Study of Formulation and Production of Okara Chili Paste

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บทคัดย่อ

โอคาราเป็นคำในภาษาญี่ปุ่นที่แปลว่า กากถั่วเหลือง ซึ่งเป็นผลผลิตที่ได้จากการทำน้ำเต้าหู้และอุตสาหกรรมเต้าหู้ โอคาราประกอบด้วยสารอาหารจำพวกโปรตีน 25 – 27 เปอร์เซ็นต์ และมีเส้นใยอาหารอยู่มากกว่า 50 เปอร์เซ็นต์ส่วนน้ำพริกเผาก็เป็นน้ำพริกที่มีชื่อเสียงโด่งดังไปทั่วโลก ผู้วิจัยได้เลือกที่จะเปลี่ยนมาใช้โอคาราแทนการใช้กุ้งในการผลิตน้ำพริกเผาสำหรับผู้ที่รับประทานมังสวิรัติ เพื่อเพิ่มมูลค่าให้กับผลผลิตที่ มีสารอาหารที่มีประโยชน์และคุณค่าทางโภชนาการ โอคาราที่ได้มาจากโรงงานอุตสาหกรรมเต้าหู้นั้น ได้ผ่านการคั่วก่อนใช้ โอคาราปริมาณ 10 ถึง 30 กรัม จะใช้ในการทำน้ำพริกเผา หากเพิ่มปริมาณโอคาราก็จะเพิ่มความหนืดให้แก่เนื้อของน้ำพริกเผาด้วย ค่าความสว่าง (L) และค่าสีแดง (a) ของน้ำพริกเผาเพิ่มขึ้นเมื่อใส่โอคาราเพิ่มขึ้น ผลลัพธ์ที่ได้จากการทดลองชิม คือ ผู้ทดสอบให้การยอมรับน้ำพริกเผาโอคาราที่มีส่วนผสมของโอคารา 10 กรัม เป็นอย่างดี น้ำพริกเผาที่ใส่โอคารา 20 กรัม ยังคงทดลองพัฒนาต่อไปด้วยการเพิ่มปริมาณน้ำ การทดลองแสดงให้เห็นว่าการเพิ่มน้ำลงในน้ำพริกเผาโอคารา ทำให้เนื้อสัมผัสของน้ำพริกเผาดียิ่งขึ้นหลังจากการเพิ่มน้ำเข้าไป 10 เปอร์เซ็นต์ ความแน่นเนื้อของน้ำพริกเผาโอคารา 20 กรัม ก็ลดลงจาก 398 กรัมต่อแรง เป็น 186 กรัมต่อแรง การประเมินรสชาติของน้ำพริกเผาโอคารา 20 กรัม ระดับความชอบปานกลางได้ 9 คะแนน

จากการทดสอบสารประกอบทางเคมี ผลที่ออกมาแสดงให้เห็นว่า น้ำพริกเผาโอคารามีเส้นใยอาหารและโปรตีนมากกว่าน้ำพริกเผาใส่กุ้ง อย่างมีนัยสำคัญที่ระดับความเชื่อมั่น 95 เปอร์เซ็นต์ คุณค่าทางโภชนาการของน้ำพริกเผาโอคาราประกอบด้วยเส้นใยอาหาร 24.29 เปอร์เซ็นต์ และโปรตีน 11.98 เปอร์เซ็นต์ ของน้ำหนักแห้ง ยิ่งไปกว่านั้นได้นำน้ำพริกเผาโอคาราไปให้ผู้ประกอบการธุรกิจอาหารมังสวิรัติ 10 แห่งในกรุงเทพมหานคร ได้ทดลองใช้เพื่อวัดความพึงพอใจ ผลที่ออกมาปรากฏว่า น้ำพริกเผาโอคาราได้รับการยอมรับเป็นอย่างดี อย่างมีนัยสำคัญที่ระดับความเชื่อมั่น 95 เปอร์เซ็นต์

คำสำคัญ: โอคารา น้ำพริกเผา ถั่วเหลือง

Abstract

Okara or soy milk residue is a by-product of the manufacture of soy milk and tofu. Okara contains about 25-27% protein on a dry basis and more than 50% fiber. *Nam prik pao* is a Thai chili paste that is very popular all over the world. This study substituted okara for shrimp to produce okara nam prik pao chili paste for vegetarians to enhance its nutritional value. The okara was obtained from a tofu factory and roasted prior to use in the formulation of the chili paste. About 10 to 30 grams of the okara was used in the production of the chili paste. By increasing the amount of okara, the textural firmness of the paste increased. The value of lightness (L) and the redness (a) of the paste increased as the amount of the okara increasesd. Sensory assessment indicated that the okara chili paste with 10 grams okara was well-accepted by panelists. Chili paste with 20 grams of okara was further developed

by the addition of more water. Tests showed that the addition of water to the okara chili paste improved the texture of the paste. After the addition of 10% more water, the firmness of the chili paste with 20 gram of okara decreased from 398 (gram·force) to 186 (gram·force). The sensory evaluation of the chili paste with 20 grams of okara was completed by a nine point hedonic scale. It was found that the paste received a score of “like moderately." The chemical composition of the okara chili paste was examined. The results showed that the dietary fiber and protein content of the okara chili paste was significantly greater than that of shrimp chili paste ($p \leq 0.05$). The dietary fiber and protein content of the okara chili paste were 24.29 and 13.62% on a dry basis respectively, and the dietary fiber and protein content of the shrimp chili paste were 20.25 and 11.98% on a dry basis respectively. Moreover, the okara chili paste was given to 10 vegetarian restaurants in Bangkok to determine their satisfaction with the okara chili paste, and it was found to be significantly acceptable based on the restaurants’ assessments ($p \leq 0.05$).

Keywords: Okara; Chili paste (nam prik pao); Soybean

Introduction

Soymilk residue or *okara* is a by-product in the manufacture of soymilk and tofu. Every pound of dry beans made into soymilk or tofu generates about 1.1 pounds of okara, which contains 76-80% moisture [1]. Most okara is sold as animal feed. However, okara contains about 27% protein (dry basis), 10% oil, 42% insoluble fiber and 12% soluble fiber [2]. The okara protein has good nutritional quality and a superior protein efficiency ratio. There is much research about ways to increase the value of okara, for example, substituting if for wheat flour to produce cookies or bread [3]. There is also research about extracting valuable protein from okara [4], [5], [6]. *Nam prik pao* is a chili paste that is very popular among Thai people, can be used as an ingredient in cooking, and can be produced very easily, even at home. The research team was interested in using okara to make nam prik pao for vegetarians. The objective of this research was to find a suitable recipe for okara nam prik pao chili paste, determine its nutritional value, and assess the satisfaction of vegetarian restaurants in Bangkok with its use.

Materials and Methods

Materials

Fresh okara was received from a soymilk factory (Chareonkij Tofu industrial Ltd.). The water was removed from the okara by a hydraulic press to obtain 75-80% (wet basis) moisture content. 500 grams of okara was vacuum-packed and kept at -20^{o}C. All spices and seasoning were purchased from Huatake Market (Bangkok). All chemical reagents were of analytical reagent grade.

Preparation of roasted okara

The okara was thawed at room temperature for one hour before roasting in a pan for 30-45 minutes to produce roasted okara of 6% (wet basis) moisture content. All the roasted okara was vacuum-packed and kept at 4^{o}C prior to use in the following experiments.

Preparation of okara nam prik pao chili paste

Nam prik pao's ingredients were 10 grams of dried shrimp, 30 grams of purple onion, 30 grams of garlic, 20 grams of dried cayenne pepper, 30 grams of oil, 20 grams of soy sauce, 50 grams of coconut sugar, and 10 grams of tamarind water. In the experiment 10-30 grams of okara were used instead of 10 grams of dried shrimp. The seasonings were adjusted to be equal. The okara nam prik pao chili paste was prepared by roasting purple onion, garlic, and dried cayenne pepper in an oven at 100^{o}C for 30 minutes. After that, it was blended at a level 3 speed for 4 minutes. Then, okara was added to the mixture and the mixture was blended for 1 minute more. Lastly, the mixture was fried in a pan for 5 minutes, and all the seasonings were added to obtain the okara chili paste. The paste was packed in a sterilized glass bottle and used in the following experiments.

Physicochemical properties

Determination of color attributes

The color of the okara chili paste was determined at the surface in the $L^*a^*b^*$mode of CIE (angle 10°, illuminant D65) using HunterLab (ColorFlex, Hunter Associates Lab., Va.,U.S.A.). L^* a^* b^* indicated lightness, redness/greenness, and yellowness/blueness respectively.

Texture measurement

Texture profile analysis of the okara chili paste was recorded in a TA-Xtplus Texture Analyser (Stable Micro System, Godalmimh, Surrey, UK) equipped with a conical probe perspex p/60, under the conditions of probe pre-test speed 1.0 mm/s, test speed 5.0 mm/s, post–test speed 5.0 mm/s, deformation 30%, and data acquisition rate 200 pps to compress the center of the sample. The parameters studied were firmness and stickiness [7].

Sensory evaluation

Sensory evaluation of the okara chili paste was carried out by 30 panelists on a nine-point Hedonic rating scale for different parameters such as color, flavor, taste, texture, and overall acceptability.

Satisfactory test

The okara chili paste was given to 10 vegetarian restaurants in Bangkok to assess their satisfaction with the use of the paste in their recipes. A questionnaire was given to determine the satisfactory level (1 = dislike extremely, 9 = like extremely).

Chemical compositions

Carbohydrate, protein, fat, ash, and moisture content were determined on a dry basis by AOAC (2012).The total dietary fiber of the chili paste was determined by the use of the enzymatic-gravimetric method [8].

Statistics

A completely random design was used throughout the study. The experiments were run in triplicate. Data were presented as mean values with standard deviations. One-way analysis of variance (ANOVA) was carried out and means comparisons were run using Duncan's multiple range tests.

Results and Discussion

Table 1 presents the water activity of the okara nam prik pao chili paste with various amounts of okara. The control was the chili paste made from 10 gram of dried shrimp. When the amount of okara increased, the water activity of the paste increased. The okara contained about 50-55% fiber (dry basis) that might

absorb water and lead to increased water activity of the paste [10]. Table 2 shows the color of the okara nam prik pao chili paste with various amounts of okara. The results showed that when there was more okara, the lightness (L*) and redness (a*) increased.he increase in redness occurred because the color of the roasted okara was darker than the dried shrimp. The texture of okara chili paste was studied as shown in Table3. The results showed that the firmness and the stickiness of the okara chili paste increased as the amount of okara increased. The okara contained a high amount of fiber that can easily absorb water, making the paste stickier [9].

Table 1 Water activity of okara chili paste with various amounts of okara

Sample	Aw
control	0.77 ± 0.01^{c}
okara 10 gram	0.81 ± 0.01^{b}
okara 20 gram	0.82 ± 0.01^{ab}
okara 30 gram	0.83 ± 0.01^{a}

$^{a, b, c,}$ means with different superscripts between column are significantly difference at $p<0.05$.

Sensory evaluation of the okara chili paste was carried out by 30 panelists on a nine-point Hedonic rating scale for different parameters such as color, flavor, taste, texture, and overall acceptability (Table 4). The chili paste with 10 grams of okara received the highest overall acceptance. However, to use the most amount of okara in the chili paste, the 20 grams okara chili paste was further modified. Table 4 clearly shows that the texture of 20 gram okara chili paste had a very low score and water was added to improve the texture of the okara. Table 5 shows the texture after the water was added to the chili paste with 20 grams okara. The result was that the firmness of the chili paste decreased when more water was added. The sensory evaluation of the chili paste with 20 grams okara containing various amounts of water added are shown in Table 6. The result was that the satisfaction level was higher when more water was added. The water activity of the okara chili paste containing 20 grams of okara increased from 0.82 to 0.84 when 10 gram of water was added. However, the microbial test showed that the paste could be kept at room temperature not more than 7 days (data not shown).

Furthermore, the okara chili paste containing 20 grams of okara with 10% water added was given to 10 vegetarian restaurants to assess their satisfaction with it. The result was overwhelmingly positive. The scores in color, texture, flavor, and overall acceptance were at the level of 'like very much.' After that, the okara chili paste was evaluated for nutritional value compared with the shrimp chili paste recipe (Table 7). The result showed that the dietary fiber and protein content of the okara chili paste was significantly greater than that of shrimp chili paste ($p\leq0.05$).

Conclusion

This experiment showed that it was possible to increase the value of okara by using it in the production of nam prik pao chili paste for vegetarian foods. The use of okara in the chili paste resulted in a significant increase in the protein and dietary fiber levels in the chili paste.

Table 2 Color of okara chili paste with various amounts of okara

Sample	L*	a*	b*
control	22.91±0.43 [b]	10.51±1.12 [b]	3.80-±0.30[d]
okara 10 gram	23.53±1.48 [ab]	14.47±2.16 [a]	1.91-±0.58[c]
okara 20 gram	24.09±1.70 [ab]	15.45±1.00 [a]	0.69±0.38[b]
okara 30 gram	25.04±0.55 [a]	16.05±0.90 [a]	1.17±0.63[a]

[a, b, c,] means with different superscripts between column are significantly different at $p<0.05$

Table 3 Firmness and stickiness of okara chili paste with various amounts of okara

Sample	Firmness (g·force)	Stickiness (kg·force)
control	97.21±15.46[d]	-0.05±0.00 [a]
okara 10 grams	256.52±30.90[c]	-0.10±0.02 [b]
okara 20 grams	366.93±26.39[b]	-0.26±0.03 [c]
okara 30 grams	525.49±15.12[a]	-0.27±0.02 [c]

[a, b, c,] means with different superscripts between column are significantly different at $p<0.05$.

Table 4 Sensory evaluation of okara chili paste with various amounts of okara

Okara (gram)	Color	Flavor	Taste	Texture	Overall acceptance
10	1.189±6.37 [a]	0.785±6.07 [a]	0.776±5.87 [a]	1.119±6.30 [a]	0.661±6.33 [a]
20	1.46±4.834 [b]	1.547±5.23 [b]	1.037±5.40 [a]	1813±4.43 [b]	1.349±5.20 [b]
30	1.629±3.63 [c]	1.633±4.57 [b]	1.814±4.47 [b]	1.756±3.53 [c]	1.539±4.10 [c]

[a, b, c,] means with different superscripts between column are significantly different at $p<0.05$.

Table 5 Firmness and stickiness of okara chili paste with various amounts of water

Water (%)	Firmness (g·force)	Stickiness (kg·force)
0	398.70±18.73 [a]	-0.11±0.01[d]
5	306.75±24.80 [b]	-0.09±0.00[c]
7.5	235.02±15.31 [c]	-0.06±0.01[b]
10	186.05±19.79 [d]	-0.05±0.01[a]

[a, b, c, d] means with different superscripts between column are significantly different at $p<0.05$.

Table 6 Sensory evaluation of okara chili paste with various amounts of water

Water (%)	Color	Flavor	Taste	Texture	Overall acceptance
0	1.336±6.36 [b]	1.071±6.93 [a]	1.204±6.71 [a]	1.562±5.86 [c]	1.361±6.14 [b]
5	1.222±6.43 [b]	1.027±6.86 [a]	1.447±6.64 [a]	1.437±6.29 [bc]	1.500±6.36 [ab]
7.5	1.158±6.57 [b]	1.762±5.79 [b]	0.997±7.07 [a]	0.730±7.07 [ab]	0.961±7.00 [ab]
10	0.756±7.43 [a]	1.141±7.07 [a]	1.858±6.29 [a]	1.739±7.29 [a]	1.027±7.14 [a]

[a, b, c,] means with different superscripts between column are significantly different at $p<0.05$

Table 7 Chemical composition of okara chili paste compared to shrimp chili paste (% dry basis)

Sample	Ash	Dietary Fiber	Protein	Fat	Carbohydrate
shrimp chili paste	7.71	20.25	11.98	27.38	27.30
okara chili paste	7.81	24.29	13.62	27.19	32.81

References

[1] Liu, K.S. 1997. **Soybean: Chemistry**, Technology and Utilization: New York. Chapman and Hall. 532 pp.

[2] O'Toole, D.K. 1999. "Characteristic and use of okara, the soybean residue from soy milk Production-A Review". **J. Agric. Food Chem**. 47: 363–371.

[3] Puechkamut, Y. and Phewnim, W. A. 2011. "Quality improvement of sandwich bread substitute wheat flour with soy milk residue". **The J. of King Mongkut's University of Technology North Bangkok**. 21: 3 607-616.

[4] Puechkamut, Y. and Thiewtua, P. 2006. "Improvement of the functionalities of soymilk residue protein by papain hydrolysis". **KMITL Sci. J. Bangkok**. Thailand. 6:2b

[5] Puechkamut, Y. 2007. "Utilization of soy milk residue". **J. of King Mongkut's Institute of Technology Ladkrabang.** 15:2 34-41.

[6] Puechkamut, Y. and Panyathitipong, W. 2012. "Characteristics of proteins from fresh and dried residues of soy milk production". **Kasetsart J**. (Nat. Sci.). 46: 5 (804-811).

[7] Navnitkumar K. Dhamsaniya. Naginbhai C. Patel. And Mukesh N. Dabhi. 2011. "Selection of groundnut variety for making a good quality peanut butter". J. **Fd. Sci Technol.** 49(1):

8] A.O.A.C. 2012. "Official Methods of Analysis Associate of Official Analytical Chemists". 19th ed. **The Associate of Official Analytical Chemists**, Inc.

[9] Genta, H. D., Genta, M. L., Alvarez, N. V. and Santana, M. S. 2002. "Production andAcceptance of a Soy Candy". **J. of Food engineering**. 53 : 199-202.

[10] Rinaldi. V. E. A 1998. "Utilization of okara to produce extruded cereal products". **Food Sci. and Tech**. 37(4):98.

[11] Toda K., K. Chiba and T. Ono. 2007. "Effect of components extracted from okara on the physical properties of soymilk and tofu texture". **J. Food Sci.** 72 (2):108–113.