

PROCESSING OF NON-COMMERCIAL AND LOW-COST FISH IN MALAYSIA

by

Q.L. Yeoh and Z. Merican
MARDI, Serdang
Selangor, Malaysia

Abstract

Traditional methods of processing surplus and low-cost fish in Malaysia include drying, smoking and fermentation. These traditionally processed products include dry and/or salted sea foods (fish including *Stolephorus* sp., prawns, shrimps, cuttlefish, squids, shellfish, jellyfish), smoked fish, 'pickled' shrimps (cencalok), fermented shrimp paste (belacan), concentrated prawn extract (heko), fermented fish sauce, fish balls and fish cakes.

Conversion of the prawn by-catch into fish meal is faced with the problem of high capital outlay for fishmeal plants, transportation and handling of the by-products and the quality of the by-catch and the finished meal.

A simpler and more economical method of processing the by-catch into silage for animal feed has been successfully demonstrated. This method makes use of a lactic acid fermentation system and is recommended for use in fishing villages.

INTRODUCTION

In Malaysia, traditional methods of preserving non-commercial fish include drying, smoking and fermentation. With the introduction of trawling, the amount of non-commercial fish has increased tremendously. It has been estimated that about 60 percent of the fish caught falls into this category (Kamari *et al.*, 1977).

It is, therefore, essential that the use of the by-catch be maximized to counter-balance the increasing cost of fishing operations. Some of this fish is, at present, preserved by drying or fermentation but, usually, only on a cottage industry scale. The fermentation process normally involves the use of high proportions of salt and the market for these types of products is rather limited.

A large proportion of this fish is converted to fish meal but this is possible only in areas where the non-commercial fish is concentrated in one area, as a large and regular supply of the fish is essential. The setting-up of a fishmeal plant also involves large capital outlay. Work has, therefore, been initiated to study the possibilities of converting this by-catch to fish silage for animal feed.

TRADITIONAL PRODUCTS

Traditional products processed by fermentation include belacan, budu and cencalok, while those preserved by salting and/or drying are salted and/or dried sea products (which include fish, squids, sepia, jellyfish, shellfish, prawns). Heko (a concentrated prawn extract), fish balls and fish cakes are primitively processed, while smoked fish has only been recently introduced for the Japanese market.

Belacan

Belacan or shrimp paste is a traditional preparation of salted and fermented minced shrimp of a tiny *Acetes* species. It is a thick, salty paste having a strong pungent odour of shrimp and a colour ranging from greyish pink to greyish purple. It is well established as one of the main condiments in Malaysian cuisine and is normally added as a flavouring ingredient in most spicy foods, especially seafood. However, the acceptance of

shrimp pastes, like the fish sauces, is an acquired taste and requires cultivation. The amount consumed varies with the individual but it is well accepted by all, irrespective of their social and economic status. Because of its high salt content, only small quantities can be consumed at each meal but, in the rural areas, this is often one of the most important sources of protein. It is also popular in the neighbouring countries and is known by different names: kappi in Thailand, ngapi ni Burma, trassi in Indonesia.

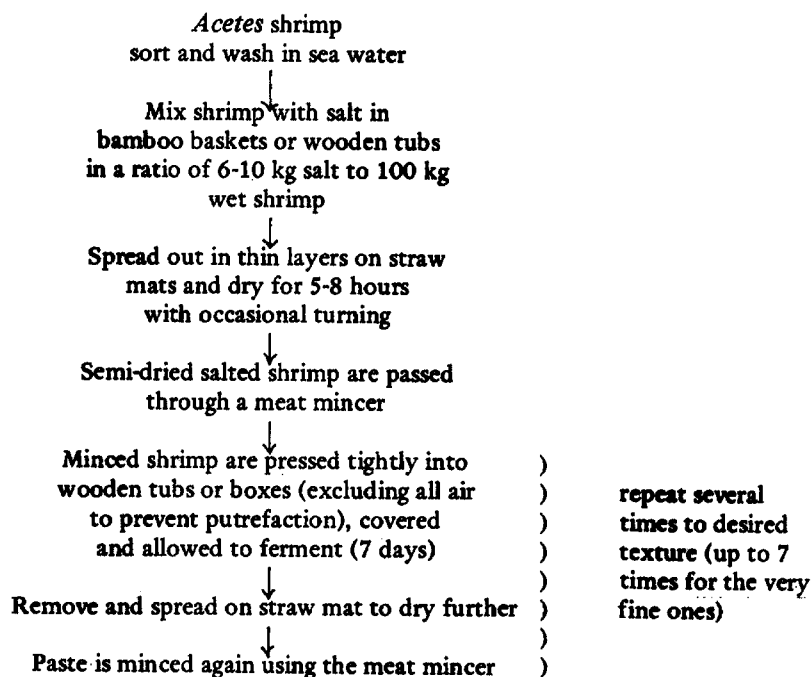
Methods of preparation

The production of belachan is still a thriving cottage industry along the coast of several states, especially Penang. Production is still largely a family concern. The utensils and equipment required include a meat mincer or wooden pestle for pounding, wooden tubs with covers, straw mats, bamboo trays, wooden stands and a drying area which is usually on the beach.

The main raw material is the *Acetes* shrimp. Although the genus *Acetes* (Milne-Edwards) is a minor crustacean group represented by a few species, it supports a subsistence fishery of some considerable importance in Malaysia. There are four important species which appear in very large swarms in the brackish shallow inshore coastal waters, with a salinity of 0.3 percent or less during certain seasons of the year (Pathansali, 1966). The nets used to catch these tiny shrimp include push and beach nets, small purse seines and stake traps. A greater part of the catch is processed into belachan. In Penang and the northwest coast of Peninsular Malaysia where most of the belachan factories are situated, the species normally found are *A. japonicus* (Kishinouye) and *A. sibogae* (Hau- sen). *A. erythraeus* (Nobili) is found exclusively on the east coast while *A. indicus* (Milne-Edwards) is found in the southern seas of Peninsular Malaysia.

The shrimp is heavily salted; salt forms the only other main ingredient. Some processors add artificial colouring or red rice to make their products more attractive.

It is suspected that the tissues undergo enzymic breakdown during the fermentation since fermentable carbohydrate is very low in the shrimp. Bacterial action, which may or may not assist in proteolysis, is assumed to play an important role in flavour development. The method of preparation is shown in Fig. 1.



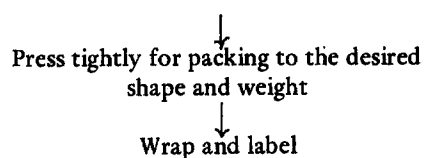


Figure 1 Flow chart of belachan production

During fermentation, the tiny gritty shrimp is transformed into a fine meaty paste which has a characteristic strong pungent fishy odour. The following table summarizes the chemical composition of belachan. Since there is no control exercised over its process, the range and inconsistency between samples is wide.

Table 1
Composition of belachan^{a/}

pH	7.2–7.8
% Ash (including salt)	20–27.6
% Moisture	27–40
% Total sugar	0.5
% Salt (NaCl)	13–25.3
% Fat	1.4–2.6
% Protein	28.7–40
% Calcium	2–3.4
% Iron (Fe)	0.02
% Thiamine	Trace
% Riboflavin	0.001
% Niacin	0.004

a/ Source: Chong, Nutrition Division, IMR, Kuala Lumpur and Chia, MARDI, Serdang (unpublished data)

There are very few licensed factories but many small backyard manufacturers in the fishing villages and rural areas. An estimate, in the State of Penang, puts the number of these 'factories' at 30, scattered throughout the state. In 1971, Peninsular Malaysia exported 4 074 tonnes of belachan valued at U.S.\$ 469 079^{1/}. Most of it went to Thailand, Singapore, the Netherlands and Hong Kong.

Budu

Budu or fish sauce is a clear liquid ranging from amber to dark brown in colour which is rich in salt and soluble nitrogen compounds. Budu is known only to Malays of the eastern states of Peninsular Malaysia comprising Kelantan, Trengganu and Pahang and processing is limited to this region. It is used in almost every home as a condiment in place of soy sauce. It can be used to add a salty taste to spicy dishes or used as a dip with hot chillies. Outside these three states the sauce is almost unknown. The fermentation is usually carried out at certain months of the year when there is an abundance of anchovies.

Method of preparation

The only utensils required are a cylindrical cement tank with a cover for fermentation, a large cauldron, a fireplace to boil the fermented sauce, filling buckets, wooden paddles, spoons and a manual corking device. Capital outlay is small and ranges perhaps from M.\$ 200–1 000,^{2/} depending on the scale of production.

1/ Source: Statistics Dept.

2/ M.\$ 1 = U.S.\$ 0.42

The basic ingredient is anchovies, locally known as ikan bilis (*Stolephorus* sp.) which come from the surrounding fishing villages. Five types are recognized and these are named bilis tembaga, bilis jalor, bilis mayam, bilis puteh and bilis sungai, according to their morphology and locality.

Other ingredients include salt, lime or tamarind and palm sugar. The fish are sorted, washed and mixed with salt in the ratio of 3:1 and allowed to ferment anaerobically in closed containers. Some manufacturers add tamarind juice or lime and palm sugars to the above mixture before fermentation. The substrate is left for several months (6 months-2 years) for proteolysis to take place. When the product is mature, as indicated by a film of oil on top of the liquid mash, it is harvested, boiled in an open cauldron, cooled, filtered and bottled. Fig. 2 is the flow chart showing the method of preparation. Since these products are not properly pasteurized, microbiological post-process contamination can cause spoilage of the product and the shelf-life is shortened.

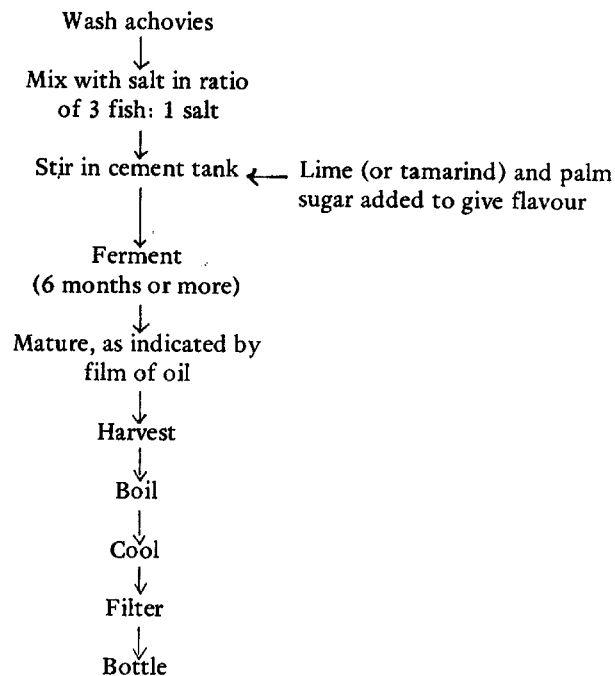


Figure 2 Flow chart for budu production

The fermentation pathway is still being investigated by several workers. It is assumed that when no fermentable carbohydrate is added to the fish salt mixture, the fermentation is affected by the enzymes of the fish. However, the microflora may be necessary for the development of aroma and flavour. When palm sugar is added (as done by some processors), the fermentation could be affected by both fish and microbial enzymes. The composition of budu is shown in Table 2.

Table 2

Composition of budu^{a/}

pH	5.4–6.2
% Ash (including salt)	18.3–20.9
% Acidity (as acetic acid)	0.4–0.9
% Moisture	54.8–76.0
% Total sugar	0–7.42
% Salt (NaCl)	21.7–28.15
% Fat	0.2–1.0
% Protein	5.8–11.5
% Calcium	10.2
% Iron (Fe)	0.4
% Vitamin B ₁	0.004
% Vitamin B ₂	0.010
% Niacin	0.20

a/ Source: Chong, Nutrition Division, IMR, Kuala Lumpur and Chia, MARDI, Serdang (unpublished data)

Due to the mobility and migration of communities from one location to another, fish sauce is being introduced to the other localities as well and is gradually gaining acceptance by the other communities.

Cencalok

Cencalok (pronounced chenchalok) or pickled *Acetes* shrimp, somewhat similar to bagoong from the Philippines, is made only in the southern Malaysian state of Malacca and is popular only with people in that locality. The product is a suspension of tiny pink shrimp in sauce and tastes salty with a very strong shrimp smell. Fig. 3 shows a flow chart of the operation.

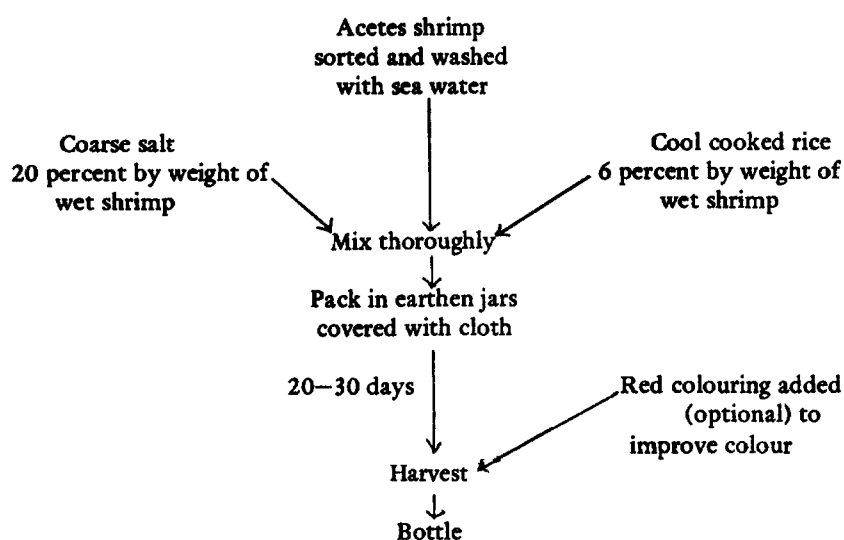


Figure 3 Flow chart for cencalok production

During the vigorous fermentation stage, the brine overflows and attracts flies, often resulting in maggot infestation. Thus, the hygiene and sanitation aspect of this and other fermented fish industries leaves much to be desired.

Fish balls and fish cakes

The product is made on a small scale and is a flourishing backyard industry among Malaysians of Chinese origin. The fish normally used are either the wolf herring (*Chirocentrus dorab*), locally known as parang, or the tenggiri, i.e., Spanish mackerel (*Scomberomorus guttatus* and *S. commersoni*). A summary of the methods generally used is shown in Fig. 4.

The ingredients added by commercial enterprises are to reduce cost. Sodium borate, although not allowed by the Malaysian Food and Drug laws, is detected in some samples and its function is believed to increase the rubbery texture of the product. Polyphosphate is added to increase the water retention properties of the fish while monosodium glutamate adds flavour and starch increases the bulk. It has been claimed that, by using fish meat alone, the rubbery texture can be attained by 'bouncing' the kneaded dough thoroughly.

Though the two fish named above are medium-priced fish, it is hoped that non-commercial fish with the same properties can be utilized for fish ball or fish cake production.

Dried and/or salted fish

The number and types of dried/salted seafoods range from jellyfish to excess commercial fish. The most popular dried/salted fish is bilis (anchovies). Anchovies are boiled in 30 percent brine on board boats immediately after catching. They are then brought ashore and sun-dried on mats on raised platforms or directly on the ground. Jellyfish are stacked in alternate layers of salt and fish for a few days, then soaked in a solution of brine and metabisulphate to decolourize the product. The thin layers are then dried slowly in stacks under a shade. Sidaway and Balasingam (1971) reported the methods of drying fish which are commonly practised in Malaysia.

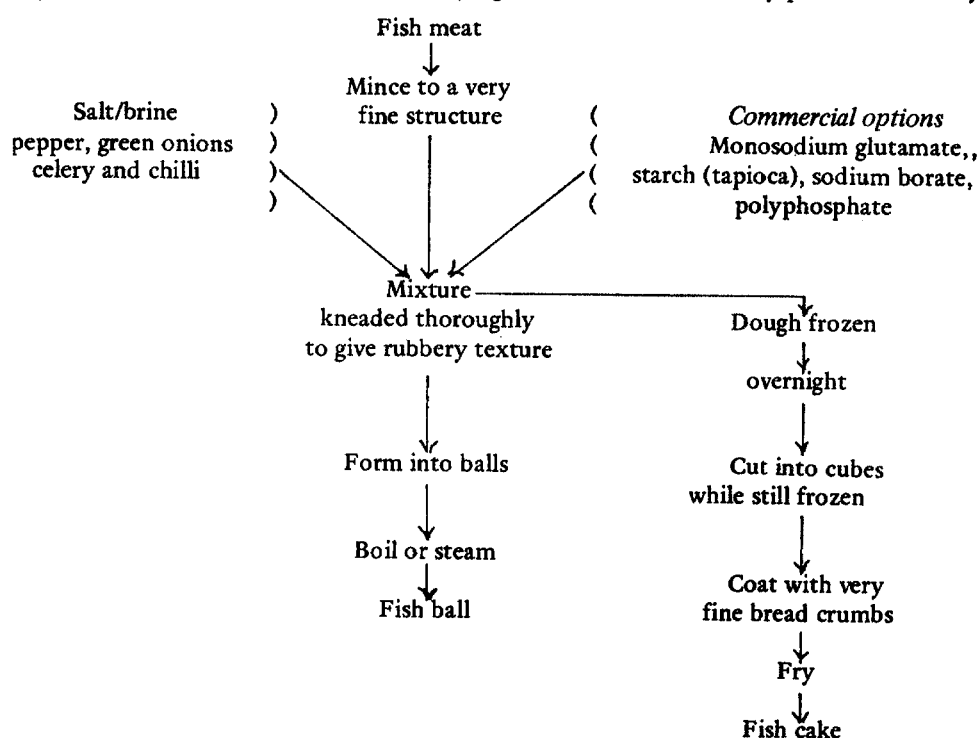


Figure 4 Flow chart for fish ball or fish cake production

Heko

Heko is a concentrate of prawn extract made in the northern state of Penang by Malaysians of Chinese origin. Extract of whole prawns and sometimes fish is concentrated by boiling to a very thick viscous consistency. Other ingredients such as sugar and flour may be added to aid thickening. This concentrate is used as condiments in fish dishes. The product is described in more detail by Sidaway and Balasingam (1971).

Kerupuk

Kerupuk (fish/prawn cracker) is a popular snack among Malaysians. It is made from deboned fish or prawns, tapioca or sago flour and salt thorough kneaded into a dough. The dough is steamed, cut and sun-dried (Sidaway and Balasingam, 1971).

Fish meal and fish manure

Fish meal and fish manure are the only outlet for trash fish at the present time. Because of seasonal fluctuations, long distances from fishing ports (thus affecting quality of the fish) and limited capacity, a high proportion of trash is wasted. Since this subject is dealt with in another paper at this meeting (Idrus *et al.*, 1978), an alternative, new non-traditional method of processing by-catch is presented.

Fish silage

Although the principle of ensilage has been practised in Europe for many decades, there has been little interest in the application of this technique in Malaysia until recently. Current areas of research include the ensiling of pineapple waste, cattle droppings, chicken manure and trash fish for conversion to animal feed. Our research has concentrated on the utilization of trash fish only, though the use of pineapple waste as an alternative carbohydrate source to cassava appears to have potential.

It is envisaged that the ensiling process will be initiated on the trawlers and continued at the fishing villages. The level of technology employed must, therefore, be simple, inexpensive and safe. For these reasons, we have concentrated on a fermentation method which does not involve the dangers of handling strong acids. Furthermore, the cost is less as it is not necessary to use acid-resistant containers, to purchase expensive organic acids, or to neutralize the silage before feeding to the animals (Disney *et al.*, 1977).

The underlying principle of this method of preserving the proteinaceous material is the rapid lowering of the pH due to the production of lactic acid by the lactic acid bacteria. The resultant pH is unsuitable for the growth and survival of pathogens and putrefactive bacteria, thus preservation is achieved (von Hofsten and Wirahadikusumah, 1971). It has also been found that addition of suitable carbohydrates will improve the fermentation (Nilsson and Rydin, 1963). A source of amylolytic enzymes to hydrolyze the starch to fermentable sugars is also essential. For our work, we have tried to make use of cheap, locally available raw materials only; the method is as follows. Whole fish are washed and minced finely using a meat chopper. This is then mixed with a pre-determined quantity of ground cassava flour. A local starter, *ragi* which contains strains of amylolytic fungi (Stanton and Yeoh, 1977) is then added, together with an inoculum of lactic acid bacteria produced by a sauerkraut-equivalent fermentation. The whole mixture is packed into air-tight containers, kept at room temperature (28°-30°C) for the fermentation process.

We have also found that, by the addition of 3-4 percent salt, the proportion of fish to carbohydrate can be increased significantly. This is important if the process is to be started on board ship as it would reduce the quantity of raw materials that have to be taken out to sea. The salt appears to serve three main functions. It helps to eliminate the non-salt tolerant organisms. Secondly, it helps to lower the water activity of the silage, thus contributing to the shelf-life of the final product. Thirdly, it makes conditions more favourable for the desired lactic acid bacteria which grow well under halophilic conditions.

Table 3 gives a summary of the formulations of some of our successful trials. Details of our trials have been reported earlier (Yeoh *et al.*, to be published).

Table 3

Silage formulations

Ingredients (%)	Trial numbers			
	I	II	III	IV
Fish	50	60	80	80
Cassava	50	40	20	20
Ragi	5	5	5	5
Starter culture	2	2	2	2
Salt	0	0	4	5

The finished product is a semi-solid mixture which can be fed direct to animals or dehydrated before feeding. After dehydration, analysis of the 4 percent salt-assisted fermentations showed that it contained 6.4 percent moisture, 33.9 percent crude protein and 7.6 percent lactic acid with a pH of 4.4. This dehydrated silage was then used for preliminary feeding trials on rats. The results show that, over a three-week period, the weight gain showed little difference from the control group and the silage appeared to have no toxic effect on the animals (Yeoh *et al.*, to be published). However, feeding trial experiments carried out in other countries have shown rather conflicting results. More work has to be carried out with our samples before any conclusion can be drawn.

Thus the data compiled so far seem to indicate that this process has potential for adaptation at cottage industry level for the preservation of non-commercial fish.

CONCLUSION

This paper briefly describes some of the traditional methods used in Malaysia for the utilization of low-cost fish. It also reports a new method for the preservation of fish by the process of ensiling which appears to have potential for the by-catch in this region. The use of all these methods will maximize the utilization of the low-cost and non-commercial fish in Malaysia and contribute significantly to the salvaging of good protein which is at present wasted.

ACKNOWLEDGEMENTS

The authors wish to acknowledge the assistance given by their colleagues and the laboratory staff. The continued interest of our Head of Division and the kind permission of the Director General of MARDI are greatly appreciated.

REFERENCES

- Disney, J.G., I.N. Tatterson and J. Olley, Recent developments in fish silage. *In* Proceedings of the Conference 1977 on the handling, processing and marketing of tropical fish. London, Tropical Products Institute, pp. 237-40

- von Hofsten, B. and S. Wirahadikusumah, Preservation of fish and other protein-rich products by lactic acid fermentation. *In* Waste recovery by micro-organisms, edited by W.R. Stanton. Kuala Lumpur, Malaysia, Dewan Bahasa dan Pustaka, Unesco/ICRO Work Study, pp. 63-72
1971
- Kamari, A., A.Z. Idrus and Z. Merican, The handling and transportation of fish in Malaysia. *In* Proceedings of the Conference on the handling, processing and marketing of tropical fish. London, Tropical Products Institute, pp. 115-9
1977
- Nilsson, R. and C. Rydin, Fermentation as a means of preserving organic materials. *Acta Chem.Scand.*, 17:73-9
1963
- Pathansali, D., *Acetes* (Sergestidae) from Malay Peninsula. *Bull.Ike Natl.Mus.Singapore*, 33. Part 8 pp. 59-63
1966
- Sidaway, E.P. and M. Balasingam, Fish processing industry in West Malaysia. Kuala Lumpur, Division of Food Technology, Ministry of Agriculture and Fisheries
1971
- Stanton, W.R. and Q.L. Yeoh, Low salt fermentation method for conserving trash fish waste under South-East Asian conditions. *In* Proceedings of the Conference on the handling, processing and marketing of tropical fish. London, Tropical Products Institute, pp. 277-82
1977
- Yeoh, Q.L., W.R. Stanton and T.K. Murkerjee, Production of fish silage for animal feed. *In* Proceedings of the Symposium on feedingstuffs for livestock. Kuala Kumpur, Malaysia (to be published)