Journal of Food Health and Bioenvironmental Science
Journal homepage : http://jfhb.dusit.ac.th/

Development of Stir-fried Chilli Paste with Protein Supplementation from Khai Phum

Pakawadee Phugan,* Suphakron Amdonkloy, Kamonrut Sirirut & Suwanan Choosing

Home Economics, Faculty of Science and Technology, Pibulsongkram Rajabhat University, Phitsanulok 65000, Thailand

Article info

Article history:
Received 28 June 2017
Revised 29 November 2017
Accepted 6 December 2017

Keywords:
Stir-fried Chaili Paste,
Khai Phum

Abstract

This research is the development of stir-fried chilli paste additive protein from Khai Phum. The objectives were 1) to add more nutrients in the stir-fried chili paste 2) to study consumers' acceptance, chemical composition and microbial quality of the product by adding 3 different swamp algae: 20, 30 and 40% which calculated from the total raw material weight. The result of consumers' acceptance with 100 participants showed that the fried chili paste with 30% of swamp algae obtained the highest scored in perception aspect. The Stir-fried chili paste with 30% of swamp algae could significantly increase nutritive values such as carbohydrate, beta-carotene and calcium. In particular, beta-carotene was increased 25449 micrograms and calcium was increased 354.9 milligrams from the basic recipe. In 100 grams of the fried chili paste with 30% of Khai Phum consisted 24.47±0.04% of protein, 25.41±0.16% of carbohydrate, 8.85±0.11% of fat, 32.33±0.17% of moisture and 8.94±0.05% of ash. Adding more swamp algae in the product decreased brightness and red value. On the other hand, it increased green value. Moreover, increasing more swamp algae slightly decreased aw value in the product. The result of microbial quality test indicated that microbial quality of the fried chili paste with 30% of swamp algae was in according to the community product standard.

Introduction

Food is a basic factor for the growth and development of body, mind, emotion, society, and wisdom, including the health promotion for healthy strength, and food consumption and nutrient intake for proper physical growth (Dollawittayakun, 2007). Traditional Thai food is the cultural inheritance of Thai people from the past, and reflects the relationship of people's lifestyle in the past. In consequence, consumption of sufficient and proper meal is are indicator of good life quality of populations in the community (Srisaleekulrat, 2013). Chilli dip or Chilli paste is a type of food that live with Thai from the past to the present day, and it is the side dish of every family in every region until we may say that Chilli paste is the pillar of Thai food system. Developing a Chilli paste for cooking is are important wisdom of our ancestors, resulting in receiving more nutrients from local vegetables and fishes (Charoensaket & Leanchamroon, 2007). Presently, the use of Swamp

* Corresponding Author
e-mail: pakawadee@psru.ac.th

algae or Khai-nam or Khai Phum, for foods increases, with the purpose of adding value to local fresh water algae of Khai Phum. Characteristics are small green pellets round shape or almost round. Khai Phum provides high nutrient (Rowchai & Somboon, 2007), such as calcium, beta-carotene, protein, and fiber (Somboon, 2015). Moreover, dehydrated Khai Phum provides 59.0% of calcium (Deepanya, 2012) and have essential amino similar to eggs. In addition, there are more Chlorophyll and anti-oxidants than spirulina which has been used to cure constipation and anemia. Thai people in the north and Isan regions like to cook Khai Phum in their local meals such as Gaeng Ohm (Dill Soup), Gaeng Kua (Curry) and Thai omelet, due to its cheap price and simple to find (Somboon, 2015). In addition, Khai Phum has the anti-oxidant effect, disinfectant quality, and balance body for Vitiligo from stress and gastroesophageal reflux due to food (Wongyai et al., 2011). Regarding the mentioned nutritional benefits, the author, therefore, has the idea to develop Chilli paste product which can be stored longer for a time, and to improve its nutrient quality by adding Khai Phum as a protein Supplemental in stir-fried chilli paste and to determine the physical and microbiological qualities of chilli paste product supplemented with Khai Phum. This newly developed product will gain more nutrition value and provide another choice for consumers who love to consume chilli paste.

This research was the addition of baked Khai Phum in stir-fried chilli paste. The ratio of Khai Phum and quality of stir-fried chilli paste product with protein supplement from Khai Phum. The experiment purposed to receive the new product with nutrition quality.

Materials and methods

1. Study of chemical elements of Khai Phum

1.1 Preparation of dry Khai Phum

Prepare Khai Phum by derived from natural water sources of Phitsanulok. Khai Phum by cleaning and drying in are electric hot air oven, with a temperature of 50 ºC, for 3-4 hours, until it becomes dehydrated store dry Khai Phum the hermetically sealed container in the refrigerator at the temperature lower than 30 ºC.

1.2 Analysis of chemical composition of dry Khai Phum

Chemical analysis of moisture, protein, fat, carbohydrate, ash, calcium, and beta-carotene were in accordance with the methods of AOAC (2000).

2. Development of stir-fried chilli paste with protein supplement from Khai Phum

2.1 Selection of basic recipe of stir-fried chilli paste product

Study the 10 basic recipes of stir chilli paste product and select only 3 recipes. The selection came from the group discussion with 5 food and nutrition experts to select the recipe that provides delicious taste, sensory appearance, and popular among consumers. The 3 recipes would be received the sensory evaluation with 100 testers who are general consumers to evaluate appearance, color, smell, taste, texture, and overall satisfaction by 9-point hedonic scale (Nicolas et al., 2010) in order to choose the recipe that received the highest scores.

Table 1 Ingredients of basic stir-fried chilli paste recipes

Raw Materials	Quantity for Each Recipe		
	Recipe 1 (gram)	Recipe 2 (gram)	Recipe 3 (gram)
Dried Red Bird Chilli	110	40	80
Grilled Fish	165	288	110
Shallot	110	60	110
Garlic	144	-	77
Shrimp Paste	12	24	12
Sugar	-	-	2
Coconut Sugar	55	12	-
Fish Sauce	48	-	2
Wet Tamarind Chopped	55	12	15
Salt	6	-	2
Coriander Root	3	-	-
Grilled Galangal	6	-	-
Grilled Lemongrass	6	-	-
Vegetable Oil	12	24	12
Total	732	460	425

Remark: Recipe 1 from Aobthom (2006), Recipe 2 from Nualkaew (2010) and Recipe 3 from Kongpan (2015)

For stri-fried chilli past preparation, all ingredients are grilled to a fragrant (red bird chilli, grilled fish, shallots, garlic and shrimp paste). Pound all the ingredients together red bird chilli, grilled fish, shallots, garlic and shrimp paste and stir all ingredients together season with sugar, salt, fish sauce and wet tamarind chopped. After that, add dry khai phum, stir all ingredients together and stir until dry.

2.2 Chemical analysis of basic stir-fried chilli paste recipe

Analysis the chemical compositions of the recipes which the consumers accept: moisture, protein, fat, carbohydrate, ash, calcium and beta-carotene were in accordance with the methods of AOAC (2000).

2.3 Study of the proper quantity ratio of Khai Phum per one product

The recipe which received the highest scores according to section 2.1, add Khai Phum into the product at 3 levels of quantity which are 20%, 30% and 40% total weight and experiment the product quality as follows:

For sensory evaluation, perform the sensory evaluation on the stir-fried chilli paste product with protein supplement from Khai Phum with 100 participants to consider appearance, color, smell, taste, texture, and overall satisfaction by 9-point hedonic scale (Nicolas et al., 2010) in order to choose the recipe that received the highest scores.

Analyze the chemical compositions of stir-fried chilli paste with protein supplement from Khai Phum which the consumers accept: moisture, protein, fat, carbohydrate, ash, calcium, and beta-carotene were in accordance with the methods of AOAC (2000).

The analysis of physical quality are as follows: color difference expressed in L* a* b*measured by Color Reader CR-10, Japan reporting lightness (L*) green-red (a*) and blue-yellow (b*) and water activity (a_w) represents the humidity affecting the growth of microbes.

Analyze the microbe quality in accordance with the community products standard of Chilli Paste No. Mor Hpor Chor 321/2556 as follows:

1) The entire amount of microbe must be less than 1x104 colony forming unit per g.

2) No Salmonella in the 25-gram sample.

3) S. aureus must be less than 10 colonies forming unit per g.

4) Bacillus cereus must be less than 1x104colony forming unit per g.

5) Clostridium perfringens must be less than 100 colonies forming unit per g.

6) Escherichia coli by MPN method must less than 3 samples per g.

7) Yeast and Mold must less than 100 colonies forming unit per g.

3. Statistical analysis

The statistical analysis in this study was randomized complete block design (RCBD) for sensory evaluation and planning of completely randomized design (CRD) for chemical compositions analysis and physical quality analysis. The data received from analysis of variance. ANOVA was applied to compare the mean of difference by least significant difference test (LSD) using the computer program.

Results and discussion

1. Study result of phum's chemical compositions

According to the study of Khai Phum's chemical compositions, 100 g of day Khai Phum contains fat and protein which is the energy source for the body. Furthermore, Khai Phum is highly nutritious aquatic plants. There are also high beta carotene and calcium or 83810 microgram and 747.3 milligram, respectively (Table 2). Consistent with the research of Deepanya (2012). It was found that Khai Phum had higher calcium content than dairy products.

Table 2 Chemical compositions of 100 g Khai Phum

Raw Materials	Quantity for Each Recipe
Moisture	**5.58 ± 0.02**
Protein	**23.65 ± 0.06**
Fat	**51.60 ± 0.05**
Carbohydrate	**5.16 ± 0.08**
Ash	**14.11 ± 0.04**
Beta-carotene	**83810 ± 0.04 ug : 100 g**
Calcium	**747.3 ± 0.03 mg : 100 g**

Remark: The results were obtained from Central Laboratory Thailand, 2017

2. Result of the development of Stir-fried Chilli Paste product with protein supplement from Khai Phum

2.1 Selected recipe

According to the selection of 3 basic stir chilli paste recipes and the sensory evaluation from 100 participants to select the most favorable recipe, to regard appearance, color, smell, taste, texture, and overall satisfaction (Table 3), the recipe 3 has been accepted mostly. May be the result of the recipe 3 has a medium spicy and the best taste.

Table 3 Mean scores of Sensory Evaluation (n = 100; 9-point hedonic scale)

Characteristics	Sample of Basic Stir- fried Chilli Paste Recipe		
	Recipe 1	Recipe 2	Recipe 3
Appearance	**6.87 ± 0.12^b**	**6.53 ± 0.12^b**	**7.35 ± 0.11^a**
Color	**6.87 ± 0.13^b**	**6.74 ± 0.12^b**	**7.60 ± 0.10^a**
Smell	**6.93 ± 0.12^a**	**6.95 ± 0.11^a**	**7.19 ± 0.10^a**
Taste	**6.81 ± 0.12^b**	**6.76 ± 0.11^b**	**7.24 ± 0.11^a**
Texture	**6.69 ± 0.14^b**	**6.62 ± 0.11^b**	**7.32 ± 0.12^a**
Overall acceptance	**7.13 ± 0.12^b**	**7.06 ± 0.11^b**	**7.50 ± 0.12^a**

Remark: The different letters in horizontal represents the difference with significance ($P \leq 0.05$).

2.2 Development of stir-fried chilli paste with protein supplement from Khai Phum

The development of stir-fried chilli paste with protein supplement by adding Khai Phum in 3 quantity levels which are 20%, 30%, and 40% of the entire raw

material weight, after the sensory evaluation considering in appearance, color, smell, taste, texture, and overall satisfaction by 9-point hedonic scale (Nicolas et al., 2010), the 100 participants found that they favor 30% of Khai Phum the most. The overall acceptance score was moderate. (Table 4).

Table 4 Mean scores of Sensory Evaluation of stir-fried chilli paste product with protein supplement from Khai Phum (n =100; 9-point hedonic scale)

Characteristics	Sample of Basic Stir Chilli Paste Recipe		
	Recipe 1 (20% Khai Phum)	Recipe 2 (30% Khai Phum)	Recipe 3 (40% Khai Phum)
Appearance	**6.31 ± 0.09^{b}**	**7.51 ± 0.10^{a}**	**5.74 ± 0.09^{c}**
Color	**6.52 ± 0.10^{a}**	**7.34 ± 0.11^{a}**	**6.40 ± 0.60^{a}**
Smell	**6.24 ± 0.11^{b}**	**7.24 ± 0.11^{a}**	**5.63 ± 0.11^{c}**
Taste	**6.46 ± 0.11^{b}**	**7.54 ± 0.12^{a}**	**5.83 ± 0.10^{c}**
Texture	**6.36 ± 0.10^{b}**	**7.38 ± 0.11^{a}**	**5.77 ± 0.10^{c}**
Overall acceptance	**6.78 ± 0.09^{b}**	**7.86 ± 0.10^{a}**	**6.05 ± 0.11^{c}**

Remark: The different letters in horizontal represents the difference with significance (P≤0.05).

According to the chemical compositions analysis of Stir-fried chilli paste product with protein supplement from Khai Phum that has been mostly accepted, the product contains higher protein comparing to the basic recipe including 25449 microgram of beta carotene and calcium 354.9 milligram. per 100 gram (Table 5).

Table 5 Chemical compositions of basic recipes and product

Characteristics	Basic Stir-fried Chilli Paste Recipe	Stir-fried Chilli Paste Product with Protein Supplement from 30% Khai Phum
Moisture (g)	**42.59 ± 0.12^{a}**	**32.33 ± 0.17^{b}**
Protein (g)	**15.41 ± 0.07^{b}**	**24.47 ± 0.04^{a}**
Fat (g)	**09.25 ± 0.11^{a}**	**08.85 ± 0.11^{b}**
Carbohydrate (g)^{ns}	**25.37 ± 0.09**	**25.41 ± 0.16**
Ash (g)	**07.38 ± 0.06^{b}**	**08.94 ± 0.05^{a}**
Beta-carotene (ug)	**0**	**25449 ± 0.03 ug : 100 g**
Calcium (mg)	**0**	**354.9 ± 0.06 mg : 100 g**

Remark: The results were obtained from Central Laboratory Thailand, 2017

According to the physical quality analysis of color difference expressed in L* a* b* of the product with 20%, 30% and 40% Khai Phum, it was discovered that when added Khai Phum, L* tends to decreases. This might be because the addition of Khai Phum in the stir chilli paste product has the characteristic as green powder resulting in the greener of the product (Table 6).

In regards to the experiment of stir-fried chilli paste with Khai Phum added 20%, 30%, and 40% in order to study their physical quality; it was revealed that a_w of the products increases depending on the higher quantity of Khai Phum. Nonetheless, to add Khai Phum

Table 6 Color difference expressed in L* a* b* of basic chilli paste recipe and stir- fried chilli paste product with protein supplement from Khai Phum

Stir-fried Chilli Paste	Lightness (L*)	Redness (a*)	Yellowness (b*)
Basic Recipe	**25.44 ± 0.06^{a}**	**16.57±0.21^{a}**	**9.26±0.17^{a}**
Add 20% Khai Phum	**19.37 ± 0.11^{b}**	**16.12±0.15^{a}**	**6.34±0.15^{c}**
Add 30 % Khai Phum	**18.34 ± 0.16^{c}**	**11.51±0.07^{b}**	**5.98±0.09^{d}**
Add 40 % Khai Phum	**18.04 ± 0.13^{c}**	**11.75±0.16^{b}**	**7.46±0.12^{b}**

Remark: The different letters in column represents the difference with significance (P≤0.05).

powder in the highest quantity (40%), a_w is an important factor in controlling the growth of microorganisms. a_w still remains lower than 0.6 which the level that bacteria are able can not to grow (Seman et al., 1980) (Fig 1).

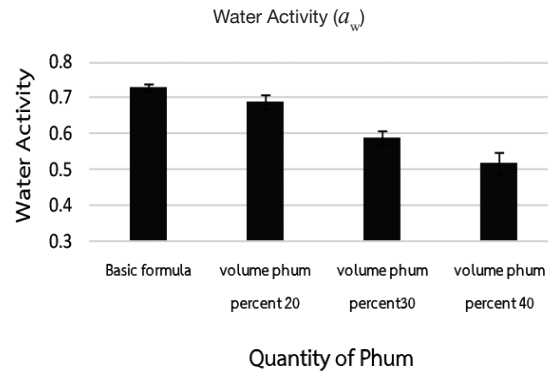

Fig. 1 Water activity (a_w) of stir-fried chilli paste with protein supplement from Khai Phum

According to the analysis of microbiological quality of stir-fried chilli paste with protein supplement from Khai Phum, the microbiological quality is in accordance with in accordance with the community products standard of Chilli-fried Paste No. Community Product Standards. 321/2556.

Table 7 Microbiological Quality of stir-fried chilli paste with protein supplement from Khai Phum 30%

Microbial Test Items	Microbial Test Items
Total Plate Count	**1.1x10^{3} Cfu/g.**
***Salmonella* spp.**	**Not Detected**
Staphylococcus aureus	**<10 est. Cfu/g.**
Bacillus cereus	**<10 Cfu/g.**
Clostridium perfringens	**<10 Cfu/g.**
Escherichia coli	**<3 MPN/g.**
Yeast and Mold	**<10 est. Cfu/g.**

Remark: The results were obtained from Central Laboratory Thailand, 2017

From the development of stir-fried chilli paste product with protein supplement from 20%, 30% and 40% Khai Phum, it was found that the consumers favor

the 30% recipe the most. It might be because the over-adding quantity of Khai Phum in the product may cause the unacceptable smell and taste. According to the study of chemical compositions, the stir-fried chilli paste with protein supplement from Khai Phum contains higher nutrition quality which includes protein 24.47%, beta-carotene 25449 micrograms, and calcium 3549 milligram per 100 gram, an increase compared to the basic recipe. Corresponding to the research of Boonyawittaya et al. (2006) the study on the result of adding Khai Phum in the chocolate muffin, it was discovered that adding Khai Phum 30% will affect the increase of beta carotene in chocolate muffin product in the higher quantity than the control. The cause is because Khai Phum or Phum is a water plant that contains high protein, high beta-carotene, and high calcium (Chareanjit, 2016). Regarding the study of physical quality in color difference expressed in L* a* b* of the product, when adding Khai Phum in the high quantity, the lightness (L*) of the product will decrease and the green color increase. This is because Khai Phum contains chlorophyll which is generally found in plants (Kongban, 2016), resulting in darker color shade compared to the basic recipe. Regarding the study of water activity (a_w) of the product, it was found that to add more Phum affect the decrease of (a_w). However, the increase of Khai Phum over 30% still affects (a_w) lower than 0.6 which the level does not allow bacteria to grow (Pornchalempong & Rattanpanone, 2016). As for the development of stir-fried chilli paste with protein supplement from Khai Phum, it is the increase of nutrition quality, specifically protein, beta-carotene, and calcium. The development leads to the new product and increases more choices for consumers who are healthy-lovers.

References

AOAC. (2000). *Official method of analysis of AOAC International* (17th ed.). Virginia: The Association of Official Analytical Chemists.

Aobthom, T. (2006). *Chili paste & dipping sauce.* Bangkok: Thaiqualitybooks.

Boonyawittaya, W., Tongcom, N., & Rittilert, P. (2016). Effects of added water meal added chocolate chip muffin quality. *VRU Research and Development Journal Science and Technology,* 11 (3), 41-54.

Chareanjit, P. (2016). Khai Phum: Local vegetables much protein. *Journal Folk Technology,* 25 (546), 108-109.

Charoensak, S., & Leanchamroon, V. (2007). *4 regions chili paste of Thailand for firm society 2*. Nontaburi: Department of Thai Traditional and Alternative Medicine Development.

Central Laboratory Thailand. (2017). *Chemical compositions.* Bangkok: Central Laboratory.

Deepanya, V. (2012). *Development of products water meal (Wolffia arrhiza (L.) Wimm.) leather* (Research report). Phitsanulok: Phetchabun Rajabhat University.

Dollawittayakun, A. (2007). *The primary nutrition.* Bangkok: Odeon Store.

Kongban, C. (2016). Chlorophyll is a green substance found in plants. *Journal 108 folk technology,* 25 (546), 108-109.

Kongpan, S. (2015). *108 chili paste*. Bangkok: Company S.S.S.S.

Nicolas, L., Marquilly, C., & Mahony, M.O. (2010). The 9-point hedonic scale: Are words and numbers compatible. *Food Quality and Preference,* 21 (3), 1008-1015.

Nualkaew, S. (2010). *Recipe for chili paste*. Bangkok: Maeban.

Pornchalempong, P. & Rattanpanone, N. (2016). *Water activity.* Retrieved July 20, 2016. Retrieved from http://www.foodnetworksolution.com

Rowchai, S., & Somboon, S. (2007). Study on factors affecting Growth of Khai-nam *(Wolffia arrhiza* (L.) Wimm.). *Journal of Fisheries,* 60 (5), 405-409.

Seman, D.L., Olson, D, G., & Mandigo, R.W. 1980. Effect of reduction and partial replacement of sodium on bologna characteristics and acceptability. *J. Food Sci.,* 45, 1116-1121.

Somboon, S. (2015). Seeding and utilization from Khai Phum *(Wolffia arrhiza)*. *Kasetsart Extension Journal,* 60 (2), 61-74.

Srisaleekulrat, K. (2013). *A learning by using teaching materials.* Retrieved March 1, 2013, from http://www.gotoknow.org.posts/209290/

Wongyai, P., Chawwanchant, S. & Changao, S. (2011). *Development of dietary supplements from Khai Phum.* Retrieved from http: www.thaihealth.or.th/Content