

# Liquid Smoking Of Some Fishery Products

NONGNUCH RAKSAKULTHAI, SIRIMA KIATSRICHART  
and WUTHISAK SANGSIWARIT

*Department of Fishery Products, Faculty of Fisheries  
Kasetsart University, Bangkok, Thailand*

## Abstract

Natural and liquid smoking of striped catfish (*Pangasius sutchi*), chub mackerel (*Rastrelliger brachysonus*), squid (*Loligo edulis*) and green mussel (*Mytilus viridis*) were compared to evaluate the feasibility of liquid smoking of these products.

The appropriate brine concentration and brining time as well as liquid smoke concentration and soaking time for each product were determined. The acceptability of these smoked products was tested by sensory evaluation using a nine-point hedonic scale. The characteristics of the products judged were colour, flavour, odour, texture and overall acceptability. A panel of 14 judges was drawn from the faculty members and students of the Department of Fishery Products, Faculty of Fisheries. The results were statistically analyzed using Student's t-test.

The appropriate brine concentration and brining time for striped catfish, chub mackerel, squid and green mussel were 15% for 7 min; 20% for 30 min; 15% for 10 min and 5% for 4 min, respectively.

The suitable liquid smoke concentration and soaking time for striped catfish and chub mackerel were 10% for 15 min; for squid and green mussel the appropriate concentration and soaking time were 6% for 15 min and 1% for 2 min respectively.

The sensory evaluation scores of both natural and liquid smoked products were comparable. The scores for colour, flavour, odour, texture and overall acceptability of striped catfish, chub mackerel and green mussel were not significantly different.

However, the score for odour of liquid smoked squid was significantly lower than that of natural smoked squid ( $P \leq 0.05$ ) but all other characteristic scores were not significantly different.

## Introduction

Smoking provides desirable colour, flavour and texture to food products but there are evidences that smoking may generate carcinogenic compounds such as polycyclic aromatic hydrocarbon (PAH). Many PAH, especially benzo(a)pyrene which is regarded as an indicator of carcinogenicity, have been found in smoked meat and fish (Sikorski, 1988). According to data compiled by Tilgner and Daun (1969), the amount of PAH in smoked products varies from 0.7-60 ng/g wet weight. The influence of smoking temperature and time on the formation of PAH was observed. Nieto and Orejana (1984) suggested a method for reducing PAH by separating the smoking chamber from the firebox. Reducing the combustion temperature, using smoke filter and controlling flow rate of inlet air will reduce 3,4 benzo(a)pyrene in smoked fish (Chandrasekhar and Kaveriappa, 1985). Studies have shown that PAH are removed in the particulate phase of smoke. Analyses of several liquid smoke preparation have shown that they do not contain PAH especially benzo(a)pyrene (Kramlich, Pearson and Tauber, 1973). It was also reported that liquid smoke still retained antioxidant and bacteriostatic properties (Hollenbeck, 1979). The other advantages of liquid smoking are as follows:

- it does not require installation of smoke generator
- the process is more repeatable as the composition of liquid smoke is more constant.

Although smoked and dried fish is very popular in Thailand, there is no report on liquid smoking of fishery products. The overall objective of this study is to study the feasibility of liquid smoking of some fishery products. The appropriate brine concentration, brining time, liquid smoke concentration and soaking time of each product are also investigated.

## Materials And Methods

### Materials

1. Striped catfish (*Pangasius sutchi*)
2. Chub mackerel (*Rastrelliger brachysonus*)
3. Squid (*Loligo edulis*)
4. Green mussel (*Mytilus viridis*)
5. Liquid smoke (Griffith Laboratories (Thailand) Ltd.)
6. Coconut hull for natural smoking
7. Smoking chamber
8. Hot air oven (Thelco, Model 28)

### Methods

The methods used to prepare the product are as follows:

#### 1. Striped Catfish

The fish was headed, gutted, washed, filleted and cut into pieces of about 4 x 5 cm. Fat was trimmed off as much as possible. The pieces of fish were soaked in 15% brine for 7 min, according to the suggested method of the Fishery Technological Development Division, Department of Fisheries. The ratio of fish to brine was 1 : 2 (wt/vol). The brined fish was divided into 2 parts.

One part was dried and cooked at 60°C for 1 hr, then smoked in the traditional kiln for 1 hr. The fish was turned and smoked for another half an hour. The second part was soaked in 3, 6 and 10% liquid smoke solution for 4, 7 and 15 min. The

ratio of fish to liquid smoke solution was 1 : 1. The fish was drained and cooked at 60°C for 1 hr then at 80°C for another 2 hr.

The flow diagram of the preparation of smoked striped catfish is shown in Fig.1

#### 2. Chub Mackerel

The fish was gutted, washed, soaked in 15 and 20% brine for 15 and 30 min. The ratio of fish to brine was 1:2 (wt/vol). The brined fish was divided into 2 parts. One part was dried and cooked at 60°C for 1 hr and natural smoked as for striped catfish. The second part was soaked in 6 and 10% liquid smoke solution for 10 and 15 min. The ratio of fish : liquid smoke solution was 1:1. The fish was drained and cooked for the same time and temperature as for striped catfish.

The flow diagram of the preparation method of smoked chub mackerel is shown in Fig. 2.

#### 3. Squid

The squid was headed, gutted, skinned, washed, blanched in boiling water for 1 min and drained. The blanched squid was soaked in 10 and 15% brine for 10, 15 and 20 min. The ratio of squid to brine was 1 : 2. The brined squid was divided into 2 parts. One part was natural smoked for 1 hr. The second part was soaked in 3 and 6% liquid smoke solution for 8 and 15 min. The ratio of squid to liquid smoke solution was 1 : 1. The squid was drained and cooked at 60°C for 1 hr and at 80°C for another  $1\frac{1}{2}$  hr.

#### 4. Green Mussel

The mussel was shucked, removed byssus, washed and blanched at 80°C for 1 min. The blanched mussel was soaked in 5 and 10% brine for 2 and 4 min. The ratio of mussel to brine was 1 : 2. The brined mussel was divided into 2 parts. One part was dried and cooked at 60°C for 1 hr and smoked for 1 hr. The second part was soaked in 0.5, 1 and 5% liquid smoke solution for 2 and 4 min. The ratio of mussel to liquid smoke solution

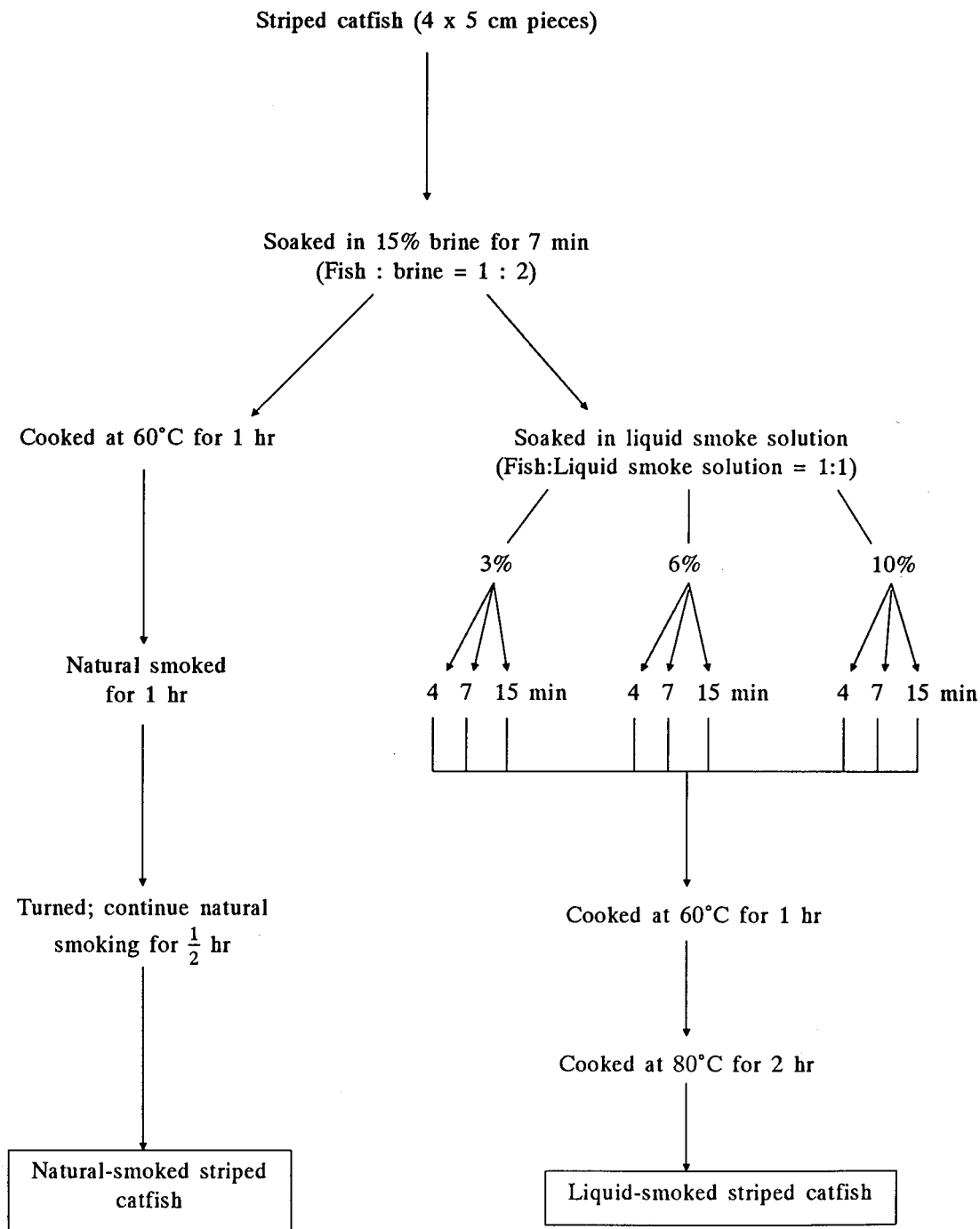


Fig. 1. Flow diagram of preparation method of smoked striped catfish.

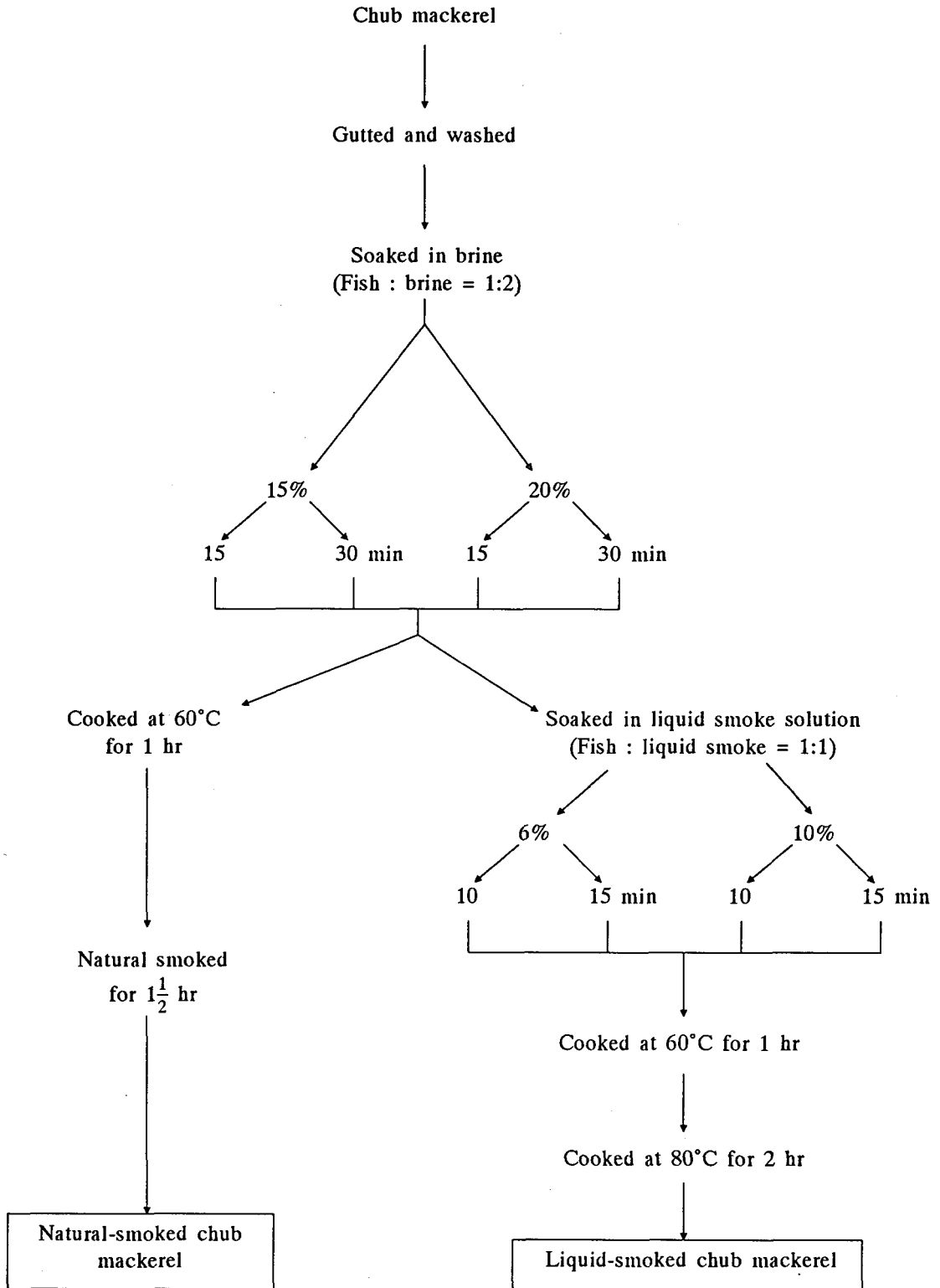


Fig. 2. Flow diagram of preparation method for smoked chub mackerel.

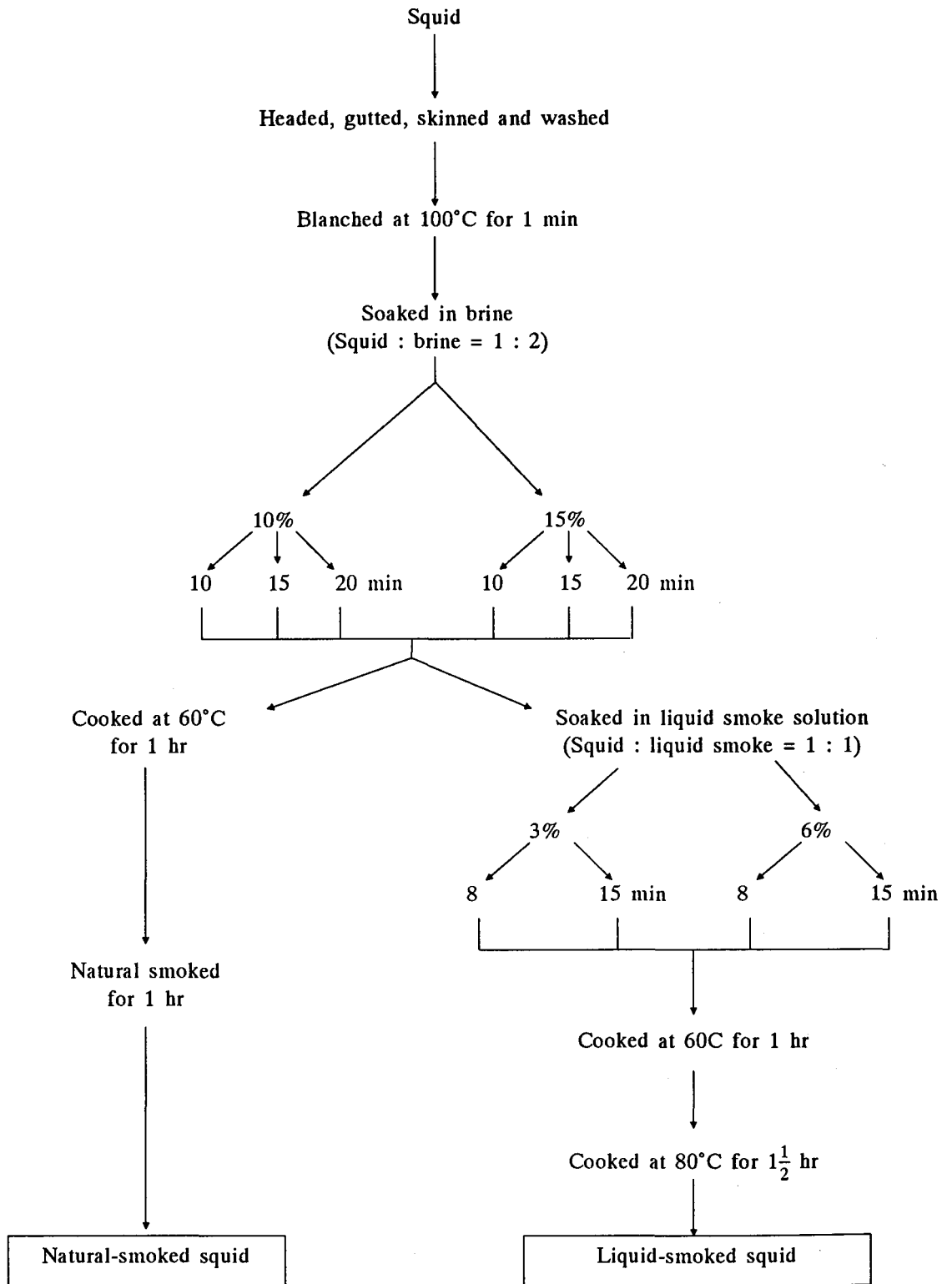


Fig. 3. Flow diagram of preparation method of smoked squid.

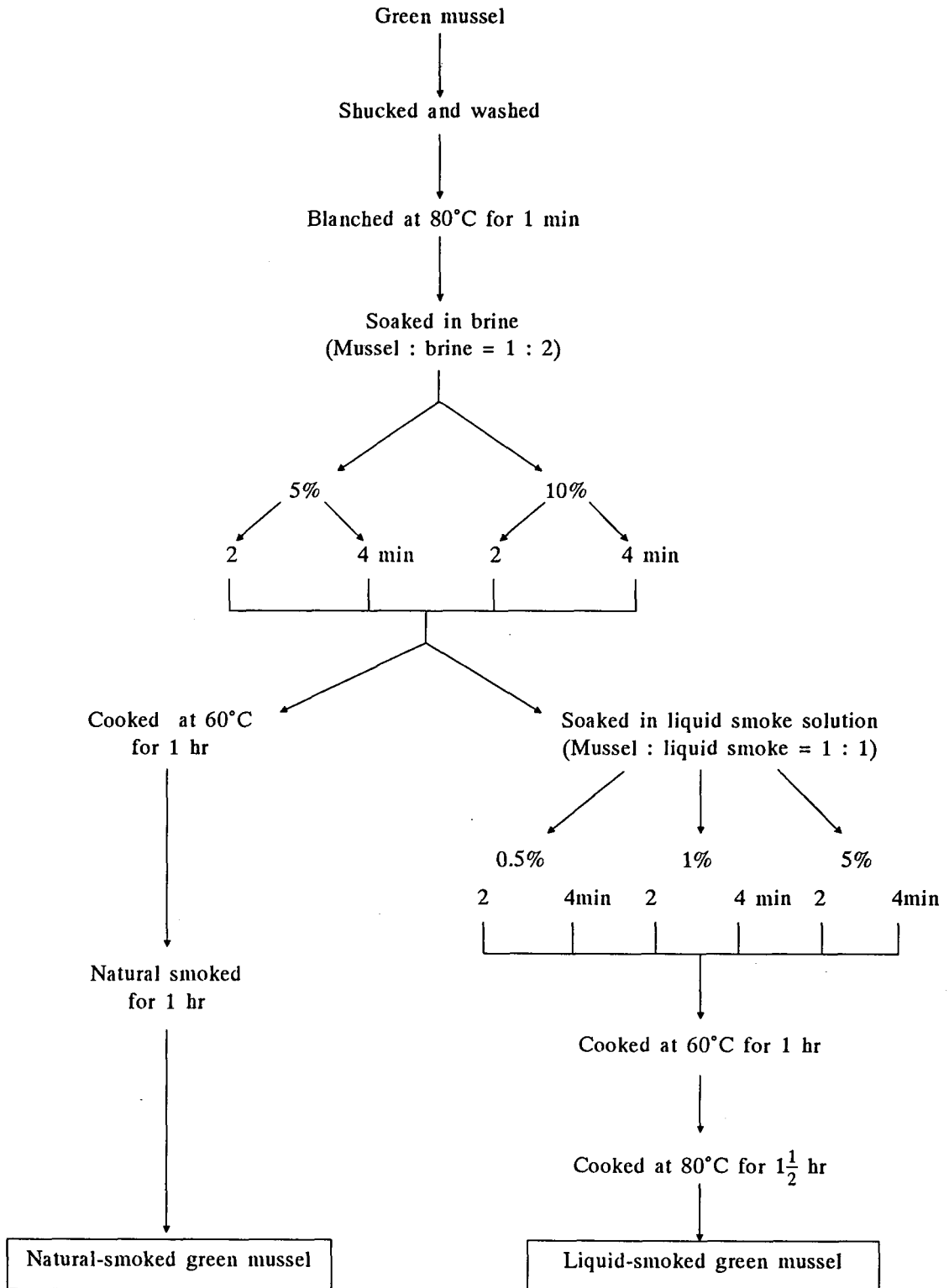


Fig. 4. Flow diagram of preparation method of smoked green mussel.

was 1 : 1 (wt/vol). The mussel was drained and cooked at 60°C for 1 hr and at 80°C for 1½ hr.

The flow diagram of the preparation of smoked green mussel is shown in Fig. 4.

### Sensory Evaluation

Natural and liquid-smoked products were evaluated for preference of colour, flavour, odour, texture and overall acceptability by a panel of 14 faculty members and students of the Department of Fishery Products, Faculty of Fisheries, using a nine point hedonic scale as described by Larmond (1977).

The results were analyzed for statistical significance using Student's t-test.

### Results And Discussion

The appropriate brine concentration, brining time, liquid smoke concentration and soaking time of each product with highest preference score are summarized in Table 1.

The sensory evaluation scores of each product are summarized in Table 2.

It was found that the appropriate concentration and the soaking time of liquid-smoked striped catfish was 10% for 15 min. The product was the most similar to a natural smoked one. The lower concentration or shorter soaking time resulted in a very light colour with lower preference score. The comparison of the natural and liquid smoked products showed no significant difference ( $P \leq 0.05$ ).

For chub mackerel, the salt penetration rate for round fish was lower, thus longer brining time was required. It was found that 20% brine for 30

**Table 1. Appropriate brine concentration and brining time, liquid smoke concentration and soaking time, smoking and cooking time for each product.**

Product	Brine		Liquid Smoke		Cooking Time (min)		Natural Smoking Time (min)
	Conc. (%)	Time (min)	Conc. (%)	Time (min)	60°C	80°C	
<b>Striped catfish</b>							
Natural smoked	15	7	-	-	60	-	90
Liquid smoked	15	7	10	15	60	120	-
<b>Chub mackerel</b>							
Natural smoked	20	30	-	-	60	-	90
Liquid smoked	20	30	10	15	60	120	-
<b>Squid</b>							
Natural smoked	15	10	-	-	60	-	60
Liquid smoked	15	10	6	15	60	90	-
<b>Green mussel</b>							
Natural smoked	5	4	-	-	60	-	60
Liquid smoked	5	4	1	2	60	90	-

**Table 2. Sensory evaluation score of natural and smoked products.**

Product	Sensory evaluation score <sup>1</sup>				
	Colour	Flavour	Odour	Texture	Overall Acceptability
<b>Striped catfish</b>					
Natural smoked	7.24	7.27	7.14	7.28	7.18
Liquid smoked	7.33	6.33	6.67	7.17	6.97
<b>Chub mackerel</b>					
Natural smoked	6.64	6.57	6.96	6.93	6.86
Liquid smoked	7.00	6.71	6.71	6.14	6.73
<b>Squid</b>					
Natural smoked	7.50	5.93	6.64a <sup>2</sup>	6.46	6.50
Liquid smoked	6.57	5.93	5.78b	6.43	6.14
<b>Green mussel</b>					
Natural smoked	6.78	6.57	6.36	6.14	6.28
Liquid smoked	6.85	6.62	6.62	6.92	6.85

<sup>1</sup> Hedonic scale 1 = extremely dislike, 9 = extremely like

<sup>2</sup> Values in the same column followed by different letter are significantly different ( $P \leq 0.05$ )

min was suitable. The colour of liquid-smoked striped catfish was darker than smoked chub mackerel when the same liquid smoke concentration and soaking time (10% for 15 min) were used. It appeared that liquid smoke was better bound to flesh than to skin. Statistical analysis of preference scores showed no significant difference between natural and liquid smoked chub mackerel.

Liquid smoked squid was not different from natural smoked squid in colour, flavour, texture and overall acceptability but was significantly lower in odour ( $P \leq 0.05$ ). The appropriate brine concentration and brining time and liquid smoke concentration and soaking time were 15% for 10 min and 6% for 15 min, respectively.

The appropriate brine concentration, brining time and liquid smoke concentration and soaking time for green mussel were 5% for 4 min and 1%

for 2 min, respectively. The colour of green mussel is darker than other raw materials, thus did not require high liquid smoke concentration.

### Conclusion

It can be concluded that it is possible to liquid-smoke some fishery products. Apart from reduction of PAH, liquid-smoked products were reported to contain lower nitrosamine (Theiler, Sato, Aspelund and Miller, 1984). Further study should be carried out to compare the cost of production using liquid smoke and natural smoke, determine PAH and nitrosamine content in both products and to investigate shelf-life of each product at different storage temperatures.



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## Discussion

Asked whether the composition of liquid smoke is known, Dr Nongnuch replied that it is a commercial product and that the composition is not known.