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Utilization of Fish Flour in Canned Concentrated Seasoning Stock for Thai Foods Preparation

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ABSTRACT

Herring fish flour possessed high contents of protein, calcium and phosphorus at 64.70 g/100 g, 2,576 mg/100 g and 1,531 mg/100 g, respectively. Herring fish flour was used to replace fresh or dehydrated fish meat in developing five canned concentrated seasoning stocks for Thai food; Nam Ya Pla (fish curry sauce), Kaeng Som (spicy sour mixed vegetable), Kaeng Tai Pla (southern hot curry), Kaeng Kua Fag (red curry with wax gourd), and Kaeng Tae Po (red curry with swamp morning glory). Sensory test exhibited that a suitable amount of herring fish flour incorporated was 15% or 18% of curry paste, that accounted for 2.6-5.1% in the recipe. It was determined that 100 g canned stocks provided protein, calcium and phosphorus as 4.32 – 6.00 g, 126.5 – 136.4 mg and 83.9 – 108.6 mg, respectively. Calcium content of fish flour incorporated dishes was high, supplying 10-25% of the adult Recommended Daily Dietary Allowance in a 100 g portion.

Key words: fish powder, Thai curry, Thai dishes, processed foods, calcium, canned concentrated seasoning stock

INTRODUCTION

Fish and fish products attracted food technologists in development of varieties of food due to their marvellous potential and health benefits (Kinsella, 1986; Kinsella *et al.*, 1990). Fish is an excellent source of protein and rich in vitamins and minerals (Guthrie, 1983). In Thailand, it was reported that over 40 % of animal proteins consumed were derived from fish, since a wide spreading in rivers, lakes and rice fields (FAO, 1982). Besides its wide distribution, the price is relatively lower than other animal proteins. Surprisingly, in 58 developing countries, more than 20% of animal protein supply came from fish (FAO, 1982). It implied that there must be thousands of recipes prepared from fishes available around the world.

Micronutrients in fish are renowned, however, with different quantities depending on the type of fishes. For example, cod, a white meat fish, contains 60 mg sodium, 9 mg calcium and 0.1 mg iron, where as 123 mg, 60 mg and 1.2 mg, respectively, were found in herring, which determined from 100 g raw edible portion (Holland *et al.*, 1993). A gutted herring contained calcium as high as 231-597 mg per 100 g fresh weight (Tahvonen *et al.*, 2000). Common fishes used in Thai cooking are fresh water fishes, such as snake-head fish, catfish and common silver barb. These fishes contained calcium in a range of 18–32 mg, 0.6–1.0 mg iron and 189–287 mg phosphorus per

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100 g raw edible portion (Institute of Nutrition, 1999). In Thailand, the sources of calcium could come from dark green vegetables, dried shrimp and small fishes. A national survey on dietary intake of mineral in 1995 reported that calcium consumption per day per person for Thai people was 344 mg (Department of Health, 1995), while the recommendation amount is 800 mg (Committee on Recommended Daily Dietary Allowances, 1989). Thus, if there is herring in a convenient form available in a market, it could supply as a good source of calcium in fish-containing Thai dishes. From health information, it is well-known that calcium is related to health due to a property on reducing the risk of developing osteoporosis.

At present, Thai people are concerned more about food safety and health foods. And food producers trend to produce easy-to-cook/ convenience products, serving a modern life style. Hence, the objectives of this study were to evaluate potential of utilizing herring fish flour into ten different Thai dishes and to develop five most accepted dishes into canned concentrated seasoning stocks.

MATERIALS AND METHODS

Herring fish flour was obtained from the Norwegian Herring Oil and Meal Industry Research Institute and kept at –18°C until used. Ten popular dishes of Thai foods were selected; Kaeng Luang (yellow curry), Pad Thai (stir fried rice noodles), Kaeng Pa (spicy curry without coconut milk), Pad Khee Mao (spicy stir fried noodles), Kaeng Tai Pla (southern hot curry), Kaeng Kua Fag (red curry with wax gourd), Nam Ya Pla (fish curry sauce), Kaeng Liang (spicy vegetable soup), Kaeng Som (spicy sour mixed vegetable) and Kaeng Tae Po (red curry with swamp morning glory). The nature of these ten dishes was possible to add a fish ingredient. Dish description and their major ingredients were presented as followed:

Kaeng Luang	Soup-type dish; dried chilli, turmeric root, garlic, shallot, shrimp paste, tamarind juice, palm sugar, fish sauce, raw papaya, fish.
Pad Thai	Stirred-fried dish; rice noodle, fish flour, hard tofu, fresh bean sprouts, Chinese chive.
Kaeng Pa	Soup-type dish; chilli, shallot, garlic, shrimp paste, lemon grass, galanga, coriander root, kaffir lime peel, coriander seed, cumin, pepper, fish, bamboo shoot, long-yard bean, baby corn, brinjal, fingerroot (krachai), holy basil leaves.
Pad Khee Mao	Stirred-fried dish; rice noodle, pepper, garlic, fish flour, onion, tomato, baby corn, cabbage, holy basil leaves.
Kaeng Tai Pla	Soup-type dish; chilli, shallot, garlic, lemon grass, galanga, kaffir lime peel, turmeric, shrimp paste, fish, fermented fish viscera, bamboo shoot, brinjal, plate brush eggplant, long-yard bean.
Kaeng Kua Fag	Soup-type dish with coconut milk; chilli, shallot, garlic, galanga, lemon grass, shrimp paste, coconut milk, dried fish, wax gourd, kaffir lime leaves.
Nam Ya Pla	Sauce with coconut milk; chilli, shallot, fingerroot, garlic, galanga, lemon grass, shrimp paste, coconut milk, fish.
Kaeng Liang	Soup-type dish; shallot, pepper, shrimp paste, fingerroot, angled gourd, straw mushroom, pumpkin, baby corn, ivy gourd leaves, hairy basil leaves, fish.
Kaeng Som	Soup-type dish; dried red chilli, shallot, fingerroot, shrimp paste,

fish, tamarind juice, Chinese radish, long-yard bean, Chinese cabbage.

Kaeng Tae Po — Soup-type dish with coconut milk; dried red chilli, shallot, garlic, galanga, lemon grass, pepper, kaffir lime peel, coriander root, shrimp paste, coconut milk, dried fish, tamarind juice, kaffir lime juice, swamp morning glory, kaffir lime leaves.

Sensory evaluation of fish flour incorporated Thai dishes

Sensory evaluation was carried out using 25 panellists with a 9-hedonic scale method (9 = like extremely, 8 = like very much, 7 = like moderately, 6 = like slightly, 5 = neither like nor dislike, 4 = dislike slightly, 3 = dislike moderately, 2 = dislike very much, 1 = dislike extremely). Two sensory tests were carried out. The interested attributes were colour, consistency, odour, taste, texture and overall acceptance. The first test was examined when ten dishes at any four different percentages of fish flour; 6, 8, 10, 12, 15 or 18% of curry paste were added. The result was used to indicate five most acceptant dishes at the best incorporated amount of fish flour. The second test was run to evaluate taste preference of five selected dishes prepared from canned concentrated seasoning stock and their controls, the traditional dishes. Five dishes which were prepared from canned concentrated seasoning stock were mixed with vegetables and water as shown in Table 1.

Processing concentrated seasoning stocks

Concentrated seasoning stocks of five most satisfied dishes, Nam Ya Pla, Kaeng Som, Kaeng Tai Pla, Kaeng Kua Fag and Kaeng Tae Po, were selected for canning. The pHs of the five dishes were 5.97, 4.37, 5.73, 5.99 and 5.07, respectively. The ingredients of five fish flour incorporated concentrated seasoning stock are shown in Table 2. All concentrated stocks were packed in lacquered tinplate can size No. 2 (307×409) and processed at

Table 1 Preparation of five Thai dishes from canned concentrated seasoning stocks.

Product	Seasoning stock,1 can (g)	Water (g)	Vegetables (g)
Nam Ya Pla	560	100	-
Kaeng Som	580	120	520
Kaeng Tai Pla	570	150	515
Kaeng Kua Fag	565	150	400
Kaeng Tae Po	580	100	275

Table 2 Ingredients of five canned concentrated seasoning stocks (g/100g total weight).

Product	Fish flour	Spices	Condiment	Coconut milk	Chicken stock
Nam Ya Pla	4.5	10.0	4.8	80.7	-
Kaeng Som	4.6	10.0	20.0	-	65.4
Kaeng Tai Pla	5.1	11.6	17.4	-	65.9
Kaeng Kua Fag	4.0	8.2	8.5	79.3	-
Kaeng Tae Po	2.6	7.1	18.7	71.5	-

121°C for 60 min, except Kaeng Som which was processed for 30 min.

Chemical analysis

Herring fish flour, canned concentrated seasoning stock, foods prepared from concentrated seasoning stock and its control recipe of five Thai dishes were analyzed for nutritional compositions.

Proximate compositions; protein, fat, ash and moisture content were determined by methods of AOAC (1984). Total dietary fibre was carried out by enzymatic–gravimetric method (Faulks and Timms, 1985; Prosky *et al.*, 1985).

The level of potassium, sodium, iron, copper, zinc, cadmium, lead, calcium and magnesium were analyzed through Atomic Absorption Spectrophotometric method followed AOAC (2000). The phosphorus content was determined by means of colourimetric method (AOAC, 1998).

Consumer test

Two hundred and eighty test subjects were randomly selected for an acceptance test. Three groups of people: 150 students, 80 teachers and 50 workers, were recruited. Each food prepared from canned fish flour concentrated seasoning stock (Table 1) was evaluated for its attributes of colour, odour, taste and overall acceptability. Verbal scale with 5 categories as follows: like very much, like, neither like nor dislike, dislike, dislike very much, was used for colour, odour and taste. For overall acceptability, only 3 categories scale was used, i.e., accepted, neither accepted nor unaccepted and unaccepted.

Statistical analysis

One way analysis of variance and Duncan's multiple range test were applied to the results of sensory data by using IRRISTAT software package (IRRISTAT version 90-1). Significance of differences of five dishes between control and its herring fish flour incorporated dish was evaluated using student's t-test at levels of 0.01 and 0.05.

RESULTS AND DISCUSSION

Nutrients of herring fish flour

Proximate analysis of herring fish flour is shown in Table 3. Herring fish flour contained 64.70 g protein/100 g which exhibits a good protein source. However, not only the protein content but also the quality of protein is important to health. Essential amino acid score is generally considered the most logical method to assess protein quality. The pattern of essential amino acids in herring fish flour protein compared to the reference protein according to FAO/WHO (1973) revealed that all of essential amino acid contents are greater than 80% of FAO/WHO suggestion (data not shown). It could be implied that incorporating fish flour into food products would help improving nutritional status to combat malnutrition problem. Fat content was 10.52 g/100 g which was higher than fresh water fish such as dried snake-head fish, 7.0 g/100 g (Ministry of Public Health, 1987).

Ash content was substantially high which had a direct correlation with the quantities of the minerals present (Table 4). Among them calcium and phosphorus level were substantially high. Thus, herring fish flour would be useful as a source of many important minerals. Phithakpol (1984) studied on calcium and phosphorus contents of roller dried fish from sardine and threadfin bream. The results showed that both minerals were noticeably lower than those in the herring fish flour (Table 4). The level of harmful heavy metals, cadmium and lead, in tested herring fish flour was low.

Sensory evaluation of ten Thai foods utilizing herring fish flour

Ten different Thai dishes which incorporated with four various percentages of herring fish flour were studied for sensory evaluation on six attributes; colour, consistency,

odour, taste, texture and acceptability (Table 5). Percentages of added herring fish flour in the selected dishes were varied depending on the nature of each dish. It was found that there were many limitations for amount of herring fish flour adding. Foods with small amount of herbs and spices could incorporate less fish flour than foods with high amount of spices, which could be observed in Pad Thai and Pad Khee Mao. Colour of most dishes was darkened when greater amount of herring fish flour was added, lead to lower acceptability, for example, Pad Thai, Pad Khee Mao, Nam Ya Pla and Kaeng Som. From the results, herring fish flour odour was detected in two dishes of stirred fried noodle, Pad Thai and Pad Khee Mao. Fish flour odour in soup-type dishes were not substantially detected as indicated by less score variation. Texture of both stirred fried noodle dishes was influenced by high percentage of fish flour. The effect was mouthcoating of fish flour particles on the tongue. For soup–type dishes, sandy mouth feel was reported when high amount of fish flour was applied. This effect was less pronounced in the

Table 3 Proximate analysis of fish flours, processed foods and foods (per 100 g sample).

Raw material	Moisture (g)	Protein (g)	Fat (g)	Ash (g)	Dietary fibre (g)	CHO* (g)	Energy (Kcal)
Fish flour							
Herring	9.31	64.70	10.52	10.81	4.13	0.53	355.60
Sardine[a]	5.55	75.20	5.26	5.19	0.72**	8.80	-
Threadfin bream[a]	6.59	74.51	7.41	5.15	0.10**	6.34	-
Canned concentrated seasoning stocks							
Nam Ya Pla	77.92	4.97	11.23	2.25	3.34	0.29	122.11
Kaeng Som	84.15	4.59	1.41	3.29	1.78	4.78	40.40
Kaeng Tai Pla	83.70	6.00	1.67	4.20	1.52	2.91	50.67
Kaeng Kua Fag	75.36	5.09	12.46	3.10	2.25	1.74	139.46
Kaeng Tae Po	65.65	4.32	13.85	2.70	2.47	11.01	185.97
Foods prepared from canned concentrated seasoning stocks							
Nam Ya Pla	76.86	5.49	11.04	2.31	3.89	0.41	122.96
Kaeng Som	87.91	3.13	0.79	2.10	1.66	4.41	37.25
Kaeng Tai Pla	86.77	4.05	1.30	2.24	1.44	4.20	44.70
Kaeng Kua Fag	82.92	3.56	6.05	1.78	2.31	3.38	82.21
Kaeng Tae Po	76.20	3.74	7.47	2.42	2.22	7.95	113.99
Traditional foods (control)							
Nam Ya Pla	80.14	3.74	11.23	1.86	2.76	0.27	117.11
Kaeng Som	89.11	2.58	0.54	1.83	1.99	3.95	30.98
Kaeng Tai Pla	87.71	3.68	1.09	2.01	1.39	4.12	41.01
Kaeng Kua Fag	85.34	2.88	5.38	1.62	2.14	2.64	70.50
Kaeng Tae Po	75.92	3.16	7.24	2.29	2.33	9.06	114.04

* carbohydrate, expressed as : 100 – (protein + fat + ash + dietary fibre + moisture)

** crude fibre

[a] source: Phithakpol, 1984

dishes with coconut milk.

Overall acceptability was evaluated. And dishes from top five at the highest incorporated percentage (Table 5) were selected for further canning process of concentrated seasoning stock. The result of selected dishes with fish flour content were Nam Ya Pla, 18% fish flour; Kaeng Tae Po, 15% fish flour; Kaeng Tai Pla, 15% fish flour; Kaeng Kua Fag, 15% fish flour and Kaeng Som, 15% fish flour.

It was found that herring flour applied in this study did not have any critical characteristic on taste, odour or consistency of the dishes. A similar research work was done in 1981 by Phithakpol *et al.*, demonstrated that the incorporated roller-dried sardine and threadfin bream had more effect on taste and odour than on colour and consistency.

Chemical compositions

Canned concentrated seasoning stock

Nutrient compositions of the five canned concentrated seasoning stock at zero month are exhibited in Table 3. Protein content of all products fell in the range of 4.32 – 6.00 g/100 g. Kaeng Tai Pla contained the highest protein content. When

Table 4 Minerals contents in fish flours, processed foods and foods (mg per 100 g sample).

Raw material	Na	Ca	P	Fe	Cu	Pb	K	Mg	Zn	Cd
Fish flour										
Herring	706.9	2,576	1,531	10.66	1.69	0.0064	904.4	140.25	11.36	0.03
Sardine [a]	n/d	970	708	5.66	0.80	0.20	n/d	n/d	4.52	0.05
Threadfin bream [a]	n/d	514	692	1.59	0.40	0.21	n/d	n/d	3.50	0.02
Canned concentrated seasoning stocks										
Nam Ya Pla	506.6	126.5	102.4	1.21	0.11	n/d	n/d	n/d	n/d	n/d
Kaeng Som	861.2	135.1	83.9	0.86	0.08	n/d	n/d	n/d	n/d	n/d
Kaeng Tai Pla	1,000.6	136.4	92.9	1.82	0.10	n/d	n/d	n/d	n/d	n/d
Kaeng Kua Fag	734.6	129.8	108.6	1.04	0.17	n/d	n/d	n/d	n/d	n/d
Kaeng Tae Po	591.8	135.3	87.1	1.00	0.21	n/d	n/d	n/d	n/d	n/d
Foods prepared from canned concentrated seasoning stocks										
Nam Ya Pla	1,055.0	204.8	175.8	1.83	0.20	n/d	n/d	n/d	n/d	n/d
Kaeng Som	971.0	122.3	123.4	1.26	0.10	n/d	n/d	n/d	n/d	n/d
Kaeng Tai Pla	1,144.0	142.5	111.8	1.28	0.23	n/d	n/d	n/d	n/d	n/d
Kaeng Kua Fag	754.0	90.9	109.9	1.10	0.19	n/d	n/d	n/d	n/d	n/d
Kaeng Tae Po	1,112.0	119.3	144.2	2.31	0.34	n/d	n/d	n/d	n/d	n/d
Traditional foods (control)										
Nam Ya Pla	1,008.6	106.6	138.3	1.46	0.14	n/d	n/d	n/d	n/d	n/d
Kaeng Som	822.3	70.2	75.4	1.03	0.13	n/d	n/d	n/d	n/d	n/d
Kaeng Tai Pla	1,037.3	104.0	109.0	1.32	0.11	n/d	n/d	n/d	n/d	n/d
Kaeng Kua Fag	736.9	63.3	83.9	0.89	0.18	n/d	n/d	n/d	n/d	n/d
Kaeng Tae Po	996.6	47.6	68.7	1.44	0.31	n/d	n/d	n/d	n/d	n/d

[a] source: Phithakpol, 1984

n/d = not determined

Table 5 Sensory evaluation of fish flour incorporated in 10 kinds of Thai dishes.

% Fish flour in curry paste	Colour	Consistency	Odour	Taste	Texture	Acceptability
Kaeng Luang						
8%	7.34^{a}	6.86^{a}	7.05^{a}	7.02^{a}	6.86^{a}	6.95^{a}
10%	7.14^{ab}	6.50^{a}	6.79^{ab}	6.64^{a}	6.76^{a}	6.64^{a}
12%	7.24^{ab}	6.86^{a}	6.98^{ab}	6.79^{a}	6.88^{a}	6.81^{a}
15%	6.95^{b}	6.71^{a}	6.68^{b}	6.62^{a}	6.52^{a}	6.57^{a}
Pad Thai						
6%	7.53^{a}	6.78^{a}	7.20^{a}	7.32^{a}	7.22^{a}	7.32^{a}
8%	7.40^{a}	6.70^{a}	7.05^{a}	7.10^{a}	6.85^{a}	7.03^{a}
10%	6.32^{b}	5.88^{b}	6.38^{b}	6.65^{b}	6.07^{b}	6.30^{b}
12%	5.60^{c}	5.55^{b}	6.00^{b}	6.30^{b}	5.65^{b}	5.50^{c}
Kaeng Pa						
8%	7.35^{a}	7.10^{a}	7.28^{a}	7.35^{a}	7.20^{a}	7.34^{a}
10%	7.40^{a}	6.95^{a}	7.03^{a}	7.20^{ab}	6.90^{a}	7.05^{a}
12%	7.38^{a}	7.07^{a}	7.03^{a}	7.35^{a}	7.00^{a}	7.20^{a}
15%	7.25^{a}	6.75^{a}	6.60^{a}	6.93^{b}	6.20^{b}	6.43^{b}
Pad Khee Mao						
6%	7.55^{a}	7.34^{a}	7.26^{a}	7.24^{a}	7.34^{a}	7.24^{a}
8%	7.24^{a}	7.03^{a}	6.97^{a}	7.16^{a}	6.71b	6.76^{a}
10%	6.68^{b}	6.03^{b}	6.42^{b}	6.63^{b}	5.66^{c}	5.74^{b}
12%	6.13^{c}	5.68^{b}	5.95^{b}	6.24^{b}	5.18^{c}	5.32^{b}
Kaeng Tai Pla						
8%	7.58^{ab}	7.53^{a}	7.53^{a}	7.74^{a}	7.63^{ab}	7.61^{a}
10%	7.76^{a}	7.71^{a}	7.66^{a}	7.82^{a}	7.74^{a}	7.76^{a}
12%	7.45^{ab}	7.68^{a}	7.45^{a}	7.63^{a}	7.26^{bc}	7.42^{ab}
15%	7.37^{b}	7.58^{a}	7.37^{a}	7.55^{a}	6.95^{c}	7.11^{b}
Kaeng Kua Fag						
8%	7.35^{bc}	7.53^{a}	7.57^{a}	7.63^{a}	7.55^{a}	7.60^{a}
10%	7.72^{a}	7.53^{a}	7.55^{a}	7.43^{ab}	7.47^{a}	7.55^{a}
12%	7.50^{ab}	7.47^{a}	7.47^{a}	7.53^{ab}	7.45^{a}	7.35^{a}
15%	7.13^{c}	7.32^{a}	7.22^{a}	7.22^{b}	6.85^{b}	6.88^{b}
Nam Ya Pla						
10%	8.02^{a}	8.00^{a}	8.20^{a}	8.24^{a}	8.11^{a}	8.39^{a}
12%	7.70^{b}	7.91^{a}	7.87^{b}	7.98^{b}	7.65^{b}	7.78^{b}
15%	7.41^{b}	7.96^{a}	7.80^{bc}	7.91^{b}	7.35^{b}	7.67^{b}
18%	7.07c	7.89^{a}	7.57^{c}	7.72^{b}	6.98^{c}	7.35^{c}
Kaeng Liang						
8%	7.40^{a}	7.02^{a}	7.43^{a}	7.31^{a}	7.43^{a}	7.25^{a}
10%	7.31^{a}	7.14^{a}	7.14^{ab}	7.24^{a}	7.05b	7.17b
12%	7.45^{a}	7.05^{a}	7.02^{bc}	6.76^{b}	6.36^{c}	6.74^{c}
15%	7.43^{a}	7.05^{a}	6.79^{c}	6.79^{b}	6.38^{c}	6.57^{c}
Kaeng Som						
8%	7.97^{a}	7.22^{a}	7.56^{a}	7.72^{a}	7.61^{a}	7.72^{a}
10%	7.61^{b}	7.06^{ab}	7.25^{b}	7.58^{ab}	7.56^{a}	7.56^{a}
12%	7.03^{c}	6.86^{b}	7.25^{b}	7.33^{bc}	6.92^{b}	6.94^{b}
15%	6.89^{c}	6.83^{b}	6.86^{c}	7.28^{c}	6.47^{b}	6.58^{b}
Kaeng Tae Po						
8%	8.07^{a}	7.52^{a}	7.80^{a}	7.75^{a}	7.91^{a}	8.02^{a}
10%	7.73^{b}	7.45^{a}	7.55^{ab}	7.45^{b}	7.52^{b}	7.50^{b}
12%	7.66^{b}	7.52^{a}	7.52^{ab}	7.50^{ab}	7.50^{b}	7.45^{b}
15%	7.57^{b}	7.48^{a}	7.30^{b}	7.41^{b}	7.07^{c}	7.25^{b}

In a column, means for each attribute followed by a same letter are not significantly different at the 5 % level by DMRT

using coconut milk as an ingredient, fat content in the products was markedly increased. Coconut milk contained dishes, namely Kaeng Tae Po, Kaeng Kua Fag and Nam Ya Pla, exhibited 11.23-13.85 g fat in 100 g. Non coconut milk dishes, Kaeng Som and Kaeng Tai Pla contained fat dramatically lower of 1.41 and 1.67 g/100g, respectively. Thus, the products without coconut milk provided low calories which were 40.40 Kcal for Kaeng Som and 50.67 Kcal for Kaeng Tai Pla.

As shown in Table 4, calcium and phosphorus contents of all products fall in the range of 126.5 – 136.4 mg/100 g and 83.9 – 108.6 mg/100 g, respectively. The ratio of calcium and phosphorus in the products was 1.2-1.6:1. The relationship between calcium and phosphorus in the diet plays an important role in the absorption of both minerals. A dietary ratio of 2 parts calcium to 1 to 2 parts phosphorus was known to promote the highest level of calcium absorption (Guthrie, 1983).

Sodium content appeared to be high as expected in canned concentrated seasoning stock. The sodium level in Kaeng Tai Pla was found to be the highest as 1000.6 mg in 100 g. The reason might come from applying tai–pla (fermented fish viscera), which contained 15,000 mg sodium in 100g (Institute of Nutrition, 1999), as an ingredient in the dish. Iron contents ranged from 0.86-1.82 mg/100 g while copper level fell in the range of 0.08-0.21 mg/100 g.

Fish flour incorporated foods and controls

The contents of protein and ash were greater in foods prepared from canned concentrated seasoning stocks than their controls (Table 3). Fat, dietary fibre and carbohydrate of five dishes incorporating fish flour were comparable to their controls recipes. The determined minerals in this section were sodium, calcium, phosphorus, iron and copper. In general, minerals level was higher in fish flour incorporated foods than their control. And there was a distinction in case of calcium which the contents appeared to be 1.4 - 2.5 times higher in all dishes using fish flour than those in the controls (Table 4). The present calcium contents were 90.9, 119.3, 122.3, 142.5 and 204.8 mg in 100g of Kaeng Kua Fag, Kaeng Tae Po, Kaeng Som, Kaeng Tai Pla and Nam Ya Pla, respectively. The Thai Recommended Daily Dietary Allowances for adult on calcium is 800 mg (Committee on Recommended Daily Dietary Allowances, 1989). Therefore, consuming 100g portion of the above dishes obtained calcium about 10-25% of RDA.

Sensory evaluation and nutrient of five selected herring fish flour incorporated foods and their controls

Dishes prepared from seasoning stock contained herring fish flour were tested along with their controls (Table 6). There was no significant differences found in all aspects on Kaeng Tai Pla at $P>0.01$. While the control dishes of Nam Ya Pla and Kaeng Som received significantly better scores of all attributes ($P<0.01$). The results demonstrated that colour was the renowned deteriorate factors. Attributes on taste of the control did not alter much from the fish flour incorporated seasoning stock in Kaeng Tae Po and Kaeng Kua Fag. Even though many attributes were not as good as the control, the verbal explanation of foods contained herring fish flour was positive expression as better than ‘ like slightly’. The overall acceptability scores of control and fish flour incorporated food were relatively good ranging from 7.43-7.91 and 6.61 – 7.64, respectively.

Consumer test

Foods prepared from five different concentrate seasoning stocks were evaluated by 280 panelists (Figure 1). The ratings of colour for the top 2 boxes (combined percentages of like very much and like) for Kaeng Tae Po, Kaeng Tai Pla, Kaeng Kua Fag, Keang Som and Nam Ya Pla were 75.7, 69.2, 64.6, 60.3 and 58.5%, respectively. The result of the bottom 2 boxes scores corresponded to dislike and dislike very much due

Table 6 Sensory evaluation of five herring fish flour incorporated dishes and their controls.

Food	Mean±S.D.					
	Colour	Consistency	Odour	Taste	Texture	Acceptability
Nam Ya Pla						
Control	7.95±0.58	7.68±0.48	7.93±0.47	7.61±0.72	7.86±0.56	7.91±0.59
18% fish flour	6.23±0.83**	7.23±0.75**	6.64±0.68**	6.70±0.96**	6.86±0.85**	6.61±1.00**
Kaeng Som						
Control	8.02±0.53	7.83±0.49	7.56±0.77	7.41±0.83	7.72±0.54	7.43±0.86
15% fish flour	6.33±0.83**	7.28±0.65**	6.65±1.00**	6.56±1.04**	6.74±0.80**	6.37±1.00**
Kaeng Tai Pla						
Control	7.82±0.52	7.82±0.39	7.64±0.80	7.70±0.61	7.68±±0.65	7.80±0.65
15% fish flour	7.52±0.64*	7.75±0.43	7.54±0.58	7.70±0.70	7.34±0.50*	7.64±0.54
Kagng Kua Fag						
Control	7.98±0.49	7.72±0.45	7.63±0.80	7.76±0.56	7.67±0.56	7.83±0.70
15% fish flour	7.04±0.66**	7.54±0.56*	7.11±0.81**	7.28±0.77*	6.87±1.02**	7.20±060**
Kaeng Tae Po						
Control	7.68±0.73	7.68±0.48	7.48±0.63	7.30±0.84	7.64±0.49	7.54±0.69
15% fish flour	6.82±0.78**	7.41±0.57**	6.91±0.70**	6.98±0.97	7.04±0.72**	6.93±1.04*

** Significantly different at $\propto = 0.01$ by student's t-test

* Significantly different at $\propto = 0.05$ by student's t-test

to off colour (Figure 1). For traditional recipe of Nam Ya Pla, steamed snake-head fish meat which is white in colour was used. Therefore, applying fish flour in Nam Ya Pla was strongly affected the colour. On the contrary, Kaeng Tai Pla had the least effect since it contained fermented fish viscera, which naturally dark in colour.

Odour of fish flour did not affect all five recipes. The panelists responded to the odour of products as like and like very much in a range of 62.3 – 76.8 %. Spices incorporated in curry pastes probably masked the fish flour odour in addition to a fish sensation that supposed to exist in the dishes.

The taste rating for the top 2 boxes was great in Kaeng Tae Po, Nam Ya Pla, Kaeng Kua Fag and Kaeng Som, while, Kaeng Tai Pla was verbally indicated as most dislike among these five dishes. However, the dislike reasons came from chilli hotness or saltiness of product, not from the taste of fish flour.

Considering the overall acceptability, Kaeng Tae Po, Nam Ya Pla, Kaeng Som and Kaeng Kua Fag obtained high percentage of 80.5, 78.3, 74.0 and 68.8, respectively, in the top 2 boxes. The sandy mouth feel was mentioned to cause unacceptability in dishes without coconut milk.

CONCLUSION

It was possible to use herring fish flour for Thai food preparations. Applying amount was varied due to the nature of foods. Some limitations could be concluded as darken colour, fish flour odour, cooking style, liquid available, coconut milk present or sandy mouth feel.

Nutritious wise, herring fish flour possessed good quality protein and high calcium content, in addition to many minerals. The five selected Thai dishes prepared by incorporating fish flour provided 90.9 – 204.8 mg of calcium per 100g, which were 1.4-2.5 times of the traditional dishes and contributed 10-25% of RDA for calcium.

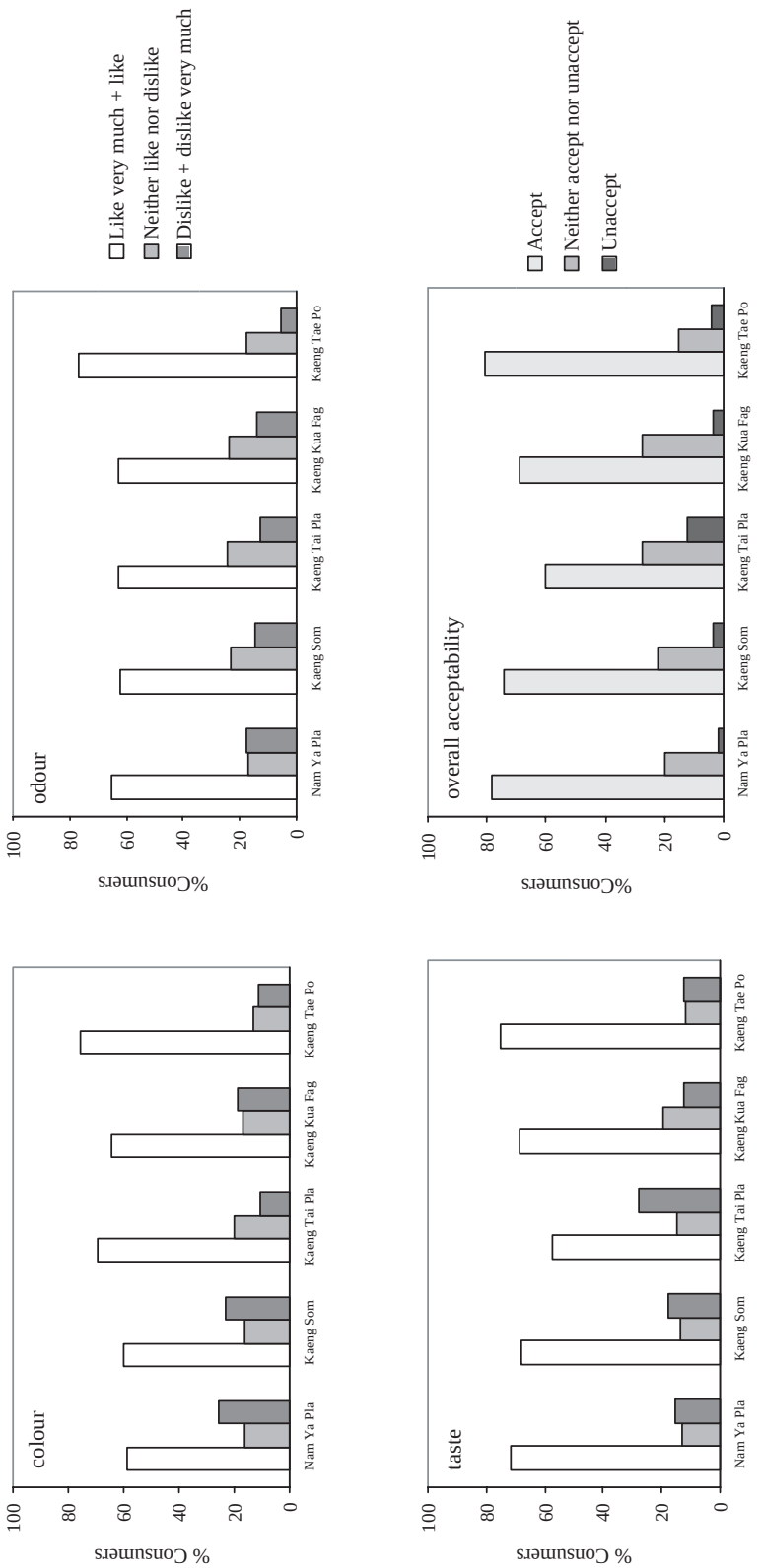

Figure 1 Percentage of consumers on preference and acceptance toward five Thai dishes prepared from canned concentrated seasoning stocks.

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