

## Utilization of Nile Tilapia (*Oreochromis niloticus*) in development of fish based Thai snacks

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### Abstract

The purposes of this study were to develop fish based healthy Thai snack implementing protein by using Nile tilapia (*Oreochromis niloticus*) and as the alternative snack for further scaling to a commercial product. The 3 selected Thai snacks including Jeep Thai, Shor Moung and Pun Khlip were developed from their original recipes by substituting Nile tilapia meat into their stuffed portions and the nutritive values of each snack were determined by using INMUCAL program. The acceptability of the developed snacks was established by 2-step panel tests for the most preferable recipe in comparison with the original recipe and to obtain recommendations from the first step. When developing the number 1(NT1) Nile tilapia snacks which was done by substituting the Nile tilapia meat for the stuffed portion of each original snack including Jeep Thai(stuffed with snake-head fish), Shor Moung (stuffed with pork belly) and Pun Khlip (stuffed with prawn), it was found that the nutritional compositions of all NT1 snacks including Jeep Thai, Shor Moung and Pun Khlip had lower energy level than those of their original recipes (206.11 kcal/100 g., 248.59kcal/100 g. and 320.99 kcal/100 g. respectively). The acceptability of NT1 was evaluated by 15 trained panelists. The result showed that the overall acceptance mean scores of NT1 snacks ranged from 5.87 to 7.73 which were higher than those of the original recipes. The significant difference of taste and overall acceptability between the original recipe and NT1 was found for Pun Khlip. The panelists indicated that the harsh texture of the dough of Shor Moung and Pun Khlip should be improved by substituting the dough recipe of Jeep Thai for Shor Moung and Pun Khlip. Moreover, the spices should be increased in order to relieve fishy odor and the sweet taste should be decreased. After improving the NT1 formula based on the suggestions from the panelists, the new recipes (Nile tilapia 2 or NT2) were developed. The nutritional compositions of NT2 snacks showed the reduction of energy level, carbohydrate and sugar as compared to those of NT1. The fat contents in all NT2 snacks were lower than their counterpart contents in original recipes. The results from the second step of panel test showed that the overall acceptance mean scores of NT2 snacks ranged from 6.73 to 8.20 which were higher than those of the original recipes. However, the overall acceptances mean score of NT1 formula of Jeep Thai was significantly higher than that of the counterpart NT2 formula. The significant differences of texture between NT1 and NT2 were also found for Jeep Thai and Pun Khlip. The results of this research indicated that the snacks containing Nile tilapia could be applied due to the benefits of low calories, nutrient containing, and more acceptable taste. The developed snack recipes from Nile tilapia in this study should be applied for serving in the school or several institutions as the alternative healthy snacks for the clients.

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### **Introduction**

At present, health food has emerged as the alternative food for modern life style. The health food containing special nutritional values derived from fish, vegetable and spice also exhibits the alternative low cost sources of good nutrition. Fish is a good source of protein and high quality fatty acid. Incorporation of fish meat with food products can help to increase nutritive value and better acceptance

of the food products (Devi *et al.*, 2013).

Tilapia is a native fish of Africa and it was introduced to another region over the world since 1940 (Food and Agriculture Organization of the United Nations, 2015). There are several species of tilapia and the Nile tilapia is one of the favorable species that has been distributed throughout the world since 1960. Currently, the main production of Nile tilapia comes from aquaculture and China is the major producer of Nile tilapia from farming

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followed by Egypt and Southeast Asia respectively (Food and Agriculture Organization of the United Nations, 2015). Due to the improved production techniques and the controlling of off-flavors, the Nile tilapia meat is one of the important sources of protein in developing countries. For industrialized countries including the USA and many countries in Europe, the products of Nile tilapia have been moved up to supermarkets, discount stores and restaurants (Food and Agriculture Organization of the United Nations, 2015). It was reported that tilapia was one of the most popular seafood in the USA due to the fact that several good menus containing tilapia have been developed with reasonable price, year round supply, delicious flavor and flexibility in preparation.

In Thailand, Nile tilapia has been brought from Japan since 1965. The culture of Nile tilapia in Thailand has been consistently developed, and now Thailand is one of the world major producers of farmed Nile tilapia (Food and Agriculture Organization of the United Nations, 2015). At present, several Thai dishes use Nile tilapia as the major ingredient probably due to the fact that Nile tilapia is easily available in the market with reasonable price. In addition, Thai dishes including main dishes, side dishes and Thai snacks have good reputation with well acceptance. Thai cuisine contains diversity of ingredients including fresh vegetables, herb and spice together with the cooking procedure that make Thai cuisine prominence in aroma and taste. Now a day, Thai cuisine has achieved international recognition (Aishah *et al.*, 2010).

The widely use of Nile tilapia and its good properties seem appropriate for the incorporation of Nile tilapia meat with several food recipes. Using Nile tilapia as one of ingredients in Thai snack can be an alternative recipe for increasing the consumption of fish. Development of fish-based Thai snacks can help to promote the alternative healthy food for the consumers. However, the information on using Nile tilapia with the Thai snacks is limited. Therefore, this present study aims to incorporate Nile tilapia meat with the development of fish-based Thai snacks with attributes of most favorable recipes as evaluated by the sensory evaluation procedure.

## Materials and Methods

### Selection of Thai snacks

As the aim of this research was to develop a fish-based snack from Nile tilapia, we selected the old tradition Thai snacks which were originally prepared by using several kinds of meat as their main ingredients. These Thai snacks possess the advantage



Figure 1. Three selected Thai snacks

of high nutrition values including protein and mineral from their main ingredients containing diversity of meat. They also show different shapes which are molded by hand into specific shapes and some of them show different colors. Therefore, the selected Thai snacks were "Jeeb Thai" (dumpling steamed mixed flour stuffed with seasoned prawn, as shown in Figure 1) "Shor Moug" (dumpling steam mixed flour with purple color and stuffed with pork belly and winter melon in thick syrup, as shown in Figure 1), and "Pun Khlip" (dumpling steamed mixed flour stuffed with minced stripped snake-head fish and minced coconut, as shown in Figure 1).

All selected snacks are popular snacks in Thailand. The origins of these snacks are not known due to the fact that the first known recipes in print of Thai dishes were found after the First World War (Klinchui, 1987). However, it was found that Shor Moug appears in a famous Thai poem that was composed by King Rama II (1809-1824) who mentioned about Thai food, Thai snack and Thai sweet. The origin of Pun Khlip is not really known but its recipe appears in a classical cook book that was contributed by M.L. Terb Choomsai since 1970. These snacks have similar characteristics including the type of used flour, main ingredients containing varieties of meat with steaming process. In addition, they exhibit high nutrition values and low calories from their ingredients and cooking processes. These snacks are served with fresh vegetables including lettuce, coriander in order to relieve the piquant taste and served with small Thai chili to relieve the oily taste from the meat.

In this study, we used three different recipes. The first two recipes include the original recipes that have been developed by the School of Culinary Art in Suan Dusit Rajabhat University based on the recipes as mentioned above and the second recipe which was developed by substituting Nile tilapia for the main ingredient in each snack. Then, the first two

Table 1. Ingredients in 3 formulae of original, NT1 and NT2 snacks (gram)

Ingredients	<i>Jeeb Thai</i> for 18 servings (5 pieces/serving)			<i>Shor Moung</i> for 7 servings (5 pieces/serving)			<i>Pun Khliip</i> For 7 servings (5 pieces/serving)		
	Original	NT1	NT2	Original	NT1	NT2	Original	NT1	NT2
	<b>Dough</b>								
Rice flour	180	180	180	120	120	90	65	80	90
William's arrow root flour	10	10	10	50	5	5	5	5	5
Glutinous rice flour	30	30	30	15	15	15	-	-	15
Tapioca flour	20	20	20	10	10	10	10	10	10
Vegetable oil	20	20	20	10	10	10	-	-	10
Water	376	376	376	200	200	188	125	130	188
<b>Stuffed portion</b>									
Steamed Nile tilapia meat	-	150	150	-	30	40	-	40	40
Chopped pork belly	-	-	-	30	-	-	-	-	-
Minced tiger prawn	-	-	-	-	-	-	40	-	-
Minced stripped snake-head fish	150	-	-	-	-	-	-	-	-
Chopped winter melon in thick syrup	-	-	-	50	50	30	-	-	-
Ground peanut	-	-	-	25	25	25	-	-	-
Roasted white sesame	-	-	-	10	10	10	-	-	-
Ground coconut	-	-	-	-	-	-	36	36	36
Sugar cane	-	-	-	15	50	50	-	-	-
Palm sugar	80	80	60	-	-	-	50	50	50
Minced coriander root	-	-	-	-	-	-	3	3	8
Thin sliced shallot	50	50	60	-	-	-	-	-	-
Garlic	10	10	20	-	-	-	5	5	10
Dry cayenne chili	5	5	7	-	-	-	-	-	-
Galangal	6	6	10	-	-	-	-	-	-
Salt	2.5	2.5	2.5	1.25	2.5	2.5	2.5	2.5	2.5
Ground pepper	-	-	-	-	-	-	2.5	2.5	2.5
Vegetable oil	10	10	10	10	15	15	15	15	15
Soya sauce	15	15	15	-	-	-	-	-	-
<b>Fried garlic for serving</b>									
Garlic	10	10	10	10	10	10	10	10	10
Vegetable oil	20	20	20	20	20	20	20	20	20

\*Serve with lettuce, coriander leave and Thai chili

recipes were evaluated by a group of 15 well-trained panelists. After the first sensory evaluation, the selected Thai snacks were reconstituted based on the new formulae resulting from the recommendations from the panelists.

### Ingredients

The ingredients used for Thai snack production were purchased from the market which were easy to find and had low cost. Nile tilapia fish was purchased freshly from the market and the average weight was 500 gram. Other ingredients were also purchased from the same market. The ingredients comprise 3 portions. The first portion is the ingredients used for doing the dough which contains several kinds of flour as described in Table 1. The second portion is the ingredients used for stuffed portion in each snack which comprise several ingredients including meats, spices, condiments, etc. as described in Table 1. The last portion is fresh vegetables that are used for serving including vegetables and fried garlic oil.

### Preparation of the dough

The processes of making dough of these selected snacks are very similar. The details of the dough making process are as follow: mix all flours together and gradually stir them until they are well mixed and then add vegetable oil and water and gradually stir the mixture simultaneously. For Shor Moung,

squeeze 3 – 4 fresh or dried butterfly pea flowers to obtain the purple color and then, heating the mixture under medium heat. Gradually stir and heat the mixture until they are glossy and tacky. Stop heating and take the dough out of the pot and put them into the bowl that has been sprinkled with tapioca flour in order to prevent the dough from attaching to the bowl surface. Gradually knead the dough while they are still warm. During this process, sprinkle the dough with tapioca flour to let the kneading process be more comfortable. When the dough is well mixed and look glossy and tacky, leave it to cool. Cover the dough with a thin white cloth.

### Preparation of the stuffed portion

The main ingredients of selected snacks comprised several kinds of meat which needed to be pre-cooked. For the preparation of fishes (Stripped snake-head fish and Nile tilapia), they had to be well washed, and their scales, intestine and viscera be removed. Then the whole fishes were subjected to steaming with fresh spices (kaffir lime leave, lemon grass and galangal root) to decrease the fishy smell for 10-15 minutes. Then, the fish meats were separated from the bones and fish skins were removed and then ground in the mortar. All spices and salt were ground in the mortar until they were well mixed and brought to stir fry until the pleasant aroma appeared, then added ground fish meat and seasoning. When the

stir fried ingredients became sticky, stopped heating and took them out of the pan and let them cool. The mixture was then molded into small pieces (3 gram for each piece).

The preparations of pork and prawn for Shor Moung and Pun Khlip were similar. Fresh pork belly and tiger prawn (head and tail removed) were cut into small pieces and chopped. All spices and salt were ground in the mortar until they were well mixed and brought to stir fry until the pleasant aroma appeared, then added chopped pork or prawn and other ingredients. All ingredients were stir fried until they became sticky, then stopped heating and took them out of the pan and let them cool. The stuffed portion was then molded into small pieces (3 gram for each piece).

#### *Preparation of the snacks*

Bring 5 gram of each dough and flatten it to be about 2 centimeters in diameter and put the prepared mixture of stuffed portions on the flatten dough, and then fold the dough over the pieces of stuffed portion and gently crimped. While folding the snacks, sprinkle those usually with tapioca flour to prevent them from attaching to the container. For making the specific shapes of Shor Moung and Jeeb Thai, they should be molded like a small ball and carved by using Thai style forceps. For Pun Khlip, its ridge should be well crimped by hand for sealing. Bring the decorated snack to steam for 5 minutes under medium heat. Then, take the snacks out from the steamed pot and sprinkle them with fried garlic oil. The 5 pieces of each snack were served with lettuce, coriander and Thai chili.

#### *Sensory evaluation and nutritional compositions evaluation of selected snacks*

The sensory evaluation of the Thai snacks containing Nile tilapia was conducted by 15 trained panelists from the School of Culinary Art and Suan Dusit International Culinary School. The panelists tested the snacks on their general appearance, color, odor, taste, texture and the overall acceptability. The selected scores in this study were a 9-point hedonic scale based on Yeh *et al.* (1998). Two steps of the tests were conducted to determine the preferable snacks made from Nile tilapia in comparison with the original recipe and to determine the preferable snack developing from the first step. The snacks were labeled with coded samples that were contributed by using different 3 digit numbers which were set by random selection. They were asked to rate the scores regarding their strength of general appearance, color, odor, taste, texture and the overall acceptability.

During the test procedure, the panelists were asked to rinse their mouths and chew a plain cracker before and between testing the snacks.

The nutrient compositions of the snacks were evaluated by using INMUCAL program that has been developed by the Institute of Nutrition, Mahidol University in Thailand (Banjong *et al.*, 2003 ; Viwatpanich, 2012). The nutritive values of the snacks were calculated by entering each weight of the ingredients of the recipes and the final cooked weight. The obtained data were showed as 100 g of each composite snack.

#### *Statistical analysis*

The t-test was used for statistical analysis of the scores of sensory evaluation. The test was used at 5% level of significance for analysis of the acceptability difference between the developed recipes.

## **Results and Discussions**

#### *Nutritional composition of original recipes and NT1*

The nutrition compositions of the snacks per 100 g for the original recipe and Nile tilapia 1 (NT1) were shown in Table 2. The nutritional compositions of each recipe varied in accordance with the ingredients. The main source of energy level of all original recipes was derived from carbohydrate. Pun Khlip showed the highest energy level (334.37 kcal/100g) among all selected snacks and had the highest carbohydrate content (54.91 g/100g). While Shor Moung and Jeeb Thai contained lower energy levels than that of Pun Khlip (276.71 kcal/100g and 215.30 kcal/100g, respectively). When Nile tilapia meat was used in substitute for stuffed portions in all selected snacks, the nutrients of Nile tilapia 1 or NT1 of all snacks were slightly different from those of original recipes. NT1 of all snacks including Jeeb Thai, Shor Moung and Pun Khlip had lower energy levels than those of their original recipes (206.11 kcal/100 g, 248.59 kcal/100 g and 320.99 kcal/100 g, respectively). The protein content in NT1 of Jeeb Thai and Pun Khlip slightly increased from those of the original recipes; while Shor Moung had lower level of protein content than that of its original recipe. The fat contents of NT1 of all snacks were lower than those of their original recipes. The reductions of fat contents of NT1 of Jeeb Thai, Shor Moung and Pun Khlip with regard to their original recipes were 4.90%, 23.45% and 7.28%, respectively. This may be due to the fact that the fat content (total lipid) in Nile tilapia was lower than the fat contents in stripped snake head fish, pork belly and tiger prawn (Chizzolini *et al.*, 1999 ; Puwastien *et al.*, 2004 ; Agricultural Research Service (ARS), USDA.,

Table 2. Nutritional composition of selected snacks (per 100 g)

Nutrient	Jeeb Thai			Shor Moung			Pun Khlip		
	original	NT 1	NT 2	original	NT 1	NT 2	original	NT 1	NT 2
Energy (kcal)	215.30	206.1	199.0	276.71	248.5	247.3	334.37	320.9	270.0
Protein (g)	5.35	5.90	5.92	5.94	5.88	6.51	5.96	5.99	4.85
Fat (g)	5.30	5.04	4.44	12.28	9.40	9.65	9.61	8.91	9.25
Carbohydrate (g)	35.37	34.61	32.80	35.79	35.10	33.50	54.91	50.41	40.82
Dietary fiber (g)	0.83	0.82	0.90	1.02	1.02	0.95	2.55	2.35	1.90
Sugar (g)	9.33	9.22	7.06	9.00	8.83	6.98	17.86	16.40	12.87
Cholesterol (mg)	21.92	14.67	14.67	4.73	5.20	7.11	25.43	9.51	7.40
Calcium (mg)	25.20	53.54	52.19	14.98	18.98	20.71	47.80	41.88	33.06
Phosphorus (mg)	77.27	80.79	81.86	73.45	82.63	89.06	80.02	101.3	83.07
Iron (mg)	1.98	2.10	1.84	1.07	1.08	1.11	3.22	3.05	2.38
Potassium (mg)	98.11	111.0	121.5	70.07	89.90	91.35	106.71	149.7	120.7
Sodium (mg)	502.29	503.1	503.7	125.61	128.5	133.9	451.64	338.2	263.3
Zinc (mg)	0.26	0.26	0.28	0.60	0.44	0.45	0.50	0.49	0.38
Copper (mg)	0.05	0.04	0.04	0.08	0.08	0.08	0.11	0.10	0.08
Vitamin A (RE)*	1.36	1.34	1.01	4.54	7.02	6.36	2.52	7.27	5.66
Vitamin B1 (mg)	0.06	0.06	0.06	0.09	0.08	0.08	0.05	0.06	0.05
Vitamin B2 (mg)	0.05	0.06	0.06	0.08	0.09	0.10	0.03	0.07	0.06
Vitamin C (mg)	1.85	1.83	2.02	1.59	1.56	1.26	2.82	2.50	2.58
Niacin (mg)	1.32	1.83	1.26	1.79	1.74	1.80	1.27	1.38	1.13
Moisture (g)	24.01	24.39	26.48	6.87	6.87	13.35	25.87	26.35	22.38

\*RE : retinol equivalent

2009). The cholesterol contents of NT1 of Jeeb Thai and Pun Khlip were lower than those of their original recipes while that of Shor Moung was higher than that of its original recipe. This may be due to the fact that the stuffed portion in original recipes of Jeeb Thai and Pun Khlip that contained stripped snake-head fish meat and tiger prawn meat having higher levels of cholesterol than the counterpart levels of the recipes that contained Nile tilapia (Puwastien *et al.*, 2004; Agricultural Research Service (ARS), USDA., 2009). However, the cholesterol content in pork belly (59 mg/100 g) (Chizzolini *et al.*, 1999) in the original recipe of Shor Moung was lower than that of Nile tilapia meat, therefore, the cholesterol content in NT1 of Shor Moung showed a higher value. Some of mineral contents of NT1 in all snacks including, potassium and phosphorus had the higher level than the counterpart levels in their original recipes.

Meanwhile, the calcium contents of NT1 of Jeeb Thai and Shor Moung were higher than those of their original recipes, but the calcium content in NT1 of Pun Khlip showed a slightly decrease when compared to that of its original recipe. This may be due to shrimp containing calcium content higher than that of Nile tilapia (Agricultural Research Service (ARS), USDA., 2009), thus the calcium content in NT1 of Pun Khlip was at the lower level than that of the original recipe.

The highest sodium content was found in the original recipe and NT1 of Jeeb Thai which contained 502.29 mg and 503.11 mg respectively. The main source of sodium in Jeeb Thai was derived from salt and soya sauces.

#### First step sensory evaluation

This step was conducted to obtain the acceptability

and recommendation of NT1 in comparison with the original recipe of selected snacks. All of snack scores were shown in Table 3. The mean acceptability levels of general appearance, color, odor, flavor, texture and overall acceptability of NT1 of all snacks varied from "like slightly" to "like very much". As shown in Table 3, significant differences of taste and overall acceptability between the original recipe and NT1 were found for Pun Khlip. The NT1 of Pun Khlip significantly showed the higher overall acceptability mean score than that of the original recipe. The score of texture of NT1 of Shor Moung was significantly higher than that of the original recipe. It was indicated that the hard texture of original recipe of Shor Moung was attributed to stuffed portion containing pork belly. Among all original recipes, Shor Moung showed the lowest scores of taste, texture, and overall acceptability. However, when the stuffed portion of original recipe was substituted by Nile tilapia meat, the mean scores of taste, texture, and overall acceptability of Shor Moung were higher. Moreover, NT1 of Shor Moung showed the best appearance among tasted snacks because of its shape that represented a flower like shape.

Regarding the preference of the panelists, the texture scores of Jeeb Thai in both recipes were found to be higher than those of other snacks. The panelists mentioned that they preferred the texture of Jeeb Thai particularly the texture of the dough which had the softest texture comparing to those of other snacks. They also suggested using the ingredients of Jeeb Thai dough in substitute for Shor Moung and Pun Khlip dough. The panelists found the fishy odor in Jeeb Thai of both recipes and they suggested for the increase of spice and herb in the ingredients of stuffed portion for decreasing the fishy odor. The

Table 3. Mean values of acceptability scores of Thai snacks from sensory evaluation step 1

Acceptability parameters	Jeeb Thai		Shor Moung		Pun Khlip	
	Original	NT1	Original	NT1	Original	NT1
General appearance	7.00±1.36	6.84±1.46	6.67±2.06	7.47±0.99	6.93±1.71	7.33±1.40
Color	7.60±0.63	7.47±0.74	7.00±1.81	7.53±0.83	7.00±1.36	7.40±1.24
Odor	6.67±1.72	7.07±1.44	6.93±1.22	6.53±1.36	7.27±1.62	7.73±1.16
Taste	6.20±1.37	7.00±1.13	5.47±2.07	6.13±1.64	6.73±1.67	7.80±1.08*
Texture	6.67±1.35	7.07±1.33	5.47±1.92	6.80±1.15*	6.40±1.72	7.00±1.60
Overall acceptability	7.07±0.70	7.07±1.44	5.87±2.10	6.60±1.50	6.73±1.53	7.73±1.03*

Note: Data are represented as mean value ± standard deviation (SD)

\* indicating significant difference between original recipe and NT1 (p -value < 0.05)

Table 4. Mean values of acceptability scores of Thai snacks from sensory evaluation step 2

Acceptability parameters	Jeeb Thai		Shor Moung		Pun Khlip	
	NT1	NT2	NT1	NT2	NT1	NT2
General appearance	7.73±0.96	7.80±0.77	7.07±1.28	7.27±2.05	8.00±0.85	7.93±1.03
Color	7.53±0.74	7.67±0.62	7.27±1.58	7.53±2.00	7.27±0.46	7.80±0.86
Odor	8.07±0.96	7.27±1.16*	7.27±1.33	7.60±1.27	7.00±1.69	7.80±0.86
Taste	8.13±0.83	7.33±0.90*	6.60±1.64	7.40±1.24	7.73±1.89	7.73±0.80
Texture	8.27±0.80	7.27±0.96*	7.47±0.83	7.20±1.08	5.87±1.68	7.07±0.80*
Overall acceptability	8.20±0.77	7.47±0.74*	7.13±1.51	7.67±1.18	6.73±1.39	7.80±0.77*

Note: Data are represented as Mean value ± standard deviation (SD)

\* indicating significant difference between NT1 and NT2 (p -value < 0.05)

panelists also indicated that the tastes of Jeeb Thai and Shor Moung appeared to be too sweet and it should be reduced by lowering the sugar proportion. Thus, for Shor Moung, we reduced the amount of winter melon in sticky syrup for the decrease in sweet taste.

#### Nutritional composition of NT2

After implementing the ingredients of NT2 following the recommendation of the panelists, the nutritional compositions of all NT2 snacks were evaluated by using the INMUCAL program. As shown in Table 2, it was observed that the energy level of NT2 in all snacks decreased comparing to that of the NT1. The reductions of carbohydrate and sugar contents in all snacks were observed due to sugar content in stuffed portion of these snacks being decreased. The content of fat in Shor Moung and Pun Khlip slightly increased due to the ingredient of the dough in NT2 containing more fat level as shown in Table 2. It was observed that the moisture contents of NT1 and NT2 increased comparing to that of the original recipes. This may be due to the moisture content of stuffed portion containing Nile tilapia meat which may cause the higher moisture content

than those of the original stuffed portions.

#### Second step sensory evaluation

This step was conducted to obtain the acceptability and recommendation of NT2 in comparison with NT1 recipe of selected snacks. All of snack scores were shown in Table 4. The overall acceptability rating mean scores of NT2 of all snacks were at the “like very much” level. A significant difference of overall acceptability between NT1 and NT 2 was found for Jeeb Thai and Pun Khlip. The overall acceptability of NT1 of Jeeb Thai was 8.20 ± .077 which was higher than that of NT2 and exhibited the highest score among selected snacks. The acceptability levels of odor, taste, and texture of NT1 were higher than the counterpart levels of NT2 for Jeeb Thai and also showed the highest scores among selected snacks. The panelists mentioned that NT2 of Jeeb Thai was too pungent and too spicy. Therefore, they preferred NT1 of Jeeb Thai more than NT2. Jeeb Thai also exhibited significant difference between NT1 and NT2 for odor, taste and texture. This could be due to the increase of more spice including shallot, garlic, chili and galangal into the stuffed portion recipe of NT2 as shown in Table 1. These spices have the hot

and spicy taste which, therefore, caused the taste of NT2 to be too pungent and too spicy.

The significant difference between the texture of NT1 and NT2 was found for Pun Khlip as a result of using the same proportion as that of the Jeeb Thai's dough recipe. The acceptability scores of NT2 of Shor Moug were higher than those of NT1 with the exception of the acceptability score of texture being slightly lower than that of NT1. The better acceptance of NT2 of Shor Moug and Pun Khlip as compared to NT1 appeared to occur as a result of using the same proportion as that of Jeeb Thai's dough. The higher acceptability levels of taste and odor of NT2 of Shor Moug and Pun Khlip probably occurred as a result of the increase in spice and herb in their stuffed portions. As a result in this study, the panelists selected NT1 for Jeeb Thai and NT2 for Shor Moug and Pun Khlip as their most preferable recipes for Nile tilapia based Thai snack.

## Conclusion

This present study shows the utilization of Nile tilapia meat as a fish based stuffed portion of 3 selected Thai snacks with 2 steps of sensory evaluations. The 3 selected Thai snacks including Jeeb Thai, Shor Moug and Pun Khlip were prepared by using Nile tilapia meat in stuffed portions. The sensory evaluation showed that using Nile tilapia in stuffed portion in substitute for that of the original recipe resulted in better acceptance. The nutritive values of the 3 selected snacks containing Nile tilapia showed the decrease of energy, carbohydrate, fat and sugar as compared to those of their original recipes indicating that the use of fish meat such as Nile tilapia incorporated with Thai snack would help to improve nutritional quality. The well acceptance of Nile tilapia containing snacks as shown in this study can be promoted to be the alternative healthy snacks for commercial products.

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