

# Maximizing Utilization of Fish Catch- *Freshwater Species*

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# **SOUTHEAST ASIAN FISHERIES DEVELOPMENT CENTER**

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## *Introduction*

### ***Freshwater fisheries in Cambodia***

Cambodia's extensive river system covers 2.7% of total surface area and contains high mineral and nutrients. This has made Cambodia rank number four in inland fisheries productivity behind China, India and Bangladesh. The coastal area also has potential productivity. The total freshwater, marine capture fisheries and aquaculture production is estimated at about 350,000 to 500,000 metric tonnes per year. This provides for 75% of the total animal protein intake in people's diets and represents a value of US\$ 200 to 300 million. As a result, the National Institute of Statistics showed in 2001 that fisheries contribute 11.4% to gross domestic product.

Freshwater capture fisheries contribute more to national food security and the economy than other fisheries do in the country. The annual catch ranges between 290,000 to 430,000 metric tonnes, which is the fourth largest in the world. Cambodia's freshwater fisheries have a rich bio-diversity of species. Rainboth (1996) reported that approximately 500 species are present or likely to be encountered in, fisheries in the Cambodian

Mekong and Tonle Sap Great Lake.

The freshwater fisheries in Cambodia play a more important role than marine fisheries sector contributing about 90% of the total fish production. The freshwater fisheries cover about one third of the country area. Most of the Cambodian people live close to water bodies and their livelihoods is largely dependent on these water bodies.

The recent and most reliable freshwater fisheries statistics in Cambodia is from the collaborative MRC and Department of Fisheries (MRC/DOF) project. The statistics has indicated the significant contribution of the fisheries sector to the rural people economy and the social requirements (Van Zalinge et al. 2000a). The freshwater fisheries statistics is important for decision-making on the options by government for the development of the country's economy.

The most comprehensive data and information are from the MRC/DOF socio-economic and catch assessment surveys of parts of the country (Ahmed et al. 1998, Van Zalinge et al. 1999, 2000).

- Cambodia's freshwater Capture fisheries production of over 400,000 metric tonnes per year.
- Estimated value at landing site is around USD 200 millions. The estimated retail value is about USD 300 millions.
- Exports are underestimated, but exceed 50,000 metric tonnes/year (Van Zalinge et al. 2001).
- Countrywide fish consumption is around 30-40 Kg/person per year. The average per capita fish consumption in central Cambodia is 67 Kg.

**Table 1: Cambodia's Total Annual Freshwater Fish Catch (Metric Tonnes, MT)**

Years	Large Scale (MT)	Small Scale (MT)	Rice field (MT)	Total Production (MT)
2000	85,600	115,000	45,000	<b>245,600</b>
2001	135,000	140,000	110,000	<b>385,000</b>
2002	110,300	140,000	110,000	<b>360,300</b>
2003	94,750	120,000	94,000	<b>308,750</b>
2004	68,100	106,000	75,500	<b>249,600</b>

Source: DOF (2000-2004)

### **Freshwater fish utilization in Cambodia**

The role of freshwater fish in food security is under represented in Cambodian policy with greater emphasis being placed on the role of rice. Whilst rice forms the basis of the Cambodian diet, it would also be fair to say that fish is included in virtually every Cambodians' meal. Soups are commonly consumed with fish sauce and vegetables are often eaten with fermented fish paste (*prahok*). Freshwater fish is the preferred fish for the majority of Cambodians (DOF, 2001d).

Traditionally, rural people would use their free time while cultivating rice, to travel to fishing regions, where they could capture or buy fish at a lower price for their consumption. Processed and fermented fish products provided the rural and remote communities as a form of food fish, as supply of fresh fish was very limited.

Contrary to anecdotal claims that ethnic Cambodian are fermented fish eaters, Csavas (1991) FAO expert, noted that Cambodians preferred fresh fish to processed and fermented products, e.g. *prahok* and *pha-ork*. In reality, Cambodians, especially those of Cambodian origin,

the major ethnic group in the country, prefer freshwater fish in live or very fresh condition. They use fermented fish paste (*prahok*) as a high protein flavor ingredient, fish sauce as a way to salt and flavour food, and sun-dried salted fish and smoked fish are other commonly eaten forms of preserved fish.

### **SEAFDEC Special 5-Year Project on Maximizing Utilization of Fish Catch-Freshwater Species**

In 2004-2005, under the Southeast Asian Fisheries Centre (SEAFDEC), Special 5-Year Programme on Maximization of the Fish Utilization, the Marine Fisheries Research Department (MFRD) Singapore, in collaboration with the Department of Fisheries (DOF), Cambodia, conducted a project on the development of value-added products from freshwater fish.

Initially, four freshwater fish species were identified to be utilized for the project. However, the project focused on three freshwater fish species for utilization. The three freshwater fish species are namely; featherback fish

(*Notopterus spp.*), snakehead fish (*Channa spp.*) and soldier river barbs (*Cyclocheilichthys enoplus*).

For the featherback fish, four value-added products were developed from frozen fish mince. The four products were namely; fish *bah kwa*, fish cracker, fish *siew mai* and fish tofu. For the snakehead fish, the same four products were developed from frozen fillets that were minced up. For the soldier river barbs, two value-added products were developed. The frozen mince was used to make fish murukku and the headed fish (whole) was used to make fish *satay*.

Shelf-life studies were conducted for all products developed for this project. The aim of the shelf-life studies is to observe the stability of the products in terms of microbiological, chemical and sensory attributes over the storage period. The data obtained will be useful to processors who are interested in developing the products.

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## *Freshwater fish species utilized*

- 1. *Notopterus notopterus***
- 2. *Channa striata***
- 3. *Cyclocheilichthys enoplus***



### Featherback fish (*Notopterus notopterus*)

<b>Family:</b>	<i>Notopteridae</i> ( Featherback or knifefishes)
<b>Order:</b>	<i>Osteoglossiformes</i> (bony tongues)
<b>Class:</b>	<i>Actinopterygii</i> (ray-finned fishes)
<b>Local name:</b>	Trey slat
<b>Country of origin:</b>	Cambodia
<b>Max. size:</b>	Up to 60 cm
<b>Importance:</b>	Commercial fisheries

#### **Biology:**

Found in freshwaters of south and southeastern Asia. Occurs in standing and sluggish waters of lake, floodplains, canals, and ponds. Feeds on insect, fish, crustaceans and some young roots of aquatic plants, it is most active during the twilight and at night. Colonizes and breeds in seasonally inundated areas during rainy season and migrates back to permanent water in the dry season. Caught by seines, lift-nets, and barrages. Marketed fresh.

#### **Season for harvesting:**

October to May (Open season)

#### **Utilization means:**

Processed into fish ball, dries salted fish etc., for local consumption and export.

#### **Export:**

Large numbers are shipped on ice from fish landing ground at the Tonle Sap Great Lake to markets in Thailand and Vietnam.





### Snakehead fish (*Channa striata*)

<b>Family:</b>	<i>Channidae</i> (Snakeheads)
<b>Order:</b>	<i>Perciformes</i> (perch-likes)
<b>Class:</b>	<i>Actinoterygii</i> (ray-finned fishes)
<b>Local name:</b>	Trey raws/ Trey phtuok
<b>Country of origin:</b>	Cambodia
<b>Max. size:</b>	Up to 100 cm
<b>Importance:</b>	Commercial fisheries (highly demanding)

#### **Biology:**

Inhabits ponds, streams, and rivers, preferring stagnant and muddy water of plains. Found mainly in the lowland rivers. More common in relatively deep (1-2m), still water. Very common in freshwater plains. Occur in medium to large rivers, brooks, flooded fields and stagnant waters including sluggish flowing canals. One of the most common snakeheads in Cambodia. Feeds on fishes, frogs, snakes, insect, earthworms, and crustaceans. Caught with seines, gill-nets, traps, and baited hooks. Marketed fresh or alive.

#### **Season for harvesting:**

October to May (Open season)

#### **Utilization means:**

Processed into frozen, dried fillet fish, pra-hoc, *mam-ruot* and *mam caloc* (varieties of fish paste) etc., for local consumption and export.

#### **Export:**

Large numbers are shipped on ice from fish landing ground at the Tonle Sap Great Lake to markets in Thailand, Australia, USA, etc.



### **Soldier river barb (*Cyclocheilichthys enoplus*)**

<b>Family:</b>	<i>Cyprinidae</i> (Minnows or carps)
<b>Order:</b>	<i>Cypriniformes</i> (Carps)
<b>Class:</b>	<i>Actinopterygii</i> (ray-finned fishes)
<b>Local name:</b>	Trey chhkok
<b>Country of origin:</b>	Cambodia
<b>Max. size:</b>	Up to 74 cm
<b>Importance:</b>	Commercial fisheries

#### **Biology:**

Found at midwater to bottom level of rivers in Cambodia. Common in Mekong river. Lives in rivers and spawns during the rainy season, probably on floodplains or inundated riparian forests. Returns to the rivers from October to December with the catch decreasing steadily in size as the fishing season progresses in the Tonle Sap Great Lake. Young feed on the zooplankton and adults on insect larvae, crustacean, and fish. Taken with seines, cast-nets, gill-nets, set-nets, and traps. A desirable food fish, marketed fresh.

#### **Season for harvesting:**

October to May (Open season)

#### **Utilization means:**

Processed into fish ball, *Pra-ork* (varieties of fish paste) etc., for local consumption and export.

#### **Export:**

Large numbers are shipped on ice from fish landing ground at the Tonle Sap Great Lake to markets in Thailand, Australia and USA, etc.



## *Value-added fish products developed*

- 1. Fish bah kwa***
- 2. Fish siew mai***
- 3. Fish tofu***
- 4. Fish cracker***
- 5. Fish murukku***
- 6. Fish satay***

## Fish *bah kwa* (Sweetmeat)

### Product Description:

#### Fish *bah kwa* (Sweetmeat)

*Bah kwa* is a traditional Chinese sweetmeat product made from pork or chicken and commonly eaten as a form of Chinese New Year goodies. It is a new product concept that uses fish to make *bah kwa*. For this product, MFRD is able to utilize freshwater fish; featherback (*Notopterus spp.*) and snakehead (*Channa spp.*) to make *bah kwa*. Fish *bah kwa* is a sweet snack with optional spicy, chili or black pepper varieties. The product has a nice shade of red to orangy color. It has a slight chewy texture with an acceptable fish and barbecued flavor. Fish *bah kwa* can be eaten as a snack, served with rice or bread as a sandwich.

#### Out line of Processing

The processing method of fish *bah kwa* is shown in Figures 1 and 1a. The marinated fish mince from featherback are minced and mixed in a low-temperature vacuum mixer to achieve a homogenous paste. As for the snakehead fillets, 70% of the marinated fillets are cut and minced into homogenous paste and 30% of the marinated fillets are cut into small pieces and mixed into the paste. The paste is then filled into a sausage casing, sealed and chilled. The product is chilled for 2 hours to allow binding in the product. The product is then freeze for 24 hours at  $-18^{\circ}\text{C}$ . The frozen product is sliced and dried in the hot air oven at  $65^{\circ}\text{C}$  for approximately 1 hour, to achieve 20 – 25% moisture content. The dried fish *bah kwa*

is then grilled before consumption.

#### 1. Ingredients preparation

The ingredients used are frozen featherback fish mince or frozen snakehead fillets. The frozen fish are thawed at ambient temperature for about 1 hour with the aid of a blowing fan.

#### Important points on quality control

Ensure freshness of thawed featherback fish mince or snakehead fillets fish by chilling them if not used immediately.

#### 2. Marinating

The fish are marinated with ingredients such as; vegetable oil, fish sauce, flavor and sugar.

#### Important points on quality control

Ensure the fish fillets are well marinated and kept chilled ( $3-5^{\circ}\text{C}$ ) for 24 hours.

#### 3. Mixing

Blend all the marinated featherback fish mince or the snakehead fillets and ingredients in the vacuum mixer. Add binding agent and mix for 3 minutes.

#### Important points on quality control

Ensure the marinated fish fillets and ingredients are blended to a uniform reddish pink colour.

#### 4. Filling

Fill the paste into a PVDC sausage casing. Seal the two ends with aluminum wire using manual or automatic clipper.

## Fish *bah kwa* (Sweetmeat) *cont*

### 5. Setting

Allow binding of meat with binder, soy protein concentrate at chilled conditions 3-5°C for 2 hours to obtain a firmer texture in the end product.

### 6. Freezing

Freeze the product at -18°C to -20°C for 24 hours.

### 7. Slicing

Slice the frozen product to the desired thickness (4mm) and place it on metal trays.

### 8. Hot Air Drying

Dry the product in the hot air oven at 70°C for approximately 1 hour to achieve moisture content of 20 to 25%.

### 9. Grilling

Grill the *bah kwa* slices using the electric griller until it turns orangy red color. The grilling process takes about 3 minutes for each slice.

### *Important points on quality control*

Constantly flip the *bah kwa* slices during the grilling process to prevent product from charring.

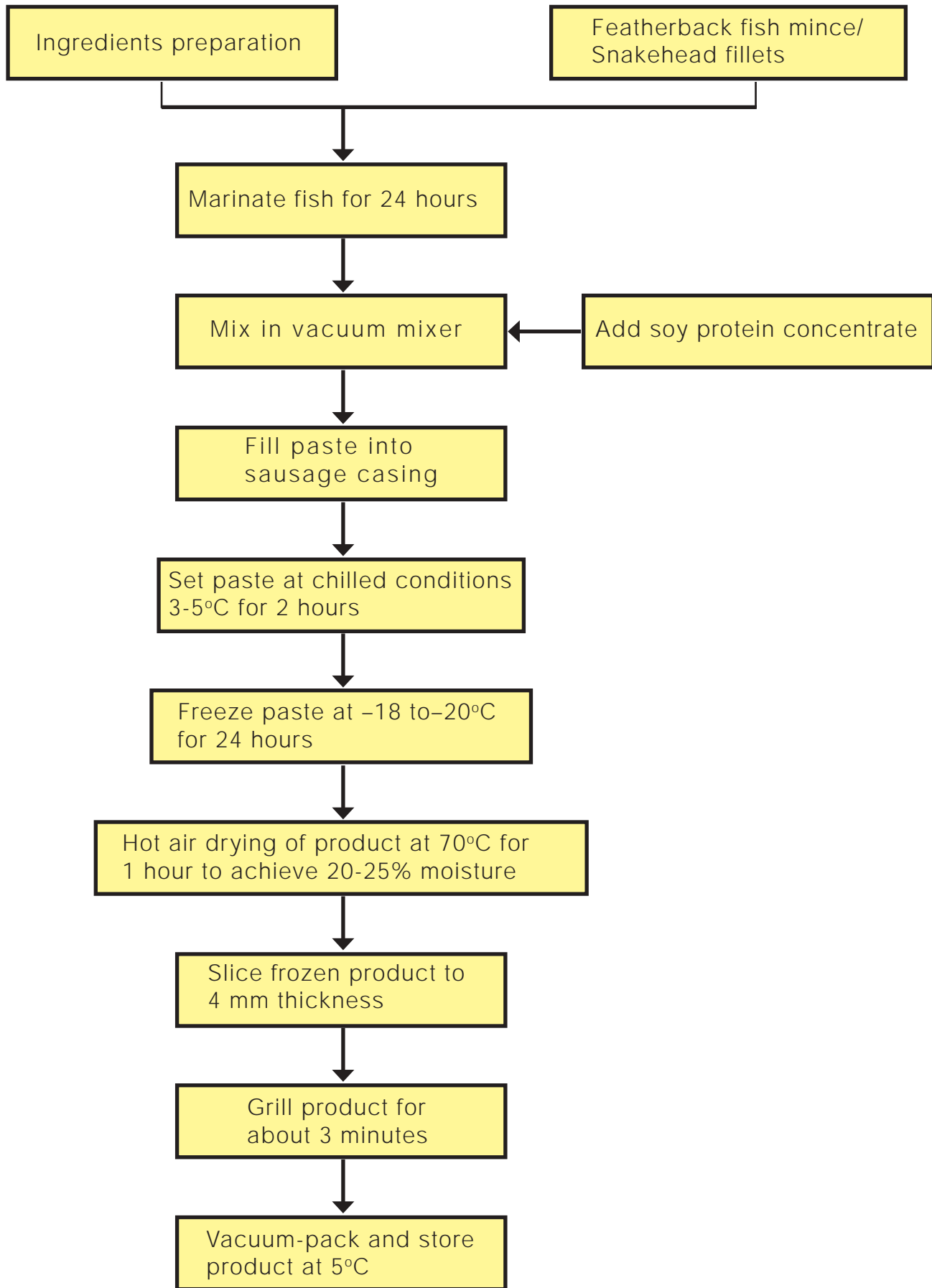
### 10. Packaging and storage

The grilled *bah kwa* is cooled and vacuum-packed. The vacuum-packed *bah kwa* is recommended to store in chilled conditions (5°C) for better quality.

### Shelf Life Study

During the shelf life study period, both the featherback fish mince and snakehead fish *bah kwa*, which were vacuum packed and stored at 5°C, showed no aerobic, anaerobic and yeast and mould count detected from week 0 to week 23 (6 months), (tables 1a and 1b). The average water activity of the featherback fish mince *bah kwa* was 0.56 and snakehead fish *bah kwa* was 0.76 (tables 1a and 1b). The peroxide value of featherback fish mince *bah kwa* ranged from 3.42mEq peroxide/kg fat in week 0 to 9.81mEq peroxide/kg fat in week 23. While the peroxide value of snakehead fish *bah kwa* ranged from 4.67mEq peroxide/kg fat in week 0 to 5.31mEq peroxide/kg fat in week 23. The chilled products were sensory assessed by dipping the packaged *bah kwa* in hot water (70-80°C) for about 5 minutes, (table 1g) showed the sensory attributes of both products. There were no signs of rancidity detected in both featherback fish mince and snakehead fish *bah kwa* during the sensory test. The other sensory attributes like texture, appearance, colour and flavour showed no major changes over the period of 6 months. The overall ranking of the product was 7 out of 10, which indicated an overall moderate liking for the product. Further improvements of the product can be made on flavour and texture to suit local preferences.

**Figure 1a. Flowchart for fish *bah kwa* processing**



**Figure 1b. Illustrated flow chart for fish *bah kwa* processing**



Frozen featherback fish mince



3. Mix/Blend



7. Dried fish *bah kwa*



Frozen snakehead fish fillet



4. Set paste at 3 – 5°C for 2 hours, then freezing it for 24 hours



8. Grill dried fish *bah kwa*



1. Raw ingredients



5. Slice frozen paste into 4 mm thickness



9. Vacuum packed fish *bah kwa*



2. Marinate fish fillet at 5°C for 24 hours



6. Dry sliced paste in the hot air oven at 70°C for 1 hour



**Table 1a. Results of shelf life studies of featherback fish mince *bah kwa***

Week	Aerobic Plate Count (cfu/g)	Yeast and Mould Count (cfu/g)	Anaerobic plate Count (cfu/g)	Peroxide value (mEq Peroxide/kg fat)	Water Activity
0	0	0	0	3.42	0.55
1	0	0	0	3.74	0.52
2	0	0	0	3.74	0.55
5	0	0	0	3.11	0.53
8	0	0	0	3.74	0.53
11	0	0	0	4.04	0.62
15	0	0	0	4.04	0.61
23	0	0	0	9.81	0.61

**Table 1b. Results of shelf life studies of snakehead fish *bah kwa***

Week	Aerobic Plate Count (cfu/g)	Yeast and Mould Count (cfu/g)	Anaerobic plate Count (cfu/g)	Peroxide value (mEq Peroxide/kg fat)	Water Activity
0	0	0	0	4.67	0.76
1	0	0	0	4.98	0.77
2	0	0	0	3.11	0.78
5	0	0	0	3.11	0.75
8	0	0	0	4.04	0.77
11	0	0	0	4.04	0.77
15	0	0	0	4.04	0.76
23	0	0	0	5.31	0.76

**Table 1c. Formulation of featherback fish mince *bah kwa***

No.	Ingredients	Composition %
1	Featherback fish mince	51.66
2	Sugar	25.32
3	Vegetable oil	13.22
4	Fish sauce	6.19
5	Seafood flavour	2.06
6	Coloring	1.00
7	Soya protein concentrate	0.51
	<b>Total</b>	100



**Table 1d. Formulation of Snakehead fish *bah kwa***

No.	Ingredients	Composition %
1	Snakehead fish fillet	51.66
2	Sugar	25.32
3	Vegetable oil	13.22
4	Fish sauce	6.19
5	Seafood flavour	2.06
6	Coloring	1.00
7	Soya protein concentrate	0.51
	<b>Total</b>	100

**Table 1e. Costing of featherback fish mince *bah kwa***

No.	Ingredients	Composition %	Cost/Unit (S\$/kg)	Cost of material (S\$/kg)
1	Featherback fish mince	51.66	4.67	2.41
2	Sugar	25.32	0.70	0.17
3	Vegetable oil	13.22	2.00	0.26
4	Fish sauce	6.19	2.30	0.14
5	Seafood flavour	2.06	45.00	0.93
6	Coloring	1.00	2.35	0.02
7	Soya protein concentrate	0.51	8.20	0.04
	<b>Total</b>	100		3.97

**Table 1f. Costing of Snakehead fish *bah kwa***

No.	Ingredients	Composition %	Cost/Unit (S\$/kg)	Cost of material (S\$/kg)
1	Snakehead fish fillet	51.66	5.85	3.02
2	Sugar	25.32	0.70	0.17
3	Vegetable oil	13.22	2.00	0.26
4	Fish sauce	6.19	2.30	0.14
5	Seafood flavour	2.06	45.00	0.93
6	Coloring	1.00	2.35	0.02
7	Soya protein concentrate	0.51	8.20	0.04
	<b>Total</b>	100		4.58

**Table 1g. Sensory attributes of featherback fish mince and snakehead fish *bah kwa***

Sensory attributes	Quality standards
Colour	Orangy red
Flavour	Barbecued and slight fish flavour
Odour	No objectionable odour
Texture	Slight chewy

# Fish *siew mai*

## Product Description:

### Fish *siew mai*

*Siew mai* is a popular Chinese *Dim Sum* delight. It is usually made from pork and prawn mince, mixed with vegetables such as chestnuts and carrots. The mince is wrapped with wonton skin leaving the top exposed. Hence, it is also known as “*open face siew mai*”. The product is then steamed and ready to be eaten. MFRD is able to utilize featherback mince and snakehead mince to make its fish *siew mai*. Other ingredients include; prawn mince, mushroom, soya sauce, fish sauce, egg white and chopped carrots as topping. The steamed product can be eaten on its own or served with chili sauce.

### Out line of Processing

The processing method of fish *siew mai* is shown in Figures 2a and 2b. The ingredients are blended in a mixer to achieve a pasty texture. The paste is then filled onto a wonton skin and wrapped, leaving only the top exposed. The open face is then topped up with chopped carrots. The *siew mai* are then placed on trays and covered with a clean moist cloth and chilled (5°C) for 2 hours. *Siew mai* are then taken out from the chiller and steamed for approximately 10 minutes. The *siew mai* is now ready to be served.

### 1. Ingredients preparation

The ingredients used are frozen featherback fish mince or frozen snakehead fillets. The frozen fish mince or fillets are thawed at ambient temperature for about 1 hour with the aid of a blowing fan. Remove head and shell of prawns and wash it clean in chilled water.

#### *Important points on quality control*

- Keep thawed items and deshelled prawns fresh by chilling them.

### 2. Cutting

The featherback fish mince or the snakehead fillets are cut into smaller pieces before putting it into the bowl cutter for mincing.

#### *Important points on quality control*

- Keep the temperature low (<10°C) during mincing.

### 3. Mixing

Add in soya sauce, fish sauce, sugar, sesame oil, mushroom and prawns into the bowl cutter to mix with the minced fish to achieve a pasty texture.

#### *Important points on quality control*

- Keep the temperature low (<10°C) during mincing.

# Fish *siew mai* (cont)

## 4. Wrapping

Wrap the paste with wonton skin and top up the open face with chopped carrots

### *Important points on quality control*

- When wrapping the paste with wonton skin, keep the temperature of the working environment low at about 20°C.

## 5. Cover the *siew mai* (uncooked) with a clean damp cloth and leave it chilled at 5°C for 2 hours

## 6. Steaming

Steam the *siew mai* in a steamer for about 10 minutes till cooked.

## 7. Cooling

Cool the steam *siew mai* before packing it into polyethylene bags to be vacuum packed.

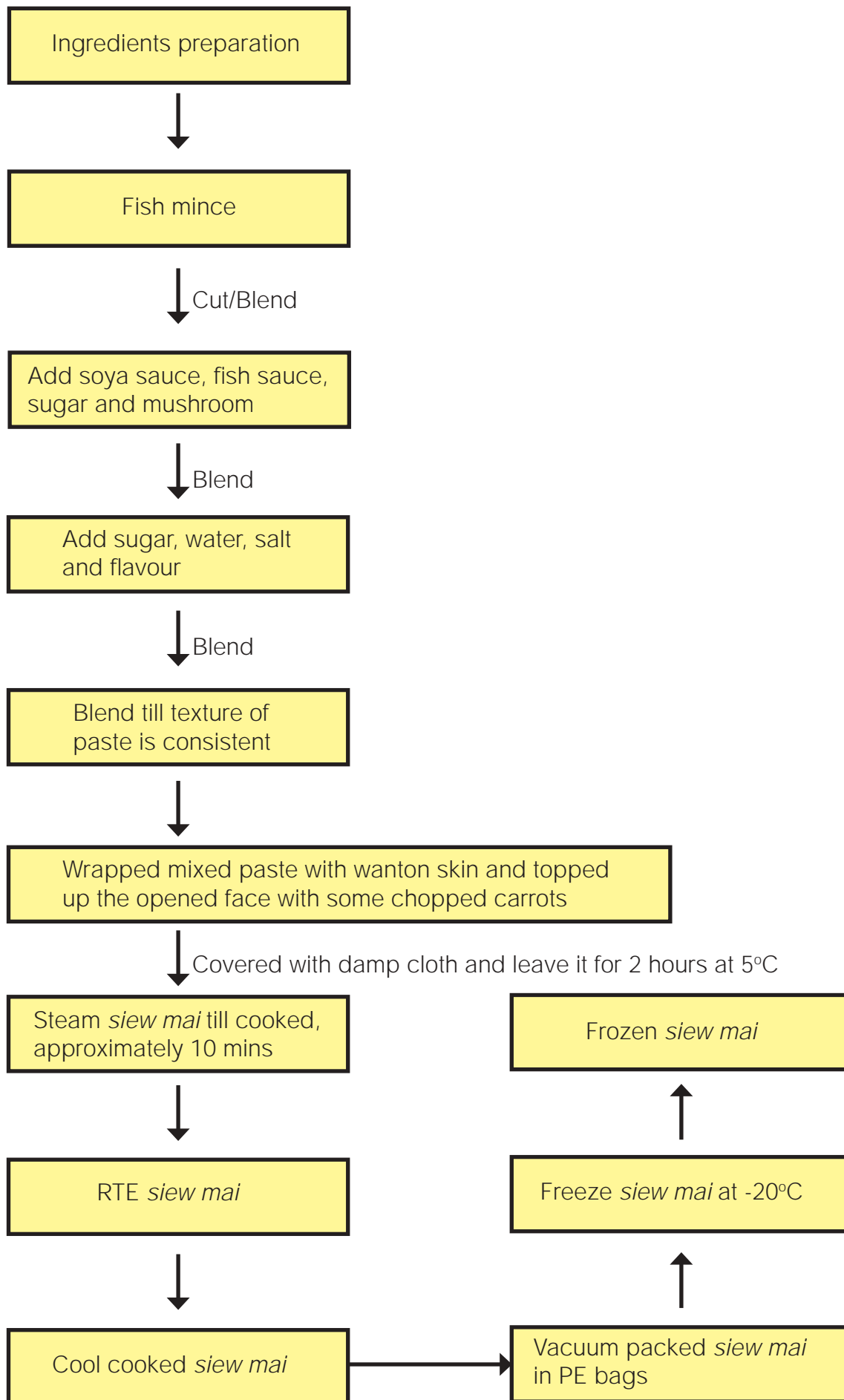
## 8. Freezing

Freeze the vacuum-packed *siew mai* at -20°C.

## Shelf Life Study

During the shelf life study period, both the featherback fish mince and snakehead fish steamed *siew mai* which were vacuum-packed in polyethylene bags and kept frozen at -20°C, showed no aerobic, anaerobic and yeast and mould count detected from week 0 to week 23 (6 months), (tables 2a and 2b). The frozen product was thawed for 20 minutes at ambient temperature and steamed to assess the sensory attributes of the product, (table 2g) showed the sensory attributes of both products. The texture, appearance, colour and flavour of the product showed no significant changes over the storage period. The overall ranking of the product is 7 out of 10, which indicated an overall moderate liking for the product by our panelists.

**Figure 2a. Flowchart of frozen fish *siew mai* processing**



**Figure 2b. Illustrated flow chart for frozen fish *siew mai* processing**



Frozen featherback fish mince



Frozen snakehead fish fillet



1. Raw Ingredients



2. Mix/Blend



3. Fill paste into wonton wrapper



4. Uncooked *siew mai*



5. Cover uncooked *siew mai* with damp cloth and leave it for 2 hours at 5°C



6. Steam *siew mai* for approximately 10 minutes



7. Steamed *siew mai*

**Table 2a. Results of shelf life study of featherback fish mince *siew mai***

Week	Total Plate Count (cfu/g)	Anaerobic Plate Count (cfu/g)
0	0	0
1	0	0
2	0	0
5	0	0
8	0	0
11	0	0
15	0	0
23	0	0

**Table 2b. Results of shelf life study of snakehead fish *siew mai***

Week	Total Plate Count (cfu/g)	Anaerobic Plate Count (cfu/g)
0	0	0
1	0	0
2	0	0
5	0	0
8	0	0
11	0	0
15	0	0
23	0	0

**Table 2c. Formulation of featherback fish mince *siew mai***

No.	Ingredients	Composition %
1	Featherback fish mince	43.62
2	Deshelled prawns	29.48
3	Soya sauce	0.96
4	Fish sauce	0.96
5	Salt	0.75
6	Sugar	1.80
7	Sesame oil	1.35
8	Canned mushroom	4.50
9	Shredded and chopped carrot	9.00
10	Wonton skin	7.52
	<b>Total</b>	100

**Table 2d. Formulation of Snakehead fish mince siew mai**

No.	Ingredients	Composition %
1	Snakehead fish fillet	43.62
2	Deshelled prawns	29.48
3	Soya sauce	0.96
4	Fish sauce	0.96
5	Salt	0.75
6	Sugar	1.80
7	Sesame oil	1.35
8	Canned mushroom	4.50
9	Shredded and chopped carrot	9.00
10	Wonton skin	7.52
	<b>Total</b>	100

**Table 2e. Costing of featherback fish mince siew mai**

No.	Ingredients	Composition (%)	Cost/Unit (S\$/kg)	Cost of material (S\$/kg)
1	Featherback fish mince	43.62	4.67	2.03
2	Deshelled prawn	29.48	9	2.65
3	Soya sauce	0.96	1.60	0.01
4	Fish sauce	0.96	2.30	0.02
5	Salt	0.75	0.26	0.001
6	Sugar	1.80	0.70	0.01
7	Sesame oil	1.35	5.00	0.06
8	Canned mushroom	4.50	6.00	0.27
9	Shredded and chopped carrot	9.00	2.00	0.06
10	Wonton skin	7.52	8.00	5.83
	<b>Total</b>	100		

**Table 2f. Costing of snakehead fish *siew mai***

No.	Ingredients	Composition (%)	Cost/Unit (S\$/kg)	Cost of material (S\$/kg)
1	Snakehead fish fillet	43.62	5.85	2.55
2	Deshelled prawn	29.48	9	2.65
3	Soya sauce	0.96	1.60	0.01
4	Fish sauce	0.96	2.30	0.02
5	Salt	0.75	0.26	0.001
6	Sugar	1.80	0.70	0.01
7	Sesame oil	1.35	5.00	0.06
8	Canned mushroom	4.50	6.00	0.27
9	Shredded and chopped carrot	9.00	2.00	0.18
10	Wanton skin	7.52	8.00	0.16
	<b>Total</b>	100		6.35

**Table 2g. Sensory attributes of featherback fish mince/ snakehead fish *siew mai***

Sensory attributes	Quality standards
Colour	Yellow wanton skin with white to slight greyish meat filling
Flavour	Seafood flavour
Odour	No objectionable odour
Texture	Firm texture with good clean bite



# Fish tofu

## Product Description:

### Fish tofu

Fish tofu is a product, which blends in fish meat and tofu. It is a unique product that one can relish in both fish and tofu flavours and enjoys the nutritional benefits of both fish and tofu. Commercially the product is usually made from surimi and soy bean. Through R&D, MFRD is able to incorporate featherback fish mince and snakehead fish mince with tofu to make the product. The texture of the product is firm but soft and smooth when eaten. The product can be a delightful dish in Chinese dinner and can be eaten with rice and noodles or stir-fry with vegetables or one can choose to dip in chili sauce and eaten on its own.

### Out line of Processing

The processing method of fish tofu is shown in Figures 3a and 3b. The smooth paste is then filled into sausage/plastic casings to be set at 40°C for 20 minutes. The set fish tofu is then placed in boiling water to cook for 20 minutes. The cooked fish tofu is then cooled in ice water for 30 minutes. The cooled fish tofu is removed of the plastic casing and cut into cubes (eg.2cm length) and deep-fried till golden brown colour.

### 1. Ingredients preparation

The ingredients used are frozen featherback fish mince or frozen snakehead fillets. The frozen fish mince or fillets are thawed at ambient temperature for about 1 hour with the aid of a blowing fan.

#### *Important points on quality control*

- Keep thawed items fresh by chilling

### 2. Cutting

The featherback fish mince or the snakehead fillets are cut into smaller pieces before putting it into the bowl cutter to break up the muscle fibres, followed by addition of salt to solubilise the myofibrillar protein.

#### *Important points on quality control*

- Keep the temperature low (<5°C) during mincing

### 3. Mixing

Add in tofu, starch, MSG and egg white powder into the bowl cutter to mix with the minced fish to achieve a homogenous smooth texture.

#### *Important points on quality control*

- Keep the temperature low (<5°C) during mincing

### 4. Filling

Fill the paste into PVDC sausage casing. Seal the two ends with aluminum wire using manual or automatic clipper.

# Fish tofu *(cont)*

## 5. Setting

Set the formed paste at 40°C for 20 minutes

### *Important points on quality control*

- Ensure the water used for setting is clean to avoid contamination to product

## 6. Cooking

Cook the filled paste in PVDC casing in boiling water (90-95°C) for 20 minutes.

## 7. Cooling

Cool cooked fish tofu in clean running water or chilled water (10°C)

### *Important points on quality control*

- If the water used for cooling is too cold (eg. 0°C), it will cause the product to be shrunken.

## 8. Cutting

Cut cooled fish tofu into length of 2 cm

## 9. Deep frying

Deep-fry (160°C) the dried product till it turned golden brown.

## 10. Cooling

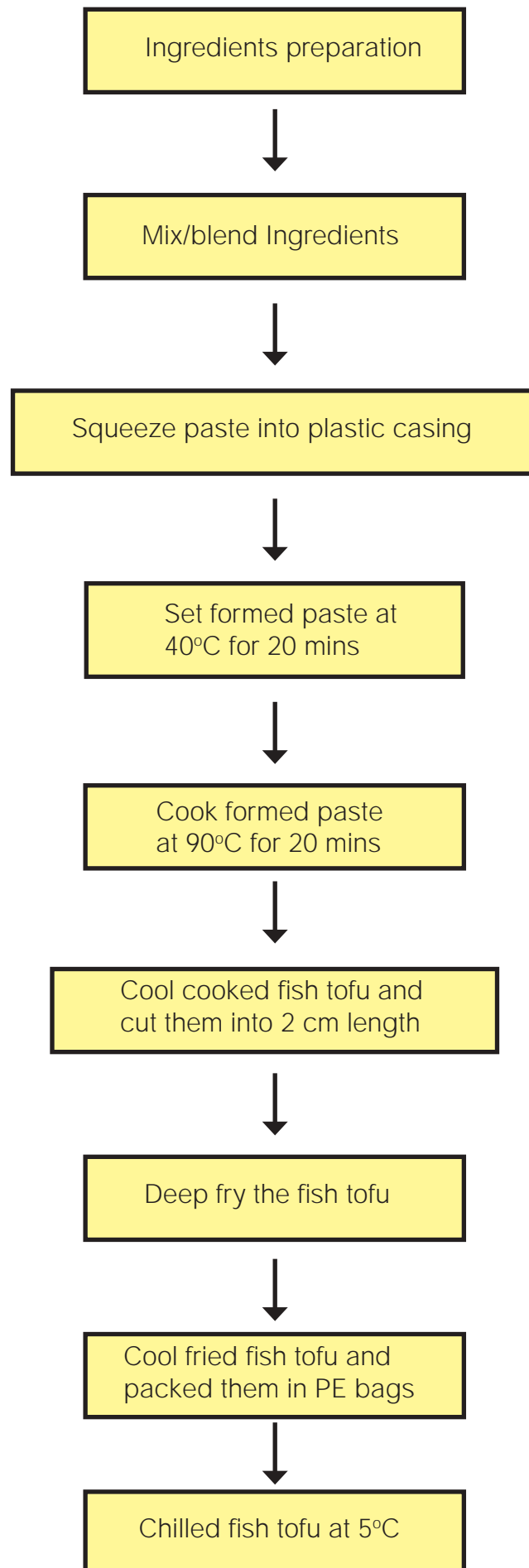
Cool deep fried fish tofu by placing in trays and fan blow it cool.

## 11. Packaging and storage

The fried fish tofu is packed into polyethylene bags, heat-sealed and stored at 5°C.

## Shelf Life Study

During the shelf life study period, both the featherback fish mince and snakehead fish tofu are cooled and packed in polyethylene bags and kept chilled at 5°C. (Tables 3a and 3b) showed that the aerobic count of featherback fish mince and snakehead fish tofu over a period 1 month. Featherback fish mince had an aerobic count of  $2.0 \times 10^3$  cfu/g at week 0 and  $5.0 \times 10^3$  cfu/g at week 3. Snakehead fish tofu had an aerobic count of  $1.5 \times 10^3$  cfu/g at week 0 and  $3.0 \times 10^3$  cfu/g at week 3. The chilled products were microwave for 3 minutes to assess the sensory attributes of the product, (table 3g) showed the sensory attributes of both products. The texture, appearance, colour and flavour of the product showed no significant changes over the storage period. The overall ranking of the product is 8 out of 10, which indicated an overall liking for the product by our panelists.

**Figure 3a. Flowchart for fish tofu processing**



**Figure 3b. Illustrated flow chart for fish tofu processing**



Frozen featherback fish mince



Frozen snakehead fish fillet



1. Raw ingredients



2. Mix/Blend



3. Fill paste into sausage casing



4. Set paste at 40°C for 20 minutes



5. Cook paste at 90°C for 20 minutes



6. Cooked fish tofu, cut into cubes



7. Deep-fry fish tofu at 180°C till golden brown colour



8. Deep-fried fish tofu

**Table 3a. Results of shelf life study of featherback fish mince tofu**

Week	Aerobic Plate Count (cfu/g)
0	$2.0 \times 10^3$
1	$2.0 \times 10^3$
2	$5.0 \times 10^3$
3	$5.0 \times 10^3$

**Table 3b. Results of shelf life study of snakehead fish tofu**

Week	Aerobic Plate Count (cfu/g)
0	$1.5 \times 10^3$
1	$2.0 \times 10^3$
2	$2.0 \times 10^3$
3	$3.0 \times 10^3$

**Table 3c. Formulation of featherback fish mince tofu**

No.	Ingredients	Composition %
1	Featherback fish mince	47.6
2	Tofu	47.6
3	Salt	1
4	Potato starch	2.3
5	MSG	0.5
6	Egg white powder	1
	<b>Total</b>	100

**Table 3d. Formulation of snakehead fish tofu**

No.	Ingredients	Composition %
1	Snakehead fish fillet	47.6
2	Tofu	47.6
3	Salt	1
4	Potato starch	2.3
5	MSG	0.5
6	Egg white powder	1
	<b>Total</b>	100

**Table 3e. Costing of featherback fish mince tofu**

No.	Ingredients	Composition (%)	Cost/Unit (S\$/kg)	Cost of material (S\$/kg)
1	Featherback fish mince	47.6	4.67	2.22
2	Tofu	47.6	0.70	0.33
3	Salt	1	0.26	0.0026
4	Potato starch	2.3	0.75	0.017
5	MSG	0.5	5.00	0.025
6	Egg white powder	1	14	0.14
	<b>Total</b>	100		2.73

**Table 3f. Costing of snakehead fish tofu**

No.	Ingredients	Composition (%)	Cost/Unit (S\$/kg)	Cost of material (S\$/kg)
1	Snakehead fish fillet	47.6	5.85	2.78
2	Tofu	47.6	0.70	0.33
3	Salt	1	0.26	0.0026
4	Potato starch	2.3	0.75	0.017
5	MSG	0.5	5.00	0.025
6	Egg white powder	1	14	0.14
	<b>Total</b>	100		3.29

**Table 3g. Sensory attributes of featherback fish mince and snakehead fish tofu**

Sensory attributes	Quality standards
Colour	Golden brown colour on the exterior and white on the interior
Flavour	Seafood/fish and tofu flavour
Odour	No objectionable odour
Texture	Firm texture with soft and smooth bite

# Fish Crackers

## Product Description:

### Fish Crackers

Fish crackers are commonly available in Southeast Asian countries as a form of snack. In Malaysia, it is known as keropok and in Indonesia it is known as krupuk. However, fish crackers are not commonly found in Cambodia. For this product, MFRD utilize freshwater fish; featherback (*Notopterus spp.*) and snakehead (*Channa spp.*) to make fish cracker. Fish crackers are low density and porous products, which is the result of gelatinization of starch and deep-frying in oil, which eventually ruptures the starch granules. The ingredients in fish crackers generally consist of fish, tapioca flour, sugar, salt and water, which are well mixed to form dough. The dough is then steamed /boiled to gelatinize the starch granules. The cooked dough is then sliced and dried under the sun or in a hot air oven. It is recommended that the product to be dried to 8-9% moisture content, to achieve good expansion when deep-fried. The product can be eaten on its own, served with rice or eaten with dips such as curry.

### Out line of Processing

The processing method of fish cracker is shown in Figures 4a and 4b. The ingredients are mixed in a mixer to achieve a pasty texture. The paste is then filled into a sausage casing, sealed and cooked for 2 hours in boiling water. The product is cooled in running water/tap water before freezing the product at 0°C for 24 hours. The frozen product is then sliced to thickness of 3-5mm and dried at 50°C

for 1 hour followed by 70°C for another 1 hour in a hot air oven. The product is to be dried to 8-9% moisture content . The dried product is then deep fried to achieve maximum expansion before it is ready for consumption.

### 1. Ingredients preparation

The ingredients used are frozen featherback fish mince or frozen snakehead fillets. The frozen fish mince or fillets are thawed at ambient temperature for about 1 hour with the aid of a blowing fan.

### Important points on quality control

- Keep thawed items fresh by chilling them

### 2. Cutting

The featherback fish mince or the snakehead fillets are cut into smaller pieces before putting it into the bowl cutter for mincing.

### Important points on quality control

- Keep the temperature low (<10°C) during mincing

### 3. Mixing

Add in tapioca starch into bowl cutter to mix with the minced fish and ensure starch is well blended with the fish mince to achieve a dry mixture. Next add in sugar, salt, flavoring and water to achieve a pasty texture.

### 4. Filling

Fill the paste into PVDC sausage casing. Seal the two ends with aluminum wire using manual or automatic clipper.

# Fish Crackers *cont*

## 5. Cooking

Cook the paste in PVDC casing in boiling water (90-95°C) for 2 hours.

### *Important points on quality control*

- Ensure thorough cooking of paste by dipping into boiling water. Cooking will ensure the starch is fully gelatinized or else uncooked starches will result in poor expansion of the product when it is being deep-fried.

## 6. Cooling

Cool the cooked paste in clean running water or cold water till product core temperature reaches about 35°C.

### *Important points on quality control*

Ensure cooling water is clean to prevent any possible contamination to the product.

## 7. Freezing

Freeze the cooled paste at 0°C for 24 hours.

## 8. Slicing

Slice the frozen paste to the desired thickness (eg. 4 mm) and placed it on clean metal trays for drying in the hot air oven.

## 8. Slicing

Dry the frozen paste in the hot air oven at 50°C for 1 hour followed by at 70°C for 1 hour.

### *Important points on quality control*

Ensure product is dried to moisture content of 8-9%, continue drying if desired

moisture content is not achieved. High moisture content in product will result in poor expansion of products when deep-fried.

## 10. Deep-frying

Deep fry the dried product till it fully expanded and colour turned white.

### *Important points on quality control*

Ensure product is deep- fried at 180 – 200°C to allow good expansion.

## 11. Packaging and storage

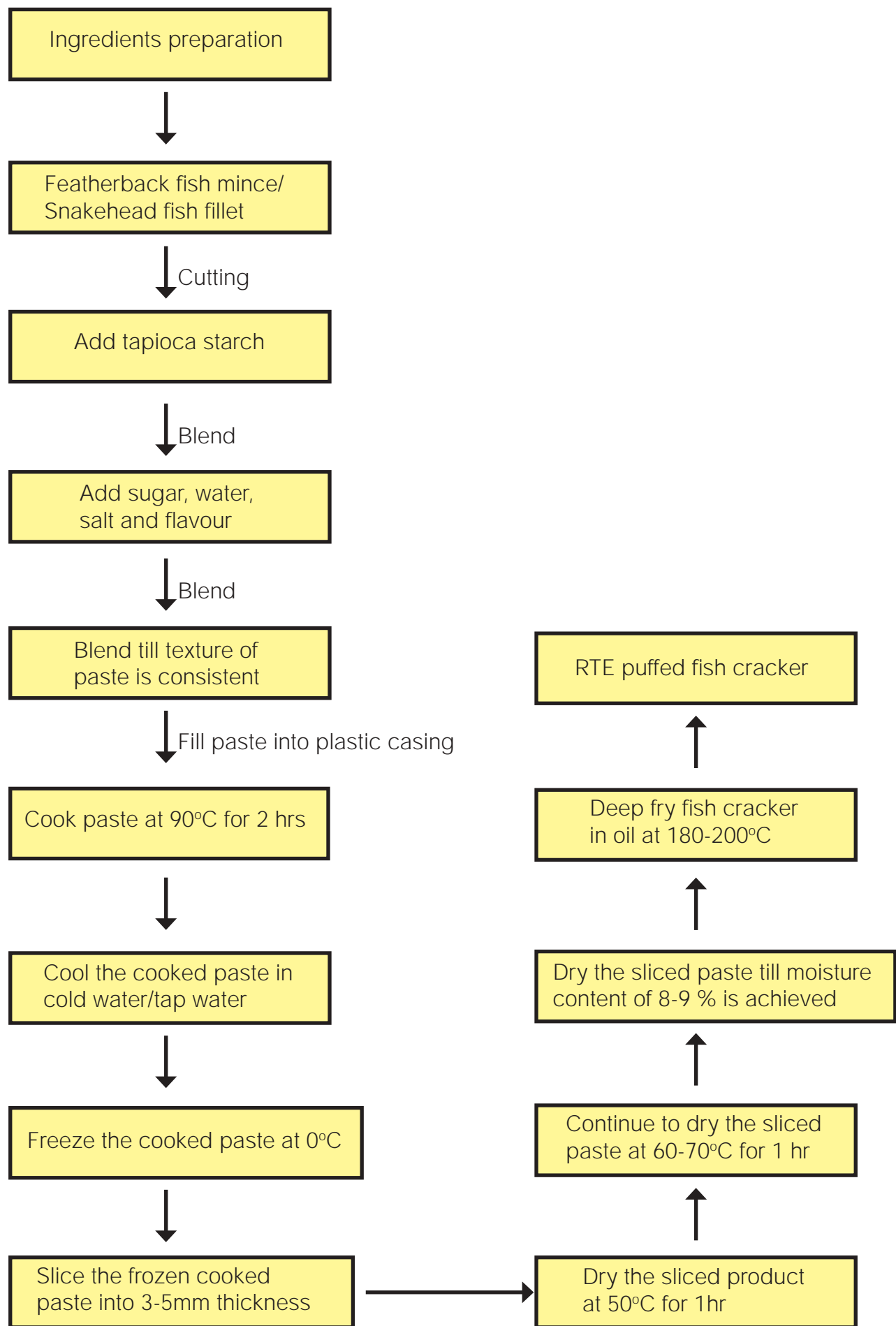
The dried product can be sealed in polyethylene bags or stored in covered plastic/glass jars. The dried product can be stored at ambient or refrigerated temperature.

## Shelf Life Study

During the shelf life study period, both the featherback fish mince and snakehead fish cracker were packed and sealed in polyethylene bags and stored at 5°C, showed no aerobic and yeast and mould count detected from week 0 to week 23 (6 months), (tables 2a and 2b). The average water activity of the featherback fish mince cracker and snakehead fish cracker was both 0.55 (tables 2a and 2b). For sensory evaluation, the dried product was deep fried each time to assess the sensory attributes of the product, (table 4g) showed the sensory attributes of both products. The texture, appearance, colour and flavour were consistent through the storage period.



**Figure 4a. Flowchart for fish cracker processing**





**Figure 4b. Illustrated flow chart of fish cracker processing**



Frozen featherback fish mince



4. Fill paste into PVDC casing and clip both ends



8. Dry product in hot air oven at 50°C for 1 hr followed by 70°C for 1 hr



Frozen snakehead fish fillet



5. Cook paste in 95°C boiling water for 2 hours



9. Deep fry the product at 180°C



1. Ingredients preparation; tapioca starch, salt, sugar, flavouring and fish



6. Blast freeze the cooked paste



10. RTE Fried Fish crackers



2. Mix fish and other ingredients in mixer



7. Slice frozen paste to 4 mm thickness

**Table 4a. Results of shelf life study of featherback fish mince cracker**

Week	Aerobic Plate Count (cfu/g)	Yeast and Mould Count (cfu/g)	Anaerobic plate Count (cfu/g)	Water Activity
0	0	0	0	0.55
1	0	0	0	0.53
2	0	0	0	0.55
5	0	0	0	0.54
8	0	0	0	0.53
11	0	0	0	0.55
15	0	0	0	0.55
23	0	0	0	0.56

**Table 4b. Results of shelf life study of snakehead fish cracker**

Week	Aerobic Plate Count (cfu/g)	Yeast and Mould Count (cfu/g)	Anaerobic plate Count (cfu/g)	Water Activity
0	0	0	0	0.55
1	0	0	0	0.54
2	0	0	0	0.55
5	0	0	0	0.55
8	0	0	0	0.53
11	0	0	0	0.55
15	0	0	0	0.55
23	0	0	0	0.56

**Table 4c. Formulation of featherback fish mince cracker**

No.	Ingredients	Composition %
1	Featherback mince	34.82
2	Tapioca starch	34.82
3	Water	25.87
4	Anchovy Flavoring	1.99
5	Salt	1.50
6	Sugar	1.00
	<b>Total</b>	100

**Table 4d. Formulation of snakehead fish cracker**

No.	Ingredients	Composition %
1	Snakehead fish fillet	34.82
2	Tapioca starch	34.82
3	Water	25.87
4	Anchovy Flavoring	1.99
5	Salt	1.50
6	Sugar	1.00
	<b>Total</b>	100

**Table 4e. Costing of featherback fish mince cracker**

No.	Ingredients	Composition (%)	Cost/Unit (S\$/kg)	Cost of material (S\$/kg)
1	Featherback fish mince	34.82	4.67	1.62
2	Tapioca starch	34.82	0.40	0.14
3	Water	25.87	0.00117	0.0003
4	Anchovy Flavoring	1.99	25.00	0.49
5	Salt	1.50	0.26	0.0039
6	Sugar	1.00	1.00	0.01
	<b>Total</b>			2.26

**Table 4f. Costing of snakehead fish cracker**

No.	Ingredients	Composition (%)	Cost/Unit (S\$/kg)	Cost of material (S\$/kg)
1	Snakehead fish fillet	34.82	5.85	2.03
2	Tapioca starch	34.82	0.40	0.14
3	Water	25.87	0.00117	0.0003
4	Anchovy Flavoring	1.99	25.00	0.49
5	Salt	1.50	0.26	0.0039
6	Sugar	1.00	0.26	0.01
	<b>Total</b>		1.00	2.67

**Table 4g. Sensory attributes of featherback fish mince and snakehead fish cracker (Deep-fried)**

Sensory attributes	Quality standards
Colour	Pale white
Flavour	Mild fish flavour
Odour	No objectionable odour
Texture	Light and crispy

# Fish murukku

## Product Description:

### Fish murukku

*Murukku* is a popular vegetarian South Indian snack that is eaten among the South Indian communities all over the world. However, in this project MFRD is able to substitute fish meat into the formula to make fish *murukku*. The product has a slight spicy flavour and it is formed into noodle light strands and is crispy after frying. Cambodia freshwater fish, soldier river barbs (*Cyclocheilichthys enoplus*) were utilized to make the product. The fish mince from soldier river barbs mince were used to substitute 30% of the ingredients in the formulation. The rest of the ingredients include dhal flour, white sesame seeds, cumin seeds, asafoetida powder, cold water and butter. The ingredients are blend together to achieve a slight pasty texture. The paste is then placed into a *murukku* mould to form noodle strands like shapes through compression. The product is then deep fried till golden brown colour. The product can be eaten on its own.

### Out line of Processing

The processing method of fish *murukku* is shown in Figures 5a and 5b. The ingredients are mixed in a mixer to achieve a pasty texture. The paste is then filled into a *murukku* mould, then pressed it out into noodle strands. The formed strands are deep-fried (180°C) to achieve a golden brown colour.

### 1. Ingredients preparation

The ingredients used is frozen soldier river barb fish mince. The frozen fish mince is thawed at ambient temperature for about 1 hour with the aid of a blowing fan.

### Important points on quality control

- Keep thawed items fresh by chilling them

### 2. Cutting

The soldier river barb fish mince is cut into smaller pieces before putting it into the bowl cutter for mincing.

### Important points on quality control

- Keep the temperature during mincing low (<10°C)

### 3. Mixing

Add in the rest of the ingredients to mix uniformly and add water to achieve the right consistency.

### 4. Forming

Filled the mixed paste into a *murukku* mould and formed into desired shapes onto greased aluminum foil.

### 5. Deep frying

Deep-fry the formed product till it turned golden brown.

### 6. Cooling

Cool the deep-fried *murukku* with the aid of a blowing fan.

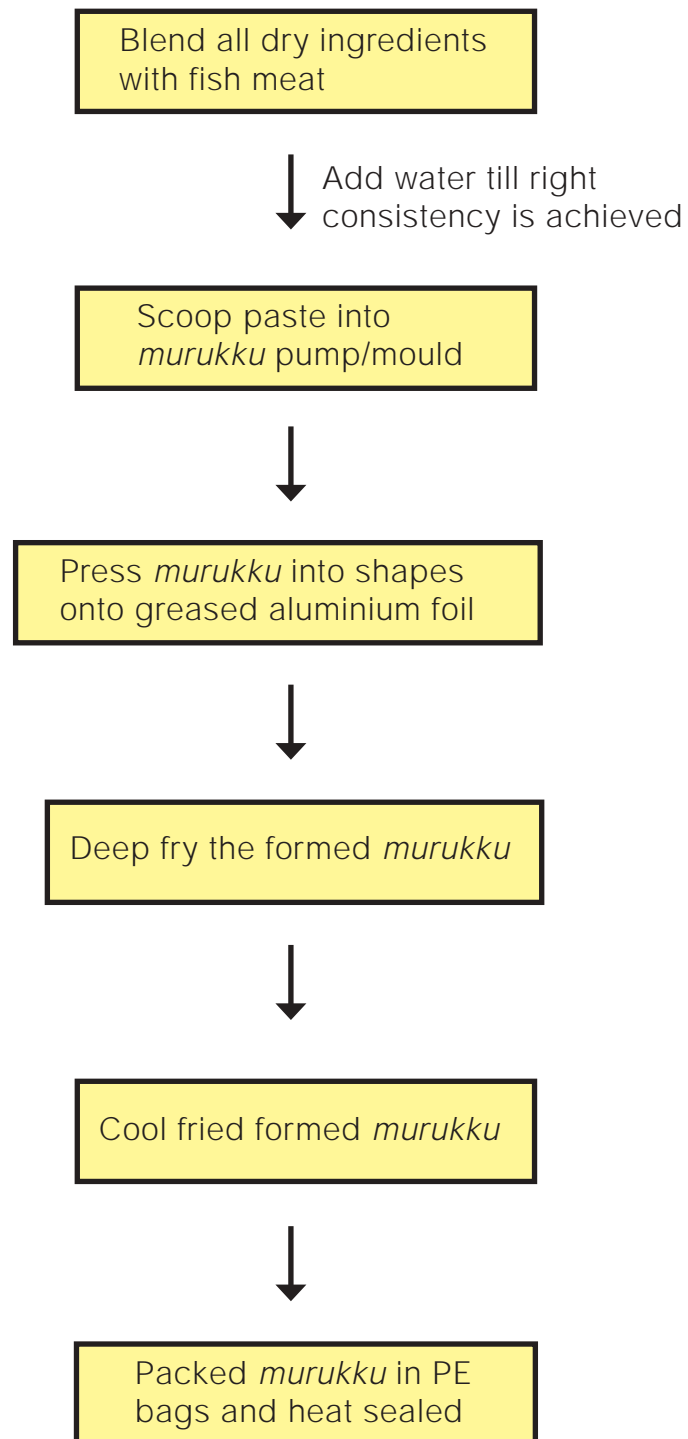
## Fish *murukku* (cont)

### 7. Packaging and storage

The fried product can be sealed in polyethylene bags or stored in covered plastic/glass jars and stored at ambient temperature.

### Shelf Life Study

During the shelf life study period, the deep-fried fish *murukku*, showed no aerobic and yeast and mould count detected from week 0 to week 11 (3 months), (table 5a). The average water activity of the soldier river barb fish *murukku* was 0.30, during the storage period at ambient temperature (table 5a). The peroxide value of the fish *murukku* ranged from 6.75 mEq peroxide/kg fat in week 0 to 7.44 mEq peroxide/kg fat in week 11. The deep-fried product was sensory assessed by opening the packaged product and consumed right away, (table 5d) showed the sensory attributes of the product. There were no signs of rancidity during the sensory test. The other sensory attributes like texture, appearance, colour and flavour showed no significant changes over the storage period. The overall ranking of the product was 7 out of 10, which indicated an overall moderate liking for the product.

**Figure 5a. Flowchart for fish *murukku* processing**

**Figure 5b. Illustrated flow chart for fish *murukku* processing**



Frozen soldier river barb mince



4. Deep-fry *murukku* at 180°C till golden brown colour



1. Ingredients preparation



5. Deep-fried *murukku*



2. Mix/Blend



3. Form paste into desired shapes using *murukku* mould



**Table 5a. Results of shelf life study of soldier river barb fish mince *murukku***

Week	Aerobic Plate Count (cfu/g)	Yeast and Mould Count (cfu/g)	Peroxide value (mEq Peroxide/kg fat)	Water Activity
0	0	0	6.75	0.32
1	0	0	6.75	0.26
2	0	0	8.12	0.30
5	0	0	7.44	0.35
8	0	0	7.44	0.30
11	0	0	7.44	0.30

**Table 5b. Formulation of soldier river barb fish mince *murukku***

No.	Ingredients	Composition %
1	<i>Murukku</i> flour	30.80
2	Cold water	31.80
3	Fish mince	30.00
4	Butter	4.00
5	White sesame seeds	1.20
6	Cumin seeds	1.20
7	Asafoetida powder	0.60
8	Salt	0.40
	<b>Total</b>	100

**Table 5c. Costing of soldier river barb fish mince *murukku***

No.	Ingredients	Composition (%)	Cost/Unit (S\$/kg)	Cost of material (S\$/kg)
1	<i>Murukku</i> flour	30.80	1.0	0.30
2	Cold water	31.80	0.00117	0.0003
3	Fish mince	30.00	7.50	2.25
4	Butter	4.00	8.00	0.32
5	White sesame seeds	1.20	4.00	0.048
6	Cumin seeds	1.20	7.00	0.084
7	Asafoetida powder	0.60	7.00	0.004
8	Salt	0.40	0.26	0.001
	<b>Total</b>	100		3.00

**Table 5d. Sensory attributes of soldier river barb fish mince *murukku***

Sensory attributes	Quality standards
Colour	Golden brown
Flavour	Slight spicy flavour
Odour	No objectionable odour
Texture	Slight hard to crispy

# Fish satay

## Product Description:

### Fish satay

Fish *satay* is a common snack product from Malaysia. It is often made from small demersal marine fish such as the yellow goatfish (*Upeneus sulphureus*). The preparation of fish *satay* involves dressing the fish by; removal of scales, tails and heads followed by a ventral cut towards the caudal region. The entrails, peritoneum and kidney tissues are also removed. The fish is then opened butterfly, removed of the lateral bones and washed thoroughly. The dressed fish are normally sun dried for 3 days to a approximate of 12% moisture content before dipped in thick *satay* sauce and oven dried for 45 minutes to achieve an approximate of 4.7% moisture content. Besides the commercially available fish *satay* made from yellow goatfish, MFRD is able to apply similar processing methods as above to make fish *satay* from soldier river barbs (*Cyclocheilichthys enoplus*) in Cambodia. The fish is dried in the hot air oven followed by grilling process. The product is of light spicy flavour and also has a peanut flavour due to the *satay* sauce applied during seasoning. The texture of fish *satay* is slight crispy and hard when eaten. The product can be eaten on its own.

### Out line of Processing

The processing method of fish *satay* is shown in Figures 6a and 6b. The fish is dressed by; removal of scales and gut, followed by butterfly cut the fish to remove

the lateral bones. The dressed fish is then washed cleaned in chilled water. The washed fish is then laid on sieve trays with sugar coated to the body overnight in the chiller at 5°C. The fish is removed from the chiller the next day and washed clean of the sugar through washing in chilled water. The fish is then dipped in thick *satay* sauce and marinate for 3 hours before putting it in the hot air dryer to dry at 40 to 65°C. The fish is then grilled and ready to be eaten.

#### 1. Ingredients preparation

The raw ingredients used are frozen beheaded soldier river barb, whole and headless. The frozen fish are thawed at ambient temperature for about 1 hour with the aid of a blowing fan. Remove the scales of the fish in chilled water followed by removal of guts by cutting the stomach area away. Butterfly cut the fish and remove the lateral bones. Wash the fish in chilled water.

#### 2. Sprinkling with sugar

Lay the treated fish on sieved metal trays with a holder below and sprinkle sugar on it and leave it chilled at 5°C overnight. This step is both to remove moisture and partial marinating of the fish.

#### 3. Removal of sugar

Remove residual sugar by washing the fish in chilled water.

#### 4. Marinating

Marinate the fish by dipping in thick *satay* sauce for 3 hours.

# Fish satay *(cont)*

## **5. Hot air drying**

Dry the marinated fish in hot air dryer from 40 to 65°C for 2 hours.

## **6. Grilling**

Grill the dried fish for about 3 to 5 minutes

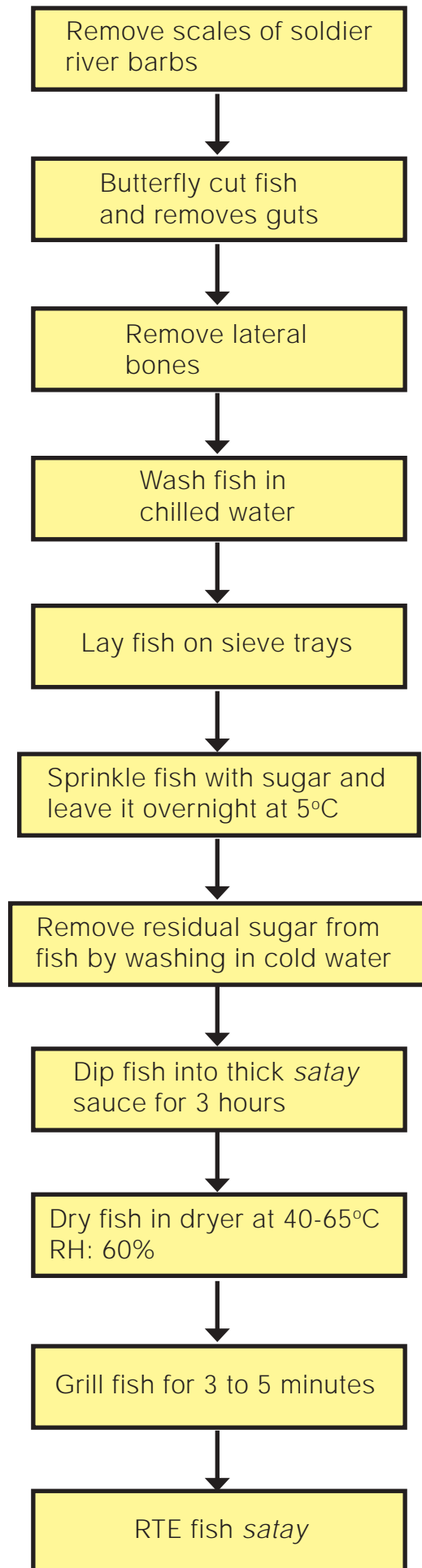
## **7. Packaging and storage**

The grilled fish is cooled before packing into polyethylene bags and heatsealed. Shelf life study of the product showed that by the 5th week, the product started to turn slightly tough and pliable through sensory evaluation. This showed that most likely moisture has gotten into the product. Hence, alternative packaging material may be considered, such as changing the plastic packaging material to polypropylene bags to further limit the permeability of moisture into the product.

## **Shelf Life Study**

During the shelf life study period, the fish satay showed no aerobic and yeast and mould count detected from week 0 to week 5 (1.5 months), (table 6a). The water activity of the product rose from 0.38 in week 0 to 0.47 in week 5 (table 6a). The grilled product was sensory assessed by opening the packaged product and consumed right away, (table 6d) showed the sensory attributes of the product. Through sensory evaluation, the texture of the product showed that it turned from crispy and hard to tough and pliable in week 5. There was slight off flavour, however the color and appearance of the product remained unchanged. Thus, the product failed the shelf life test at week 5. One possible cause of the failure was likely due to packaging material. Alternative packaging material may be considered, such as changing the plastic packaging material from polyethylene bags to polypropylene bags to further limit the permeability of moisture into the product. The overall ranking of the product was 7 out of 10, which indicated an overall moderate liking for the product.

**Figure 6a. Flowchart of soldier river barb fish *satay* processing**



**Figure 6b. Illustrated flow chart of soldier river barb fish satay processing**



1. Frozen soldier river barbs (whole, headless)



2. Removal of scales in chilled



3. Removal of gut, lateral bones and butterfly cut the fish



4. Washed butterfly cut fish



5. Lay dressed fish on sieve trays



5. Ingredients for fish satay ; butterfly cut fish, sugar and satay paste



6. Sprinkle sugar on fish and leave chilled overnight at 5°C



7. Remove sugar from fish by washing it in chilled water



8. Marinate fish in satay sauce for 3 hours



9. Dry marinated fish in hot air oven at 70°C for 2 hours



10. Grill dried fish satay over electric griller



11. RTE grilled fish satay

**Table 6a. Results of shelf life study of soldier river barb fish satay**

Week	Aerobic Plate Count (cfu/g)	Yeast and Mould Count (cfu/g)	Water Activity
0	0	0	0.38
1	0	0	0.40
2	0	0	0.45
5	0	0	0.47

**Table 6b. Formulation of soldier river barb fish satay**

No.	Ingredients	Composition %
1	Soldier river barb (whole headless)	33.33
2	Sugar	11.11
3	Satay gravy	55.55
	<b>Total</b>	100

**Table 6c. Costing of soldier river barb fish satay**

No.	Ingredients	Composition (%)	Cost/Unit (S\$/kg)	Cost of material (S\$/kg)
1	Soldier river barb (whole headless)	33.33	3.34	1.11
2	Sugar	11.11	0.70	0.07
3	Satay gravy	55.55	6.25	3.47
	<b>Total</b>	100		4.65

**Table 6d. Sensory attributes of soldier river barb fish satay**

Sensory attributes	Quality standards
Colour	Roasted brown
Flavour	Satay and mild fish flavour
Odour	No objectionable odour
Texture	Crispy and hard



# *Appendix*

## ***Method References for Shelf Life Study***

## Appendix

### Method References for Shelf Life Study

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