderate GI (= 56-69). Amylose amounts were not only related to GI, but also RAG and SAG. According to the study of Sahaspot et al. (2015) on the comparison between RAG and SAG amounts in sticky rice and landrace rice, totally 31 varieties. It was found that rice with higher amylose than sticky rice was with lower RAG and mostly higher SAG. It was also found that RAG was negatively related to amylose. RAG and SAG referred to glucose amounts released into bloodstream from consumed food in 20 minutes (RAG) and in the next 100 minutes or at 120 minutes (SAG). Both values are important indeed because good with high RAG and low SAG implies that starch or carbohydrate in food can be digested promptly by enzymes into glucose. This means RAG and SAG are the key factors to indicate GI in food. Sahaspot et al. (2015) stated that rice with low RAG (< 10 g/100 g of cooked rice) could be interpreted that those varieties were with low GI whereas those with RAG between 10-18g/100 grams of cooked rice were rice with moderate GI. However, apart from the factor of different rice varieties and amylose amounts that affect digestibility and GI in food, there are also other factors affecting digestibility, e.g., starch bead size, starch structure and density of crystals, gelatinization levels, swelling during cooking process, and protein as well as fat amounts in food. Protein and fat amounts in food can adhere to amylose molecules in food until they become complex molecules between amylose-protein complexes and amylose-lipid complexes. This finally causes delayed sugar release in the structure, resulting in less change of blood sugar levels.

### **Glycemic index**

Glycemic index or GI is the measurement unit of carbohydrate for blood sugar levels. Carbohydrate will break down into sugar promptly during digestion, with GI between 0-100, depending on certain food effects on high or low blood sugar levels up to 2-3 hours. GI can be classified into 3 levels, i.e., high GI (> 70), moderate GI, and low GI (< 55). Consumption of low GI or reducing GI helps controlling blood sugar levels and reducing risks of diseases. According to the international principle, GI analysis in food used in-vivo experiment, the samples were healthy volunteers. Still, there were several factors affecting GI, along with rather complications of experiments in humans and high cost. Later on, Englyst et al. (1992) developed an analysis method for starch or carbohydrate digestion ratios in good into sugar by in-vitro experiment, of which sugar was divided in to rapidly available glucose (RAG) and slowly available glucose (SAG). Sugar in the experiment referred to glucose amounts obtained by prompt carbohydrate digestion by enzymes in 20 minutes (RAG) and then the next 100 minutes (SAG). This method was imitated from sugar absorption in our body. The results from this method conformed to in-vivo experiment, particularly the conformity between RAG and GI. Then, Sopade and Gidley (2009), and Mahasukhonthachat et al. (2010) studied starch digestion in lab tubes by starch digestive enzymes at 0-180 minutes. Then,

the digestion ratio was calculated, and starch was obtained. The digestion ratio was calculated by the modified first-order kinetic. Then, the ratio obtained was calculated for estimated glycemic index (EGI) by the equation  $GI=39.21+(0.803 \cdot H90)$ . According to the study on the confirmation of results from previous labs, it was found that this method generated results conforming to in-vivo experiment (Humans and lab animals). It was also a cost-saving and time-saving method for validation.

These data brought the researchers an idea to develop RD43 Rice flour with low GI into Kanom Hin Fon Thong product, which has lost for a very long time. We would like preserve this dessert, with an aim to reduce GI in it. GI would be evaluated by digestion mimic techniques as an option for healthcare people and those who like consuming Thai desserts.

### **Related works**

Puchit Sawangsuk (2015) studied "Thai Food With Rice Culture." It was found that the study on Thai food characteristics of meat dishes and desserts, having been inherited for over 100 years, was divided into 2 parts, i.e., the comparison between meat dishes and desserts in Thailand because some Thai food already lacked cultural continuity, finally resulting in its disappearance from Thai society. Only names have remained. There were dessert originated in Ayutthaya Period, e.g., Kanom Hin Fon Thong and Lao nougats according to the Testimony Paper of Khun Luang Wat Pradue Somgtham (Siamese Chronicle, 2010), recorded that "On the Dessert Forest Street, the villagers make desserts and open their shops of Kanom Chamod, Kong Kwian, Sam Kler, Hin Fon Thong, Kanom Grub, Mung Bean Sweets, Kanom Sum Pun Mee, and other dry desserts." Likewise, In the Tale of Khun Chang - Khun Phaen, the version of the National Library 1971 (B.E. 2514), Kanom Hin Fon Thong was used as part of the offerings for monks in the procession from home to the Dhamma pavilion. It was described in this literature as follows.

Tell servants to prepare the offerings. We have a lot of taros and potatoes. White sugarcane, red sugarcane, watermelon, pomelos, moringa, Burmese grapes, Chamod, Kong Kwian, red sticky rice, Hin Fon Thong, Krong Kraeng, and big melons. Piles of stuff outside the pavilion. Arrange them in order and do not mess up." Those desserts were usually made in the eleventh month, with longboat racing and providing Thai crispy pancakes. The name "Kanom Ta Kwai" also appeared, finally developed into Kanom Tom Kao nowadays.

Laddawan Mankong (2017) studied "Development of Hin Fon Thong Dessert Partially Substituted Riceberry Rice Flour for Rice Flour." It was found that the ratio with the highest score out of 4 levels was 85.15 or Recipe 3. The lowest score was 8.03 and the highest one was 8.33, respectively, in all characteristics. Then, the dessert was tested for acceptance in general people. The ratio of product

development, e.g., preference, purchase decision, and packaging by the statistic (Percentage) was over 50:100, with the acceptance of “moderately high preference” and “need less sweetness.” Then, the nutritive value between the standard recipe and the accepted recipe was compared. According to the substitution of riceberry at the ratio of 85:15, the accepted recipe contained higher nutritive value, e.g., vitamin E, beta-carotene, Omega-3, folate, polyphenol, tannins, Gamma Oryzanol, and antioxidants calculated by INMUCAL nutrients. Thus, the proper serving size of Kanom Hin Fon Thong developed from partially substituted riceberry rice flour as accepted was equivalent to 5 g or 1 piece.

Tarinee Nilkamhaeng (2021) studied “Evaluation of the Glycemic Index of RD43 Rice, and Its Products by Means of in Vitro Glucose Digestion Mimic Techniques.” The rice was with low amylose and moderate GI, which was actually low when comparing with other rice varieties. According to the data, the researchers had an idea to process RD43 Rice flour into 4 products, i.e., noodle, pasta, bread, and cake in order to reduce GI in those products. Thus, GI was evaluated by digestion mimic techniques in lab tubes by analyzing RAG and SAG, the kinetic constant (k), the hydrolysis index (HI), and (eGI). The results found that RAG, k, and HI of all 4 products conformed to eGI. The products with low RAG, k, and HI generated low eGI. In contrast, the products with high RAG, k, and HI generated high eGI. Using RD43 Rice flour for processing into noodle and pasta did not change eGI of the products. Noodle and pasta made from RD43 Rice flour were with eGI of 51.47 and 54.87, respectively, implying low GI ( $GI \leq 55$ ). Using RD43 Rice flour processing into bread and cake. To clarify, bread made from RD43 Rice flour was with eGI of 63.64, implying moderate GI ( $GI = 56-69$ ). Cake made of RD43 Rice flour was with eGI of 285.92, implying high GI ( $GI > 70$ ).

## **Research Methodology**

### **Materials and equipment**

#### Materials

- |                         |                 |                    |
|-------------------------|-----------------|--------------------|
| 1. RD43 Rice flour      | 2. Coconut milk | 3. Sugar           |
| 4. Coir charcoal powder | 5. Gold foils   | 6. Scented candles |
| 7. Dried rice           |                 |                    |

#### Equipment for making Kanom Hin Fon Thong

- |                  |                 |                  |
|------------------|-----------------|------------------|
| 1. Brass pan     | 2. Spatula      | 3. Aluminum tray |
| 4. Digital scale | 5. Mixing basin | 6. Measuring cup |

**The components of Kanom Hin Fon Thong**

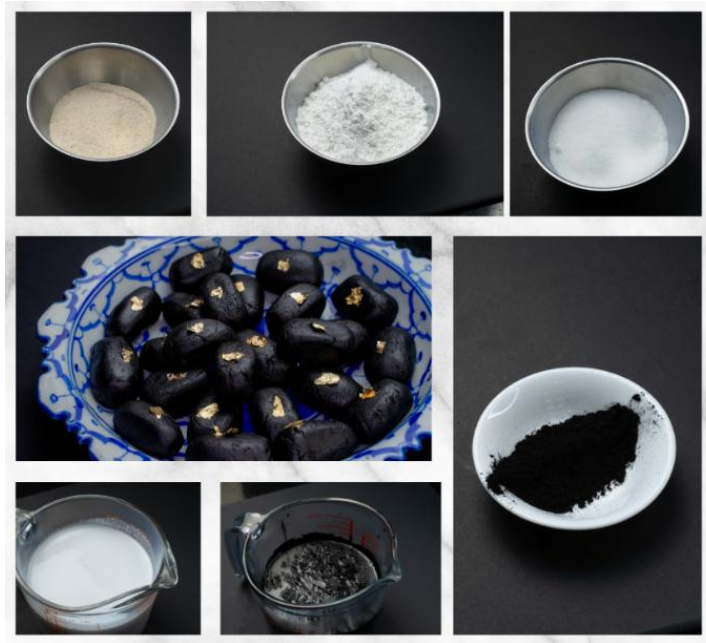


Figure 1: Kanom Hin Fon Thong and its materials (Punnee, 2021).

**Ingredients/Materials**

- 1. Rice flour
- 2. Coconut milk
- 3. Sugar
- 4. Coir charcoal powder
- 5. Gold foils
- 6. Scented candles
- 7. Dried rice

**Instructions**

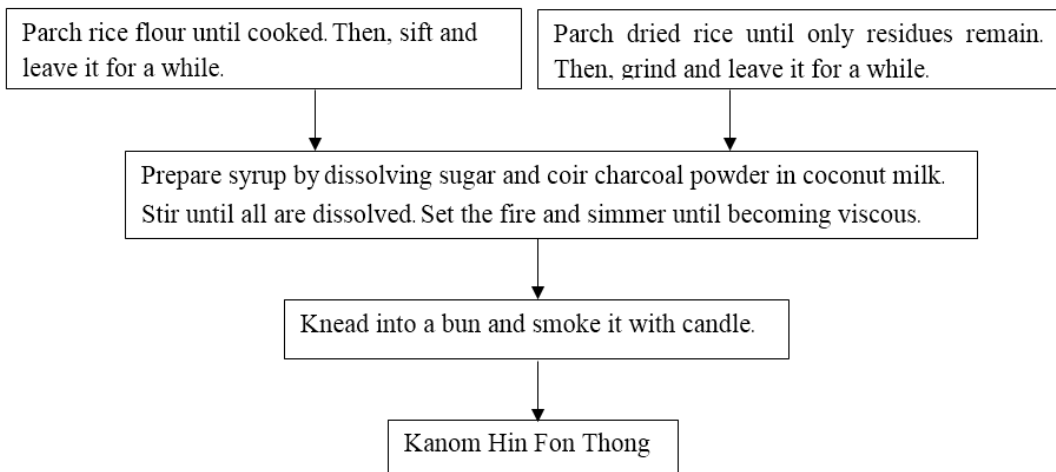


Figure 2: Kanom Hin Fon Thong instruction (Punnee, 2021).

### **Chemical composition analysis equipment**

Moisture volume analysis (AOAC, 2000) Total protein/nitrogen amount analysis by Kjeldahl method

Fats amount analysis by Soxhlet extract method (AOAC, 2000)

Crude fiber amount analysis (AOAC, 2000)

Ashes amount analysis (AOAC, 2000)

Carbohydrate amount analysis by calculation (AOAC, 2000)

### **GI evaluation analysis equipment**

Test tubes, Incubator shaker and Stopclock

### **Sensory test equipment**

The sample of Kanom Hin Fon Thong product

The 9-hedonic scale questionnaire about senses

### **Statistical analysis**

CRD (Completely randomized design) was planned for chemical and GI analysis. The data obtained was analyzed for variance. The differences of mean were compared. The level of confidence was 95%. SPSS was used.

### **Research results**

#### **The results of the development of Kanom Hin Fon Thong product for health by mixture design**

Mixture design refers to the experiment of analyzing returns as the function of percentage of components (Myers et al. 2002). The objective is to survey those returns in order to estimate the parameter of each component that will generate the highest return value, or to be in accordance with experimenter desire. Mixture design is a type of response surface design with the limitation, i.e., factor levels or components are not independent to each other. For example, if a mixed stuff for an experiment includes 3 mixtures, it is possible that each mixture will be used under a ratio from 0-100%. And the sum of each mixture must be exactly 100% or 1 part.

For the results of the development of Kanom Hin Fon Thong product for health by mixture design, Kanom Hin Fon Thong modified from the recipe of the research of Punnee (2021) from the standard formula of Kanom Hin Fon Thong from the Thai literature. There were rice flour, sugar, and coconut milk at 19.60, 25.33, and 45.57, respectively. The 3 required materials of Kanom Hin Fon Thong for health were studied, i.e., RD43 Rice flour, sugar, and coconut milk as in Table 1 under 3 different amounts. To clarify, RD43 Rice flour and sugar were fixed at 18.10, 27.15, 31.68, and 45.25%, respectively. Coconut milk was fixed at 27.15, 36.20, 40.72, and 54.30%, respectively. Coir charcoal powder was fixed at 9.50%, of which the selected type was fixed at 100%. The factor levels were displayed into 7 formulas. Then, they were studied for sensory acceptance and nutritive value analysis.

Table 1  
Mixture design Kanom Hin Fon Thong for health

| Ingredients     | Mixture Design (%) |       |       |       |       |       |       |
|-----------------|--------------------|-------|-------|-------|-------|-------|-------|
|                 | M1                 | M2    | M3    | M4    | M5    | M6    | M7    |
| RD43 Rice flour | 45.25              | 18.10 | 18.10 | 27.15 | 18.10 | 31.68 | 31.68 |
| Coconut milk    | 27.15              | 27.15 | 54.30 | 36.20 | 40.72 | 40.72 | 27.15 |
| Sugar           | 18.10              | 45.25 | 18.10 | 27.15 | 31.68 | 18.10 | 31.68 |
| charcoal powder | 9.50               | 9.50  | 9.50  | 9.50  | 9.50  | 9.50  | 9.50  |

### **The study on consumer acceptance of Kanom Hin Fon Thong for health**

For the study on sensory acceptance of Kanom Hin Fon Thong product for health, 50 samples were tested. The questionnaire about consumer acceptance was used, with 9-point Hedonic scale (Wiriyacharee, 2018) from 1-9 points of preference (1 = Most dislike and 9 = most preference). The evaluation was conducted by calculating mean from evaluation scores of consumers. It was found that the mean values of the sensory test in terms of texture, total preference, taste, scent of taste, physical characteristics, color, and scent were  $6.18 \pm 1.90$ ,  $6.48 \pm 2.12$ ,  $6.74 \pm 1.86$ ,  $6.80 \pm 1.95$ ,  $7.10 \pm 1.66$ ,  $7.12 \pm 1.78$ , and  $7.16 \pm 2.05$ , respectively, interpreted as "high - moderate preference." Right protection of the samples.

In this research, the right of the samples was protected by prior notification of Kanom Hin Fon Thong for health as a product made from RD43 Rice flour, coconut milk, and sugar. Those who were allergic to a certain type of these ingredients should not try this dessert. In this regard, it depended on willingness of the samples who tried the dessert whether or not they would answer the questions. Their willingness did not affect their try at all. The overview of the data obtained could not identify who the samples were.

### **The results of the nutritive value and GI of Kanom Hin Fon Thong product for health developed from RD43 Rice flour.**

#### **The nutritive value of Kanom Hin Fon Thong product for health developed from RD43 Rice flour**

Nutritive value analysis included carbohydrate, protein, fats, moisture, ashes, and total fibers as in Table 2.

Table 2  
The nutritive value of Kanom Hin Fon Thong product for health developed from RD43 Rice flour.

| Nutritive Value | Control | M1    | M2    | M3    | M4    | M5    | M6    | M7    |
|-----------------|---------|-------|-------|-------|-------|-------|-------|-------|
| Carbohydrate(%) | 71.10   | 70.86 | 78.09 | 76.80 | 73.44 | 71.16 | 58.73 | 79.06 |
| protein (%)     | 2.21    | 4.01  | 1.46  | 2.25  | 2.51  | 1.97  | 3.14  | 2.69  |

|                 |       |       |       |       |       |       |       |       |
|-----------------|-------|-------|-------|-------|-------|-------|-------|-------|
| fats (%)        | 10.10 | 7.92  | 4.96  | 1.53  | 4.86  | 6.78  | 15.71 | 0.95  |
| moisture(%)     | 14.70 | 14.82 | 13.23 | 16.35 | 17.12 | 17.20 | 19.81 | 14.39 |
| ashes (%)       | 0.78  | 0.72  | 0.78  | 1.11  | 0.90  | 0.92  | 0.78  | 0.78  |
| total fibers(%) | 1.11  | 1.67  | 1.48  | 1.96  | 1.17  | 1.97  | 1.83  | 2.13  |

According to Table 2 revealed the nutritive value between the standard formula of Kanom Hin Fon Thong and Kanom Hin Fon Thong for health developed from RD43 Rice flour by Chemical composition analysis (AOAC, 2000) that included the amounts of included carbohydrate, protein, fats, moisture, ashes, and total fibers in Kanom Hin Fon Thong product for health of all 7 formulas developed from RD43 Rice flour. It was found that Kanom Hin Fon Thong were with carbohydrate at 58.73, 70.86, 71.16, 73.44, 76.09, 76.80, and 79.06%, respectively; protein at 1.46, 1.97, 2.25, 2.51, 2.69, 3.14, and 4.01%, respectively; fats at 0.95, 1.53, 4.86, 4.96, 6.78, 7.92, and 15.71%, respectively; moisture at 13.23, 14.82, 14.39, 16.35, 17.12, 17.20, and 19.81%, respectively; ashes at 0.72, 0.78, 0.90, 0.92, and 1.11%, respectively; and total fibers at 1.17, 1.48, 1.67, 1.96, 1.97, 1.83, and 2.13%, respectively.

#### **GI of Kanom Hin Fon Thong product for health developed from RD43 Rice flour.**

For GI assessment by digestion mimic techniques in the lab tubes, the following values were analyzed.

1) For the analysis of RAG at 20 minutes and SAG as the remaining glucose amounts that were digested in the next 100 minutes (at 240 minutes). SAG and RAG amounts were analyzed by the method of Englyst et al. (1992). The sample of Kanom Hin Fon Thong was grinded thoroughly. The sample of 0.5g rice was weighed in a 50ml lab tube. Then, 5ml pepsin solution was added, and warmed under 37°C for 30 minutes. Next, 10ml sodium acetate at the concentration of 0.1M. 5 glass beads, size 1.5 cm., were added, along with enzyme solutions, i.e., invertase, pancreatin, and amyloglucosidase at 2.5 ml. After that, the sample was warmed in the incubator shaker under 37°C for 20 minutes. This step was called starch digestion. 200 µl of the sample were sucked into a tube with ethanol solution at 66% and 4 ml. The previous tube was warmed further immediately in the incubator shaker under 37°C for another 100 minutes. 200 µl of the sample were sucked from starch digestion and added into the tube with ethanol solution at 66% and 4 ml. The sample from starch digestion at 20 and 240 minutes was analyzed to find RAG and SAG amounts, respectively. Glucose amounts were analyzed by the test kit from Megazyme International (Ireland). Glucose amounts were compared by the standard graph of glucose for calculation (µg glucose/g sample).

2) eGI evaluation by starch digestion monitoring technique in the sample by enzymes in the tubes.

The experiment took 240 minutes. GI was modified from the methods of Mahasukhonthachat et al. (2010), Sopade and Gidley (2009), and Goni et al. (1997).

The sample passed drying process and was sifted through 0.5ml sieve at 0.5 grams, mixed with 1ml alpha amylase solution (40ml enzyme was dissolved in sodium acetate buffer at the concentration of 1.2M, with pH). Then, 5ml pepsin solution was added (1g enzyme solution was dissolved in hydraulic acid solution with 1.5 pH). It was incubated in hot water under 37°C for 30 minutes to make it neutral by using 5ml sodium hydroxide solution at the concentration of 0.02M. 3 units of pancreatin enzyme and glucosidase enzyme were added in 5ml and 25ml acetate buffer solution. The solution obtained was incubated under 37°C in hot water that was shaken all the time. The sample was collected at 0, 10, 20, 30, 45, 60, 90, 120, 160, 180, 200, 220, and 240 minutes. It was analyzed by calculating glucose amounts by the test kit from MegazymeInternational (Ireland). The amounts were compared by the standard graph of glucose. The kinetic constant (k), hydrolysis index (HI), and eGI were calculated by the method of Goni et al. (1997) as per the following first order equation.

$$C = C_{\infty}(1 - e^{-kt})$$

When

C = The concentration of digestion at t (µg/g).

C<sub>∞</sub> = The concentration balance of digestion (µg/g).

k = The kinetic constant (minute<sup>-1</sup>).

t = Time (minute).

Then, AUC was calculated as per the following equation.

$$AUC = C_{\infty}(tf - t_0) - (C_{\infty}/k)[1 - \text{Exp}\{-k[tf - t_0]\}]$$

HI was calculated as per the following equation.

$$HI = \frac{\text{AUC of test food}}{\text{AUC of reference sample}} \times 100 (\%)$$

Note: AUC was calculated and compared with the reference example, i.e., white bread (Farmhouse)

eGI was calculated as per the following equation.

$$eGI = 39.71 + (0.549 \times HI)$$

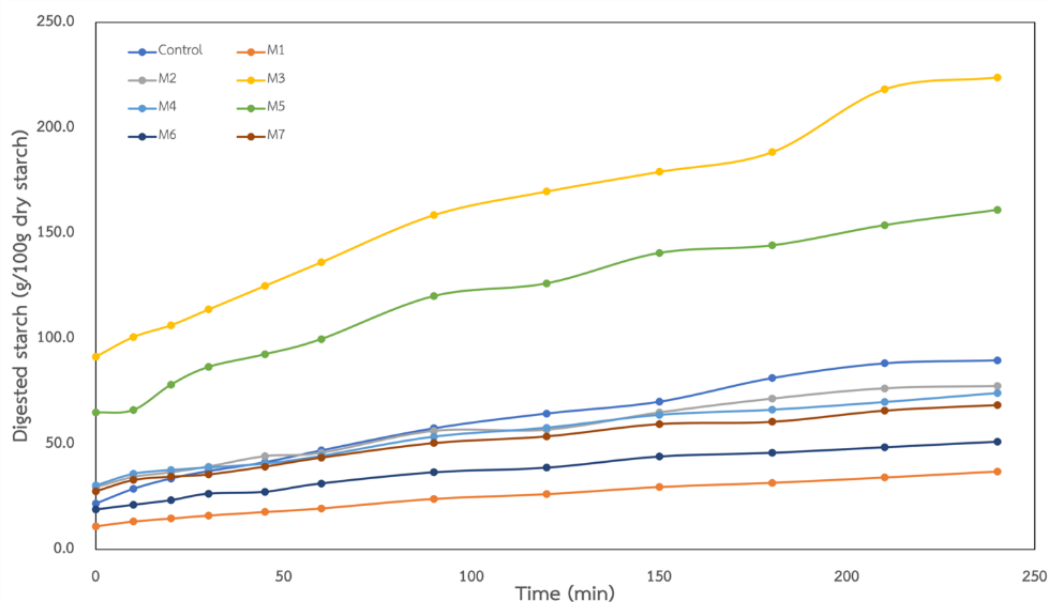


Figure 2: Starch digestion ratios compared with the time of Kanom Hin Fon Thong at the different formulas.

Table 3  
D<sub>0</sub>, D<sub>∞</sub>, and K in the predictive model; along with the ratios of starch digestibility/hydrolysis (HI), glycemix index (GI), and glycemix load (GL) of Kanom Hin Fon Thong

| Sample  | D <sub>0</sub><br>(g/100 g<br>dry starch) | D <sub>∞</sub><br>(g/100 g dry<br>starch) | K<br>( $\times 10^{-3}$<br>min <sup>-1</sup> ) | H <sub>90</sub> | HI          | Average<br>Glycemic<br>index (GI) | Glycemic<br>load (GL) |
|---------|---|---|--|-----------------|-------------|-----------------------------------|-----------------------|
| Control | 23.78±0.31                                | 109.31±0.90                               | 4.0±0.03                                       | 56.82±0.11      | 79.88±0.86  | 64.19±0.50                        | 7.97±0.01             |
| M1      | 11.47±0.27                                | 44.59±0.70                                | 3.4±0.02                                       | 23.23±0.26      | 31.88±0.69  | 49.45±0.21                        | 14.98±0.03            |
| M2      | 30.56±0.14                                | 80.34±0.20                                | 3.8±0.02                                       | 53.83±0.22      | 70.35±0.22  | 61.41±0.17                        | 8.93±0.06             |
| M3      | 92.99±0.21                                | 261.79±0.97                               | 2.9±0.01                                       | 153.13±0.71     | 199.45±0.67 | 101.41±0.57                       | 4.74±0.08             |
| M4      | 31.34±0.26                                | 70.08±0.16                                | 3.9±0.01                                       | 52.08±0.78      | 66.69±0.08  | 60.32±0.10                        | 8.58±0.04             |
| M5      | 62.84±0.77                                | 125.46±0.68                               | 6.2±0.03                                       | 116.49±0.84     | 147.20±0.42 | 85.36±0.10                        | 5.82±0.01             |
| M6      | 19.00±0.06                                | 44.26±0.38                                | 5.3±0.02                                       | 35.79±0.44      | 46.21±0.67  | 53.95±0.15                        | 11.07±0.02            |
| M7      | 28.58±0.52                                | 55.93±0.20                                | 5.1±0.01                                       | 49.16±0.16      | 62.17±0.14  | 58.94±0.21                        | 9.41±0.05             |

## Discussion and Conclusion

According to the development of Kanom Hin Fon Thong product for health by mixture design, 7 formulas of Kanom Hin Fon Thong product for health, with the different amounts of RD43 Rice flour, coconut milk, and sugar. They were brought for the sensory test and analysis of the nutritive value that included

carbohydrate, protein, fats, moisture, ashes, and total fibers. It can be concluded that there were nutrients for body energy, i.e., carbohydrate, protein, and fats. The formula with highest carbohydrate and protein was Formula 7, which included RD43 Rice flour and sugar at 31.68%. The formula with high fats was Formula 6, which included coconut milk at 40.72%. Formula 6 and 7 were the formulas that generated highest nutrient for energy, and were the required nutrients to control chemical reactions in our body and functions of all organs. Another interesting nutritive value of Kanom Hin Fon Thong was fiber amounts that were useful for excretion and reducing sugar, fats, and cholesterol absorption; reducing the risks of cardiovascular diseases and colorectal cancer; increasing immune; and reducing free radicals. Coir charcoal powder is an ingredient in Kanom Hin Fon Thong, with benefits to our body. As for sensory assessment results, it was found that the mean values of total acceptance could be interpreted as high - moderate preference. The mean values of the sensory test in terms of texture, total preference, taste, scent of taste, physical characteristics, color, and scent were  $6.18 \pm 1.90$ ,  $6.48 \pm 2.12$ ,  $6.74 \pm 1.86$ ,  $6.80 \pm 1.95$ ,  $7.10 \pm 1.66$ ,  $7.12 \pm 1.78$ ,  $7.16 \pm 2.05$ , respectively, interpreted as "high - moderate preference."

For the analysis of GI in the lab tube by the method of Mahasukhonthachat et al. (2010), starch digestion enzyme was used at 0-240 minutes. The ratios of digestion were calculated. Starch was obtained by the equation of the modified first-order kinetic. The ratios obtained were calculated for GI. It was found that the method was in accordance with in-vivo experiment. Thus, this method was primarily used in the experiment to save time and cost.

Consumption of various food and products in Thailand basically contains flour as a required component. For example, Thai desserts usually contains cassava flour and rice flour, with high GI. Rice flour is mostly used in Kanom Hin Fon Thong, with lower amylose than RD43 Rice that is usually with amylose at 18.82% and GI at 57.6 (Wasusun et al., 2017). High amylose in rice caused slow change of blood sugar because the linear structure of amylose slowed down digestion into sugar and absorption than amylopectin, of which the structure was the branched chain (Nounmusig et al., 2018). Thus, RD43 Rice flour was substituted for rice flour in this research.

D0 is basically an indicator of starch digestion ratio, called "very rapidly digested starch" that usually happens at the beginning ( $\leq 1$  minute) by oral alpha-amylase. According to Table 3, it was found that D0 increased with sugar and coconut amounts in the dessert. For example, in Formula 2, 3, and 5 with sugar and coconut up to 72.40%, the values of D0 were high up to 30.56, 92.99, and 62.84 g/100 grams of starch; and kept reducing with sugar and coconut amounts, respectively. In Formula 4 and 1 with sugar and coconut at 63.35% and 45.25%, the values of D0 were high up to 31.34 and 11.47 grams of starch. When considering the ratios between coconut milk and sugar in the formulas with equal amounts of both ingredients, it was found that the formulas with high coconut milk increased

D0, like Formula 6 and 7, of which the total amount sugar and coconut amount was 58.83%. But when separating between sugar and coconut, it was found that Formula 7 contained coconut milk up to 31.68%, with D0 = 28.58 g/100 grams of starch; and Formula 6 with coconut milk up at only 18.10%, with D0 = 19.00 g/100 grams of starch only.

The kinetic constant ( $k$ ) and hydrolysis index (HI) are the parameters that indicate digestibility of starch or carbohydrate in food. In this research HI conformed to GI. HI in Formula 3 was highest (= 199.45), followed by Formula 5 (= 147.20). The lowest one was Formula 1 (= 31.88). When comparing with the standard formula, HI was 79.88. According to the study of Barine et al. (2016), low  $k$  and HI had high endurance against enzyme digestion, with low GI.

Moreover, GI (Glycemic index) in Table 1 revealed that the standard formula was 64.19. Also, Kanom Hin Fon Thong in the research using RD43 Rice revealed that the formula with the lowest GI was Formula 1, with GI = 49.45. The formula with the highest GI was Formula 3, with GI = 101.41, of which sugar and coconut amounts were high up to 72.4% but with RD43 Rice flour at only 18.10%. Formula 1 was with the lowest GI, with sugar and coconut amounts at only 45.25%; RD43 Rice flour at 45.25%. Thus, Kanom Hin Fon Thong in this research that must be substituted with RD43 Rice flour could reduce GI when comparing with the standard formula. Basically, food is classified by GI into 3 groups, i.e., (1) low GI ( $\leq 55$ ), e.g., beans, vegetables, grain seeds, etc.; (2) moderate GI (= 56-69) that affect change of blood sugar levels, e.g., noodles/pastas, parched beans, potatoes, pineapples, etc.; and (3) high GI ( $\geq 70$ ), e.g., white breads, cornflakes, fried potatoes, etc. (Jacob, 2011). In this research, Kanom Hin Fon Thong in the standard formula was classified into moderate GI. Kanom Hin Fon Thong substituted with RD43 Rice flour in Formula 1 and 6 was classified into low GI. Formula 2, 4, and 7 were classified into moderate GI. Formula 3 and 5 was classified into high GI.

Deciding to consume food based on GI only is not sufficient for health and nutrition concern because some types of food are with low GI but possible high fats. What's more, GI cannot indicate serving size. For this reason, glycemic load (GL) is to measure carbohydrate amounts in food that cause higher blood sugar equivalent to consumption of 1 gram of glucose. Thus, GL depends on GI and carbohydrate amounts or sugar amounts in food. Food with GL between 0-10 is classified into low GL. Food with GL between 11-19 is classified into moderate GL. Food with  $GL \geq 20$  is classified into high GL. According to the research, it was found that Kanom Hin Fon Thong in the standard formula was 7.97, classified into low GL like Kanom Hin Fon Thong made from RD43 Rice flour in all formulas, except Formula 1 and 4 (= 14.98 and 11.07, respectively), classified into moderate GL. Getting total GL at excessive amounts per day increases the risks of heart diseases, diabetes, obesity, and insulin hormone resistance. Thus, each meal should contain GL between 20-25 (Netnapi et al., 2016).

Thus, Kanom Hin Fon Thong in the standard formula, classified into high GI but low GL, rarely affects our body in case of regular amounts. For Kanom Hin Fon Thong substituted with RD43 Rice flour in the formulas with low GI but high GL, i.e., Formula 1 and 4 will increase blood sugar levels slowly. But food with carbohydrate but no fibers, or with high sugar or starch, will cause high GL. Thus, high amounts can cause high blood sugar levels, like the research of Arikawa et al. (2015), which found that this group of food was positively related to oxidative stress.

## References

- AOAC. 2000. Official Methods of Analysis of AOAC Internati AOAC. 2000. *Official Methods of Analysis of AOAC International 17<sup>th</sup> ed*, Maryland, USA.
- Arikawa, A.Y. 2015. Consumption of a high glycemic load but not a high glycemic index diet is marginally associated with oxidative stress in young women. *Nutr. Research*. 35:7-13.
- Barine, K.K.D & Yorte, G.S (2016). In vitro starch hydrolysis and prediction of glycemic index (PGI) in “Amala” and plantain based baked products. *Journal of Food Research*. 5(2): 73-80.
- Charoenphun, N.& Pakeechai, K. 2019. A Study of Suitable Formula for Gluten-free Tart Cups Production. *Journal of Food Technology, Siam University, Vol. 14 No. 1 January - June 2019*. (26-36).
- Englyst, H.N., Kingman, S.M. & Cummings, J.H. (1992). Classification and measurement of nutritionally important starch fractions. *European Journal of Clinical Nutrition*. 46: S33-S50.
- Ezygo DIET. 2014. How is the difference between GI-GL. <http://www.ezygodiet.com/gi-gl/> (25 April 2022).
- Jacob, A. 2011. The glycemic index table of fruits & vegetables. Available: <http://www.livestrong.com/article/379508-the-glycemic-index-table-of-fruits-vegetables/> (25 April 2022).
- Laddawan Ngongkong (2017). Developing golden rainstone pastry with rice berry flour replaces some rice flour. *Home Economics Thesis, Rajamangala University of Technology Phra Nakhon*.
- Mahasukhonthachat, K., Sopade, P.A. & Gidley, M.J. (2010). Kinetics of starch digestion and functional properties of twin-screw extruded sorghum. *Journal of Cereal Science*. 51(3): 392-401.
- Mankong, L. 2017. Development of Hin Fon Thong Dessert Partially Substituted Riceberry Rice Flour for Rice Flour. *Thesis of Home Economics, Rajamangala University of Technology PhraNakhon*.
- Ninkumheang, T. 2021. Evaluation of the Glycemic Index of RD43-Rice, and Its Products by Means of in Vitro Glucose Digestion Mimic Techniques. *Journal of Food Technology, Siam University, Vol. 16 No. 1 January - June 2021*. (59-77).
- Nounmusig, J., Kongkachuichai, R., Sirichakwai, P., Wongwichain, C. & Saengkrajang, W. (2018). Glycemic index, glycemix load and serum insulin

- response of alternative rice noodles from mixed Sago Palm flour (*Metroxylon* spp.) and Chiang rice flour. *Burapha Science Journal* 23(2): 839-851.
- Puchit Sawangsuk. (2015). Thai food in rice culture. *Department of Home Economics*, National Research in Ramkhamhaeng University
- Punnee Suanpang. (2021). Finding food culture prototypes and developing Ayutthaya food decks, the port city of the East. *Faculty of Science & Technology*, Suan Dusit Rajabhat University, Bangkok, Thailand.
- Sahaspot, S., Charoensiri, R. & Kongkachuichai, R. (2015). Glycemix index of glutinous and non-glutinous landrace rice varieties using "In vitro rapidly available glucose". *Burapha Science Journal* 20(2): 1-13.
- Sawangsuk, P. 2015. Thai Food With Rice Culture (Department of Home Economics). *Institute of International Studies*, Ramkhamhaeng University.
- Sopade, P.A. & Gidley, M.J. (2009). A rapid In- vitro digestibility assay based on glucometry for investigating kinetics of starch digestion. *Starch/Stärke*. 61(5) : 245-255.
- Strategic Planning & Evaluation Group. (2016). Annual report, 2016. Bureau of Non- Communicable Diseases (NCDs), *Department of Disease Control*, Ministry of Public Health. Bangkok: The War Veterans Organization of Thailand Press. (in Thai).
- Tarinee Nilkamhaeng. (2021). Valuation of the glycemic index of rice BK43 and its products with the technique of imitating the digestion of sugar. Evaluation of the Glycemic Index of RD43-Rice and Its Products by Means of in Vitro Glucose Digestion Mimic Techniques. *Journal of Food Technology Siam University* Vol. 16 No. 1 January -June 2021.
- Wasusun, A., Wongpiyachon, S., Songchitsomboon, S., Sukkiwat, W., Maneein, P. & Pakkethati, S. (2017). Rice variety RD43: medium glycemic index rice fore niche market. In Proceedings of 34th Conference of Rice and Cold Grain, Thailand. 309-320.
- Wiriyacharee P. (2018). Sensory Evaluation. *Office of Research Administration* Chiang Mai University.