MAXIMIZING UTILIZATION OF PELAGIC FISH RESOURCES

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The Southeast Asian Fisheries Development Center (SEAFDEC) is a technical organisation devoted to the accelerated development of fisheries in the region. The member countries of SEAFDEC are Japan, Brunei Darussalam, Cambodia, Indonesia, Lao PDR, Malaysia, Myanmar, Philippines, Singapore, Thailand and Vietnam. SEAFDEC has four departments, namely, the Training Department in Thailand, the Aquaculture Department in Philippines, Marine Fisheries Research Department in Singapore, the Marine Fishery Resources Development and Management Department in Malaysia and the Marine Fisheries Research Department in Singapore.

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INTRODUCTION

The Asia Pacific region has dominated many aspects of world fisheries in term of production and value. Indeed, five out of ten of the largest fish producers in the world come from this region (China, Indonesia, India, Thailand and Japan) and two from Southeast Asian region. Marine fisheries resources have been important commodity in this region, both in term of food security, poverty alleviation and important export earning. Many of the species available have been well exploited, such as tuna. Other species like pelagic fish species are also heavily exploited albeit ironically, grossly undervalued.

Pelagic fish makes up to 30 – 55% of the total fish landing in this region. The total amount will inevitably increase overtime with fishing effort, although there is a trend of slowing down over the last few years due to overfishing. A large fraction of this fish (up to 80% in some countries) ends up as non-food use, such as fishmeal and direct feed to both livestock and high-value species aquaculture. Only a small fraction is being used for human food use, such as traditional fish products (fermented, dried) and freshly consumed.

In its technical paper, published in 1991, FAO stated that by the turn of the century, the demand for fish would exceed the currently available supplies, leading to rapidly increasing prices and intensified search for alternative sources. This has been proven right. With the evergrowing human population, combined with overfishing, the price of preferred finfish (e.g. tuna) has doubled/ tripled since 1980s. In short, demand of fish as human food has been more intense. Maximisation utilization of fish would be seen as not only as an option, but also an ultimate importance.

Project Background

In the South China Sea, there are many commercially important pelagic fishes that may be shared by different countries in this region. Recognizing this issue, a series of a regional workshops on shared stocks were organized by Southeast Asian Fisheries Development Center (SEAFDEC) Marine Fishery Resources Development and Management Department (MFRDMD), however the information on pelagic fisheries and biological characteristics are quite limited. As the result, status of these pelagic fish resources, its existence of under-exploited resources and the possibility of further utilization of pelagic fish is not well understood. Similarly, Marine Fisheries Research Development (MFRD) has conducted some preliminary studies on the use of pelagic fish for production of surimi and surimi-based products. However, more work needs to be done in relation to suitability of different pelagic fish for the production of surimi and other processed products.

The information on the pelagic fisheries would contribute to their proper management and appropriate exploitation as well as maximize the utilization of the pelagic fish resources and hence the realization of sustainable pelagic fisheries in the region. Therefore, ASEAN-SEAFDEC Ministers responsible for fisheries had recognize this issue and adopted the "Plan of Action of Sustainable Fisheries for Food Security for the ASEAN Region" at the "ASEAN-SEAFDEC Conference on sustainable Fisheries for Food Security in the New Millennium" to address this issue. In this connection, SEAFDEC proposed a program under the Japanese Trust Fund entitled "Information Collection for

Sustainable Pelagic Fisheries in the South China Sea" carrying objectives as follows:

a. To clarify the actual status of operation and catches of the purse seine fishery in the South China Sea for sustainable fisheries
b. To examine the existence of under-exploited resources in the purse seine fishery in the South China Sea
c. To examines maximizing utilization of catches in the purse seine fishery in the South China Sea, and
d. To clarify the biological characteristics of pelagic fishers caught by the purse seine fishery in the South China Sea

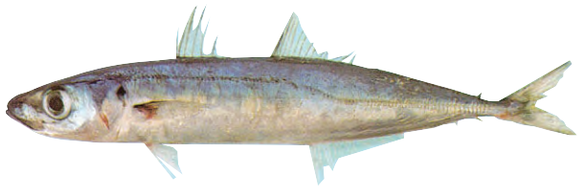
To achieve the general objectives as stated above, the program is divided into three major components; Component I – Meeting/ workshops for effective program implementation, Component II – Survey for actual status of operation and catches of the purse seine fishery and Component II – Examination of maximizing utilization of pelagic fish resources.

Under the program, the MFRD was responsible for implementing Component III on Development of products and processing technology for maximizing utilization. MFRD collaborated with three countries that is, (Malaysia Fishery Institute (MFI)), Philippines (Bureau of Fisheries and Aquaculture Research (BFAR)) and Thailand (Fishery Technological Development Division of the Department of Fisheries (FTDD)) to conduct pilot projects in three countries to develop and process value-added products using small pelagic fish. Shelf life studies of the products developed were also carried out.

Species utilized

At the first Regional Technical Consultation Meeting for the program, it was agreed by the participating countries (Brunei Darussalam, Cambodia, Indonesia, Malaysia, Myanmar, Philippines, Thailand and Vietnam) that five species of small pelagic fishes would be the prime focus that is, two species of mackerels *(Rastrelliger kanagurta, Rastrelliger brachysoma)* and three species of round scads *(Decapterus maruadsi, Decapterus macrosoma, Decapterus russelli)*.

1. Decapterus macrosoma



Common name	Round scad, shortfin scad, selayang
Size	Body length: 15 – 25 cm, but can attain 30 cm
Morphology	Body slender, elongate, somewhat circular in cross section. Pectoral fin very short, ending below mid-first dorsal fin. Anterior part of if lateral line slightly arched, longer than straight part which has 28 – 30 scutes. Colour metallic blue dorsally, silvery ventrally, opercle with a small black spot
Biology	A predominately pelagic schooling species
Distribution	South China Sea, off Tioman Island

2. Decapterus russelli

Common name	Round scad, Indian scad, *selayang*
Size	Body length: 15 – 30 cm, but can attain 45 cm. Depth: 4.5 – 5.5 cm
Morphology	Lateral line curved below soft dorsal with 30-44 scutes. Pectoral fin long, extending to end of first dorsal fin. Colour bluish green above, silvery below, caudal fin bluish, dorsal fins bluish. Opercle with small, black spot
Biology	A predominately pelagic schooling species
Distribution	South China Sea, off Tioman Island, East Coast of West Malaysia

3. Decapterus maruadsi

Common name	Japanase scad
Size	Body length: 20 - 25 cm
Morphology	Lateral line curved below soft dorsal with 30-44 scutes. Body rather high – body depth is about ¼ full length. Dorsal fin and caudal fin yellowish
Biology	A predominately pelagic schooling species
Distribution	Indo-West Pacific, South China Sea

4. Rastrelliger kanagurta

Common name	Indian mackerel, *kembong*
Size	Body length: 17 - 35 cm. Depth: 3.5 cm
Morphology	Head longer than body depth. Mouth large, oblique. Dusky stripes along sides of body. 2nd dorsal and anal fins followed by 5 finlets. Caudal deeply forked
Biology	A predominately pelagic schooling species
Distribution	South China Sea, Indo-West Pacific

5. Rastrelliger brachysoma

Common name	Short-bodied mackerel, *kembong*
Size	Body length: 20cm, but can attain 34.5 cm, Depth: 2.8 – 3.5 cm
Morphology	Head equal to or less than body depth. Mouth large, oblique. 5 finlets each behind 2nd dorsal and anal fins. No dusky stripes along sides of body. Caudal deeply forked
Biology	A predominately pelagic schooling species
Distribution	Andaman Sea to Thailand, Indonesia, Philippines

About the manual

The objective of this publication is to provide detailed description of the processing of the value-added products developed in the pilot project, both new products and improved traditional products, which can be adopted for commercialisation by small-medium enterprises. It also incorporates quality control procedures specific to the process flow of the products developed.

Shelf life studies of the products developed are also featured in this manual. This includes expected shelf life of the products, and the results of the chemical and microbiological tests and sensory evaluation.

Pelagic Fish *Processing*

A. Comminuted products

B. Dried products

C. Fermented products

D. Smoked products

E. Other products

A. Comminuted products

1. Fish burger (Malaysia)
2. Fish sausage (Philippines)
3. Fish kikiam (Philippines)
4. Fish loaf (Philippines)
5. Fish siomai (Philippines)
6. Fish burger (Philippines)
7. Fish cocktail (Philippines)
8. Fish crunchies (Philippines)
9. Fish sausage (MFRD)

Introduction

Minced fish meat is a versatile intermediate raw material for the processing of fish products. First developed by the Japanese, minced fish meat was traditionally prepared from fresh fish, normally white fish. Traditionally washed minced fish meat (surimi) was used to prepare kamaboko, which is a generic term for surimi products or fish jelly products. It was later utilized by the United States and other western countries to make seafood analogs, such as imitation crab and prawn, which are hugely popular for salad.

When salt is added to the surimi during grinding or comminuting, it forms an adhesive paste, which later turns to irreversible gel during cooking. This characteristic makes surimi a very useful intermediate material for making a wide variety of fish jelly products, ranging from the traditional fish ball to modern shellfish analogues.

The washing process removes water-soluble proteins, blood, fat and other nitrogenous compound that affect gel strength of the surimi. Texture and colour of the final product are greatly improved when these impurities are being removed by washing. Pelagic fish generally have a higher blood and fat content than light muscle fish. This higher content of blood reduces the meat's pH, resulting in poor water holding capacity as well as affecting its gel forming ability. Therefore, the production of frozen surimi using pelagic fish requires an additional step of alkaline leaching as compared to surimi made from light muscle fish. Alkaline leaching helps to raise the pH of red meat fish, thus improving the water holding capacity of fish meat.

A number of traditional comminuted fish jelly-type products are made from unwashed minced fish meat instead of surimi. Cost is definitely one of the obvious reasons. The other possible, often-mentioned reason is the original fish flavour that is retained in the products made from unwashed minced fish meat. Whatever the reason is, good quality products can still be made from unwashed fish minced meat, as long as good processing and hygiene practices are applied.

In this section, the processing of nine comminuted pelagic fish products made from both washed and unwashed minced fish meat are described. The processing of washed minced fish meat (surimi) as intermediate raw material, together with the recommended standard operating procedures is also included.

1. FISH BURGER

A. Description

Burger is one of the popular food in Asia, thanks to the ever growing fast food chain. It is used to be made solely from chicken or beef, but nowadays fish burger is not uncommon. Fish burger is made from either fish fillet or white-meat surimi, coated with breadcrumbs and fried. Malaysia Fisheries Institute (MFI) has experimented new delicious and healthy fish burger, which used low value pelagic fish, such as Indian mackerel *(Rastrelliger kanagurta)* and short-bodied mackerel *(Rastrelliger brachysoma).* This grilled plain burger can be served just like any other convenience food. This lower fat and high protein burger is suitable to people are who concerned about weight but in the same time want to have nutritious and delicious food.

Fish burger

B. Processing of Fish Burger

Process flow

1. Raw materials

a. Otoshimi — Thawing

b. Other Ingredients

c. Food additives

d. Water and ice

↓

2. Mixing
(by silent cutter/mixer)

↓

3. Forming
(Burger mould)

↓

4. Steaming
(100°C, 10min – cover with cotton cloth)

↓

5. Cooling
(at room temperature)

↓

6. Freezing
(until the inner temperature reach -18°C or less)

↓

7. Packaging

↓

8. Storage at -18°C

DESCRIPTION OF EACH PROCESSING STEP

1. Raw material

The main raw materials used are Indian mackerel (*Rastrelliger kanagurta*) and short-bodied mackerel (*Rastrelliger brachysoma*) minced meat. The ingredients for fish burger are listed on Table 1.

Table 1. Product formulation of fish burger

Ingredient	Composition (%)	Weight (gram)
Otoshimi	70.00	1400.00
Salt	1.30	26.00
Sugar	1.86	37.20
Fresh onion	4.51	90.20
Fresh garlic	0.45	9.00
Fresh red chilli	0.45	9.00
Milk	4.51	70.20
Margarine	0.42	8.40
Egg white powder	3.26	66.20
Breadcrumb	4.32	86.40
Tapioca starch	6.32	126.40
Pepper	0.45	9.00
Soya protein	0.45	9.00
MSG	0.23	4.60
IG	0.02	0.40
Water	2.45	49.00

GMP:

Frozen otoshimi should be semi-thawed to temperature of 3-5°C. If the thawed otoshimi is not used immediately, store it at chilled temperature of 3-5°C

Reason:

Storing the otoshimi that is not used immediately will reduce the rate of bacterial growth or pathogenic bacteria should there be any contamination

2. Mixing

The otoshimi is ground in the silent cutter or mixer. During mixing, salt is added first to extract the salt myofibril proteins, then followed by dry ingredients and wet/ fresh ingredients. To maintain low temperature, chilled water with ice are gradually added during mixing. The mixture is blended till smooth homogenous paste is obtained.

GMP:

Keep the temperature low (≤10°C) during mixing

Reason:

Keeping low temperature will reduce the rate of bacterial growth and chemical spoilage

3. Forming

The paste can be formed manually or using machine prior to battering and breading process. Manual forming is usually tedious and labour intensive. However, for a small batch processing, e.g. trial processing, it is more cost-effective to do manual forming. Mechanical forming can ensure faster processing time, more uniform products and higher volume production. If properly done, it can also ensure products to be more hygiene.

GMP:

Maintain the temperature low (≤10°C) during forming.

4. Steaming

The formed mix is steamed at 100°C for 10 minute.

GMP:

Ensure the steamer is in setting temperature (100°C) before steaming.

5. Cooling

The shaped mixture is cooled to room temperature for 15 minute.

GMP:

Ensure there is no foreign substance around cooling area

6. Freezing

Freeze the fish burger at -18°C.

7. Packing and storing

The frozen burger is packed, then stored at -18°C cold storage.

ILLUSTRATED FLOW CHART OF PROCESSING OF FISH BURGER

1. Minced meat and other ingredients (see Table 1)

2. Mix otoshimi and other ingredients in a silent cutter

3. Form manually mix into burger shape using burger mould

4. Steam shaped burger mix at 100ºC for 10 minutes

5. Freeze the cooked burger at –18ºC after cooling to room temperature

6. Pack and seal frozen mix. Store at -18ºC cold storage

Serving the burger

To serve: grill the frozen burger

Ready to eat fish burger

C. Shelf Life Study of Fish Burger

The burger was subjected to shelf life study during the 8-month frozen storage. The tests included were total aerobic count, coliform count, *Eschericia coli* count and *Staphylococcus aureus* count, measured on the pre-cooked burger. The microbial counts were then compared against standard set by International Commission on Microbiological Specification in Food (ICMFS), 1986 (see Table 2) for similar products. Sensory evaluation of the product was conducted at the end of the eight-month storage.

At the end of eight month, the microbial count of the uncooked product was still relatively low, 11.6 x 10^3 cfu, much below the regular limit for ready-to-eat product of 10^5 cfu. No *E. coli* was detected on the burger, and the amount of total coliform and *Staph. aureus* count was still less than ICMFS limit for marginally acceptable quality precooked fish products (see Table 3).

Table 2. Recommended microbiological standards for precooked fish products (International Commission on Microbiological Specification in Food (ICMSF), 1986)

		Limit/ g or cm²	
Products	**Test**	**Max recommended bacterial count for good quality products**	**Max recommended bacterial count for marginally acceptable quality products**
Precooked breaded fish	Total aerobic plate count	5 x 10^5	10^7
	E. coli	11	500
	Staph. aureus	10^3	10^4

Table 3. Microbiological content of fish burger during cold storage

Month	*Total Aerobic Count (cfu/g)*	*Total Coliform Count (cfu/g)*	*E. coli Count (cfu/g)*	*S. aureus Count (cfu/g)*
0	<30 x 10^1	<30 x 10^1	<30 x 10^1	<30 x 10^1
1	<30 x 10^1	<30 x 10^1	<30 x 10^1	<30 x 10^1
2	<30 x 10^1	<30 x 10^1	<30 x 10^1	<30 x 10^1
3	6.9 x 10^3	<30 x 10^1	<30 x 10^1	2.1 x 10^3
4	<30 x 10^1	<30 x 10^1	ND	<30 x 10^1
5	7.2 x 10^3	<30 x 10^1	1.1 x 10^4	10.3 x 10^3
6	11.6 x 10^3	<30 x 10^1	ND	0
7	7.2 x 10^3	<30 x 10^1	ND	4.7 x 10^2
8	11.6 x 10^3	<30 x 10^1	ND	<30 x 10^1

2. FISH SAUSAGE

A. Description

Sausage is a popular finger food, can be eaten with bun or as snack item. In this project, fish sausage is made from minced roundscad, mixed with salt, seasoning and spices. It scores relatively well compared with the conventional meat sausage, in terms of both taste and nutritive value. Artificial colouring is added to improve the appearance of the fish sausage.

Fish sausage

B. Processing of Fish Sausage

Process flow

1a. Minced meat + **1b. Other ingredients**

↓

2. Mixing
in silent cutter

↓

3. Filling/stuffing
into sausage casing

↓

4. Clipping

↓

5. Cooking
90°C for 45 min.

↓

6. Cooling
under running water

↓

7. Packing
in styrofoam boxes covered with cling film

↓

8. Storage
at frozen and chilled condition

DESCRIPTION OF EACH PROCESSING STEP

1. Raw material

The main raw materials used is roundscad *(Decapterus maruadsi)* minced meat. The other ingredients are listed on Table 4.

Table 4. Product formulation of fish sausage

Ingredients	Composition (%)	Weight (gram)
Surimi	66.08	250.0
Isolate	0.79	3.0
TVP	1.32	5.0
Agar	0.26	1.0
Salt	1.72	6.5
Curing salt	0.13	0.5
Oil	4.10	15.5
Phosphate	0.33	1.25
Pineapple juice	7.66	29.0
Water	12.69	48.0
Brown sugar	1.85	7.0
Black pepper	0.40	1.5
Garlic powder	1.32	5.0
Anisado wine	1.06	4.0
MSG	0.13	0.5
Food colour	0.16	0.6

GMP:

- *Always use fresh fish as raw material.*
- *The raw materials should be fresh, well washed or iced at all times*

2. Mixing

Minced meat is mixed with weighed ingredients in silent cutter. In the mixing process, salt is added first to create the sticky sol fish paste followed by other ingredients and mixed until a homogenous mixture is obtained

GMP:

Keep the temperature low (3^{o} – 5^{o}C) during mixing

3. Filling/ stuffing and clipping

Stuff the paste into sausage casing using a stuffer. Both ends of the casing are clipped with cotton thread.

GMP:

Ensure that the temperature of the paste be always kept at 5^{o}C during filling process

4. Cooking

The stuffed fish sausages are cooked in hot water at 90^{o}C for 45 minutes.

GMP:

Ensure the product is cooked at the specified time and temperature.

Reason:

Ensuring the product is cooked properly at specified time and temperature will ensure the texture and flavour are well developed, in the same time destroy pathogens that may contaminate the product. Care must be taken not overcooked the product to avoid mushy texture

5. Cooling

Cool the finished products (sausage) by placing it under running water

6. Packaging and storage

The cooked fish sausage is packed in polyethylene (PE) bags and stored chilled (3 – 5^{o}C) or frozen (- 18^{o}C).

GMP:

Ensure that the packaging materials are food grade and the temperature of chiller and freezer are well maintained

ILLUSTRATED FLOW CHART OF PROCESSING OF FISH SAUSAGE

1. Ingredients

2. Mixing minced fish and other ingredients in silent cutter in a silent cutter

3. Filling paste into sausage casing

4. Clipping ('close') both end of the product using a clipping machine

5. Cooking of sausage at 90°C for 45 minutes

6. Cooling under running water

7. Pack in styrofoam box covered with cling film

8. Store the products either frozen or chilled

C. Shelf Life Study of Fish Sausage

Fish sausage was stored in two conditions, frozen (-18°C) and chilled (5 – 10°C). During its storage, once every week, the sample was subjected to series of microbiological tests and sensory test to see its acceptability.

By the end of the 2nd week for chilled sausage and 8th week for frozen sausage, the microbiological content of the products (see Table 5) were still far below the maximum limit recommended by ICMFS.

The peroxide value of the product ranged from 2.5 meq/kg in week 0 to 45.99 meq/ kg in week 8 (2 months). Low (1992) stated that rancid taste in the oil begins to be noticeable when the peroxide value is between 20 – 40 meq/ kg. However, in this product, the increase in peroxide value over the period of storage was not detected by the sensory panellists probably due to the product's relatively low oil content.

Both products stored at chilled and frozen temperature had a very negligible content of histamine.

No changes were observed in the sensory attributes in term of appearance, colour and odour. However, the sensory rating of the product falls to 'like slightly' on the 7th to 8th week of storage due to dry texture. The shelf life study was therefore terminated at 2nd week and 8th week for chilled and frozen sausage respectively (see Fig 1).

Table 5. Microbiological and chemical content of fish sausage during chilled and frozen storage

Week	Storage temperature					
	Chilled (5 – 10°C)			Frozen (-18°C)		
	Total Aerobic Count (cfu/g)	*Staphylococcus aureus (cfu/g)*	*Histamine (ppb)*	*Total Aerobic Count (cfu/g)*	*Staphylococcus aureus (cfu/g)*	*Histamine (ppb)*
0	1.0×10^1	ND	29.0	1.0×10^1	1.0×10^1	29
1	1.1×10^5	1.0×10^1	30.6			
2	4.4×10^2	1.5×10^1	32.3	1.6×10^4	2.0×10^1	30.6
4	-	-	-	5.0×10^2	4.0×10^1	30.6
6	-	-	-	1.0×10^2	ND	31.9
8	-	-	-	2.0×10^2	20×10^1	32

Table 6. Sensory attributes of fish sausage

Sensory attributes	Quality Standards
Colour	Pink
Flavour	Mild spicy
Odour	No objectionable odour
Texture	Chewy, with fairly good gel strength

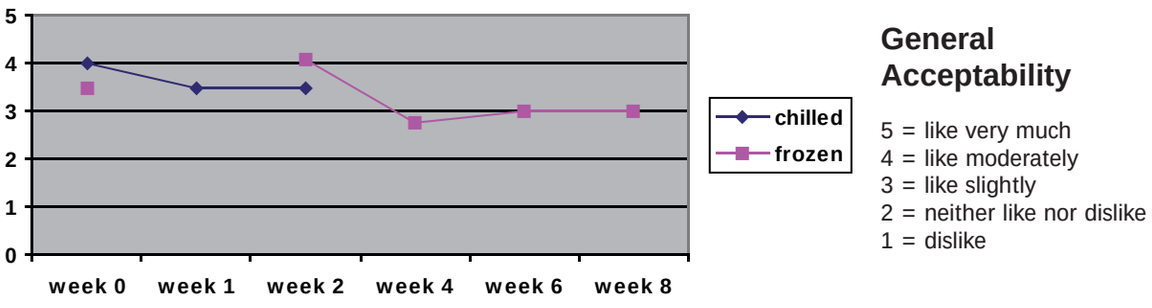


Fig 1. Sensory evaluation of fish sausage during frozen and chilled storage

3. Fish Kikiam

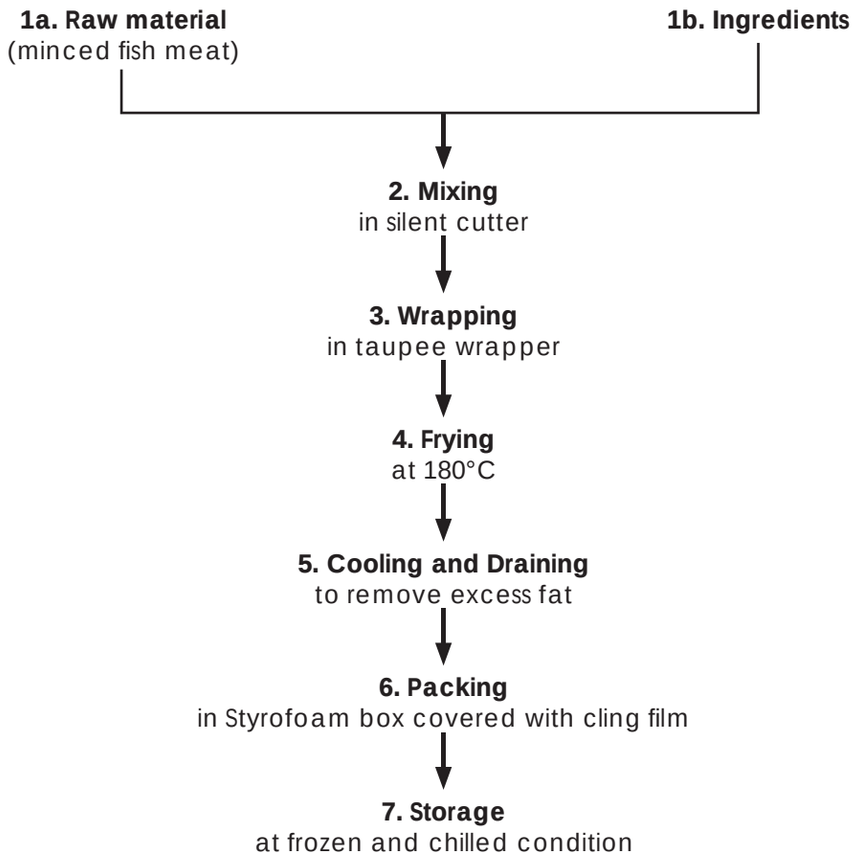
A. Description

Fish kikiam is a traditional Philippines finger food, made from minced fish meat mixed with shrimp meat and vegetables, wrapped in soybean sheet *(taupee)*. Traditionally in Philippines, it is normally deep fried upon serving, and served with sweet and sour sauce.

Fish Kikiam

B. Processing of Fish Kikiam

Process flow



DESCRIPTION OF EACH PROCESSING STEP

1. Raw material

The main raw material used is roundscad *(Decapterus maruadsi)* minced meat. The other ingredients are listed on Table 7.

Table 7. Product formulation of fish kikiam

Ingredients	Weight (gram)	Composition (%)
Fishmeat	250.0	4.14
Shrimp meat	75.0	12.41
TVP	10.0	1.65
Egg	60.0	9.92
Onion	36.5	6.04
Celery	34.5	5.71
Carrots	31.0	5.13
Turnips	37.5	6.20
Cornstarch	25.0	4.14
Flour	25.0	4.14
Nguyong powder	3.0	0.50
White pepper	2.5	0.41
Coarse salt	12.0	1.98
MSG	2.5	0.41
Taupee wrapper		

GMP:

Frozen minced meat should be semi-thawed to temperature of 3-5°C. If the thawed minced meat is not used immediately, store it at chilled temperature of 3-5°C

2. Mixing

Minced meat is mixed with weighed ingredients in silent cutter. Salt is added first to create the sticky sol fish paste, followed by other ingredients. Mixed until a homogenous mixture is obtained.

GMP:

Keep the temperature to <10°C during mixing

3. Wrapping

Wrap the fish mixture (approximately 1/8 cup) in taupee wrapper.

GMP:

Wrapping the mixture should be carried out as quickly as possible

Reason:

This is to avoid the prevent pathogen growth and possible contamination of the product

4. Frying

Deep fry the kikiam until golden yellow

GMP:

- *Ensure oil reaches 180°C before frying*
- *Use fresh oil*

Reason:

Using fresh oil instead of used oil will prevent the product to be easily rancid during storage

5. Cooling

Cool the fried kikiam at room temperature and allow the excess oil to drip.

6. Packing

Pack in styrofoam tray, covered with cling film.

GMP:

Ensure that the packaging materials are clean and free from adulteration

7. Storage

Store chilled (3 – 5°C) or frozen (-18°C)

ILLUSTRATED FLOW CHART OF PROCESSING OF FISH KIKIAM

1. Ingredients

2. Mix minced fish and other ingredients in silent cutter

3. Wrapping in *taupee* wrapper

4. Frying

5. Cooling

6. Pack in styrofoam box covered with cling film

7. Store the products either frozen or chilled

C. Shelf Life Study of Fish Kikiam

Fish kikiam was stored in two conditions, frozen (-18°C) and chilled (3-5°C). During its storage, once every week, the sample was subjected to series of microbiological tests and sensory test to see its acceptability.

Stored at chilled temperature, the total bacterial count of the fish kikiam on week 0 was 4.5 x 10^2 cfu/g and 1.2 x 10^4 cfu/g on week 2 (Table 8), still below the maximum limit of 10^5 cfu/g. The shelf life study, however, was stopped at 2nd week, based on sensory evaluations conducted and presence of moulds. Frozen kikiam lasted for 10 weeks based on sensory evaluation result. Although in week 10, the total bacterial count was still 1.2 x 10^2 cfu/g, the sensory evaluation result showed that the preference rating has decreased substantially since week 0 (Fig 2).

Table 8. Results of shelf-life study of fish kikiam

Week	Storage Temperature			
	Chilled (3 – 5°C)		Frozen (-18°C)	
	Total Aerobic count (cfu/g)	*Staphylococcus aureus (cfu/g)*	*Total Aerobic count (cfu/g)*	*Staphylococcus aureus (cfu/g)*
Week 0	4.5 x 10^2	ND	4.5 x 10^2	ND
Week 1	3.7 x 10^3	7.0 x 10^1		
Week 2	1.2 x 10^4	1.6 x 10^3	2.5 x 10^2	0
Week 3			1.0 x 10^2	5.0
Week 4			1.0 x 10^2	1.5 x 10^1
Week 5			2.0 x 10^2	ND
Week 6			2.0 x 10^2	ND
Week 7			3.0 x 10^2	ND
Week 8			1.0 x 10^3	4.0 x 10^1
Week 9			3.7 x 10^3	1.3 x 10^3
Week 10			1.2 x 10^2	1.0 x 10^1

Table 9. Sensory attributes of fish kikiam

Sensory attributes	Quality Standards
Colour	Light brown to medium brown when fried
Flavour	Savory with acceptable fish taste
Odour	No objectionable odour
Texture	Chewable with some gel strength

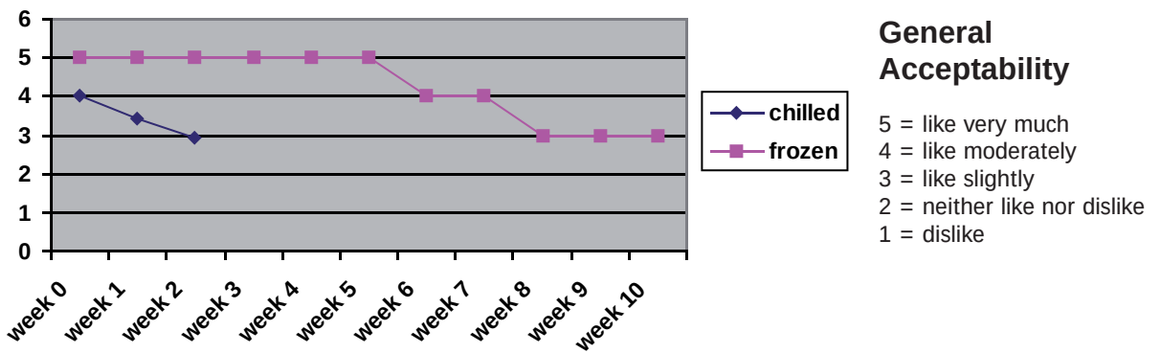


Fig 2. Sensory evaluation of fish kikiam during frozen and chilled storage

4. Fish Loaf

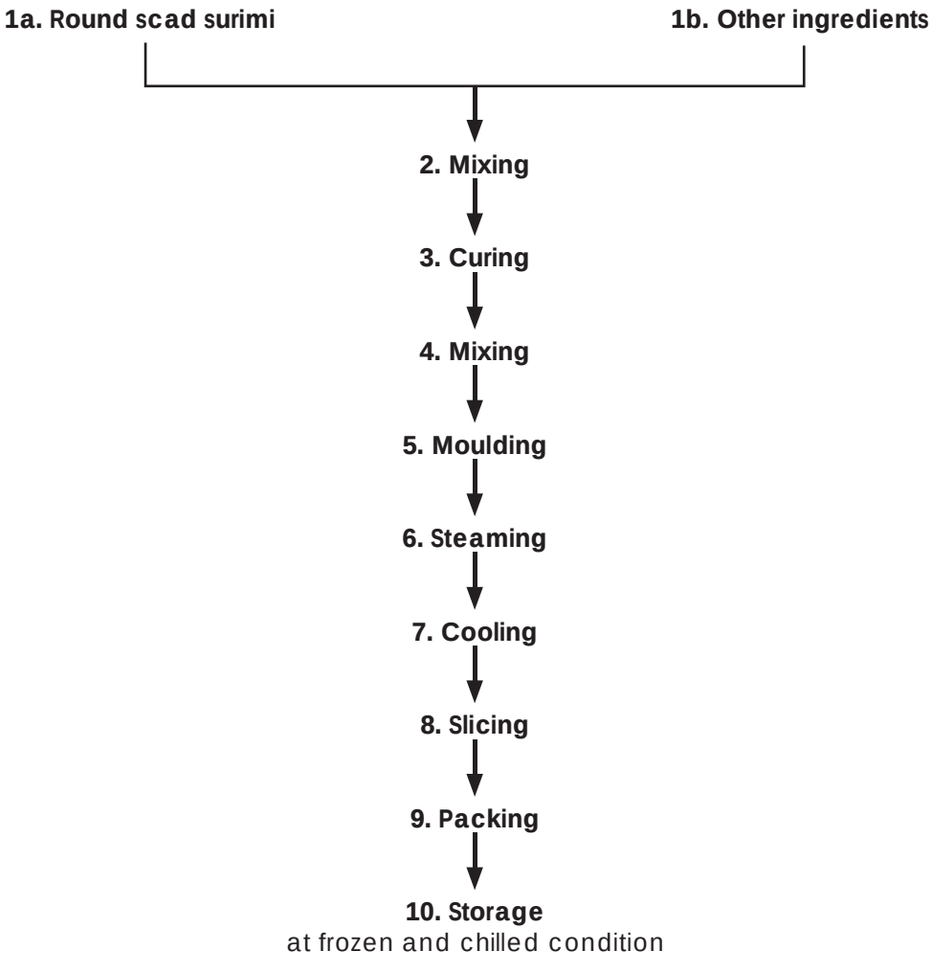
A. Description

Fish loaf is a healthier version from the usual meat loaf. Originally meat loaf is made from beef or pork. In this project, the loaf is prepared from round scad surimi with added seasoning and spices. This fish loaf can be served with buns or bread, or consumed as snack.

Fish loaf

B. Processing of Fish Loaf

Process flow



DESCRIPTION OF EACH PROCESSING STEP

1. Raw material

The main raw material used is round scad *(Decapterus maruadsi)* surimi. The other ingredients are listed on Table 10.

Table 10. Formulation of fish loaf

Ingredients	Weight (gram)	Composition (%)
Surimi	350.0	48.46
Egg	60.0	8.31
Ground shrimp	60.0	8.31
Water	90.0	12.46
Quick-cooking rolled oats	125.0	17.31
Finely chopped onion	31.25	4.33
Salt	2.5	0.35
Pepper	1.5	0.21
Dried leaf marjoram	0.75	0.10
Dried leaf basil	0.37	0.05
Dried leaf rosemary	0.35	0.04
Curing salt	0.5	0.07

GMP:

Always use fresh fish in the preparation of surimi.

Reason:

Surimi prepared from fresh fish has better gel strength and colour than that prepared from not fresh fish

2. Mixing

Surimi is mixed with weighed ingredients in silent cutter. Salt is added first to create the sticky sol fish paste, followed by other ingredients. Mix until a homogenous paste is obtained.

GMP

Keep the temperature during mixing at <10°C

Reason:

Keeping low temperature will prevent bacterial growth as well as reducing the rate of protein denaturation that can affect gel strength of the final products.

3. Curing

Cure the mixture at chilling temperature overnight.

GMP:

Ensure that the temperature of the chiller is 3 – 5°C

Reason:

Storing surimi at the temperature of 3 - 5°C reduce the rate of bacterial, including pathogens growth

4. Mixing

Grind the cured mixture in silent cutter for 5 minutes.

GMP

Ensure all utensils are clean

Reason:

All utensils should be clean to prevent the possibility of cross contamination.

5. Moulding

Mould the mixture in stainless loaf pan. Pack well to avoid air holes.

6. Steaming

Cover the pan with aluminium foil and steam for 45 minutes.

GMP

Ensure that the product is cooked thoroughly. The temperature of the inner loaf should be minimum of 80°C

7. Cooling

Cover the pan with aluminium foil and steam for 45 minutes.

8. Slicing

Remove from pan and slice into desired thickness.

GMP

Ensure all utensils used to slice the loaf (knives, cutting board) are clean

9. Packing

Pack in styrofoam trays and cover with cling film.

10. Storing

Store the product chilled (3 – 5°C) or frozen (-18°C).

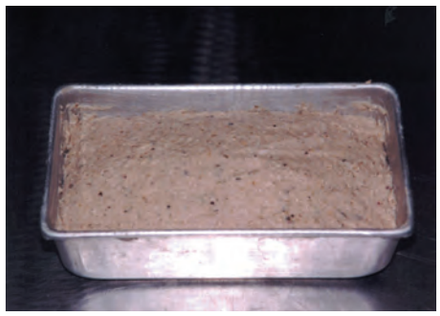
ILLUSTRATED FLOW CHART OF PROCESSING OF FISH LOAF

1. Ingredients

2. Mixing in silent cutter

3. Moulding

4. Steaming



5. Cooling

6. Slicing

7. Pack in styrofoam box covered with cling film

8. Store the products either frozen or chilled

C. Shelf Life Study of Fish Loaf

Fish loaf was stored in two conditions, frozen (-18°C) and chilled (3 - 5°C). During its storage, once every week, the sample was subjected to series of microbiological tests and sensory test to see its acceptability.

At chilled temperature, the fish loaf could be stored for three weeks and at frozen temperature, it could be stored for 6 weeks. At the end of the 3rd week, the total aerobic bacterial content of the chilled loaf was relatively still quite low (1.5 x 10^2 cfu/g), however there was presence of mould noticed as well as the distinctively reduced sensory rating by the panellist. Similarly for frozen fish loaf, at the end of week 6, the bacterial content was still quite low (Table 11); in addition there was no growth of mould noticed. The sensory rating apparently improved with the storage period. The shelf life study, however, was terminated due to the apparent dry texture (Fig 3).

Table 11. Results of shelf-life study of fish loaf

Week	Storage Temperature			
	Chilled (5°C-10°C)		Frozen (-18°C)	
	Total Aerobic Count (cfu/g)	*Staphylococcus aureus (cfu/g)*	*Total Aerobic Count (cfu/g)*	*Staphylococcus aureus (cfu/g)*
Week 0	ND	ND	ND	ND
Week 1	1.5 x 10^2	1.0 x 10^1	5.0 x 10^1	1.0 x 10^1
Week 2	1.0 x 10^2	5	5.0 x 10^1	5
Week 3	1.5 x 10^2	ND	1.5 x 10^2	1.0 x 10^2
Week 4	-	-	1.5 x 10^2	ND
Week 5	-	-	3.0 x 10^2	1.0 x 10^1
Week 6	-	-	1.4 x 10^2	1.0 x 10^1

Table 12. Sensory attributes of fish loaf

Sensory attributes	Quality Standards
Colour	Cream
Flavour	Just right spiced flavour
Odour	No objectionable odour
Texture	Fairly good gel strength and chewy

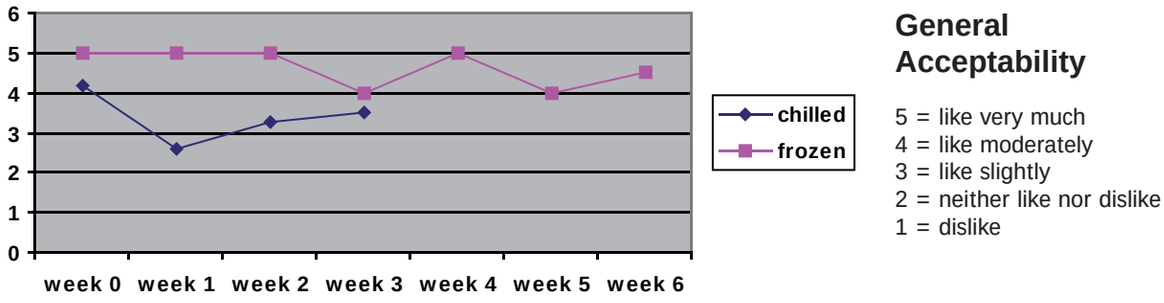


Fig 3. Sensory evaluation of fish loaf during frozen and chilled storage

5. Fish Siomai

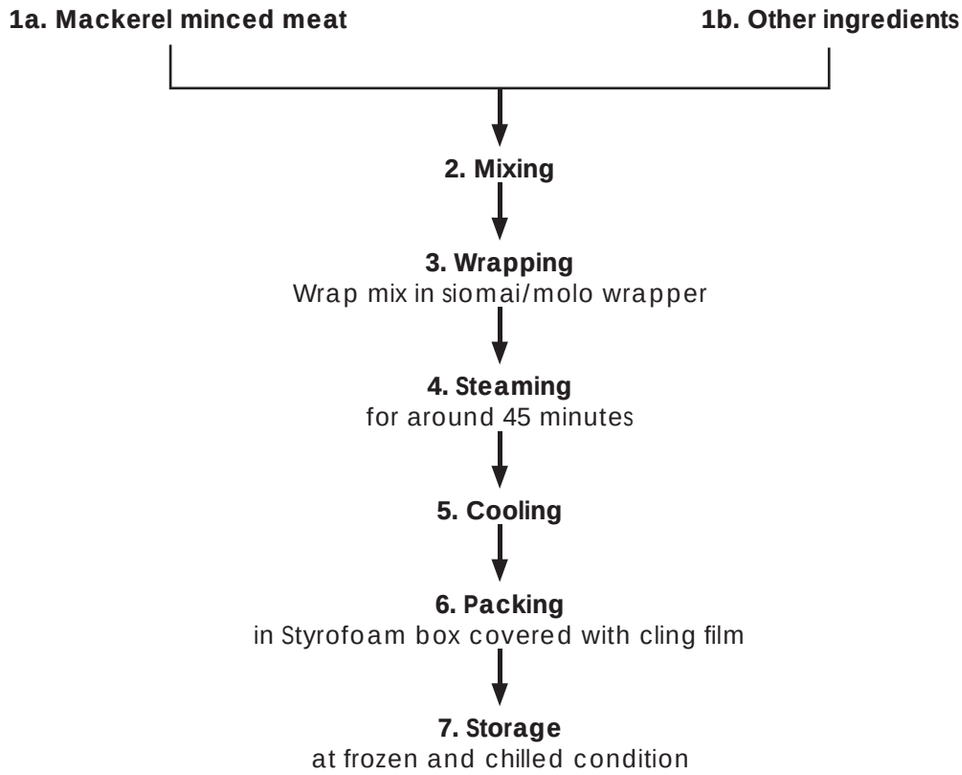
A. Description

Siomai or Chinese dumpling, is a widely consumed snack. Originally siomai's filling is made from minced lean pork, vegetables (such as water chestnut) and spices. In this project, fish minced meat *(Rastrelliger spp.)* is used to replace pork as main ingredient. Fish siomai can be steamed or fried and eaten with sauce. Either way, they were tasty and highly acceptable.

Fish siomai

B. Processing of Fish Siomai

Process flow



DESCRIPTION OF EACH PROCESSING STEP

1. Raw material

The main raw material used is frozen minced fish meat from Indian mackerel (*Rastrelliger kanagurta*). The other ingredients are listed on Table 13.

Table 13. Formulation of fish siomai

Ingredients	Weight (gram)	Composition (%)
Minced fishmeat	250.0	48.89
Sugar	10.6	2.07
Coarse salt	11.2	2.19
Sesame oil	1.5	0.30
Shrimp meat	62.5	12.22
MSG	0.5	0.10
Pepper	0.5	0.10
Carrot	30.0	5.87
Egg	60.0	11.73
Tapioca/cornstarch	6.5	1.27
Water	60.0	11.73
Garlic, chopped	15.0	2.93
Spring onion	3.0	0.60
Siomai wrapper		

GMP:

Frozen minced fishmeat should be semi-thawed to temperature of 3-5°C. If the thawed minced meat is not used immediately, store it at chilled temperature of 3-5°C

2. Mixing

Minced meat is mixed with weighed ingredients in silent cutter. Salt is added first to create the sticky sol fish paste, followed by other ingredients. Mixed until a homogenous mixture is obtained. Chilled water is used in mixing to maintain its low temperature.

GMP:

Ensure the temperature is kept low at <10°C during mixing

3. Wrapping

Wrap paste in siomai wrapper or rolled dough.

GMP:

Keep the temperature of the paste low during wrapping process

4. Steaming

The fish siomai are cooked at 100°C for 45 minutes.

GMP:

Ensure that the product is steamed at specified time and temperature

5. Cooling

Cool the steamed siomai is to room temperature.

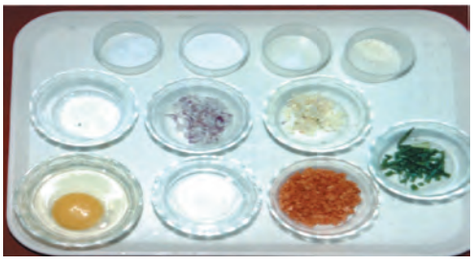
GMP:

Ensure that the product is cool enough prior to packing

6. Packing and storage

The cooled products are packed in styrofoam trays covered with cling film and stored at chilling (3 – 5°C) or freezing temperature (-18°C).

ILLUSTRATED FLOW CHART OF PROCESSING OF FISH SIOMAI



1. Ingredients

2. Mixing in silent cutter

3. Wrapping in siomai wrapper

4. Steaming

5. Cooling

6. Packing in styrofoam box covered with cling film then store either frozen or chilled

C. Shelf Life Study of Fish Siomai

Fish siomai was stored in two conditions, frozen (-18°C) and chilled (3-5°C). During its storage, once every week, the sample was subjected to series of microbiological tests and sensory test to see its acceptability.

Initially, all fish siomais have no detected bacteria and pathogens (see Table 14). As the storage progress, the chilled siomai showed a sign of spoilage, both due to the high bacterial content (>10^5 cfu/g) and noticeable mould growth. Frozen siomai could be stored much longer, up to 8 weeks. By the end of its shelf lilfe study, the microbiological count was still low, of 4.0 x 10^2 cfu/g and not detected *Staphylococcus aureus.* The shelf life study at this stage was stopped due to the response from of the sensory evaluation conducted.

Table 14. Results of shelf-life study of fish siomai

Week	Storage Temperature			
	Chilled (5-10°C)		Frozen (-18°C)	
	Total Aerobic Count (cfu/g)	*Staphylococcus aureus (cfu/g)*	*Total Aerobic Count (cfu/g)*	*Staphylococcus aureus (cfu/g)*
Week 0	ND	ND	ND	ND
Week 1	1.0 x 10^2	ND	1.5 x 10^2	ND
Week 2	1.9 x 10^5	1.5 x 10^2	1.0 x 10^2	ND
Week 3	-	-	5.0 x 10^1	ND
Week 4	-	-	4.0 x10^2	ND
Week 5	-	-	4.5 x 10^2	5.0 x 10^1
Week 6	-	-	ND	ND
Week 7	-	-	3.5 x 10^2	ND
Week 8	-	-	4.0 x 10^2	ND

Table 15. Sensory attributes of fish siomai

Sensory attributes	Quality Standards
Colour	Creamy color with tiny particles of vegetable
Flavour	Slightly fish taste with sweet taste
Odour	Mild fishy odour
Texture	Slight gel strength

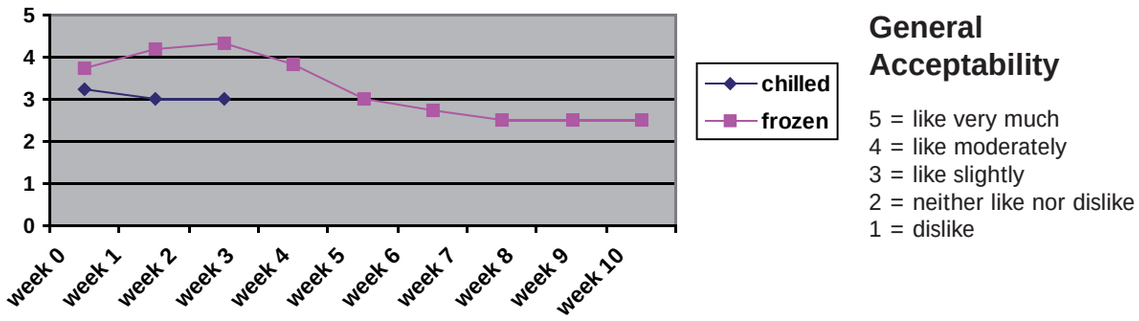


Fig 4. Sensory evaluation of fish siomai during frozen and chilled storage

6. Fish Burger

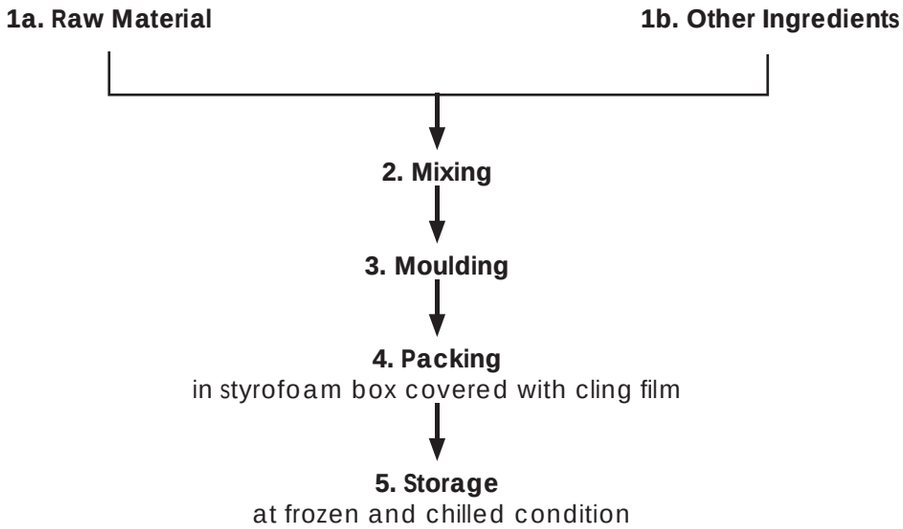
A. Description

Rastrilleger kanagurta is the raw material in the formulation of this low-cost fish burger. Burger is one of the many convenience foods available in the market. Fish burger developed in this project can be prepared using simple, not-so-sophisticated equipment. It is a less expensive version of the hamburger but equally delicious and nutritious.

Fish Burger

B. Processing of Fish Burger

Process flow



DESCRIPTION OF EACH PROCESSING STEP

1. Raw material

The main raw material used is frozen minced fish meat from Indian mackerel (*Rastrelliger kanagurta*). The other ingredients are listed on Table 16.

Table 16. Formulation of low cost fish burger

Ingredients	Weight (gram)	Composition (%)
Minced fish meat	350.0	58.43
TVP	18.0	3.00
Carageenan	0.6	0.10
Water	60.0	10.02
Refined salt	8.0	1.33
Phosphate	1.5	0.25
Sugar, white	7.0	1.17
Black pepper, ground	2.3	0.38
Garlic powder	1.6	0.27
MSG	1.0	0.17
Milk, evaporated	17.0	2.84
Egg, medium	60.0	10.02
Potato starch	10.0	1.67
Onion, chopped	60.0	10.02
Hamburger seasoning	2.0	0.33

GMP:

The frozen minced meat should be semi-thawed to temperature of 3 – 5°C. If the thawed minced meat is not used immediately, store it at chilled temperature of 3 – 5°C.

2. Mixing

Minced meat is mixed with weighed ingredients in silent cutter. Salt is added first to create the sticky sol fish paste, followed by other ingredients. Mixed well until sticky in texture. Cold ice milk is added gradually to lower down the temperature. The mixing stopped when homogenous paste is obtained.

GMP:

Ensure the temperature is kept low at ≤ 5°C during mixing

3. Moulding/forming

Mould paste manually by using manual burger moulder.

GMP:

Ensure the burger moulder is clean and free from contamination as well as the plastic wrapper used in the product

4. Packing/storage

Pack fish burger in styrofoam trays and cover with cling film.

GMP:

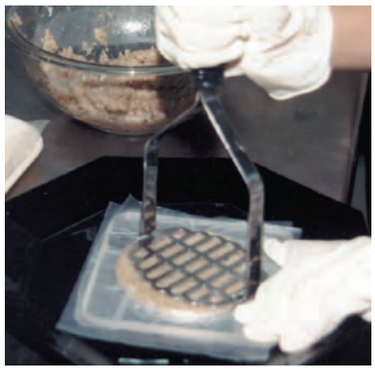
Ensure the packaging material is clean and free from contamination

5. Storing

Store the packed fish burger at chilling (3 – 5°C) or freezing temperature (-18°C).

ILLUSTRATED FLOW CHART OF PROCESSING OF FISH BURGER

1. Ingredients



3. Moulding

2. Mixing in silent cutter

4. Packing in styrofoam box covered with cling film then store either frozen or chilled

C. Shelf Life Study of Fish Burger

Fish burger was stored in two conditions, frozen (-18°C) and chilled (3-5°C). During its storage, once every week, the sample was subjected to series of microbiological tests and sensory test to see its acceptability. The microbiological count was then compared against Council Directive 88/657/EEC for (raw) minced meat or meat pieces (see Table 17).

In chilled storage, the raw fish burger can last for as long as 3 weeks. At the end of the study, although the microbiological content is still less than EEC's maximum recommended limit, the sensory panellists suggested that the taste of the cooked burger has changed substantially from the initial one. Frozen raw fish burger can be kept for at least 10 weeks. Like its chilled counterpart, by the end of the shelf life study, its microbiological content was still much less than maximum legal limit. The result of the sensory testing of this product showed that although there is not much changes on the appearance, colour and odour of the 10-week stored products, the texture change, i.e. dryer texture, can be clearly detected.

Table 17. Bacteriological standards for minced meat and meat pieces of less than 100g or as an ingredient in meat preparation (Council Directive 88/657/EEC)

Bacteria	*Counts per g*		*Criteria*	
	M[a]	*m*[b]		
Aerobic mesophiles (30°C)	5×10^6	5×10^5	n[c] = 5	c[d] = 2
E. coli	5×10^2	50	n = 5	c = 2
Staphylococcus aureus	5×10^2	50	n = 5	c = 2

[a] M = acceptability threshold above which counts are no longer satisfactory where *M* equals 10*m* (count in solid medium) and *M* equals 30*m* (count in liquid medium using multiple tubes)
[b] = threshold below which all counts are satisfactory
[c] = number of samples tested
[d] = number of samples giving values between *m* and *M*

Table 18. Results of shelf-life study of fish burger

Week	Storage Temperature			
	Chilled (5°C-10°C)		Frozen (-18°C)	
	Total Aerobic Count (cfu/g)	*Staphylococcus aureus (cfu/g)*	*Total Aerobic Count (cfu/g)*	*Staphylococcus aureus (cfu/g)*
Week 0	2.4×10^4	1.0×10^1	2.4×10^4	1.0×10^1
Week 1	1.97×10^5	1.2×10^2	1.3×10^4	5.0×10^1
Week 2	-	3.1×10^2	2.8×10^4	ND
Week 3	-	-	8.8×10^4	4.0×10^1
Week 4	-	-	1.6×10^5	1.5×10^1
Week 5	-	-	7.9×10^4	2.0×10^1
Week 6	-	-	1.3×10^4	ND
Week 7	-	-	9.1×10^3	ND
Week 8	-	-	1.7×10^4	1.0×10^1
Week 9	-	-	7.2×10^3	ND
Week 10	-	-	1.7×10^4	ND

Table 19. Sensory attributes of fish burger

Sensory attributes	Quality Standards
Colour	Greyish color with tiny spots of ingredients
Flavour	No fishy taste with sweet peppery taste
Odour	No fishy odor
Texture	Moderate gel strength

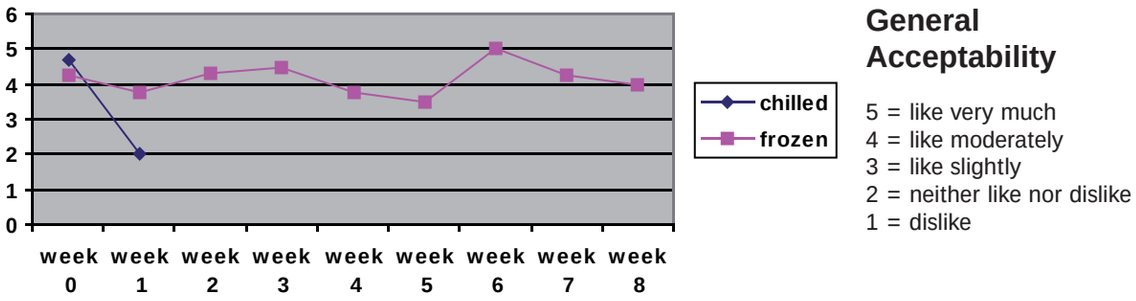


Fig 5. Sensory evaluation of fish burger during frozen and chilled storage

7. Fish Cocktail

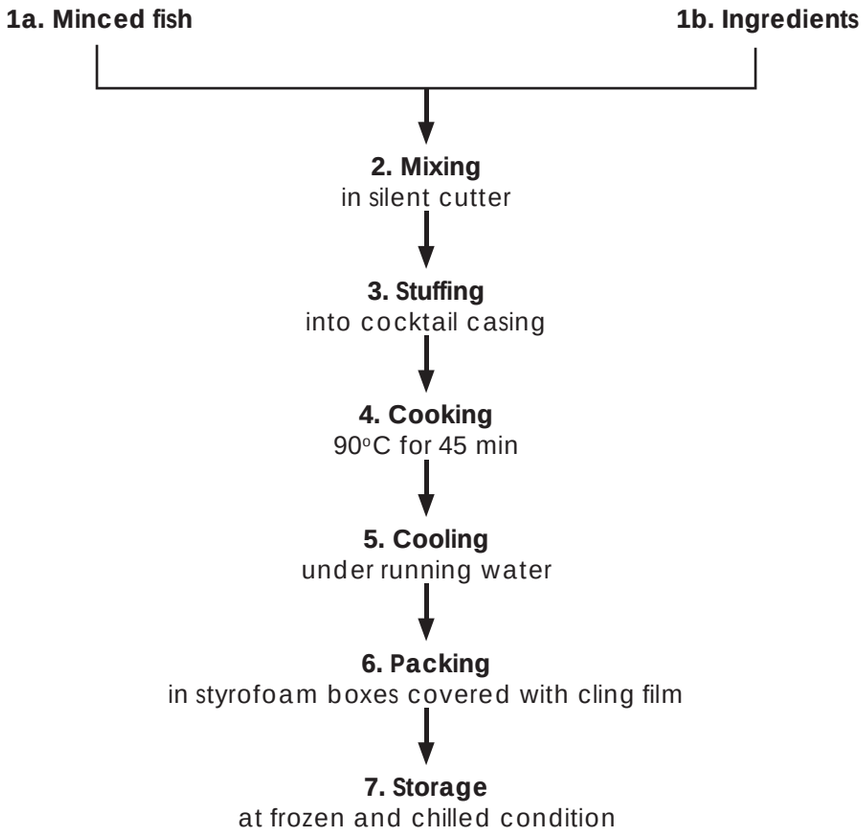
A. Description

Like sausage, cocktail is a popular finger food, and can be eaten with bun or as snack item. In this project, fish cocktail is made from minced mackerel, mixed with salt, seasoning and spices. Fish cocktail is a good alternative from its regular pork and chicken counterpart. It is relatively simple and not expensive to make and serves as good source of protein.

Fish Cocktails

B. Processing of Fish Sausage

Process flow



DESCRIPTION OF EACH PROCESSING STEP

1. Raw material

The main raw material used is frozen minced fish meat from mackerel (*Rastrelliger kanagurta*). The other ingredients are listed on Table 20.

Table 20. Formulation of fish cocktail

Ingredients	Weight (gram)	Composition (%)
Minced fish	500.0	59.0
Pork fat	60.0	7.08
TVP	18.0	2.12
Salt	20.0	2.36
Curing salt	1.4	0.16
Phosphate	2.0	2.36
Sugar refined	15.0	1.77
Black pepper	3.0	0.35
All purpose flour	20.0	2.36
Pickle relish	20.0	2.36
Onion, chopped	20.0	2.36
Raisin	15.0	1.77
MSG	1.0	0.12
Carrots	20.0	2.36
Pineapple juice	15.0	1.77
Water	100.0	11.80
Garlic oil	1.0	0.12
Garlic chopped	15.0	1.77
Carrageenan	1.0	0.12

GMP:

The frozen minced fish should be semi-thawed to temperature of 3 – 5°C. If the thawed minced meat is not used immediately, store it at chilled temperature of 3 – 5°C.

2. Mixing

The minced fish meat is ground in a pre-cooled silent cutter. Salt is added to fish meat and ground until the mixture is sticky. The remaining ingredients are mixed and grind for 5 minutes.

GMP:

Maintain the temperature of the paste ≤ 5°C during mixing

3. Stuffing

Fill the paste into tiny sausage casing using a sausage stuffer. Tie both ends of casing into a tiny cocktail-sized product.

GMP:

Maintain the temperature of the paste at ≤ 5°C

4. Cooking

Cook the cocktails for 60 minutes at < 90°C, then cooled

GMP:

Ensure the product is cooked thoroughly at specified time and temperature

5. Packing

Pack fish cocktail in styrofoam trays and cover with cling film.

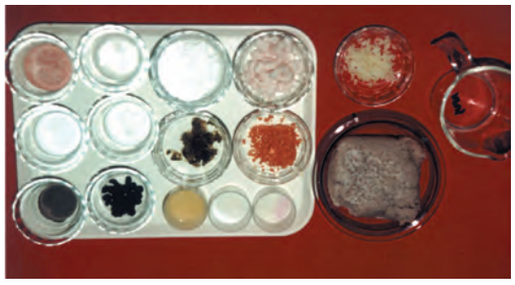
6. Storage

Store the packed fish cocktail at freezing temperature (-18°C).

GMP:

Ensure the temperatures of the chilling or freezing compartment are kept constant

ILLUSTRATED FLOW CHART OF PROCESSING OF FISH COCKTAIL



1. Frozen minced meat and ingredients

2. Mixing with salt and other ingredients in silent cutter

3. Stuffing in a casing

4. Cooking of fish cocktail in a water bath at 90°C for 1 hour

5. Packing in styrofoam box covered with cling film

6. Storing in frozen (-18°C) temperature

C. Shelf Life Study of Fish Cocktail

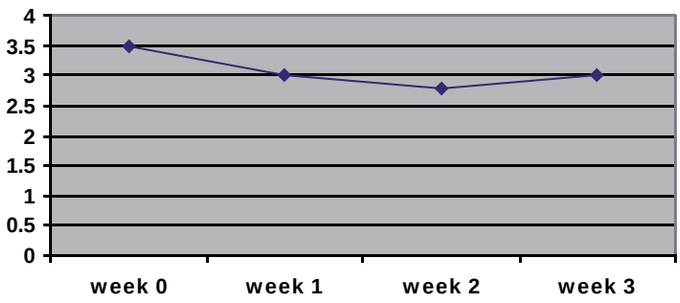
Frozen fish cocktails can be stored for minimum of 4 week. By the end of the 4th week storage, the microbiological content, both total aerobic count and *Staphylococcus* count, was still very low (compared to the standard set by ICMFS, see Table 2). Although it is relatively safe to consume it still, the sensory evaluation suggested that the quality of the products has decreased, mainly due to more distinctively dryer and grainier texture.

Table 21. Results of shelf-life study of frozen fish cocktail

Week	*Total Aerobic Count (cfu/g)*	*Staphylococcus aureus (cfu/g)*
Week 0	0	0
Week 1	6.5×10^2	10
Week 2	1.0×10^3	0
Week 3	1.5×10^3	5
Week 4	4.0×10^2	0

Table 22. Sensory attributes of fish cocktail

Sensory attributes	Quality Standards
Colour	Light brown with tiny spots of ingredients.
Flavour	No fishy taste
Odour	No fishy odor
Texture	Slight gel strength



General Acceptability

5 = like very much
4 = like moderately
3 = like slightly
2 = neither like nor dislike
1 = dislike

Fig 6. Sensory evaluation of frozen fish cocktail

8. Fish Crunchies

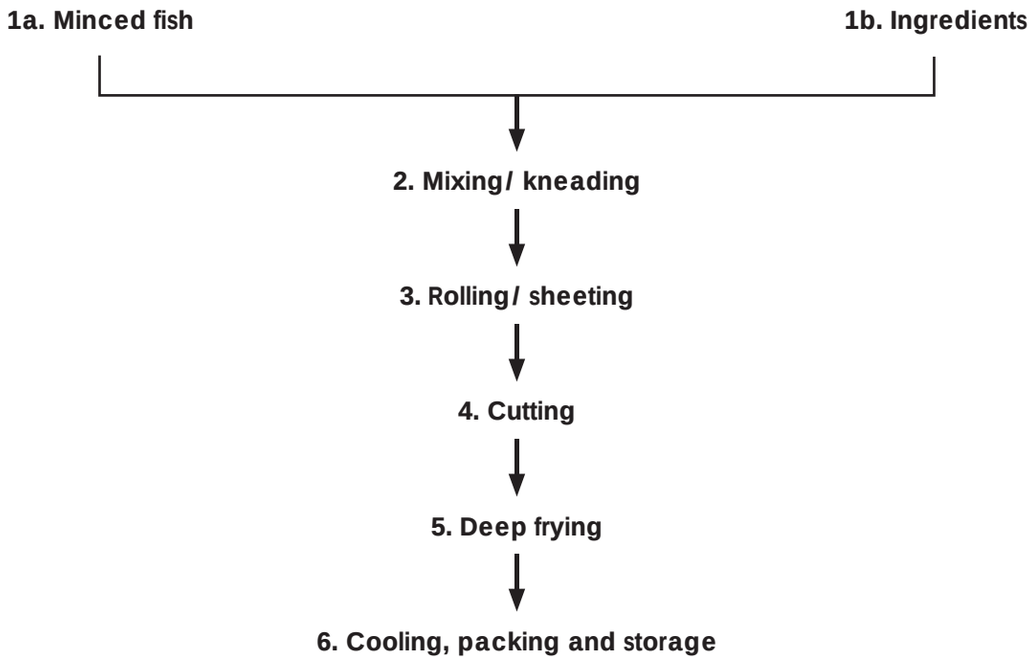
A. Description

Who would ever wonder that from simple fish meat, a crispy snack can be made? BFAR made a full use of low-value mackerel *(Rastrelliger kanagurta)* to make crispy fish crunchies, that suppose to be a healthier snack for young and adult alike.

Fish crunchies

B. Processing of Fish Crunchies

Process flow



DESCRIPTION OF EACH PROCESSING STEP

1. Raw material

The main raw material used is frozen minced fish meat from mackerel (*Rastrelliger kanagurta*). The other ingredients are listed on Table 23.

Table 23. Formulation of fish crunchies

Ingredients	Weight (gram)	Composition (%)
Minced fish meat	170	22.43
Iodized salt	13.5	1.78
Garlic powder	6.6	0.87
Egg beaten	180	23.75
Wheat flour	375	49.48
MSG	1.8	0.24
Chilli powder	6.6	0.87
Baking powder	4.4	0.58
Oil (for frying)		

GMP

The frozen minced meat should be semi-thawed to temperature of 3 – 5°C. If the thawed minced meat is not used immediately, store it at chilled temperature of 3 – 5°C

2. Mixing/ kneading

The semi-thawed minced meat was placed in a bowl. Salt is added and mixed thoroughly by hand, followed by other ingredients. The mixture is formed to dough

GMP:

Maintain the temperature of the paste at ≤ 10°C during mixing

3. Rolling/ sheeting

The mixture (dough) is passed through rollers of the pasta machine to produce a thin sheet of the product.

GMP:

Ensure the roller is clean and free from foreign substance contamination

Reason:

Clean rollers will prevent or minimise contamination from machine to the product

4. Cutting

Pass the thin sheet through the cutting roller or cut the dough strips manually.

GMP:

Ensure that the dough cutter or rollers are free from foreign substance

Reason:

Clean equipment will prevent or minimise contamination to the product

5. Deep fat frying

The fish crunchies were deep fried to at temperature of 190°C for 2 minutes.

GMP:

Ensure the products are cooked at specified time and temperature.

Reason:

Sufficient cooking will ensure that the pathogens are eliminated or reduced to a safe level, as well as to ensuring the quality of the product (i.e. good colour and texture)

6. Cooling, packing and storage

The fried products are cooled, packed and sealed. The packed crunchies are stored at room temperature.

ILLUSTRATED FLOW CHART OF PROCESSING OF FISH CRUNCHIES

1. Frozen minced meat and other ingredients

2. Knead the ingredients in the mixing bowl or in food processor

3. Sheet the dough through the pasta maker

4. Cut the dough to strips

5. Deep fry the dough strips

6. Cool the fried crunchies to room temperature

7. Pack and store at room temperature

C. Shelf Life Study of Fish Crunchies

Stored at room temperature, fish crunchies can last for around 3 weeks. During shelf life study, total aerobic count, *Staphylococcus aureus* and mould counts were examined once a week. Up to the 3rd week of storage, the bacterial count was still very low, however mould growth was observed. The shelf life of this product at room temperature, therefore, can be concluded of around 2 weeks.

Table 24. Results of shelf-life study of frozen fish crunchies

Week	Storage Temperature Room Temperature		
	Total Aerobic count (cfu/g)	***Staphylococcus aureus (cfu/g)***	**Moulds (cfu/ g)**
Week 0	0	0	0
Week 1	2.5×10^2	0	0
Week 2	4.0×10^2	0	0
Week 3	1.2×10^2	0	15

Table 25. Sensory attributes of fish crunchies

Sensory attributes	Quality Standards
Colour	Golden yellow with tiny spots of spices
Flavour	No fishy taste
Odour	No fishy odor
Texture	Crispy

9. Fish Sausage

A. Description

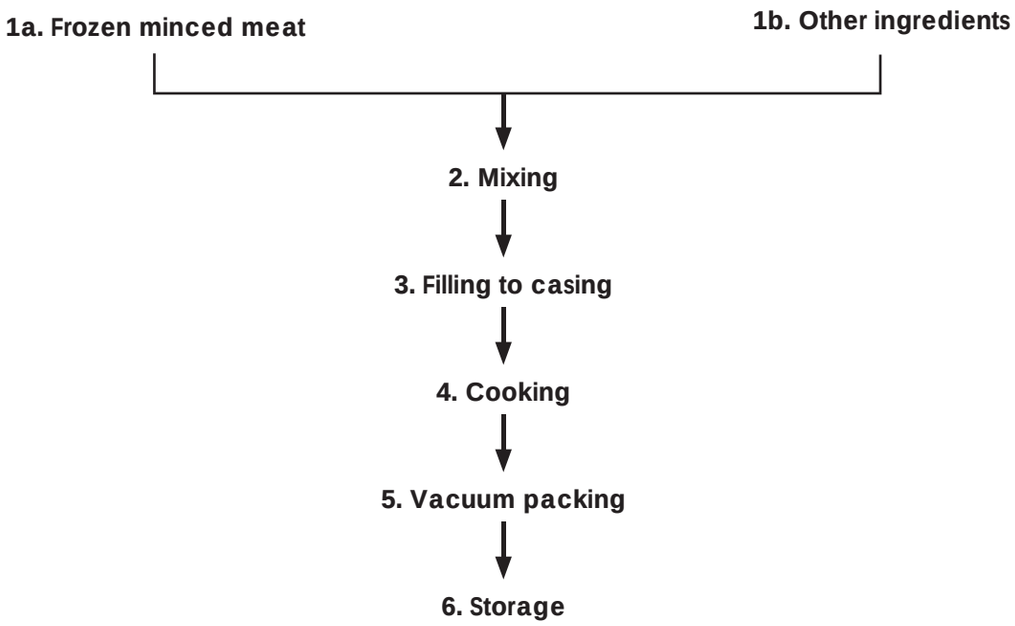
Fish sausage was first being commercialised by Japanese in 1980s. It was popular especially as snacks for school children. The fish sausage was cooked under high temperature and pressure, thus enable it to have very long shelf life. The consumption of fish sausage itself in its origin country has declined due to the preference of youngsters for soft western food, such as burger.

The consumption of meat sausage in Asia has never been as good as these past few years, thanks to the influence of Western diet. However, with problems arisen from safety of meat supply (bird flu, nipah virus and mad cow disease), the consumers would tend to choose alternative safe materials. Hence, in this project, MFRD offered to develop sausage, made from low value fish, which was selected as safe and affordable materials.

Fish Sausage

B. Processing of Fish Sausage

Process flow



DESCRIPTION OF EACH PROCESSING STEP

1. Raw material

The main raw material used is frozen minced fish meat from mackerel *(Rastrelliger kanagurta*). The other ingredients are listed on Table 26.

Table 26. Formulation of fish sausage

Ingredients	Composition (%)
Mince fish	66.46
Water	20.00
Salt	2.00
Sugar	1.02
Milk powder	1.94
Starch	3.33
MSG	0.67
Oil	3.33
Garlic powder	0.24
Phosphate	0.27
NaNO3	0.22
White pepper	0.07
Allspice	0.03
Ascorbic acid	0.02
Wheat fibre	0.39

GMP:

The frozen minced fish should be semi-thawed to temperature of 3 – 5°C. If the thawed minced meat is not used immediately, store it at chilled temperature of 3 – 5°C.

2. Mixing

The minced fish meat is ground in a pre-cooled silent cutter. Salt is added to fish meat and ground until the mixture is sticky. The remaining ingredients are mixed and grind for 5 minutes.

GMP:

- *Maintain the temperature of the paste ≤ 5°C during mixing*
- *Hydrate wheat fibre in water for around 5 minutes*

Reason:

- *Keeping temperature low during mixing will ensure less protein denaturation which affect product texture and to reduce the chances of protein growth*
- *Hydrated Wheat fibre before mixing will ensure even mixing*

3. Filling to casing

Fill the paste into edible sausage casing either manually using a sausage stuffer or automatically. For manual filling, twist or tie both ends of casing into the required size.

GMP:

Ensure good personnel hygiene and clean equipments used

4. Cooking

Steam or cook the sausage at 80 – 90°C temperature.

GMP:

Ensure the water bath or steamer temperature has reached cooking temperature (80 – 90°C) before cooking the sausage

5. Vacuum packing

After cooling, vacuum pack the sausage.

6. Storage

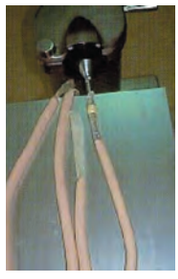
Store the sausage at chilled condition (4°C).

ILLUSTRATED FLOW CHART OF PROCESSING OF FISH SAUSAGE

1a. Minced fish

1b. Other ingredients

2. Mixing



3. Filling to casing

4. Cooking

5. Packing and storage

C. Shelf Life Study of Fish Sausage

Vacuum chilled fish sausage was subjected to shelf life study for 4 weeks. During shelf life study, total aerobic count and anaerobic count was examined once a week. The histamine content was tested on the 1st day of production and on the last day of the shelf life study (Week 4). Please refer to Table 27 for the shelf life study tests results.

Fish sausage can still be safely consumed even after 4 weeks of chilled storage. There was no bacteria, both aerobic and anaerobic detected. The histamine content of the product was merely 4.23 ppm upon production, far less than the maximum limit of 200 ppm for scombroid products (i.e. tuna).

Table 27. Results of shelf-life study of chilled fish sausage

Week	*Total Aerobic Count (cfu/g)*	*Total Anaerobic Count (cfu/g)*	*Histamine (ppm)*
Day 3	ND	ND	4.23
Week 1	ND	ND	
Week 2	ND	ND	
Week 3	ND	ND	
Week 4	ND	ND	5.04

B. Dried products

1. **Seasoned dried minced fish sheet (Pla Pan) (Thailand)**
2. **Semi dried fish sticks (Pla Sen) (Thailand)**
3. **Fish crackers (Malaysia)**
4. **Fish cubes (Philippines)**

Introduction

Drying has been used as traditional method to preserve fish. There are a number of types of drying methods. The oldest and probably best known of drying is sun drying, where the water is evaporated from fish surface by airing it under the sun. It is the cheapest method available, especially in Southeast Asia where hot sun is available all year round. It is still widely used in this region, especially among the backyard and small scale industry.

Sun drying, however, also has its shortcomings. Dried fish normally absorb the moisture when the relative humidity exceeds 75%. As the relative humidity around this region is quite high, the quality of sun-dried fish is not constant.

The "artificial" drying is another method for drying process. Though more expensive, it is much more reliable, as the manufacturer can greatly control the parameters of the process. In artificial drying, the process in placed inside the dryer. Air, with controlled temperature and relative humidity, enters the dryer and evaporates the moisture from the product. This method is widely used among the small-medium and large industry.

Dried fish products have been important commodity in Southeast Asian region. The Southeast Asian export of this humble dried fish (including other seafood) made up to more than one-quarter of the total world export of dried fish and seafood (FAO Fishstats) in year 2000. As dried fish often been used as intermediate material for other value-added products, no doubt the production and export can continuously increase from year to year.

In this section, there are four dried fish products made from both minced fish meat and whole fish. This section also includes the recommended GMP procedures to ensure quality and safety of the products.

1. Seasoned Dried Minced Fish Sheet

A. Description

Seasoned dried minced fish sheet, in Thai, is called Pla Pan (Pan means sheet). It is a deep fried, crispy spicy snack, usually made from pork. In this project, Pla Pan is made from both short-body mackerel *(Rastrelliger brachysoma)* and round scad *(Decapterus maruadsi*). The final product has golden brown, crispy texture with unique herbal, spicy flavour.

Seasoned Dried Minced Fish Sheet (Pla Pan)

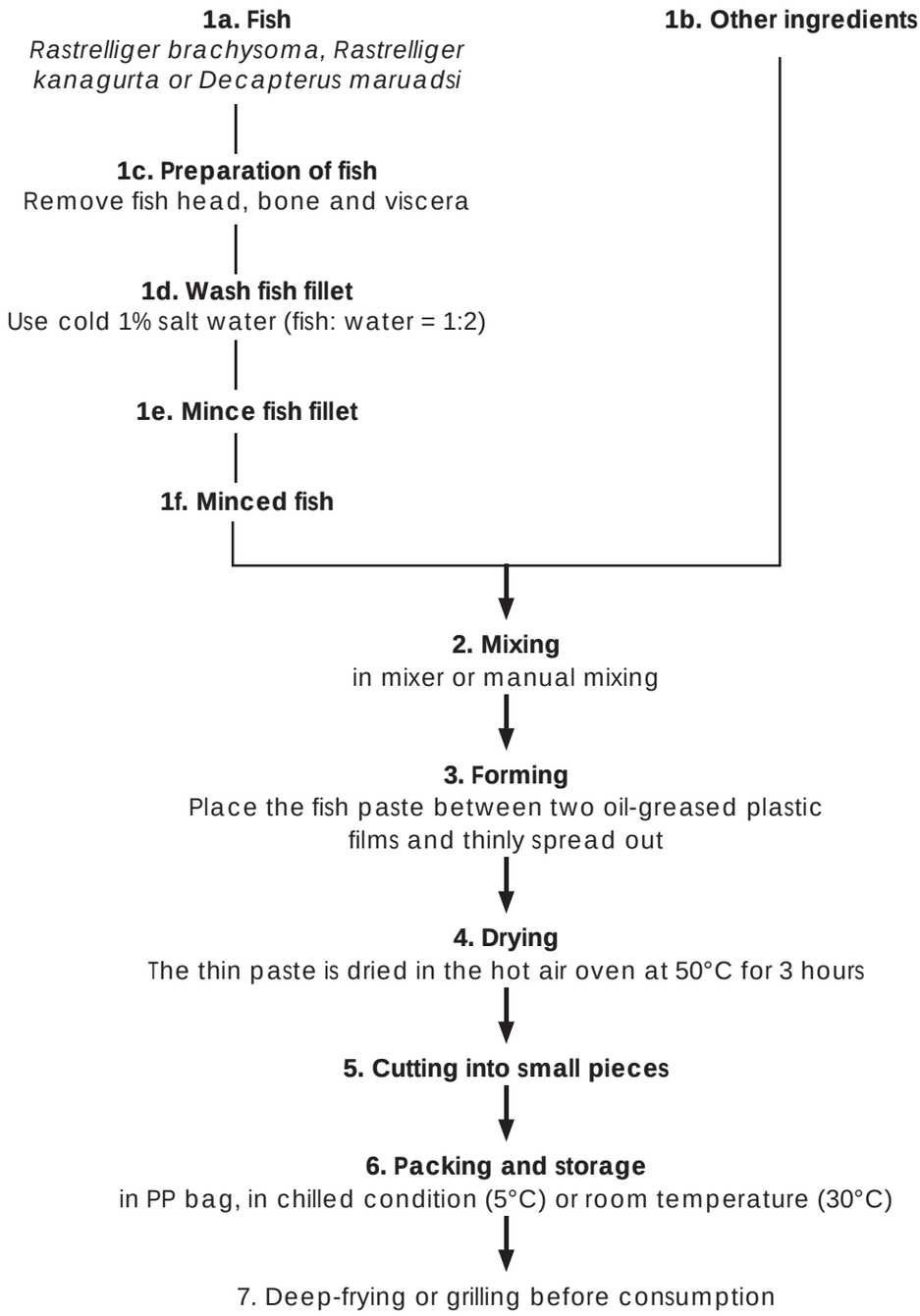
The nutritional properties of this product are shown in Table 28 below. Seasoned dried minced fish sheet is relatively low in fat and high in calcium and phosphorus.

Table 28. Chemical composition of Seasoned Dried Minced Fish Sheet (Pla Pan)

Seasoned Dried Minced Fish Sheet raw material	Moisture (%)	NaCl (%)	Ash (%)	Protein (%)	Fat (%)	P (mg/100g)	Ca (mg/100g)	TBA (mg/100g)
R. kanagurta	10.77	3.72	6.03	44.29	1.14	562.80	745.74	8.44
D. maruadsi	7.83	3.26	5.83	49.29	3.95	369.07	456.05	7.61
R. brachysoma	8.57	3.41	6.30	46.09	2.66	786.06	817.89	10.81

B. Processing of Seasoned Dried Minced Fish Sheet

Process flow



DESCRIPTION OF EACH PROCESSING STEP

1. Raw material

The main raw material is either short mackerel (*Rastrelliger brachysoma)* or Indian mackerel *(Rastrelliger kanagurta)* or Round scad *(Decapterus maruadsi).* The ingredients for Pla Pan are listed in Table 29.

Remove the fish head, bone and viscera. Wash the fish fillet in iced water with 1% salt (volume of water to fish is 2:1). Mince fish using mincing or grinding machine.

Table 29. Product formulation of Pla Pan

Ingredient	Composition (%)
Minced fish meat	85.46
Soybean sauce	5.56
Sugar	8.55
Coriander seed (roasted and pounded)	0.13
Fennel (roasted and pounded)	0.14
Pepper powder	0.17

GMP:

Ensure the fish fillet is well washed and kept chilled or ice before use

2. Mixing

The minced meat is mixed with other ingredients using mixer or manually.

GMP:

Ensure the minced fish and ingredient are mixed homogeneously

3. Forming

Grease the plastic film with oil. Place the fish paste between the two oil-greased plastic films. Form into thin (5 mm) rectangular or round shape.

GMP:

Ensure the thickness of the paste is even

4. Drying

Dry the thin fish paste in the hot air oven (45°C) for 4 hours.

GMP:

Ensure product is dried evenly until the moisture content reach 8 to 11%

5. Cutting to small pieces

Cool the sheet. Cut to small pieces

6. Packaging and Storage

Pack the Pan Pla in PP bag. Store under chilled condition (5°C) and room temperature (30°C)

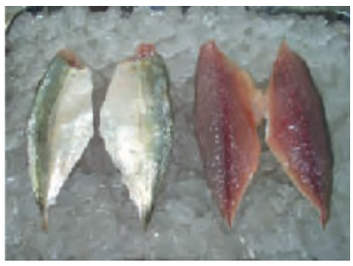
7. Deep frying

Before consumption, deep-fry Pan Pla in hot oil until golden brown

GMP:

- *Ensure the oil is hot (160°C) before frying.*
- *Ensure the oil used is fresh*

ILLUSTRATED FLOW CHART OF PROCESSING OF SEASONED DRIED MINCED FISH SHEET



1. Wash fish fillet with 1% salted ice water (1:2)

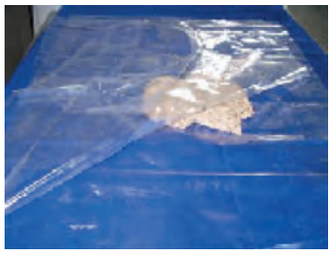
2. Mincing

Minced fish meat

3. Other ingredients

4. Mixing minced fish with other ingredients by mixer or manually

5. Coat the plastic film with oil



6. Place the fish paste between the two oil coated plastic film

7. Forming into thin rectangular shape

8. Drying in the hot air oven at 45°C, 4 hours. Remove the upper film before placing the fish paste in the oven

9. After 1 hour, turn the sheet over

10. Drying in the oven at 45°C for 3 hours

11. Cut into small pieces

Seasoned dried minced fish sheet (Pla Pan)

12. Deep fried before serving

C. Shelf Life Study of Seasoned Dried Minced Fish Sheet (Pla Pan)

The Pla Pan was subjected to shelf life study under two conditions: room temperature and chilled storage. Every certain period of time, the sample was taken and subjected to series of microbiological tests (total aerobic count and yeast and mould count), chemical test (peroxide value), physical test (water activity) and sensory evaluation. The microbiological tests results were then compared to ICMFS, 1986 for precooked fish products (see Table 2). The maximum standard limit of total aerobic count in the product is 5 x 10^5 cfu/g. The limit for peroxide value was taken from Tan, 1992, who stated that the rancid taste can be detected if the peroxide content in the product reaches 20 – 40 mEq/ kg. Yeast and mould maximum recommended limit was taken from FDA requirement for food in general, that is, 10^2 cfu/g.

Pla Pan stored at room temperature can last for around 16 weeks (see Table 23). At the beginning of the study, the water activity (a_w) of the product initially was as low as 0.45. As the storage time progress, it increased constantly, reaching 0.59 at Week 16. This low a_w may explain the relatively low count of bacteria in the product, as bacteria normally thrives at a_w of 0.91. Osmophilic yeast, on the other hand, can grow at environment of minimum of a_w 0.60, which is why the relatively low number of yeast was found.

At the end of the shelf life study (Week 16), the peroxide value increased to 34.8 mEq/ kg. From the sensory test, somehow the rancid flavour was not detected, probably due to the low content of fat in the product. The other sensory attributes such as texture, appearance and colour showed not much changes over the period of 16 weeks.

Pla Pan stored at chilled temperature can last much longer, minimum of 27 weeks (Table 31). At the end of Week 27, all counts of total aerobic bacteria and yeast and mould were still much lower than the recommended maximum legal limit.

Table 30. Shelf life study tests of seasoned dried minced fish sheet (pla pan) at room temperature storage

Week	*Total Aerobic Count (cfu/g)*	*Yeast & Mould (cfu/g)*	*Peroxide value mEq/kg fat*	*Water activity*
Week 0	1.3x10^2	ND	18.39	0.45
Week 1	3.65 x10^2	2.5 x10^2	18.92	0.47
Week 3	2 x10^2	2.5 x10^2	20.28	0.52
Week 7	1 x10^2	1.5 x10^1	28.68	0.52
Week 10	2.5 x10^1	2 x10^1	38.13	0.55
Week 13	1.0 x10^1	1 x10^1	42.6	0.59
Week 16	1.0 x10^1	1 x10^1	34.85	0.59

Table 31. Shelf life study tests of seasoned dried minced fish sheet (pla pan) at chilled storage (5°C)

Week	*Total Aerobic Count (cfu/g)*	*Yeast & Mould (cfu/g)*	*Peroxide value mEq/kg fat*	*Water activity*
Week 1	4x10^2	2.5 x10^1	17.97	0.52
Week 4	3.55 x10^2	1.5 x10^1	22.13	0.54
Week 7	2.95 x10^2	0	16.5	0.55
Week 10	2.4 x10^2	2.5 x10^1	16.5	0.55
Week 13	1.5 x10^2	1.5 x10^1	45.0	0.56
Week 16	1.1 x10^2	0	39.35	0.57
Week 20	4.15 x10^2	1.5 x10^1	39.57	0.57
Week 24	1.6 x10^2	3.5 x10^1	45.77	0.57
Week 27	1.1 x10^2	3.1 x10^1	45.86	0.58

2. Semi Dried Fish Stick

A. Description

Semi dried fish stick (Pla Sen) is another snack product developed in this project. Originally made from meat (pork), this snack can be served with rice and porridge. The use of fish instead of its usual pork, can offer as a better, i.e. healthier and more economical, alternative. Pla Sen, in this project used Indian mackerel and short mackerel as main raw materials.

Semi Dried Fish Stick (Pla Sen)

B. Processing of Semi Dried Fish Stick (Pla Sen)

Process flow

1a. Fish
Rastrelliger brachysoma, Rastrelliger kanagurta

1b. Other ingredients

1c. Preparation of fish
Remove fish head, bone and viscera

1d. Washing fish fillet
Use cold 1% salt water (fish: water = 1:2)

1e. Cutting into strips

2. Marinating fish strips and stored in ice overnight

3. Hot air drying, 3½ hours, 50°C

4. Packing and storage
in PP bag, in chilled condition (5°C) or room temperature (30°C)

5. Deep-frying before consumption

DESCRIPTION OF EACH PROCESSING STEP

1. Raw material

The main raw material used is mackerel *(Rastrelliger brachysoma, Rastrelliger kanagurta)* meat. The formulation is listed on Table 32.

Remove the fish head, bone and viscera. Wash the fish fillet in iced water with 1% salt (volume of water to fish is 2:1). Cut fish fillet to strips.

Table 32. Product formulation of Semi dried fish stick (Pla sen)

Ingredient	Composition (%)
Fish meat	89.93
Kikkoman	4.5
Sugar	4.5
Pepper	0.49
Sesame	0.58

GMP:

- *Always use fresh fish as raw material.*
- *The raw materials should be washed well and chilled or iced at all times*

2. Marinating

Marinate the fish strips with other ingredients overnight.

GMP:

Ensure the meat is covered with food wrappers, such as aluminium foil or plastic (film) to prevent contamination during marinating

3. Sun drying or hot air drying

Dry the strips in the hot air oven (50°C) for about $3^1/_2$ hours until the moisture content of the product reaches 45 to 50%. Alternatively, sun dry for 20 minutes

4. Packaging and Storage

Pack the pla sen in PP bag. Store under chilled condition (5°C) and room temperature (30°C)

5. Deep frying

Before consumption, deep-fry pla sen in hot oil until golden brown

GMP:

- *Ensure the oil is hot (160°C) before frying.*
- *Ensure the oil used is fresh*

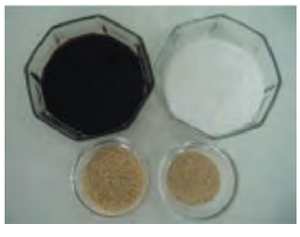
ILLUSTRATED FLOW CHART OF PROCESSING OF SEMI DRIED FISH STICK (PLA SEN)

1. Remove fish head and viscera, cut into fillet

2. Wash fish fillet with 1% salted ice water (1:2)

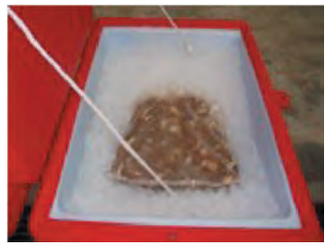
3. Cut fillet into strips

Fish strips



4. Other ingredients

5. Marinate fish strips



6. Store in fridge or ice overnight

7. Dry in hot air oven, 50°C, 3½ hours

8. Cool the fish strips before packing

Semi dried fish stick (Pla Sen)

9. Deep frying before serving

C. Shelf Life Study of Semi Dried Fish Stick (Pla Sen)

The pla sen, both cooked and uncooked, was packed, stored chilled, and subjected to shelf life study tests, which include microbiological tests (total aerobic count and yeast and mould count), chemical test (peroxide value), physical test (water activity) and sensory evaluation. The microbiological tests results were then compared to ICMFS, 1986 for precooked fish products (see Table 2). The maximum standard limit of total aerobic count in the product is 5 x 10^5 cfu/g and not detected yeast and mould. The limit for peroxide value was taken from Tan, 1992, who stated that the rancid taste can be detected if the peroxide content in the product reaches 20 – 40 meq/ kg. Yeast and mould maximum recommended limit was taken from FDA requirement for food in general, that is, 10^2 cfu/g.

Uncooked pla sen cannot last long, even though it is stored under 5°C condition (see Table 33). Though the initial aerobic microbial count was relatively low, by 6th day, it grew to the extent that was higher than recommended limit by ICMFS. Packaging may play a part in here, since the increase in a_w during storage may provide a thriving environment for the bacteria.

Cooked pla sen, stored chilled can last much longer than uncooked ones (Table 34). By 9th day, the bacterial content was still very low. The peroxide value increased slightly during storage. Though high, the rancidity taste may not be distinctive due to its low fat content.

The overall liking, as evaluated by sensory test was around 6 out of 9. The sensorypattributes of fish stick are stated in Table 35.

Table 33. Shelf life study tests of uncooked fish stick (pla sen) stored chilled (5°C)

Day	*Total Aerobic Count (cfu/g)*	*Yeast & Mould (cfu/g)*	*Peroxide value (mEq/kg fat)*	*Water activity*
Day 0	$7.5x10^3$	$1.1x10^2$	30.56	0.87
Day 6	$2.23 x10^7$	$1.25 x10^4$	35.72	0.95
Day 11	$8 x10^7$	$1.2 x10^5$	34.22	0.95

Table 34. Shelf life study tests of cooked fish stick (pla sen) stored chilled (5°C)

Day	*Total Aerobic Count (cfu/g)*	*Yeast & Mould (cfu/g)*	*Peroxide value (mEq/kg fat)*	*Water activity*
Day 1	$1.05x10^2$	$1.5x10^2$	39.99	0.87
Day 2	$4.5 x10^1$	ND	38.42	0.89
Day 3	$0.5 x10^1$	$0.5 x10^1$	36.46	0.87
Day 5	$1.0 x10^1$	$0.5 x10^1$	33.48	0.86
Day 7	$1.6 x10^1$	$4.2 x10^2$	38.66	0.88
Day 9	$2.5 x10^1$	ND	41.43	0.87

Table 35. Sensory attributes of cooked fish stick (pla sen)

Sensory attributes	Quality standard
Color	Golden brown
Flavour	Slightly sweet and salty
Odor	No objectionable odor or rancidity
Texture	Slightly soft not hard

3. Fish cracker

A. Description

Fish cracker, also known as *keropok stick,* is a popular snack in Malaysia and other Southeast Asian region. This product, made from prawn and/ or fish and starch, expands after deep frying or microwave-heating. Fish cracker is usually made traditionally in small, or backyard industry. In this project, Malaysia Fisheries Institute has experimented to make crispy, colourful cracker, using the improved method. The main raw material was low value pelagic fish, such as round scad (*Decapterus maruadsi*) and slender scad (*Decapterus macrosoma*).

Fish Cracker

B. Processing of Fish Cracker

Process flow

1. Raw materials

a. Otoshimi b. Prawn c. Starch d. Seasoning e. Additives f. Water and Ice

↓

2. Mixing
(by silent cutter/mixer)

↓

3. Forming

↓

4. Cooking

↓

5. Cooling
(to room temperature,15 minute)

↓

6. Dipping in colouring solution

↓

7. Aging overnight

↓

8. Slicing

↓

9. Drying

↓

10. Packaging

↓

11. Storage

DESCRIPTION OF EACH PROCESSING STEP

1. Raw material

The main raw material used is round scad (*Decapterus maruadsi*) and slender scad (*Decapterus macrosoma* minced meat. The product formulation can be referred to Table 36.

Table 36. Product formulation of fish cracker

Ingredient	Composition (%)	Weight (g)
Otoshimi	50.00	1000.00
Dried shrimp	5.00	100.00
Sago flour	8.00	160.00
Tapioca starch	28.00	560.00
Salt	1.50	30.00
MSG	0.45	9.00
I.G	0.05	1.00
Water and ice	7.00	140.00
Colouring solution*		

***Colouring solution**

Red Code no. 311821	Colouring powder Water	– 2.5g – 1497.5 ml
Green Code no. 19140,42090	Colouring powder Water	– 2.5g – 1497.5 ml
Yellow (tartrazine) Code no. 19140	Colouring powder Water	– 4.5g – 1497.5 ml

GMP:

Frozen otoshimi should be semi-thawed to temperature of 3-5°C. If the thawed otoshimi is not used immediately, store it at chilled temperature of 3-5°C

2. Mixing

The otoshimi is ground in the silent cutter or mixer. During mixing, salt is added first to extract the salt myofibril proteins, then followed by dry ingredients and wet/ fresh ingredients. To maintain low temperature, chilled water with ice gradually added during mixing. The mixture is blended till smooth homogenous paste is obtained.

GMP:

Keep the temperature low (≤10°C) during mixing

3. Forming

Form the paste (dough) to rectangular loaf.

GMP:

Ensure good personnel hygiene and clean equipments used processing

Reason:

A good personnel and equipment hygiene will ensure minimal cross contamination during processing

4. Cooking

Cooked or steamed the at 95 - 98°C for 15 - 20 minute.

GMP:

Ensure the steamer is set at cooking temperature (98°C) before cooking.

5. Cooling

Cool the cooked loaf to room temperature for around 15 minute.

6. Dipping

Apply colouring to the loaf by dipping it into colouring solution.

GMP:

Ensure uniform dipping around the mixture

7. Aging

Age the coloured loaf by keeping it at room temperature overnight

GMP:

Prevent foreign substance around keeping area. Keep the gap between each product during aging

8. Slicing

Slice the loaf thinly by slicing machine.

9. Drying

Dry the cracker stick under the sun or using over dryer (60º, 3 hours).

10. Packaging

Pack the cracker using normal seal packaging.

11. Storage

Store at room temperature.

GMP:

Avoid storing fish cracker under direct sunlight and/ or high humidity area

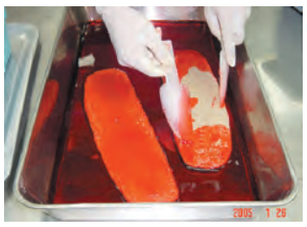
ILLUSTRATED FLOW CHART OF PROCESSING OF FISH CRACKER

1. Minced meat and other ingredients

5. Drain for 15 minutes

9. Dry under the sun or by using oven dryer

2. Mix fish meat and other ingredients in a silent cutter



6. Dipped into colour solution

Packed fish cracker (keropok)

3. Form the paste to rectangular loaf shape

7. Age the coloured loaf overnight in refrigerator (≤10ºC)

4. Cook loaf at 98 - 100ºC for 15 - 20 minutes

8. Slice loaf

Serving the fish cracker

To serve: deep fry the fish cracker

Ready-to-eat fish cracker

C. Shelf Life Study of Fish Cracker

The fish cracker was subjected to shelf life study during a few months storage. The tests included were total aerobic count, coliform count, *Eschericia coli* count and *Staphylococcus aureus* count, measured on the pre-cooked cracker. The microbial counts were then compared against standard set by International Commission on Microbiological Specification in Food (ICMFS), 1986 (see Table 2) for similar products. Sensory evaluation of the product was conducted at the end of the eight-month storage.

Fish cracker that was dried under the sun tends to have more exposure to bacteria and other foreign matters that that dried using oven. Fish cracker can be stored at room temperature for around 2 months. By the 3rd (and subsequently, 4th and 5th) month, the *E. coli* and *S. aureus* counts increased substantially. The moisture content of the product has been quite stable during storage, if packed sealed.

Table 37. Shelf life study tests of fish cracker stored at room temperature

Month	*Total Aerobic Count (cfu/g)*		*Total Coliform Count (cfu/g)*		*E.coli Count (cfu/g)*		*S. aureus Count (cfu/g)*		Moisture Content (%)
	Uncooked	Cooked	Uncooked	Cooked	Uncooked	Cooked	Uncooked	Cooked	Uncooked
Month 0	$<30x10^1$	0	<30	0	$<30x10^1$	0	$<30x10^1$	0	6.18
Month 1	$<30x10^1$	0	<30	0	$<30x10^1$	0	$<30x10^1$	0	6.27
Month 2	$<30x10^1$	0	<30	0	$<30x10^1$	0	$<30x10^1$	0	6.27
Month 3	$1.2x10^4$	0	<30	0	$12x10^3$	0	$12.80x10^3$	0	6.22
Month 4	$4.9x10^4$	0	<30	0	$3.80x10^2$	0	$8.16x10^2$	0	6.18
Month 5	$5.4x10^4$	0	<30	0	$11x10^3$	0	$6.56x10^2$	0	6.21

4. Fish Cubes

A. Description

Flavour is a very important attribute of quality of food. Each food has its characteristic flavour. Fish in this project, is used as main material for the preparation of fish cubes, which intended to be flavour enhancer. Fish cubes contribute the characteristic of fish taste to the cooking, such as soup and other fish recipes.

Fish Cubes

B. Processing of Fish Cubes

Process flow

1a. Fish Powder + **1b. Ingredients**

↓

2. Mixing manually

↓

3. Moulding in tray

↓

4. Steaming

↓

5. Cutting into cubes

↓

6. Oven-drying

↓

7. Cooling

↓

8. Wrapping in aluminium foil
Wt. 14 g/pc

↓

9. Packing and storage
Storing at ambient temp.

DESCRIPTION OF EACH PROCESSING STEP

1. Raw material

The main raw material used is fish powder that was processed from round scad (*Decapterus maruadsi*) minced meat, oven dried and pulverised. The composition of materials for fish cubes is shown in Table 38.

Table 38. Product formulation of fish cubes

Ingredients	Weight (gram)	Composition (%)
Fish powder	95.5	19.44
Toasted flour	100.0	20.36
Onion powder	8.7	1.77
Garlic powder	5.5	1.12
Agar	2.3	0.47
White pepper	3.7	0.75
Refined salt	180.0	36.65
All spice	3.0	0.61
Corn oil	85.0	17.31
Sesame oil	0.5	0.06
Ascorbic acid	2.5	0.51
MSG	3.0	0.61
Brown sugar	1.5	0.31
Sodium benzoate	0.15	0.03

GMP:

- *Use of fresh raw material in the preparation of fish powder*
- *Use freshly prepared fish powder*
- *If the fish powder is not used immediately, store it in sterilized covered container*

2. Mixing

Mix fish powder with dried ingredients, followed by liquid ingredients. Keep stirring until the uniform paste is obtained. The mixing can be done manually or by using food processor.

GMP:

- *Ensure the paste is well blended*
- *Ensure all ingredients and utensils are free from foreign materials or other contaminating materials*

3. Moulding

Mould the paste in stainless steel pan, using spatula, then cover with aluminium foil

GMP:

Ensure that the utensils and packaging materials are clean and of food grade

4. Steaming

Steam the paste for 30 minutes

GMP:

Ensure the steamer has reach the steaming temperature before cooking

5. Cutting to cubes

Cut the steamed paste to uniform sizes using stainless steel cutter or knife

GMP:

Ensure the cutter or knife is clean

6. Oven-drying

Oven-dry the cubes for 30 minutes, 50°C

GMP:

- *Ensure that the cube is dried thoroughly at desired time and temperature*
- *Ensure the oven has reached the required temperature before drying the cubes*

7. Cooling

Cool the cubes to room temperature

8. Wrapping

Wrap the cube individually in aluminium foil (14g/ piece)

9. Packing and storage

Pack the wrapped cubes in the PE bags, store them in plastic container at room temperature

ILLUSTRATED FLOW CHART OF PROCESSING OF FISH CUBES

1. Ingredients (see Table 1)

2. Mix all ingredients until become uniform paste

3. Mould paste to stainless steel pan

4. Steam paste for 30 minutes

5. Cut the steamed paste to cubes

6. Oven dry for 30 minutes, 50°C

7. Cool fish cubes

8. Wrap with aluminum foil

9. Pack and store at romm temperature

C. Shelf Life Study of Fish Cubes

The fish cubes were subjected to shelf life study during a few weeks storage. Under room temperature storage, fish cubes can last for 2 weeks. Though at the 3rd week, the total aerobic count is still lower than maximum standard set by ICMFS for good quality ready-to-eat products, mould growth was observed. The histamine content of this product is relatively low, 35.23 ppb, much lower than maximum allowed standard in fish products of 50 ppm. The peroxide value of fish cubes ranges from 2.05 mEq/kg at 0 week storage and 22.72 mEq/kg at 3 week storage.

The sensory evaluation conducted for this product indicate that the fish cube were acceptable in all attributes and still rated good on week two (2) but has to be terminated due to the presence of moulds on week 3.

Further study on the improvement in packaging of the product is recommended.

Table 39. Shelf life study tests of fish cubes stored at room temperature

Week	Room temperature		
	Total Aerobic Counts (cfu/ g)	*Yeast/Moulds (cfu/ g)*	*Histamine (ppb)*
Week 0	2.6×10^5	0	35.23
Week 1	7.4×10^4	0	NA
Week 2	9.4×10^4	0	NA
Week 3	8.1×10^4	50	NA

C. Fermented products

1. Fish Sauce (MFRD)

Introduction

Abundantly available, fish used to and still is a major source of animal protein in Southeast Asian region. Due to its perishable nature, however, fish undergoes rapid spoilage, especially under tropical conditions of high temperature and high humidity like in this region. Various ways and means, therefore, were used to preserve fish. One of the low-cost traditional preservation methods that make a full use of this environment condition is fermentation.

Fermented fish products vary from countries to countries, but the basic principles are generally similar. Fish is mixed with salt, with the ratio ranges from low salt content (around 6 – 18%) to high salt content (1 – 5 times of fish weight). The mixture is then being left to ferment under room temperature (25 – 30°C) for certain period. Short fermentation produces solid or semi solid fermented products (such as salted fish or fish paste). Long fermentation produces liquid fermented products (such as fish sauce).

The dietary pattern of people in the Southeast Asian region did play a large part in the development of fermented fish products. Rice has been a staple food in this region. The large consumption of rice, which is bland in taste, necessitates the use of side dish, which is normally consumed in small quantity and relative savoury or even salty.

Commercially, the worldwide popularity of fermented fish products has been promising with the growing popularity of ethnic foods, such as Vietnamese and Thai dishes. According to FAO, the worldwide export of fermented fish products, including fish sauce in year 2000 was 336,213 metric tonnes, valued at more than US$ 800 million. This quantity has been growing from 311,006 metric tonnes in 1998 and 312,995 metric tonnes in 1999, and it is expected to increase further in future.

In this section, the processing of fish sauce is described. Unlike its regular counterpart, this product was processed in relatively short period, thus enable higher and more effective production, albeit still relatively low cost. This section also reviews the monitoring process of fermentation to ensure controlled quality of the final product.

1. Fish Sauce

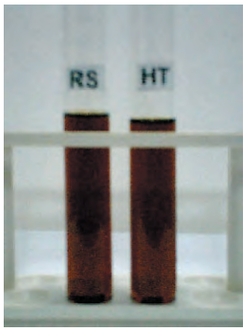
A. Description

In Southeast Asia, fish sauce is made from various types of fish, from both freshwater and marine fish species, by various types of methods. Each has its unique taste and characteristic. The processing method for fish sauce can be different in each country, but the basic principle is quite similar. The main ingredients of fish sauce are fish and salt. The fish is washed and mixed with salt with the ratio ranges from 1:1 to 1:5. The mixture is left in room temperature for a period varying from 5 to 24 months. The liquid will be skimmed off the top or drained from the bottom of the container. During this fermentation process, the fish will undergo hydrolysis, both microbial and enzymatic. The term 'fish sauce' itself, according to Amano (1962) refers to 'clear, brown liquid hydrolysate from salted fish'.

As the traditional process of fish fermentation can take up to 24 months to complete, there have been some attempts to accelerate the fermentation process without affecting the characteristic flavour and nutritional quality of the fish sauce, e.g. by increasing the fermentation temperature (Mabesa, et al, 1989), adding the antibacterial agent instead of salt (Amano, 1962), using plant protease such as bromelain, papain or ficin (Ooshira, et al, 1981, Beddows and Ardeshir, 1977), or even using soya sauce koji (Chae, et al, 1989)

Koji is an essential ingredient in the fermentation process in soy sauce production. The term 'koji' derives from the Chinese characters, meaning mouldy grain. During fermentation, koji serves as a source of a variety of enzymes which catalyse the degradation of solid raw materials to soluble products that provide fermentable substrates for yeast and bacteria in the subsequent fermentation stage (Mheen, 1972).

It would be advantageous for the production of fish sauce, (a) if the fermentation period can be shortened to reduce the capital costs and to increase the throughput, (b) if fish that is underutilised and has low value can be used. The present study was conducted to investigate the use of soya sauce koji inoculated with *Aspergillus oryzae* and commercial protease for the acceleration of fish sauce production from pelagic fish species without



Fish Sauce

B. Processing of Fish Sauce

Process flow

a. Preparation of koji

1a. Soybean
↓
Wash
↓
Steam for 30 minutes

1b. Wheat flour
↓
Roast to 150ºC for 1 hour

↓
2. Mix with ratio of 1:1
↓
3. Add Aspergillus oryzae culture seed to the mixture (ratio of 1: 16,000)
↓
4. Incubate
↓
5. Koji

b. Preparation of fish sauce

1. Raw round scad or mackerel
↓
2. Cut fish to 2 – 3 pieces
↓
3. Boil fish
↓
4. Drain and cool fish
↓
5. Add protease and water
↓
6. Adjust the pH to 6.5 by adding lactic acid
↓
7. Incubate mixture at 45ºC for 4 hours

8. Cool mixture to 28ºC
↓
9. Add salt and koji alternately to fish-water mixture
↓
10. Place mixture in earthen jar and cover
↓
11. Ferment at 28ºC for 2.5 months
↓
12. Filter, then heat the liquid to 80ºC for 15 minutes
↓
13. 2nd filtration
↓
14. Fish sauce (liquid)

DESCRIPTION OF EACH PROCESSING STEP

A. Preparation of koji

1. Raw material

The ingredients for koji are dried soybean and wheat flour. The soybean was washed and steamed at 100°C for 30 minutes. At the same time, the wheat flour was roasted at 150ºC for 1 hour. After cooling the ingredients to less than 40ºC.

GMP:

Ensure that both soybean and wheat flour are thoroughly cooked at instructed time and temperature

Reason:

Proper cooking will reduce the rate of possible contamination

2. Mixing

The cooked soybeans and roasted wheat were mixed in the ratio of 1:1 (w/w)

GMP:

Ensure the mixing was done in hygienic condition

3. Add *Aspergillus oryzae* culture seed to the mixture (ratio of 1: 16,000)

Inoculate the mixture with *Aspergillus oryzae* seed culture, added in the ratio of 1:16,000. The mixture was then kneaded to dough, placed in plastic trays

4. Incubate

Incubate the mixture in a temperature-humidity chamber. Adjust the temperature, according to the stage of growth of the *Aspergillus oryzae* culture, that is:

1. Germination of *Aspergillus,* occurred at optimum temperature of 35ºC

2. Initial growth of *Aspergillus*

During this phase, the growth of *Aspergilus* would generate heat. The increase of dough temperature would be observed. However, enzyme would be deactivated if the temperature rose too high. Hence, during this stage, it is necessary to reduce the temperature of the chamber to 30ºC and to spread the koji to around 30 cm thickness. The surface of koji should be covered with a wet cloth to maintain saturated humidity of 100%. Rewetting of cloth should be done frequently as the cloth would dry up by the heat generated.

3. Logarithmic growth stage of mould

By this stage, the surface of koji would be covered by white mycelium. Wet cloth should be removed and the koji should be broken to small pieces and re-spread. The temperature of chamber should be maintained at 30ºC.

4. Final stage

Koji was maintained at a humidity of 95% for 18 – 20 hours. At this stage, the temperature of chamber should be maintained to 25ºC to prevent deactivation of peptidase (Miyazaki and Honkawa, 1964).

GMP:

- *Ensure the humidity chamber is hygienic before use*
- *Check the texture of the koji during incubation. If it dries up, add cooked water and knead the dough hygienically*

B. Preparation of fish sauce

1. Raw material

The main raw materials used are Indian mackerel (*Rastrelliger kanagurta*) and round scad (*Decapterus spp*). The other ingredients are listed in Table 40.

Table 40. Product formulation of fish sauce

Materials	Composition (%)
Fish	
Protease	1.0 % of fish weight
Water	30.0 % of fish weight
Koji	25.0% of fish-water mixture weight
Salt	16.0 % of fish-water mixture weight

GMP:

Ensure that only fresh fish is used for processing fish sauce

2. Cut fish to 2 – 3 pieces

Cut fish to 2 – 3 pieces, depending on the fish size. Do not remove the viscera of the fish.

3. Boil fish

Boil fish in boiling water for 5 minutes or until the colour of the flesh changes

4. Drain and cool

5. Add protease and water

Add protease, derived from *Aspergillus oryzae* (can be obtained from Nagase Enzyme Co. Ltd) and water to the fish, then mix thoroughly.

6. Adjust the pH to 6.5 by adding lactic acid

Measure the pH of the mixture. If the pH is above 6.5, add lactic acid until the pH reach 6.5.

7. Incubate mixture at 45°C for 4 hours

8. Cool mixture to 28°C

9. Add salt and koji alternately to fish-water mixture

10. Place mixture in earthen jar and cover

11. Ferment at 28°C for 2.5 months

Allow the mixture to ferment for 2.5 month in room temperature. Stir the mixture periodically to allow uniform fermentation.

12. Filter, then heat the liquid to 80°C for 15 minutes

When the fermentation is ended, filter the mixture by using cotton cloth. Collect as much liquid as possible. Use vacuum suction with Wattman paper no. 35 to obtain the liquid. Heat the clear liquid until 80°C for 15 minutes.

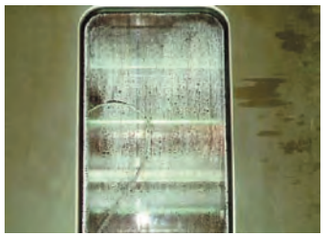
13. 2nd filtration

Filter again the liquid by using Wattman paper No. 35. Keep it inside the clean bottle and store in room temperature.

ILLUSTRATED FLOW CHART OF PROCESSING OF FISH SAUCE

A. *Processing of Koji*

1a. Raw soybean



Steam for 30 minutes

1b. Wheat flour

Roast to 150ºC for 1 hour

2. Mixing soybean and wheat flour (1:1)

3. Adding *Aspergillus oryzae* cultures

4. Incubating

Koji

B. *Processing of Fish Sauce*

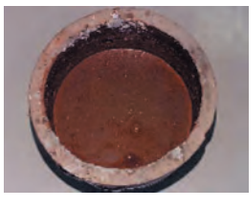
1. Raw round scad or mackerel

2. Cut fish to 2 - 3 pieces

3. Boil fish, then drained and cool

4. Add salt and koji alternately to incubated fish-water mixture

5. Place mixture in earthen jar and cover

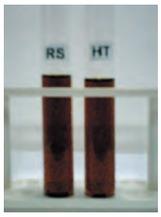


6. Ferment at 28ºC for 2.5 months

7. Filter

8. Boil the filtered liquid for 5 minutes

9. 2nd filtration – vacuum filtering



Fish sauce

C. Fish Sauce: Composition and Legal Standard

With the method adopted by MFRD, the fish sauce was processed with only 10 - 20 weeks fermentation period, compared to 9 – 12 months of ordinary fermentation period.

During fermentation, a series of chemical and physical tests were carried out to monitor the fermentation progress. Acidity I, acidity II, formol-N and total soluble solids tests were carried out weekly while pH measurements were done fortnightly. Yield factor, or the proportion of fish sauce weight obtained from initial raw material was measured. The chemical composition of final fish sauce as compared to the commercial Thai fish sauce can be seen in Table 41.

The overall flavour of fish sauce depends on the balance of all amino acids, i.e. those that account for umami, sweet and bitter taste. As taste is subjective, there is no standard formula of 'balance' amino acid composition. However, it is worthy to note that taste contributed by amino acid in these oligopeptides can mask the saltiness of fish sauce (Funatsu, 2001). The composition of amino acid of both lab-based fish sauce and commercial fish sauce is listed in Table 42.

The amino acids that contribute to umami taste are glutamic acid and aspartic acid. Serine, glycine, alanine, threonine and proline are associated with sweet taste. Histidine, arginine, tyrosine, cystine, valine, methionine, phenylalanine, isoleucine, leucine and lysine are related to bitter taste (Funatsu, 2001). Though commercial fish sauce has the lowest total amino acid content, it has the highest umami amino proportion (33%) and the lowest bitter amino proportion (37%) as compared to the lab-produced fish sauce (the proportion of umami and bitter proportion were 25.1% and 50.6% in Round scad sauce and 25.3% and 44.3% in mackerel sauce).

Table 41. Physical and chemical composition of fish sauce

Fish sauce	Yield (%)	pH	Salt (%)	Total soluble solid (%)	Total nitrogen (g/ 100g)	VBN ((mg/ 100ml)
Round scad	45.0	5.00	18.0	35	2.1	318
Mackerel	41.6	5.05	21.7	45	2.53	393
Commercial Thai fish sauce	NA	5.11	25.0	41.5	1.90	139

Table 42. Amino Acid Composition of fish sauce

Amino Acid type	Amino acid composition (g/ 100ml)		
	Mackerel	Round Scad	Commercial
Aspartic acid	0.87	0.71	1.03
Glu	1.28	1.59	1.69
Ser	0.24	0.15	0.40
Gly	0.71	0.67	0.63
Thr	0.44	0.19	0.51
Ala	0.81	0.84	0.72
Pro	0.35	0.37	0.15
Arg	0.53	0.19	0.04
His	0.21	0.2	0.17
Tyr	0.14	0.62	0.06
Cys	0.08	0.05	0.08
Val	0.61	0.66	0.58
Met	0.24	0.28	0.23
Iso	0.46	0.52	0.32
Phen	0.38	0.38	0.34
Leu	0.64	0.73	0.46
Lys	0.51	1	0.82
Total amino acid (g/ 100 ml)	**8.5**	**9.15**	**8.23**
Sum (g/ total)			
Umami	2.15	2.30	2.72
Sweet	2.55	2.22	2.41
Bitter	3.80	4.53	3.1
Sum (% of total amino acid)			
Umami	25.3%	25.1%	33.05
Sweet	30.0%	24.3%	29.28
Bitter	44.3%	50.6%	37.67

Thailand is the world's largest fish sauce producer, contributing more than 20% of total world fish sauce production. The production of Thai fish sauce, *nam pla*, is regulated by two standards established by the Thai Food and Drug Administration (FDA) and Thai Industrial Standard Institute (TISI). The former is mandatory whereas the latter is voluntary. The requirements of both standards are shown in Table 43 and 44.

Table 43. Thai Food and Drug Administration Standard for Fish Sauce *(Nam Pla)

No.	Requirement	Type of *nam pla*		
		Naturally processed	Artificially processed	Blended
1.	Sodium chloride (%)	>20	>20	>20
2.	Total-N (g/ 100 ml)	>0.9	>0.9	>0.4
3.	Amino acid nitrogen (%) [(amino acid-N/ Total-N) x 100]	40 – 60	40 – 60	-
4.	Glutamic acid/ Total-N (G/N)	0.4 – 0.6	0.4 – 0.6	0.4 – 1.3

*Source: Virulhakul, 2000

Table 44. Thai Industrial Standard Institute Standard for Fish Sauce *(Nam Pla) - TIS 3-1983**

No.	Requirement	Grade 1	Grade 2
1.	Relative density at 27ºC	1.2	1.2
2.	pH	5.0 – 6.0	5.0 – 6.0
3.	Sodium chloride (g/ l), not less than	230	230
4.	Total-N (g/ 100 ml), not less than	20	20
5.	Glutamic acid/ Total-N (G/N)	0.4 – 0.6	0.4 – 0.6
6.	Amino acid nitrogen (g/ l)	10	7.5

*Source: Virulhakul, 2000

The comparison of lab-produced and commercial fish sauce with requirements as set by Thai FDA and TISI is shown in Table 45.

Table 45. Comparison Of Lab-Produced and Commercial Fish Sauce with Standards Set by Thai FDA and TISI

	Sodium chloride (%)	Total-N (g/ 100 ml)	Amino acid nitrogen (%) [(amino acid-N/ Total-N) x 100]	Glutamic acid/ Total-N (G/N)	Relative density at 27ºC	pH
Thai FDA	>20	>0.9	40 – 60	0.4 – 0.6	-	-
TISI	>23	>2.0	40 – 60	0.4 – 0.6	1.2	5.0 – 6.0
Mackerel	21.7	2.53	NA	0.51	NA	5.05
Round scad	18.0	2.60	NA	0.75	NA	5.00
Comm	25.0	1.95	NA	0.87	NA	5.11

Comm: Commercial Thai fish sauce, Tra Chang Brand

NA: Not available

In general, both lab-produced fish sauces were able to meet standards as set by Thai FDA and TISI.

D. Smoked fish products

1. Smoked mackerel (Thailand)

Introduction

Smoking was originally developed to preserve food. The application of smoke and salt effectively inhibit the bacterial growth. Moreover, the combination of smoke and salt in right proportion gives the product an appealing taste and colour. The addition of spices (and alcohol for certain markets) will enable the product to be easily adapted to local taste.

Smoking can make appetizing and attractive value-added products from low value small pelagic fish, which abundantly available in this region. This offers opportunities for small medium fish processing industry to enjoy higher profit margin from this value-added smoked products.

It is not necessary to have large-scale production with fancy equipments to process an excellent quality smoked fish. Proper processing and hygiene however, are ultimate necessities.

In this section, one smoked fish product made from small pelagic fish is described, together with the recommended GMP procedures to ensure quality and safety of the product.

1. SMOKED MACKEREL

A. Description

Smoked mackerel is a seafood-substitute of smoked pork, one of Thailand traditional side dish. Usually fried before consumption, the processing of this product includes sun drying, smoking and oven drying. Smoked mackerel has savoury, smoky flavour, can be served together with rice.

Smoked Mackerel

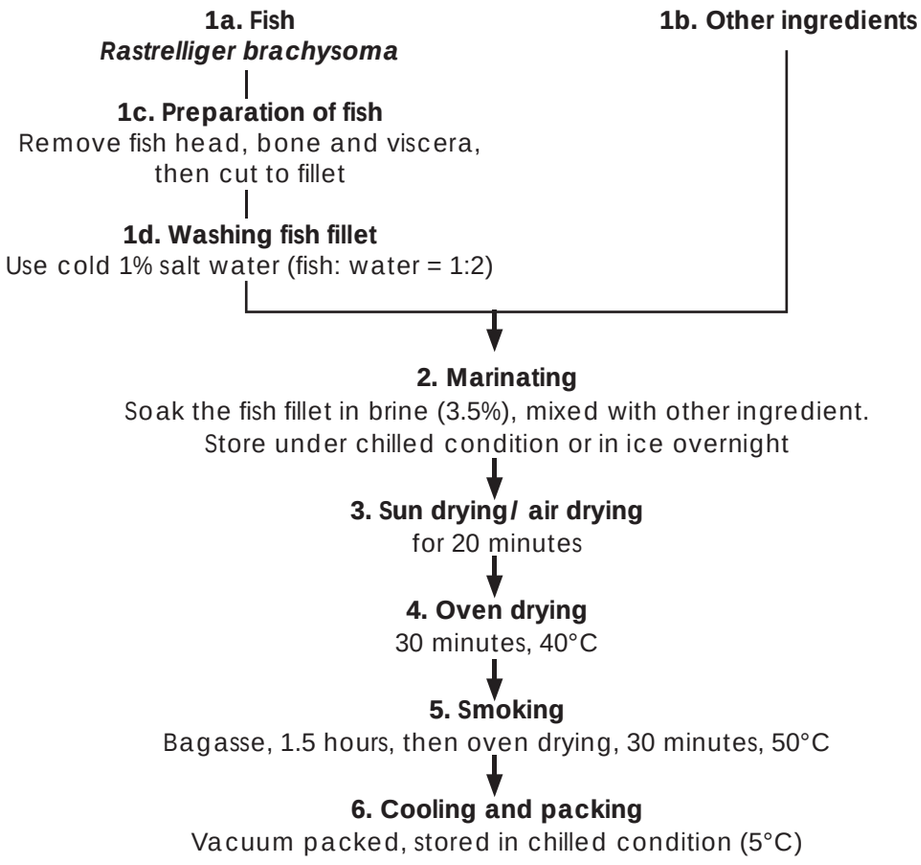
The nutritional value of smoked mackerel is listed in the table below.

Table 46. Chemical composition of Smoked Mackerel

Sample	a_w	Salt (%)	Moisture (%)	Ash (%)	Protein (%)	Fat (%)	P (mg/ 100g)	Ca (mg/ 100g)
Smoked mackerel (R.brachysoma)	0.98	2.00	61.33	3.07	29.23	2.25	619	256

B. Processing of Smoked Mackerel

Process flow



DESCRIPTION OF EACH PROCESSING STEP

1. Raw material

The main raw material used is mackerel *(Rastrelliger brachysoma)* meat. The formulation is listed on Table 47.

Remove the fish head, bone and viscera. Wash the fish fillet in iced water with 1% salt (volume of water to fish is 2:1).

Table 47. Product formulation of smoked fish

Ingredient	Composition (%)
Fish fillet	66.68
Salt	1.03
Sugar	2.42
Nut meg	0.13
Allspice	0.07
Pepper powder	0.33
Water	29.34

GMP:

- *Always use fresh fish as raw material*
- *The raw materials should be washed well and chilled or iced at all times*

2. Marinating

Soak the fish fillet in 3.5% brine with other ingredients that has been wrapped in the pocket cloth overnight.

GMP:

Ensure the meat is covered with food wrappers, such as aluminium foil or plastic (film) to prevent contamination during marinating

3. Sun drying or air drying

Sun dry or air dry the fish for 20 minutes.

GMP:

Ensure the drying area is clean and free from insects

4. Oven drying

Dry the fish fillet in the hot air oven for 30 minutes, 40°C.

GMP:

Ensure the oven temperature has reached the 40C or the desired temperature before placing the fish in the oven

5. Smoking

Smoke the fish using bagasse (dried sugar cane) for 1½ hours, then dry for 30 minutes, 50°C.

GMP:

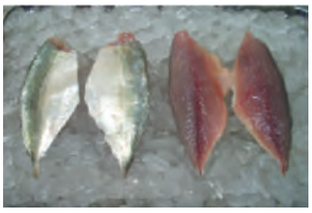
Ensure the bagasse is clean and dry. There should be no presence of mould in the bagasse

6. Packaging and storage

Cool the smoked fish to room temperature. Vacuum packed, the stored in chilled condition (5°C).

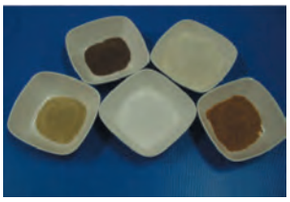
ILLUSTRATED FLOW CHART OF PROCESSING OF SMOKED MACKEREL

1a. Remove fish head and viscera



1b. Remove the bone

2. Wash fish fillet with 1% brine (1:2)



3. Other ingredients

4. Soak fish fillet in brine (3.5%) mixed with all ingredients and store it chilled over night

5. Air drying for 20 minutes

6. Hot air oven drying 40°c for 30 minutes

7. Smoking using bagasse for 1½ hours, then drying for 30 minutes, 50°C

8. Vacuum pack

Smoked mackerel

9. Deep fry or steam before serving

C. Shelf Life Study of Smoked Mackerel

The chilled smoke mackerel subjected to shelf life study tests, which include microbiological tests (total aerobic count and yeast and mould count), chemical test (TBA), physical test (water activity) and sensory evaluation.

Under chilled condition, smoked mackerel can be kept for around 1 week. By 12th day, the yeast and mould count test will be a slightly high and TBA content doubled. Since the fat content of smoked fish is relatively low, the rancid flavour was not detected, even in Day 12. The sensory evaluation for this product was 7.2 out of 9, indicating that the product was well-liked.

Table 48. Shelf life study tests of smoked mackerel at chilled storage (5°C)

Day	Total Aerobic Count (cfu/g)	Yeast & Mould (cfu/g)	TBA (mg/100g)
0	$2.75x10^3$	$<10^1$	3.16
2	$7.4 x10^3$	$<10^1$	2.27
6	$5.4 x10^3$	$1.5x10^1$	2.23
12	$5.75 x10^4$	$6.1x10^2$	5.86

E. Other products

1. **Frozen butterfly breaded fish (Malaysia)**
2. **Steamed fish (Thailand)**
3. **Frozen braised fish (MFRD)**
4. **Fish muffin (MFRD)**
5. **Fish biscuit (MFRD)**

Introduction

There are five products described in this section: steamed/ boiled fish, frozen butterfly breaded fish, frozen braised ready-to-eat fish, fish muffin and fish biscuit.

Frozen products are usually processed in the medium-large scale industry. Steamed fish is a traditional product usually processed in small or backyard industry. Fish muffin and fish biscuit are new products developed by MFRD.

Whether the product is new or traditional, this publication describes the processing in a hygienic method to ensure good quality and safe products.

1. Frozen Butterfly Breaded Fish

A. Description

Frozen fish products have the advantage of long shelf life, much more than its chilled or room temperature counterparts. MFI, in this project, developed frozen butterfly breaded fish using low value fish, such as slander scad (*Decapterus macrosoma*) and round scad *(Decapterus maruadsi)*. This product can be stored for as long as 6 months, without any changes in quality. Since this product use whole fish rather than minced meat, it retains its original fish flavour and fish shape. The butterfly breaded fish can be served as side dish, together with rice or noodles; in fast food, such as fish and chips; and snack food.

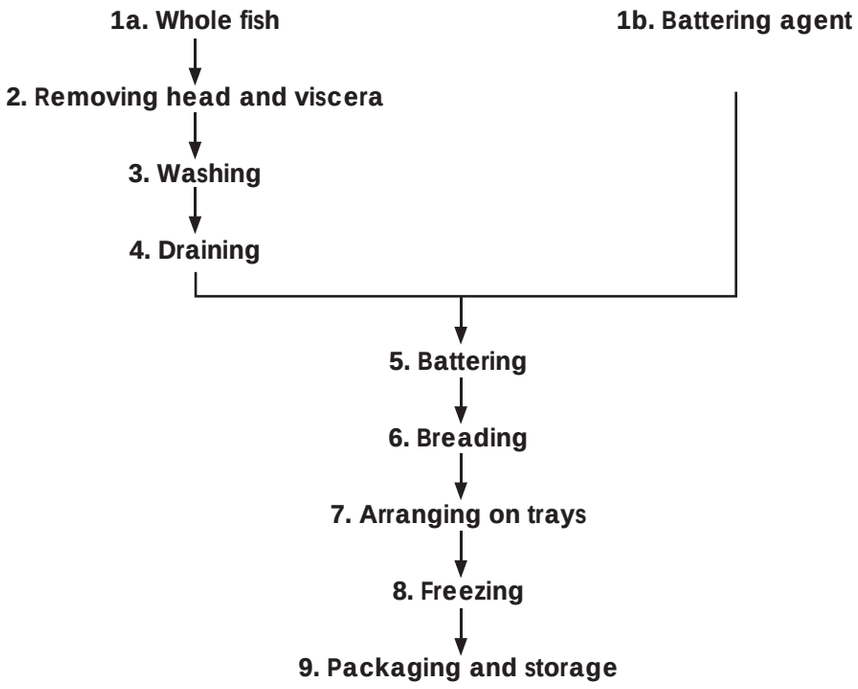
Frozen Butterfly Breaded Fish

The nutritional properties of this product are shown in Table 49 below. Non-fried butterfly breaded fish is relatively low in fat and high in calcium and phosphorus.

Table 49. Chemical composition of frozen butterfly breaded fish (before cooking)

Sample	Moisture (%)	Protein (%)	Fat (%)	Carbohydrate (%)	Energy (kcal) 100g
Frozen butterfly breaded fish	64.92	19.07	2.82	13.19	154.42

B. Processing of Frozen Butterfly Breaded Fish



DESCRIPTION OF EACH PROCESSING STEP

1. Raw material

The main raw materials used are slander scad (*Decapterus macrosoma*) and round scad *(Decapterus maruadsi)*. The ingredients for fish butterfly breaded fish are listed on Table 50.

Table 50. Product formulation of butterfly breaded fish

Ingredient	Composition (%)	Weight (g)
Fish		
Battering agent:		
Batter mix	24.000	240.0
Salt	1.500	15.0
Sugar	2.000	20.0
Pepper	0.500	5.0
MSG	0.025	0.250
I.G	0.005	0.050
Water	71.970	719.7
Total	**100.00**	**1000.0**
Breading agent:		
Bread crumb (golden)	300	3000.0

GMP:

Ensure the fish used is fresh

2. Remove fish head and viscera

GMP:

Use ice to keep fish fresh

3. Washing

Wash the fish in chilled brine

GMP:

Keep the temperature low during washing (≤10°C)

4. Draining

Drain the water from fish using basket

GMP:

Keep the temperature low during draining (≤10°C)

5. Battering

Apply batter mix to the fish

GMP:

Ensure uniform batter around the fish

6. Breading

Apply breading (golden bread crumbs) to the fish

GMP:

Ensure uniform breading around the fish

7. Arranging on trays

GMP:

Ensure there is no foreign material around the trays

8. Freezing

Freeze the fish at –18°C

9. Packing and storage

Pack the frozen fish using vacuum packaging, then store frozen (-18°C)

ILLUSTRATED FLOW CHART OF PROCESSING OF FROZEN BUTTERFLY BREADED FISH

1. Cut fish head, tail and fins, Remove viscera, split open the fish

2. Wash the fish in chilled brine

3. Drained the washed fish

Battering mix (with salt, sugar, pepper, M.S.G, IG) and breading mix (breadcrumbs)

5. Dip the fish inside batter. Add other ingredients

6. Bread the fish

7. Arrange fish on trays

8. Pack and seal the fish, then store frozen

Serving the Frozen butterfly breaded fish

To serve: deep fry the frozen butterfly breaded fish

Ready to eat butterfly fillet

C. Shelf Life Study of Frozen Butterfly Breaded Fish

The frozen breaded fish was subjected to shelf life study during the 8-month storage. The tests included were total aerobic count, coliform count, and *Staphylococcus aureus* count, measured on the pre-cooked breaded fish. The microbial counts were then compared against standard set by International Commission on Microbiological Specification in Food (ICMFS), 1986 (see Table 2) for similar products. Sensory evaluation of the product was conducted at the end of the eight-month storage.

At the end of eight month, the microbial count of the uncooked product was still relatively low, 4.05 x 10^3 cfu/g, much below the regular limit for good ready-to-eat product of 10^5 cfu. The amount of total coliform and *S. aureus* count was still less than ICMFS limit for marginally acceptable quality precooked fish products (see Table 51).

Table 51. Microbiological content of butterfly breaded fish during cold storage

Months	*Total Aerobic Count (cfu/g)*		*Total Coliform Count (cfu/g)*		*S. aureus Count (cfu/g)*		*Moisture Content (%)*
	Uncooked	**Cooked**	**Uncooked**	**Cooked**	**Uncooked**	**Cooked**	
Month 0	$<30x10^1$	0	<30x10	0	$<30x10^1$	0	65.91
Month 1	$<30x10^1$	0	<30x10	0	$<30x10^1$	0	65.87
Month 2	$<30x10^1$	0	<30x10	0	$<30x10^1$	0	65.01
Month 3	$12.00x10^3$	0	<30x10	0	$9.50x10^2$	0	65.08
Month 4	$5.97x10^3$	0	<30x10	0	$14.80x10^2$	0	65.17
Month 5	$3.50x10^3$	0	<30x10	0	$10.9x10^3$	0	65.22
Month 6	$4.06x10^3$	0	<30x10	0	$<30x10^1$	0	66.01
Month 7	$5.99x10^3$	0	<30x10	0	$1.45x10^2$	0	65.03
Month 8	$4.05x10^3$	0	<30x10	0	$<30x10^1$	0	65.07

2. Steamed Fish

A. Description

Steamed fish is one of the popular traditional dishes in Thailand. Called '*Pla Thu Nung*' in local language which literally means steamed fish, the fish was actually cooked by boiling instead of steaming. The main raw material used is short mackerel, Indian mackerel and round scad; of which short mackerel gives the best flavour and texture. Steamed fish has slightly salty/ savoury texture. Although it is ready-to-eat, locals prefers to deep-fry it until golden brown before consumption.

Steamed Fish

The nutritional properties of this product are shown in Table 52 below. Steamed fish is relatively low in fat and high in protein.

Table 52. Chemical composition of frozen steamed fish

Sample	Moisture (%)	Protein (%)	Fat (%)	Salt (%)	Ash (%)	a_w
Steamed fish	71.16	21.95	2.08	3.14	3.14	0.96

B. Processing of Steamed Fish

1. Raw material
Remove fish viscera
↓
2. Soaking fish in brine
(10%), 10 minutes
↓
3. Draining fish
↓
4. Boiling fish
↓
5. Cooling, pack and storage

DESCRIPTION OF EACH PROCESSING STEP

1. Raw material

The main raw materials used are short mackerel *(Rastrelliger brachysoma)*. The ingredients for steamed fish are listed on Table 53. Remove the fish viscera then wash fish with chilled water.

Table 53. Product formulation of steamed fish

Ingredient	Weight (g)
Whole fish	1000
Table salt	100
Crude salt	600

GMP:

- *Ensure the fish used is fresh*
- *Ensure that the fish is washed properly and stored chilled or in ice before and during processing*

2. Soak fish in brine

Soak fish in brine (10% salt) for 10 minutes. The weight ratio of brine to fish is 2:1.

GMP:

Ensure even mixing of salt to water in preparing brine

3. Drain fish

Drain the fish by placing them in the bamboo basket. Rinse with chilled water.

GMP:

Ensure the basket is clean

4. Boil fish

Boil fish in boiling brine (18% salt) for 5 minutes or until the fish is well cooked.

GMP:

Ensure the temperature of the boiling brine is not higher than 100°C

5. Cooling and packing

Cool the fish to room temperature. Pack in PE plastic bag, then seal. Store the steamed fish at chilled temperature (5°C).

ILLUSTRATED FLOW CHART OF PROCESSING OF STEAMED FISH

1a. Raw material: *Decapterus spp*. Remove viscera. Wash fish

1b. Salt solution 10%

2. Soak fish in brine (10%) for 10 minutes

3. Drain fish in bamboo basket

4. Boil the fish in brine (20%) for 5 minutes

5. Cool fish

6. Pack steamed fish and store chilled (5°C)

C. Shelf Life Study of Steamed Fish

The shelf life study of steamed fish includes the microbiological testing (total aerobic count and yeast and mould) and chemical testing (TBA). The microbiological test result would be compared to the standard limit for ready-to-eat fish products (ICMFS, 1986) (Table 2).

Steamed fish can be stored up to 9 days at chilled temperature (Table 54) but only 2 days at room temperature. The microbiological count was still excellently very low at 9th days, however, at 12th days, yeast and mould could be detected. At day 18 of storage, the total plate count and yeast and mould were too high, indicating that the product may not be suitable for consumption anymore. There is not much change in the TBA of the product during storage, which may refer to the fact that the rancidity of the product did not change a lot.

The sensory tests were also conducted on the product during the shelf life study. At day 0, the panellist gave 7.88 out of 9, at day 12 to 18, the rating dropped to 6.8 out of 9. The sensory attributes of steamed fish is listed in Table 55.

Table 54. Shelf life study of steamed fish during chilled storage (5°C)

Day	*Total Aerobic Count (cfu/g)*	*Yeast and Mould (cfu/g)*	*TBA (mg/100g)*
Day 0	$<10^1$	$<10^1$	17.26
Day 6	$<10^1$	$<10^1$	17.07
Day 9	$<10^1$	$<10^1$	17.56
Day 12	1.65×10^2	5.0×10^1	16.8
Day 18	TNTC	8.35×10^2	17.34

Table 55. Sensory attributes of steamed fish

Sensory attributes	Quality standard
Colour	Shiny silver and blue skin
Flavour	Slightly salty
Odour	No objectionable odor or rancidity
Texture	Soft and springy

3. Frozen Braised Fish

A. Description

Convenience food and health food are two of the three key trends that appear to have driven the growth within general food and beverage group in the past few years (AC Nielsen survey, 2004). It's a no wonder, considering that the increasing pressure of modern life has gradually changed the shopping and meal preparation habits everywhere. More females are joining the workforce, thus only have fewer time to preparing meals, not to mention healthy home-cooked food for their family. In line with that, for this project, MFRD processed a ready-to-eat fish product that is, frozen braised fish. The fish was braised in teriyaki sauce, before cook it at high pressure and temperature. The result was a nutritious ready meal that only requires simple reheating upon consumption.

Frozen Braised Fish

B. Processing of Frozen Braised Fish

1. Raw mackerel

↓

2. Remove gills and viscera

↓

3. Marinate with seasonings

↓

4. Boil with seasonings

↓

5. Pressure-cooked
115°C, 1kg/ cm^2

↓

6. Vacuum pack and frozen storage

DESCRIPTION OF EACH PROCESSING STEP

1. Raw material

The main raw materials used are short mackerel *(Rastrelliger brachysoma)*. The ingredients for frozen braised fish are listed on Table 56.

Table 56. Product formulation of braised fish

No	Ingredient	Composition %
1.	Raw mackerel *(Rastrelliger spp.)*	70
	Seasonings:	
2.	Water	18.6
3.	Soy sauce	3.0
4.	Garlic	1.4
5.	Ginger	2.9
6.	Sugar	4.1

Cook the seasoning materials under low heat. Let it cool.

GMP:

- *Ensure the fish used is fresh*
- *Ensure that the fish is washed properly and stored chilled or in ice before and during processing*

2. Remove gills and viscera

Remove the viscera and gills of the fish. Wash thoroughly with cold water.

3. Marinate with seasonings

Marinate fish with seasonings for 30 minutes.

GMP:

Store the fish in fridge to keep the temperature of the fish low during marinating

4. Boil with seasonings

Boil fish with seasoning around 5 minutes or until it is thoroughly cooked.

5. Pressure-cooked

Pressure-cook the fish at 115ºC, 1kg/ cm^2. After cooking, cool the fish to room temperature.

6. Vacuum pack and frozen storage

Pack the fish in vacuum packaging, and store it in frozen condition (-18ºC).

ILLUSTRATED FLOW CHART OF PROCESSING OF FROZEN BRAISED FISH

1a. Raw fish

1b. Other ingredients

2. Remove gills and viscera

1c. Cook the seasoning materials. Let it cool

3. Marinate the fish with seasonings

4. Pressure cook

5. Vacuum packed

C. Shelf Life Study of Braised Fish

The shelf life study of steamed fish includes the microbiological testing (total aerobic count and anaerobic count) and chemical testing (POV). The microbiological test result would be compared to the standard limit for ready-to-eat fish products (ICMFS, 1986) (Table 2).

Frozen braised fish can be stored for minimum 6 months (Table 57). Even at Month 6, the aerobic count was still extremely low and no anaerobic bacteria were detected. The peroxide value (POV) was relatively still quite low, much below the recommended amount of POV in fat to be able to be detected (20 mEq/ kg fat). Worth to note that the product fat content is around 2.3%, thus the likelihood for the rancidity to be detected is relatively low.

Table 57. Shelf life study of frozen braised fish during storage (-18°C)

	Total Aerobic Count (cfu/g)	*Total Anaerobic Count (cfu/g)*	*POV (mEq/ kg fat)*
Day 3	10^3	ND	15.6
Week 1	ND	ND	18.8
Month 1	ND	ND	15.9
Month 2	1.5×10^2	ND	15.1
Month 3	10^2	ND	15.1
Month 4	10^2	ND	15.2
Month 5	ND	ND	14.3
Month 6	ND	ND	22.6

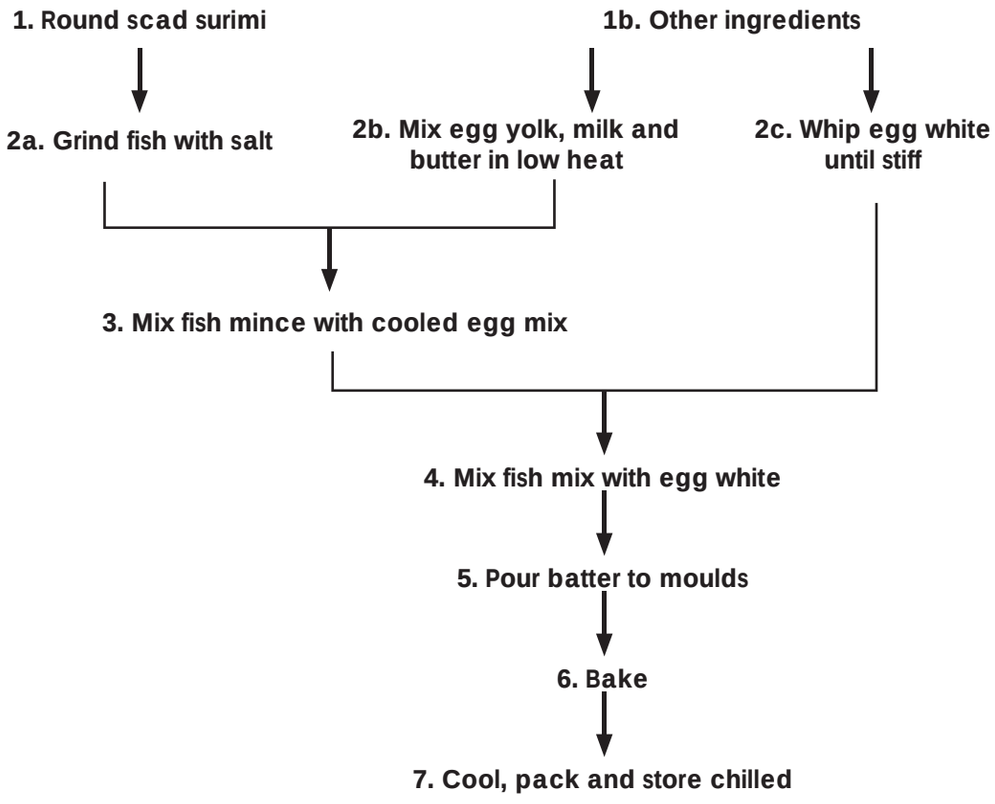
4. Fish Muffin

A. Description

Who would have thought that humble minced fish could be made to muffin? Muffin is a tasty, favourite snack in everywhere, taken both as snack or sometimes, desserts. With a fat content of 22% (HPB, 2003), muffin may not be exactly the snacks that health conscious people would like to take. In this project, MFRD used minced fish as main ingredients of muffin. The fishy taste is surprisingly almost not detectable, due to the fruit flavouring added. The gelling property of fish meat is manipulated to reduce the fat needed for processing muffin. With half of fat content and 30% higher protein than regular muffin, the fish muffin is offered to provide healthier alternative for those with sweet tooth.

Fish Muffin

B. Processing of Fish Muffin



DESCRIPTION OF EACH PROCESSING STEP

1. Raw material

The main raw materials used are round scad *(Decapterus macrosoma)*. The ingredients for frozen braised fish are listed on Table 58.

Table 58. Product formulation of fish muffin

Ingredient	Composition (%)
Surimi	29.88
Salt	0.01
Milk powder	2.55
Water	15.27
Butter	6.36
Egg yolk	11.20
Lemon flavour	0.37
Corn flour	5.09
Sugar	12.73
Cream of tartar	0.25
Egg white	16.29

GMP:

Frozen surimi should be semi-thawed to temperature of 3-5°C. If the thawed surimi is not used immediately, store it at chilled temperature of 3-5°C

2. Mixing of ingredients

a. Grind fish with salt in food processor until paste is formed.
b. On a separate batch, mix egg yolk, milk and butter in low heat.
c. Whip egg white with sugar and flour until stiff peak.

GMP:

Keep the temperature low (≤10°C) during mixing of fish

3. Mix fish with cooled egg mix

Add cooled egg mix to fish paste, then grind by using food processor.

GMP:

- *Ensure that the egg mixture is cooled enough before mixing with fish*
- *Keep the temperature low (≤10°C) during mixing of fish*

4. Mix fish mix with egg white

Pour fish mixture to egg white. Whip it with high speed until the fish and egg white are mixed thoroughly.

GMP:

Do not overmix the mixture

Reason:

Overmixing the mixture will cause the muffin to be flat

5. Pour batter to mould

Pour batter to muffin moulds.

6. Bake

Bake 120°C, 50 minutes.

GMP:

The oven temperature has to be at set temperature (120°C) before baking the maffin

ILLUSTRATED FLOW CHART OF PROCESSING OF FISH MUFFIN

1. Surimi + other ingredients

2a. Mix surimi mince with salt

2b. Mix egg yolk, milk and butter in low heat

2c. Beat egg white until stiff Add sugar and flour

3. Mix surimi paste with cooled egg mix

4. Add surimi paste mix to beaten egg white

5. Pour batter to mould

6. Bake

7. Fish muffin

C. Shelf Life Study of Fish Muffin

The shelf life study of fish muffin includes the total aerobic count and anaerobic count and yeast and mould. Sensory tests and chemical test (POV) were also done periodically. The microbiological test result would be compared to the standard limit for ready-to-eat fish products (ICMFS, 1986) (Table 2).

Fish muffin was stored in chilled condition and room temperature. At room temperature storage, fish muffin had shelf life of around 3 days. Although upon baking and packing, there is no bacteria detected, after 1 day being stored at ambience temperature, the bacteria multiply to slightly more 10^3 cfu/g, and after 3 days storage, 10^5 cfu/g. Yeast and mould were initially not detected, however, after 3 days storage, there were more 10^2 cfu/g detected. By 1 week, the bacteria was too numerous to count already and yeast and mould were feasibly seen on the product. From the sensory test conducted, the off flavour and fishy odour had become more distinctive after 3 days storage.

Chilled fish muffin has much longer shelf life. After 11 weeks storage, there were still no bacteria (both aerobic and anaerobic) and yeast and mould detected. There was also no off flavour detected, even after 11 weeks storage.

The fish muffin has fat content of 14%. Therefore, POV was conducted periodically to detect the rancid odour that may be developed during storage. At day 3, where the off flavour was detected in the room temperature-stored product, the POV was only 4 mEq/ kg fat.

Table 59. Shelf life study of fish muffin during chilled storage (4°C)

	Chilled storage			Room temperature storage		
	Total Aerobic Count (cfu/g)	***Total Anaerobic Count (cfu/g)***	***Yeast and mould Count (cfu/g)***	***Total Aerobic Count (cfu/g)***	***Total Anaerobic Count (cfu/g)***	***Yeast & Mould Count (cfu/g)***
Day 1	ND	ND	ND	1.70×10^3	ND	ND
Day 3	100	ND	ND	1.04×10^5	ND	5×10^2
Week 1	100	ND	ND	TNTC	ND	Feasibly seen
Week 2	ND	ND	ND	-	-	-
Week 3	ND	ND	ND	-	-	-
Week 5	ND	ND	ND	-	-	-
Week 7	ND	ND	ND	-	-	-
Week 9	ND	ND	ND	-	-	-
Week 11	ND	ND	ND	-	-	-

5. Fish Biscuit

A. Description

Traditionally cookies and biscuit have been viewed as indulgent treat, with people buying them as enjoyment rather than say, health platform. However, customers have become more sophisticated nowadays. They still want the enjoyment factor, without, or at least less the guilt. Other factor, such as less preservatives and artificial flavouring will also a tick factor. Therefore, MFRD in this project created fish biscuit, which is feather-light in texture, no flavouring added, and more importantly, tasty.

Fish Biscuit

B. Processing of Fish Biscuit

1. Round scad minced meat

↓

2. Mixing

↓

3. Moulding/ shaping dough

↓

4. Baking

↓

5. Cooling

↓

6. Packing and storage

DESCRIPTION OF EACH PROCESSING STEP

1. Raw material

The main raw material used is round scad *(Decapterus macrosoma)* minced meat. The ingredients for fish biscuit are listed on Table 60.

Table 60. Product formulation of fish biscuit

Ingredient	Composition (%)
Self raising flour	12.63
Minced fish	50.54
Salt	1.26
Vegetable oil	12.63
Egg	16.85
Spices	0.69
Sugar	4.76
Fish sauce	0.63

GMP:

Frozen minced fish should be semi-thawed to temperature of 3-5°C. If the thawed otoshimi is not used immediately, store it at chilled temperature of 3-5°C

2. Mix fish with other ingredients

The minced fish is ground in the silent cutter or mixer. During mixing, salt is added first to extract the salt myofibril proteins, then followed by other ingredients. The mixture is blended till smooth homogenous paste is obtained.

GMP:

Keep the temperature low (≤10°C) during mixing

3. Mould/ shape dough

Pipe the dough to baking trays.

4. Baking

Bake the dough at 160°C for 20 minutes, then lower the temperature to 120°C for 15 minutes.

GMP:

The oven temperature has to be at set temperature (160°C) before baking

5. Cooling

Cool the biscuit to room temperature.

6. Packing and storage

Pack in PE plastic bag, then store at room temperature.

ILLUSTRATED FLOW CHART OF PROCESSING OF FISH BISCUIT

1. Minced fish meat *(Decapterus macrosoma)* + other ingredients

↓

2. Mix minced fish with other ingredients

↓

3. Mould/ shape the dough

↓

4. Bake biscuit

↓

5. Cool until room temperature

↓

6. Pack and store

C. Shelf Life Study of Fish Biscuit

The shelf life study of fish biscuit includes the microbiological testing (total aerobic count and anaerobic count), chemical test (POV) and sensory test. The microbiological test result would be compared to the standard limit for ready-to-eat fish products (ICMFS, 1986) (Table 2).

At room temperature, fish muffin can still be safely consumed even up to Week 4 (Table 60). However, the sensory evaluation conducted to this product proved otherwise. Up to the 2nd week of storage, the texture of the product has not changed. By the 3rd week of storage, change in texture (i.e. soggy, not crispy) started to be detected. By 4th week, the biscuit's texture was not acceptable. Hence, with non vacuum, plastic packaging, the fish biscuit can have shelf life of approximately 2 weeks.

Table 61. Shelf life study of fish biscuit stored at room temperature

	Total Aerobic Count (cfu/ g)	*Total Anaerobic Count (cfu/ g)*	*POV (mEq/ kg fat)*	a_w
Day 2	**ND**	**ND**	6.2	0.25
Week 1	**ND**	**ND**	5.8	
Week 2	**ND**	**ND**	7.1	
Week 3	**ND**	**ND**	7.3	0.47
Week 4	**ND**	**ND**	7.4	0.51

Appendix

Costing

1. Comminuted Products
2. Dried Products
3. Smoked Product
4. Other Products

Costs is, no doubt, one of the utmost consideration in small medium enterprises. The ability to produce good quality products at the lowest production costs, combined with correct marketing to the right target consumers, are the key to the profitability of a company and, hopefully, long term success. The product costing is relatively complex, which involves the basic, straightforward costs, such as ingredients, manpower, equipments and rental, as well as indirect costs, such as the cost of marketing, retail and distribution and even equipment maintenance.

In this section, only the costs of product ingredients are considered. Granted that even for ingredient costs, there is a wide variation from country to country. However, it is hoped that this basic information may be useful for prospective enterprises as reference for cost estimation.

Rate of US$ to other currencies as in 22 Jun 2006:

US$ 1 = Malaysia RM 3.6637
US$ 1 = Philippines Peso 53.1506
US$ 1 = Singapore $ 1.5908
US $ 1 = Thai Baht 38.3002

1. Comminuted Products

1. Fish burger (Malaysia)

Ingredient	Composition (%)	Weight (g)	Ingredient retail cost/ kg (RM)	Material cost for 2 kg fish burger (RM)
Mackerel minced meat	70.00	1400.00	2.50	3.50
Salt	1.30	26.00	1.00	0.03
Sugar	1.86	37.20	1.40	0.05
Onion	4.51	90.20	1.60	0.14
Garlic	0.45	9.00	3.50	0.03
Red chilli	0.45	9.00	5.00	0.05
Milk	4.51	70.20	4.40	0.31
Margarine	0.42	8.40	1.00	0.01
Egg white	3.26	66.20	36.00	2.38
Bread crumb	4.32	86.40	5.50	0.48
Tapioca starch	6.32	126.40	1.20	0.15
Pepper	0.45	9.00	10.00	0.09
Soya protein	0.45	9.00	10.50	0.09
M.S.G	0.23	4.60	8.00	0.04
I.G	0.02	0.40	95.00	0.04
Water	2.45	49.00		0.12
Total	**100.00**	**2000.00**		**7.50**

Estimated ingredient cost for making 2 kg of frozen fish burger (approximately 43 pieces): RM 7.50 (US$ 2.05)

Fish Burger

2. Fish sausage (Philippines)

Ingredients	Composition (%)	Ingredient retail cost/ unit (P)	Material cost for 1 kg fish sausage (P)
Surimi	66.08	266.67/ kg	176.22
Isolate	0.79	25.00/ 100 g	1.98
TVP	1.32	70.00/ kg	0.92
Agar	0.26	40.00/ 100 g	1.04
Salt	1.72	30.00/ kg	0.52
Curing salt	0.13	9.00/ 250 g	0.05
Oil	4.10	27.00/ 1000 ml	1.11
Phosphate	0.33	30.00/ 250 g	0.40
Pineapple juice	7.66	14.50/ 236 ml	4.71
Water	12.69	-	0.00
Brown sugar	1.85	27.00/ kg	0.50
Black pepper	0.40	35.25/ 35 g	4.03
Garlic powder	1.32	485/ kg	6.40
Anisado wine	1.06	15.00/ 350 ml	0.45
MSG	0.13	97.00/ kg	0.13
Food colour	0.16	18.15/ 20 ml	1.45
Total	**100.00**		**199.89**

Estimated ingredient cost for making 1 kg of frozen fish sausage (equivalent of around 25 pieces of 40 g/ piece): 199.89 Pesos (US$ 3.76)

Fish Sausage

3. Fish kikiam (Philippines)

Ingredients	Composition (%)	Ingredient retail cost/ unit (P)	Material cost for 1 kg fish kikiam (P)
Roundscad minced meat	41.36	266.67/ kg	110.2947
Shrimp meat	12.41	150.00/ kg	18.615
TVP	1.65	70.00/ kg	1.155
Egg	9.92	3.50/ pc	5.75
Onion	6.04	50.00/ kg	3.02
Celery	5.71	70.00/ kg	3.997
Carrots	5.13	30.00/ kg	1.539
Turnips	6.20	25.00/ kg	1.55
Cornstarch	4.14	40.00/ kg	1.656
Flour	4.14	40.00/ kg	1.656
Nguyong powder	0.50	30.00/kg	0.15
White pepper	0.41	348.95/530 g	2.699425
Coarse salt	1.98	10.00/kg	0.198
MSG	0.41	97.00/kg	0.3977
Taupee wrapper		5.00/pc	25
Total	**100.00**		**177.68**

Estimated ingredient cost for making 1 kg of fish kikiam (equivalent of around 27 pieces of 36 g/ piece): 177.68 Pesos (US$ 3.34)

Fish Kikiam

4. Fish loaf (Philippines)

Ingredients	Composition (%)	Ingredient retail cost/ unit (P)	Material cost for 1 kg fish loaf (P)
Round scad surimi	48.46	266.67/ kg	129.23
Egg	8.31	3.50/ pc	4.82
Ground shrimp	8.31	150/ kg	12.47
Water	12.46		
Quick-cooking rolled oats	17.31	80.30/ kg	13.90
Finely chopped onion	4.33	50.00/ kg	2.17
Salt	0.35	30.00/ kg	0.11
Pepper	0.21	39.50/ 50 g	1.66
Dried leaf marjoram	0.10	27.95/ 7 g	3.99
Dried leaf basil	0.05	29.85/ 9 g	1.66
Dried leaf rosemary	0.04	30. 45/ 11 g	1.11
Curing salt	0.07	9.00/ 250 g	0.03
Total	**100**		**171.13**

Estimated ingredient cost for making 1 kg of fish loaf (equivalent of around 34 pieces of 29 g/ piece): 171.13 Pesos (US$ 3.32)

Fish Loaf

5. Fish siomai (Philippines)

Ingredients	Composition (%)	Ingredient retail cost/ unit (P)	Material cost for 1 kg fish siomai (P)
Indian mackerel minced meat	48.89	200/ kg	97.78
Sugar	2.07	38.00/ kg	0.79
Coarse salt	2.19	10.00/ kg	0.22
Sesame oil	0.30	94.75/ 207 ml	1.37
Shrimp meat	12.22	150.00/ kg	18.33
MSG	0.10	97.00/ kg	0.10
Pepper	0.10	348.95/ 530 gm	0.66
Carrots	5.87	30.00/ kg	1.76
Egg	11.73	3.50/ pc	6.80
Tapioca/ corn starch	1.27	40.00/ kg	0.51
Water	11.73		0.00
Chopped garlic	2.93	40/ kg	1.17
Spring onion	0.60	185/ kg	1.11
Siomai wrapper		16.35/ 100 pc	8.18
Total	**100**		**138.77**

Estimated ingredient cost for making 1 kg of fish siomai: 138.77 Pesos (US$ 2.61)

Fish Siomai

6. Fish burger (Philippines)

Ingredients	Composition (%)	Ingredient retail cost/ unit (P)	Material cost for 1 kg fish burger (P)
Round scad minced meat	58.43	200/ kg	116.86
TVP	3.00	70.00/ kg	2.10
Carageenan	0.10	1,000/ kg	1.00
Water	10.02		
Refined salt	1.33	30.00/ kg	0.40
Phosphate	0.25	30.00/ 250 g	0.30
White sugar	1.17	38.00/ kg	0.44
Ground black pepper	0.38	35.25/ 35 g	3.83
Garlic powder	0.27	485.00/ kg	1.31
MSG	0.17	97.00/ kg	0.16
Evaporated milk	2.84	36.30/ 378 ml	2.73
Egg	10.02	3.50/ pc	5.81
Potato starch	1.67	40.00/ kg	0.67
Onion chopped	10.02	50.00/ kg	5.01
Hamburger seasoning	0.33	28.00/ 32 g	2.89
Total	**100**		**143.51**

Estimated ingredient cost for making 1 kg of low cost fish burger: 143.51 Pesos (US$ 2.70)

Fish Burger

7. Fish cocktail (Philippines)

Ingredients	Composition (%)	Ingredient retail cost/ unit (P)	Material cost for 1 kg fish cocktail (P)
Mackerel minced meat	59.0	200.00/ kg	118.00
Pork fat	7.08	90.00/ kg	6.37
TVP	2.12	70.00/ kg	1.48
Salt	2.36	30.00/ kg	0.71
Curing salt	0.16	9.00/ 250 g	0.06
Phosphate	2.36	30/ 250 g	2.83
Refined sugar	1.77	38.00/ kg	0.67
Black pepper	0.35	35.25/ 35 g	3.53
All purpose flour	2.36	40.00/ kg	0.94
Pickle relish	2.36	80.00/ kg	1.89
Onion	2.36	50.00/ kg	1.18
Raisin	1.77	80.00/ kg	1.42
MSG	0.12	97.00/ kg	0.12
Carrots	2.36	30.00/ kg	0.71
Pineapple juice	1.77	14.50/ 236 ml	1.09
Water	11.80		0.00
Garlic oil	0.12	94.75/ 207 ml	0.57
Chopped garlic	1.77	40.00/ kg	0.71
Carageenan	0.12	1,000/ kg	1.20
Total	**100**		**143.47**

Estimated ingredient cost for making 1 kg of fish cocktail: 143.47 Pesos (US$ 2.70)

Fish Cocktail

8. Fish crunchies (Philippines)

Ingredients	Composition (%)	Ingredient retail cost/ unit (P)	Material cost for approximately 1 kg fish crunchies (P)
Round scad minced meat	22.43	200.00/ kg	44.86
Iodized salt	1.78	30.00/ kg	0.53
Garlic powder	0.87	485.00/ kg	4.22
Egg	23.75	3.50/ pc	13.78
Wheat flour	49.48	40.00/ kg	19.79
MSG	0.24	97.00/ kg	0.23
Chili powder	0.87	20.25/ 45 g	3.92
Baking powder	0.58	8.75/ 50 g	1.02
Oil (for frying)		110.80/ 1.6 kg	12.23
Total	**100**		**100.57**

Estimated ingredient cost for making 1 kg of fish crunchies: 100.57 Pesos (US$ 1.89).

Fish Crunchies

9. Fish sausage (MFRD)

Ingredients	Composition (%)	Ingredient retail cost/ kg (S$)	Material cost for 1 kg fish sausage (S$)
Mackerel mince meat	66.46	5.00	3.32
Water	20.03		
Salt	2.00	0.80	0.016
Sugar	1.02	1.65	0.007
Milk powder	1.94	7.00	0.136
Starch	3.33	1.00	0.033
MSG	0.67	5.00	0.034
Oil	3.33	2.00	0.067
Garlic powder	0.24	15.94	0.038
Phosphate	0.27	3.50	0.009
$NaNO_3$	0.22	1.00	0.002
White pepper	0.07	2.50	0.002
Allspice	0.03	15.55	0.005
Wheat fibre	0.39	5.00	0.020
Edible casing		0.13/m	0.344
Total	**100**		**4.03**

Estimated ingredient cost for making 1 kg of fish sausage: S$ 4.03 (US$ 2.53)

Fish Sausage

2. Dried Fish Products

1. Seasoned dried minced fish sticks (Pla Pan) (Thailand)

Ingredient	Composition (%)	Ingredient retail cost/ kg (Baht)	Cost of 1 kg raw material (Baht)
Mackerel minced meat	85.46	90	76.91
Soybean sauce	5.56	39	2.17
Sugar	8.55	15	1.28
Coriander seed	0.13	110	0.14
Fennel	0.14	340	0.48
Pepper powder	0.17	160	0.27
Total			81.26
1 kg raw material will yield approximately 380 g end product (Pla Pan)			
Estimated cost of 1 kg Pla Pan			***253.92***

Estimated cost of 1 kg of *Pla Pan*: 253.92 Baht (US$ 6.63)

Seasoned dried minced fish sticks (Pla Pan)

2. Semi dried fish sticks (Pla Sen) (Thailand)

Ingredient	Composition (%)	Ingredient retail cost/ kg (Baht)	Cost of 1 kg raw material (Baht)
Mackerel minced meat	89.93	90	80.94
Kikkoman	4.5	109	4.91
Sugar	4.5	15	0.68
Pepper	0.49	160	0.78
Sesame	0.58	111.5	0.65
Total			87.95
1 kg raw material will yield approximately 560 g end product (Pla Sen)			
Estimated cost of 1 kg Pla Sen			***157.10***

Estimated ingredient cost for making 1 kg of Pla Sen: 157.10 Baht (US$ 4.10)

Semi dried fish sticks (Pla Sen)

3. Fish cracker (keropok stick) (Malaysia)

Ingredient	Composition (%)	Weight (g)	Ingredient retail cost/ kg (RM)	Material cost for 1 kg fish cracker (RM)
Round scad/ slander scad minced meat	50.00	1000.00	2.50	2.50
Dried shrimp	5.00	100.00	30.00	3.00
Sago flour	8.00	160.00	1.30	0.21
Tapioca starch	28.00	560.00	1.20	0.67
Salt	1.50	30.00	1.00	0.03
M.S.G	0.45	9.00	8.00	0.07
I.G	0.05	1.00	95.00	0.10
Water and ice	7.00	140.00		
Total		2000		6.58
1 kg raw material will yield approximately 500 g final material (Fish cracker)				
Estimated cost of 1 kg Smoked mackerel				***142.72***

Estimated ingredient cost for making 1 kg of fish cracker (estimated from 2 kg of mixture):
RM 6.58 (US$ 1.80)

Fish cracker (keropok stick)

4. Fish cubes (Philippines)

Ingredients	Composition (%)	Ingredient retail cost/ unit (P)	Material cost for 1 kg fish cubes (P)
Fish powder	19.44	1,000/kg	194.40
Toasted flour	20.36	40.00/ kg	8.14
Onion powder	1.77	23.00/ 37 gm	11.00
Garlic powder	1.12	485.00/kg	5.43
Agar	0.47	40.00/ 100 gm	1.88
White pepper	0.75	348.95/530 gm	4.94
Refined salt	36.65	30.00/kg	11.00
Allspice	0.61	25.80/ 32 gm	4.92
Corn oil	17.31	152.50/ 1.5 kg	17.60
Sesame oil	0.06	94.75/ 207 gm	0.27
Ascorbic acid	0.51	35.00/ 50 gm	3.57
MSG	0.61	97.00/kg	0.59
Brown sugar	0.31	27.00 / kg	0.08
Sodium benzoate	0.03	140.00 / 100 gm	0.42
Total			**264.25**

Estimated ingredient cost for making 1 kg of fish cubes: 264.25 Pesos (US$ 4.97)

Fish cubes

3. Smoked Fish Product

1. Smoked mackerel (Thailand)

Ingredient	Composition (%)	Ingredient retail cost/ kg (Baht)	Material cost for 1 kg smoked mackerel (Baht)
Mackerel fillet	66.68	90	60.01
Salt	1.03	25	0.26
Sugar	2.42	15	0.36
Nutmeg	0.13	1,200	1.60
Allspice	0.07	2,760	1.84
Pepper powder	0.33	160	0.53
Water	29.34	-	-
Total			65.60
1 kg raw material will yield approximately 680 g final material (Smoked mackerel)			
Estimated cost of 1 kg Smoked mackerel			***142.72***

Estimated ingredient cost for making 1 kg of smoked mackerel: 142.72 Baht (US$ 3.73)

Smoked mackerel

4. Other Fish Products

1. Frozen butterfly breaded fish (Malaysia)

Ingredient	Composition (%)	Weight (g)	Ingredient retail cost/ kg (RM)	Material cost for 4 kg butterfly breaded fish (RM)
Round scad fish		3000.0	3.00	9.00
Battering agent:				
Batter mix		240.0	6.50	1.56
Salt		15.0	1.00	0.02
Sugar		20.0	1.40	0.03
Pepper		5.0	10.00	0.10
MSG		0.25	8.00	0.002
I.G		0.05	95.00	0.005
Water		719.7		
Total		***100.0***		
Breading agent:				
Bread crumb (golden)		750.0	5.50	4.13
Total				**14.97**

Estimated ingredient cost for making 4.75 kg of frozen butterfly breaded (approximately 24 pieces): RM 14.97 (US$ 4.09)

Frozen butterfly breaded fish

2. Steamed fish (Thailand)

Ingredient	Composition (%)	Ingredient retail cost/ kg (Baht)	Material cost for 1 kg steamed fish (Baht)
Mackerel fish	58.82	60	35.29
Table salt	5.88	25	1.47
Crude salt	35.29	10	3.53
Total			**40.29**

Estimated ingredient cost for making 1 kg of steamed fish: 40.29 Baht (US$ 1.05)

Steamed Fish

3. Frozen braised fish (MFRD)

Ingredients	Composition (%)	Ingredient retail cost/ kg (S$)	Material cost for 1 kg braised fish (S$)
Raw mackerel	70	2.00	1.40
Seasonings:			
Water	18.6	-	
Soy sauce	3.0	2.30	0.07
Garlic	1.4	1.50	0.02
Ginger	2.9	3.00	0.09
Sugar	4.1	1.65	0.03
Total			**1.64**

Estimated ingredient cost for making 1 kg of braised fish: S$ 1.64 (US$ 1.04)

Frozen braised fish

4. Fish muffin (MFRD)

Ingredient	Composition (%)	Ingredient retail cost/ kg (S$)	Material cost for 1 kg raw material of fish muffin (S$)
Round scad surimi	29.88	5.00	1.49
Salt	0.01	0.80	0.0008
Milk powder	2.55	7.00	0.18
Water	15.27		
Butter	6.36	4.00	0.25
Egg yolk	11.20	0.20/ pc	1.66
Lemon flavour	0.37	6.00	0.02
Corn flour	5.09	1.00	0.05
Sugar	12.73	1.65	0.09
Cream of tartar	0.25	18.67	0.01
Egg white	16.29	0.20/ pc	0.95
Total			**4.87**

Estimated ingredient cost for making 1 kg of raw material of fish muffin (yielding 800 g of muffin): S$ 4.87 (US$ 3.06)

Fish Muffin

8. Fish biscuit (MFRD)

Ingredient	Composition (%)	Ingredient retail cost/ kg (S$)	Material cost for 1 kg raw material of fish biscuit (S$)
Self raising flour	12.63	1.00	0.13
Round scad minced fish	50.54	5.00	2.53
Salt	1.26	0.80	0.01
Vegetable oil	12.63	2.00	0.25
Egg	16.85	0.20/ pc	0.76
Spices	0.69	15.00	0.10
Sugar	4.76	1.65	0.08
Fish sauce	0.63	2.30	0.01
Total			**3.88**

Estimated ingredient cost for making 1 kg of raw material of fish biscuit: S$ 3.88 (US$ 2.44)

Fish Biscuit

Appendix

Standard Operating Procedures (SOP) processing of Surimi and Unwashed Minced Fish Meat from Pelagic Fish

STANDARD OPERATING PROCEDURES (SOP) FOR PROCESSING OF SURIMI AND UNWASHED MINCED FISH MEAT FROM PELAGIC FISH

1. Treatment of raw materials

- Fish should be iced to maintain fish at low temperature (~5°C) to avoid deterioration
- Remove head and viscera of fish (including the kidneys and the peritoneal membranes)
- Wash deheaded and degutted fish with ice water (preferably in a fish washer) to remove gross contamination

Fish washer

2. Meat-bone separation

- Chilled deheaded and degutted fish are sent to the meat bone separator to remove fish skin and bones.
- During operation, keep machine in cooled conditions with ice to ensure minced meat obtained is maintained at low temperature

Meat bone separator

For preparation of unwashed minced fish meat, go to step 5

For preparation of surimi, go to step 3

3. Alkaline leaching

- Place fish meat into leaching tank in ratio of (2-3 : 4-5) (fish meat : iced water 10-15°C) respectively
- Iced water should be added with 0.2 to 0.3% salt
- Adjust pH of water to 6.8 to 7.0 by the use of sodium bicarbonate, with the pH indication from pH meter or pH strips

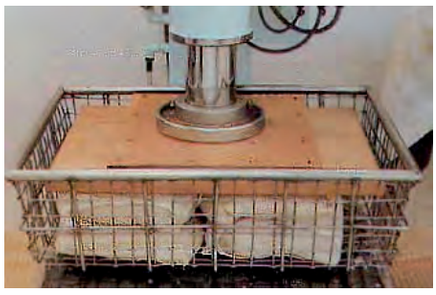
3.3.1 Removal of excess water

(This process can be achieved in batch leaching or continuous leaching methods)

Leaching using nylon mesh

3.3.2 Batch leaching method

- Leached meat is removed from washing tank and placed on nylon mesh to drain the water
- Drained meat is transferred to nylon bags and with the help of manual hydraulic press to further press out more water (final moisture 80-82%)



Hydraulic press

3.3.3 Continuous leaching method

Continuous leaching using rotary sieve

- The meat slurry from the washing tank is pumped to the rotary sieve
- Water is sprayed onto the meat on the rotary sieve
- The leached meat from the rotary sieve falls directly into the continuous screw press to press out more water (final moisture 80-82%)

Continuous screw press

4. Removal of excess water (straining)

Strainer

- Meat is passed through the strainer to remove the remaining scales, connective tissues, membrane and small bones from the leached meat. The leached meat filter through strainer with the fine mesh of size 1.2 – 3.2 mm.

5. Mixing with cryoprotectants and polyphosphate

- Strained meat is thoroughly mixed with cryoprotectants (eg.sugar) and polyphosphate, which act to prevent freezer burnt and serve as water binding agent respectively.
- Add sugar as cryoprotectants in amounts of 3-5%
- Add polyphosphate in amounts not more than 0.3%

Mixing using silent cutter

6. Frozen storage

- Surimi is packed in polyethylene bags of 10 kg /bag and about 8 cm thick
- Store surimi blocks in contact freezer to bring down temperature of the center surimi block to –20°C
- Store frozen surimi block at –20°C

Figure 1. Continuous and Batch Surimi/ Unwashed Fish Minced Meat Processing